DOE/CE-0154
(Previous No. DOE/ER-0241)

ENERGY MATERIALS COORDINATING COMMITTEE (EMaCC)

Fiscal Year 1985

May 1986

ANNUAL
TECHNICAL REPORT

U.S. Department of Energy
Office of Assistant Secretary for Conservation
and Renewable Eenergy
Office of Transportation Systems

DOE F 1325.8
(12-84)

United States Government **Department of Energy**

memorandum

71
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Thanks / el

DATE: June 6, 1986

REPLY TO
ATTN OF: ER-132

SUBJECT: Reconciliation of Materials Research Funds Reported in the EMaCC 1985 Annual Report and Reported to OMB on April 9, 1986

TO: L. C. Ianniello

Page 7 of the 1986 EMaCC Annual Report contains the FY 1985 budget summary for EMaCC DOE materials activities compiled by DHR, Inc., the contractor who put the EMaCC report together. The total amount is $496,621,000. The amount reported to OMB for FY 1985 based on my survey was $403,189,400. The difference, $93,431,600 can be explained as follows:

The differences of $1,039,600 in Conservation and of $5,219,000 in Renewable Energy are due to the more restricted definition of materials research used for the OMB table. EMaCC is reporting materials activities which includes some development work.

In the Office Research line, the difference of $7,900,000 is due to the inclusion of the SBIR materials research in the total. In the OMB table, SBIR funds are given in a footnote.

In the Office of Nuclear Energy line, the difference of $41,468,000 is due to an error in the EMaCC table. Breeder Technology Projects and Space Reactor Projects are part of Reactor Systems, Development and Technology. (Breeder Technology Projects no longer exists as a separate Office.) The remaining 10 or so million difference is due to the more restricted definition of materials research used for the OMB table.

No funds were included in the OMB table from the Office of Civilian Radioactive Waste Management because the work supported there is development.

The difference of $19,648,000 in the Defense Programs line is again due to the more restricted definition of materials research used for the OMB table.

In the Fossil Energy line, the difference is -$1,762,000. I don't have a good explanation for this difference. My guess is that, as with all of these numbers, the value depends on whom you ask because the materials activities are not separated in most of the programs and a subjective decision is involved in selecting the portion of the program to call materials.

Except for the errors, the differences are all due to the definition of materials research. Unfortunately, there is no way to avoid such differences because the compilations were made at different times and for different purposes.

I. L. Thomas

I. L. Thomas
Division of Materials Sciences
Office of Basic Energy Sciences

DOE/CE-0154
(Previous No. DOE/ER-0241)
Dist. Category UC-25

ENERGY MATERIALS COORDINATING COMMITTEE (EMaCC)

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Washington, D.C. 20585

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INTRODUCTION

The DOE Energy Materials Coordinating Committee (EMaCC) serves primarily to enhance coordination among the Department's materials programs and to further the effective use of materials expertise within the Department. These functions are accomplished through the exchange of budgetary and planning information among program managers and through technical meeting/workshops on selected topics involving both DOE and major contractors. Four topical sub-committees on Structural Ceramics, Batteries and Fuel Cells, Radioactive Waste Containment, and Steel are established and are continuing their own program. The FY 1985 and FY 1986 meeting program is given on page 5. In addition, the EMaCC aids in obtaining materials-related inputs for both intra- and inter- agency compilations.

Membership in the EMaCC is open to any Department organizational unit; participants are appointed by Division or Office Directors. The current active membership is listed on the following three pages.

The EMaCC reports to the Director of the Office of Energy Research in his capacity as overseer of the technical programs of the Department. This annual technical report is mandated by the EMaCC terms of reference. This report summarizes EMaCC activities for FY 1985 and describes the materials research programs of various offices and divisions within the Department.

The Executive Secretary of EMaCC for FY 1986 is Iran L. Thomas. I am grateful to him and to EMaCC sub-committee chairmen Stanley J. Dapkunas, Alan Landgrebe, Henry F. Walter, and Donald Keefer for their contributions to our program in FY 1986. The compilation of this report was assisted by DHR, Incorporated with the skilled capabilities of Donald M. Horne.

Robert B. Schulz
Office of Transportation Systems
Office of Conservation and Renewable Energy
Chairman of EMaCC, FY 1985-86

MEMBERSHIP LIST
DEPARTMENT OF ENERGY
ENERGY MATERIALS COORDINATION COMMITTEE

ORGANIZATION	REPRESENTATIVE	PHONE NUMBER
CONSERVATION AND RENEWABLE ENERGY		
Energy Utilization Research	James J. Eberhardt, CE-12	252-1484
	Terry M. Levinson, CE-12	252-1477
Buildings and Community Systems		
Building Systems	William Gerken, CE-131	252-9187
Building Equipment	Robert Boettner, CE-132	252-9130
	Ronald Fiskum, CE-132	252-9130
	Danny C. Lim, CE-132	252-9130
Industrial Programs		
Waste Energy Reduction	Jerome F. Collins, CE-141	252-2369
	Scott Richlen, CE-141	252-2085
Improved Energy Productivity	Robert Massey, CE-142	252-2079
Transportation Systems		
Heat Engine Propulsion	Robert B. Schulz, CE-151	252-8055
	Charles H. Craig, CE-151	252-1506
Energy Storage and Distribution	Russel Eaton, CE-32	252-4844
	Michael Gurevich, CE-32	252-1507
	Eberhart Reimers, CE-32	252-5855
	Stanly S. Ruby, CE-32	252-1482
Solar Heat Technologies		
Solar Thermal Technology	Frank Wilkins, CE-331	252-1684
Solar Buildings Technology	John Goldsmith, CE-332	252-8170
	David Pellish, CE-332	252-8110
Renewable Energy		
Biofuels and Municipal Waste	Donald Walter, CE-341	252-6104
Geothermal Technology	Raymond LaSala, CE-342	252-8077
Solar Electric Technologies		
Wind/Ocean Technologies	William Richards, CE-351	252-5517
Photovoltaic Technology	Morton B. Prince, CE-352	252-1725

MEMBERSHIP LIST (Continued)

ORGANIZATION	REPRESENTATIVE	PHONE NUMBER
DEFENSE PROGRAMS		
Defense Waste and Byproducts		
R&D and Byproducts	Ray D. Walton, Jr., DP-123	353-3388
Weapons Research Development and Testing		
Weapons Research	Ross E. Lushbough, DP-225.2	353-3912
	Robert A. Jones, DP-225.2	353-5492
Inertial Fusion		
Fusion Research	Carl B. Hilland, DP-232	353-3687
ENERGY RESEARCH		
Basic Energy Sciences		
Materials Sciences	Louis C. Ianniello, ER-13	353-3427
Metallurgy and Ceramics	Robert J. Gottschall, ER-131	353-3428
Solid State Physics and Materials Chemistry	Iran L. Thomas, ER-132	353-3426
Engineering and Geosciences	Oscar P. Manley, ER-15	353-5822
Advanced Energy Projects	Ryszard Gajewski, ER-16	353-5995
Fusion Energy		
Reactor Technologies	Theodore C. Reuther, ER-533	353-4963
Health and Environmental Research		
Physical and Technological	Gerald Goldstein, ER-74	353-5348

MEMBERSHIP LIST (Continued)

ORGANIZATION	REPRESENTATIVE	PHONE NUMBER
FOSSIL ENERGY		
Management, Planning, and Technical Coordination		
Technical Coordination	Stanley J. Dapkunas, FE-14	353-2790
Coal Utilization, Advanced Conversion and Gasification		
Surface Coal Gasification	James P. Carr, FE-24	353-5985
NUCLEAR ENERGY		
Program Support		
Safety QA and Safeguards	Benjamin C. Wei, NE-141	353-3927
Remedial Action and Waste Technology		
Waste Treatment Projects	Henry F. Walter, NE-24	353-5510
Uranium Enrichment		
Technology Deployment and Strategic Planning	Arnold Litman, NE-34	353-5777
Reactor Systems Development and Technology		
Defense Energy Projects and Special Applications	William Barnett, NE-522	353-3097
Advanced Reactor Programs	Andrew Van Echo, NE-53	353-3930
	J. Edward Fox, NE-531	353-3985
	Arthur S. Mehner, NE-531	353-4474
Naval Reactors	Robert H. Steele, NE-60	557-5561
CIVILIAN RADIOACTIVE WASTE MANAGEMENT		
Engineering Licensing	Mark Frei, RW-23	252-9322
Transportation and Waste	Tien Nguyen, RW-33	252-2834

THE FY 1985-86* EMaCC MEETING PROGRAM

Date and Place	Special Meeting Subjects	Guest Speakers and EMaCC Subcommittee Chairman
Oct 19, 1984 Germantown	DOE On-Line Numeric Data Network: A Materials Data Demonstration	Bonnie C. Carroll Director, Office of Program Development, DOE/OSTI
Dec 3, 1984 Germantown	Workshop on How to Obtain Information on Materials Science Research	Dora Moneyhun Director, Office of Scientific and Technical Information (OSTI)
Jan 8, 1985 Forrestal	Structural Ceramics Subcommittee Joint Meeting	Sandy Dapkunas, Chairman
Jan 25, 1985 Forrestal	Batteries and Fuel Cells Subcommittee Joint Meeting	Iran Thomas, Chairman
Feb 15, 1985 Germantown	Radioactive Waste Containment Subcommittee Joint Meeting	Henry Walter, Chairman
Feb 15, 1985 Germantown	Structural Ceramics (Part 2)	Sandy Dapkunas, Chairman
May 14, 1985 Germantown	Steel Subcommittee Joint Meeting	Ted Reuther, Chairman
Nov 15, 1985 Germantown	Structural Ceramics Subcommittee Joint Meeting	Sandy Dapkunas, Chairman
Jan 10, 1986 Germantown	Polymeric Materials Meeting	Iran Thomas, Chairman
Mar 26, 1986 Forrestal	Batteries and Fuel Cells Subcommittee Meeting	Alan Landgrebe, Chairman
Apr 17, 1986 Germantown	Radioactive Waste Containment Subcommittee Meeting	Henry Walter, Chairman
Planned for FY 1986	Steel Subcommittee Meeting	Donald Keefer, Chairman
Planned for FY 1986	Carbon-Carbon Composites Meeting	
Planned for FY 1986	Surface Modification and Coatings Meeting	

* During FY 1985, Robert J. Gottschall, ER-131, was EMaCC Chairman and Robert B. Schulz, CE-151, was Executive Secretary.

ORGANIZATION OF THE REPORT

The first part of the Program Descriptions consists of a funding summary for each Assistant Secretary office and the Office of Energy Research. This is followed by a summary of project titles and objectives, including the program/project manager(s) and principal investigator (listed in the Directory, pages 368-398).

The second part of the Program Descriptions (starting on page 176) consists of more datailed project summaries with project goals and accomplishments. Each of these are numbered for purposes of reference in the Key Word Index (pages 399-404).

The Table of Contents lists two (2) page numbers for each entry: the first page number gives the funding summary or first program description; the second page number gives the first detailed project description.

The FY 1985 Budget Summary for materials activities in each of the 21 programs within the DOE are presented on pages 7 and 8.

FY 1985 BUDGET SUMMARY TABLE FOR DOE MATERIALS ACTIVITIES

(These numbers represent materials-related activities only. They do not include that portion of program budgets which are not materials-related.)

	FY 1985
Energy Conservation	$ 25,868,000
Office of Energy Utilization Research	$ 4,900,000
Office of Buildings and Community Systems	2,251,000
Office of Industrial Programs	919,000
Office of Transportation Systems	17,798,000
Renewable Energy	$ 38,419,000
Office of Energy Storage and Distribution	$ 7,300,000
Office of Solar Heat Technologies	4,929,000
Office of Solar Electric Technologies	24,600,000
Office of Renewable Technology	1,590,000
Office of Energy Research	$162,479,000
Office of Basic Energy Sciences	$134,361,000
Office of Health and Environmental Research	868,000
Office of Fusion Energy	19,350,000
Small Business Innovation Research Program	7,900,000
Office of Nuclear Energy	$~~203,788,000~~ 171,158,000
Office of Converter Reactor Deployment	$ 6,590,000
Office of Terminal Waste Disposal and Remedial Action	9,700,000
Office of Uranium Enrichment	62,648,000
Office of Reactor Systems, Development and Technology	32,220,000
~~Office of Space Reactor Projects~~	~~2,485,000~~
~~Office of Breeder Technology Projects~~	~~30,145,000~~
Office of Naval Reactors	60,000,000
Office of Civilian Radioactive Waste Management	$ 18,613,000
Office of Storage and Transportation Systems	$ 760,000
Basalt Waste Isolation Project Waste Package Materials Development	6,230,000
Office of Geological Repositions - Nevada Nuclear Waste Storage Investigations Projects	9,363,000

FY 1985 BUDGET SUMMARY TABLE FOR DOE MATERIALS ACTIVITIES
(Continued)

Salt Repository Project	1,935,000
Sandia National Laboratories: Brittle Fracture Technology Program	325,000
Office of Defense Programs	$ 39,503,000
Office of Inertial Fusion	$ 3,000,000
Office of Military Applications	36,503,000
Office of Fossil Energy	$ 7,951,000
Office of Technical Coordination	$ 6,319,000
Office of Surface Coal Gasification	562,000
Office of Coal Utilization	1,070,000
TOTAL	~~$496,621,000~~ 463,991,000

PROGRAM SUMMARIES

Brief summaries of the materials research programs associated with each office and division are presented in the following text, including tables listing individual projects and the FY 1985 budgets for each. More details on the individual projects within the divisions and the specific tasks or subcontracts within the various projects are given in the paragraph descriptions.

CONSERVATION AND RENEWABLE ENERGY

The Office of Conservation and Renewable Energy seeks to develop the technology needed for the Nation to use its existing energy supplies more efficiently, and for it to adopt, on a large scale, renewable energy sources. Toward this end, the Office conducts long-term, high-risk, high- payoff R&D that will lay the groundwork for private sector action.

A number of materials R&D projects are being conducted within the Conservation and Renewable Energy program. The breadth of this work is considerable, with projects focusing on coatings and films, elastomers and polymers, corrosion, materials characterization, transformation, and other research areas. The level of funding indicated refers only to the component of actual materials research.

The Office of Conservation and Renewable Energy conducts materials research in the following offices and divisions:

			1985
1.	Energy Conservation		$25,867,912
	a.	Office of Energy Utilization Research	4,900,000
	(1)	Energy Conversion and Utilization Technologies Division	4,900,000
	b.	Office of Buildings and Community Systems	2,250,512
	(1)	Building Systems Division	785,000
	(2)	Building Equipment Division	1,465,512
	c.	Office of Industrial Programs	919,400
	(1)	Improved Energy Productivity Division	919,400
	d.	Office of Transportation Systems	17,798,000
2.	Renewable Energy		38,839,000
	a.	Office of Energy Distribution and Storage	7,720,000
	(1)	Energy Storage Division	4,555,000
	(2)	Electric Energy Systems Division	3,165,000
	b.	Office of Solar Heat Technologies	4,929,000
	(1)	Active Heating and Cooling Division	2,455,000
	(2)	Passive and Hybrid Solar Energy Division	600,000
	(3)	Solar Thermal Technology Division	1,874,000
	c.	Office of Solar Electric Technologies	24,600,000
	(1)	Photovoltaic Energy Technology Division	24,600,000
	d.	Office of Renewable Technology	1,590,000
	(1)	Geothermal and Hydropower Technologies Division	1,360,000
	(2)	Biofuels and Municipal Waste Division	230,000

OFFICE OF ENERGY UTILIZATION RESEARCH

	FY 1985
Office of Energy Utilization Research Grand Total	$ 4,900,000
Energy Conversion and Utilization Technologies Division	$ 4,900,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 1,740,000
Recovery and Reuse of Plastic Scrap Via Separation and Bonding	$ 35,000
Recovery and Reuse of Plastic Scrap Via Decomposition	50,000
Economics of Recovery and Reuse of Plastic Scrap	15,000
Laser Surface Modifications of Ceramics	150,000
Plasma Sintering of Ceramics	100,000
Ion Implantation of Ceramics	310,000
Electrosterically-Stabilized Suspensions of Oxide Ceramics for Injection Molding	55,000
Dispersoid Toughened Ceramic Composite Coatings Via Chemical Vapor Deposition	75,000
Hollow Thin-Wall Ceramic Spheres from Slurries	75,000
Toughened $MoSi_2$	50,000
Ordered Metallic Alloys for Lightweight Applications	95,000
Solid Lubricants Deposited From the Gas Phase	75,000
Tribological Surface Modifications and Coatings	400,000
Modeling of Hard Coatings for Tribological Systems Operating Under Extreme Conditions	80,000
Tribological Studies on Coated High Speed Steel Cutting Tools	75,000
Abrasion and Impact Resistant Coatings	50,000
Mechanical Interactions of Rough Surfaces	50,000
Materials Structures and Composition	$ 770,000
Mechanisms of Adherence at Ceramic Joints	$ 150,000
Machining and Surface Preparation of Ceramics	25,000
Materials by Design Assessment	0
Boron-Effect-in-Ni_3Al	570,000
Assessment of Liquid Crystal Polymers for Structural Applications	$ 25,000
Materials Approaches to Ice Abatement	0
Materials Properties, Behavior, Characterization, or Testing	$ 825,000
Ordered Metallic Alloys for High Temperature Applications	$ 825,000

	FY 1985
Energy Conversion and Utilization Technologies Division (Continued)	
Materials Properties, Behavior, Characterization, or Testing (Continued)	
Coatings for High Temperature Energy Conversion Systems	0
Supercritical Fluid Equations of State	0
Device or Component Fabrication, Behavior, or Testing	$ 1,384,000
Modeling of Solid Ceramic Joints	$ 200,000
Electromagnetic Joining of Ceramics	190,000
Friction and Wear of Ceramics at Elevated Temperatures	344,000
Observations of "Hot Spots" on Ceramics and Development of Theory	75,000
Lubricant Qualities of the Constituents of Base Stock Oil	450,000
Reactive Metallic Brazes for Ceramic-Ceramic and Ceramic-Metal Joints	50,000
Nondestructive Evaluation of Ceramic Joints	75,000
Instrumentation and Facilities	$ 181,000
Instruments for Harsh Environments	$ 100,000
Assessment of X-ray Methods for Investigations of Ceramic Wear Surfaces	81,000

OFFICE OF ENERGY UTILIZATION RESEARCH

This office supports generic research of a long-term, high-risk, high-payoff nature aimed at stimulating innovation in conservation technology. The research is both broadly based and multi-sectoral, providing a technology base for the other conservation programs.

Energy Conversion and Utilization Technologies Division

The mission of the ECUT Program is to support generic, long-term, high risk directed basic and applied research and exploratory development of new or improved concepts to produce a technology base which private industry can use in producing products that use energy more efficiently. Materials-related research in the ECUT Program is found in fiscal year 1984 in two projects, the Materials Project and the Tribology Project. In FY 1984 both projects were managed for ECUT by the Oak Ridge National Laboratory (ORNL). Beginning in FY 1985, the Tribology Project will be managed by Argonne National Laboratory (ANL). The goal of both projects is to develop innovative concepts to a point where they can be taken over for further development by private industry or other government programs. The materials work in the Materials Project is in the areas of intermetallic compounds, ceramic-ceramic and ceramic-metal attachments, surface modifications of ceramics, recovery and reuse of plastic scrap, ceramic coatings, and materials structures theory. Materials research in the Tribology Project is in the areas of wear of lubricated solids, the friction and wear of ceramics, and tribological surface modifications and coatings. The DOE contact is James J. Eberhardt, (202) 252-1484 for the Materials Project and Terry Levinson, (202) 252-1484 for the Tribology Project.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Recovery and Reuse of Plastic Scrap Via Separation and Bonding - DOE Contact J. Eberhardt, 202-252-1484; Plastics Institute of America Contact Mike Curry, 201-420-5552

- Development of methods of producing useful materials from mixed plastic scrap via bonding of the scrap as-is or by separations and subsequent processing.
- Current work centered mainly on scrap from shredded automobiles.

Recovery and Reuse of Plastic Scrap Via Decomposition - DOE Contact J. Eberhardt, 202-252-1484; Plastics Institute of America Contact Giuliana Tesoro, 718-643-5244, 914-639-5329, and 201-420-5552

- Investigations of technologies for reuse of or recovery of value from plastics via methods involving the molecular decomposition of the plastics.
- FY 1984 and FY 1985 activities were concerned with the planning of future work.

Economics of Recovery and Reuse of Plastic Scrap - DOE Contact J. Eberhardt, 202-252-1484; ORNL Contact Randy Curlee, 615-576-4864

- Studies of the economic viability of the recovery and reuse of plastic scrap and institutional barriers to be overcome.

Laser Surface Modifications of Ceramics - DOE Contact J. Eberhardt, 202-252-1484; North Carolina State Contacts Bob Davis, 919-737-3272 and Jagdish Narayan, 919-248-1902 and 919-737-2933

- Investigations of the effects induced by pulsed laser irradiation of thin films of metals deposited onto surfaces of ceramics.

- Films of Fe, Cr, and Ni on SiC, Si_3N_4, and Al_2O_3.

Plasma Sintering of Ceramics - DOE Contact J. Eberhardt, 202-252-1484; Northwestern University Contact Lynn Johnson, 312-492-3537

- Exploration of the acceleration of sintering of ceramics via plasmas.

Ion Implantation of Ceramics - DOE Contact J. Eberhardt, 202-252-1484; ORNL Contact Carl McHargue, 615-574-4344; Georgia Tech Contact Joe Cochran, 404-891-2051; Universal Energy Systems Contact Peter Pronko, 513-426-6900, ext. 113

- Exploration of the effects of ion implantation on certain properties (viz. strength, fracture toughness, hardness, friction coefficient, and wear rates) of ceramics.

- Current work is on ion implantation into TiB_2, ZrO_2, Al_2O_3, SiC, and Si_3N_4.

Electrosterically-Stabilized Suspensions of Oxide Ceramics for Injection Molding - DOE Contact J. Eberhardt, 202-252-1484; University of Washington Contact Ilhan Aksay, 206-543-2625

- Attempts to produce a ceramic oxide suspension suitable for higher speed injection molding but using an aqueous solvent and minimum organic additives.

- Approach is to absorb polymer onto surface of submicron particle in suspension.

- Initial work on alpha-Al_2O_3.

Dispersoid Toughened Ceramic Composite Coatings Via Chemical Vapor Deposition - DOE Contact J. Eberhardt, 202-2452-1484; ORNL Contact Dave Stinton, 615-574-4556

- Attempts to produce toughened ceramic matrix coatings via simultaneous chemical vapor deposition of dispersoid and matrix phases.

- Current work on SiC (matrix) - $TiSi_2$ (dispersoid).

Hollow Thin-Wall Ceramic Spheres from Slurries - DOE Contact J. Eberhardt, 202-252-1484; Georgia Tech Contact Ted Chapman, 404-894-4815

- Development of a technique for producing hollow, thin-wall ceramic spheres in the .1-5 mm diameter range using conventional dispersions of ceramic powders (slurries).

- Initial work on Al_2O_3.

Toughened $MoSi_2$ - DOE Contact J. Eberhardt, 202-252-1484; LANL Contact John Petrovic, 505-667-5452

- Attempts to toughened $MoSi_2$ by incorporation of LANL's SiC whiskers.

Ordered Metallic Alloys for Lightweight Applications - DOE Contact J. Eberhardt, 202-252-1484; ORNL Contact Chain Liu, 615-574-4459

- Identification and development of ordered metallic alloys as potential lightweight structural materials for automobiles.

- Current work on Mg-Al, Mg-Si, and Mg-Li intermetallics.

Solid Lubricants Deposited From the Gas Phase - DOE Contact T. Levinson, 202-252-1484; Pennsylvania State University Contact E.E. Klaus, 814-865-2574

- Determine the kinetics of formation and the structures of solid lubricant films deposited on ceramic or metal surfaces from the gas phase.

Tribological Surface Modifications and Coatings - DOE Contact T. Levinson, 202-252-1484; ANL Contact Manfred Kaminsky, 312-972-4074

- Emphasis on FY 1984 and 1985 work is on coatings for cutting tool wear.

Modeling of Hard Coatings for Tribological Systems Operating Under Extreme Conditions - DOE Contact T. Levinson, 202-252-1484; Massachusetts Institute of Technology Contact Bruce Kramer (currently at George Washington University), 202-676-8237

- Work based on Kramer's Thermomechanical-Mechanical Theory for tool wear, and predictions for increased wear resistance.

- Theory confirmed for coatings on Carbide inserts.

- Current tests of theory focusing on TiC, TiN, ZrC, ZrN, HfC, HfN coatings on T-15 High Speed Cutting Tool Steel inserts.

Tribological Studies on Coated High Speed Steel Cutting Tools - DOE Contact T. Levinson, 202-252-1484; University of California in Los Angeles Contact Rointan Bunshah, 213-825-2210

- Preparing coatings by a patented Activated Reactive Evaporation Process, for characterization and evaluation at ANL, as part of the program to confirm and exploit Professor Kramer's theory.

Abrasion and Impact Resistant Coatings - DOE Contact T. Levinson, 202-252-1484; LLNL Contact Tomas Hirschfeld, 415-422-6364

- Development and testing of innovative wear resistant coatings constructed by anchoring high density mat of very fine, hard filaments or "hairs" into surface of bulk matrix, at near vertical angles.

- Tests established that dense mat of 2 to 5 micron diameter carbon fibers embedded in the surface of any epoxy matrix provided complete protection to the matrix in a sandblast tester (which completely destroyed unprotected specimens).

- Future tests are focusing on metal matrices, and on C, B, SiC, Al_2O_3, and ZrO fibers.

Mechanical Interactions of Rough Surfaces - DOE Contact T. Levinson, 202-252-1484; SKF Industries, Incorporated Contact John McCool, 215-265-1900, ext. 267

- Joint effort with Office of Basic Energy Sciences.

- Developing guidelines and techniques for the processing of surface roughness data generated in analog form.

Materials Structures and Composition

Mechanisms of Adherence at Ceramic Joints - DOE Contact J. Eberhardt, 202-252-1484; ORNL Contact Joe Carpenter, 615-574-4571

- Investigations of the mechanisms of adherence at ceramic-ceramic and ceramic-metal joints.

- Current approaches are based on thermodynamics and microstructural analyses.

Machining and Surface Preparation of Ceramics - DOE Contact J. Eberhardt, 202-252-1484; ORNL Contact Dave Stinton, 415-574-4456

- Assessment of the current state-of-the-art in the technologies of machining and surface preparation of ceramics.

- Attempts to determine if further research and development is needed.

Materials By Design Assessment - DOE Contact J. Eberhardt, 202-252-1484; Universal Oil Products Contact Al Wilks, 312-391-3179

- Assessment to determine if it is now, or soon will be, possible to develop, experimentally verify, and use interatomic or intermolecular models to design and optimize practical engineering materials and processes.

Boron-Effect-in-Ni_3Al - DOE Contact J. Eberhardt, 202-252-1484; LANL Contact Jeff Hay, 505-667-2097

- Objective is to explain at the atomic level the effects that boron has in increasing the ductility of polycrystalline Ni_3Al.

- LANL carries out theoretical predictions of the possible atomic arrangements of B in Ni_3Al grain boundaries and ORNL and others (funded by BES) attempt to experimentally verify the predictions.

Assessment of Liquid Crystal Polymers for Structural Applications - DOE Contact J. Eberhardt, 202-252-1484; ORNL Contact Paul Phillips, 615-574-5304

- Assessment of the potential of using liquid crystal polymer technologies for producing polymeric materials for structural applications.

Materials Approaches to Ice Abatement - DOE Contact J. Eberhardt, 202-252-1484; Consultant Contact Larry Casper, 612-541-2508

- Assessment to determine if there may be any viable materials approaches to ice abatement on surfaces such as heat pump condenser coils, roofs, and solar collectors.

Materials Properties, Characterization, Behavior, or Testing

Ordered Metallic Alloys for High Temperature Applications - DOE Contact J. Eberhardt, 202-252-1484; ORNL Contact Chain Liu, 615-574-4459

- Development and determination of properties of ductile long-range ordered alloys based on the $(Fe,Ni)_3V$ system and ductile intermetallic alloys based on the Ni_3Al system.

- Main applications in high temperature service in steam turbines, heat engines, and heat exchangers.

Coatings for High Temperature Energy Conversion Systems - DOE Contact J. Eberhardt, 202-252-1484; LBL Contact Al Levy, 415-486-5822

- Friction and wear tests to 1400^{o}F of candidate coatings for use on the top piston rings of the adiabatic diesel engine.

Supercritical Fluid Equations of State - DOE Contact J. Eberhardt, 202-252-1484; National Bureau of Standards Contact James Ely, 303-320-5467

- Investigations of the exact thermodynamic states of fluids in the supercritical state.
- Useful for separations and extractions in various materials processing methods.

Device or Component Fabrication, Behavior, or Testing

Modeling of Solid Ceramic Joints - DOE Contact J. Eberhardt, 202-252-1484; Norton Company Contact Pierre Charreyron, 617-863-1000, ext. 2667

- Development of finite element models of stress states in and around solid joints between a ceramic and a ceramic or metal part of five specific geometries.
- Initial work on butt-on-butt in cylindrical and rectangular cross sections.

Electromagnetic Joining of Ceramics - DOE Contact J. Eberhardt, 202-252-1484; DHR, Incorporated Contact Richard Silberglitt, 703-556-8660

- Investigations of the potential of using radio frequency radiation to effect solid bonds between a ceramic piece and another ceramic or a metal piece.
- Initial proof-of-principle shown in FY 1985 by joining Al_2O_3 with lead-glass braze.

Friction and Wear of Ceramics at Elevated Temperatures - DOE Contact T. Levinson, 202-252-1484; ORNL Contact Charlie Yust, 615-574-4812

- Measurements of the friction coefficient and wear rates under unidirectional sliding and investigations of the wear mechanisms of ceramics during tests of ceramics run against themselves and other ceramics up to 800°F.

Observations of "Hot Spots" on Ceramics and Development of Theory - DOE Contact T. Levinson, 202-252-1484; Georgia Institute of Technology Contact Ward Winer, 404-894-3270

- The wearing surfaces of the ends of ceramic pins are observed through a rotating sapphire (Al_2O_3) disk to see if they exhibit "hot spots" (i.e., extremely hot surface asperities) and, if so, to develop a theory of wear of ceramics based on the observations.

Lubricant Qualities of the Constituents of Base Stock Oil - DOE Contact T. Levinson, 202-252-1484; NBS-Gaithersburg Contact Stephen Hsu, 301-921-2113

- Commercial base stock (without additives) oils are separated into molecular fractions and the fractions are tested for friction and wear qualities and oxidation stability.

- Objectives are to prove that there are significant differences in the lubricant qualities of the various molecular constituents of base stock oils and to improve the understanding of the influence of the molecular structure of lubricant molecules on their lubricant qualities.

Reactive Metallic Brazes for Ceramic-Ceramic and Ceramic-Metal Joints - DOE Contact J. Eberhardt, 202-252-1484; ORNL Contact Artie Moorhead, 615-574-5153

- Development and testing of reactive metal brazes for joining ceramics to ceramics and metals.

- Main applications in joining parts for high temperature service up to 900°C.

Nondestructive Evaluation (NDE) of Ceramic Joints - DOE Contact J. Eberhardt, 202-252-1484; ORNL Contact Bob McClung, 615-574-4466

- Explores the limits of nondestructive evaluation (NDE) techniques for assessing the strength and integrity of ceramic-ceramic and ceramic-metal joints.

Instrumentation and Facilities

Instruments for Harsh Environments - DOE Contact J. Eberhardt, 202-252-1484; NBS-Gaithersburg Contact Ken Kreider, 301-921-3281

- Develop thin film sensor for less intrusive temperature measurements inside combustion chambers.

- Initial work on iron-based substrates completed in FY 1985, redirected to ceramic substrates.

Assessment of X-Ray Methods for Investigation of Ceramic Wear Surfaces - DOE Contact J. Eberhardt, 202-252-1484; Virginia Polytechnic Institute and State University Contact Charles Houska, 703-961-5652

- Determine the potential of x-ray diffraction and fluorescence methods for nondestructive analyses of the near-surface wear regions of ceramics.

OFFICE OF BUILDINGS AND COMMUNITY SYSTEMS

	FY 1985
Office of Buildings and Community Systems Grand Total	$ 2,250,512
Building Systems Division	$ 785,000
Materials Properties, Behavior, Characterization, or Testing	$ 785,000
Unguarded Flat Insulation Nichrome Wire Screen Tester	$ 170,000
Settled Density Studies of Loose-fill Insulation	50,000
Heat Flow Modeling	100,000
Gas Diffusion and Effective Conductivity of Foam Insulation Versus Age	50,000
Corrosiveness of Thermal Insulating Materials	20,000
Improved Standard Reference Materials	100,000
Smoldering Combustion Hazards of Thermal Insulation Materials	8,000
Reflective Foil Thermal Performance Modeling	40,000
High Temperature Insulation Standard Reference Materials	50,000
Radiation Transmission Properties of Thermal Insulation	40,000
Theory of Radiative Heat Transport in Low-Density Insulations	30,000
Dynamic Latent Heat Storage Effects of Building Construction Materials	35,000
Assessment of the Physical and Thermal Properties of Masonry Block Products	92,000
Building Equipment Division	$ 1,465,512
Materials Properties, Behavior, Characterization, or Testing	$ 1,079,912
Materials for Condensing Heat Exchangers	$ 125,000
Advanced Insulation for Appliances	250,000
Non-Azeotropic Refrigerant Mixtures	400,000
New Gases/Diagnostics for High and Low Pressure Discharge Lamps	304,912
Device or Component Fabrication, Behavior, or Testing	$ 285,600
Mercury Isotope Enrichment	$ 80,000
Zeeman Effect on Lamp Gas Plasma	40,000
Explore Performance of New Ingredients in High Intensity Discharge Lamps	165,600

OFFICE OF BUILDING ENERGY RESEARCH AND DEVELOPMENT (Continued)

		FY 1985
Building Equipment Division (Continued)		
Instrumentation and Facilities	$	100,000
Absorption Fluid Pairs Research		100,000

OFFICE OF BUILDINGS AND COMMUNITY SYSTEMS

The Office of Buildings and Community Systems works to increase the energy efficiency of the buildings sector through performance of R&D on building systems, building equipment, and community energy systems. In addition, the Office carries out the statutory requirements of appliance standards and labeling, building energy performance standards, the residential conservation service, and Federal energy management program. Specific objectives include providing the technology to:

- reduce energy consumption in existing buildings, and in new buildings;
- increase the energy efficiency of oil and gas combustion heating systems and of oil- and gas-fired heat pump systems;
- improve the energy efficiency of advanced electric heat pump and refrigeration systems, and of light systems; and
- develop new planning techniques and systems that will decrease the energy consumption of communities.

Building Systems Division

The goal of this Division is to provide a scientific and technical basis (including model standards) for reducing the use of energy in residential and commercial buildings by 35% by the year 2000 from that used in 1975, while maintaining existing levels of human comfort, health and safety. The Division's primary objectives are to support research that advances the scientific and technical options for increased energy efficiency in buildings, to promote the substitution of abundant fuels for scarce fuels in buildings, and to promulgate standards for increased efficiency of energy use. To accomplish a portion of this, the Building Materials Program seeks to increase the knowledge base concerning the physical, chemical and mechanical properties of building materials that determine their effectiveness, durability, safety, and health impacts; to develop and verify useful models for the behavior of those materials; to develop improved test methods for measuring the performance of the materials; and to develop consensus standards for characterizing the materials. The DOE contact is Bill Gerken, 202-252-9191.

Materials Properties, Behavior, Characterization, or Testing

Unguarded Flat Insulation Nichrome Wire Screen Tester - DOE Contact B. Gerken, 202-252-9191; ORNL Contact David McElroy, 615-574-5976

- Study of transient thermodynamic processes in insulation materials including mineral fiberboard and powdered insulations.

Settled Density Studies of Loose-Fill Insulation - DOE Contact B. Gerken, 202-252-9191; ORNL Contact David McElroy, 615-574-5976

- Laboratory and field studies of loose fill insulation materials to determine the effects of settling on density and R-value.

- Testing involves vibration of these materials in a simulated wall cavity and in actual residential attics.

Heat Flow Modeling - DOE Contact B. Gerken, 202-252-9191; ORNL Contact David McElroy, 615-574-5976

- Mathematical modeling of heat transfer along longitudinal and radial coordinates.

- Elucidation of "apparent" thermal conductivity in materials.

Gas Diffusion and Effective Conductivity of Foam Insulation Versus Age - DOE Contact B. Gerken, 202-252-9191; MIT Contact Dr. Leon Glicksman, 617-253-2233

- Freon-blown rigid urethane foam is studied for changes due to diffusional effects as insulation ages.

- Experimental measurements of gas permeability through cell wall materials.

- Investigation of new concepts which reduce overall thermal conductivity of foam material.

Corrosiveness of Thermal Insulating Materials - DOE Contact B. Gerken, 202-252-9191; Stevens Institute of Technology Contact Dr. Rolf Weil, 201-420-5257

- Effects of leachants on interaction of cellulose, rockwool, fiberglass and urea formaldehyde foam with contact metals.

Improved Standard Reference Materials - DOE Contact B. Gerken, 202-252-9191; NBS Contact Brian Rennex, 301-921-3195

- Candidates for improved standard reference materials are being investigated using a one meter diameter line-heat-source guarded hot plate.

Smoldering Combustion Hazards of Thermal Insulation Materials - DOE Contact B. Gerken, 202-252-9191; NBS Contact Thomas Ohlemiller, 301-921-3771

- Examination of cellulosic insulation transition from smoldering to flaming combustion with emphasis on the effects of forced air flow.

- Determination of level and effects of various combustion retardants on transition process.

Reflective Foil Thermal Performance Modeling - DOE Contact B. Gerken, 202-252-9191; Tennessee Technological University Contact David Yarbrough, 615-528-3494

- Modeling of reflective foil radiation barrier systems is being conducted as part of an effort to develop an acceptable method for determining the R-value of such systems.

High Temperature Insulation Standard Reference Materials - DOE Contact B. Gerken, 202-252-9191; National Bureau of Standards Contact Jerome Hust, 303-497-3733

- Cerroboard and a high temperature loose-fill insulation are candidates to be investigated for use as new Standard Reference Materials, using a new 800 degrees K guarded hot plate.

Radiation Transmission Properties of Thermal Insulation - DOE Contact B. Gerken, 202-252-9191; University of Kentucky Contact Timothy Tong, 606-257-3236

- A data-reduction method for determining the thermal conductivity of thermal insulation from transient heat transfer data is being developed.

- Radiation transmission properties of thermal insulation are being measured.

Theory of Radiative Heat Transport in Low-Density Insulations - DOE Contact B. Gerken, 202-252-9191; University of Connecticut Contact Paul Klemens, 203-486-3134

- Theoretical mathematical and physics analysis of radiative heat flow under transient conditions.

- Realistic model used to derive a new heat transfer equation, to be applied to steady-state and transient test cases.

- Leads to computer simulations of heat transfer for diurnal cycle and for measurement techniques such as laser diffusivity and the flat screen tester.

Dynamic Latent Storage Effects of Building Construction Materials - DOE Contact B. Gerken, 202-252-9191; ORNL Contact David McElroy, 615-574-5976

- Acquisition of data concerning time rate of moisture adsorption and desorption in building construction materials and furnishings as a function of temperature and humidity changes.

Assessment of the Physical and Thermal Properties of Masonry Block Products - DOE Contact B. Gerken, 202-252-9191; ORNL Contact David McElroy, 615-574-5976

- Identification of available data regarding thermal properties of concrete and masonry units typically encountered in building practice.

Building Equipment Division

The mission of the Building Equipment Division is to provide the long range technical support needed to supply the private sector with the technological basis for developing and testing high efficiency equipment utilized in the operation of residential and commercial buildings. This equipment supplies the heating, cooling, lighting, hot water, and other services required to operate a building efficiently and offer its occupants a comfortable environment. The division supports applied research in the engineering phenomena surrounding the conversion of raw energy in the form of oil, gas, and electricity into the useful energy forms of heat, refrigeration, and light. The division supports the development and revision of the DOE test procedures for consumer products. As part of the applied research program, the division conducts research on materials problems that are key to advanced technology equipment.

Materials Properties, Behavior, Characterization, or Testing

Materials for Condensing Heat Exchangers - DOE Contact Danny C. Lim, 202-2529130; Battelle Contact George Stickford, 614-424-4210; Brookhaven Contact Roger J. McDonald, 515-282-4197

- Investigation of materials feasible for use in heat exchangers for condensing oil- and gas-fired heating systems.

Advanced Insulation for Appliances - DOE Contact Ronald Fiskum, 202-252-9130; ORNL Contact Fred Creswick, 615-574-2009

- Thermal conductivity of materials potentially suitable for advanced insulation for refrigeration systems.

Non-Azeotropic Refrigerant Mixtures - DOE Contact Ronald Fiskum, 202-252-9130; ORNL Contact Phil Fairchild, 615-574-2020

- Development of knowledge base of non-azeotropic refrigerants for use in refrigeration systems.
- Testing of novel mixtures to generate properties data.

New Gases/Diagnostics for High and Low Pressure Discharge Lamps - DOE Contact Robert Boettner, 201-252-9136; GTE Contact Dr. Jacob Maya, 617-777-2309

- Establish the viability of Laser Induced Fluorescence (LIF) technique for measuring radial excited state distributions in low and high pressure discharges as well as novel discharges such as isotopically enriched and magnetic fluid enhanced fluorescent lamps.

Device or Component Fabrication, Behavior, or Testing

Mercury Isotope Enrichment - DOE Contact Robert Boettner, 202-252-9136; LBL Contact Dr. Sam Berman, 415-486-5682

- Determination of optimum isotope mix both technically and economically in Hg discharge lamps.

- Goal is a 10-15% efficiency improvement in test lamps.

Zeeman Effect on Lamp Gas Plasma - DOE Contact Robert Boettner, 202-252-9136; LBL Contact Dr. Sam Berman, 415-486-5682

- Determination of efficiency improvements of radiation of ultraviolet spectrum through application of a magnetic field to the lamp discharge.

Explore Performance of New Ingredients in High Intensity Discharge Lamps - DOE Contact Robert Boettner, 202-252-9136; GE Contact Dr. V.D. Roberts, 518-385-8983

- Examine the performance (efficacy, electrical properties) of new ingredients in high intensity discharge lamps.

Instrumentation and Facilities

Absorption Fluid Pairs Research - DOE Contact Ronald Fiskum, 202-252-9130; ORNL Contact George Privon, 615-574-1013

- Development of complete data base on known fluid pairs over the temperature and pressure ranges of heat pumps.

OFFICE OF INDUSTRIAL PROGRAMS

	FY 1985
Office of Industrial Programs Grand Total	$ 919,400
Improved Energy Productivity Division	$ 919,400
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 487,000
Corrosion Resistant Amorphous Metallic Films	$ 220,000
Investigation of Material for Inert Electrodes in Aluminum Electrodeposition Cells	267,000
Materials Properties, Behavior, Characterization, or Testing	$ 212,000
Diagnostic Sources of Current Inefficiency in Industrial Molten Salt Electrolytic Cells by Raman Spectroscopy	$ 100,000
Diagnostic Sources of Current Inefficiency in Industrial Molten Salt Electrolytic Cells by Raman Spectroscopy	112,000
Instrumentation and Facilities	$ 220,400
Rapid In-Situ Analysis of Molten Metal	$ 51,400
Direct Measurement of Thermal State of Solids	169,000

OFFICE OF INDUSTRIAL PROGRAMS

This office supports cost-shared research and development for industrial energy conservation technologies that offer large potential for saving scarce fuels and to encourage the private sector to implement and deploy such technologies as they are developed. Materials research is done in support of the technologies under development or to develop materials with lower embodied energy.

Improved Energy Productivity Division

This division conducts research and creates new energy conserving processes for ore reduction, base metals, and basic shape processing; sensing and control instrumentation; concentration, evaporation, separation, and reaction processes and food production and processing.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Investigation of Material for Inert Electrodes in Aluminum Electro-Deposition Cells - DOE Contact M.J. McMonigle, 202-252-2087; MIT Contact J.S. Haggarty, 617-253-3300

- Generation of ultra pure powders and single crystals of candidate ceramics (TiB_2, LaB_6, $NiO-NiFe_2O_4$) using laser units.

Corrosion Resistant Amorphous Metallic Films - DOE Contact Robert Massey, 202-252-2079; JPL Contact Dennis Fitzgerald, 818-577-9079

- Development of magnetron sputtering of MoRuB and FeCrPC on carbon steel to provide corrosion resistant surface.

Materials Properties, Behavior, Characterization, or Testing

Diagnostic Sources of Current Inefficiency in Industrial Molten Salt Electrolytic Cells by Raman Spectroscopy - DOE Contact M.J. McMonigle, 202-252-2087; MIT Contact D.R. Sadoway, 617-253-3300

- Analysis of molten salts with Raman Spectroscopy to determine bath chemistry during electrolysis.

Diagnostic Sources of Current Inefficiency in Industrial Molten Salt Electrolytic Cells by Raman Spectroscopy - DOE Contact M.J. McMonigle, 202-252-2087; PNL Contact Pat Hart, 509-375-2906

- Potential anode materials to be tested are: cermets of Ni-Fe spinels with copper additions, metal alloys, and nobel metal alloys. Raman spectroscopic techniques will be used to identify surface reactions and limiting current density.

Instrumentation and Facilities

Rapid In-Situ Analysis of Molten Metal - DOE Contact J.C. Fulton, 202-252-8668; LANL Contact L. Blair, 505-667-6250

- Development of a laser-based system for spectrographic analysis of liquid steel to provide for a faster analytical method in order to increase productivity in the steel industry.

Direct Measurement of Thermal State of Solids - DOE Contact J.C. Fulton, 202-252-8668; PNL Contact Douglas Lemon, 509-375-2306

- Use of an ultra-sonic device to determine temperature distribution in a piece of steel slab or recently poured ingot before entering reheating furnaces.

OFFICE OF TRANSPORTATION SYSTEMS

	FY 1985
Office of Transportation Systems Grand Total	$17,798,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 2,847,000
Silicon Carbide Powder Synthesis	$ 110,000
Powder Characterization	31,000
Sintering of Si_3N_4	70,000
High Pressure Sintering Furnace	80,000
Si_3N_4 Powder Syntheses	110,000
Dispersion Toughened Silicon Carbide	77,000
Dispersion Toughened Si_3N_4	35,000
Dispersion Toughened Si_3N_4	35,000
Dispersion Toughened Si_3N_4	38,000
Oxide Matrix Composites	345,000
Processing of Improved Transformation-Toughened Ceramic	100,000
Sol Gel Oxide Powder	100,000
Advanced Transformation Toughened Oxides	160,000
Injection Molded Composites	200,000
Toughened Ceramics Adiabatic Diesel Engines	147,000
Fiber Reinforced Silicates	130,000
Advanced Coating Technology AGT	100,000
Advanced Coating Technology Diesel	200,000
Active Metal Brazing PSZ-Iron	250,000
Ceramic-Metal Joints AGT	105,000
Diesel Ceramic-Metal Joint Scale-up	100,000
Ceramic-Ceramic Joints AGT	100,000
Ceramics for Stirling Engine Applications	26,000
Materials Development - Intermetallic Evaluation	48,000
Cast Iron Alloy Nonstrategic Elements	150,000
Materials Properties, Behavior, Characterization, or Testing	$ 3,131,000
High Temperature Coating to Reduce Contact Stress	$ 150,000
Adherence Coatings Deposited on Substrates	4,000
Dynamic Interface	110,000
Design Allowables Code	130,000
Advanced Statistical Calculations	40,000
Advanced Statistics Calculations	100,000
Effects of Translucence on Diesel Engines	43,000
Characterization of Transformation-Toughened Ceramics	80,000
Time-Temperature Properties of Advanced Ceramics	85,000
Fracture Behavior of Toughened Ceramics	190,000
Cyclic Fatigue of Toughened Ceramics	90,000
Static Behavior of Toughened Ceramics	120,000
Corrosion/Erosion Effects	240,000

Materials Properties, Behavior, Characterization, or Testing (Continued)	FY 1985
Environmental Effects in Toughened Ceramics	$ 125,000
High Temperature Fracture Toughness Measurement	150,000
High Temperature Tensile Testing	100,000
Standard Tensile Test Development	90,000
Non-Destructive Characterization	70,000
Needs Assessment	80,000
Characterization Development	0
Materials Characterization Development	130,000
Computer-Tomography	50,000
Standard Reference Materials	110,000
Failure Analysis	0
Ceramic Durability Evaluation	100,000
High Temperature Creep Evaluation	44,000
Ceramic Corrosion Evaluation	60,000
Ceramic Component Technology	90,000
International Exchange Agreement	100,000
Specimens and Hardware for IEA	50,000
Technical Support and Monitoring Contracts	250,000
Technology Assessment and Planning	30,000
Technology Transfer	120,000
Device or Component Fabrication or Testing	$ 9,760,000
Advanced Gas Turbine Engine Technology (AGT-100)	$ 4,860,000
Advanced Gas Turbine Engine Technology (AGT-101)	4,900,000
Instrumentation and Facilities	$ 2,060,000
HTML Preoperational Support	$ 160,000
Capital Equipment for Advanced Materials Development Program	1,900,000

OFFICE OF TRANSPORTATION SYSTEMS

The Office of Transportation Systems has established a number of programs to conserve energy used for transportation and to shift transportation energy demand to nonpetroleum fuels.

The Vehicle Propulsion Technology Development program is underway to provide industry with proof-of-concepts for advanced gas turbine and Stirling engine technologies that demonstrate improvements in fuel efficiency and to develop technology for heavy-duty diesel operation under uncooled minimum friction conditions, including waste heat utilization.

The Advanced Materials Development program's objective is to establish an industrial technology base capable of providing reliable and cost-effective structural ceramics for application to advanced heat engines. Project management responsibility for the Heat Engine Highway Vehicle Systems project (gas turbine and Stirling engines) and the Heavy Duty Transport Technology project (diesel engine) has been delegated to the NASA Lewis Research Center. Project management of the Ceramic Technology for Advanced Heat Engines project (Advanced Materials Development program) has been assigned to the Oak Ridge National Laboratory (ORNL). The Army Materials and Mechanics Research Center (AMMRC) support is part of the Ceramic Technology project under ORNL technical management.

The success of these advanced heat engine systems depends strongly on the development of new or improved materials. Ceramic materials are needed for the hot-flow-path components of the advanced gas turbine and the minimum friction adiabatic (uncooled) diesel engines, to meet operating temperature and manufacturing cost requirements. The Stirling engine requires low-cost iron-based alloys capable of operating at high temperatures while exposed to high-pressure hydrogen. Material technology development programs are underway for each of these heat engine systems. The generic ceramic technology program consists of three general topics: materials and processing; data base and life prediction; and design methodology. To support the advanced material work conducted under this and other research programs, a High Temperature Materials Laboratory (HTML) is being constructed at ORNL.

Key elements of each program are organized and described briefly in the following. Robert B. Schulz is the DOE contact, (202) 252-8055, for overall coordination of the following Office of Transportation Systems material projects.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Silicon Carbide Powder Synthesis - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact E.L. Long, Jr., 615-574-5172; Sohio Engr. Mat. Co. Contact J. Halstead, 716-278-2330

- Develop improved, sinterable silicon carbide powder that is scalable, environmentally acceptable, amenable to doping, low cost (< $20/lb), submicron particle size, narrow distribution, high surface area, and high purity.

Powder Characterization - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; AMMRC Contact R.N. Katz, 617-923-5415

- Investigate solution chemistry, laser vapor chemistry, organometallic chemistry.

Sintering of Si_3N_4 - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; AMMRC Contact R.N. Katz, 617-923-5415

- Determine optimum sintering aid and time-temperature-pressure for sintered Si_3N_4.

High Pressure Sintering Furnace - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; AMMRC Contact George E. Gazza, 617-923-5408

- Provide technical support for sintering of silicon nitride (AMMRC) via on-site personnel assignments to conduct high nitrogen pressure sintering experiments.

Si_3N_4 Powder Syntheses- DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact E.L. Long, Jr., 615-574-5172; Ford Contact Gary M. Crosbie, 313-574-1208

- Develop improved, sinterable Si_3N_4 powder that is scalable, environmentally acceptable, amenable to doping, low cost, submicron particle size, narrow distribution, high surface area, high purity.

Dispersion Toughened Silicon Carbide - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832

- Identify silicon carbide matrix-dispersed particle system(s) having superior high-temperature fracture toughness and fracture strength to monolithic ceramics.

Dispersion Toughened Si_3N_4 - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact T.N. Tiegs, 615-574-5173; AiResearch Casting Company Contact M.V. Mitchell

- Development of toughened silicon nitride ceramic for AGT applications.

Dispersion Toughened Si_3N_4 - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact T.N. Tiegs, 615-574-5173; Rocketdyne Contact J.R. Wooten, 818-710-5972

- Development of toughened silicon nitride ceramic for application in advanced heat engines.

Dispersion Toughened Si_3N_4 - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact M.A. Janney, 615-574-4281; GTE Laboratories, Incorporated Contact Han Kim, 617-466-2742

- Development of toughened silicon nitride ceramic for AGT applications.

Oxide Matrix Composites - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact T.N. Tiegs, 615-574-51737

- Develop oxide matrix composites with improved strength and toughness over monolithic oxide ceramics.

Processing of Improved Transformation-Toughened Ceramics - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact P.F. Becher, 615-574-5157; Norton Company Contact L.A. Ebel, 617-853-1000

- Improved transformation-toughened ceramic for adiabatic diesel application.

Sol Gel Oxide Powder - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact W.D. Bond, 615-574-7071

- Determine processing requirements to provide homogeneous submicron dispersion of zirconia (yttria) and zirconia (hafnia yttria) in alumina powders and provide coatings for silicon carbide whiskers.

Advanced Transformation Toughened Oxides - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact R.N. Katz, 617-923-5415; University of Michigan Contact T.Y. Tien, 313-764-9449

- Development of transformation-toughened alumina and mullite ceramics for adiabatic diesel application.

Injection Molded Composites - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact M.A. Janey, 615-574-4281

- Development of advanced methods for forming ceramic matrix composites, such as injection molding with short binder burnout time.

Injection Molded Composites - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact M.A. Janney, 615-574-4281

- Development of an industrial process for forming whisker or particulate toughened ceramics to near-net-shape by injection molding.

Toughened Ceramics Adiabatic Diesel Engines - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact P.F. Becher, 615-574-5157; Ceramatec Contact Raymond Cutler, 801-486-5071

- Develop toughened ceramics for use in the adiabatic diesel engines via layering chemical compositions to achieve compressive surface stresses.

Fiber Reinforced Silicates - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact T.N. Tiegs, 615-574-5173; GE, VFSC Contact Robert C. Rosenberg, 215-354-1000

- Development of toughened mullite ceramic for adiabatic diesel application.

Advanced Coating Technology - AGT - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.P. Stinton, 615-574-4556

- Develop an oxidation resistant, adherent coating for SiC and Si_3N_4 that will reduce contact stress among touching static parts. RFPs will be prepared to locate qualified subcontractor.

Advanced Coating Technology Diesel - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.P. Stinton, 615-574-4556

- Development of adherent, wear-resistant refractory ceramic coatings on metal substrates for use on components of uncooled diesel engines.

Active Metal Brazing PSZ-Iron - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact M.L. Santella, 615-574-4805

- Develop brazing processes for joining ceramic components to nodular cast iron for adiabatic diesel application.

Ceramic-Metal Joints AGT - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact A.J. Moorhead, 615-574-5153

- Development of the technology required to reliably join advanced gas turbine (AGT) ceramic rotors to the high-temperature alloy rotor shafts.

Diesel Ceramic-Metal Joint Scale-up - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact A.J. Moorhead, 615-574-5153

- To extend technology developed at ORNL (in WBS 1.4.1.1) to larger shapes and to mechanically characterize the joints under appropriate conditions of high temperatures and combustion-product gaseous atmospheres.

Ceramic-Ceramic Joints AGT - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact A.J. Moorhead, 615-574-5153

- Develop technology for strong reliable SiC/SiC and Si_3N_4/Si_3N_4 joints for application in the Advanced Gas Turbine.

Ceramics for Stirling Engine Applications - DOE Contact Patrick L. Sutton, 202-252-8012; NASA LeRC Contact Tom Herbell, 216-433-6092

- Assess the potential of several candidate ceramics for application to Stirling engines, with emphasis on mullite.

Materials Development - Intermetallic Evaluation - DOE Contact Patrick L. Sutton, 202-252-8012; NASA LeRC Contact Joseph R. Stephens, 216-433-3195; Case Western Research University Contact Krishna Vedula, 216-368-4211

- Investigate intermetallic compounds as potential materials for advanced Stirling engines.

Cast Iron Alloy Nonstrategic Elements - DOE Contact Patrick L. Sutton, 202-252-8012; NASA LeRC Contact C.M. Scheuerman, 216-433-3199; United Technologies Research Center Contact F.D. Lemkey, 203-727-7318

- Identify a ferrous alloy for the automotive Stirling engine cylinder and regenerator housings which contain only nonstrategic materials.

Materials Properties, Behavior, Characterization, or Testing

High Temperature Coating to Reduce Contact Stress - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; Garrett Turbine Engine Company Contact James P. Donlan, 602-231-1000

- Develop zirconia coatings on silicon carbide and silicon nitride ceramics to reduce static contact stresses and resulting loss of strength in gas turbine structural parts.

Adherence Coatings Deposited on Substrates - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact C.J. McHargue, 615-574-4344; University of Tennessee Contact J.E. Stoneking, 615-974-2171

- Provide financial support for graduate research assistantship in the Department of Engineering Science.

Dynamic Interface - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact E.L. Long, Jr., 615-574-5172; Battelle Columbus Laboratories Contact K.F. Dufrane, 614-424-6424

- Develop generic understanding of the friction and wear behavior of material interfaced between monolithic ceramics and ceramic-coated alloys in which the materials experience motion as in adiabatic diesel engines.

Design Allowables Code - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; AMMRC Contact R.N. Katz, 617-923-5415

- Continue development and improvement of component failure and life estimating technology by developing a computer code for determining design allowables from experimental strength data.

Advanced Statistical Calculations - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact W.P. Eatherly, 615-574-5220

- Statistical tools for characterization strength of structural ceramics in a meaningful and realistic way for use in design codes.

Advanced Statistics Calculations - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact W.P. Eatherly, 615-574-5220; GE Contact Barbara Kuhn, 518-387-6378

- Develop advanced statistical techniques for describing and characterizing frequency distributions of strengths in realistic cases of multiple and time-dependent distributions.

Failure Analysis - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; National Bureau of Standards Contact S.M. Hsu, 301-921-2846

- Microstructural analysis of corrosive reactions in structural ceramics.

Effects of Translucence on Diesel Engines - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; ITI Contact T. Morel, 312-789-0003

- Evaluate the effects of translucence on diesel engines that use ceramics for heat barriers.

Characterization of Transformation-Toughened Ceramics - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615- 576-6832; AMMRC Contact R.N. Katz, 617-923-5415

- Determine the effect of time-at-temperature on toughened oxide ceramics especially zirconia and alumina zirconia materials.

- Screen advanced and experimental toughened oxide ceramics.

Time-Temp Properties of Advanced Ceramics - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; AMMRC Contact R.N. Katz, 617-923-5415

- Characterize time dependent high-temperature behavior of SiC and Si_3N_4 ceramics.

Fracture Behavior of Toughened Ceramics - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact P.F. Becher, 615-574-5157

- Determine fatigue life characteristics of PSZ and dispersion toughened Al_2O_3 as function of temperature.

Cyclic Fatigue of Toughened Ceramics - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact C.R. Brinkman, 615-576-5106

- Characterize tensile cyclic fatigue of toughened ceramics at high temperatures.

Static Behavior of Toughened Ceramics - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact V.J. Tennery, 615-574-5124; University of Illinois-Urbana Contact M.K. Ferber, 217-333-7579

- Determine fatigue life characteristics of PSZ and dispersion toughened Al_2O_3 as function of temperature.

Corrosion/Erosion Effects - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; NBS Contact S.M. Hsu, 301-921-2487

- Characterize the behavior of AGT materials subjected to corrosion by salts in combustion air and/or alternate fuels combined with erosion by combustion.

Environmental Effects in Toughened Ceramics - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact V.J. Tennery, 615-574-5124; University of Dayton Contact N.L. Hecht, 513-229-4343

- Investigate effects of water vapor (in combustion gas from adiabatic diesel) on time-dependent strength of transformation-toughened ceramics.

High Temperature Fracture Toughness Measurement - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact V.J. Tennery, 615-574-5124; University of Washington Contact R.C. Bradt, 206-543-2600

- Develop and demonstrate improved fracture toughness test(s).

High Temperature Tensile Testing - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D. Ray Johnson, 615-576-6832; N.C. A&T University Contact J. Sankar, 919-379-7620

- Design and fabricate the ceramic specimens, grips, and extensometer.
- Conduct uniaxal tensile testing of SiC and Si_3N_4.

Standard Tensile Test Development - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; National Bureau of Standards Contact S.M. Hsu, 301-921-2846

- Development of tensile test standards for characterizing strength and creep behavior of ceramic specimens at elevated temperatures.

Non-Destructive Characterization - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact R.W. McClung, 615-574-4466

- Develop and demonstrate non-destructive characterization tools for structural ceramics.

Needs Assessment - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact R.W. McClung, 615-574-4466

- National assessment of the material characterization measurements and techniques needed for the manufacturing of reliable ceramic components.

Characterization Development - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact R.W. McClung, 615-574-4466

- New effort in materials characterization techniques for manufacture of structural ceramics as opposed to (inspecting-in).

Materials Characterization Development - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; AMMRC Contact J.W. McCauley, 617-923-5364

- Establish set quantifiable powder characteristics and properties to measure.

Computer-Tomography - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; ANL Contact W.A. Ellingson, 312-972-5068

- X-ray beam hardening correction and calibration development for computer-tomography applications to structural ceramics.

Standard Reference Materials - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D.R. Johnson, 615-576-6832; NBS Contact S.M. Hsu, 301-921-2846

- Sampling and characterization of ceramic starting powders.

Ceramic Durability Evaluation - DOE Contact Saunders B. Kramer, 202-252-8012; NASA LeRC Contact Sunil Dutta, 216-433-3282; Garrett Turbine Engine Company Contact K.W. Benn, 602-231-4373

- Assess the capability of ceramic materials to perform satisfactorily at temperatures and exposure times defined for automotive turbine engines.

High Temperature Creep Evaluation - DOE Contact Patrick L. Sutton, 202-252-8012; NASA LeRC Contact R.H. Titran, 216-433-3200

- Evaluate the effects of brazing cycle and alloy composition or creep-rupture properties and Stirling engine operating temperatures.

Ceramic Corrosion Evaluation - DOE Contact Saunders B. Kramer, 202-252-8012; NASA LeRC Contact Carl A. Stearns, 216-433-5500

- Determine the effects of fuel and ingested impurities on the most promising of the durability tested ceramic materials.

Ceramic Component Technology - DOE Contact Saunders B. Kramer, 202-252-8012; NASA LeRC Contact Alex Vary, 216-433-6019

- Identify and develop NDE techniques for ceramic heat engine components.

International Exchange Agreement - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D. Ray Johnson, 615-576-6832

- Stimulate and encourage international cooperation in the development of voluntary standards for structural ceramics.

Specimens and Hardware for IEA - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D. Ray Johnson, 615-576-6832

- Provide funding for procurement of specimens and hardware for annex II of the IEA agreement.

Technical Support and Monitoring Contracts - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D. Ray Johnson, 615-576-6832

- Expert technical support and technical program monitoring by cognizant researchers who support industrial and university subcontracts.

Technology Assessment and Planning - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D. Ray Johnson, 615-576-6832

- Technology assessment and planning in order to keep ORNL ceramic technology for advanced heat engines program plan current.

Technology Transfer - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D. Ray Johnson, 615-576-6832

- Facilitation of the transfer of technology to private industry.

Device or Component Fabrication or Testing

Advanced Gas Turbine Engine Technology (AGT-100) - DOE Contact Saunders B. Kramer, 202-252-8012; NASA LeRC Contact P. Kerwin, 216-433-3409; GM/Allison/Pontiac Contact H.E. Helms, 317-242-5335

- Develop an advanced technology base applicable to a competitive automotive gas turbine engine.

Advanced Gas Turbine Engine Technology (AGT-101) - DOE Contact Saunders B. Kramer, 202-252-8012; NASA LeRC Contact T.V. Strom, 216-433-3408; Garrett/Ford Contact E.E. Strain, 602-231-2797

- Develop an advanced technology base applicable to a competitive automotive gas turbine engine.

Instrumentation and Facilities

HTML Pre-Operational Support - DOE Contact Anne Marie Zerega, 202-252-8053; ORNL Contact V.J. Tennery, 615-574-5123

- Provide pre-operational support for the high temperature materials laboratory (HTML) in FY 1985.

Capital Equipment for Advanced Materials Development Program - DOE Contact Robert B. Schulz, 202-252-8055; ORNL Contact D. Ray Johnson, 615-576-6832

- Purchase capital equipment for the advanced materials development project.

OFFICE OF ENERGY STORAGE AND DISTRIBUTION

	FY 1985
Office of Energy Storage and Distribution Grand Total	$ 7,300,000
Energy Storage Technology Division	$ 4,135,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 3,155,000
Hydrogen Technology Evaluation Center	$ 100,000
Anode Depolarization Studies	15,000
Medium Temperature Solid Electrolytes - Proton Conductors	125,000
Ceramics Research	1,000,000
Metals and Alloys	900,000
Organometallic Compounds	300,000
Polymers	180,000
Composite High Temperature Thermal Storage Media	150,000
Formation of Encapsulated Metallic Eutectic Thermal Storage Alloy	50,000
Materials for Advanced High-Temperature Molten Salt Storage	25,000
Water Electrolysis with Protonic " Alumina Electrochemical Cells	150,000
Hydrogen Production with Photoactive Semiconductor Catalysts	160,000
Materials Properties, Behavior, Characterization, or Testing	$ 975,000
Solid State Radiative Heat Pump	$ 50,000
Use of Micro Particles as Heat Exchangers and Catalysts	50,000
Formation and Dissolution of Gas Clathrates	50,000
Evaluation of Advanced Thermal Energy Storage Media	250,000
High Temperature Water Electrolysis	200,000
Hydrogen Embrittlement of Pipeline Steels	45,000
Geochemical Stability of Sandstones	15,000
Metal-Assisted Cold Storage (MACS) of Hydrogen on Activated Carbon	140,000
Electrochemical Techniques for H_2 Storage in Metal Hydrides	50,000
Advanced Hydrogen Storage - Modified Vanadium Hydride	125,000
Instrumentation and Facilities	$ 5,000
Analysis of Zeolite Augmented Ice Storage	$ 5,000

<u>Electric Energy Systems Division</u>	$ 3,165,000
<u>Materials Properties, Behavior, Characterization, or Testing</u>	$ 1,665,000
High Voltage Breakdown Strengths of Insulating Gases and Liquids	$ 520,000
Factors Influencing Aging in Extruded Dielectrics	150,000
Threshold and Maximum Operating Electric Stresses for Selected High Voltage Insulations	150,000
Multifactor Aging and Evaluation of Polymeric Materials	$ 220,000
Solid Dielectrics and Interfacial Breakdown	150,000
Investigation of Interfacial Phenomena in Compressed Gases	75,000
Interfacial Aging Phenomena in Power Cable Insulation Systems	150,000
Study of Dynamic Insulation with Advanced Metal Oxide (ZnO) Materials	100,000
Development of Amorphous Ferromagnetic Alloy for Motors and Transformers	150,000
<u>Device or Component Fabrication, Behavior, or Testing</u>	$ 1,500,000
AC Superconducting Power Transmission Cable Development	$ 1,500,000

OFFICE OF ENERGY STORAGE AND DISTRIBUTION

Energy Storage Division

The principal function of the Energy Storage Division is to foster more efficient and more economical use of intermittent energy sources. A vital part of this R&D effort is the development of new and improved materials. Activities include materials development, fabrication, characterization and compilation of data bases.

Materials Preparation, Synthesis, Deposition, Growth or Forming

Hydrogen Technology Evaluation Center - DOE Contact M. Gurevich, 202-252-1507; BNL Contact P.D. Metz, 516-252-4091

- Establishment of a test/simulation facility which includes a 5 kW photovoltaic array with automated data control and recording equipment, an advanced 15 kW General Electric SPE electrolyzer, and an advanced technology metal hydride compressor.

Anode Depolarization Studies - DOE Contact M. Gurevich, 202-252-1507; BNL Contact F. Salzano, 516-282-4458

- Investigate whether an anode depolarizing agent could be used to reduce the overvoltage required to produce hydrogen at the same time producing an alternate product at the anode.
- Identification of redox couples that could provide a two-step reaction sequence.
- Upgrading of hydrocarbons via the conversion of alkanes to alcohols in electrochemical reactions.

Medium Temperature Solid Electrolytes - Proton Conductors - DOE Contact M. Gurevich, 202-252-1507; BNL Contact F. Salzano, 516-282-4458

- Development of proton-conducting electrolytes capable of operating in 500 - 600 degrees C temperature regime.

Water Electrolysis with Protonic β'' Alumina Electrochemical Cells - DOE Contact M. Gurevich, 202-252-1507; University of Pennsylvania Contact G. Farrington, 215-898-8337

- Preparation and evaluation of proton (or hydronium ion) conducting membranes suitable for use in medium temperatures (300-600°C) vapor electrolysis.

Hydrogen Production with Photoactive Semiconductor Catalysts - DOE Contact M. Gurevich, 202-252-1507; Battelle Columbus Lab Contact R. Schwerzel, FTS 976-5637

- Obtain metallized plasma-polymerized films of suitable transparency and conductivity that exhibit stable long life, and are compatible with the semiconductor band gap requirements for photo-assisted electrolysis.

- Characterization of single-crystal and powdered photocatalysts using advanced coatings prior to conducting acqueous electrolysis experiments.

Ceramics Research - DOE Contact A. Landgrebe, 202-252-1483; LBL Contact E. Cairns, 415-486-5028; SNL Contact R. Clark, 505-844-6332

- Superconducting ionic materials.

- Materials for electrochemical corrosion prevention in batteries.

Metals and Alloys - DOE Contact A. Landgrebe, 202-252-1483; LBL Contact E. Cairns, 415-486-5028

- Aluminum alloys prepared as negative electrodes.

- Platinum alloys prepared for use as electrocatalysts in fuel cells and aluminum/air batteries.

Organometallic Compounds - DOE Contact A. Landgrebe, 202-252-1483; Eltech Systems Corporation Contact L. Gestaut, 216-357-4041

- Macrocyclic compounds of transition metals for use as electrocatalysts in fuel cells.

Polymers - DOE Contact A. Landgrebe, 202-252-1483; LBL Contact E. Cairns, 415-486-5028

- Electronically and ionically conducting polymers for use as electrodes and electrolytes in batteries and fuel cells.

Composite High Temperature Thermal Storage Media - DOE Contact Eberhart Reimers, 202-252-4844; IGT Contact Randy Petri, 312-567-3985

- Development of prototype fabrication process for impregnating ceramic powder (MgO, $NaAlO_2$, $LiAlO_2$) with carbonate salts for thermal storage pellet.

Formation of Encapsulated Metallic Eutectic Thermal Storage Alloy- DOE Contact Eberhart Reimers, 202-252-4844; Ohio State University Contact Prof. Robert Rapp, 614-422-2491

- Develop a method of achieving an impermeable coating on pellets of metallic eutectic with high melting temperatures for latent heat thermal energy storage.

Materials for Advanced High Temperature Molten Salt Storage - DOE Contact M. Gurevich, 202-252-1507; SERI Contact B. Goodman, 303-231-1005

- Testing of materials corrosion on Incoloy 800, Inconel 600, and Nickel 600.

Materials Properties, Behavior, Characterization, or Testing

Solid State Radiative Heat Pump - DOE Contact Eberfort Reimers, 202-252-4844; LBL Contact Roland Otto, 415-486-5289

- Investigation of a cooling effect using galvanometric luminescence from indium-antimonide.

Use of Micro Particles as Heat Exchangers and Catalysts - DOE Contact Eberhart Reimers, 202-252-4844; LBL Contact Roland Otto, 415-486-5289

- Measurement of dissociated fraction for $SO_3 \rightarrow SO_2 + 1/2\ O_2$ when concentrated sunlight is absorbed by a gas particle mixture.

Formation and Dissolution of Gas Clathrates - DOE Contact Eberhart Reimers, 202-252-4844; ORNL Contact Jim Martin, 615-574-3784

- Study of use of gas clathrates of mixed refrigerants for thermal energy storage for air conditioners and heat pumps.

Evaluation of Advanced Thermal Energy Storage Media - DOE Contact Eberhart Reimers, 202-252-4844; ORNL Contact J. F. Martin, 615-576-3977

- Development of dual temperature TES media for heat and cool storage.

- Evaluation of heats of mixing and crystallization in multicomponent solutions.

- Identify through computer molecular modeling, clathrates suitable for dual temperature storage.

- Determine phase behavior of selected singly-complexing and multiply-complexing ammoniated salts in phase regions appropriate to dual temperature storage.

High Temperature Water Electrolysis - DOE Contact M. Gurevich, 202-252-1507; Westinghouse R&D Center Contact E. Buzzeli, 412-256-1952

- Solid oxide electrolyte fuel cells operated in reverse to produce hydrogen at 1000 degrees C.

Hydrogen Embrittlement of Pipeline Steels - DOE Contact M. Gurevich, 202-252-1507; Battelle Columbus Contact J. Holbrook, 614-424-4347

- Pipeline steel fracture-mechanics and fatigue-crack growth rates investigation.

- Identification of additives that inhibit effects of hydrogen embrittlement.

- Results will serve as input to a Design/Operation Manual for pipeline designers concerned with hydrogen transmission.

Metal-Assisted Cold Storage (MACS) of Hydrogen on Activated Carbon - DOE Contact M. Gurevich, 202-252-1507; Syracuse University Contact J. Schwartz, 315-423-2807

- Scale-up and operation of macrobalance apparatus to permit verification of earlier results at 100-fold increase in sample size and pressure.

- Identify optimum carbon/catalyst system useful in the operating temperature-pressure ranges appropriate to vehicle applications.

Electrochemical Techniques for H_2 Storage in Metal Hydrides - DOE Contact M. Gurevich, 202-252-1507; Stanford University Contact R. Huggins, 415-497-4110

- Study of a low melting organometallic salt ($NaAlEt_4$) saturated with NaH in which the H^- ions act as hydrogen transmitters.

- Investigate alternate systems aiming for compatibility between electrolytes, H^- ion carrier, alloy electrodes and useful operating P-C-T conditions.

Advanced Hydrogen Storage - Modified Vanadium Hydride - DOE Contact M. Gurevich, 202-252-1507; Allied Corporation Contact G. Libowitz, 201-455-9571

- Studying desorption of hydrogen at conditions compatible with practical applications.

- Study substitutional metals to allow hydrogen desorption at pressures above 1 atm at temperatures of 175°C to bring two P-C-T plateaus closer together.

Geochemical Stability of Sandstones - DOE Contact Eberhart Reimers, 202-252-4844; PNL Contact Landis Kannberg, 509-375-3919

- Laboratory testing of the effects of 150 degrees C water flow through porous sandstones.

- Determination of the degree and rate of change in sandstone hydraulic and mechanical properties.

Instrumentation and Facilities

Analysis of Zeolite Augmented Ice Storage - DOE Contact Eberhart Reimers, 202-252-4844; PNL Contact Landis Kannberg, 509-375-3919

- Facility for testing solar regenerated zeolites for augmenting the chill obtained from seasonally stored ice by using heat of sublimation rather than simply heat of fusion.

- Facility will involve cyclic absorptive capacity of several types of zeolites under highly varied operating conditions.

Electric Energy Systems Division

The EES program supports R&D to expedite the development of high-risk, long-term payback technologies which have a significant potential for improving the reliability, efficiency, and safety of the nation's electrical energy system. Research is also conducted in technologies for integrating new electrical energy sources (dispersed generation and storage) into the grid. DOE contact is Russell Eaton, 202-252-4844.

Materials Properties, Behavior, Characterization, or Testing

High Voltage Breakdown Strengths of Insulating Gases and Liquids - DOE Contact Russell Eaton, 202-252-4844; ORNL Contact Lucas Christophorou, 615-574-6199

- Determine physiochemical factors of breakdown strength of gaseous and liquid dielectrics

Factors Influencing Aging in Extruded Dielectrics - DOE Contact Russell Eaton, 202-252-4844; Battelle Columbus Contact Mike Epstein, 614-424-6424

- Identify aging mechanisms of extruded dielectrics using advanced techniques, such as thermally stimulated currents, mechanical spectroscopy, and differential scanning calorimetry.

Threshold and Maximum Operating Electric Stresses for Selected High Voltage Insulations - DOE Contact Russell Eaton, 202-252-4844; Cable Technology Lab Contact Carlos Katz, 201-846-3220

- Determine threshold voltage and maximum operating electric field strengths for selected high voltage insulation systems

Multifactor Aging and Evaluation of Polymeric Materials - DOE Contact Russell Eaton, 202-252-4844; ORNL Contact Steinar Dale, 615-574-4829

- Investigate aging of polymeric film materials. The aging will be done under combined mechanical, electrical, and thermal stresses, as well as under single stress application. The materials will be periodically analyzed for characteristic changes.

Solid Dielectrics and Interfacial Breakdown - DOE Contact Russell Eaton, 202-252-4844; ORNL Contact Steinar Dale, 615-574-4829

- Investigate electron and ion transports across interfaces between a solid dielectric and metal. Effects of electric fields, impurities, defects, and microstructures at the interfaces will be studied.

Investigation of Interfacial Phenomena in Compressed Gases - DOE Contact Russell Eaton, 202-252-4844; ORNL Contact Steinar Dale, 415-574-4829

- Investigate the initiation and propagation mechanisms of surface discharges along insulators in compressed gases. Measurements will be made of the secondary yield coefficients from insulator surfaces in the N_2 and SF_6. Models of the discharge propagation will be made.

Interfacial Aging Phenomena in Power Cable Insulation Systems - DOE Contact Russell Eaton, 202-252-4844; ORNL Contact Steinar Dale, 415-574-4829

- Investigate aging of semi-conducting/polymer insulator interfaces. Phase II will be initiated using purified materials of semi-conducting shields. Union Carbide has agreed to supply the required varieties of materials.

Study of Dynamic Insulation with Advanced Metal Oxide (ZnO) Materials - DOE Contact Russell Eaton, 202-252-4844; ORNL Contact Steinar Dale, 415-574-4829

- Determine performance of ORNL-developed sol-gel ZnO material in overhead line insulators. The performance will be compared with insulators made of commercial ZnO material, studied in FY 84 and FY 85.

Development of Amorphous Ferromagnetic Alloy for Motors and Transformers - DOE Contact Russell Eaton, 202-252-4844; ORNL Contact Steinar Dale, 615-574-4829

- Investigate micro-alloying of Fe- and Ni-based metallic glasses. A major effort will be to develop understanding of the mechanism by which cerium additions affect the mechanical and magnetic properties. Other elements which can improve the embrittlement problem in metallic glasses will also be investigated.

Device or Component Fabrication, Behavior, or Testing

Advanced Underground Power Delivery - DOE Contact Russell Eaton, 202-252-4844; BNL Contact E. Forsyth, 516-282-4676

- Develop underground AC superconducting cable system (138 kV, 4000 A) employing superconducting Nb_3Sn tape and insulation consisting of synthetic tape impregnated with supercritical helium.

- Develop underground transmission cables using oil-impregnated, fully synthetic insulating tapes as an alternative to conventional oil-impregnated kraft paper insulation used throughout the cable industry.

OFFICE OF SOLAR HEAT TECHNOLOGIES

	FY 1985
Office of Solar Heat Technologies Grand Total	$ 4,929,000
Active Heating and Cooling Division	$ 2,455,000
Materials Properties, Behavior, Characterization, or Testing	$ 1,515,000
Influence of Combined Stresses on Degradation of Polymeric Coverplate Materials	$ 300,000
Thin Film Materials Research	625,000
Sorption Studies of Desiccant Materials	120,000
Heat and Mass Transfer Analysis of Advanced Dehumidifiers	300,000
Research on Liquid Desiccant Materials	100,000
Solar Collector Materials Exposure Testing	70,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 620,000
Low Cost Process for the One Step Synthesis of U.V. Inhibitor	395,000*
Development of Improved Desiccant Materials	225,000
Device or Component Fabrication, Behavior, or Testing	$ 320,000
Research and Development on Stainless Steel Thin Material Collectors	320,000
Passive and Hybrid Solar Energy Division	$ 600,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 400,000
Optical Switching Apertures	$ 100,000
Optical Switching Materials	100,000
Transparent Insulating Materials	100,000
Phase Change Thermal Storage Materials	100,000
Materials Properties, Behavior, Characterization, or Testing	$ 200,000
Daylight Enhancement	$ 100,000
Low-Emittance, High-Transmittance Materials	100,000

* This is a Small Business Innovation Research Program project which is managed by this office.

OFFICE OF SOLAR HEAT TECHNOLOGIES (Continued)

	FY 1985
Solar Thermal Technology Division	$ 1,874,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 880,000
Silver/Polymer Reflector Research	$ 880,000
Materials Properties, Behavior, Characterization, or Testing	$ 994,000
High Temperature Materials	$ 620,000
Photo-Enhanced Degradation of Materials	120,000
Front Surface Reflector on Metal Substrates	100,000
High Temperature Windows	75,000
Composite Materials for Concentrators	79,000

Active Heating and Cooling Division

This program funds R&D projects with industry and academic institutions directed towards the development of cost-effective, reliable and publicly acceptable active solar heating and cooling systems. A major emphasis of the program is to ensure that the information derived from these projects is made available to all of the members of the solar research, manufacturing and construction communities who will benefit from it.

Materials Properties, Behavior, Characterization, or Testing

Influence of Combined Stresses on the Degradation of Polymeric Coverplate Materials - DOE Contact John Goldsmith, 202-252-8171; NBS Contact David Waksman, 301-921-3114

- Characterization of moisture degradation mechanisms occuring in polymeric glazing materials.
- Comparison of microstructural and engineering properties of cover materials and investigation of micro-level changes used to detect materials degradation.
- Prediction of service life of polymeric materials through development of mathematical models for use with short-term accelerated aging test data.

Thin Film Materials Research - DOE Contact John Goldsmith, 202-252-8171; SAN Operations Office Contact Robert LeChavalier, 415-273-6362

- Identification of appropriate polymeric glazing materials, absorber laminates and adhesives and fabrication techniques to make a practical, durable and low cost thin film collector.

Sorption Studies of Desiccant Materials - DOE Contact John Goldsmith, 202-252-8171; SERI Contact Frederica Zangrando, 303-231-1761

- Measure adsorption/desorption characteristics of promising desiccant materials as a function of physical properties, geometry, and operating environment.

Heat and Mass Transfer Analysis of Advanced Dehumidifiers - DOE Contact John Goldsmith, 202-252-8171; SERI Contact Ahmad Pesaran, 303-231-7636

- Extend, improve, and validate the solid-side resistance model of packed dehumidifier to more advanced, cost-effective dehumidifier geometries for incorporation in performance prediction and design tools.

Research on Liquid Desiccant Materials - DOE Contact John Goldsmith, 202-252-8171; ANL Contact Jack Parks, 312-972-4334

- Identify and evaluate candidate organic liquids on multi-component liquid mixtures for use in the Liquid Desiccants that can be regenerated by Liquid-Liquid Phase Separation (LIQDES-RELLPS) concept.

Solar Collector Materials Exposure Testing - DOE Contact John Goldsmith, 202-252-8171; LANL Contact Robert Jones, 505-667-6441

- Develop a database of information on the response of various solar collector materials to long-term exposure to solar radiation, elevated temperatures, and moisture.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Low Cost Process for the One Step Synthesis of U.V. Inhibitor - DOE Contact John Goldsmith, 202-252-8171; Helix Associates Contact Walther Heldt, 302-738-6581 *

- Development of a low cost one step synthesis of tetrahydroxybenzophenol for use as an additive to inhibit degradation of transparent films due to exposure to sunlight.

Development of Improved Desiccant Materials - DOE Contact John Goldsmith, 202-252-8171; ANL Contact Anthony Fraioli, 303-972-7550

- Determine moisture adsorption/desorption characteristics of MNO_2 and MNO_2/Silica Gel desiccant materials.
- Development of methods to measure absorptive equilibrium rate data on MNO_2 and silica gel.

Device or Component Fabrication, Behavior, or Testing

Research and Development on Stainless Steel Thin Material Collectors- DOE Contact John Goldsmith, 202-252-8171; BNL Contact William Wilhelm, 516-282-4708

- Development of a thin foil stainless steel/copper foil absorber-heat exchanger solar collector capable of withstanding temperatures above 150 degrees C.

* Funded under SBIR Program.

Passive and Hybrid Solar Energy Division

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Optical Switching Apertures - DOE Contact Dave Pellish, 202-252-8110; SERI Contact Dave Benson, 303-231-1162

- Evaluate the feasibility of using solid state electrochromic coatings to control transmittance through apertures in passive solar heated buildings.

Optical Switching Materials - DOE Contact Dave Pellish, 202-252-8110; LBL Contact Carl M. Lampert, 415-486-6093

- Research and synthesize new electrochromic materials (e.g., NiO_x) with broad band and response characteristics.

- Identify and synthesize potential compounds that exhibit photochromic or thermochromic properties.

- Provide scientific coordination, materials analysis and guidance to DOE contractors.

Transparent Insulating Materials - DOE Contact Dave Pellish, 202-252-8110; LBL Contact Arlon Hunt, 415-486-5370

- Investigation of optical, thermal, and structural properties of silica aerogel.

Phase Change Thermal Storage Materials - DOE Contact Dave Pellish, 202-252-8118; SERI Contact Dave Benson, 303-231-1162

- Study of solid state phase change materials (SS PCM's) for use in thermal energy storage components of passive solar heated buildings.

Materials Properties, Behavior, Characterization, or Testing

Daylight Enhancement - DOE Contact Dave Pellish, 202-252-8110; LBL Contact Mike Rubin, 415-486-7124

- Reduction of electric lighting requirements by development of light guide materials and systems which collect and transmit daylight.

Low-Emittance, High-Transmittance Materials - DOE Contact Dave Pellish, 202-252-8110; LBL Contact Mike Rubin, 415-486-7124

- Development of next generation of low-emittance, high-transmittance coatings for the control of radiant heat transfer in buildings.

Solar Thermal Technology Division

Solar Thermal Technology is developing central receivers, parabolic dishes, and parabolic troughs to concentrate the sun's energy. This concentrated energy can then be used for industrial process heat, generating electricity, or producing fuels and chemicals. The combination of concentrated direct solar flux (to 2000 suns) and high temperature (to 2000°F) cause unique materials problems that are now being characterized in areas of heat transfer fluids, metals, ceramics, and windows. In addition, the solar caused degradation of silvered polymers is also being studied with the objective being a highly reflective, environmentally stable, low cost reflector.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Silver/Polymer Reflector Research - DOE Contact Frank Wilkins, 202-252-1684; SERI Contact Gordon Gross, 303-231-1222

- Develop understanding of degradation mechanisms in candidate polymer/silver combinations.
- Identify silvered polymers that have a useful life of 5-10 years, at least a 90% reflectance and low cost.
- Modify polymers using two approaches - bulk stabilization and surface modification.
- Improve durability of polymers in solar thermal applications.

Materials Properties, Behavior, Characterization, or Testing

High Temperature Materials - DOE Contact Frank Wilkins, 202-252-1684; SERI Contact Gordon Gross, 303-231-1222

- Identify the radiative absorptance and transmittance of carbonate salts from 500°C to 900°C.
- Identify suitable ceramic materials for solar thermal applications, particularly in combination with carbonate salts.
- Identify and define failure modes of metal tubes that have been subjected to high flux, high temperature, and thermal cycling.
- Investigate durability of ceramic and metallic parts under cyclic heating typical of solar thermal systems.

Photo-Enhanced Degradation of Materials - DOE Contact Frank Wilkins, 202-252-1684; SERI Contact Gordon Gross, 303-231-1222

- Investigate high flux photo-enhanced degradation of materials, and identify possible changes in coatings to reduce these effects.

- Compare the degradation caused by oven heating and that produced by radiant flux.

Front Surface Reflector on Metal Substrates - DOE Contact Frank Wilkins, 202-252-1684; SERI Contact Gordon Gross, 303-231-1222

- Establish the limits of surface smoothness for stainless steel.

- Explore the use of leveling polymers as a specular base for silver deposited on stainless steel.

High Temperature Windows - DOE Contact Frank Wilkins, 202-252-1684; SERI Contact Gordon Gross, 303-231-1222

- Identify coatings to prevent the devitrification of high temperature, transparent windows.

- Identify and test methods of joining window sections together that would allow them to withstand high flux.

Composite Materials for Concentrators - DOE Contact Frank Wilkins, 202-252-1684; SERI Contact Gordon Gross, 303-231-1222

- Determine feasibility of using advanced composite materials and wood laminates for low cost heliostats.

OFFICE OF SOLAR ELECTRIC TECHNOLOGIES

	FY 1985
Office of Solar Electric Technologies Grand Total	$24,600,000
Photovoltaic Energy Technology Division	$24,600,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$19,800,000
Amorphous Silicon for Solar Cells	$ 8,000,000
Polycrystalline Thin Film Materials for Solar Cells	3,600,000
Deposition of High Purity Polycrystalline Silicon from Silane in a Fluidized-Bed Reactor	700,000
Growth of Silicon Ribbons For Solar Cells	4,000,000
Deposition of III-V Semiconductors for High-Efficiency Solar Cells	3,500,000
Materials Properties, Behavior, Characterization, or Testing	$ 3,000,000
Materials and Device Characterization	$ 3,000,000
Device or Component Fabrication, Behavior, or Testing	$ 1,800,000
High-Efficiency Crystal Silicon Solar Cells	$ 1,800,000

Photovoltaic Energy Technology Division

The primary goal of the national photovoltaic program is to reduce the uncertainties surrounding photovoltaic technology, so that the private sector may make informed investment decisions in this area. Successful uncertainty reduction will require advances in several areas of materials technology.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Amorphous Silicon for Solar Cells - DOE Contact Morton B. Prince, 202-252-1725; SERI Contact Ed Sabisky, 303-231-1483

- Plasma enhanced CVD (glow discharge), thermal CVD, and sputtering techniques with long term goal of developing 12% efficient cells of area of 1000 cm^2.

Polycrystalline Thin Film Materials for Solar Cells - DOE Contact Morton B. Prince, 202-252-1725; SERI Contact Kenneth Zweibel, 303-231-7141

- Investigation of chemical and physical vapor deposition, electrodeposition, and sputtering techniques for depositing stoichiometric films of $CuInSe_2$ and CdTe.
- Large area (1000 cm^2) control of interlayer diffusion, lattice matching and stoichiometry for long-term enhancement of 15% efficient large area solar cells.

Deposition of High Purity Polycrystalline Silicon from Silane in a Fluidized-Bed Reactor - DOE Contact Morton B. Prince, 202-252-1725; JPL Contact Andrew Morrison, 818-354-7200

- Deposition of semiconductor grade silicon from high purity silane in a fluidized bed reactor.
- Investigation of nucleation and growth of silicon particles and determination of impurities in deposited silicon.

Growth of Silicon Ribbon for Solar Cells - DOE Contact Morton B. Prince, 202-252-1725; JPL Contact Andrew Morrison, 818-354-7200

- Investigation of high speed crystal growth stresses on ribbon formation and solar cell performance.
- Study of fundamental problems of ribbon growth.

Deposition of III-V Semiconductors for High-Efficiency Solar Cells- DOE Contact Morton B. Prince, 202-252-1725; SERI Contact John Benner, 303-231-1396

- Deposition by CVD, LPE, and MBE of III-V's in order to study interfaces between layers and for precise control of thickness and uniformity.

- Long-term goal of 35% efficient concentrator cells and 20% and 100 cm^2 flat plate cells.

Materials Properties, Behavior, Characterization, or Testing

Materials and Device Characterization - DOE Contact Morton B. Prince, 202-252-1725; SERI Contact Larry Kazmerski, 303-231-1115; JPL Contact Ram Kachare, 818-354-4583

- Surface and interface analysis, electro-optical characterization and cell performance evaluation.

- Critical material/cell parameters study of such things as impurities, layer mismatch and other defects using a wide variety of instruments.

Device or Component Fabrication, Behavior, or Testing

High-Efficiency Crystal Silicon Solar Cells - DOE Contact Morton B. Prince, 202-252-1725; SERI Contact John Benner, 303-231-7299; JPL Contact Ram Kachare, 818-354-4583

- Investigation of new coatings and/or dopants and other treatment that reduce electron-hole recombination at cell surfaces or in the bulk.

OFFICE OF RENEWABLE TECHNOLOGY

	FY 1985
Office of Renewable Technology Grand Total	$ 1,590,000
Geothermal Technologies Division	$ 1,360,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 550,000
High Temperature Elastomers for Dynamic Sealing Applications	$ 125,000
Advanced Materials for Lost Circulation Control	75,000
Pitting Resistant Steels	50,000
In-Situ Conversion of Drilling Fluids into Cements	30,000
Geothermal Waste Utilization and Disposal	135,000
Materials for Non-Metallic Heat Exchangers	100,000
Biochemical Concentration and Removal of Toxic Components from Geothermal Wastes	35,000
Materials Properties, Behavior, Characterization, or Testing	$ 300,000
Corrosion Resistant Elastomeric Liners for Well Casing	$ 150,000
Downhole Testing of High Temperature Geothermal Well Cements	100,000
Corrosion in Binary Geothermal Systems	50,000
Device or Component Fabrication, Behavior, or Testing	$ 510,000
High Temperature Cathodic Protection Systems	$ 50,000
Field Tests of Advanced Monitoring Instruments	185,000
Particle Measurement In-Line Instrument	275,000
Biofuels and Municipal Waste Division	$ 230,000
Materials Properties, Behavior, Characterization, or Testing	$ 230,000
Refuse Derived Fuel (RDF) Binder Research	$ 230,000

Geothermal Technology Division

The primary goal of the geothermal materials program is to ensure that the private sector development of geothermal energy resources is not constrained by the availability of technologically and economically viable materials of construction. This requires the performance of long-term high risk GTD-sponsored materials R&D.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

High Temperature Elastomers for Dynamic Sealing Applications - DOE Contact R. LaSala, 202-252-8077; BNL Contact L.E. Kukacka, 516-282-3065

- Chemical modification of previously developed and tested Y-267 EPDM 260 degrees C static seal material for use in dynamic sealing applications.
- Optimization of EPDM formulations for use in critical high cost applications such as in downhole drill motors and open-hole packers.

Advanced Materials for Lost Circulation Control - DOE Contact R. LaSala, 202-252-8077; BNL Contact L.E. Kukacka, 516-282-3065

- Investigation of hydrothermally stable and pumpable chemical systems for use as lost circulation control materials in geothermal well drilling operations.

Pitting Resistant Steels - DOE Contact R. LaSala, 202-252-8077; BNL Contact D. van Rooyen, 516-282-4050

- Studies of the mechanism whereby high corrosion resistance is obtained through alloying of stainless steels with molybdenum combined with nitrogen.

In-Situ Conversion of Drilling Fluids into Cements - DOE Contact R. LaSala, 202-252-8077; BNL Contact L. E. Kukacka, 516-282-3065

- Studies of high temperature interactions between the constituents of drilling muds, reactive solid additives and chemical fluids.

Geothermal Waste Utilization and Disposal - DOE Contact R. LaSala, 202-252-8077; BNL Contact L.E. Kukacka, 516-282-3065

- Studies of methods for utilizing waste constituents as raw materials for cementitious binders or as nonleachable fillers in composites that can be used for general construction purposes.

Biochemical Concentration and Removal of Toxic Components From Geothermal Wastes - DOE Contact R. LaSala, 202-252-8077; BNL Contact L.E. Kukacka, 516-282-3065

- Analyses of biochemical techniques for concentrating and subsequent removal of toxic metals from waste.
- Establish optimum conditions for microorganism-metal interactions.

Materials for Non-Metallic Heat Exchangers - DOE Contact R. LaSala, 202-252-8077; BNL Contact L.E. Kukacka, 516-282-3065

- Development of corrosion resistant metallic and silicon carbide-filled composites which have thermal conductivities in the range of stainless steels.

Materials Properties, Behavior, Characterization, or Testing

Corrosion Resistant Elastomeric Liners for Well Casing - DOE Contact R. LaSala, 202-252-8077; BNL Contact L.E. Kukacka, 516-282-3065

- Investigation of high temperature chemical coupling systems for bonding elastomeric liners to carbon steel well casing.
- Data on corrosion resistance of Y-267 EPDM-lined carbon steel casing for comparison with those for high chrome and nickel alloys.

Advanced High Temperature Geothermal Well Cements - DOE Contact R. LaSala, 202-252-8077; BNL Contact L. E. Kukacka, 516-282-3065

- Preliminary screening tests on lightweight cement slurries.
- Characterization of promising light weight, high temperature well cements under placement and downhole environmental conditions.

Corrosion in Binary Geothermal Systems - DOE Contact R. LaSala, 202-252-8077; BNL Contact D. van Rooyen, 516-282-4050

- Quantitative corrosion data from laboratory and plant tests for metals presently used in binary plants and other more potentially resistive metals and nonmetals.

Metallic Lines for Well Casing - DOE Contact R. LaSala, 202-252-8077; BNL Contact D. van Rooyen, 516-282-4050

- Quantitative corrosion data from laboratory and field test of metals being considered for use as lines on geothermal well casings.

Device or Component Fabrication, Behavior, or Testing

High Temperature Cathodic Protection Systems - DOE Contact R. LaSala, 202-252-8077; BNL Contact D. van Rooyen, 516-282-4050

- Testing and characterization of high temperature electrochemical processes designed to cathodically protect the external surfaces of well casing and heat exchangers.

Field Tests of Advanced Monitoring Instruments - DOE Contact G.J. Hooper, 202-252-4153; PNL Contact D.W. Shannon, 509-376-3139

- Field testing of advanced instruments to monitor brine chemistry, corrosion, scaling and suspended solids in geothermal waters.

Particle Measurement In-Line Instrument - DOE Contact G.J. Hooper, 202-252-4153; PNL Contact D.W. Shannon, 509-376-3139

- Development and testing of instruments capable of measuring total amount of solid material pumped into geothermal injection wells.

- Measurement of the particle counts in each size range as a function of time and total fluid injections.

Biofuels and Municipal Waste Division

The goal of the Energy from Municipal Waste (EMW) Division is to provide the technical information base from which industry can develop future technologies for the recovery of liquid and gaseous fuels and other usable energy products and materials from municipal solid waste, and to increase the energy efficiency of municipal wastewater treatment processes.

Materials Properties, Behavior, Characterization, or Testing

Refuse Derived Fuel (RDF) Binder Research - DOE Contact Donald Walter 202-252-1697; ANL Contact Ole Ohlsson, 312-972-5593

- Identification and testing of chemical binders that will enhance the storability and overall material integrity of densified RDF.

- Identification of alternative methods of densifying RDF.

- Economic evaluation of the applications of identified binders and alternative densification methods vis-a-vis existing technology.

OFFICE OF ENERGY RESEARCH

	FY 1985
Office of Energy Research Grand Total	$162,479,000
Office of Basic Energy Sciences	$134,361,000
Division of Materials Sciences	$133,055,000
Metallurgy and Ceramics	$ 49,510,000
Structure of Materials	$ 18,645,000
Mechanical Properties	8,300,000
Physical Properties	9,580,000
Radiation Effects	5,370,000
Engineering Materials	7,615,000
Solid State Physics	$ 69,900,000
Neutron Scattering	$ 21,290,000
Experimental Research	35,875,000
Theoretical Research	5,390,000
Particle-Solid Interactions	2,090,000
Engineering Physics	5,255,000
Materials Chemistry	$ 13,645,000
Chemical Structure	$ 3,150,000
Engineering Chemistry	4,070,000
High Temperature and Surface Chemistry	6,425,000
Division of Engineering and Geosciences	$ 1,306,000
Materials Properties, Behavior, Characterization, or Testing	$ 691,000
Damage Accumulation by Crack Growth under Combined Creep and Fatigue	$ 56,000
Electrochemical Wear Mechanism and Deposit Formation in Lubricated Systems	93,000
Engineering Analysis of Elastic-Plastic Fracture	175,000
Continuous Damage Theory	43,000
Loss Characteristics of Cord-Rubber Composites	75,000
A Study of the Chemical Mechanism in Lubrication	60,000

		FY 1985
Office of Basic Energy Sciences (Continued)		
Division of Engineering and Geosciences (Continued)		
Materials Properties, Behavior, Characterization, or Testing (Continued)		
Effects of Crack Geometry and Near-Crack Material Behavior on Scattering of Ultrasonic Waves for QNDE Applications	$	59,000
Crack-Tip Fields for Materials with Exponential-Law Creep Behavior at High Stress		0
Mechanical Interactions of Rough Surfaces		130,000
Device or Component Fabrication, Behavior, or Testing	$	145,000
Improvement of Reliability of Welding by In-Process Sensing and Control	$	145,000
Instrumentation and Facilities	$	470,000
Crack Characterization With Ultrasonic NDE	$	110,000
High Frequency Transducers		110,000
A Composite, Multiviewing Transducer		250,000
Office of Health and Environmental Research	$	868,000
Division of Physical and Technological Research	$	868,000
Materials Properties, Behavior, Characterization or Testing	$	868,000
Development of Mercuric Iodide and Other New Concepts for the Detection and Spectroscopy of Ionizing Radiation	$	260,000

	FY 1985
<u>Office of Health and Environmental Research (Continued)</u>	
<u>Division of Physical and Technological Research (Continued)</u>	
<u>Materials Properties, Behavior, Characterization, or Testing (Continued)</u>	
Semiconductor Radiation Detector Technology	$ 360,000
Avalanche Photodiodes for Positron Emission Tomography	248,000
<u>Office of Fusion Energy</u>	$ 19,350,000
<u>Materials Properties, Behavior, Characterization, or Testing</u>	$ 8,310,000
Alloy Development for Irradiation Performance (ADIP)	$ 4,270,000
Damage Analysis and Fundamental Studies (DAFS)	1,990,000
Special Purpose Materials (SPM)	1,100,000
Tritium Breeding Materials	800,000
Analysis and Evaluation	150,000
<u>Device or Component Fabrication, Behavior, or Testing</u>	$ 5,140,000
Plasma Materials Interaction and High Heat Flux Component Development Programs	$ 5,140,000
<u>Instrumentation and Facilities</u>	$ 5,900,000
Radiation Facilities Operation	$ 3,900,000
Operation of Oak Ridge Research Reactor	2,000,000

		FY 1985
Small Business Innovation Research Program*	$	7,900,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$	2,152,000
Phase I Projects:		
Fabrication and Characterization of Ceramic-Matrix-Ceramic Whisker Composites with Random Orientation of the Whiskers	$	49,884
Synthesis of a Transparent Conductive Polymer Film using Methods Compatible with Solar Cell Fabrication		48,930
Investigation of the Reduction of Impurities in Silicon by Reaction with Rare Earth Metals		49,972
Development of a New Manufacturing Process for Very High Current Density Multifilament Superconducting Nb3Sn Composite		50,000
Development of a Continuous Process fo Clad Superconductors with High-Purity Aluminum		50,000
The Investigation of the Scaleability of the Powder Process for Manufacture of Nb-Al Conductors		50,000
The Direct Production of Intermetallic Compound Powder		50,000
Self-Lubricating, Diamond-Like Coatings by a Simultaneous Sputter-Deposition/Ion-Implantation Project		49,991
Feasibility of Lithium and Lithium/Hydrogen Passivation of Sheet Silicon Solar Cells		49,752
The Investigation of an Improved Processing Method for High Current Density, Fine-Filamentary Superconductors		48,494
The Development of a Process for Producing Aluminum Stabilized, Fine-Filamentary Superconducting Composites		48,961
Castable Gold Cermet for Electrical Contacts		50,000
A New Castable, Dispersion Strengthened Ferritic Alloy		50,000
The Application of Ion Beams to the Fabrication of First Wall Materials		48,739

* Includes 32 new Phase I and 13 new Phase II awards made in FY 1985 and second-year incremental funding for 17 Phase II projects initiated in FY 1984; totals rounded to nearest $1000. Totals reflect the fact that Phase II funding levels are spread over a two year period.

		FY 1985
Small Business Innovation Research Program (Continued)		
Materials Preparation, Synthesis, Deposition, Growth, or Forming (Continued)		
Phase II Projects: (First Year)		
Growth of BaF_2 Crystals by the Heat-Exchanger Method (HEM) with Enhanced Fast Component for Scintillator Applications	$	270,479
Brazing of Machineable Glass Ceramics and Other Ceramic Materials		368,495
Development of a New Process for the Production of Very Find Filamentary Superconducting NbTi Composites		494,989
Phase II Projects: (Second Year)		
Horizontal Growth of Silicon Sheet Crystals via Edge-Supported Pulling (ESP) from a Melt Contained in a Cold Crucible		285,019
Growth of Bismuth Germanate ($Bi_4Ge_3O_{12}$,BGO) Using the Heat Exchanger Method (HEM)		417,532
Process for Manufacture of 2,2',4,4'-Tetrahydroxybenzophenone and Polymerizable/Polymeric Compositions Thereof		419,188
An Investigation to Determine the Commercial Feasibility of "In Situ" Cu-Nb Composites for High-Strength, High Conductivity Applications		350,000
Improvement of Carbon Foils and Applications		306,464
Materials Structure or Composition	$	543,864
Phase I Projects:		
Oxygen Complexes in Silicon	$	48,662
Phase II Projects: (Second Year)		
Fabrication of Amorphous Metallic Films and Coatings for Industrial Application Using High-Energy Ion Beam Mixing		495,202

		FY 1985
Small Business Innovation Research Program (Continued)		
Materials Properties, Behavior, Characterization, or Testing	$	1,102,000
Phase I Projects:		
Unexplored Thermoelectric Improvement Opportunities in Silicon Boride Material	$	50,000
Development of a Physically-Based Model for Material Strength and Embrittlement under HTGR Operating Conditions		49,914
Phase II Projects: (First Year)		
Processing and Characterization of SiCALON Ceramics		488,048
Reduction of Surface Recombination in Silicon Solar Cells		499,015
Phase II Projects: (Second Year)		
Fracture Mechanics Investigation of Grinding of Ceramics		215,976
Mathematical Modeling of Electrochemistry of Stress Corrosion Cracking		331,735
High Temperature and/or High-Speed Thickness Gauging of Metals		469,262
Device or Component Fabrication, Behavior, or Testing	$	3,372,000
Phase I Projects:		
The Design and Fabrication of Flat Panels with High Acoustic Transmissivity	$	30,708
Highly Versatile Multilayer Tactile Sensor Arrays		50,000
A Cryovaristor for Quench-Protection of Superconducting Coils		49,506
Direct Energy Conversion with a Pyroelectric Polymer		49,927
A Magnetic Field/Current Sensing Optical Fiber		49,855
Gas Separations Using Ferroelectric Materials		49,968
Shape-Memory Connectors for Superconducting and Conventional High-Field Magnet Systems		47,835
Reduction of Low-Level Radwaste Disposal in Water Clean-up Systems by use of Magnetite		50,000

	FY 1985
Small Business Innovation Research Program (Continued)	
Device or Component Fabrication, Behavior, or Testing (Continued)	
A Mossbauer Source/Absorber System for High-Temperature Strain Measurements in Reactor Systems	49,979
Phase II Projects: (First Year)	
Eddy-Current, Nondestructive Evaluation of Laser-Glazed Metallic Surfaces	490,000
Fresnel-Lens Photovoltaic Concentrator Design Innovations	390,000
Development of Fe-Nd-B Metal-Matrix Magnets	284,615
Immunodiagnostic Biosensor Device Based on Conductive Organic Polymers	483,124
Titanium Nitride Coating of High-Speed Steel and Carbide Metal Cutting Tools Using Fluid Bed Furnace Technology	495,040
Method and Device for Nondestructive Inspection of Niobium to Improve Superconductivity	494,424
Wear Resistant Ferrous Metal Matrix Composites for Municipal Solid Waste Processors	499,960
Phase II Projects: (Second Year)	
A SQUID-Based Airborne Magnetic Gradiometer System	483,908
Fiber-Optic Beam Monitor	499,951
Fiber-Optic Current Probe	324,411
Avalanche Photodiodes for Positron Emission Tomography	496,371
Stepped Frequency Ultrasonic Holography for Flaw Characterization	455,638
Research on Advanced Cell Designs for High-Efficiency Flat-Plate Applications	489,854
Instrumentation and Facilities	$ 978,000
Phase I Projects:	
The Construction of a Soft X-ray Source using Transition Radiation for Lithography	49,928
A New Two-Dimensional Position Encoder for Positron Emission Tomography (PET)	50,000
A High Efficiency Helium-3 Neutron Detector	50,000

	FY 1985
Small Business Innovation Research Program (Continued)	
Instrumentation and Facilities (Continued)	
A High-Resolution, Vacuum-Ultraviolet, Imaging, Fourier Transform Spectrometer	49,637
An InP Semiconductor Neutrino Detector	50,000
A Semiconductor Nuclear Sensor for Positron Tomography Cameras	49,783
Phase II Projects: (First Year)	
Fiber-Optic Track Detector	469,184
Phase II Projects: (Second Year)	
Extreme Ultraviolet and Soft X-Ray Instrumentation for Microcharacterization of Materials	499,550
Closed Cycle Cryocooler with Hybrid Heat Exchanger-Regenerator	388,186

The Director of Energy Research is responsible for three major outlay programs: Basic Energy Sciences, High Energy and Nuclear Physics, and Magnetic Fusion Energy. The Director of Energy Research also advises the Secretary on DOE physical research programs, the Department's overall energy research and development programs, university-based education and training activities, grants, and other forms of financial assistance. The Director also carries out additional duties assigned to the Office related to basic and advanced research, and monitors the well-being and management of the multiprogram laboratories under the jurisdiction of the Department.

Four multiprogram and seven single-purpose laboratories are administratively assigned to the Office of Energy Research. The multiprogram facilities are Argonne National Laboratory, Oak Ridge National Laboratory, Brookhaven National Laboratory, and Lawrence Berkeley Laboratory. The single-purpose or specialized laboratories are the Bates Linear Accelerator Facility at the Massachusetts Institute of Technology, the Ames Laboratory at the Iowa State University, the Fermi National Accelerator Laboratory, the Notre Dame Radiation Laboratory, the Princeton University Plasma Physics Laboratory, the Michigan State University Plant Research Laboratory, and the Stanford Linear Accelerator Center. The multiprogram laboratories conduct significant research activities for other DOE programs (e.g., Conservation, Nuclear, etc.) and other Federal agencies, while the seven specialized laboratories are funded almost totally by the Office of Energy Research.

The Office of Energy Research conducts materials research in the following offices and divisions:

Office of Basic Energy Sciences: Division of Engineering and Geosciences; Division of Materials Sciences

Office of Fusion Energy

Small Business Innovation Research Program

Office of Health and Environmental Research: Division of Physical and Technologies Research

Office of Basic Energy Sciences

Division of Materials Sciences

This basic research program has several roles. One is to increase the understanding of materials properties, behavior, and phenomena in those classes of materials that either presently or in the future might be important to the mission of the Department of Energy. Another concerns the development of new forefront analytical instruments and facilities that are used to probe the structure and behavior of matter. Thus this program carries a major responsibility for many of the nation's premier research facilities including several neutron sources, a synchrotron radiation source, processing facilities, and frontier electron microscopes. Some of the materials research has a specific relationship to an identified energy technology (e.g., photovoltaic phenomena for solar energy conversion, fast-ion diffusion for solid electrolytes in fuel cells and batteries, etc.); some is related to many energy technologies simultaneously (e.g., hydrogen embrittlement, corrosion, high temperature structural metals and ceramics, etc.); and some important to fundamental understanding of new experimental and theoretical research tools.

This research is conducted at DOE laboratories, universities, and to a lesser extent at industrial laboratories by metallurgists, ceramists, solid state physicists, and materials chemists in about 100 different institutions.

There are three subprograms:

- Metallurgy and Ceramics seeks to understand the synergistic relationship between properties/behavior, structure, and processing parameters of materials.

- Solid State Physics is concerned with understanding the interactions of electrons, atoms, and defects and their role in determining the structure and properties of condensed matter.

- Materials Chemistry focuses on understanding the chemical properties of materials and their relationship to composition, structure, and specimen environment.

The DOE contact for this Division is Dr. Louis Ianniello, 301-353-3427. For specific detailed information, the reader is referred to DOE publication Materials Sciences Programs Fiscal Year 1985 (DOE/ER-0143/3 dated September 1985). This publication contains: summaries of all funded programs at DOE laboratories; summaries of all funded grant programs in universities and private sector organizations; summaries of all Small Business Innovation Research programs; Collaborative Research Centers (descriptive information); cross-cutting indices: investigators, materials, techniques, phenomena, environment. Limited copies may be obtained by calling 301-353-3428.

Division of Engineering and Geosciences

Materials Properties, Behavior, Characterization, or Testing

Damage Accumulation by Crack Growth Under Combined Creep and Fatigue - DOE Contact Oscar P. Manley, 301-353-5822; Battelle-Columbus Laboratories Contact C.E. Jaske, 614-424-4417

- Develop and evaluate methods for assessing creep/fatigue crack growth under inelastic straining

- A fracture-mechanics approach implementing the J-integral for fatigue and the C*-integral for creep is being employed

- Experimentally will test Type 316 stainless steel and modified 9Cr-1Mo steel at various temperatures: 538, 593, and 649 degrees C

Electrochemical Wear Mechanism and Deposit Formation in Lubricated Systems - DOE Contact Oscar P. Manley, 301-353-5822; Electrochemical Technology Corp. Contact T.R. Beck, 206-632-5965

- Measure and determine the importance of electrokinetic- or zeta-corrosion and deposit formation in lubricated rolling and sliding systems

- Compare measurements of wear for rolling and sliding lubricated systems to calculate zeta corrosion rates based on extensions of the valve wear model

Engineering Analysis of Elastic-Plastic Fracture - DOE Contact Oscar P. Manley, 301-353-5822; Idaho National Engineering Laboratory Contact W.G. Reuter, 208-526-0111

- Improve design and analytical techniques for predicting the integrity of flawed structural components.

- Experimental research with analytical evaluation guiding the direction of experimental testing. Tests are conducted on a modified ASTM A-710 material exhibiting a range of fracture toughness but essentially constant yield and ultimate tensile strength.

- Use of metallographic techniques to measure crack tip opening displacement for comparison with analytical models. Laser interferometry and infrared thermography will be used to evaluate and quantify the deformation in the crack region.

Continuous Damage Theory - DOE Contact Oscar P. Manley, 301-353-5822; University of Illinois Contact D. Krajcinovic, 312-996-7000

- Phenomenological description of the nucleation and growth of microdefects in a metallic solid and their influence on the mechanical response.

- Investigation of the interaction of viscuous effects (reflecting boundary slip) and the brittle effects (growth of microcracks). Problems in creep rupture and fatigue will be considered using the continuum damage model developed.

Loss Characteristics of Cord-Rubber Composites - DOE Contact Oscar P. Manley, 301-353-5822; University of Michigan Contact S.K. Clark, 313-764-4256

- Data acquisition on the loss characteristics of cord-rubber composites under both uniaxial and multiaxial stress states, including the effects of prestrain, frequency, strain amplitude and temperature in the assessment of the viscoelastic properties of the materials.

- Analysis of the rolling loss of a pneumatic tire using the viscoelastic properties obtained in the first task, together with finite element codes suitable for the problem. Theoretical results will be compared against measured values.

<u>A Study of the Chemical Mechanism in Lubrication</u> - DOE Contact Oscar P. Manley, 301-353-5822; National Bureau of Standards Contact S.M. Hsu, 301-921-3113

- Study of the nature and extent of influence of chemical reactions in the contact zone on friction and wear. Surface topography of worn surfaces will be characterized to predict oil film thickness under different speed, load ranges in a NBS- developed four-ball wear tester.

- Calculation of micro-asperity temperatures and the wear film temperatures of the oil film using Archard-Jaeger equations as well as finite-element analysis techniques.

- A theoretical model linking elastohydrodynamic theories to tribochemical rate constants with material properties will be attempted to predict lubrication effectivness a priori.

<u>Effects of Crack Geometry and Near-Crack Material Behavior on Scattering of Ultrasonic Waves for QNDE Applications</u> - DOE Contact Oscar P. Manley, 301-353-5822; Northwestern University Contact J.D. Achenbach, 312-491-5527

- Application of the scattered field approach to the detection of a cracklike flaw, and to the determination of its location, size, shape and orientation. Interior, as well as surface-breaking and near-surface cracks, are considered.

- Mathematical modeling of ultrasonic wave scattering by cracks adjusted to account for several typical characteristics of fatigue and stress-corrosion cracks, and the environment of such cracks.

- Investigation of local anisotropy and inhomogeneity due to near-tip voids and the effect of a zone of plastic deformation near a crack tip.

<u>Crack-Tip Fields for Materials With Exponential-Law Creep Behavior at High Stress</u> - DOE Contact Oscar P. Manley, 301-353-5822; University of Pennsylvania Contact - John L. Bassani, 215-898-5632

- Elastic-viscoplastic analyses of cracks under creep conditions, with particular emphasis on the influence of the assumed stress dependence on the creep strain-rate, where the total strain rate is taken as the sum of linear elastic and hyperbolic-sine-creep rates.

- Analysis of the crack-tip fields under plane strain Mode I conditions.

Mechanical Interactions of Rough Surfaces - DOE Contact Oscar P. Manley, 301-353-5822; SKF Industries, Inc. Contact J.I. McCool, 215-265-1900

- Development of fundamental information and the resolution of a number of issues that impact on the design of mechanical systems in which surface microtopography per se or events which occur on the microgeometric scale play a critical role.

- Design and construct an apparatus designed and constructed to obtain optical interferograms of the lubricated contact of rough surfaces along with measurements of traction transmitted under conditions of combined rolling, sliding, and spinning.

- Develop guideline and techniques for the digital processing of surface roughness data generated in analog form by a stylus profile instrument.

Device or Component Fabrication, Behavior, or Testing

Improvement of Reliability of Welding by In-Process Sensing and Control - DOE Contact Oscar P. Manley, 301-353-5822; MIT Contact K. Masubuchi, 617-255-6820

- Develop closed-loop control of welding variables in a cost-effective approach to improving weld quality.

- Implement a geometry control system on a mechanized welding system and provide one formal framework for implementation of welding control.

Instrumentation and Facilities

Crack Characterization With Ultrasonic NDE - DOE Contact Oscar P. Manley, 301-353-5822; Idaho National Engineering Laboratory Contact J.A. Seydel, 208-526-0111

- Develop the instrumentation and analytical models that can predict and identify the frequency dependence of the amplitude and phase of ultrasonic echoes from defects.

- Treatment of transducer/media/defect combination as a linear system which allows separation of the individual contributions to the signal detected at the transducer.

High Frequency Transducers - DOE Contact Oscar P. Manley, 301-353-5822; Stanford University Contact G.S. Kino, 415-497-0205

- Develop a new theory for cross-coupling in acoustic transducer arrays used for acoustic imaging. Application of theory in acoustic devices for NDT, medical and sonar arrays, as well as electromagnetic and antenna arrays.

A Composite, Multiviewing Transducer - DOE Contact Oscar P. Manley, 301-353-5822; Iowa State University Contact D.O. Thompson, 515-294-5320

- Demonstration of a composite multiviewing NDE transducer

- Approach uses recent advances in ultrasonic scattering and inversion theories.

- Reconstruction protocol fits acquired data to an "equivalent" ellipsoid (3 axes and 3 angles)

Office of Health and Environmental Research

The Office of Health and Environmental Research supports a broad multidisciplinary program in basic and applied life sciences research for the purpose of achieving a comprehensive understanding of the health and environmental effects associated with energy technologies. Research is conducted to characterize and measure energy-related hazards, study transport and transformations in the environment, determine the biological and ecological response and define the potential impact on human health. In addition, new applications of nuclear science and energy technologies are developed for use in the diagnosis and treatment of human disease. Material interests are primarily in development of sensors for radiation and chemical detection.

Division of Physical and Technological Research

The Physical and Technological Research Division conducts physical, chemical, and instrumentation research related to the health and environmental aspects of energy technology development. Included are support of physical and chemical characterization studies, atmospheric sciences research, research on measurement and dosimetry techniques, and fundamental radiation biophysics.

Materials Properties, Behavior, Characterization or Testing

Development of Mercuric Iodide and Other New Concepts for the Detection and Spectroscopy of Ionizing Radiation - DOE Contact G. Goldstein, 301-353-5348; University of Southern California Contact G. Huth, 213-822-9184

- Study of mercuric iodide and other semiconductor compounds for use as radiation detectors, focusing on the basic physics of the detection process and on detector design.

Semiconductor Radiation Detector Technology - DOE Contact G. Goldstein, 301-353-5348; LBL Contact F. S. Goulding, 415-486-6432

- Study of semiconductor materials, primarily germanium and silicon, for use as radiation detectors. Research includes crystal growth and purification, measurement of materials properties, and signal processing.

Avalanche Photodiodes for Positron Emission Tomography - DOE Contact G. Goldstein, 301-353-5348; Radiation Monitoring Devices Contact G. Entine, 617-926-1167

- Fabrication and testing of silicon avalanche devices for use as solid state photosensors. Research focuses on defining the proper surface preparation technique and on the electrical properties of the photodiode.

Office of Fusion Energy

Fusion Materials Research - Definition of the Materials in Fusion Energy Development

The ultimate economics of fusion energy, like most other energy systems, will depend on the materials required for the system. Fusion materials research separates naturally into two classes of problems: those associated with interaction of plasma with the materials and those associated with the interaction of fusion neutrons with the materials. Both involve basic and applied research. The former are near-term problems which must be solved to advance plasma confinement research; the latter problems are more fundamental to the ultimate success of fusion as an energy source.

The last decade of research, using available nuclear test facilities, has revealed that there are materials which could withstand the nuclear environment of a fusion reactor with reasonable system economics and relatively modest waste disposal requirements. However, studies have also shown that it is important to improve the economics of these systems and to reduce the need for long-term waste disposal of fusion materials even further through the development of specialized materials. The future fusion materials program must include both the basic research on fundamental new materials and the development of the new technology required for testing those materials.

Objective

The objective of the Fusion Materials Program is to develop the necessary structural, plasma-interactive, breeding, low activation, and special purpose materials to support present and future fusion plasma experiments and to form the foundation for a reliable, economic, and environmental assessment of fusion energy.

I. The objective of the Plasma Interactive Materials (PIM) and High Heat Flux Materials and Component Development (HHF) Programs are to provide the necessary materials and technological support for fusion plasma experiments as they progress to longer pulse length, higher temperatures and densities, and limited tritium operation.

II. Eighty percent of the energy of the deuterium-tritium reaction is released in the form of high energy (14.1 MeV) neutrons and the influence of those radiation fields on materials is profound. The objectives of the (neutron) Radiation Interaction Materials Program elements are to provide the foundation of knowledge and the development and understanding of new or improved materials required to evaluate, design, construct, and operate future fusion devices considering, especially, the interaction of that high energy neutron irradiation on the materials. In addition to the general functional requirements of materials, this program topic has the further special objective to develop materials that would have sufficiently reduced neutron induced radioactivity to significantly shorten or eliminate the burden of long-term (>100 years) waste management -- a primary program objective to make fusion a more attractive energy option.

Organization and "Projects"

The fusion materials research program is managed by the Reactor Technology Branch in the Division of Development and Technology of the Office of Fusion Energy. It is structured around the two major technical issues that are specific to fusion--plasma interactive materials, and neutron radiation interactive materials. These are organized into eight sub-elements (or projects in the context of this report). These sub-elements of the program are each guided by technical level task groups drawn from laboratory, university, and industrial participants. Each task group is claimed by a laboratory program manager in cooperation with a DOE counterpart.

Materials Properties, Behavior, Characterization, or Testing

Alloy Development for Irradiation Performance (ADIP) - DOE Contact T.C. Reuther, 301-353-4963; ORNL Contact A. Rowcliffe, 615-576-5057

- Research and development of structural alloys, focusing on neutron irradiation efforts.
- Development of variations of austenitic stainless, 9-12Cr ferritic/martensitic starts, vanadium alloys and reduced activation alloys.

Damage Analysis and Fundamental Studies (DAFS) - DOE Contact T.C. Reuther, 301-353-4963; Hanford Engineering Development Laboratory Contact D.G. Doran, FTS 444-3187

- Establish the mechanistic basis to evaluate and project the effect of the fusion radiation environment from currently available irradiation facilities.

- Analyze Dosimetry and damage in order to establish the fundamental response of materials to the fusion environment.

Special Purpose Materials (SPM) - DOE Contact M.M. Cohen, 301-353-4253; ORNL Contact J.L. Scott, FTS 624-4834

- Investigate radiation effects on magnet system materials (superconductor, stabilizer, insulator) ceramic applications for insulators, diagnostics, etc., Be for neutron multipliers, etc.

Tritium Breeding Materials - DOE Contact M.M. Cohen, 301-353-4253; ANL Contact C.E. Johnson, FTS 972-7533

- Establish the properties, behavior, and tritium breeding and release characteristics of lithium bearing oxides. It includes in-reactor and post-irradiation studies and laboratory preparations and characterization.

Analysis and Evaluation - DOE Contact T.C. Reuther, 301-353-4963; McDonnell Douglas Astronautics Co. Contact J. Davis, FTS 314-234-4826

- Provide a bridge between the materials and design communities.

- Develop and publish the Materials Handbook for Fusion Energy Systems.

Device or Component Fabrication, Behavior, or Testing

Plasma Materials Interaction and High Heat Flux Component Development Programs - DOE Contact M.M. Cohen, 301-353-4253; SNL Contact W. Gusster, 415-422-1648

- Develop and maintain a basic long range technological capability which can be utilized by all confinement communities.

- Development of specific component projects for present and future confinement facilities and experiments.

Instrumentation and Facilities

Radiation Facilities Operation - DOE Contact M.M. Cohen, 301-353-4253; LLNL Contact C. Henning, FTS 532-0235

- U.S. share of the joint U.S./DOE and Japanese operations of RTNS-II, or 14 MeV DT neutron source.

Operation of Oak Ridge Research Reactor - DOE Contact T.C. Reuther, 301-353-4963; ORNL Contact J.L. Scott, FTS 624-4834

- Operating cost of the ORR for Energy Research users.

Small Business Innovation Research Program

The Small Business Innovation Research (SBIR) program was established in compliance with the Small Business Innovation Development Act of 1982, Public Law 97-219. The program is designed for implementation in a three-phase process, with Phase I determining, insofar as possible, the scientific or technical merit and feasibility of ideas proposed for investigation. The period of performance in this initial phase is about 6 months and awards are limited to $50,000. Phase II is the principal research or research and development effort, and awards can be as high as $500,000 for work to be performed in periods of up to 2 years. Under Phase III, commercial applications of the research or research and development are to be pursued by small businesses with non-Federal capital or, alternatively, Phase III may involve follow-on non-SBIR Federal contracts for products or processes desired by the Government.

The materials-related projects, like all other projects in the DOE SBIR program, were selected using the specific evaluation criteria listed in the program solicitation. Conclusions were reached on the basis of detailed reports returned by reviewers drawn from DOE laboratories, universities, private industry, and government. In the case of Phase II, if several proposals were judged to be of approximately equal technical merit, preference was given to those proposals that had demonstrated third phase, non-Federal capital commitments.

The work supported in this program represents high-risk research, but the potential benefits are also high if the objectives are met. Brief descriptions of all DOE SBIR projects (not just those of interest in materials research) are given in the following publications: Abstracts of Phase I Awards, 1985 (DOE/ER-0181/2), Abstracts of Phase II Awards, 1984 (DOE/ER-0209), and Abstracts of Phase II Awards, 1985 (DOE/ER-0209/1). Copies of these publications may be obtained by calling Mrs. Gerry Washington on 301-353-5867.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Phase I Projects:

Fabrication and Characterization of Ceramic Matrix-Ceramic Whisker Composites with Random Orientation of the Whiskers - DOE Contact Iran Thomas, 301-353-34261; Ceramatec, Inc. Contact L. Viswanathan, 801-486-5071

Synthesis of a Transparent Conductive Polymer Film Using Methods Compatible with Solar Cell Fabrication - DOE Contact Morton Prince, 202-252-1752; EIC Laboratories, Inc. Contact Dr. Timothy L. Rose, 617-769-9450

Investigation of the Reduction of Impurities in Silicon by Reaction with Rare Earth Metals - DOE Contact Morton Prince, 202-252-1725; Energy Materials Corporation Contact Dr. Joseph B. Milstein, 617-456-8707

Development of a New Manufacturing Process for Very High Current Density Multifilament Superconducting Nb3Sn Composite - DOE Contact Earle Fowler, 301-353-4801; Intermagnetics General Corporation Contact Mr. Gennady Ozeryansky, 203-753-5215

Development of a Continuous Process to Clad Superconductors With High-Purity Aluminum - DOE Contact Earle Fowler, 301-353-4801; Intermagnetics General Corporation Contact Dr. Kanithi Hemachalam, 203-753-5215

The Investigation of the Scaleability of the Powder Process for Manufacture of Nb-Al Conductors - DOE Contact Victor Der, 301-353-5736; Intermagnetics General Corporation Contact Mr. Gennady Ozeryansky, 203-753-5215

The Direct Production of Intermetallic Compound Powder - DOE Contact Iran Thomas, 301-353-3426; Materials and Electrochemical Research Corporation Contact Dr. James C. Withers, 602-749-3257

Self-Lubricating, Diamond-Like Coatings by a Simultaneous Sputter-Deposition/Ion-Implantation Process - DOE Contact Iran Thomas, 301-353-3426; Spire Corporation Contact Dr. Piran Sioshansi, 617-275-6000

Feasibility of Lithium and Lithium/Hydrogen Passivation of Sheet Silicon Solar Cells - DOE Contact Morton Prince, 202-252-1725; Spire Corporation Contact Dr. Mark Spitzer, 617-275-6000

The Investigation of an Improved Processing Method for High Current Density, Fine-Filamentary Superconductors - DOE Contact Earle Fowler, 301-353-4801; Supercon, Inc. Contact Dr. Eric Gregory, 617-842-0174

The Development of a Process for Producing Aluminum Stabilized, Fine-Filamentary Superconducting Composites - DOE Contact Earle Fowler, 301-353-4801; Supercon, Inc. Contact Dr. Eric Gregory, 617-842-0174

Castable Gold Cermet for Electrical Contacts - DOE Contact Iran Thomas, 301-353-3426; Technical Research Associates, Inc. Contact Mr. Charles D. Baker, 801-582-8080

A New Castable, Dispersion Strengthened Ferritic Alloy - DOE (ORNL) Contact Eugene Hoffman, 615-576-0735; Technical Research Associates, Inc. Contact Mr. Joseph K. Weeks, Jr., 802-582-8080

The Application of Ion Beams to the Fabrication of First Wall Materials-DOE Contact Ted Reuther, 301-353-4963; Universal Energy Systems, Inc. Contact Dr. David Ingram, 513-426-6900

Phase II Projects: (First Year)

Growth of BaF_2 Crystals by the Heat-Exchanger Method (HEM) with Enhanced Fast Component for Scintillator Applications - DOE Contact Stanley Whetstone, 301-353-3613; Crystal Systems, Inc. Contact Dr. Chandra P. Khattak, 617-745-0088

Brazing of Machineable Glass Ceramics and Other Ceramic Materials- DOE Contact Marvin Cohen, 301-353-4253; Hittman Materials & Medical Components, Inc. Contact Mr. Harold N. Barr, 301-730-7800

Development of a New Process for the Production of Very Fine Filamentary Superconducting NbTi Composites - DOE Contact Earle Fowler, 301-353-4801; Supercon, Inc. Contact Dr. Eric Gregory, 617-842-0174

Phase II Projects: (Second Year)

Horizontal Growth of Silicon Sheet Crystals via Edge-Supported Pulling (ESP) from a Melt Contained in a Cold Crucible - DOE Contact Robert Gottschall, 301-353-3428; Ceres Corporation Contact Mr. Joseph F. Wenckus, 617-667-3000

Growth of Bismuth Germanate ($Bi_4Ge_3O_{12}$,BGO Using the Heat Exchanger Method (HEM) - DOE Contact John Erskine, 301-353-3613; Crystal Systems Inc. Contact Ms. Chandra P. Khattak, 617-745-0088

Process for Manufacture of 2,2',4,4',- Tetrahydroxybenzophenone and Polymerizable/Polymeric Compositions Thereof - DOE Contact John Goldsmith, 202-252-8170; Helix Associates Inc. Contact Dr. Walter Z. Heldt, 302-738-6581

An Investigation to Determine the Commercial Feasibility of "In Situ" Cu-Nb Composites for High-Strength, High-Conductivity Applications- DOE Contact Iran Thomas, 301-353-3426; Supercon, Inc. Contact Dr. James Wong, 617-655-0500

Improvement of Carbon Foils and Applications - DOE Contact David Sutter, 202-252-1725; The Arizona Carbon Foil Company, Inc. Contact Dr. Stanley Bashkin, 602-621-6814

Materials Structure of Composition

Phase I Projects:

Oxygen Complexes in Silicon - DOE Contact Morton Prince, 202-252-1725; Universal Energy Systems, Inc. Contact Mr. John Baker, 513-426-6900

Phase II Projects: (Second Year)

Fabrication of Amorphous Metallic Films and Coatings for Industrial Applications Using High-Energy Ion Beam Mixing - DOE Contact Joseph Darby, 301-353-4174; Universal Energy Systems, Inc. Contact Dr. Peter P. Pronko, 513-426-6900

Materials Properties, Behavior, Characterization, or Testing

Phase I Projects:

Unexplored Thermoelectric Improvement Opportunities in Silicon Boride Material - DOE Contact Bill Barnett, 301-353-3079; Altas Corporation, Mr. Francis de Winter, 408-425-1211

Development of a Physically-Based Model for Material Strength and Embrittlement under HTGR Operating Conditions - DOE Contact Ed Fox, 301-353-3985; S. Levy, Inc. Contact Dr. Yogendra S. Garud, 408-377-4870

Phase II Projects: (First Year)

Processing and Characterization of SiCALON Ceramics - DOE Contact Iran Thomas, 301-353-3426; Ceramatec, Inc. Contact Dr. Raymond A. Cutler, 801-487-5411

Reduction of Surface Recombination in Silicon Solar Cells - DOE Contact Morton Prince, 202-252-1725; Spire Corporation Contact Dr. Mark B. Spitzer, 617-275-6000

Phase II Projects: (Second Year)

Fracture Mechanics Investigation of Grinding of Ceramics - DOE Contact Robert Gottschall, 301-353-3428; Ceramic Finishing Company Contact Dr. Henry P. Kirchner, 814-238-4270

Mathematical Modeling of Electrochemistry of Stress Corrosion Cracking- DOE Contact Joseph Darby, 301-353-4174; Electrochemical Technology Corporation Contact Dr. Theodore R. Beck, 206-632-5965

High Temperature and/or High-Speed Thickness Gauging of Metals - DOE Contact James Fulton, 202-252-8668; Materials Engineering Associates (Calif.) Contact Dr. Bruce W. Maxfield, 509-375-0663

Device or Component Fabrication, Behavior, or Testing

Phase I Projects:

The Design and Fabrication of Flat Panels with High Acoustic Transmissivity - DOE Contact Iran Thomas, 301-353-3426; Analysis Consultants Contact Dr. B.G. Martin, 714-380-1204

Highly Versatile Multilayer Tactile Sensor Arrays - DOE Contact Oscar Manley, 301-353-5822; Bonneville Scientific Contact Dr. Allen R. Grahn, 801-359-0402

A Cryovaristor for Quench-Protection of Superconducting Coils - DOE Contact Earle Fowler, 301-353-4801; CeramPhysics, Inc. Contact Dr. W.N. Lawless, 614-882-2231

Direct Energy Conversion with a Pyroelectric Polymer - DOE Contact Bill Barnett, 301-353-3097; Chronos Research Laboratories, Inc. Contact Dr. Randall B. Olsen, 619-756-1447

A Magnetic Field/Current Sensing Optical Fiber - DOE Contact Donald Priester, 301-353-3421; EOTec Corporation Contact Dr. Mokhtar S. Maklad, 203-934-7961

Gas Separations Using Ferroelectric Materials - DOE Contact Robert Massey, 202-252-2079; Maxdem Inc. Contact Dr. Matthew Marrocco, 818-793-5224

Shape-Memory Connectors for Superconducting and Conventional High-Field Magnet Systems - DOE Contact Victor Der, 301-353-5736; Memory Metals, Inc. Contact Dr. Stephen Fisher, 203-358-0437

Reduction of Low-Level Radwaste Disposal in Water Clean-up Systems by Use of Magnetite - DOE Contact Michael Baraínca, 208-526-1585; Nuclear Consulting Services, Inc. Contact Dr. Djordjiji R. Sain, 614-846-5710

A Mossbauer Source/Absorber System for High-Temperature Strain Measurements in Reactor Systems - DOE Contact John Lewellen, 301-353-2899; Technology Products and Services, Inc. Contact Mr. James C. McCue, 305-686-5949

Phase II Projects: (First Year)

Eddy-Current, Nondestructive Evaluation of Laser-Glazed Metallic Surfaces - DOE Contact Iran Thomas, 201-353-3426; American Research Corporation of Virginia Contact Dr. Russell J. Churchill, 703-731-0836

Fresnel-Lens Photovoltaic Concentrator Design Innovations - DOE Contact Michael Pulscak, 202-252-1726; ENTECH, Inc. Contact Mr. Mark J. O'Neill, 214-456-0900

Development of Fe-Nd-B Metal-Matrix Magnets - DOE Contact Iran Thomas, 301-353-3426; KJS Associates Contact Mr. Reinhold M.W. Strnat, 513-879-0114

Immunodiagnostic Biosensor Device Based on Conductive Organic Polymers- DOE Contact George Duda, 301-353-3651; MKM Research/Ohmicron Contact Mr. Mark K. Malmros, 609-737-9050

Titanium Nitride Coating of High-Speed Steel and Carbide Metal Cutting Tools Using Fluid Bed Furnace Technology - DOE Contact Raymond LaSala, 202-252-8077; Procedyne Corporation Contact Mr. Joseph E. Japka, 201-249-8347

Method and Device for Nondestructive Inspection of Niobium to Improve Superconductivity - DOE Contact David Sutter, 301-353-5228; Sonoscan, Inc. Contact Dr. Lawrence W. Kessler, 312-766-7088

Wear Resistant Ferrous Metal Matrix Composites for Municipal Solid Waste Processors - DOE Contact Donald Walter, 202-252-6104; Waste Energy Technology Corporation Contact Dr. David B. Spencer, 617-275-6400

Phase II Projects: (Second Year)

A SQUID-Based Airborne Magnetic Gradiometer System - DOE Contact George Kolstad, 301-353-5822; Dynamics Technology, Inc. Contact Dr. Kenneth Poehls, 213-373-0666

Fiber-Optic Beam Monitor - DOE Contact David Sutter, 301-353-5228; Dynamics Technology, Inc. Contact Dr. C. Michael Dube, 213-373-0666

Fiber-Optic Current Probe - DOE (BPA) Contact Craig Mortensen, 202-252-5656; OPTRA, Inc. Contact Mr. Geert Wyntjes, 617-389-7711

Avalanche Photodiodes for Positron Emission Tomography - DOE Contact Gerald Goldstein, 301-353-5348; Radiation Monitoring Devices, Inc. Contact Dr. Gerald Entine, 617-926-1167

Stepped Frequency Ultrasonic Holography for Flaw Characterization- DOE Contact Arthur Mehner, 301-353-4474; Sigma Research, Inc. Contact Mr. B.P. Hildebrand, 206-575-9324

Research on Advanced Cell Designs for High-Efficiency Flat-Plate Applications - DOE Contact Morton Prince, 202-252-1725; Spire Corporation Contact Dr. Mark B. Spitzer, 617-275-6000

Instrumentation and Facilities

Phase I Projects:

The Construction of a Soft X-Ray Source using Transition Radiation for Lithography - DOE Contact Iran Thomas, 301-353-3426; Adelphi Technology Contact Dr. Melvin A. Piestrup, 415-861-0633

A New Two-Dimensional Position Encoder for Positron Emission Tomography (PET) - DOE Contact Gerald Goldstein, 301-353-5348; Computer Technology and Imaging, Inc. Contact Dr. Ronald Nutt, 615-966-7539

A High Efficiency Helium-3 Neutron Detector - DOE Contact Stanley Whetstone, 301-353-3613; KMS Fusion, Inc. Contact Mr. Timothy M. Henderson, 313-769-8500

A High-Resolution, Vacuum-Ultraviolet, Imaging, Fourier Transform Spectrometer - DOE Contact Donald Priester, 301-353-3421; Newton Optical Technologies Contact Dr. Peter L. Smith, 617-495-4984

An InP Semiconductor Neutrino Detector - DOE Contact Stanley Whetstone, 301-353-3613; Radiation Monitoring Devices, Inc. Contact Dr. Gerald Entine, 617-926-1167

A Semiconductor Nuclear Sensor for Positron Emission Tomography Cameras- DOE Contact Gerald Godstein, 301-353-5348; Radiation Monitoring Devices, Inc. Contact Dr. Gerald Entine, 617-926-1167

Phase II Projects: (First Year)

Fiber-Optic Track Detector - DOE Contact Stanley Whetstone, 301-353-3613; Synergistic Detector Designs Contact Dr. Arthur H. Rogers, 415-964-4756

Phase II Projects: (Second Year)

Extreme Ultraviolet and Soft X-Ray Instrumentation for Microcharacterization of Materials - DOE Contact Thomas Kitchens, 301-353-3426; Altex Corporation Contact Dr. Herbert Pummer, 312-372-3440

Closed Cycle Cryocooler with Hybrid Heat Exchanger-Regenerator - DOE Contact Earle Fowler, 301-353-4801; CVI Inc. Contact Mr. J.E. Jensen, 614-876-7381

OFFICE OF NUCLEAR ENERGY

	FY 1985
Office of Nuclear Energy Grand Total	$203,788,000
Office of Converter Reactor Deployment	$ 6,590,000
High Temperature Reactor Development Division	$ 6,590,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 695,000
Fuel Process Development	$ 695,000
Materials Properties, Behavior, Characterization, or Testing	$ 5,895,000
Fuel Materials Development	$ 510,000
Fuel Development and Testing	880,000
Graphite Development	950,000
Graphite Development and Testing	845,000
Metals Technology Development	1,055,000
Structural Materials Development	585,000
Advanced Gas Reactor Materials Development	1,070,000
Office of Terminal Waste Disposal and Remedial Action	$ 9,700,000
Division of Storage and Treatment Projects	$ 9,700,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 2,500,000
Technical Support to West Valley Demonstration Project	$ 2,500,000
Materials Properties, Behavior, Characterization, or Testing	$ 6,700,000
Materials Characterization Center Testing of West Valley Formulation Glass	$ 200,000
Nuclear Waste Treatment	6,500,000

	FY 1985
Device or Component Fabrication, Behavior, or Testing	$ 500,000
West Valley Joule Heated Ceramic Melter Design and Fabrication	$ 0
Special Waste Form Lysimeter for Arid Regions	250,000
Special Waste Form Lysimeter for Humid Regions	250,000
Office of Uranium Enrichment	$ 62,648,000
Device or Component Fabrication, Behavior, or Testing	$ 62,648,000
Gaseous Diffusion: Barrier Quality	$ 1,085,000
Gaseous Diffusion: Barrier Science	1,020,000
Gaseous Diffusion: Materials and Chemistry Support	2,874,000
Gas Centrifuge	33,469,000
Atomic Vapor Laser Isotope Separation Process Separator Development	24,200,000
Office of Reactor Systems, Development and Technology	$ 32,220,000
Division of Special Applications	$ 2,105,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 1,705,000
Development of Improved Thermoelectric Materials	$ 850,000
Development of an Improved Process for the Manufacture of DOP-26 Iridium Alloy Blank	525,000
Carbon Bonded Carbon Fiber Insulation Manufacturing Process Development and Product Characterization	330,000
Materials Properties, Behavior, Characterization, or Testing	$ 400,000
Characterization of State-of-the-Art Thermoelectric Device/Materials and Exploratory Studies of Rare Earth Sulfide Thermoelectric Materials	$ 400,000

	FY 1985
Office of Space Reactor Projects	$ 2,485,000
Office of Breeder Technology Projects	$ 30,145,000
Fuels and Core Materials Division	$ 25,445,000
Materials Properties, Behavior, Characterization, or Testing	$ 25,445,000
Core Systems: Mixed Oxide Fuel - Reference Core	$ 0
Mixed Oxide Fuel - Extended Life	2,515,000
Mixed Oxide Fuel - Long Life	12,450,000
Fuel Blanket	0
Absorber - Boron Carbide	0
Fuel Support Technology	0
Alloy Development	0
Component Fabrication or Testing for Safe Automated Facility	10,480,000
Powder Operations	0
Pellet Operations	0
Fuel Pin Operations	0
Process Support	0
Engineering, Testing, and Evaluation	0
Materials and Structures Division	$ 4,700,000
Materials Properties, Behavior, Characterization, or Testing	$ 4,700,000
High Temperature Structural Design, Mechanical Property Design Data, Tribology, Coolant Technology, Fabrication, Handbook, and Advanced Alloy Development	4,700,000
Office of Naval Reactors	$ 60,000,000*
Reactor Material Division	$ 60,000,000*

* Approximate.

OFFICE OF NUCLEAR ENERGY

The Office of Nuclear Energy conducts research projects in the Office of Converter Reactor Development, the Office of Terminal Waste Disposal and Remedial Action, the Office of Uranium Enrichment, the Breeder Reactors Program, and the Office of Naval Reactors. Summarized below are the areas of research in which the Department is currently engaged.

- Conducts the Light Water Reactor R&D program to improve the operation and availability of LWR's, extending plant lifetimes, enhancing plant safety (utilizing Three Mile Island information, as appropriate) and improving plant licensability, and plans and carries out R&D to provide base technology in High Temperature Reactors.

- Conducts R&D programs which support the development of converter reactors to exploit state-of-the-art and encouraging technologies to meet future requirements. This includes advanced LWRs's, HIGR's, and innovative LMR's.

- Develops advanced Breeder Reactor Technology to determine the optimum economic, environmental, and safety qualities in plants, systems, and components preparatory to commercial application in the power plant market.

- Conducts programs to develop and apply Advanced Nuclear System technology to space and terrestial application requirements including defense applications.

- Conducts the Naval Reactor Program to meet the nation's military requirements.

- Conducts programs to fulfill the Federal Government's responsibility for providing uranium enrichment services and for supporting low-level waste management and waste technology development.

- Conducts programs to fulfill the department's responsibilities for remedial action to protect public health and safety or to fulfill specific legislative requirements.

- Determines obstacles which stand in the way of increased use of Nuclear Energy and the steps needed to overcome them and implements other programs as directed by the Secretary.

Office of Converter Reactor Deployment

The overall mission of this office is to undertake activities which will resolve technical and institutional obstacles to the further deployment of converter reactors by private industry. This office includes the following divisions: High Temperature Reactor Development, Light Water Reactor

Projects, Nuclear Regulation and Safety, and Nuclear Reactor Economics and Financing. The major materials interests of this office include those required for the following reactor applications: fuels, fuel cladding, moderators, structural components, and heat exchangers.

Division of High Temperature Reactor Development

The objective of this division is to develop the base technology, systems concepts, and reactor designs which will permit the Government, in cooperation with utilities and private industry, to commercialize the High Temperature Reactor. The materials interests of this division include those required for the development of coated particles fuels, graphite moderator and reflector blocks, graphite core support blocks and posts, pre-stressed concrete reactor vessels, thermal barrier pads and insulation, and heat exchanger tubing and tube sheets.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Fuel Process Development - DOE Contact J.E. Fox, 301-353-3985; GA Technologies Contact O.M. Stansfield, 619-455-2895

- Production of depleted and enriched uranium oxycarbide microspheres.
- Coating of microspheres with multiple ceramic layers of pyrolytic carbon and silicon carbide.

Materials Properties, Behavior, Characterization, or Testing

Fuel Materials Development - DOE Contact J.E. Fox, 301-353-3985; GA Technologies Contact O.M. Stansfield, 619-455-2895

- Development of technology base required to design, qualify, and license fuel systems for near-term steam cycle/cogeneration and advanced process HTRs.
- Preparation, testing, and evaluation of irradiation experiments.
- Performance of post-irradiation fission product release tests.
- Development and verification of fuel performance models.

Fuel Development and Testing - DOE Contact J.E. Fox, 301-353-3985; ORNL Contact M.J. Kania, 615-576-4856

- Fabrication, testing, and evaluation of irradiation experiments; development of post-irradiation examination equipment and methods.
- Evaluation of fuel performance and development of fission product release mechanism and models; development of fuel kernel and coating production specifications.

Graphite Development - DOE Contact J.E. Fox, 301-353-3985; GA Technologies Contact H. Jones, 615-455-2360

- Selection, characterization, and qualification of graphite materials for application in HTRs.

Graphite Development and Testing - DOE Contact J.E. Fox 301-353-3985; ORNL Contact W. Eatherly, 615-576-5220

- Selection, characterization, and qualification of graphite materials; evaluation of high temperature corrosion resistance and mechanical properties (tensile, creep, fatigue, fracture mechanics, etc.)

- Fabrication, testing, and evaluation of irradiation experiments; development of high strength, oxidation resistant graphites with high resistance to irradiation damage.

Metals Technology Development - DOE Contact J.E. Fox, 301-353-3985; GA Technologies Contact D. Roberts, 619-455-2560

- Characterize and qualify the metallic materials selected for application in the near-term steam cycle/cogeneration HTR system.

- Develop base technology required for selection of alloys for advanced HTR systems.

Structural Materials Development - DOE Contact J.E. Fox, 301-353-3985; ORNL Contact P. Rittenhouse, 615-574-5103

- Selection, characterization, and qualification of high temperature alloys; evaluation of effects of exposures in simulated environments on mechanical properties (creep, fatigue, fracture mechanics).

- Development of the data base and correlations required for qualification; development of welding procedures and evaluation of weldment properties.

Advanced Gas-Reactor Materials Development - DOE Contact J.E. Fox, 301-353-3985; GE Contact O.F. Kimball, 518-385-1427

- Selection and evaluation of candidate high temperature alloys; evaluation of effects of exposures in simulated environments on mechanical properties (tensile, impact, creep, fatigue).

- Generation of a data base for development of design criteria and code qualification rules for temperatures above 760 degrees C (1400 degrees F).

Office of Terminal Waste Disposal and Remedial Action

Division of Storage and Treatment Projects

The mission of the Division of Storage and Treatment Projects is to facilitate development of a reliable national system for managing low-level waste and to develop acceptable technologies for the treatment and immobilization of nuclear fuel cycle and special types of radioactive waste.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Technical Support to West Valley Demonstration Project - DOE Contact T.W. McIntosh, 301-353-4728; PNL Contact H.C. Burkholder, 509-375-2860

- Provide technical assistance in supernate treatment and borosilicate glass formulation for West Valley Demonstration Project waste.

Materials Properties, Behavior, Characterization, or Testing

Materials Characterization Center Testing of West Valley Formulation Glass - DOE Contact H.F. Walter, 301-353-5510; PNL Contact J.E. Mendel, 509-375-2905

- Evaluate, using various MCC test methods, samples of glass having the expected composition of West Valley borosilicate glass incorporating high-level waste.

Nuclear Waste Treatment - DOE Contact J.B. Zorn, 301-353-4728; PNL Contact H.C. Burkholder, 509-375-2860

- Develop acceptable technologies for treatment and immobilization of waste from the nuclear fuel cycle and special waste.

Device or Component Fabrication, Behavior, or Testing

West Valley Joule Heated Ceramic Melter Design and Fabrication - DOE Contact H.F. Walter, 301-353-4728; PNL Contact H.C. Burkholder, 509-375-2860

- Design and fabricate a liquid fed joule heated ceramic melter capable of making about 0.8 cubic meters per day of borosilicate glass incorporating West Valley high-level waste.

Special Waste Form Lysimeter for Arid Regions - DOE Contact J.L. Smiley, 301-353-4728; EG&G Idaho Contact - E. Jennrich, 208-526-9490

- Conduct waste form leaching tests in a field facility in order to determine typical source terms generated by commercial solidified low-level waste in an arid climate.

- Identify the chemical and physical processes that control the concentrations of radionuclides in the surrounding soil.

- Determine methods for representing the source term boundary conditions for transport models.

Special Waste Form Lysimeter for Humid Regions - DOE Contact J.L. Smiley, 301-353-4728; EG&G Idaho Contact E. Jennrich, 208-526-9490

- Conduct waste form leaching tests in a field facility in order to determine typical source terms generated by commercial solidified low-level waste in a humid climate.

- Identify the chemical and physical processes that control the concentration of radionuclides in the surrounding soil.

- Compare radionuclide-emigration from solidified commercial low-level waste in order to evaluate the benefits of solidification.

Office of Uranium Enrichment

The Department of Energy is authorized by the Atomic Energy Act, as amended, to provide toll uranium enrichment services to commercial customers. This is, customers deliver natural uranium to one of DOE's plants and for a fee, DOE returns material enriched to the desired level in the isotope uranium-235. The goal of the Uranium Enrichment program is to meet the requirements of domestic and foreign customers and the United States Government for uranium enrichment services in an economical, reliable, safe, secure, and environmentally acceptable manner.

Until 1974, the United States held a virtual monopoly in the world enrichment market. Since that time, competition from foreign suppliers has reduced DOE's share of the foreign market to approximately one-third of its previous level and has made inroads into the domestic market. The ability of foreign suppliers to penetrate DOE's previously exclusive market was due principally to significant price differences and more favorable contract terms.

In early 1984, DOE announced that it was embarking on a major initiative to restore the competitive position of the United States in the world enrichment market. The elements of the Department's initiative were: to stabilize DOE's market share through the issuance of a new more flexible enrichment contract; to reduce prices to competitive levels; to enhance DOE customer services and marketing activities; and to reduce program costs in all major areas, including diffusion operations and advanced technology research and development activities. The underlying philosophy of the DOE approach was to operate the program as much like a competitive business as possible keeping in mind that there will be an oversupply of world uranium enrichment services well into the 1990's.

One major element in the initiative to recapture the enrichment market was the selection in June 1985, after a lengthy evaluation, of the Atomic Vapor Laser Isotope Separation (AVLIS) process over the Advanced Gas Centrifuge

(AGC) for having the best potential of these advanced processes for providing the lowest cost uranium enrichment in the future. Because the enrichment market will be dynamic for at least the next decade, the timing and extent of integration of AVLIS into the enrichment enterprise must be carefully evaluated.

Uranium as found in nature contains about seven-tenths of 1 percent uranium 235 which is fissionable. The remainder is essentially uranium 238 which is nonfissionable. The fissionable characteristics of uranium 235 make it desirable for use as nuclear fuel and light water reactors typically require uranium 235 concentrations in the 2 to 4 percent range. Presently uranium is enriched to the desired uranium 235 product assay levels in gaseous diffusion plants located at Portsmouth, Ohio, and Paducah, Kentucky. The diffusion plant at Oak Ridge, Tennessee, used since World War II, has been placed in standby operation.

The Office of the Deputy Assistant Secretary for Uranium Enrichment, reporting to the Assistant Secretary for Nuclear Energy, is responsible for the management of DOE resources to attain the uranium enrichment goal. Uranium enrichment is composed of four major offices: Marketing and Business Operations, Operations and Facility Reliability, Technology Deployment and Strategic Planning, and Advanced Technology Projects and Technology Transfer. Operations and Facility Reliability is responsible for overseeing all aspects of the gaseous diffusion plants including the electrical power contracts which are a major cost element. The Technology Deployment and Strategic Planning Office is responsible for integrating production, business, marketing and technology development plans into a single strategic plan for the uranium enrichment enterprise. This includes working with the private sector to determine optimum means of financing new technology deployment. This Office is also responsible for the orderly termination and search for alternative uses for the canceled Gas Centrifuge Enrichment Plan (GCEP) project and the Advanced Gas Centrifuge equipment and facilities. The Office of Advanced Technology Projects and Technology Transfer is responsible for all research/development/demonstration and generation of production plant concepts for the AVLIS technology.

Revenues received by DOE for the enrichment of uranium are retained and used for the specific purposes of offsetting costs incurred by the Department in providing uranium enrichment service activities as authorized by Section 201 of Public Law 95-238, not withstanding the provisions of Section 3617 of the Revised Statutes (31 USC 484). The sum appropriated is reduced as uranium enrichment revenues are received during a fiscal year so as to result in a final fiscal year appropriation estimated at $0. Total obligations for all uranium enrichment activities in FY 1985 was $1.678 billion and is expected to be $970 million in FY 1986.

Materials activities within the Office of Uranium Enrichment are varied and for the most part, especially the test results, classified Restricted Data. In FY 1985, approximately $63 million was used in these endeavors. The Appendix summarizes these activities for the purpose of this report. The DOE contact is A.P. Litman, 301-353-5777.

Materials Activities

Gaseous Diffusion: Barrier Quality

- Studies of the short- and long-term changes in the separative capability of the diffusion barrier.

- Methods to recover and maintain barrier quality and demonstration in the production facilities.

Gaseous Diffusion: Barrier Sciences

- Work on barrier theory is performed and assistance is given to the barrier quality activities.

Gaseous Diffusion: Materials and Chemistry Support

- Characterization of contaminant-process gas cascade reactions, physical/chemical properties of UF_6 substances, corrosion of materials, failure analyses, trapping technology, alternative materials replacement.

Gas Centrifuge

- Program for enrichment of uranium by means of the gas centrifuge process was terminated in June 1985. Immediately thereafter, construction ceased on GCEP in southern Ohio, and all development of the AGC was terminated.

- Current activity is dedicated to decommissioning and decontamination of manufacturing and development facilities, disposal of surplus materials and equipment, and final documentation of centrifuge technology.

- Approximately 1,200 gas centrifuges have been retained for possible use in enrichment of isotopes other than uranium.

Atomic Vapor Laser Isotope Separation Process Separator Development (AVLIS)

- Utilizes the differences in the electronic spectra of atoms of uranium isotopes to induce the selective absorption required for isotopic separation. Utilizes the controlled vaporization of uranium atoms followed by selective excitation and ionization of uranium 235 using tunable lasers in the visible regions of the spectrum. Resulting plasma of uranium enriched in uranium 235 ions can then be removed from the vapor using electromagnetic methods.

- Development of process separator; coating development for various substrates to contain uranium and development/demonstration of engineering subcomponents.

Office of Reactor Systems: Division of Special Applications

The Division of Special Applications is responsible for the development, system safety and production of radioisotope thermoelectric generators (RTG) and dynamic power systems for NASA and DoD space and terrestrial applications and advancing base technologies for these power systems. Thus, applied materials research programs are supported in the areas of thermoelectric materials and devices, high temperature heat source materials, materials systems compatibility and safety related materials characterization and testing.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Development of Improved Thermoelectric Materials for Space Nuclear Power Systems - DOE Contact W. Barnett, 301-353-3097; General Electric Co., Space Systems Division Contact P. Gorsuch, 215-354-5047

- Study of Si-Ge type thermoelectric alloys. Key variables include alloy and dopant additions, processing parameters, and structure control. Goal is an average Figure of Merit, Z, of 1×10^{-3} per degree C from 300 to 1000° C.

- Exploratory studies of potential advanced refractory thermoelectric materials, namely beta boron and boron carbide.

Development of an Improved Process for the Manufacture of DOP-26 Iridium Alloy Blank - DOE Contact W. Barnett, 301-353-3097; ORNL Contact R. Heestand, 615-574-4352

- Development of a consumable arc melt/extrusion route process for the production of DOP-26 iridium alloy sheet.

Carbon Bonded Carbon Fiber (CBCF) Insulation Manufacturing Process Development and Product Characterization - DOE Contact W. Barnett, 301-353-3097; ORNL Contact W. Eatherly, 615-574-5220

- Improve process control systems, optimization of process parameters, and accommodation of a new type carbon fiber for the manufacture of CBCF, carbon bonded carbon-fiber thermal insulation.

Characterization of State-of-the-Art Thermoelectric Device/Materials and Exploratory Studies of Rare Earth Sulfide Thermoelectric Materials - DOE Contact W.J. Barnett, 301-353-3097; Iowa State University Contact B. Beaudry, 515-294-1366

- Evaluation and characterization of state-of-the-art Si-Ge/GaP and other "improved" silicon-germanium type thermoelectric materials.

Office of Space Reactor Projects

Investigation of fundamental material properties and resolution of compatibility issues are critical for the successful development of space nuclear reactor power systems. Feasibility of using refractory metals in a reactor concerns the material transport fluid/cladding/fuel chemical interaction. Knowledge of the creep strength, ductility, fracture toughness, and fabricability of refractory alloys is an important factor in the selection of materials for the reactor system. The effects of fast neutron irradiation on their mechanical behavior are also important factors for this selection. The candidate structural materials include molybdenum, niobium, tantalum, and tungsten-based alloys.

One objective is the measurement of the high temperature creep strength and the DBTT of refractory alloy, wrought and weldment specimens, for use in early structural alloy selection decisions. A second objective is to analyze the available high temperature creep data for candidate refractory alloys.

Office of Breeder Technology Projects

Fuels and Core Materials Division

The applied research and development technology activities, conducted at several national laboratories, industrial organizations, universities, and through bilateral and trilateral technology programs and exchanges with foreign nations, relate to current and advanced reactor systems. The scope of these activities include the following areas: fucl cycles; design and performance of high quality core components for fuels, blanket, and control systems; development of the structural materials used in these components and systems; development and demonstration of equipment, processes, and procedures for fabricating, processing, handling, and producing mixed oxide bearing fuels, materials, and components; sodium technology; standards and quality assurance; assuring a reliable high quality economical fuel supply for LMR's; destructive and non-destructive testing, examination, and evaluation of core components and the facilities and capabilities for conducting such examinations; responsibility for engineering and supporting facilities; associated safety, safeguards, and non-proliferation; maintaining competent capabilities in the several contractor organizations that conduct the pertinent R&D activities and programs. These activities are responsive to the administration's policies and goals and, to the DOE programs that support them.

In-reactor and out-of-reactor property evaluations are being conducted on core materials, clad/ducts, fuels and absorber materials. Through irradiation testing in FFTF and EBR-II, the Fuels and Core Materials Program is developing, qualifying, and verifying the use of reference, improved and advanced mixed oxide fuels and boron carbide absorbers, including full size driver and blanket fuel, and absorber element pins and assemblies-- same for carbide fuels. Fabrication development, evaluation, qualification, and verification (raw material processing, melting, hot working, cold working, and finishing) are conducted on reference, improved, and advanced alloys including in-reactor qualification of pins, ducts, and assemblies; surveillance assemblies of reference materials now in FFTF Core 1. Improved and advanced materials are being tested for use in future cores. The DOE contact is Dave Nulton, 301-353-5004.

Materials and Structures Division

The objectives of the Materials and Structures Division are to develop procedures that will assure economic and safe components and systems while providing designers with sufficient flexibility in components and systems design to facilitate optimization. Materials being evaluated are low alloy and stainless steels as well as ferrous superalloys. Major areas include materials characterization, radiation effects, mechanical properties, joining methods, non-destructive testing, tribology, corrosion and wear, and materials data documentation. The DOE contact is Nick Grossman, 301-353-3405.

Office of Naval Reactors

The Materials Research and Development Program is in the Reactor Materials Division under the Deputy Assistant Secretary for Naval Reactors. The program supports the development and operation of improved and longer life reactors and pressurized water reactor plants for naval nuclear propulsion.

The objective of the materials program is to develop and apply in operating service materials capable of use in the high power density and long life required of naval ship propulsion systems. This work includes irradiation testing of reactor fuel, poison, and cladding materials in the Advanced Test Reactor at the Idaho National Engineering Laboratory. This testing and associated examination and design analysis demonstrates the performance characteristics of existing materials as well as defining the operating limits for new materials.

Corrosion, mechanical property, and wear testing is also conducted on reactor plant structural materials under both primary reactor and secondary steam plant conditions to confirm the acceptability of these materials for the ship life. This testing is conducted primarily at two Government laboratories - Bettis Atomic Power Laboratory in Pittsburgh and Knolls Atomic Power Laboratory in Schenectady, New York.

One result of the work on reactor plant structural material is the issuance of specifications defining the processing and final product requirements for materials used in naval propulsion plants. These specifications also cover the areas of welding and nondestructive testing.

Funding for this materials program is incorporated in naval projects jointly funded by the Department of Defense and the Department of Energy. This funding amounts to approximately $60 million in FY 1985 including approximately $30 million as the cost for irradiation testing in the Advanced Test Reactor. The Naval Reactors contact is Robert H. Steele, FTS 557-5565.

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

	FY 1985
Office of Civilian Radioactive Waste Management Grand Total	$ 18,613,000
Office of Storage and Transportation Systems	$ 760,000
Materials Properties, Behavior, Characterization, or Testing	$ 760,000
Development of Criteria for Nuclear Spent Fuel Storage in Air	$ 600,000
Development of Zircaloy Deformation and Creep Rupture Models for Predicting Cladding Behavior During Interim Dry Storage	80,000
Behavior of Water-Logged Spent Fuel During Interim Dry Storage	80,000
Basalt Waste Isolation Project Waste Package Materials Development	$ 6,230,000
Materials Properties, Behavior, Characterization or Testing	$ 5,910,000
Metal Barriers, Development for Nuclear Waste Packages	$ 1,780,000
Packing Materials development for Nuclear Waste Packages	1,280,000
Waste Package Materials Integrated Testing	2,850,000
Device or Component Fabrication or Testing	$ 170,000
Waste Package Container Welding and NDE Process Development	$ 70,000
Waste Package Fabrication Process Development	100,000
Instrumentation and Facilities	$ 150,000
High Temperature PH and EH Probe Development	150,000

Office of Geological Repositions - Nevada Nuclear Waste Storage Investigations Projects	$	9,363,000
Materials Properties, Behavior, Characterization or Testing	$	8,298,000
Waste Package Environment	$	590,000
Waste Form Testing		1,550,000
Metal Barrier Testing		1,750,000
Other Engineered Barrier Waste Package Components		325,000
Waste Package - Performance Assessment		600,000
Research on Modeling of Radionuclide Migration in a Fractured Rock Matrix		530,000
Spent Fuel Storage in Crystalline Rock		800,000
Rockmass Analysis - Yucca Mountain Media		321,000
Field Tests - Welded Tuff - G-Tunnel - NTS		929,000
Tuff - Laboratory Properties		683,000
Sealing Materials Evaluation		220,000
Device or Component Fabrication, Behavior or Testing	$	1,065,000
Waste Package - Design, Fabrication, and Prototype Testing	$	400,000
Waste Package Environmental Field Tests		665,000
Salt Repository Project	$	1,935,000
Materials Properties, Behavior, Characterization, or Testing	$	1,935,000
Waste Form Evaluation Task	$	465,000
Waste Package Environment Studies		525,000
Metal Barrier Testing		895,000
Repository Seal Materials Development Task		50,000
Sandia National Laboratories: Brittle Fracture Technology Program	$	325,000
Materials Structure and Composition	$	50,000
Microstructure Investigations of Nodular Cast Iron	$	25,000
Composition Investigation of Nodular Cast Iron		25,000

		FY 1985
Sandia National Laboratories: Brittle Fracture Technology Program (Continued)		
Materials Properties, Characterization, Behavior, or Testing	$	145,000
Generate Material Property Database for Nodular Cast Iron	$	140,000
Investigate the Feasibility of Using Depleted Uranium as a Structural Component in Cask Construction		5,000
Instrumentation and Facilities	$	130,000
Evaluate Current NDE Methods for Applicability to Thick Section Nodular Cast Iron	$	130,000

Office of Storage and Transportation Systems

The objectives of the Commercial Spent Fuel Management (CSFM) Program are to encourage and expedite the implementation of existing and new spent nuclear fuel storage technologies; to accelerate the availability of dry storage and rod consolidation technologies through licensed cooperative demonstrations at reactor sites and unlicensed testing at Federal facilities; and to provide the planning for a Federal capability to store up to 1900 MT of spent fuel for those utilities that the NRC determines cannot reasonably provide increased at-reactor storage when needed.

Materials Properties, Behavior, Characterization, or Testing

Development of Criteria for Nuclear Spent Fuel Storage in Air - DOE Contact D.E. Shelor, 202-252-9433; PNL Contact E.R. Gilbert, 509-375-2533

- Testing spent fuel and unclad UO_2 in air to determine the temperature dependence of degradation by oxidation.
- Development of models to derive storage criteria to prevent degradation of spent fuel in air by oxidation.

Development of Zircaloy Deformation and Creep Rupture Models for Predicting Cladding Behavior During Interim Dry Storage - DOE Contact D.E. Shelor, 202-252-9433; PNL Contact E.R. Gilbert, 509-375-2533

- Analysis of existing data on deformation and creep rupture for nonirradiated Zircaloy.
- Development of theoretical models for deformation and creep rupture for spent fuel under dry storage conditions.
- Comparison of models with FRG deformation and creep rupture data on spent fuel and irradiated Zircaloy cladding.
- Prediction of spent fuel cladding behavior under dry storage conditions.

Behavior of Water-Logged Spent Fuel During Interim Dry Storage - DOE Contact D.E. Shelor, 202-252-9433; PNL Contact E.R. Gilbert, 509-375-2533

- Perform tests with water-logged spent fuel to determine the behavior under dry storage conditions.

Basalt Waste Isolation Project Waste Package Materials Development

The objective of the Basalt Waste Isolation Project Waste Package Materials Development effort is to identify, characterize and evaluate the performance of potential waste package materials under the environmental conditions expected for a repository constructed in basalt. This information is used in developing design specifications for the waste package and in evaluating waste package design performance relative to regulatory requirements.

Materials Properties, Behavior, Characterization or Testing

Metal Barriers Development for Nuclear Waste Packages - DOE Contact P.E. Lamont, 509-376-6117; Rockwell Hanford Operations Contact T.B. McCall, 509-376-7114

- Investigate iron and copper base metals for use as nuclear waste package container materials that will provide containment for 1000 years under conditions expected for a repository constructed in basalt.

Packing Materials Development for Nuclear Waste Packages - DOE Contact M. J. Furman, 509-376-7062; Rockwell Hanford Operations Contact P.F. Salter, 509-376-7207

- Investigate crushed basalt and sodium bentonite clay composites for use as a packing material around nuclear waste containers which will retard/limit long term radionuclide release from the waste package under conditions expected for a repository constructed in basalt.

Waste Package Materials Integrated Testing - DOE Contact M. J. Furman, 509-376-7062; Rockwell Hanford Operations Contact P.F. Salter, 509-376-7207

- Testing of Nuclear Waste/Engineered Barrier/Rock/Groundwater interactions over the range of conditions expected for waste packages emplaced in a repository in basalt in order to evaluate long term radionuclide releases from the waste package relative to regulatory criteria.

Device or Component Fabrication, Behavior or Testing

Waste Package Container Welding and NDE Process Development - DOE Contact P.E. Lamont, 509-376-6117; Rockwell Hanford Operations Contact T. B. McCall, 509-376-7114

- Develop a remote welding and NDE process for waste package containers which will ensure the integrity of the welds is equal to the base metal.

Waste Package Packing Fabrication Process Development - DOE Contact P. E. Lamont, 509-376-6117; Rockwell Hanford Operations Contact T. B. McCall, 509-376-7115

- Develop a fabrication and emplacement process for waste package packing which will ensure that the packing will meet its post-closure performance requirement to limit water flow around the waste package to that necessary to ensure mass transport is dominated by diffusion.

Instrumentation and Facilities

High Temperature PH and EH Probe Development - DOE Contact M. J. Furman 509-376-7062; Rockwell Hanford Operations Contact P.F. Salter, 509-376-7207

- High temperature (100-300°C) pH and Eh probes are being developed for use in the waste package fully radioactive waste release hydrothermal interactions testing program.

Office of Geological Repositories Nevada Nuclear Waste Storage Investigations Project (OGR/NNWSI)

The primary goal of the OGR/NNWSI materials program is the development of Tuff specific waste packages that meet the performance requirements of the NRC criteria and are cost effective. This goal requires the definition of physical and chemical conditions of the site, selection of package materials, waste package design activity, prototype waste package fabrication, and performance testing.

Materials Properties, Characterization or Testing

Waste Package Environment - DOE Contact D.L. Vieth, 702-295-3662; LLNL Contacts L. Ballou, 213-422-4911; V. Oversby, 213-423-2228

- Characterize the time-dependent behavior of the hydrogeologic environment in which the waste packages will reside in order to establish the envelope of conditions that define package design parameters, materials testing conditions, and boundary conditions for performance analysis.

Waste Form Testing - DOE Contact D.L. Vieth, 702-295-3662; LLNL Contacts L. Ballou, 213-422-4911; V. Oversby, 213-423-2228

- Characterize the behavior of and determine the radionuclide release rates for the various waste forms in the geological tuff environment and as modified by corrosion products in the Metal Barrier Testing.

Metal Barrier Testing - DOE Contact D.L. Vieth, 702-295-3662; LLNL Contacts L. Ballou, 213-422-4911; R.D. McCright, 213-423-7051

- Characterize the behavior of and determine the degradation modes and rates for candidate metallic barrier materials in the environment. This information is needed to establish the data base to support license applications predictions of containment of radioactivity for times required by NRC 10 CFR 60.

Other Engineered Barrier Waste Package Components - DOE Contact D.L. Vieth, 702-295-3662; LLNL Contacts L. Ballou, 213-422-4911; V. Oversby, 213-423-2228

- Characterize the properties and behavior of other engineered barrier waste package components that may be present in a repository. This information is needed to establish the predicted performance of other materials, such as packing materials, that may be present to assist waste forms and metal barriers in meeting NEC 10 CFR 60 performance requirements.

Waste Package - Performance Assessment - DOE Contact D.L. Vieth, 702-295-3662; LLNL Contacts L. Ballou, 213-422-4911; V.K. Eggert, 213-423-6779

- Provide a quantitative prediction of long-term waste package performance. This information, including uncertainties, is needed: 1) to provide feedback to design optimization studies, 2) to demonstrate compliance with NRC performance objectives for the Waste Package Subsystem, and 3) to provide a source term for the Engineered Barrier System and the Total System performance assessments required by NRC 10 CFR 60 and EPA 40 CFR 191.

Research On Modeling of Radionuclide Migration in a Fractured Rock Matrix - DOE Contact D.L. Vieth, 702-295, 3662; LLNL Contacts D. Emerson, 213-422-6504; T. Wolery, 213-423-5789

- Further develop the geochemical modeling code DO3/6 for use in long-term predictions of radionuclide release from a nuclear waste repository.

Spent Fuel Storage in Crystalline Rock - DOE Contact D.L. Vieth, 702-295-3662; LLNL Contact W. Patrick, 213-422-6495

- Demonstrate the feasibility of short-term storage and retrieval of spent, unreprocessed fuel; to measure the response of a crystalline rock mass to simulated repository conditions and use these data to validate thermal and thermomechanical models; and to compare the effects of heat alone and heat in combination with intense ionizing radiation on a crystalline rock mass.

Rockmass Analysis - Yucca Mountain Media - DOE Contact D.L. Vieth, 702-295-3662; SNL Contact S. Bauer, 505-846-9645

- Evaluate intact and rockmass thermomechanical properties based on analysis of available laboratory and field experiments and finite element analyses. This information will be used to recommend rock properties for calculations that support the conceptual design, Environmental Assessment (EA), and Site Characterization Plan (SCP).

Field Tests - Welded Tuff - G-Tunnel - NTS - DOE Contact D.L. Vieth, 702-295-3662; SNL Contact R.M. Zimmerman, 505-846-0187

- G-Tunnel on the Nevada Test Site (NTS) contains welded tuffs that have stress states and thermal and mechanical properties similar to those of welded tuffs in Yucca Mountain, the prospective site for a radioactive waste repository. Until field experiments can be carried out in the exploratory shaft (ES) in Yucca Mountain, field testing is being conducted in G-Tunnel to provide information and test results under conditions similar to those at the ES.

Tuff-Laboratory Properties - DOE Contact D.L. Vieth, 702-295-3662; SNL Contact F.B. Nimick, 505-844-6696

- Develop, through laboratory measurements, a data base for the bulk, thermal, and mechanical properties of tuff. The data base will include the spatial variation of these properties and the variations of the properties that result from variations in environmental parameters (e.g., temperature, pressure, and moisture content).

Sealing Materials Evaluation - DOE Contact D.L. Vieth, 702-295-3662; Penn State Unversity and LLNL Contacts D.M. Roy, C. Duffy, 505-843-5154

- Develop sealing materials for fractures, boreholes, and access shafts and drifts and assess their chemical stability and possible effects upon water chemistry. In particular, determine how changes in mineralogy or dissolution may affect the permeability of the seals and if interaction between water and the seals can change the water chemistry in such a way as to increase waste-element solubility.

Device or Component Fabrication, Behavior, or Testing

Waste Package-Design, Fabrication and Prototype Testing - DOE Contact D.L. Vieth, 702-295-3662; LLNL Contacts L. Ballou, 213-422-4911; E. Russell, 213-423-6398

- Develop, analyze, fabricate, and test waste package designs that incorporate qualified materials and which are fully compatible with the repository design. This work supports license application by demonstrating conformance with requirements for safe handling, emplacement, possible retrieval, and credible accident conditions per NRC 10 CFR 60 and 10 CFR 71 in a cost-effective manner.

Waste Package Environmental Field Tests - DOE Contact D.L. Vieth, 702-295-3662; LLNL Contacts L. Ballou, 213-422-4911; J. Yow, 213-423-3521

- Develop a detailed engineering test plan for the waste package environment in situ testing program.

- Evaluate, design, fabricate, and test thermomechanical and hydrologic instrumentation for waste package in situ test measurements.

Salt Repository Project

The Salt Repository Project has sponsored a Waste Package Program at PNL that has the objective of conducting nuclear waste package component development and interactions testing, and applying the resulting database to the development of predictive models describing waste package degradation and radionuclide release.

Materials Properties, Behavior, Characterization, or Testing

Waste Form Evaluation Task - DOE Contact K.K. Wu, FTS 976-5916; PNL Contact D.J. Bradley, 509-375-2587

- Evaluation of the radioactive release from spent fuel in a simulated salt repository environment.

Waste Package Environment Studies - DOE Contact K.K. Wu, FTS 976-5916; PNL Contact D.J. Bradley, 509-375-2587

- Definition of the most probable range of environments to be expected in a salt repository.

- Determination of the solubilities of radionuclides in these environments.

Metal Barrier Testing - DOE Contact K.K. Wu, FTS 976-5916; PNL Contact D.J. Bradley, 509-375-2587

- Determination of the resistance of candidate waste package container materials to uniform corrosion and stress corrosion cracking in brine environments.

Sandia National Laboratories: Brittle Fracture Technology Program

The objective of this program is to qualify alternate materials (other than stainless steel) for use in nuclear spent fuel cask construction. Candidate materials include nodular cast iron and ferritic steel. The main technical issue which must be addressed is the application of fracture mechanics to cask analysis and design. Materials, such as nodular cast iron, exhibit a ductile/brittle failure mode transition. Hence, a cask constructed out of this material may be susceptible to brittle fracture under certain environmental and loading conditions. The application of fracture mechanics can provide the cask analyst/designer the ability to guarantee ductile cask material response to design loadings.

Materials Structure and Composition

Microstructure Investigations of Nodular Cast Iron - DOE Contact F. Falci, FTS 233-5466; SNL Contact K.B. Sorenson, 505-844-5360

- Investigation of the effect of microstructure on material properties.
- Study of the effect of graphite nodule size and spacing on fracture toughness.

Composition Investigation of Nodular Cast Iron - DOE Contact F. Falci, FTS 233-5466; SNL Contact K.B. Sorenson, 505-844-5360

- Investigation of the effect of material composition on material properties.
- Study of the effect of material composition on fracture toughness and tensile properties.

Materials Properties, Behavior, Characterization, or Testing

Generate Material Property Database for Nodular Cast Iron - DOE Contact F. Falci, FTS 233-5466; SNL Contact K.B. Sorenson, 505-844-5360

- Generate a database for nodular cast iron which includes material properties pertinent to fracture mechanics.

Investigate the Feasibility of Using Depleted Uranium as a Structural Component in Cask Construction - DOE Contact F. Falci, FTS 233-5466; SNL Contact K.B. Sorenson, 505-844-5360

- Investigate the feasibility of using depleted uranium (DU) as a structural component in cask body construction.

Instrumentation and Facilities

Evaluate Current NDE Methods for Applicability to Thick Section Nodular Cast Iron - DOE Contact F. Falci, FTS 233-5466; SNL Contact K.B. Sorenson, 505-844-5360

- Evaluate state-of-the-art NDE methods for specific application to thick-walled nodular cast iron.

Repository Seal Materials Development Task - DOE Contact R.B. Lahoti, 976-5916; Army Corps of Engineers Contact

- Laboratory experiments will be designed and conducted leading to the identification of specific compositions and/or forms of the candidate sealing materials that appear to be acceptable for use as a seal component in penetrations in the salt repository.

OFFICE OF DEFENSE PROGRAMS

	FY 1985
Office of Defense Programs Grand Total	$ 39,503,000
Office of Inertial Fusion	$ 3,000,000
Fusion Research Division	$ 3,000,000
Device or Component Fabrication, Behavior, or Testing	$ 3,000,000
Target Fabrication	$ 1,500,000
Laser Materials and Optical Components	1,500,000
Office of Military Applications	$ 36,503,000
Sandia National Laboratories - Albuquerque	$ 16,505,000
Solid State Sciences Directorate, 1100	$ 2,550,000
Ion Implantation and Radiation Physics Research Department, 1110	$ 750,000
Materials Properties, Behavior, Characterization, or Testing	$ 750,000
Ion Implantation Studies for Friction and Wear	$ 250,000
Silicon-Based Radiation Hardened Microelectronics	500,000
Condensed Matter and Surface Science Department, 1130	$ 1,150,000
Materials Properties, Behavior, Characterization, or Testing	$ 1,150,000
Shock Chemistry	$ 500,000
Initiation of Granular Explosives	350,000
Strained-Layer Superlattices for IR Detectors	300,000

	FY 1985
Solid State Research Department, 1150	$ 650,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 550,000
Materials Growth by MOCVD	$ 150,000
Materials Growth by MBE	300,000
Conducting Organic Materials	100,000
Materials Properties, Behavior, Characterization, or Testing	$ 100,000
Passivation of Semiconductor Grain Boundaries and Defects	$ 100,000
Organic and Electronic Materials Department, 1810	$ 1,870,000
Chemistry of Organic Materials Division, 1811	$ 400,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 250,000
Polysilanes, Photoresists, and Non-Charring Dielectrics	$ 150,000
Sulfonated Aromatic Polysulfones	100,000
Materials Properties, Behavior, Characterization, or Testing	$ 150,000
Radiation Hardened Dielectrics	$ 150,000
Physical Chemistry and Mechanical Properties of Polymers Division, 1812	$ 670,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 300,000
Effects of Material and Processing Variables on the Mechanical and Thermal Expansion Behavior of Graphite/Epoxy and Kelvar/Epoxy Composites	$ 300,000

		FY 1985
Physical Chemistry and Mechanical Properties of Polymers Division, 1812 (Continued)		
Materials Structure and Composition	$	320,000
The Chemical Characterization of Plasma Deposited Thin Films	$	150,000
Materials Structure and Properties by NMR Spectroscopy		70,000
Electron and Photon Stimulated Desorption From Organic Surfaces		100,000
Materials Properties, Behavior, Characterization, or Testing	$	50,000
Surface Chemistry and Bond of Plasma-Aminated Polyaramid Filaments	$	50,000
Physical Properties of Polymers Division, 1813	$	500,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$	100,000
Microcellular Foams for X-ray Laser	$	100,000
Materials Properties, Behavior, Characterization, or Testing	$	400,000
Cure Kinetics of Thermosets by DSC	$	100,000
Creep Rupture of Kelvar Composites		300,000
Electronic Property Materials Division, 1815	$	300,000
Materials Properties, Behavior, Characterization, or Testing	$	300,000
High Electric Field Varistors	$	100,000
Microelectronic Aluminum Metallizations		100,000
High Resistivity Thin Film Polycrystalline Silicon		100,000

	FY 1985
Materials Characterization Department, 1820	$ 1,240,000
Analytical Chemistry Division, 1821	$ 350,000
Instrumentation and Facilities	$ 350,000
Development of Automated Methods for Chemical Analysis	$ 350,000
Electron Optics and X-Ray Analysis Division, 1822	$ 350,000
Materials Properties, Behavior, Characterization, or Testing	$ 80,000
Thermomechanical Treatment of U Alloys	$ 80,000
Instrumentation and Facilities	$ 270,000
Advanced Methods for Electron Optical, X-Ray, and Image Analysis	$ 270,000
Surface Chemistry and Analysis Division, 1823	$ 240,000
Instrumentation and Facilities	$ 240,000
Advanced Methods for Surface and Optical Analysis	$ 240,000
Thermophysical Properties Division, 1824	$ 300,000
Instrumentation and Facilities	$ 300,000
Design and Fabrication of a Gamma-Ray Attenuation Spectrometer	$ 150,000
Infrared Reflectometer Development	150,000
Metallurgy Department, 1830	$ 3,935,000
Cleaning and Coating Technology Division, 1831	$ 1,005,000

	FY 1985
Metallurgy Department, 1830 (Continued)	
Cleaning and Coating Technology Division, 1831 (Continued)	
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 410,000
Plasma Deposition of Amorphous Metal Alloys	$ 130,000
Electrophoretically-Deposited Coatings	110,000
Near-Net-Shape Processing of Nickel-based Alloys	150,000
High Temperature Semiconductors	20,000
Materials Structure and Composition	$ 40,000
Surface Modification of Coating Morphology Using Ion Bombardment	$ 40,000
Materials Properties, Behavior, Characterization, or Testing	$ 440,000
Optical Diagnostics for Metallurgical Processing	$ 440,000
Device or Component Fabrication, Behavior, or Testing	$ 115,000
Plasma Removal of Metal Oxides	$ 115,000
Physical Metallurgy Division, 1832	$ 1,030,000
Materials Properties, Behavior, Characterization, or Testing	$ 1,030,000
Toughness of Ductile Alloys	$ 350,000
Analytical Electron Microscopy of Engineering Alloys	150,000
Friction and Wear of Modified Surfaces	230,000
Alloy Deformation Response and Constitutive Modeling	300,000

	FY 1985
<u>Process Metallurgy Division, 1833</u>	$ 1,115,000
<u>Materials Preparation, Synthesis, Deposition, Growth, or Forming</u>	$ 75,000
Vacuum Arc Remelting	$ 75,000
<u>Materials Properties, Behavior, Characterization, or Testing</u>	$ 100,000
Toughness of Inertia Welds	$ 60,000
Metallurgical Characterization of TiCode 12 Resistance Welds	40,000
<u>Device or Component Fabrication, Behavior, or Testing</u>	$ 865,000
Aluminum Laser Welding	$ 80,000
Low Temperature, Solid-State Welds of Copper	60,000
Dissimilar Metal Welds	120,000
Welding of Nickel-Based Alloys	225,000
Plasma Arc Welding	230,000
Laser Welding	150,000
<u>Instrumentation and Facilities</u>	$ 75,000
Electrode Gap Controller	$ 75,000
<u>Surface Metallurgy Division, 1834</u>	$ 785,000
<u>Materials Preparation, Synthesis, Deposition, Growth, or Forming</u>	$ 80,000
Deposition of Amorphous Materials with a Dual Beam Ion System	$ 80,000
<u>Materials Properties, Behavior, Characterization, or Testing</u>	$ 25,000
Modification of Mechanical Properties by Ion Implantation	$ 25,000

	FY 1985
<u>Surface Metallurgy Division, 1834 (Continued)</u>	
<u>Device or Component Fabrication, Behavior, or Testing</u>	$ 500,000
Development of Materials for Magnetic Fusion Reactors	$ 500,000
<u>Instrumentation and Facilities</u>	$ 180,000
Ion Beam Reactive Deposition System	$ 100,000
In-Situ Friction, Wear, and Electrical Contact Resistance System	80,000
<u>Chemistry and Ceramics Department, 1840</u>	$ 6,910,000
<u>Corrosion Division, 1841</u>	$ 1,150,000
<u>Materials Properties, Behavior, Characterization, or Testing</u>	$ 1,150,000
Corrosion	$ 1,150,000
<u>Ceramics Development Division, 1845</u>	$ 3,260,000
<u>Materials Preparation, Synthesis, Deposition, Growth, or Forming</u>	$ 2,580,000
Ceramic Processing	$ 2,580,000
<u>Materials Properties, Behavior, Characterization, or Testing</u>	$ 680,000
Fracture of Ceramics	$ 680,000
<u>Inorganic Materials Chemistry Division, 1846</u>	$ 2,500,000
<u>Materials Preparation, Synthesis, Deposition, Growth, or Forming</u>	$ 2,500,000
Glass and Glass-Ceramic Development	$ 2,500,000

	FY 1985
Sandia National Laboratories - Livermore	$ 2,200,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 650,000
Powder Metallurgy	$ 250,000
Advanced Electrodeposition Studies	150,000
Metal Forming	250,000
Materials Properties, Behavior, Characterization, or Testing	$ 1,350,000
Helium Induced Crack Growth in Metals and Alloys	$ 700,000
Welding Science and Technology	550,000
Composites: Stability, Compatibility, and Joining	100,000
Instrumentation and Facilities	$ 200,000
New Surface Spectroscopy	$ 200,000
Lawrence Livermore National Laboratory	$ 5,303,000
Materials Properties, Behavior, Characterization, or Testing	$ 4,623,000
Materials Modification by Ion Beams	$ 263,000
Weld Modeling	120,000
Synchrotron Radiation Studies	225,000
Metal Deformation Modeling	120,000
Rapid Solidification Processing of Alloys	380,000
Microstructure of Stainless Steel Welds	70,000
Powder Metallurgy	125,000
Coating Adhesion	70,000
Dislocation Structures and Reversed Strains	60,000
Weld Library Generation	70,000
Electron Beam Welder Data Acquisition System	100,000
Deformation of Aluminum to Large Strains	50,000
Corrosion of 7050 Aluminum	60,000
Electrochemical Oxidation	1,100,000
Microstructure Research	300,000
Pu Metallurgy	240,000
Pu Alloy Characterization	220,000
Pu Sputtering	360,000
Directed Energy Surface Processing	212,000

	FY 1985
Lawrence Livermore National Laboratory (Continued)	
Materials Properties, Behavior, Characterization, or Testing	
Formation of Metastable Surface Alloys	$ 193,000
Pu Laser Welding	25,000
Adhesives Evaluation	40,000
Mechanics of Low Density Materials	100,000
Polymeric Materials Computer Modeling	60,000
Lifetime Prediction Theory for Polymeric Materials	60,000
Instrumentation and Facilities	$ 680,000
Weapons Database Development	$ 200,000
Tritium Facility Upgrade	480,000
Los Alamos National Laboratory	$12,495,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$10,200,000
Fluidized Bed Coatings	$ 200,000
Materials Synthesis by Solid State Composition	250,000
Powder Preparation by Plasma Chemical Synthesis	350,000
Precision Tungsten Tubes	170,000
Superhard Materials	36,000
Glass Fabrication Technology	50,000
Slip Casting of Ceramics	218,000
Whisker Growth Technology	265,000
Development of Ceramic Matrix Whisker-Reinforced Composites	250,000
New Hot Processing Technology	210,000
Glass and Ceramic Coatings	10,000
Cold Pressing, Cold Isostatic Pressing and Sintering	175,000
Single Crystal Growth and Characterization	90,000
Plasma-Flame Spraying Technology	170,000
Electroplating Low Atomic Number Materials	0
Super-Hard Parylene Coating Development	80,000
Three New Conducting Polymers	240,000
New Highly Conductive Doped Polyacetylene	200,000
Liquid Crystal Polymer Development	75,000
Surface Property Modified Plastic Components	70,000
High-Z Loaded Parylene Polymer Coatings	70,000
Low Density, Microcellular Plastic Foams	400,000
Radiochemistry Detector Coatings	250,000

	FY 1985
Los Alamos National Laboratory (Continued)	
Materials Preparation, Synthesis, Deposition, Growth, or Forming (Continued)	
Target Coatings	700,000
Physical Vapor Deposition and Surface Analysis	600,000
High Energy Density Joining Process Development	400,000
Arc Welding Process Development	150,000
Superplastic Forming	150,000
Actinide Alloy Development	1,331,000
Surface Studies	250,000
Tritiated Materials	450,000
Actinide Surface Properties	690,000
Mechanical Properties and Alloy Development	340,000
Mechanical Properties of Uranium	70,000
Phase Transformations in Pu and Pu Alloys	375,000
High Strain Rate Testing	595,000
Neutron Diffraction of Pu and Pu Alloys	180,000
Powder Characterization	90,000
Device or Component Fabrication, Behavior, or Testing	$ 2,295,000
Polymers and Adhesives	$ 905,000
Salt Fabrication	324,000
Ceramic Technology	56,000
Glass and Ceramic Sealing, Metallizing Technology	65,000
Microwave Sintering/Processing	45,000
Injection Mold Process for Making Snap-On Fittings	50,000
Composite Spring Support Structures	300,000
Solid State Bonding	100,000
Nondestructive Evaluation	450,000

OFFICE OF DEFENSE PROGRAMS

The Assistant Secretary for Defense Programs directs the Nation's nuclear wepons research, development, testing, production, and surveillance programs. In addition, the Assistant Secretary coordinates a safeguards and security program to provide accountability and physical protection of special nuclear materials, including research and development for improvements, testing, evaluation, and implementation of safeguards systems. Additional responsibilities include management of the inertial fusion development and nuclear materials production programs, classification and declassification of sensitive weapons information, and analysis and coordination of international activities related to nuclear technology and materials.

Materials activities in Defense Programs are concentrated in the Offices of Inertial Fusion, Military Application, and Nuclear Materials Production.

Office of Inertial Fusion

Fusion Research Division

Target Fabrication - DOE Contact Carl B. Hilland, 301-353-3687; LANL Contact Richard Mah, 505-667-3238; KMS Fusion, Inc. Contact Timothy Henderson, 313-769-8500, ext. 302; LLNL Contact Irving Stowers, 415-422-5343

- Targets filled with dueterim-tritium gas are irradiated with a laser or particle beam to produce a fusion burn.

Laser Materials and Optical Components - DOE Contact Carl B. Hilland, 301-353-3687; LL Contact E. Storm, 415-422-0400; KMS Fusion, Inc. Contact A. Glass, 313-769-8500; University of Rochester Contact R. McCrory, 716-275-5286

- Development of Nd:glass amplifier discs and optical components for kilojoule-class laser systems.

Office of Military Applications

Solid State Sciences Directorate 1100

Ion Implantation and Radiation Physics Research, Department 1110

The mission of Department 1110 is to provide Sandia National Laboratories with a comprehensive research program and technology base in ion implantation, ion-solid microanalysis/channeling, defects in solids, and laser and electron beam annealing. The research is designed to enhance our fundamental understanding of the physical and chemical processes necessary to control the near-surface and interfacial regions of solids as well as to develop new techniques for the controlled modification and analysis of these near-surface and interfacial regions. A major aspect of the work is thus to develop an underlying understanding and control of defects, alloying processes, and the formation of metastable and amorphous phases. In addition, the mission of the department is to relate this knowledge to laboratory problems and needs in the development of advanced weapons and energy systems.

Materials Properties, Behavior, Characterization, or Testing

Ion Implantation Studies for Friction and Wear - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts D.M. Follstaedt, 505-844-2102; S.T. Picraux, 505-844-7681; L.E. Pope, 505-844-5041

- Modification via ion implantation of the surface and near-surface regions of metals.

- Evaluation of implantation-modified materials for improved friction and wear characteristics.

Silicon-Based Radiation Hardened Microelectronics - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts H.J. Stein, 505-844-6279; K.L. Brower, 505-844-6131

- Determination of the fundamental defect structures and materials properties required for radiation-hardened Si-based microelectronics using optical and electrical measurements, in conjunction with electron paramagnetic resonance and related techniques.

Condensed Matter and Surface Science, Department 1130

The mission of Department 1130 is to provide the Laboratories with fundamental understanding and strong technology bases in the following areas: (1) shock wave and explosives physics and chemistry; (2) electronic structure and transport in solids; and (3) surface science. Current areas of emphasis include shock-induced solid state chemistry, shock initiation of heterogeneous explosives, electromechanical phenomena and phase transitions in ferroelectrics, electronic properties of compound semiconductor strained-layer superlattices, electronic properties of polycrystalline and amorphous semiconductors, defects and deep levels in semiconductors, the use of Auger lineshape analysis to study the sensitivity of chemical explosives, and the modification and control of the properties of surfaces.

Materials Properties, Behavior, Characterization, or Testing

Shock Chemistry - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact R.A. Graham, 505-844-1931

- Investigation of organic and inorganic solids to determine the influence of molecular structure on shock-induced bond scission, and the influence of line and point defects on the observed enhanced, shock-induced solid state reactivity.

Initiation of Granular Explosives - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact R.E. Setchell, 505-844-5459

- Development of a fundamental understanding of the mechanisms involved in the shock wave initiation and growth to detonation of heterogeneous granular explosives. Materials of current interest include hexanitrostilbene and PBX 9404.

Strained-Layer Superlattices for IR Detectors - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact G.C. Osbourn, 505-844-8850

- Investigation of strained-layer superlattices based on the InAs/InSb/AlSb systems for use as attractive alternatives to the difficult HgCdTe alloys for IR detector applications in the 8-12 micron and 3-5 micron wavelength ranges.

Solid State Research, Department 1150

Department 1150 supports the Laboratories by providing fundamental, theoretical, and experimental research on novel materials and phenomena. Projects include synthesis and characterization of new materials not available from other sources as well as extensive modeling of materials and material behavior of interest to a wide variety of weapons and energy initiatives.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Materials Growth by MOCVD - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact R.M. Biefeld, 505-844-1556

- Growth of GaP/GaAsP strained layer superlattices (SLS's) both conventionally and modulation doped for application in a variety of typical and novel device structures.

Materials Growth by MBE - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact T.J. Drummond, 505-844-9677

- Investigation of the AlGaAs/AlAs system and the InGaAs system for material growth.

- Development of new devices including bistable optical switches, rad-hard photodiodes and the first p-channel SLS MODFET.

Conducting Organic Materials - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts D.S. Ginley, 505-844-8863; P.J. Nigrey, 505-844-8985

- Synthesis of a variety of charge transfer organic superconductors and polymeric organic conductors.

Materials Properties, Behavior, Characterization, or Testing

Passivation of Semiconductor Grain Boundaries and Defects - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact D.S. Ginley, 505-844-8863

- Study of the chemistry and kinetics of the passivation of polycrystalline silicon grain boundaries and defects with monatomic hydrogen.

Organic and Electronic Materials Department, 1810

Department 1810 provides support to Sandia projects through selection, development, and characterization of organic and electronic materials and associated manufacturing processes. Responsibilities span exploratory development through design, production, and stockpile life. The Department provides the Laboratories with knowledge and engineering data on properties and reliability of organic and electronic materials pertinent to our unique applications and conducts in-depth studies in order to understand and improve these properties. Department 1810 investigates unique and innovative approaches to applying organic materials to problems of interest at Sandia.

Chemistry of Organic Materials Division, 1811

Division 1811 supports the Laboratories in the area of chemistry of organic materials. It is responsible for selecting, formulating, and characterizing polymer films and coatings, adhesives, and resins for casting and molding as well as developing or synthesizing new organic materials for unique and innovative applications. This division coordinates aging and compatibility studies throughout the Laboratories. To accomplish these goals, the Division carries out in-depth chemical investigations to characterize the reaction chemistry of these materials which influence their formulation, processing, or aging.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Polysilanes, Photoresists and Non-Charring Dielectrics - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts J.M. Zeigler, 505-844-8728; L.A. Harrah, 505-844-6847

- Investigation of alkyl substituted polysilanes as potential positive-working non-solvent-developed photoresists for use in microelectronic circuit manufacture.

Sulfurated Aromatic Polysulfones - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts C. Arnold, Jr., 505-844-8728; R.A. Assink, 505-844-6372

- Synthesis of sulfonated aromatic polysulfones as stable ionic battery membranes.

Materials Properties, Behavior, Characterization, or Testing

Radiation Hardened Dielectrics - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts C. Arnold, 505-844-8728; S.R. Kurtz, 505-844-5436

- Development of polymer dielectrics that display a minimum radiation-induced conductivity (RIC). These materials will be used in capacitors and cables exposed to high dose-rate radiation so that little charge is lost due to RIC in this environment.

Physical Chemistry and Mechanical Properties of Polymers Division, 1812

The mission of Division 1812 is two-fold: to structurally and chemically characterize organic materials used in Sandia's applications and to characterize the mechanical properties of structural polymers. It is responsible for characterizing the molecular, electronic, and microphase structure of organic materials and their chemical reactivity toward the use environment as well as formulation of organic composites and adhesives. The Division carries out aging studies, compatibility studies, and coordinates these activities with designers and quality assurance staff. To support these programs, the division carries out in-depth studies on radiation chemistry, photochemistry, surface chemistry, and spectroscopy on polymeric systems.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Effects of Material and Processing Variables on the Mechanical and Thermal Expansion Behavior of Graphite/Epoxy and Kelvar/Epoxy Composites - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact T.R. Guess, 505-844-5604

- Examination of the processing of high performance composites to determine the influence of process variables on dimensional and environmental stability of the finished parts.
- Development of materials with thermal expansion coefficients for structural and electronic applications.

Materials Structure and Composition

The Chemical Characterization of Plasma Deposited Thin Films - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact R. Buss, 505-844-7494

- Structural characterization of plasma deposited polymers on thin films as a function of plasma characteristics, monomer structure, and deposition geometry.
- Use of dopants to study the growth reactions during deposition.
- Characterization of materials and plasmas by a variety of spectroscopic techniques.

Materials Structure and Properties by NMR Spectroscopy - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact R.A. Assink, 505-844-6372

- Use of NMR studies to characterize the microstructure and reaction kinetics of polymers and the transport characteristics of polymeric membranes.

- Use of magic angle spinning high resolution solid NMR spectroscopy to define the structure of rigid polymers formed by plasma deposition.

- Fourier transform studies to study the reaction kinetics of sol-gel materials.

- Pulsed decay experiments to study the mobility of the fluid phase in ion exchange resins.

Electron and Photon Stimulated Desorption From Organic Surfaces - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact J.A. Kelber, 505-844-3408

- Examination of the structure of surfaces and the fundamental mechanisms of radiation damage by electron and photon stimulated desorption from organic surfaces.

Surface Chemistry and Bond of Plasma-Aminated Polyaramid Filaments - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact R.E. Allred, 505-844-5538

- Study development of methods to improve fiber-matrix adhesion by modifying the fiber surface to allow covalent chemical bonding to the matrix resin.

Physical Properties of Polymers Division, 1813

Division 1813 provides support to Sandia projects through selection, development, and processing of foams, elastomers, encapsulants, and molding compounds. It is responsible for characterizing the physical properties and aging behavior of these materials. This Division also carries out in-depth physical property studies when necessary in order to understand or improve these properties.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Microcellular Foams for X-Ray Laser - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact P.B. Rand, 505-844-7953

- Development of ultra-low density (<0.005 g/cc) microcellular foams for the Narya pulsed-power-driven x-ray laser development program.

- Use of these foams, which are molded into rods, in gas puff implosion experiments on the Proto-II accelerator.

Materials Properties, Behavior, Characterization, or Testing

Cure Kinetics of Thermosets by DSC - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact M.R. Keenan, 505-844-6631

- Use of isothermal differential scanning calorimetry (DSC) to obtain the cure kinetics of a commercial epoxy film adhesive.

Creep Rupture of Kelvar Composites - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact R.H. Ericksen, 505-844-8333

- Identification of a variation in stress-rupture life of fibers from nominally identical Kevlar 49.

- Develop further insight into microstructural features controlling stress-rupture.

Electronic Property Materials Division, 1815

Division 1815 provides support to Sandia programs through selection, development, and characterization of electronic materials. Responsibilities span exploratory development through design, production, and stockpiling. The Division also performs in-depth studies in order to understand material properties and associated electronic phenomena. Areas of activity include inhomogeneous materials, contacts to electronic materials, dielectrics, and special materials and processes.

Materials Properties, Behavior, Characterization, or Testing

High Electric Field Varistors - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact G.E. Pike, 505-844-7562

- Preparation of ZnO varistors from fine powders precipitated from chemical solutions, yielding switching electric fields from 30 to 100 kV/cm.

Microelectronic Aluminum Metallizations - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact J.S. Arzigian, 505-844-2465

- Development of characterization of thin film aluminum alloy metallizations for microelectronic applications for their electromigration resistance and their compatibility with proposed VLSI circuit fabrication methods.

High Resistivity Thin Film Polycrystalline Silicon - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact W.K. Schubert, 505-846-2466

- Investigation of the roles of dopant diffusion and grain growth in determining the resistivity of ion implanted thin polycrystalline silicon films.

- Process development for high sheet resistance polysilicon used to make integrated circuit resistors.

Materials Characterization Department, 1820

Department 1820 performs chemical, physical, and thermophysical analyses of materials in support of weapons and energy programs throughout the Laboratories. The department also has the responsibility for the development of advanced analytical techniques to meet existing or anticipated needs. Consulting and process reviews are other important functions of the department.

Analytical Chemistry Division, 1821

The Analytical Chemistry Division 1821 is responsible for performing chemical analyses in support of weapon and energy programs at Sandia. The division is equipped to analyze a variety of samples such as gases, liquids, solutions, solids, organics, inorganics, glasses, alloys, ceramics, and geological materials. Analyses are performed by a variety of techniques using absorption and emission spectroscopy, gas chromatography, gas chromatography/mass spectrometry, ion chromatography, neutron activation analysis, electrochemistry, combustion, and classical methods of chemical analysis.

Instrumentation and Facilities

Development of Automated Methods for Chemical Analysis - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact N.E. Brown, 505-844-2747

- Development of new, highly automated methods for chemical analysis of a wide variety of materials: a new automated inductively coupled plasma emission spectroscope for trace analysis, an automated optical densitometer, an automated high performance liquid chromatograph, and an automated multichannel electronic recording emission spectrometer.

Electron Optics and X-Ray Analysis Division, 1822

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Thermomechanical Treatment of U Alloys - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact K.H. Eckelmeyer, 505-844-7775

- Investigation of thermomechanical treatments of uranium alloys as a means of improving properties and ease of processing.

- Development of methods for significantly reducing the quench severity required in U-Ti alloys, and for simultaneously increasing yield strength and ductility in U-0.75%Ti.

Instrumentation and Facilities

Advanced Methods for Electron Optical, X-Ray, and Image Analysis - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact W.F. Chambers, 505-844-6163

- Development of advanced methods of automated electron and x-ray instrumental analysis to improve resolution, accuracy, and efficiency.

- Initiation of a new system in advanced centralized image analysis, interface this system with several optical and electron optical instruments.

Surface Chemistry and Analyses Division, 1823

The Surface Chemistry and Analyses Division 1823 provides analytical surface and optical analyses of materials in support of Sandia programs throughout the Laboratories. In addition, staff members in the division engage in advanced materials research and in research funded by specific weapons or energy programs which can be uniquely investigated using their expertise. Specific techniques employed within the division include Auger spectroscopy, x-ray photoelectron spectroscopy, low energy ion scattering and secondary ion mass spectroscopies, energetic ion analysis methods, fluorescence and Raman spectroscopies, dispersive and Fourier transform infrared spectroscopies.

Instrumentation and Facilities

Advanced Methods for Surface and Optical Analysis - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact J.A. Borders, 505-844-8855

- Improvements in the multivariate least squares software package for quantitative Fourier transform infrared spectroscopy.

- Improvments in software for automated data acquisition and reduction for the laser Raman microprobe system.

Thermophysical Properties Division, 1824

The mission of Division 1824 is the measurement and analysis of thermal and optical properties of engineering materials in support of Sandia's weapons and energy programs. Capabilities include thermal conductivity and diffusivity measurements, calorimetry, densitometry, dilatometry, optical reflectance, optical emittance, and ellipsometry.

Instrumentation and Facilities

Design and Fabrication of a Gamma Ray Attenuation Spectrometer - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact W.D. Drotning, 505-844-7934

- Design and fabricaiton of a new system based on attenuation of monochromatic gamma rays from a radioactive isotopic source in order to analyze special materials for a strategic defense initiative program.

Infrared Reflectometer Development - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact H.L. Tardy, 505-846-6548

- Design and construction of a new infrared reflectometer to be used in support of a strategic defense initiative program and for reentry systems.

Metallurgy Department, 1830

Department 1830 selects, develops, and characterizes the non-electronic behavior of all metals and processes that may be needed to meet systems and components requirements. Responsibilities span exploratory development through design, production, and stockpile life. If either current or anticipated demands cannot be met by commercially-available metals and processes, Department 1830 is responsible for the necessary development. Understanding mechanisms of alloy bulk and surface behavior provides the basis for alloy and process development and increases the confidence of predictions of behavior. Surface treatment and coating processes receive special emphasis because of the close coupling of the surface and "bulk" behavior.

Cleaning and Coating Technology Division, 1831

Division 1831 conducts basic and applied research in two areas: (1) cleaning and contamination control; and (2) coatings. Coating research is currently being conducted in the areas of plasma deposition, chemical vapor deposition, electrophoretic deposition, and sputtering. In addition, this Division provides support for design engineers in the specification of processes and transfer of technology involving cleaning and coating.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Plasma Deposition of Amorphous Metal Alloys - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact A.K. Hays, 505-844-9996

- Production of amorphous metal alloys composed of Ni, P and C by decomposing $Ni(CO)_4$ and PH_3.

Electrophoretically-Deposited Coatings - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact D.J. Sharp, 505-844-8604

- Development of electrophoretically-deposited coatings for use as electrically insulating coatings on large, irregularly-shaped objects and as IEMP hardeners on electronic component packages.

Near-Net-Shape Processing of Nickel-Based Alloys - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact A.W. Mullendore, 505-844-6833

- Experimentation to produce Ni from the chemical vapor deposition of $Ni(CO)_4$.

- Determination of the materials mechanical properties.

High Temperature Semiconductors - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact A.W. Mullendore, 505-844-6833

- Study of single crystals of boron carbide grown using a chemical vapor deposition process in order to determine the applicability of boron-based compounds for use as high temperature semiconductors.

Materials Structure and Composition

Surface Modification of Coating Morphology Using Ion Bombardment - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact D.J. Sharp, 505-844-1647

- Development of technique using ion bombardment of films during sputter deposition to obtain Be films with very small grain size and low surface roughness.

Materials Properties, Behavior, Characterization, or Testing

Optical Diagnostics for Metallurgical Processing - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact H.C. Peebles, 505-844-1647

- Use of emission spectroscopy to investigate laser light absorption during plume formation that occurs during a laser welding process. Specifically Nd:YAG laser welding of aluminum.

Device or Component Fabrication, Behavior, or Testing

Plasma Removal of Metal Oxides - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact R.R. Sowell, 505-844-1038

- Development of plasma etching to remove metal oxides during glass-to metal sealing processes.

Physical Metallurgy Division, 1832

The mission of the Physical Metallurgy Division 1832 is to provide the characterization and understanding of the properties of metals and alloys. This includes the selection of alloys and the conduct of research in alloy design and thermo-mechanical effects on material behavior. Sophisticated mechanical testing capabilities are part of this Division, and extensive use is made of the analytical capabilities at Sandia.

Materials Properties, Behavior, Characterization, or Testing

Toughness of Ductile Alloys - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts R.J. Salzbrenner, 505-844-5041; J.A. VanDenAvyle, 505-844-1016

- Study of elastic-plastic fracture toughness (J_{IC}) to determine if it can be used as the basis for structural design.

- Investigation of the experimental techniques used to measure toughness and the application of the parameter in computer code calculations.

- Examination of the correlation between microstructure and toughness.

Analytical Electron Microscopy of Engineering Alloys - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact A.D. Romig, 505-844-8358

- Develop techniques which allow complex engineering alloys to be examined by transmission electron microscope modifications and the use of Monte Carlo simulations.

Friction and Wear of Modified Surfaces - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts R.J. Bourcier, 505-844-6638; A.D. Romig, 505-844-8358

- Use of finite element computer modeling of modified materials and microstructural axamination to enhance understanding of metallurgy resulting from the use of novel techniques such as laser glazing and ion implatation.

Alloy Deformation Response and Constitutive Modeling - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts W.B. Jones, 505-844-4026; R.J. Bourcier, 505-844-6638

- Development of microstructurally-based constitutive models using uniaxial and biaxial mechanical testing at ambient and elevated temperatures.

Process Metallurgy Division, 1833

The Process Metallurgy Division supports the Laboratories by selecting, characterizing, and developing metallurgical processes needed in the manufacture of components and systems. The objective is to provide process definition and control by understanding the mechanisms which operate. Attention is devoted toward structure-property modifications that occur during manufacturing processes. Principal processes currently under study include laser welding, arc welding (GTA and Plasma), brazing, soldering, vacuum induction melting, vacuum arc remelting, and casting techniques for metal-ceramic composites.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Vacuum Arc Remelting - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact F.J. Zanner, 505-844-7073

- Investigaiton of vacuum arc remelting in order to reduce inhomogeneities and defects in structural alloys and uranium alloys.

Materials Properties, Behavior, Characterization, or Testing

Toughness of Inertia Welds - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact G.A. Knorovsky, 505-844-1109

- Determination of the fracture toughness of alloy steel inertia welds.

Metallurgical Characterization of TiCode 12 Resistance Welds - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact G.A. Knorovsky, 505-844-1109

- Evaluation of the effect of resistance upset welding on the microstructure and mechanical properties of titanium alloy TiCode 12.

Device or Component Fabrication, Behavior, or Testing

Aluminum Laser Welding - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact M.J. Cieslak, 505-846-7500

- Study of the role of vaporization during laser welding on composition, mechanical properties, and hot cracking of aluminum alloys.

Low Temperature, Solid-State Welds of Copper - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact F.M. Hosking, 505-844-8401

- Evaluation of solid-state welding and solid-liquid interdiffusion techniques for joining copper flex circuits in the 373-450 K range.

Dissimilar Metal Welds - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact M.J. Cieslak, 505-846-7500

- Development of fusion welding procedures for dissimilar welds with emphasis on avoidance of hot-cracking.

Welding of Nickel-Based Alloys - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts M.J. Cieslak, 505-846-7500; G.A. Knorovsky, 505-844-1109

- Study of the mechanisms of hot-cracking during the fusion welding of both solid solution strengthened and precipitation strengthened nickel-based alloys.

Plasma Arc Welding - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts P.W. Fuerschbach, 505-846-2464; J.L. Jellison, 505-844-6397

- Development of variable polarity plasma arc welding of aluminum to produce significantly narrower welds.

Laser Welding - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact J.L. Jellison, 505-844-6397

- Development of pulsed and CW laser welding for application to component closures.

- Evaluation of mechanisms of beam-plume interactions for various material-process combinations.

Instrumentation and Facilities

Electrode Gap Controller - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact F.J. Zanner, 505-844-7073

- Development of instrumentation for monitoring and maintaining the electrode gap during vacuum arc remelting is being developed. A control algorithm based on an inverse relationship between electrode gap and the frequency of drop shorts is being tested.

Surface Metallurgy Division, 1834

Surface Metallurgy Division 1834 is concerned with the influence of surface and near-surface regions to the engineering application of materials. Basic and applied research is conducted to understand and control deposition processes for reproducible surface modification and to correlate surface properties (composition, structure, and stress) with friction, wear, and electrical contact resistance. Controlled deposition of amorphous materials by sputtering, reactive ion beam deposition of compound films, low-pressure plasma spraying, and surface modification by ion implantation are techniques used to tailor surface properties. This Division also supports design and component groups in areas where surface properties are critical.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Deposition of Amorphous Materials with a Dual Beam Ion System - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact J.K.G. Panitz, 505-844-8604

- Development of a dual beam ion system to sputter-deposit films onto selected substrates.

Materials Properties, Behavior, Characterization, or Testing

Modification of Mechanical Properties by Ion Implantation - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact L.E. Pope, 505-844-5041

- Investigation of the effects of implantation species such as titanium and carbon on friction and wear of stainless steels.

Device or Component Fabrication, Behavior, or Testing

Development of Materials for Magnetic Fusion Reactors - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact M.F. Smith, 505-846-4270

- Development of a low-pressure plasma spray process to deposit for first wall surfaces or for graded thermal expansion layers.

Instrumentation and Facilities

Ion Beam Reactive Deposition System - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact D.E. Peebles, 505-844-1647

- Construction of a system for reactive ion beam deposition of compound films.

- Characterization of the mechanism of compound film formation for TiN.

- Study of complex film deposition of compounds not readily obtained by current methods.

In-Situ Friction, Wear, and Electrical Contact Resistance Systems - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts L.E. Pope, 505-844-5041; D.E. Peebles, 505-844-1647

- Fabrication of an in-situ friction, wear, and electrical contact resistance device in a scanning Auger system.

- Determine the correlation between surface composition and measured experimental parameters.

Chemistry and Ceramics Department, 1840

Department 1840 supports Sandia weapons and energy programs by selecting, developing, and characterizing ceramics glasses and glass ceramics. The department also supports the Laboratories through the study of metallurgical corrosion and oxidation. Electrochemistry constitutes a major element of these studies. Initiative is taken to stimulate advanced weapons and energy related concepts by providing new materials and developing prototype components.

Corrosion Division, 1841

Division 1841 personnel perform research to understand and control the corrosion and oxidation of metals, and they also characterize gas-metal reactions involving species such as hydrogen and ammonia. Corrosion research is directed toward: (a) developing new and improved materials; (b) defining boundaries for applying existing materials; and (c) performing failure analyses. Emphasis is on understanding the mechanistic nature of corrosion processes. The Division maintains expertise in the areas of: corrosion by aqueous and non-aqueous electrolytes; corrosion by gases; stress corrosion cracking; gas-metal interactions, including scattering, adsorption, and desorption; and electrodeposition.

Materials Properties, Behavior, Characterization, or Testing

Corrosion - DOE Contact R. Cooper, 505-887-0586; SNL Contact R. Diegle, 505-846-3450

- Evaluation of titanium alloys, particularly TiCode 12 (Ti-0.8% Ni-0.3% Mo), in bedded salt and subseabed environments as nuclear waste containers.

Ceramics Development Division, 1845

Division 1845 is responsible for supporting laboratory programs involving glass- or ceramic-to-metal seals and other uses of glass or ceramics in moderate temperature environments. Expertise in the division includes the following areas: fracture surface analysis of brittle materials; seal design and fabrication processes; and glass and ceramic properties, i.e., strength, electrical conductivity. The division also maintains an active materials development program to formulate new glass or glass ceramics to meet particular requirements, e.g., corrosion resistance or high thermal expansion.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Glass and Glass Ceramic Development - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts F.P. Gerstle, Jr., 505-844-4304; R.K. Quinn, 505-844-1933

- Development of high expansion phosphate based glasses for sealing to Al, Cu, and stainless steels.

- Improvement of the chemical durability to the point that the glasses compare favorably to many silicate glasses.

- Development of a transformation toughened glass ceramic wherein a metastable ZrO_2 phase is precipitated in a glass matrix.

Materials Properties, Behavior, Characterization, or Testing

Fracture of Ceramics - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact F.P. Gerstle, 505-844-4304

- Investigation of the role of P_2O_5 as a nucleating agent in glass ceramics through an experimental study using TEM and XRD to identify crystalline phases present.

Inorganic Materials Chemistry Division, 1846

Division 1846 has responsibility for relating the chemical properties of inorganic materials to their application in a variety of SNL weapons, energy, and reactor safety programs. The Division has programs in the chemical preparation of glasses and ceramics including sol-gel chemistry of glasses for coatings and monolithic structure and electroactive ceramic powders, precipitation of ion exchangeable transition metal oxides for catalysts, rad-waste and thin-film capacitors, and solution stabilization to yield homogeneous, monodispersed structural and electronic ceramics. The Division also has programs to study the properties and survivability of inorganic materials in reactive environments, e.g., solvent (aqueous, acidic and basic, corrosive) dissolution of inorganic glasses, ionic conductivity of high temperature electrolytes, and the physical and chemical properties, especially thermal stability, of inorganic materials at high temperature.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Glass and Glass/Ceramic Development - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; SNL Contact R.J. Eagan, 505-844-4069

- Development of a glass for use in Li/So_2 batteries to resist the environment of Li batteries for five years.

Ceramic Processing - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contact R.K. Quinn, 505-844-1933

- Preparation of high purity homogeneous PZT powders by sol-gel chemistry techniques.

- Preparation and evaluation of ZnO varistor material by sol-gel chemistry techniques.

Powder Metallurgy - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts J.A. Brooks, 415-422-2051; J.E. Smugeresky, 415-422-2910; J.W. Zindel, 415-422-2051

- Use of inert gas atomization and spark erosion processes to advance development of the powder metallurgy and rapid solidication processing of a variety of alloy systems.

Advanced Electrodeposition Studies - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts R.W. Carling, 415-422-2206; J.E. Farmer, 415-422-3418; H.R. Johnson, 415-422-2822

- Engineering applications, electroanalytical development, and fundamental investigations in the area of electrodeposition of metals from both aqueous and non-aqueous media.

Metal Forming - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts J. Lipkin, 415-422-3115; T.C. Lowe, 415-422-3187; J.B. Woodard, 415-422-3115

- Examination of nonelastic deformation through crystal plasticity modeling and experimentation.

Helium Induced Crack Growth in Metals and Alloys - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts S.L. Robinson, 415-422-2209; S.H. Goods, 415-422-3274; J.E. Costa, 415-422-2352

- Experimental investigation of the effect of helium on the low temperature mechanical properties of fcc metals.

- Use of tritium decay to introduce helium into metals without introducing radiation damage into the metal.

Welding Science and Technology - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts J.A. Brooks, 415-422-2051; K.W. Mahin, 415-422-2051; J.R. Spingarn, 415-422-3307

- Development of a science-based methodology for improving the fundamental understanding of the behavior of welded structures and modeling of the complex fusion weld process.

Composites: Stability, Compatibility, and Joining - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts J.B. Woodard, 415-422-3115; B.C. Odegard, 415-422-2789; J.R. Spingarn, 415-422-3307

- Investigation of the stability, compatibility, and joining of polymer matrix composite materials, focusing on graphite fiber reinforced materials.

- Identification of moisture adsorption sites in thermosetting resins.

- Study of coatings to increase stability for special designs.

- Joining studies of adhesives, mechanical fasteners and the welding of thermoplastics.

New Surface Spectroscopy - DOE Contact R.E. Lushbough, 301-353-3912; SNL Contacts R.W. Carling, 415-422-2206; D.A. Nissen, 415-422-2767; M.C. Nichols, 415-422-2906; M.R. McClellan, 415-422-2598; B.E. Mills, 415-422-3230

- Development of new spectroscopic techniques such as micro-fluorescence spectroscopy, high resolution energy loss spectroscopy

(HREELS), and x-ray photoelectron spectroscopy (XPS), for special applications.

Lawrence Livermore National Laboratory

Materials Properties, Behavior, Characterization, or Testing

Materials Modification by Ion Beams - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact R.G. Musket, 415-422-0483

- Research on the applications of ion implantation and ion-beam mixing for the modification of the surface properties of materials.

Weld Modeling - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact K.W. Mahin, 415-423-0740

- Generate better definitions for the boundary conditions needed to accurately model a gas tungsten arc weld.

- Develop a general weld model for the prediction of penetration and distortion in fusion welds. The material under investigation is 304 SST.

Synchrotron Radiation Studies - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contacts J.H. Kinney and O.C. Johnson, 415-422-6669

- Study of high-resolution three-dimensional elemental and chemical phase mapping in small samples using the fine structure in the x-ray absorption coefficient.

- Development of a high spatial resolution array detector for applications in computed x-ray tomography.

Metal Deformation Modeling - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact E.C. Flower, 415-423-1572

- Develop LLNL existing finite element methods (FEM) codes (NIKE/DYNA) to accurately predict metal deformation during a forming operation.

- Extend efforts to include modeling of two-phase alloy systems and predictions of residual stresses.

Rapid Solidification Processing of Alloys - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact L.E. Tanner, 415-423-2753

- Elucidate mechanisms of high-rate solidification of alloys leading to microdisperse two-phase microstructures. Materials under investigation include Al-Be, Bi-B, Fe-Mn-S, and Fe-Al-O.

Microstructure of Stainless Steel Welds - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact J.W. Elmer, 617-253-6474 (MIT)

- Identify and model of variables which affect the welding behavior of stainless steels.

Powder Metallurgy - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact C.E. Witherell, 415-423-1732

- Explore powder metallurgy techniques to prepare high performance metals with improved microstructure and properties.

Coating Adhesion - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact R.S. Rosen, 415-422-9559

- Study of the effect of substrate temperature on coating interface.

Dislocation Structures and Reversed Strains - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact G.F. Gallegos, 415-422-7002

- Study of deformation mechanisms in stainless steel at elevated temperatures and biaxial stress conditions.

- Determine effects of prestraining on deformation behavior under multiaxial loading.

Weld Library Generation - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact K.W. Mahin, 415-423-0740

- Compilation of a weld library database from existing weld information at DOE facilities for the purpose of generating trends in weld process parameters for various materials.

Electron Beam Welder Data Acquisition System - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact K.W. Mahin, 415-423-0740

- Installation of a data acquisition system to gain a better understanding of cause and effect of discontinuity and their correlation between the electron beam process and materials being used.

Deformation of Aluminum to Large Strains - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact M.E. Kassner, 415-423-2329

- Identification of deformation mechanism over a large temperature range for aluminum subjected to large strains.

Corrosion of 7050 Aluminum - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact R. Glass, 415-423-7140

- Investigation of potential stress-accelerated corrosion of 7050 aluminum with relevance to the W87 aft support application.

Electrochemical Oxidation - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact R.R. McGuire, 415-422-7792

- Explore the electrochemical oxidation of nitrogen tetroxide (N_2O_4) to nitrogen pentoxide (N_2O_5) in 100% nitric acid.

Microstructure Research - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact Tomas Hirschfeld, 415-422-6364

- Project focuses on a basic research effort and a feasibility demonstration effort run in parallel.

- Study of the effects of size scale on physiochemical and engineering processes to create guidelines for work in the micro domain.

Pu Metallurgy - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact P.H. Adler, 415-423-4417

- Theoretical study of the kinematics of the $\alpha \leftrightarrow \delta$ martensitic transformation in Pu alloys leading to an understanding of the basic mechanisms and crystallographic features of this important phase change.

- Enhance the ductility and fracture toughness of brittle alpha-Pu by means of a deformation-induced $\alpha \leftrightarrow \delta$ transformation.

Pu Alloy Characterization - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact P.H. Adler, 415-423-4417

- Elucidation of a technically important region of the Pu-Ga-Fe phase diagram at temperatures in the range 425 to 600^{o} using a combination of theoretical calculations and experimental measurements.

- Improved understanding of the effect of small Fe additions on alloy homogenization which, in turn, is likely to lead to a change in the heat-treating temperature currently used in a process line at Rocky Flats.

Pu Sputtering - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact H.F. Rizzo, 415-422-6369

- Exploration of the glass forming ability of various elements with plutonium by sputtering. Binary alloys of Fe, Ta, V, Os, Re, Co, and Si with plutonium have been prepared which show strong evidence for the formation of glassy phases.

- Oxidation experiments to confirm the outstanding oxidation resistance of Pu-Si, Pu-Ta, and Pu-Fe glassy alloy coatings; these same sputtered coatings also resisted hydriding when exposed to one atmosphere of hydrogen.

- Predict the glass forming ability of various Pu alloys.

Directed Energy Surface Processing - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact E.N. Kaufmann, 415-423-2640

- Study of the mechanisms of formation of metastable surface alloys using laser, electron and ion beams applied to metallic surfaces.
- Identify new methods to improve surface resistance to hostile environments.

Formation of Metastable Surface Alloys - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact E.N. Kaufmann, 415-423-2640

- Study of the fundamental mechanisms involved in the formation of metastable structures by rapid solidification of surface melts by extracting quantitative data on the kinetics of nucleation and growth in a variety of alloys.

Pu Laser Welding - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact H. Weiss, 415-422-6268

- Development of welding techniques for use with pure plutonium materials.

Adhesives Evaluation - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact D. Mark Hoffman, 415-422-7759

- Long term reliability testing, using measurement of stress relaxation in shear, of adhesives with known differences in structure, composition, curing behavior and adhesion.
- Identification of the nature of the polymer degradation with time.

Mechanics of Low Density Materials - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact Richard Christensen, 415-422-7136

- Investigation of the mechanics of open cell and closed cell low density materials in order to design improved materials.

Polymeric Materials Computer Modeling - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact Robert Cook, 415-422-6993

- Computer simulation studies of the deformation and failure of polymeric materials.

Lifetime Prediction Theory for Polymeric Materials - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact Robert Cook, 415-422-6993

- Development of polymeric material failure theory based on activated rate process concepts encompassing both stress induced and environmentally induced failure.

- Application of theory to lifetime behavior of Kevlar strands under load, including median lifetimes and the dispersion of lifetime.

Instrumentation and Facilities

Weapons Database Development - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contact D.D. Jackson, 415-422-8054

- Development of a computer database system to facilitate the analysis of stockpile life data to better assess the current condition of the stockpile and predict its probable future condition.

Tritium Facility Upgrade - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LLNL Contacts G.M. Morris, 415-423-1770 and M. Holda, 415-423-7240

- Upgrade of the Tritium Facility Upgrade to include a clean-up system and an office/mechanical technician shop addition.

Los Alamos National Laboratory

Materials Synthesis, Deposition, Growth, or Forming

Fluidized Bed Coatings - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact D.W. Carroll, 505-667-2145, FTS 843-2145

- Development of techniques for low temperature deposition of tungsten, molybdenum, rhenium, and nickel on hollow substrates of spherical and cylindrical shapes.

- Fabrication of ultra-thin, free-standing shapes.

Materials Synthesis by Solid-State Combustion - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R.G. Behrens, 505-667-8327, FTS 843-8327

- Investigation of solid-state combustion as a viable technology for rapid, high-temperature synthesis of alloys, ceramics, ceramic composites, and metals either as powders or as near-net-shape forms.

Powder Preparation by Plasma Chemical Synthesis - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact G.J. Vogt, 505-667-5813, FTS 843-5813

- Development of plasma-assisted chemical vapor deposition for the production of ultrafine, ultrapure ceramic powders.

- Use of extended this technology to ultrafine metal and metal alloy powders.

Precision Tungsten Tubes - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact D.W. Carroll, 505-667-2145, FTS 843-2145

- Development of a technique for producing precision tungsten tubes of various wall thicknesses in substantial lengths by chemical vapor deposition.

Superhard Materials - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Addition of B_4C to conventional W-Ni-Fe alloys to improve hardness, wear resistance, and resistance to deformation.

- Investigation of optimum composition and processing to attain uniform microstructure, and characterization of fracture toughness and hardness.

Glass Fabrication Technology - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365; R. Mah, 505-667-3238, FTS 843-3238

- Casting and hot forming into hemispheres, disks, plates, sheets, and rods.

- Composition control to yield good strength, hardness, nuclear requirements, or chemical durability.

- Optimize forming process to yield precise shapes, for example by glass-blowing in a gravity-free environment.

- Investigate silica, sodalime, and pyrex glasses.

- Investigate perfection of shape by surface forces in a high temperature microgravity experiment in the space shuttle.

Slip Casting of Ceramics - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Slip casting of many ceramics including aluminum, magnesia, and thoria.

- Use colloidal chemistry and powder characterization theory along with materials engineering.

Whisker Growth Technology - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Growth silicon carbide whiskers by a vapor-liquid-solid process which produces very long fibers.

- Improving control over the process itself to obtain mono-sized whiskers of regular morphology; processing whiskers to remove detritus and impurities, characterizing the whiskers and relating their properties to structural features; and growth of Si_3N_4 whiskers by same process.

Development of Ceramic Matrix Whisker-Reinforced Composites - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Fabrication by hot pressing of structural ceramic materials, borosilicate glass, $MoSi_2$, and Si_3N_4-matrix composites reinforced with SiC whiskers.

- Achieve uniform microstructures of dispersed whiskers with low porosity which result in high fracture toughness.

New Hot Processing Technology - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Use of hot pressing techniques to consolidate bodies of materials such as Al_2O_3, ZrO_2, UO_2, B_4C, copper, aluminum, and carbon for application such as armor, ceramic components for nuclear reactor melt dowm experiments, nuclear shielding, and filters.

Glass and Ceramic Coatings - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Develop vitreous enamels and general ceramic coatings to provide radiation-hardened, electrical-insulating components for accelerator technolgogy.

Cold Pressing, Cold Isostatic Pressing and Sintering - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Use of cold pressing and cold isostatic pressing to consolidate ceramic and metal powders to support laboratory program.

Single Crystal Growth and Characterization - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Use of techniques such as Czochralski, Bridgman-Stockbarger, Flux, Sublimation, and various traveling heater or traveling solvent methods to promote single crystal growth.

- Evaluation of microstructures of single crystals by metallographic techniques. Materials include WO_3, LiF with various dopants, CdTe and $BeAl_2O_4$.

Plasma-Flame Spraying Technology - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Fabrication of free-standing shapes, and metallic and ceramic coatings by plasma spraying.

Electroplating Low Atomic Number Materials - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Investigation of electroplating low atomic number metals (aluminum and beryllium) by using non-aqueous plating baths.

Super-Hard Parylene Coating Development - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Use of a unique plasma cross-linking technique during the deposition of thermally pyrolyzed p-xylylene monomer in an inert atmosphere yields a highly cross-linked, hard, polymer product.

- Development of new polymer.

Three New Conducting Polymers - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Synthesis of one polyphenylguinoxaline and two polypyrrones unique electrically conductive properties when treated with appropriate doping agents.

New Highly Conductive Doped Polyacetylene - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Use of new cesium electride to induce a high level of electrical conductivity in polyacetylene films and to improve the stability.

Liquid Crystal Polymer Development - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. May, 505-667-3238, FTS 843-3238

- Synthesize a liquid crystal polymer with strength in three dimensions.

Surface Property Modified Plastic Components - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Modification of surface properties of plastic components by a solvent infusion process.
- Use of process to improve the biocompatibility properties of such plastics as acrylics and silicones.

High-Z Loaded Parylene Polymer Coatings - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Infuse high-Z metals such as gold into parylene coatings using organometallic-solvent systems.
- Preparation of uniformly loaded and graded Z coatings.

Low-Density, Microcellular Plastic Foams - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Manufacture microstructural polyolefin foams with densities between 0.01 g/cc and 0.2 g/cc by a nonconventional foaming process.

Radiochemistry Detector Coatings - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Physical vapor deposition of coatings for radiochemical detectors.

Target Coatings - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Development of single and multilayer metallic and nonmetallic thin film coatings, smooth and uniform in thickness.

Physical Vapor Deposition and Surface Analysis - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Physical vapor deposition and sputtering to produce materials for structural applications, corrosion resistance, optical properties, and thin film transducers.
- Doped, in-situ laminates of aluminum and Al_xO_y for high strength and smooth surface finish.
- Ion plating of aluminum and rare earth oxides, onto various substrates for corrosion resistance to gases and liquid plutonium.

- Deposition of oriented AlN onto various substrates to enable nondestructive evaluation of materials.

- Reflective and anti-reflective coatings for infrared, visible, ultra-violet, and x-ray wavelengths.

High Energy Density Joining Process Development - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Development of microcomputer technology and signal analysis for process control, and multiaxis, programmable component manipulation for high-voltage electron beam welding.

- Operation of a high-voltage electron beam welder for fabrication of products in the fissile material area.

- Investigation of real time diagnostics of laser welding efficiency.

- Study of plasma effects on laser welding efficiency.

- Correlate photodiode, acoustic, light-spectral and electron current measurements with high speed cinematography and resultant weld geometry.

Arc Welding Process Development - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Video monitoring and Varistraint testing established as techniques to investigate crack-susceptibility of gas-tungsten-arc welds.

Superplastic Forming - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Investigation of superplastic forming of titanium and uranium alloys.

- Evaluation of fine grained U-6 wt% Nb (2 m grain size) in biaxial forming.

Actinide Alloy Development - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact D.C. Christensen, 505-667-2556, FTS 843-2556

- Development of new alloys of plutonium, including casting, thermo-mechanical working, sputtering, and stability studies.

- Measurements of resistivity, thermal expansion and bend ductility are made to evaluate fabrication processes and alloy stability.

Surface Studies - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact H.K. McDowell, 505-667-4686, FTS 843-4686

- Studies of surface structures and atomic and electronic properties of uranium alloys and intermetallics, NO_2 and ThO_2 single crystals, heavy fermion system, and palladium/hydrogen systems.

- Develop essential atomic-level understanding of surface properties of materials and physical and chemical processes.

- Investigate and study surface modification, synchrotron radiation of uranium, UPt_3 surface properties, valence bands of UO_2, residues on electropolished/oxidized uranium, and use of MeV ion beams to probe surface structure.

- Use of techniques such as Low Energy Electron Diffraction (LEED), Auger and Loss Spectroscopies, Ion-Scattering Spectroscopy (ISS), Ultraviolet Photoelectron Spectroscopy (UPS), Synchrotron Radiation, and MeV-ion-beam scattering.

Tritiated Materials - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact D.H.W. Carstens, 505-667-5849, FTS 843-5849

- Advanced R&D on low-Z, tritiated materials with the emphasis on Li(D,T) (salt) and other metal tritides.

- Studies of new methods for preparing, fabricating, and containing such compounds.

Actinide Surface Properties - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact D.C. Christensen, 505-667-2556, FTS 843-2556

- Characterization of actinide metal, alloy and compound surfaces using the techniques of x-ray photoelectron spectroscopy, Auger analysis, ellipsometry and Fourier-transform infrared spectroscopy.

- Studies of surface reactions, chemisorption, attack by hydrogen, nature of associated catalytic processes.

Mechanical Properties and Alloy Development - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact S.E. Bronisz, 505-667-4665, FTS 843-4665

- Develop thermomechanical processing of plutonium alloys to optimize mechanical properties.

- Study of complex microstructures, grain refinement, and deformation-induced transformations.

Mechanical Properties of Uranium - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact S.E. Bronisz, 505-667-4665, FTS 843-4665

- Investigate mechanical properties of U-6 wt% nB and pure U at high strain rates.
- Study of the effects of crystallographic texture on high rate (shock regime) uranium deformation.

Phase Transformations in Pu and Pu Alloys - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact S.E. Bronisz, 505-667-4665, FTS 843-4665

- Investigate mechanisms, crystallography, and kinetics of transformations in plutonium and alloys using pressure and temperature dilatometry, optical metallography, and x-ray diffraction.

High Strain Rate Testing - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact P.S. Follansbee, 505-667-8021, FTS 843-8021

- Testing of metals at rates up to, but not including the shock-wave regime to elicit fundamental understanding of changes in mechanism as a function of deformation rate.

Neutron Diffraction of Pu and Pu Alloys - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact S.E. Bronisz, 505-667-4665, FTS 843-4665

- Neutron diffraction studies of plutonium and its alloys conducted at the Los Alamos WNR pulsed neutron source.
- Time-of-flight technique used to measure diffraction at elevated temperatures and pressures.

Powder Characterization - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233 3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Characterization of starting powders (RF plasma SiC, commercial powders of ThO_2, tungsten, copper, Si_3N_4, MgO and Al_2O_3).
- Determine particle size and distribution, morphology, state of agglomeration, zeta potential, and surface area.

Device or Component Fabrication or Testing

Polymers and Adhesives - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact W.A. May, Jr., 505-667-6362; FTS 843-6362

- Development of fabrication processes, and evaluation and testing of commercial plastic materials for weapons programs.

- Development of plastic-bonded composites, cushioning materials, and compatible adhesives.

- Applications of commercial and developmental plastics fabrication techniques to specific weapons-related materials and components for the purpose of improving efficiency and economy of weapons design.

Salt Fabrication - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.E. Nasise, 505-667-1459, FTS 843-1459

- Development and evaluation of fabrication processes of lithium tritide.

- Use of hot pressing and hot isostatic pressing to near net shape to improve part shape versatility, density, and surface quality.

- Conduct component integrity studies involving radiation induced growth and outgassing.

Ceramic Technology - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Fabricate castable ceramics for energy technologies.

Glass and Ceramic Sealing, and Metallizing Technology - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Design sealing techniques to join ceramic components, and ceramic and metal components, which are used in experimental devices for energy technologies.

- Development of an alumina assembly consisting of a large number of oval tubes joined together to form an arc of accelerator path.

Microwave Sintering/Processing - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Investigate techniques of bonding and sintering ceramics such as Al_2O_3 and glass.

- Use of very high frequency microwaves which suscept directly to the area in which the heat is needed.

- Investigate the control of the heating and its effect on microstructure.

Injection Mold Process for Making Snap-On Fittings - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Use of injection molding to create high-strength snap-on tube fittings made from carbon-fiber reinforced polyether ether ketone, polycarbonate and nulon.

Composite Spring Support Structures - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact R. Mah, 505-667-3238, FTS 843-3238

- Fabrication of composite spring support structures from filament-wound, carbon-fiber epoxy composites.

Solid State Bonding - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact J.M. Dickinson, 505-667-4365, FTS 843-4365

- Evaluate aluminum solid state bonding for seamless ICF targets.

- Evaluate bond load modulation and ion bombardment cleaning.

- Investigate bonding technique optimization.

Nondestructive Evaluation - DOE Contact R.E. Lushbough, 301-353-3912, FTS 233-3912; LANL Contact A. Wilson, 505-667-6404, FTS 843-6404

- Develop nondestructive evaluation techniques that produce quantitative estimates of material properties.

- Apply multivariate analysis to welding processes. Use tomographic techniques to extend radiographic inspections.

OFFICE OF FOSSIL ENERGY

	FY 1985
Office of Fossil Energy Grand Total	$ 7,951,000
Office of Technical Coordination	$ 6,319,000
Advanced Research and Technology Development Program	$ 6,319,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 1,361,000
Evaluation of the Feasibility of Pressure Quenching to Produce Hard Metastable Materials	$ 0
Investigation of Candidate Alloys for Advanced Steam Cycle Superheaters and Reheaters	200,000
Consolidation of Rapidly Solidified Aluminide Metal Powders	246,000
Investigation of Electrospark Deposited Coatings for Protection of Materials in Sulfidizing Atmospheres	35,000
Short Fiber Reinforced Structural Ceramics	260,000
Fabrication of Fiber-Reinforced Composites by CVD Infiltration	340,000
Transfer of CVD Infiltration Technology to Industry	100,000
Development of Advanced Fiber Reinforced Ceramics	180,000
Materials Properties, Behavior, Characterization, or Testing	$ 3,617,000
Technical Monitoring of Coal Gasification Subcontracted Materials Projects for the AR&TD Fossil Energy Materials Program	$ 40,000
Study of Damage Mechanisms in Coal Conversion Atmospheres Affecting the Fatigue and Creep Rupture Properties of Cr-Mo Steels	150,000
Microstructure and Micromechanical Response in Austenitic Stainless Steel Overlays on Low Alloy Steel Plates	0

	FY 1985

Office of Technical Coordination (Continued)

Advanced Research and Technology Development Program (Continued)

Materials Properties, Behavior, Characterization, or Testing (Continued)

	FY 1985
The Fatigue Behavior of Chromium-Containing Ferritic Steels at Elevated Temperatures	$ 0
Transformation, Metallurgical Response and Behavior of the Weld Fusion and Heat Affected Zone in Cr-Mo Steels for Fossil Energy Applications	100,000
Investigation of Correlation of Carbide Size and Percentage with Mechanical Properties of High-Strength, Low Alloy Steels	0
Hydrogen Attack in Cr-Mo Steels at Elevated Temperatures	0
Analysis of Hydrogen Attack on Pressure Vessel Steels	120,000
Deformation and Fracture of Low Alloy Steels at High Temperatures	0
Evaluation of 3 Cr-1.5 Mo Steel in a Simulated Coal Conversion Environment	80,000
Creep Rupture of High-Chromium Alloys in Mixed-Gas Environments	115,000
Investigation of the Weldability of Ductile Alumindes	50,000
Development of Iron and Nickel Aluminides	200,000
Joining of Advanced Aluminides	246,000
Pilot Plant Materials Testing and Failure Analysis	100,000
Corrosion of Alloys for Internal and Heat Exchangers in Mixed-Gas Environments	110,000
Corrosion of Alloys in FBC Systems	100,000
A Mechanistic Study of Low-Temperature Corrosion on Materials in the Coal Combustion Environment	140,000
Investigation of Corrosion Mechanisms of Coal Combustion Products in Alloys and Coatings	80,000
Investigation of the Mechanisms of Molten Salt Corrosion of Candidate Materials for Molten Carbonate Fuel Cells	225,000
Erosion in Dual-Phase Microstructures	0
Evaluation of Advanced Materials for Slurry Erosion Service	0
Mechanisms of Erosion-Corrosion in Coal Combustion Environments	215,000
Study of Particle Rebound Characteristics and Material Erosion at High Temperature	80,000

	FY 1985
Office of Technical Coordination (Continued)	
Advanced Research and Technology Development Program (Continued)	
Materials Properties, Behavior, Characterization, or Testing (Continued)	
Development of Nondestructive Evaluation Techniques for Structural Ceramics	$ 205,000
Effect of Flaws on the Fracture Behavior of Structural Ceramics	100,000
Joining of Silicon Carbide Reinforced Ceramics	245,000
Nondestructive Evaluation of Advanced Ceramic Composite Materials	246,000
Investigation of the Mechanisms of Failure of Ceramic Materials for Hot Gas Filtration	15,000
High Temperature Applications of Structural Ceramics	260,000
Development of Refractory Composites with High Fracture Toughness	35,000
High Temperature Creep Behavior of Refractory Bricks	100,000
Investigation of the Effect of Slag Penetration on the Mechanical Properties of Refractories	135,000
Corrosion of Refractories in Slagging Gasifiers	125,000
Device or Component Fabrication, Behavior, or Testing	$ 1,001,000
"Materials and Components in Fossil Energy Applications" Newsletter	$ 105,000
Three-Dimensional Residual Stress Characterization of Thick Plate Weldments with Advanced Instrumentation and Methodologies	10,000
Studies of Materials Erosion in Coal Conversion and Utilization Systems	350,000
Mechanisms of Galling and Abrasive Wear	0
Thermomechanical Modeling of Refractory Brick Linings for Slagging Gasifiers	125,000
Alkalai Attack of Coal Gasifier Refractory Linings	90,000
Thermodynamic Properties and Phase Relations for Refractory-Slag Reactions in Slagging Coal Gasifiers	95,000
Oxid Electrodes for High-Temperature Fuel Cells	226,000

		FY 1985
Office of Technical Coordination (Continued)		
Advanced Research and Technology Development Program (Continued)		
Instrumentation and Facilities	$	340,000
Management of the AR&TD Fossil Energy Materials Program	$	340,000
Office of Surface Coal Gasification	$	562,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$	377,000
Electroslag Component Casting	$	197,000
Protective Coatings and Claddings: Application/Evaluation		180,000
Materials Properties, Behavior, Characterization, or Testing	$	185,000
Corrosion of Structural Ceramics in Coal Gasification Environments	$	185,000
Device or Component Fabrication, Behavior, or Testing	$	
Materials Review and Component Failure Analysis	$	*
Office of Oil, Gas, Shale, and Coal Liquids	$	0
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$	0
Coating Studies for Coal Conversion	$	0
Materials Properties, Behavior, Characterization, or Testing	$	0
Assessment of Materials Selection and Performance for Coal Liquefaction Plants	$	0
Materials Review and Support for the SRC-I Liquefaction Project		0

* Funds provided by DOE/METC on a job basis.

	FY 1985
Office of Oil, Gas, Shale, and Coal Liquids (Continued)	
Materials Properties, Behavior, Characterization, or Testing (Continued)	
Coal Liquefaction Pilot Plant Materials Testing and Failure Analysis	0
Elastomer Test Program	0
Office of Coal Utilization	$ 1,070,000
Fuel Cells Program	$ 260,000
Materials Preparation, Synthesis, Deposition, Growth, or Forming	$ 260,000
Electrode Surface Chemistry	$ 200,000
Development of Ternary Alloy Cathode Catalysts for Phosphoric Acid Fuel Cells	60,000
Organometallic Catalysts for Primary Phosphoric Acid Fuel Cells	0
Materials Properties, Behavior, Characterization, or Testing	$ 0
Molten Carbonate Fuel Cell and Stack Technology Development	$ 0
Molten Carbonate Fuel Cell Component Technology Development	0
Alternative Molten Carbonate Fuel Cell Cathodes	0
Device or Component Fabrication, Behavior, or Testing	$ 0
High Temperature Solid Oxide Electrolyte Fuel Cell Power Generation System	$ 0
Advanced Fuel Cell Research	0

	FY 1985
Office of Coal Utilization (Continued)	
Magnetohydrodynamics Program	$ 810,000
Materials Properties, Behavior, Characterization, or Testing	$ 810,000
MHD Materials Development, Testing, and Evaluation	$ 30,000
UTSI MHD Development Testing	680,000
MHD Heat and Seed Recovery Technology	100,000

OFFICE OF FOSSIL ENERGY

The mission of the Fossil Energy Program is to develop technologies that will increase domestic production of oil and gas or that will permit the Nation to shift from oil or gas to more abundant coal. Specifically, the Fossil Energy role is to develop technologies to support the following objectives:

- Provide a capability to convert coal to liquid and gaseous fuels;
- Increase domestic production of coal, oil, and gas;
- Ensure that current and new facilities that burn coal can do so in an economically viable and environmentally acceptable manner; and
- Allow more efficient and more economically attractive utilization of fossil energy resources.

The Fossil Energy activity includes fourteen major programs, which are grouped under seven program offices. One of these seven is the Advanced Research and Technology Development Program of the Office of Technical Coordination, which is the central point of contact for inquiries from universities concerning the Fossil Energy program.

Project execution and technical monitoring are administered in five energy technology centers and selected national laboratories.

Office of Technical Coordination

Advanced Research and Technology Development Program

The objectives of the Advanced Research and Technology Development program are to assess and identify long-range advanced research needs in coal processing, fossil fuels utilization and extraction, materials, components, and instrumentation; to provide oversight of ongoing advanced research in fossil energy so as to ensure balance and proper priorities; to initiate and fund projects involving new, exploratory concepts or goal-oriented basic research; to manage the Materials Research and University Coal Research programs; and to provide policies for, and overview of, Fossil Energy-supported university activities. The Advanced Research and Technology Development program also is designed to provide an effective communications channel between the Fossil Energy program and academic institutions; to encourage these institutions to become involved in programs related to the DOE Fossil Energy mission; and to manage programs concerned with providing an adequate technical base for development of commercial construction materials and instrumentation for Fossil Energy pilot plants and demonstration plants.

The program supports workshops to identify research needs in all fossil energy technologies and manages selected training programs for faculty and students at Energy Technology Centers.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Evaluation of the Feasibility of Pressure Quenching to Produce Hard Metastable Materials - DOE Contact S.J. Dapkunas, 301-353-2784; R&D Associates Contact Richard Latter, 213-822-1715

- Design, build and test a high-pressure press system to evaluate "pressure quenching" of materials.

Investigation of Candidate Alloys for Advanced Steam Cycle Superheaters and Reheaters - DOE Contact S.J. Dapkunas, 301-353-2784; ORNL Contact R.W. Swindeman, 615-574-5108

- Development of an austenitic stainless steel with improved high-temperature mechanical properties and corrosion resistance for use in superheaters and reheaters in advanced steam cycles.

Consolidation of Rapidly Solidified Aluminide Metal Powders - DOE Contact S.J. Dapkunas, 301-353-2784; Idaho National Engineering Laboratory Contacts A.D. Donaldson, J.E. Flinn, R.N. Wright, FTS 583-2627

- Determination of the most effective means of, and associated parameters for, consolidating rapidly solidified nickel-iron aluminide powders.

Investigation of Electrospark Deposited Coatings for Protection of Materials in Sulfidizing Atmospheres - DOE Contact S.J. Dapkunas, 301-353-2784; Hanford Engineering Development Laboratory Contact R.N. Johnson, 509-376-0715

- Examination of the use of the electrospark deposition coating process for the application of corrosion-, erosion-, and wear-resistant coatings to candidate superheater alloys.

Short Fiber Reinforced Structural Ceramics - DOE Contact S.J. Dapkunas, 301-353-2784; LANL Contacts G.F. Hurley, F.D. Gac, 505-647-9498

- Investigate the utility of whisker reinforcement technology for producing structural ceramic composites of improved strength and fracture toughness.

Fabrication of Fiber-Reinforced Composites by CVD Infiltration - DOE Contact S.J. Dapkunas, 301-353-2784; ORNL Contact D.P. Stinton, 615-574-4556

- Develop a ceramic composite having higher than normal toughness and strength yet retaining the typical ceramic attributes of refractories and high resistance to abrasion and corrosion.

Transfer of CVD Infiltration Technology to Industry - DOE Contact S.J. Dapkunas, 301-353-2784; ORNL Contact D.P. Stinton, 615-574-4556

- Transfer AR&TD-developed CVD infiltration technology to Babcock and Wilcox as part of a joint R&D program with Babcock and Wilcox Research Laboratories.

Development of Advanced Fiber Reinforced Ceramics - DOE Contact S.J. Dapkunas, 301-353-2784; Georgia Institute of Technology, Georgia Tech Research Institute Contact T.L. Starr, 404-894-3678

- Conduct a theoretical and experimental program to identify new compositions and processing methods to improve the physical and mechanical properties of selected fiber reinforced ceramics.

Materials Properties, Behavior, Characterization, or Testing

Technical Monitoring of Coal Gasification Subcontracted Materials Projects for the AR&TD Fossil Energy Materials Program - DOE Contact S.J. Dapkunas, 301-353-2784; ANL Contact W.A. Ellingson, 312-972-5068

- Assist with the technical monitoring of the subcontracts of the AR&TD Fossil Energy Materials Program which are related to high-temperature gaseous corrosion, corrosion of refractories and ceramics, and nondestructive evaluation methods.

Study of Damage Mechanisms in Coal Conversion Atmospheres Affecting the Fatigue and Creep Rupture Properties in Cr-Mo Steels - DOE Contact S.J. Dapkunas, 301-353-2784; University of California Contacts E.R. Parker, R.O. Ritchie, 415-642-0863

- Evaluate the effects of high-temperature service in adverse environments on the metallurgical properties of weld metal and heat affected zone (HAZ) regions in thick section weldments of 3 Cr-Mo steels.

Microstructure and Micromechanical Response in Austenitic Stainless Steel Overlays on Low Alloy Steel Plates - DOE Contact S.J. Dapkunas, 301-353-2784; University of Cincinnati Contact J. Moteff, 513-475-3096

- Develop sufficient information to establish correlations between the weld overlay process, postweld heat treatment, microstructure, micromechanical response and macroscopic mechanical behavior.

The Fatigue Behavior of Chromium-Containing Ferritic Steels at Elevated Temperatures - DOE Contact S.J. Dapkunas, 301-353-2784; University of Connecticut Contact A.J. McEvily, 203-486-2941

- Obtain a detailed understanding of the fatigue behavior of chromium-containing ferritic steel alloys in terms of metallurgical and environmental effects.

Transformation, Metallurgical Response and Behavior of the Weld Fusion and Heat Affected Zone in Cr-Mo Steels for Fossil Energy Applications - DOE Contact S.J. Dapkunas, 301-353-2784; University of Tennessee Contact C.D. Lundin, 615-974-5310

- Develop fundamental information on the metallurgical behavior of the heat affected zone of welds in chromium-molybdenum alloys.

Investigation of Correlation of Carbide Size and Percentage with Mechanical Properties of High-Strength, Low Alloy Steels - DOE Contact S.J. Dapkunas, 301-353-2784; Westinghouse Contact B.J. Shaw, 412-256-1201

- Examine the correlation between the size and percentage of carbides in high-strength Cr-Mo steels, analyzing them by scanning transmission electron microscopy.

Hydrogen Attack in Cr-Mo Steels at Elevated Temperatures - DOE Contact S.J. Dapkunas, 301-353-2784; Cornell University Contact Che-Yu Li, 607-256-4349

- Determine the kinetics of hydrogen attack in 2 1/4 Cr-1 Mo steels at elevated temperatures.

Analysis of Hydrogen Attack on Pressure Vessel Steels - DOE Contact S.J. Dapkunas, 301-353-2784; University of California at Santa Barbara Contact G.R. Odette, 805-961-3525

- Refine the analysis and confirm the adequacy of the basic thermodynamic information available in the literature.

Deformation and Fracture of Low Alloy Steels at High Temperatures - DOE Contact S.J. Dapkunas, 301-353-2784; University of Illinois Contact D.L. Marriott, 217-333-7237

- Investigate the microstructural changes and the mechanisms of damage accumulation that accompany, or arise from, high temperature deformation of a range of 2 1/4 Cr-1 Mo steels.

Evaluation of 3 Cr-1.5 Mo Steel in a Simulated Coal Conversion Environment - DOE Contact S.J. Dapkunas, 301-353-2784; Westinghouse Contact B.J. Shaw, 412-256-1201

- Develop a fracture mechanics characterization of candidate materials for coal gasification pressure vessels.

Creep Rupture of High-Chromium Alloys in Mixed-Gas Environments - DOE Contact S.J. Dapkunas, 301-353-2784; ANL Contacts W.A. Ellingson, K. Natesan, 312-972-5068

- Experimentally evaluate the uniaxial creep rupture behavior of selected high-chromium alloys in mixed-gas environments and correlate creep properties such as rupture life, rupture strain and minimum creep rate with the chemistry of exposure environment, temperature, and alloy chemistry.

Investigation of the Weldability of Ductile Aluminides - DOE Contact S.J. Dapkunas, 301-353-2784; Colorado School of Mines Contact G.R. Edwards, 303-273-3773

- Determine the role of microstructure in the intergranular cracking of alumindes, with special emphasis on weld cracking susceptibility.

Development of Iron and Nickel Aluminides - DOE Contact S.J. Dapkunas, 301-353-2784; ORNL Contact C.T. Liu, 615-574-4459

- Design and test materials that will use Al_2O_3 as the main protective layer to prevent sulfidation attack and that will possess good mechanical properties at high temperatures.

Joining of Advanced Aluminides - DOE Contact S.J. Dapkunas, 301-353-2784; Idaho National Engineering Laboratory Contacts A.D. Donaldson, D.E. Clark, FTS 583-2627

- Investigate weldability problems limiting the use of aluminides in welded structures.

Pilot Plant Materials Testing and Failure Analysis - DOE Contact S.J. Dapkunas, 301-353-2784; ORNL Contact J.R. Keiser, 615-574-4453

- Provide screening data on the susceptibility to corrosion and stress-corrosion cracking of potential construction materials for coal liquefaction plants.

Corrosion of Alloys for Internal and Heat Exchangers in Mixed-Gas Environments - DOE Contact S.J. Dapkunas, 301-353-2784; ANL Contacts W.A. Ellingson, K. Natesan, 312-972-5068

- Provide a basic understanding of the corrosion behavior of commercial and model alloys after exposure to multi-component gas mixtures.

Corrosion of Alloys in FBC Systems - DOE Contact S.J. Dapkunas, 301-353-2784; ANL Contacts W.A. Ellingson, K. Natesan, 312-972-5068

- Experimentally evaluate the corrosive behavior of alloys in various gas environments and evaluate deposit-induced corrosion behavior of heat-exchanger and gas-turbine materials after exposure to such environments.

A Mechanistic Study of Low-Temperature Corrosion on Materials in the Coal Combustion Environment - DOE Contact S.J. Dapkunas, 301-353-2784; General Electric Contact R.W. Haskell, 518-385-4226

- Develop a mechanistic understanding of the low-temperature corrosion phenomena observed in the Long-Term Materials Test, focusing on corrosion morphology and interface chemistry of selected specimens, thermochemical calculations and laboratory test to correlate experimental results with the calculations.

Investigation of Corrosion Mechanisms of Coal Combustion Products in Alloys and Coatings - DOE Contact S.J. Dapkunas, 301-353-2784; University of Pittsburgh Contact G.H. Meier, 412-624-5316

- Investigate the formation and breakdown of protective oxide scales in mixed oxident gases.

Investigation of the Mechanisms of Molten Salt Corrosion of Candidate Materials for Molten Carbonate Fuel Cells - DOE Contact S.J. Dapkunas, 301-353-2784; ORNL Contact H.S. Hsu, 615-576-4810

- Investigation of the corrosion mechanisms of the anode and cathode current collectors in molten carbonate fuel cells.

Erosion in Dual-Phase Microstructures - DOE Contact S.J. Dapkunas, 301-353-2784; University of Notre Dame Contact T.H. Kosel, 219-239-5642

- Systematically investigate the effects of microstructural variables in dual-phase metallic alloys containing large second-phase particles on erosion by solid particle impact.

Evaluation of Advanced Materials for Slurry Erosion Service - DOE Contact S.J. Dapkunas, 301-353-2784; Battelle-Columbus Laboratories Contacts I.G. Wright, A.H. Clauer, 614-424-4377

- Obtain erosion data on candidate valve trim materials under varied wear conditions.

- Explore and characterize behavior of the new erosion-resistant materials.

- Develop a substitute erodent and liquid carrier combination to reduce health risks in the laboratory.

Mechanisms of Erosion-Corrosion in Coal Combustion Environments - DOE Contact S.J. Dapkunas, 301-353-2784; ORNL Contact J.R. Keiser, 615-574-4453

- Microscopically evaluate erosion-corrosion of alloys after being subjected to a flowing gas stream of erodent particles.

Study of Particle Rebound Characteristics and Material Erosion at High Temperature - DOE Contact S.J. Dapkunas, 301-353-2784; University of Cincinnati Contact W. Tabakoff, 513-475-2849

- Investigate the erosion processes and fluid mechanics phenomena that occur in coal combustion systems.

Development of Nondestructive Evaluation Techniques for Structural Ceramics - DOE Contact S.J. Dapkunas, 301-353-2784; ANL Contact W.A. Ellingson, 312-972-5068

- Study and develop acoustic and radiographic techniques as well as possible novel techniques to characterize structural ceramics with regard to various properties and flaws.

Effect of Flaws on the Fracture Behavior of Structural Ceramics - DOE Contact S.J. Dapkunas, 301-353-2784; ANL Contact W.A. Ellingson, 312-972-5068

- Establish correlations between the composition, microstructure, and mechanical properties of structural ceramics with well-defined flaws.

- Provide information to relate mechanical properties to nondestructive evaluation results.

Joining of Silicon Carbide Reinforced Ceramics - DOE Contact S.J. Dapkunas, 301-353-2784; Idaho National Engineering Laboratory Contacts A.D. Donaldson, R.M. Nielson, FTS 583-2627

- Identify and develop techniques for joining silicon carbide fiber-reinforced composite materials.

Nondestructive Evaluation of Advanced Ceramic Composite Materials- DOE Contact S.J. Dapkunas, 301-353-2784; Idaho National Engineering Laboratory Contacts A.D. Donaldson, J.B. Walter, FTS 583-2627

- Develop an effective capability for nondestructive evaluation of ceramic fiber reinforced ceramic composites focusing on ultrasonic and radiographic techniques.

Investigation of the Mechanisms of Failure of Ceramic Materials for Hot Gas Filtration - DOE Contact S.J. Dapkunas, 301-353-2784; United Kingdom Coal Research Establishment/ORNL Contact R.A. Bradley, 615-574-6094

- Investigate the mechanisms of failure of high temperature ceramic filters used for removing particulates from gas streams and apply the results to similar rigid ceramic filters.

High Temperature Applications of Structural Ceramics - DOE Contact S.J. Dapkunas, 301-353-2784; National Bureau of Standards Contacts E.R. Fuller, S.J. Schneider, 301-921-2901

- Characterize the high temperature failure mechanisms to improve the properties of structural ceramics.

Development of Refractory Composites with High Fracture Toughness- DOE Contact S.J. Dapkunas, 301-353-2784; ANL Contacts W.A. Ellingson, J.P. Singh, 312-972-5068

- Fabricate refractories with improved thermal shock properties without sacrificing corrosion resistance.

High Temperature Creep Behavior of Refractory Bricks - DOE Contact S.J. Dapkunas, 301-353-2784; Iowa State University Contact T.D. McGee, 515-294-9619

- Study of the creep behavior of high-chromia refractories suitable for lining the hot section of slagging gasifiers.

Investigation of the Effect of Slag Penetration on the Mechanical Properties of Refractories - DOE Contact S.J. Dapkunas, 301-353-2784; National Bureau of Standards Contact S.M. Wiederhorn, 301-921-2901

- Evaluate the effect of slag and microstructure on the fracture and deformation behavior of refractory materials, and model refractory degradation caused by slag penetration.

Corrosion of Refractories in Slagging Gasifiers - DOE Contact S.J. Dapkunas, 301-353-2784; ANL Contacts W.A. Ellingson, S. Greenberg, 312-972-5068

- Examine the effects of slag and flux composition on the corrosion of alumina and chromia refractories.

Device or Component Fabrication, Behavior, or Testing

"Materials and Components in Fossil Energy Applications" Newsletter- DOE Contact S.J. Dapkunas, 301-353-2784; Battelle-Columbus Laboratories Contact I.G. Wright, 614-424-4377

- Publish a periodic newsletter to address current developments in materials and components in fossil energy applications.

Three-Dimensional Residual Stress Characterization of Thick Plate Weldments with Advanced Instrumentation and Methodologies - DOE Contact S.J. Dapkunas, 301-353-2784; Pennsylvania State University Contact C.O. Rudd, 814-863-2843

- Characterization of the three-dimensional residual stress field in an approximately 30cm thick V-groove weldment of 2 1/4 Cr-1 Mo steel.
- Evaluate various postweld heat treatment techniques.

Studies of Materials Erosion in Coal Conversion and Utilization Systems- DOE Contact S.J. Dapkunas, 301-353-2784; LBL Contact A.V. Levy, 415-486-5822

- Determine the erosion-corrosion behavior of materials used in the flow passages of liquid slurries under conditions representative of those in coal liquefaction systems.

Mechanisms of Galling and Abrasive Wear - DOE Contact S.J. Dapkunas, 301-353-2784; National Bureau of Standards Contact L.K. Ives, 301-921-2943

- Study of the wear mechanisms of materials associated with valves in coal conversion systems.

Thermomechanical Modeling of Refractory Brick Linings for Slagging Gasifiers - DOE Contact S.J. Dapkunas, 301-353-2784; Massachusetts Institute of Technology Contact Oral Breyukozturk, 617-253-7186

- Study of the failure mechanisms of refractory-brick-lined coal gasification vessels under transient temperature loadings.

Alkali Attack of Coal Gasifier Refractory Linings - DOE Contact S.J. Dapkunas, 301-353-2784; Virginia Polytechnic Institute and State University Contact J.J. Brown, Jr., 703-961-6777

- Investigate the physical and chemical characteristics of alkali attack of coal gasifier linings under nonslagging conditions.

Thermodynamic Properties and Phase Relations for Refractory-Slag Reactions in Slagging Coal Gasifiers - DOE Contact S.J. Dapkunas, 301-353-2784; Pennsylvania State University Contact Arnulf Muan, 814-865-7659

- Determine the chemical constraints affecting the performance of refractory material under experimental conditions corresponding to those prevailing in slagging gasifiers.

Oxide Electrodes for High-Temperature Fuel Cells - DOE Contact S.J. Dapkunas, 301-353-2784; PNL Contact J.L. Bates, 509-375-2579

- Find and develop highly electronically conducting oxides for use as cathodes in SOFC's.

Instrumentation and Facilities

Management of the AR&TD Fossil Energy Materials Program - DOE Contact S.J. Dapkunas, 301-353-2784; ORNL Contacts R.A. Bradley, P.T. Carlson, 615-574-6094

- Management of the AR&TD Fossil Energy Materials Program under DOE approved guidelines.

Office of Surface Coal Gasification

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Electroslag Component Casting - DOE Contact J.P. Carr, 301-353-5985; ORNL Contact V.K. Sikka, 615-574-5112

- Development of electroslag casting technology for use in coal conversion components such as valve bodies, pump housings, and pipe fittings.

Protective Coatings and Cladding: Application/Evaluation - DOE Contact J.P. Carr, 301-353-5985; ANL Contact D.J. Baxter, 312-972-5117

- Experimental evaluation and thermodynamic analysis of metallic protective coatings for coal gasifier waste heat steam generators and superheaters.

- Development of coating inspection methods.

Materials Properties, Characterization, Behavior, or Testing

Corrosion of Structural Ceramics in Coal Gasification Environments- DOE Contact J.P. Carr, 301-353-5985; ANL Contact T.E. Easler, 312-972-4250

- Provide experimental data for SiC when exposed to coal gasification heat exchanger environments.

Device or Component Fabrication, Behavior, or Testing

Materials Review and Component Failure Analysis - DOE Contact J.P. Carr, 301-353-5985; ANL Contact D.R. Diercks, 312-972-5032

- Review and evaluation of materials performance in coal gasification pilot and demonstration plants.

Office of Oil, Gas, Shale, and Coal Liquids

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Coating Studies for Coal Conversion - DOE Contacts T.B. Simpson (HQ), 301-353-3913, S.R. Lee (PETC), 412-675-6137; ORNL Contact A.J. Caputo, 615-574-4566

- Development of chemically vapor deposited coatings which offer the hope of extending the life of valve trim materials in coal conversion applications.

- Determination of erosion rates using an established test in order to evaluate whether these coatings appear promising for valve trim and other severe erosion environment fossil applications.

Materials Properties, Behavior, Characterization, or Testing

Assessment of Materials Selection and Performance for Coal Liquefaction Plants - DOE Contact J.A. Reafsnyder (ORO), 615-576-1051; ORNL Contact A.R. Olsen, 615-574-1753

- Collection, assessment, and compilation of materials selection and performance data for coal liquefaction pilot plants, including data from applicable research and development programs and other sources such as the American Petroleum Institute (API) and the National Association of Corrosion Engineers (NACE).

Materials Review and Support for the SRC-I Liquefaction Project - DOE Contact J.A. Reafsnyder (ORO), 615-576-1051; ORNL Contact A.R. Olsen, 615-574-1753

- Provide assistance in the review of contractor documents for materials selection.

- Review and provide input to materials testing and failure analysis plans

- Compile materials information for specific processing steps to assist designers in making appropriate materials choices.

Coal Liquefaction Pilot Plant Materials Testing and Failure Analysis - DOE Contacts T.B. Simpson (HQ), 301-353-3913, S.R. Lee (PETC), 412-675-6137; ORNL Contact J.R. Keiser, 615-574-4453

- Provide alloy screening data on the susceptibility to corrosion and stress-corrosion cracking of potential materials of construction for coal liquefaction plants.

Elastomer Test Program - DOE Contacts T.B. Simpson (HQ), 301-353-3913, S.R. Lee (PETC), 412-675-6137; ORNL Contact J.R. Keiser, 615-574-4453

- Testing of O-ring elastomers for use in coal liquids. Laboratory immersion tests are being performed at ORNL and in-plant testing is being performed at the Wilsonville Advanced Coal Liquefaction Research and Development Facility.

Office of Coal Utilization

Fuel Cells Program

The purpose of the Fuel Cells Program of the Office of Coal Utilization is to develop technology required to make fuel cells commercially viable. This involves reducing costs while increasing lifetime and performance. Typical materials issues include corrosion, both as it affects the cells under their operating potentials and as it affects contiguous ducts or manifolds; sintering of catalysts; development of low-cost manufacturing processes; and achieving requisite porosity distribution while maintaining structural integrity. Projects with no dollar figures are subtasks of singly funded, larger statements of work and no information on specific funding breakdowns is available for these tasks.

Materials Preparation, Synthesis, Deposition, Growth, or Forming

Electrode Surface Chemistry - DOE Contact W.J. Huber, 304-291-4663; LBL Contact P.N. Ross, 415-486-4000

- Synthesis of bimetallic catalysts by thermal annealing of platinum with refractory metals, refractory metal oxides, and refractory metal carbides.

Development of Ternary Alloy Cathode Catalysts for Phosphoric Acid Fuel Cells - DOE Contact W.J. Huber, 304-291-4663; Giner Contact V. Jalan, 617-899-7270

- Synthesis of binary and ternary platinum alloy catalysts, a few of which showed increased catalytic activity compared to platinum catalysts alone.

Organometallic Catalysts for Primary Phosphoric Acid Fuel Cells - DOE Contact W.J. Huber, 304-291-4663; ECO Contact F. Walsh, 617-964-7010

- Synthesis of several metal-cobalt-organic liquid type catalysts, which have shown increased catalytic activity compared to platinum catalysts.

Materials Properties, Behavior, Characterization, or Testing

Molten Carbonate Fuel Cell and Stack Technology Development - DOE Contact F.D. Gmeindl, 304-291-4751; United Technologies Corporation Contact A. Meyer, 203-727-2214

- Evaluation of materials which maintain springiness under molten carbonate fuel cells (MCFC) operating conditions with temperatures up to about 700 degrees C for use in the construction of flexible flanges which maintain sealing pressures against electrolyte-filled ceramic matrices.

- Study of corrosion of 316 SS and other alloys in a MCFC cathode gas/molten carbonate film environment for the effects of heat and forming operations on the corrosion rate and the nature of the protective layer under normal operation of the fuel cell and under the stress of thermal cycling.

- Evaluation of ZrO_2 materials as gasket materials between gas manifolds and the MCFC stack.

Molten Carbonate Fuel Cell Component Technology Development - DOE Contact F.D. Gmeindl, 304-291-4751; Energy Research Corporation Contact H. Maru, 203-792-1460

- Improvement of anode creep resistance by filling the anode with lithium aluminate powders and improvement of porosity by controlling particle synthesis and improving the method of pressing and sintering the powders.

- Development of catalysts for reforming of methane in the anode compartment of the fuel cell.

- Development of a coating for separator plate materials that meets goals of overpotential and resistance to corrosion and spalling after thermal cycling.

Alternative Molten Carbonate Fuel Cell Cathodes - DOE Contact F.D. Gmeindl, 304-291-4751; ANL Contact R.D. Pierce, 312-972-4450

- Evaluation of ceramic materials (e.g., Li_2MnO_3, $LiFeO_2$, and ZnO) as possible alternatives to NiO for the cathode material for molten carbonate fuel cells because in-cell migration of NiO has been found to be excessive for long-term operation.

Device or Component Fabrication, Behavior, or Testing

High Temperature Solid Oxide Electrolyte Fuel Cell Power Generation System - DOE Contact C.M. Zeh, 304-291-4265; Westinghouse Electric Corporation R&D Center Contact W. Feduska, 412-256-1951

- Qualification of submodule performance prior to initiating development of a 5kW generator.

- Demonstrate essential design features (sealless generator concept, temperature profiles, fuel and oxidant distribution) in the submodule prior to design and fabrication of the 5kW generator.

- Diffusion studies to determine potential life limiting factors are underway.

Advanced Fuel Cell Research - DOE Contact C.M. Zeh, 304-291-4265; ANL Contact D.C. Fee, 312-972-8931

- Development of a fabrication process for a monolithic fuel cell design composed of a "honeycomb" of small 1- to 2-mm diameter cells.

Magnetohydrodynamics Program

Successful economic operation of commercial MHD power systems will depend to a large measure on the availability of reliable materials of construction, capable of extended service at MHD operating conditions. The primary objective of the Materials Program of the Office of MHD is the development of materials applicable to the unique operating environment of coal-fired MHD systems. Program effort is divided into two general categories: (1) research effort to provide a fundamental understanding of materials

behavior and a basis for the development of particular materials properties for MHD systems; and (2) applied engineering development of MHD component materials.

Materials Properties, Behavior, Characterization, or Testing

MHD Materials Development, Testing, and Evaluation - DOE Contact T.W. Arrigoni, 412-675-5981; PNL Contact P.E. Hart, 504-375-2905

- Development of composite, multi-layered, high temperature electrodes of hafnium oxide/rare-earth oxides/indium oxides with improved thermal shock resistance.

UTSI MHD Development Testing - DOE Contact C.A. Thomas, 412-675-5731; University of Tennessee Space Institute Contact N.R. Johanson, 615-455-0631

- Evaluation of materials for use in MHD system superheaters and air heaters including Croloy, Inconel, and 304, 316, 446, and 26-1 stainless steels.

MHD Heat and Seed Recovery Technology - DOE Contact R.F. Sperlein, 412-675-5985; ANL Contact T. Johnson, 312-972-5964

- Investigation of critical factors affecting the formation and growth of seed/slag deposites in a coal-fired MHD steam plant.
- Produce simulated MHD channel exhaust gas by burning a slurry of heating oil, potassium sulfate, and fly ash with preheated air.

OFFICE OF ENERGY UTILIZATION RESEARCH

This office supports generic research of a long-term, high-risk, high-payoff nature aimed at stimulating innovation in conservation technology. The research is both broadly based and multi-sectoral, providing a technology base for the other conservation programs.

Energy Conversion and Utilization Technologies Division

The mission of the ECUT Program is to support generic, long-term, high-risk directed basic and applied research and exploratory development of new or improved concepts to produce a technology base which private industry can use in producing products that use energy more efficiently. Materials-related research in the ECUT Program is found in fiscal year 1984 in two projects, the Materials Project and the Tribology Project. The DOE contacts are Jim Eberhardt (202-252-1484; FTS 252-1484) for the Materials Project and Terry Levinson, (202-252-1484; FTS 252-1484) for the Tribology Project. In FY 1984 both projects were managed for ECUT by the Oak Ridge National Laboratory (ORNL). The ORNL technical manager of both projects was Joe Carpenter (615-574-4571; FTS 624-4571). In FY 1985, the Tribology Project will be managed by Argonne National Laboratory (ANL). The ANL technical manager will be Manfred Kaminsky (312-972-4074; FTS 972-4074). The goal of both projects is to develop innovative concepts to a point where they can be taken over for further development by private industry or other government programs.

The materials work in the Materials Project is in the areas of ductile ordered alloys, ceramic-ceramic and ceramic-metal attachments, surface modifications of ceramics, recovery and reuse of plastic scrap, building insulation, ceramic coatings, ceramic composites, and materials structures theory. Materials research in the Tribology Project is in the areas of friction and wear of ceramics, lubricants, and tribological surface modifications and coatings.

1. Ordered Metallic Alloys for High Temperature Applications

FY 1985
$ 825,000

DOE Contact - James Eberhardt, 202-252-1484
ORNL (Contract DE-AC05-84OR21400) Contact - Chain Liu, 615-574-4459
Rensselaer (ORNL Subcontract 19X-22217C) Contact - Norman Stoloff, 518-266-6436
NC State (ORNL Subcontract 19X-43368C) Contact - Carl Koch, 919-737-2377
Lehigh (ORNL Subcontract 19X-43367C) Contact - Russell Chou, 215-861-4235
Vanderbilt (ORNL Subcontract 19X-07821C) Contact - James Wert, 615-322-3583
VPI&SU (ORNL Subcontract 19X-89672C) Contact - Diana Farkas, 703-961-4742
Columbia (ORNL Subcontract 19X-89664C) Contact - John Tien, 212-280-5192
Carnegie-Mellon (ORNL Subcontract 19X-89678V) Contact - Ted Massalski, 412-578-2700
University of Tennessee (ORNL Subcontract S7685-S91) Contact - Ben Oliver, 615-974-5326

Long-range ordered (LRO) alloys based on the $(Fe,Ni)_3V$ system and intermetallic compounds based on the Ni_3Al and TiAl systems are being developed and assessed as replacements for superalloys in a variety of high temperature applications such as advanced automotive engines, steam turbines, and industrial heat exchangers. At ORNL developmental alloys are prepared using classical composition approaches and important properties are measured. Fatigue resistances and crack-growth behavior are studied at RPI; grain boundary diffusion, at Lehigh and VPI&SU; and wear resistances, at Vanderbilt. At NC State, alloys based on mechanical alloying approaches are prepared and investigated. Directionally solidified alloys are prepared and evaluated at Columbia. Theoretical work on better understanding the influence of electronic structure on the ordering temperatures of the LRO alloys being investigated is conducted at Carnegie-Mellon. Single crystals of TiAl are prepared at the University of Tennessee.

Keywords: Alloys, Long-Range Order, Intermetallics

2. Reactive Metallic Brazes for Ceramic-Ceramic and Ceramic-Metal Joints

FY 1985
$ 50,000

DOE Contact - James Eberhardt, 202-252-1484
ORNL (Contract No. DE-AC05-84OR21400) Contact - Artie Moorhead, 615-574-5153

Reactive metallic brazes are being developed for joining ceramics to ceramics and metals for high-temperature service up to about 900°C. Development brazes are screened by a levitation melting device and a wetting angle (sessile drop) test. Joints are brazed, tested to failure, and analyzed.

Keywords: Ceramic, Joining, Brazes

3. Modeling of Solid Ceramic Joints

FY 1985
$ 200,000

DOE Contact - James Eberhardt, 202-252-1484
The Norton Company (ORNL Subcontract 86X-00208C) Contact - Pierre Charreyron, 617-853-1000, ext. 2667
ORNL (Contract No. DE-AC05-84OR21400) Contact - Artie Moorhead, 615-574-5153

Generalized finite element models are being developed by Norton to predict the stress states existing in and near solid ceramic-ceramic and ceramic-metal joints of simple geometry. Butt-on-butt joints of rectangular cross sections and cylindrical cross sections are being modeled first. ORNL is developing laboratory tests, devices, and procedures to verify the predictions. The purpose of the effort is to provide guidance concerning compatible ceramic joints and applications.

Keywords: Ceramics, Metals, Joining, High Temperature Service

4. Electromagnetic Joining of Ceramics

FY 1985
$ 190,000

DOE Contact - James Eberhardt, 202-252-1484
DHR, Incorporated (ORNL Subcontract 86X-00217C) Contact - Richard Silberglitt, 703-556-8660

The objective of this effort is to establish the technical feasibility of using electromagnetic radiation in the radiofrequency (Rf) range to effect solid joints between ceramics and ceramics and ceramics and metals. Many ceramics are virtually transparent to electromagnetic radiation in the Rf range whereas all metals and other ceramics are not. Therefore, it may be possible to heat a ceramic-ceramic or ceramic-metal interface uniformly without having to use outside-to-inside heating which can tend to crack the ceramics due to nonuniform thermal expansion. In fiscal years 1983 and 1984 preliminary designs of the Rf equipment were completed and equipment fabrications were begun. Initial proof of feasibility was accomplished in fiscal year 1985.

Keywords: Ceramics, Metals, Joining, High Temperature Service

5. Nondestructive Evaluation (NDE) of Ceramic Joints — FY 1985 $ 75,000

DOE Contact - James Eberhardt, 202-252-1484
ORNL (Contract No. DE-AC05-840R21400) Contact - Bob McClung, 615-574-4466

This task is exploring the development of nondestructive evaluation (NDE) techniques for ceramic-ceramic and ceramic-metal joints. Various NDE techniques are being tried on joints with known defects in sample attachments and attempts were made to correlate the signals with performance of the attachments. Selected specimens are nondestructively evaluated using radiography and ultrasound prior to destructive testing in order to try to develop a correlation between "indications" found by NDE and the mechanical behavior of the brazements. A high-frequency ultrasound system has been assembled and used to demonstrate resolution commensurate with the thickness scale of the braze components in a typical ceramic joint and with the critical flaw size in the ceramic itself. Elastic moduli of the ceramic materials available have also been determined ultrasonically.

Keywords: Ceramics, Joining, Testing

6. Mechanisms of Adherence at Ceramic Joints — FY 1985 $ 150,000

DOE Contact - James Eberhardt, 202-252-1484
ORNL (Contract No. DE-AC05-840R21400) Contacts - Robin Williams, 615-576-2631; Mike Santella, 615-574-4805

This task investigates the fundamental physical and chemical parameters controlling the adhesion of ceramics to ceramics and metals in order to increase the understanding of the problems and limitations inherent in such attachments if they are to be used in future heat engines and high temperature industrial heat exchangers.

Keywords: Ceramics, Joining, Adherence

7. Ion Implantation of Ceramics — FY 1985 $ 310,000

DOE Contact - James Eberhardt, 202-252-1484
ORNL (Contract No. DE-AC05-840R21400) Contact - Carl McHargue, 615-574-4344

Georgia Institute of Technology (ORNL Subcontract 19B-07802C) Contact - Joseph Cochran, Jr., 404-894-2851
Universal Energy Systems (ORNL Subcontract 86X-22015C) Contact - Peter Pronko, 513-426-6900, ext. 113

The objective of these efforts is to explore the effects of ion implantation on certain properties of ceramics. Properties measured include strength, strength reliability (Weibull modulus), hardness, fracture toughness, coefficient of friction, and wear rates. Work at ORNL is concentrated on implantation into TiB_2; at Georgia Tech, into Al_2O_3 and ZrO2; and at UES, on SiC and Si_3N_4. In fiscal years 1984 and 1985, in the work at ORNL, an extraordinarily low (.03 - .04) coefficient of friction was observed in unlubricated pin-on-disc tests in which a diamond pin was slid on Ni-implanted TiB_2 in nitrogen at room temperature. Studies are underway to identify the mechanisms.

Keywords: Ceramics, Ion Implantation

8. Laser Surface Modifications of Ceramics — FY 1985 $ 150,000

DOE Contact - James Eberhardt, 202-252-1484
North Carolina State University (ORNL Subcontract 19X-43377C) Contacts - Bob Davis, 919-737-3272; Jagdish Narayan, 919-248-1902 and 919-737-2933

The objective of this effort is to investigate the nature and implications of surface modifications induced by driving or diffusing certain metal ions into ceramic surfaces by irradiation with a pulsed laser. Thin layers of either Cr, Fe, or Ni are deposited onto flat surfaces of either alpha- or beta-SiC, Si_3N_4, or Al_2O_3 and then irradiated by pulsed lasers. Fracture strength and toughness, friction and wear behavior, fatigue resistance, and microstructural and compositional variations are determined and related to the wavelength of the laser radiation, the pulse duration, and the energy density.

Keywords: Ceramics, Coatings and Films, Diffusion, Erosion and Wear, Surface Characterization and Treatment

9. Electrosterically-Stabilized Suspensions of Oxide Ceramics for Injection Molding — FY 1985 $ 55,000

DOE Contact - James Eberhardt, 202-252-1484
University of Washington (ORNL Subcontract 19X-27458C) Contact - Ilhan Aksay, 206-543-2625

The objective of this study is to develop a process or processes for producing high quality ceramic bodies with a uniform sintered pore size distribution through higher (than present) speed injection molding techniques using an aqueous solvent medium and a minimum amount of organic additives. The approach is to absorb a polymer onto the surface of the submicron particle in order to block agglomeration, yet allow easy handling in relatively concentrated suspension which can be injection molded.

Keywords: Ceramics, Injection Molding, Polymers

10. Hollow, Thin-Wall Ceramic Spheres from Slurries FY 1985 $ 75,000

DOE Contact - James Eberhardt, 202-252-1484
Georgia Institute of Technology (ORNL RFP in Progress) Contact - A.T. Chapman, 404-894-4815

This effort is investigating the development of processes for economically fabricating hollow thin wall spheres from conventional ceramic powders using dispersions. Currently, hollow thin wall spheres can only be made of ceramics that are easily melted or can be formed from solutions; the ability to produce them from conventional slurries would open the technique to ceramics such as SiC or Si_3N_4. Ceramic spheres of small (.1-5 mm) diameter might have numerous novel applications as high temperature insulations or even lightweight structural materials. A collection system will be developed to dry the spheres in free fall, the drying to be completed after the spheres have separated from the connecting fibers and surface tension has provided near perfect spheres. Approaches include the use of microwave heating in the free-fall stage to accelerate the removal of the slurry water or the substitution of a highly volatile liquid such as acetone as the slurry medium. Process variables using a standard Al_2O_3-based dispersion will then be characterized. Spheres of a variety of compositions will be formed and the properties of the spheres, individually and collectively, in the form of both loose fills and bonded monoliths will be measured. Prototype quantities of microspheres of several compositions will be available for testing by government agencies and commercial companies. Work was scheduled to begin in fiscal year 1986.

Keywords: Ceramics, Fabrication

11. Toughened $MoSi_2$ FY 1985 $ 50,000

DOE Contact - James Eberhardt, 202-252-1484
LANL (Contract W-7405-Eng-36) Contact - John Petrovic, 505-667-5452

This project seeks to improve the mechanical properties of molybdenum disilicide ($MoSi_2$) so that it can be used as a high temperature structural material. At the present time, its strength is limited by brittle fracture at low temperatures and by plastic deformation at high temperatures. To address this problem, SiC whisker-$MoSi_2$ matrix composites are being synthesized and evaluated. The whisker reinforcement may toughen the materials at lower temperatures where the matrix is brittle and strengthen the material at higher temperatures where the matrix is ductile. Initially, microstructures and room temperature mechanical properties are being evaluated and interpreted to determine the beneficial effects of the composite approach on low temperature properties. Investigations will later be extended to encompass the affects of volume fraction of SiC whiskers, the nature of the whisker-matrix interfacial bond, elevated temperature mechanical properties, and oxidation behavior.

Keywords: Physical Properties, Ceramics, Composites, Whiskers

12. Machining and Surface Preparation of Ceramics — FY 1985 $ 25,000

DOE Contact - James Eberhardt, 202-252-1484
ORNL (Contract No. DE-AC05-84OR21400) Contact - Dave Stinton, 615-574-4556

This task is directed toward an understanding of the effects of current machining and surface preparation methods on the performance of ceramics. The initial work in fiscal years 1985 and 1986 assesses the need for further work, set specific objectives, and establishes priorities in an effort to resolve the question of whether or not machining and surface preparation technology presently exists which can minimize the introduction of surface flaws which tend to reduce the effective strengths of structural ceramics. If the initial assessment indicates that such technology does not now exist, novel machining or surface preparation methods that are less degrading to the ceramics' performances and less costly than present methods will be developed.

Keywords: Machining, Surface Preparation, Ceramics

13. Dispersion Toughened Ceramic Composite Coatings Via Chemical Vapor Deposition — FY 1985 $ 75,000

DOE Contact - James Eberhardt, 202-252-1484
ORNL (Contract No. DE-AC05-84OR21400) Contact - Dave Stinton, 615-574-4556

The objective of this effort is to produce toughened ceramic matrix composite coatings by simultaneous chemical vapor deposition (CVD) of a dispersoid phase and a matrix phase. The basic mechanisms which control the toughness, strength, thermal expansion, and thermal conductivity of the composite coatings are investigated by varying the quantity, composition, and morphologies of the two phases. Initial work in fiscal year 1985 has concentrated on SiC (matrix)-$TiSi_2$ (dispersoid) composite coatings.

Keywords: Coatings, Ceramics, Chemical Vapor Deposition, Composites

14. Plasma Sintering of Ceramics — FY 1985 $ 100,000

DOE Contact - James Eberhardt, 202-252-1484
Northwestern (ORNL Subcontract TBD) Contact - D. Lynn Johnson, 312-492-3537

The objective of this effort is to explore and elucidate the mechanisms of sintering of ceramics in a plasma. Previous work (supported by DoD and NSF) has shown that some ceramics can be sintered to high densities quite rapidly by means of plasmas and microwaves by means of (1) simple heating and (2) activation of mass transport properties (e.g., grain boundary diffusion) important to sintering. In the present work, attempts are being made to decouple the two mechanisms, i.e., the specimen is heated by conventional means such as resistance heating while in a low-pressure, non-equilibrium plasma. Initial work, begun in late fiscal year 1985, was on sintering of Al_2O_3.

Keywords: Ceramics, Sintering, Plasma

15. Recovery and Reuse of Plastic Scrap Via Separation and Bonding
FY 1985
$ 35,000

DOE Contact - James Eberhardt, 202-252-1484
Plastics Institute of America (ORNL Subcontract 9100) Contact - Mike Curry or Al Spaak, 201-420-5552

The PIA is coordinating and participating in an effort with five universities, a marketing consultant, and several industrial firms to assess the potential of recycling or reusing post-consumer plastic scrap via bonding and/or separation approaches. At the universities, binders for clean plastic "fluff" residue from auto shreds and for shredded beverage containers were developed or acquired, and then used to produce laboratory test specimens. The properties of these specimens were measured. The use of the auto shred residue as a filler for polymer concretes and techniques for separating it into its constituents was also investigated. In fiscal year 1985, some binders identified in the laboratory scale tests were being used to produce large specimens from several tons of the residue using large scale equipment supplied by the industrial firms. The large scale tests are funded by the DOE Office of Industrial Programs. A survey to identify potential markets for products made from the recycled plastics is being conducted by the marketing consultant.

Keywords: Plastics, Recycle

16. Recovery and Reuse of Plastic Scrap Via Decomposition FY 1985
$ 50,000

DOE Contact - James Eberhardt, 202-252-1484
Plastics Institute of America (ORNL Subcontract 9100) Contact - Giuliana Tesoro, 718-543-5244, 914-693-5329, and 201-420-5552

Work is being conducted in the area of recovery and reuse of plastic scrap by means of techniques in which the scrap plastics are decomposed in some way to products such as uncrosslinked polymers, chemical feedstocks, free monomer, or fuels. Techniques being considered include pyrolysis, hydrolysis, solvolysis, radiolysis, and various combinations thereof followed by appropriate separations. An international symposium was held on the subject on August 31 and September 1, 1983 at the Annual Meeting of the American Chemical Society in Washington, D.C. Pertinent literature was reviewed to determine the scope of further work to be done under subcontracts; RFPs for the work were being developed at the end of fiscal year 1985.

Keywords: Plastics, Recycle

17. Economics of Recovery and Reuse of Plastic Scrap FY 1985
$ 15,000

DOE Contact - James Eberhardt, 202-252-1484
ORNL (Contract No. DE-AC05-84OR21400) Contact - Randall Curlee, 615-576-4864

A series of studies on the economic viability of the recovery and reuse of plastic scrap over the next twenty years were done. Expected quantities and prices of various types of plastic scrap are predicted, current data on costs of various recycling schemes are collected and assessed, and prices of products made from the recycled plastics are compared to prices for similar products made from virgin materials. Initial results indicated that many plastics recovery and reuse techniques are and will be economically viable. Current studies are concerned with the institutional barriers that may have to be overcome before large scale recovery and reuse of plastic scrap can occur.

Keywords: Plastics, Recycle

18. Ordered Metallic Alloys for Lightweight Applications — FY 1985: $ 95,000

DOE Contact - James Eberhardt, 202-252-1484
ORNL (Contract No. DE-AC05-84OR21400) Contact - Chain Liu, 615-574-4459
Consultant (ORNL Subcontract 11-89661V) Contact - Erland Schulson, 603-446-2888 or 603-643-4464

The objective of this effort is to explore the potential of ordered intermetallic alloys for possible use as lightweight structural materials. Initial efforts are concentrating on magnesium-based alloys. Assessments were conducted in fiscal years 1984 and 1985 to determine if ductile intermetallic alloys based on magnesium are possible. The conclusion was that such alloys probably are feasible and alloys based on Mg-Si, Mg-Al, and Mg-Li were identified as candidates for initial development. Work on such alloys began in fiscal year 1985.

Keywords: Metals, Intermetallics, Lightweight

19. Assessment of Liquid Crystal Polymers for Structural Applications — FY 1985: $ 25,000

DOE Contact - James Eberardt, 202-252-1484
ORNL (Contract No. DE-AC05-84OR21400) Contact - Paul Phillips, 615-574-5114 and 615-974-5304

This project assesses the potential of emerging liquid crystal technologies for producing polymeric materials for structural applications. Liquid crystal polymers are curious materials which retain a degree of molecular regularity and orientation even in the melt stage. A possibility exists that such materials may be capable of forming a self-reinforcing composite in which the solid part of the melt stage acts as a reinforcement for the remainder after solidification. A unique advantage of such material would be that it could be melted and shaped like any thermoplastic.

Keywords: Polymers, Liquid Crystals

20. Materials by Design Assessment — FY 1985: $ 0

DOE Contact - James Eberhardt, 202-252-1484
Signal UOP, Inc. (ORNL Subcontract 86X-00210C) Contact - Alan Wilke, 312-391-3179

The ultimate objective of the overall effort, of which this task is the initial part, is to establish the technical feasibility of developing, experimentally verifying, and using mathematical models of certain transition interatomic processes and phenomena in order to have the predictive power to design and optimize practical engineering processes and materials. The objective of this assessment is to determine if the current paces of the states of the art in quantum mechanical and semiempirical models, supercomputers, and experimental analytical tools are such that an effort to achieve the ultimate objective is possible, or will be possible, in the next 5 to 10 years. The materials science phenomena of interest are bonding of solid coatings to solid substrates, grain boundary adhesion, and the structure and properties of amorphous materials; in addition, phenomena in heterogeneous catalysis and tribology are considered. The assessment was completed in FY 1985.

Keywords: Alloys, Metals, Ceramics, Coatings and Films, Joining

21. Boron-Effect-in-Ni_3Al — FY 1985 $ 570,000

DOE Contact - James Eberhardt, 202-252-1484
LANL (Contract W-7405-Eng-36) Contact - Jeff Hay, 505-843-2097
ORNL (Contract No. DE-AC05-84OR21400) Contact - Joe Carpenter, 615-574-4571 or Chain Liu, 615-574-4459

The objective of this task is to explain the mechanism(s) whereby small amounts (100-500 ppm) of boron are able to make Ni_3Al a quite ductile polycrystalline material. Los Alamos is carrying out theoretical calculations whereas ORNL is leading the complimentary experimental efforts being performed at ORNL and elsewhere under funding provided by the DOE Office of Basic Energy Sciences (OBES).

Keywords: Alloys, Intermetallics, Grain Boundaries

22. Instruments for Harsh Environments — FY 1985 $ 100,000

DOE Contact - James Eberhardt, 202-252-1484
National Bureau of Standards - Gaithersburg (Interagency Agreement OR-21375) Contact - Ken Kreider, 301-921-3281

The objective of this effort is to provide fundamental information needed for the construction and performance of thin-film surface sensors for less intrusive measurements of temperatures of combustion gases in internal combustion engines. Initially the work was directed toward thermocouples for iron-based substrates; this phase of the work was completed in fiscal year 1985. Subsequent work is directed toward ceramic substrates.

Keywords: Coatings and Films, Physical Vapor Deposition, Engines, High Temperature Service, Ceramics

23. Supercritical Fluid Equations of State

FY 1985
$ 0

DOE Contact - James Eberhardt, 202-252-1484
National Bureau of Standards - Boulder (Interagency Agreement OR-21374)
Contact - James Ely, 303-320-5467

The objective of this effort was to develop better equations of state for fluid mixtures in the supercritical region. There are potential applications of supercritical fluids technology for separations and extractions in numerous materials processing areas. The work entailed (1) measurements of thermodynamic and transport properties of CO_2, (2) development of a model to predict phase equilibria, and (3) measurements of solubilities of various gases in CO_2, all three phases dealt with the supercritical state. This work was completed in fiscal year 1985.

Keywords: Separations

24. Coatings for High Temperature Energy Conversion Systems

FY 1985
$ 0

DOE Contact - James Eberhardt, 202-252-1484
LBL (ORNL Subcontract 41X-70342V) Contact - A.V. Levy, 415-486-5822

The objectives of this effort were to (1) assess the current state-of-the-art of plasma-sprayed and chemically vapor-deposited coatings and (2) to test the friction and wear characteristics and analyze certain thermal barrier and wear resistant coatings being considered for use on the piston rings of the adiabatic diesel engine. Plasma-sprayed coatings included a variety of MCrAl, Y_2O_3-ZrO_2, WC-Co, Cr_3C_2, Al_2O_3-TiO_2, and TiC_2. The CVD coatings include TiB_2 and others. The coatings were tested to determine the friction and wear rates in a Falex 6 washer-on-disk wear tester modified to achieve 1400oF in air. Coatings were analyzed before and after testing to determine compositions, microstructure, surface finish, hardness, and failure mode. This work was completed in early fiscal year 1985.

Keywords: Alloys, Ceramics, Coatings and Films, Corrosion and Wear, Physical Vapor Deposition, Chemical Vapor Deposition, Engines

25. Materials Approaches to Ice Abatement

FY 1985
$ 0

DOE Contact - James Eberhardt, 202-252-1484
Consultant (ORNL Subcontract 11X-89682V) Contact - Lawrence Casper, 612-541-2508

An assessment is being conducted to determine if there may be any viable materials (as opposed to systems) approaches to the abatement of ice adhesion on surfaces such as heat pump condenser coils, roofs, and solar collectors.

Keywords: Surfaces, Ice

26. Lubricant Qualities of the Constituents of Base Stock Oil

FY 1985
$ 450,000

DOE Contact - Terry Levinson, 202-252-1484
National Bureau of Standards - Gaithersburg (Interagency Agreement OR-21350) Contact - Stephen Hsu, 301-921-2113

The overall objective of this effort is to improve the understanding of the influences of lubricant molecular structure on the lubricant qualities. Three commercial base stock (without additives) oils, commonly used in formulating engine oils, are separated into various molecular fractions and each fraction tested for friction and wear in a specially devised four-ball test and oxidation stability in a unique microoxidation test. Chemical species produced during both tests are identified.

Keywords: Metals, Oils, Friction, Wear, Engines

27. Friction and Wear of Ceramics at Elevated Temperatures

FY 1985
$ 344,000

DOE Contact - Terry Levinson, 202-252-1484
ORNL (Contract No. DE-AC05-84OR21400) Contact - Charlie Yust, 615-574-4812
Advanced Mechanical Technology, Inc. (ORNL Subcontract 86X-17479C) Contact- Forest Carignan, 617-964-2042

Tribological experiments are run on high technology ceramics of current interest to determine apparent friction coefficients and wear rates and the ceramics are analyzed to elucidate the active wear mechanisms. A 5 X 5 matrix experiment was run in which pins of five types of ceramics were run against disks of themselves and the other four ceramic types. These ceramics studied included a Si_3N_4, a SiC, a toughened Al_2O_3, an untoughened Al_2O_3, and a partially stabilized ZrO_2. Tests were conducted in air and dry nitrogen at room temperature, 400 and 800 degrees F at speeds of 1 foot per second and nominal loads of 40 pounds per square inch (2 lb normal load on 1/4-inch diameter pin). Further work is concentrating on defining the limits of the "no-" or "low-wear" region for these and other ceramics.

Keywords: Ceramics, Friction, Wear

28. Observations of "Hot Spots" on Ceramics and Development of Theory

FY 1985
$ 75,000

DOE Contact - Terry Levinson, 202-252-1484
Georgia Institute of Technology (ORNL Subcontract 780219X-15) Contact- Ward Winer, 404-894-3270

The objectives of this effort are (1) to determine if ceramics exhibit "hot spots" during pin-on-disk tests and, if so, (2) to develop a theory for the severe wear of ceramics based on plastic flow or melting of the hot spots. Pins of partially stabilized zirconia or silicon nitride are tested against sapphire (Al_2O_3) disks. The wear on the ends of the pins is observed optically through the transparent disk. The output expected from this work is a better understanding of the mechanisms of wear of ceramics, ultimately leading to improvements in the wear resistances of ceramics.

Keywords: Ceramics, Erosion and Wear

29. Assessment of X-ray Methods for Investigations of Ceramic Wear Surfaces

FY 1985
$ 81,000

DOE Contact - Terry Levinson, 202-252-1484
Virginia Polytechnic Institute and State University (ORNL Subcontract 19-B07733C) Contact - Charles Houska, 703-961-5652

This is an assessment of the potential of x-ray diffraction and fluorescence techniques for nondestructive investigations of the near-surface region of ceramic wear surfaces. The limitations of standard x-ray diffraction and fluorescence equipment are defined and the possibilities afforded by the Brookhaven Synchrotron Light Source are explored. The ultimate output expected from this work is a program of research to develop and use x-ray techniques for investigating ceramic wear surfaces.

Keywords: Ceramics

30. Solid Lubricants Deposited From the Gas Phase

FY 1985
$ 75,000

DOE Contact - Terry Levinson, 202-252-1484
The Pennsylvania State University (IAA No. DE-AI02-83OR21350) Contact- E.E. Klaus, 814-865-2574

This is an investigation of the feasibility of depositing (from the gas phase) hydrocarbon and solid lubricant films onto metal and ceramic substrates. The objective is to assess the viability of the gas phase deposition approach for lubrication of heat engines and industrial machinery and for metal working. The deposition rates and the compositions and structures of the films are determined as functions of the vapor pressures of the lubricant precursors and oxygen in the gas phase, gas flow rate, and substrate temperature. The films are then tested for friction and wear characteristics. Initial efforts are concerned with the development of a vapor delivery system and deposition of films from mineral oil vapors onto steel substrates held at temperatures below 700 degrees F.

Keywords: Coatings and Films, Chemical Vapor Deposition

31. Tribological Surface Modifications and Coatings

FY 1985
$ 400,000

DOE Contact - Terry Levinson, 202-252-1484
ANL (Contract No. W-31-109-ENG-38) Contact - Manfred Kaminsky, 312-972-4074
Borg-Warner (ANL Subcontract No. 432024C1) Contact - William Sproul, 312-827-3131

This program will provide quantitative experimental and theoretical information on improving tribological properties of solid materials for use under extreme conditions. Program emphasis will be on developing wear resistant surfaces for tribological systems operating under extreme conditions, such as high temperature (>600°C), high speed, high stress, and high chemical activity. This project will commence with two tasks: (1) the development of hard coatings for high speed steel cutting tools to improve tool life and performance; and (2) the development of novel materials/surfaces for tribological systems operating under extreme environments, including the development of hard coatings with strong adhesion, low wear, good chemical and dimensional stability and high temperature stability. A three-step process will be explored, including ion implantation for substrate modification, ion plating to form well adherent overlayers with controlled composition, and ion doping/electric beam or laser beam glazing of overlayers. This will also include a modeling effort.

Keywords: Surface Modification, Coatings, Tribology

32. <u>Modeling of Hard Coatings for Tribological Systems Operating Under Extreme Conditions</u>

FY 1985
$ 80,000

DOE Contact - Terry Levinson, 202-252-1484
MIT (Contract No. DE-AC02-84CE90225) Contact - Bruce Kramer, 202-676-8237

A specific model of the wear behavior of hard wear coatings has been developed that includes the effects of chemical dissolution and of mechanical abrasion on the wear rate. Inputs to the model include the free energy of formation on the potential coating material, the excess free energies of solution of the constituent elements of the coating in the workpiece, the hardness of the coating and the cutting temperature. An algorithm has been written to search the available literature database and estimate the wear performance of candidate materials. Preliminary results indicate that significant improvements in wear resistance relative to conventional TiN coatings may be possible by employing new coating compositions. Coatings are being prepared and tested to experimentally evaluate the predictions of the theory and calibrate the wear model.

Keywords: Coatings, Friction, Wear, Metals, Machining

33. <u>Tribological Studies on Coated High Speed Steel Cutting Tools</u>

FY 1985
$ 75,000

DOE Contact - Terry Levinson, 202-252-1484
University of California in Los Angeles (Contract No. DE-AC02-84CE90227)
Contact - Rointan Bunshah, 213-825-2210

Hard coatings are prepared by a patented Activated Reactive Evaporation Process, and then sent to MIT and ANL for testing and characterization, as part of a project to confirm Professor Kramer's theory. Another project objective is to develop high wear resistant coatings for tool steels and other applications based on this theory.

Keywords: Coatings, Friction, Wear, Metals, Machining

34. Abrasion and Impact Resistant Coatings

FY 1985
$ 50,000

DOE Contact - Terry Levinson, 202-252-1484
LLNL (Contract No. W-7405-ENG-48) Contact - Tomas Hirschfeld, 415-422-6364

This project is developing innovative wear resistant coatings constructed by anchoring a high density mat of very fine, hard filaments or "hairs" into the surface of a bulk matrix, which is to be protected from abrasion and wear. These filaments form an intertwined, compliant mat which effectively resists impacts. Tests have been conducted in a sandblaster with controlled air flow, and controlled sand size and flow. Initial tests were conducted on carbon fibers imbedded in an epoxy matrix. These tests have established that a dense mat of 2 to 5 micron carbon fibers can provide complete protection to the epoxy matrix. Unprotected epoxy specimens were completely destroyed. Future tests will focus on metal matrices, and on C, B, SiC, Al_2O_3, and ZrO fibers.

Keywords: Coatings, Wear, Friction, Fibers, Metals, Polymers

35. Mechanical Interactions of Rough Surfaces

FY 1985
$ 50,000

DOE Contact - Terry Levinson, 202-252-1484
SKF Industries, Inc. (Contract No. DE-AC02-84ER13163) Contact - John McCool, 215-265-1900, Ext. 267

This project is a joint effort with the Office of Basic Energy Sciences. The project is exploring the behavior of lubricated concentrated contacts involving microscopically rough surfaces under conditions of combined rolling, sliding and spinning, with and without the presence of contaminating particles. It also is developing processing principles and techniques for the analysis of digitized rough surface profiles to yield surface descriptors that are predictive of functional performance and which have acceptable systematic and random error. It consists of both experimental and analytical work.

Keywords: Friction, Wear, Surface Roughness

Building Systems Division

36. Unguarded Flat Insulation Nichrome Wire Screen Tester — FY 1985 $ 170,000

DOE Contact - Bill Gerken, 202-252-9191
ORNL Contact - David McElroy, 615-574-5976

Materials under investigation include mineral fiberboard, and powdered insulations. Most existing insulation test equipment has been designed to provide data on steady-state thermodynamic conditions. In actual use, however, insulating materials experience a continually changing thermal environment. The research is designed to (a) validate the device through comparisons with guarded hot plates, and (b) study transient thermodynamic processes in insulation materials. A series of technical presentations and reports, detailing the equipment and the results of a variety of test series, is planned.

Keywords: Building Insulation, Heat Transfer, Nondestructive Evaluation

37. Settled Density Studies of Loose-Fill Insulation — FY 1985 $ 50,000

DOE Contact - Bill Gerken, 202-252-9191
ORNL Contact - David McElroy, 615-574-5976

Loose-fill cellulosic and mineral fiber insulating materials are being subjected to both laboratory and field studies to determine the effects of settling on density and R-value. These materials are typically sold on the basis of the R-value as-installed. R-value is a function of insulation thickness and density, and pronounced settling results in a lower than anticipated insulating capacity for a given quantity of material. Laboratory testing involves vibration of these materials in a simulated wall cavity. The in-situ studies consist of repeated visits to sites in several parts of the country, over as long as two years, to record measurements of insulation depth and density in residential attics. A series of reports and technical presentations will result from this effort.

Keywords: Building Insulation, Settled Density, Nondestructive Evaluation

38. Heat Flow Modeling — FY 1985 $ 100,000

DOE Contact - Bill Gerken, 202-252-9191
ORNL Contact - David McElroy, 615-574-5976

There are two aspects in this effort. The first is the mathematical modeling of heat transfer along longitudinal and radial coordinates. One dimensional heat flow studies in various materials are being undertaken and calculation of errors associated with edge heat loss effects are also considered.

The second component involves the physical description of heat transfers in a material with respect to "apparent" thermal conductivity. The factors that contribute to heat transfer phenomena are being studied in detail.

Keywords: Building Insulation, Heat Transfer, Mathematical Modeling

39. Improved Standard Reference Materials — FY 1985 $ 100,000

DOE Contact - Bill Gerken, 202-252-9191
National Bureau of Standards Contact - Brian Rennex, 301-921-3195

Candidates for improved standard reference materials are being investigated under this task, using a one meter diameter line-heat-source guarded hot plate. At present, only two materials are available from NBS for calibrating guarded hot plates and heat flow meters. A need exists to supply the measurement community with calibration samples whose apparent thermal conductivity and thermal resistance is both higher and lower than those now available, either using materials that more nearly resemble those that will be measured in current production or using an entirely new calibration material approach. The results of this effort will be, first, an assessment of candidate materials and, later, an improved standard reference material.

Keywords: Building Insulation, Heat Transfer, Nondestructive Evaluation

40. Gas Diffusion and Effective Conductivity of Foam Insulation Versus Age — FY 1985 $ 50,000

DOE Contact - Bill Gerken, 202-252-9191
Massachusetts Institute of Technology Contact - Leon Glicksman, 617-253-2233

Freon-blown rigid urethane foam insulation is being investigated under this task, to quantify the degree to which the effective thermal conductivity of insulation foamed with low thermal conductivity refrigerants changes due to diffusional effects as the insulation ages. A quasi-one dimensional model with upper and lower limits is used to examine heat conduction through the solid and gas in the foam insulation, and to study the effect of cell-wall geometry and cell arrangement on the thermal resistance, as well as the effect of the thermal conductivity of the solid and the amount of solid in the corners of the nodules. The transparency of the cell walls to infrared radiation and the transmission of thin layers of insulation is being measured to evaluate the extinction coefficient versus wavelength. A multi-layer heat transfer model is used together with the measured extinction coefficient to calculate the overall thermal conductivity. The project objective is to develop a combined mass and heat transfer model which will predict that material's overall thermal resistance to aging as well as to develop new concepts which reduce overall conductivity. This work is in follow-up to work begun by the ECUT program.

Keywords: Building Insulation, Heat Transfer, Diffusion

41. <u>Corrosiveness of Thermal Insulating Materials</u> <u>FY 1985</u> $ 20,000

DOE Contact - Bill Gerken, 202-252-9191
Stevens Institute of Technology Contact - Rolf Weil, 201-420-5257

The corrosiveness of four materials - cellulose, rock wool, fiberglass, and urea-formaldehyde foam - is being investigated to determine their effects on the metals with which they may come in contact when used as thermal insulation in residential buildings. Metal coupons are exposed to the insulating materials under laboratory and field conditions. A round robin test series involving several laboratories is being conducted using leachants from the insulating materials. Corrosion is evaluated by coupon weight loss and voltammetry. The objective of this study is to develop a uniform method for determining the corrosiveness of these materials.

Keywords: Building Insulation, Corrosion, Leaching

42. <u>Smoldering Combustion Hazards of Thermal Insulation Materials</u> <u>FY 1985</u> $ 8,000

DOE Contact - Bill Gerken, 202-252-9191
National Bureau of Standards Contact - Thomas Ohlemiller, 301-921-3771

Cellulosic insulation is being studied under this task to (a) examine the conditions and mechanism for transition from smoldering to flaming combustion, with special emphasis on the effect of forced air flow past or through the smoldering insulation, (b) determine how much various combustion retardants in the insulation influence the transition process, and (c) assess whether a test method for smoldering-to-flaming tendency is needed and is feasible. Cellulosic insulation is particularly prone to smoldering combustion. Once initiated, smoldering is self-sustaining and provides a relatively easy pathway to flaming combustion that is not precluded by the presence of flame retardants. In a test apparatus, air is forced across or through a layer of insulation, and smoldering is initiated by an igniter. Behavior of the smolder zone is followed by thermocouples embedded in the insulation, by monitoring the major exhaust gases, and by a near infrared TV camera. The expected output of this activity will be a technical report covering the research and a suggested standard test for the tendency to transition.

Keywords: Building Insulation, Combustion Ignition, Transition and Propagation, Fire Safety

43. <u>Reflective Foil Thermal Performance Modeling</u> <u>FY 1985</u> $ 40,000

DOE Contact - Bill Gerken, 202-252-9191
Tennessee Technological University Contact - David Yarbrough, 615-528-3494

Modeling of reflective foil radiation barrier systems is being conducted as part of an effort to develop an acceptable method for testing the R-value of such systems. No such test now exists, making it difficult to make valid comparisons between foil and other insulating materials. A technical report will be prepared at the conclusion of this effort.

Keywords: Building Insulation, Heat Transfer, Mathematical Modeling, Reflective Foils, Metals

44. High Temperature Insulation Standard Reference Materials

FY 1985
$ 50,000

DOE Contact - Bill Gerken, 202-252-9191
National Bureau of Standards Contact - Jerome Hust, 303-497-3733

Ceraboard and a high temperature loose-fill insulation are candidates to be investigated for use as new Standard Reference Materials (SRM), using a new 800 degree K guarded hot plate being completed as part of this effort. High temperature SRMs are needed in the industrial insulation field, and it is expected that this effort will complete certification testing of one such material during FY 1986.

Keywords: Industrial Insulation, Heat Transfer, Nondestructive Evaluation

45. Radiation Transmission Properties of Thermal Insulation

FY 1985
$ 40,000

DOE Contact - Bill Gerken, 202-252-9191
University of Kentucky Contact - Timothy Tong, 606-257-3236

This project is developing a data-reduction method for determining the thermal conductivity of thermal insulation from transient heat transfer data and is measuring radiation transmission properties. The energy transport equation being used includes conduction and radiation heat transfer terms, and is an extension of Fourier's law for conductive heat flow. The output will be a data reduction method for dynamic test results.

Keywords: Building Insulation, Radiative Heat Transfer, Computer Modeling

46. Theory of Radiative Heat Transport in Low-Density Insulations

FY 1985
$ 30,000

DOE Contact - Bill Gerken, 202-252-9191
University of Connecticut Contact - Paul Klemens, 203-486-3134

Radiative heat flow under transient conditions is divided into an instantaneous component that is transmitted without interacting with the insulation, and an absorbed and re-emitted component that contributes to diffusive heat transfer. This theoretical mathematical and physics-based analysis employs a realistic model that accounts for this division. A new heat transfer equation will be derived and applied to steady-state and transient test cases. The analysis will also lead to computer simulations of heat transfer for diurnal cycle effects and for measurement techniques such as laser diffusivity and the flat screen tester. This project is complementary to the radiation transmission properties study listed above, and will result in technical reports and papers describing the work.

Keywords: Building Insulation, Radiative Heat Transfer, Mathematical Analysis

47. Dynamic Latent Heat Storage Effects of Building Construction Materials

FY 1985
$ 35,000

DOE Contact - Bill Gerken, 202-252-9191
Manville Corporation Contact - Jack Verschoor, 303-972-2262

Latent heat considerations are important in developing optimum energy conservation strategies in the operation of air conditioning systems for both commercial and residential buildings. Comprehensive data is needed, but is not now available, on the time rate of moisture adsorption and desorption in building construction materials and furnishings as temperature and humidity conditions change. The data will be obtained by exposing various materials in a programmable climatic chamber using conditions simulating several air conditioning/ventilation strategies.

Keywords: Latent Heat Storage

48. Assessment of the Physical and Thermal Properties of Masonry Block Products

FY 1985
$ 92,000

DOE Contact - Bill Gerken, 202-252-9191
Steven Winter Associates Contact - Deane Evans, 212-564-5800

A data bank is needed on the thermal properties of concrete and masonry units covering the range of raw materials, densities and moisture contents typically encountered in building practice. Presently available handbook data on thermal properties used for concrete and clay masonry are not sufficiently comprehensive to cover all of the variables. This precursor activity is a survey and technical assessment of the present available physical and thermal property data for concrete and clay masonry block products commonly used in building wall construction. The assessment will also identify gaps in known information on these products and will recommend approaches for filling those gaps.

Keywords: Thermal Properties

Building Equipment Division

The mission of the Building Equipment Division is to provide the long range technical support needed to supply the private sector with the technological basis for developing and testing high efficiency equipment utilized in the operation of residential and commercial buildings. This equipment supplies the heating, cooling, lighting, hot water, and other services required to operate a building efficiently and offer its occupants a comfortable environment. The division supports applied research in engineering phenomena surrounding the conversion of raw energy in the form of oil, gas, and electricity into the useful energy forms of heat, refrigeration, and light. The division supports the development and revision of the DOE test procedures for consumer products. As part of the applied research program, the division conducts research on materials problems that are key to advanced technology equipment.

49. Materials for Condensing Heat Exchangers — FY 1985 $ 125,000

DOE Contact - Danny C. Lim, 202-252-9130
Battelle Contact - George Stickford, 614-424-4810
BNL Contact - Roger J. McDonald, 515-282-4197

This project investigates materials feasible for use in heat exchangers for condensing oil- and gas-fired heating systems. Properties of metallic and non-metallic materials are being experimentally evaluated for corrosion rates, stress resistance, and fabrication techniques under corrosive condensate environments. Low cost materials capable of 30 year service life are being sought.

Keywords: Corrosion, Materials Characterization, Ceramics, Polymers, Coatings, Metals Fabrication Techniques

50. Advanced Insulation for Appliances — FY 1985 $ 250,000

DOE Contact - Ronald Fiskum, 202-252-9130
ORNL Contact - Fred Creswick, 615-574-2009

The objective of this project is to develop the technology for advanced insulation for refrigeration systems and appliances having an R-value of 20 hr. Ft^{2}Btu in @ 200 degrees F. The thermal conductivity of materials or combinations of materials that are potentially suitable for advanced insulation are being evaluated. The best transfer theory governing novel insulation concepts will be developed.

Keywords: Conductivity, Material Characterization

51. Non-Azeotropic Refrigerant Mixtures — FY 1985 $ 400,000

DOE Contact - Ronald Fiskum, 202-252-9130
ORNL Contact - Phil Fairchild, 615-574-2020

The objective of this project is to investigate and expand the knowledge base of non-azeotropic refrigerants for use in refrigeration systems in an effort to improve the energy efficiency. Computer codes for design and investigative purposes to enhance the understanding of the operational characteristics of non-azeotropic refrigerant mixtures will be developed. Necessary modifications to the system for enhanced compatability with various mixtures will be identified. Novel systems and components will be tested and evaluated. Mixture properties data will be produced.

Keywords: Refrigerants, Refrigeration Systems

52. <u>Mercury Isotope Enrichment</u> FY 1985
$ 80,000

DOE Contact - Robert Boettner, 202-252-9136
LBL Contact - Sam Berman, 415-486-5682

The material under investigation is the element mercury (Hg) and its various isotopes that are used as a fill gas (in vapor form) in discharge lamps to maintain the discharge. The research is both basic and applied and was undertaken for the purpose of improving the efficiency of the conversion of electricity to visible spectrum radiation. Based on a theory developed by Dr. Berman, improved efficiency can be achieved by increasing the concentration of certain Hg isotopes that are found naturally and normally used in lamp fills. The problems under investigation are determining the optimum isotope mix, both technically and economically. The investigation involves precipitating desired Hg isotopes from HgO feedstock, introducing the isotopes into the test lamps in the desirable concentrations and testing the radiation characteristics for improved ultraviolet radiation. The expected results include the determination of an optimum isotope mix for an efficiency improvement of 10-15%.

Keywords: Metals, Precipitation, Radiation

53. <u>Zeeman Effect on Lamp Gas Plasma</u> FY 1985
$ 40,000

DOE Contact - Robert Boettner, 202-252-9136
LBL Contact - Sam Berman, 415-486-5682

The specific material under investigation is mercury (Hg) and its isotopes that are used in gas discharge lamps. This basic research effort aims to determine the improvement of efficiency of radiation of ultraviolet spectra through the application of a magnetic field to the lamp discharge. The problems under investigation are the quantity and characteristics of the phenomena and its potential for lamp efficiency improvements. The techniques used to study this phenomena are the testing lamps containing various Hg isotope mixes enclosed by a Helmholtz coil that generates the magnetic field. The project is expected to identify the increase in ultraviolet radiation (253.7nm) as a function of magnetic field strength for each type of lamp. These test results will then be compared to theoretical predictions developed earlier by Dr. Sam Berman.

Keywords: Metals, Radiation

54. <u>Absorption Fluid Pairs Research</u> FY 1985
$ 100,000

DOE Contact - Ronald Fiskum, 202-252-9130
ORNL Contact - George Privon, 615-574-1013

The objective of this project is to develop a complete data base on existing known fluid pairs over the temperature and pressure ranges experienced by heat pumps. A methodology for screening characterizing and selecting novel fluid pairs and ternary mixtures for advanced absorption cycles is being developed. Selected materials for corrosion effects and compatibility with existing and novel fluid pairs are under investigation.

Keywords: Absorption, Fluid Pairs, Corrosion, Heat Pump

55. New Gases/Diagnostics for High and Low Pressure Discharge Lamps

FY 1985
$ 304,912

DOE Contact - Robert W. Boettner, 202-252-9130
GTE Products Corporation (Contract No. DE-AC03-84SF12235) Contact - Dr. Jakob Maya, 617-777-1900, ext. 2309

The object of this program is to establish Laser Induced Fluorescence (LIF) as a novel nonintrusive diagnostic technique for light sources and explore new gases that might hold potential for a high efficiency practical illumination source using the LIF technique. The project seeks to establish the viability of LIF technique for measuring radial excited state distributions in low pressure as well as high pressure discharges. Using the LIF technique, the excited state radial distributions in novel discharges such as isotopically enriched and magnetic field enhanced fluorescent lamps will then be studied. Promising new molecular radiators will be determined by calculations. Performance of the promising systems found in three in electroded discharges will be studied experimentally. The performance of promising systems that are incompatible with electrodes, in electrodeless Radio Frequency (RF) excited discharges will also be studied. Reports on the utility of the LIF method for characterizing the radial Hg excited and ground state distributions in the low pressure Hg-rare gas plasma will be issued. The impact of such measurements will be analyzed and future research directions that may yield greater understanding toward more efficient fluorescent lamps will be pointed out.

Keywords: New Gases Diagnostics, Discharge Lamps

56. Explore Performance of New Ingredients in High Intensity Discharge Lamps

FY 1985
$ 165,600

DOE (San Francisco Operations Office) Contact - Michael Lopez, 415-273-4264
GE Contact - Dr. V.D. Roberts, 518-385-8983

The objective is to examine the performance (efficacy, electrical properties) of new ingredients in high intensity discharge lamps. The approach is to provide excitation of HID lamps through electrodeless discharges operating at 13.56 MHz. This permits use of ingredients which might otherwise attack conventional electrodes. Power input is in the range of 100 - 1000 watts. The expected results are higher efficacy than conventional electroded lamps, along with good color.

Keywords: Discharge Lamps

OFFICE OF INDUSTRIAL PROGRAMS

This office supports cost-shared research and development for industrial energy conservation technologies that offer large potential for saving scarce fuels and to encourage the private sector to implement and deploy such technologies as they are developed. Materials research is done in support of the technologies under development or to develop materials with lower embodied energy.

Improved Energy Productivity Division

This division conducts research and creates new energy conserving processes for ore reduction, base metals, and basic shape processing; sensing and control instrumentation; concentration, evaporation, separation, and reaction processes and food production and processing.

57. Corrosion Resistant Amorphous Metallic Films — FY 1985 $ 220,000

DOE Contact - Robert Massey, 202-252-2079
JPL Contact - Dennis Fitzgerald, 818-577-9079

A technology is being developed for depositing amorphous metallic films having high corrosion resistance on carbon steel shapes of industrial interest. Magnetron sputtering is being used to deposit mixtures of MoRuB and FeCrPC. The objective is to provide a material of construction that will reduce the impact of corrosion on heat transfer, equipment maintenance and capital cost.

Keywords: Coatings and Films, Sputtering, Corrosion

58. Investigation of Material for Inert Electrodes in Aluminum Electrodeposition Cells — FY 1985 $ 267,000

DOE Contact - M.J. McMonigle, 202-252-2087
MIT Contact - J.S. Haggarty, 617-253-3300

Materials being tested are ceramics (TiB_2, LaB_6, $NiO-NiFe_2O_4$). Laser units are being used to generate ultra pure powders and single crystals of candidates. Electrical conductivity and rate of solution tests in cryolite melts will be run. Data will characterize these materials and lead to better candidate materials for inert anodes and stable cathodes.

Keywords: Ceramics, Material Science, Aluminum, Cryolite

59. Diagnostic Sources of Current Inefficiency in Industrial Molten Salt Electrolytic Cells by Raman Spectroscopy — FY 1985 $ 112,000

DOE Contact - M.J. McMonigle, 202-252-2087
MIT Contact - D.R. Sadoway, 617-253-3300

Cryolite, aluminum chloride, and magnesium chloride melts will be analyzed with Raman spectroscopy to determine bath chemistry during electrolysis. Identification of molten species will lead to identification of process chemical steps and possible sources of current efficiency losses.

Keywords: Molten Salts, Cryolite, Aluminum Chloride, Magnesium Chloride

60. <u>Diagnostic Sources of Current Inefficiency in Industrial Molten Salt Electrolytic Cells by Raman Spectroscopy</u> <u>FY 1985</u>
$ 100,000

DOE Contact - M.J. McMonigle, 202-252-2087
PNL Contact - Pat Hart, 509-375-2906

Potential anode materials to be tested are: cermets of Ni-Fe spinels with copper additions, metal alloys, and noble metal alloys. Raman spectroscopic techniques will be used to identify surface reactions and limiting current density. Electrochemical techniques will determine rates of metal phase dissolution.

Cathode work will center on T_1B_2 failure mechanisms and attachment techniques.

Keywords: Ceramics, Cryolite, Material Science, Aluminum

61. <u>Rapid In-Situ Analysis of Molten Metal</u> <u>FY 1985</u>
$ 51,400

DOE Contact - J.C. Fulton, 202-252-8668
LANL Contact - L. Blair, 505-667-6250

Material of tests is liquid steel. A laser-based system for spectrographic analysis of samples is being developed. The steel industry needs a faster analytical method to increase productivity. Problems relate to the type of laser and the thermal diffusion in the liquid. A system for use in steel refining is expected.

Keywords: Chemical Analysis, Liquid Steel, Laser, Spectrographic Analysis

62. <u>Direct Measurement of Thermal State of Solids</u> <u>FY 1985</u>
$ 169,000

DOE Contact - J.C. Fulton, 202-252-8668
PNL Contact - Douglas Lemon, 509-375-2306

Materials tested are steels. An ultra-sonic device is being used to determine the temperature distribution in a piece of steel slab or in a recently poured ingot. The steel industry needs the instrument for measurement of heat content of hot slabs or ingots before entering reheating furnaces. It will control the reheating schedule according to heat content. Problems include calibration of various steel alloys for response to ultra-sonic signal. Development of an instrument is expected.

Keywords: Temperature Distribution, Ultra-sonics, Physics, Heat Transfer, Metallurgy, Steel

OFFICE OF TRANSPORTATION SYSTEMS

The Office of Transportation Systems has established a number of programs to conserve energy used for transportation and to shift transportation energy demand to nonpetroleum fuels.

The Vehicle Propulsion Technology Development program is underway to provide industry with proof-of-concepts for advanced gas turbine and Stirling engine technologies that demonstrate improvements in fuel efficiency and to develop technology for heavy-duty diesel operation under uncooled minimum friction conditions, including waste heat utilization.

The Advanced Materials Development program's objective is to establish an industrial technology base capable of providing reliable and cost-effective structural ceramics for application to advanced heat engines. Project management responsibility for the Heat Engine Highway Vehicle Systems project (gas turbine and Stirling engines) and the Heavy Duty Transport Technology project (diesel engine) has been delegated to the NASA Lewis Research Center. Project management of the Ceramic Technology for Advanced Heat Engines project (Advanced Materials Development program) has been assigned to the Oak Ridge National Laboratory (ORNL). The Army Materials and Mechanics Research Center (AMMRC) support is part of the Ceramic Technology project under ORNL technical management.

The success of these advanced heat engine systems depends strongly on the development of new or improved materials. Ceramic materials are needed for the hot-flow-path components of the advanced gas turbine and the minimum friction adiabatic (uncooled) diesel engines, to meet operating temperature and manufacturing cost requirements. The Stirling engine requires low-cost iron-based alloys capable of operating at high temperatures while exposed to high-pressure hydrogen. Material technology development programs are underway for each of these heat engine systems. The generic ceramic technology program consists of three general topics: materials and processing; data base and life prediction; and design methodology. To support the advanced material work conducted under this and other research programs, a High Temperature Materials Laboratory (HTML) is being constructed at ORNL.

Key elements of each program are organized and described briefly in the following. Robert B. Schulz is the DOE contact, (202) 252-8055, for overall coordination of the following Office of Transportation Systems material projects.

63. Powder Characterization — FY 1985: $ 31,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - E.L. Long, Jr., 615-576-5172
MIT Contact - H.K. Bowen, 617-253-6892

The four areas to be investigated include solution chemistry, laser vapor chemistry, organometallic chemistry, and other novel techniques.

Specific goals and plans for this work are reviewed by an MIT-developed industrial consortium at regular meetings at MIT.

Keywords: Structural Ceramics, Powder Synthesis, Powder Processing

64. Silicon Carbide Powder Synthesis — FY 1985 $ 110,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - E.L. Long, Jr., 615-574-5172
SOHIO/Carborundum Contact - John Halstead, 716-278-2330

Gas phased reactions in a plasma reactor have been selected after a review of the powder synthesis flow sheets described in the competitive proposals.

Keywords: Silicon Carbide, Sintering, Structural Ceramics

65. High Pressure Sintering Furnace — FY 1985 $ 80,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832
AMMRC/GEO Contact - George E. Gazza, 617-923-5408

The objective of this project is to determine development compositions and process conditions for sintering of silicon nitride.

Keywords: Sintering, Silicon Nitride, High Pressure

66. Si_3N_4 Powder Synthesis — FY 1985 $ 110,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - E.L. Long, Jr., 615-574-5172
Ford Motor Co. Contact - Gary M. Crosbie, 313-574-1208

A subcontractor for Si_3N_4 synthesis is being selected.

Keywords: Silicon Nitride, Powder Synthesis, Engines

67. Sintering of Si_3N_4 — FY 1985 $ 70,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832
AMMRC Contact - R.N. Katz, 617-923-5415

This project uses post-heat Si_3N_4 treatments to increase the viscosity of phases produced by sintering Si_3N_4 with Y_2O_3/Al_2O_3 additions. Also under investigation is high N_2 over-pressure either directly or using a two-step technique.

Keywords: Silicon Nitride, Sintering, High Temperature Service

68. Dispersion Toughened Silicon Carbide

FY 1985
$ 77,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - V.J. Tennery, 615-574-5123

Procurement of materials is being completed. Tooling processing development and specimen fabrication will then commence.

Keywords: Dispersion Toughness, Silicon Carbide

69. Dispersion Toughened Si_3N_4

FY 1985
$ 38,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - Mark Janney, 615-574-4281
GTE Laboratory Contact - Han Kim, 617-466-2742

The objective of this project is to develop a silicon nitride matrix composite based on a commercial GTE material with SiC and other particles or whiskers dispersed in the matrix. The material will be characterized and a low-cost, near-net-shape process (injection molding) for fabricating CATE turbine blades will be developed.

Keywords: Toughness, Near-net-shape Processing, Whiskers, Particulates, Si_3N_4 Matrix

70. Dispersion Toughened Si_3N_4

FY 1985
$ 35,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - T.N. Tiegs, 615-574-5173
AiResearch Casting Co. Contact - M.V. Mitchell, 213-618-7441

Standard powder processing specifications will be used. Hot pressing, sintering, and/or HIPing will be used for final consolidation. Material will be characterized. A low cost slip casting process will be developed.

Keywords: Structural Ceramics, SiC Whiskers, Hot Pressing, Hot Isostatic Pressing, Near-net-shape Processing

71. Dispersion Toughened Si_3N_4

FY 1985
$ 35,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - T.N. Tiegs, 615-574-5173
Rocketdyne Contact - J.R. Wooten, 818-710-5972

The objective of this project is to develop a transformation-toughened silicon nitride composite based on commercially available silicon nitride powder and a hafnia-rich mixed oxide for retention of strength and toughness at high temperature.

Keywords: Silicon Nitride Matrix, Composite, Near-net-shape Processing, High Temperature

72. Advanced Transformation Toughened Oxides — FY 1985 $ 160,000

DOE Contact - Robert B. Schulz, 202-252-8055
AMMRC Contact - R.N. Katz, 617-923-5415
University of Michigan Contact - T.Y. Tien, 813-764-9449

The purpose of this project is to identify promising sintering conditions and microstructures for optimization of alumina for use in adiabatic diesel engines.

Keywords: Transformation Toughness, Sintering, Engines, Oxides

73. Procesing of Improved Transformation-Toughened Ceramics — FY 1985 $ 100,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - P.F. Becher, 615-574-5157
Norton Co. Contact - C.A. Ebel, 617-853-1000, ext. 2351

The mechanical property goals are:

	Temperature, Degrees C			
	22	500	750	1000
• Fracture Strength, MPa	600	500	500	500
• Fracture Toughness, MPa $m^{1/2}$	8			6

- Room temperature strength and toughness retained after aging at 1000 degrees C.
- Thermal conductivity greater than 0.1 W/cm at T greater than 400 degrees C.

Keywords: Transformation-Toughened, Sintering, Diesel Engines, Powder Synthesis

74. Injection Molded Composites — FY 1985 $ 200,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - M.A. Janney, 615-574-4281

The objective of this project is twofold: (1) demonstration of a complex shape forming capability for Al_2O_3-SiC whisker composites, utilizing wax- or polymer-based binder to injection mold test bars; and (2) development of complex shape forming techniques which improve on wax- or polymer-based molding techniques currently in use.

Keywords: Injection Molding, Composites, Binders, SiC Whiskers

75. Sol Gel Oxide Powder — FY 1985 $ 100,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - W.D. Bond, 615-574-5123

Chemical conditions governing homogeneity of zirconia-yttria and hafnia-yttria-alumina will be determined.

Keywords: Transformation-Toughened, Oxide, Sintering, Whiskers, Powder Synthesis

76. <u>Advanced Coating Technology AGT</u> — <u>FY 1985</u> $ 100,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832

The objective of this project is the development of an oxidation resistant, adherent coating for SiC and Si_3N_4 that will reduce contact stress among touching static parts. A procurement plan has been developed to locate a qualified subcontractor.

Keywords: Coatings, Films

77. <u>Advanced Coating Technology Diesel</u> — <u>FY 1985</u> $ 200,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832

Adherent, wear-resistant refractory ceramic coatings on metal substrates for use on uncooled diesel engine components will be developed. An industry procurement plan has been prepared.

Keywords: Chemical Vapor Deposition, Adiabatic Diesel Engine, Coatings

78. <u>Active Metal Brazing PSZ-Iron</u> — <u>FY 1985</u> $ 250,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - V.J. Tennery, 615-574-5123

In FY 84, processes were developed and demonstrated for brazing PSZ to nodular cast iron (NCI) at temperatures below 735 degrees C. In FY 85, brazing cycles at 723 and 735 degrees C with 10 minute holds will be qualified for fabricating PSZ/NCI joints in piston quality grade 5506 cast iron; shear strength of braze interfaces will be characterized. In FY 86-87, avenues for improving mechanical properties and lowering the costs of fabricated PSZ/NCI joints will be pursued.

Keywords: Joining Dissimilar Materials, PSZ, Iron Base Alloys, Adiabatic Diesel

79. <u>Ceramic-Metal Joints AGT</u> — <u>FY 1985</u> $ 105,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832

The technology necessary to join advanced gas turbine (AGT) ceramic rotors to high-temperature alloy rotor shafts will be developed. An industry procurement plan has been prepared.

Keywords: Joining, Structural Ceramics, Gas Turbine Engine

80. Diesel Ceramic-Metal Joint Scale-up FY 1985 $ 100,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832

An industry procurement plan has been prepared to extend ORNL-developed technology to larger shapes and to mechanically characterize the joints under appropriate conditions of high temperatures and combustion-product gaseous atmospheres.

Keywords: Joining, Ceramic-to-Metal, PSZ, Iron Base Alloys, Adiabatic Diesel Engines

81. Ceramic-Ceramic Joints AGT FY 1985 $ 100,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832

An industry procurement plan has been prepared to develop strong reliable SiC/SiC and Si_3N_4/Si_3N_4 joints for Advanced Gas Turbine applications.

Keywords: Joining, Ceramic-to-Ceramic, Similar Materials, Silicon Carbide, Silicon Nitride

82. Ceramics for Stirling Engine Applications FY 1985 $ 26,000

DOE Contact - Patrick L. Sutton, 202-252-8012
NASA LeRC Contact - Tom Herbell, 216-433-6092

The potential of several candidate ceramics for application to Stirling engines will be assessed, concentrating on investigation of mullite whose properties appear to be ideally suited to Stirling engine applications, especially in high strength applications.

Keywords: Ceramics, Mullite, Stirling Engine, Silicon Carbide, Silicon Nitride

83. Materials Development - Intermetallic Evaluation FY 1985 $ 48,000

DOE Contact - Patrick L. Sutton, 202-252-8012
NASA LeRC Contact - Joseph R. Stephens, 216-433-3195
Case Western University Contact - Krishna Vedula, 216-368-4121

The advantage of intermetallic compounds is their lightweight, good oxidation resistance and resistance to hydrogen permeation, and potential strength at required temperatures. Research is being performed on developing processing methods, alloying techniques, and other possible matrix modifications of equatomic alumindes of iron and nickel which will improve low temperature ductility. Part of the effort will include a grant-funded fundamental study at Case Western University on low temperature deformation mechanisms of Fe-50 atomic Al and Ni-50 atomic Al.

Keywords: Intermetallics, Iron Aluminide, Nickel Aluminide, Material Properties

84. Cast Iron Alloy Containing Nonstrategic Elements — FY 1985 $ 150,000

DOE Contact - Patrick L. Sutton, 202-252-8012
NASA LeRC Contact - C.M. Scheurman, 216-433-3199
United Technologies Research Center Contact - F.D. Lemkey, 203-727-7318

An alloy based on Fe-Cr-Mn(mO)-Al-C(N) system containing asymmetric iron solid solution matrices reinforced by finely dispersed carbide (carbonitride) phases will be identified. These alloys will be fabricated for use in Stirling engine cylinder and regenerator housings.

Keywords: Iron Based Alloys, Stirling Engines

85. High Temperature Coating to Reduce Contact Stress — FY 1985 $ 150,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832
Garrett Turbine Engine Co. Contact - Y. Schienle, 602-231-4666

After receiving ZrO_2-20% Y_2O_3, electron beam physical vapor deposition coatings and exposure to static oxidation (1200-1400 degrees C), RBSN, SSN, SSC specimens were subjected to four-point flexure tests and coating evaluation. In FY 1985, task two was revised to "Advanced pre-treatment and coating study" with seven subtasks including oxidation, oxygen diffusion barrier, high purity interlayer, diffusion/graduation zone, coating variation, surface preparation, and mullite coating.

Keywords: Coating, High Temperature ZrO_2, Physical Vapor Deposition, Silicon Carbide, Silicon Nitride

86. Dynamic Interface — FY 1985 $ 110,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - E.L. Long, Jr., 615-574-5172
Battelle Columbus Labs Contact - Keith Dufrane, 614-424-4618

Specimens of a monolithic ceramic, ceramic coatings and chrome plated coatings will be obtained from commercial vendors for testing in a diesel engine environment. Specimens will be tested with a wear testing machine that simulates the sliding action and environment of an adiabatic engine. A wear model will be developed.

Keywords: Tribology, Coatings, Adiabatic Diesel Engine Wear

87. Advanced Statistical Calculations — FY 1985: $ 40,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - W.P. Eatherly, 615-574-5220

This project is investigating the use of Weibull statistics to represent data to characterize the strength of structural ceramics. Non-failure tolerance limites for the ceramic material will be established.

Keywords: New Concepts, Fracture, Advanced Statistics, Brittle Material

88. Advanced Statistics Calculations — FY 1985: $ 100,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - W.P. Eatherly, 615-574-5220
General Electric Research Lab Contact - C.E. Johnson, 518-385-8649

A literature review to assess current state-of-the-art statistics techniques will be performed. Analytic methods and algorithms before initiating Monte Carlo calculations will be developed. Concurrently, studies on fracture position and time-dependent materials will be undertaken.

Keywords: New Concepts, Advanced Statistics, Fracture, Brittle Material

89. Design Allowables Code — FY 1985: $ 130,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832
AMMRC Contact - E.M. Lenoe, 617-923-5427

The objectives of this project include building the AMMRC computer code for characterizing experimental strength data, determining design allowables, and interfacing with a finite element analysis code. The code will be developed and improved to accommodate the required advanced statistical concepts.

Keywords: New Concepts, Advanced Statistics, Brittle Material

90. Failure Analysis — FY 1985: $FY 84 carry-over

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832
National Bureau of Standards Contact - Nancy J. Tighe, 301-921-2901

An interagency agreement will be placed with the National Bureau of Standards for this analysis. Analysis shall include electron microscopy and small angle neutron diffraction scattering.

Keywords: Environmental Effects, Microstructure, Components, Structural Ceramics

91. Characterization of Transformation-Toughened Ceramics FY 1985 $ 80,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832
AMMRC Contact - R.N. Katz, 617-923-5415

In FY 1985, the Japanese produced Y2O3-TZP materials for resistance to over-aging at engine temperatures were examined. In FY 1986, heat treatment of Japanese materials will be completed. AMMRC will perform stepped-temperature-stress-rupture and stress-rupture tests. The Japanese materials will be characterized.

Keywords: Fracture Toughness, Time-Dependent Behavior, Transformation-Toughened

92. Cyclic Fatigue of Toughened Ceramics FY 1985 $ 90,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - V.J. Tennery, 615-574-5123

This project involves the design and fabrication of a prototype grip system with self centered features. An evaluation of grips and load train at room temperatures will be completed. Elevated-temperature testing capabilities will be developed and tension-tension fatigue tests on advanced ceramic materials will be conducted.

Keywords: Tensile Strength, Time-Dependent Behavior, Structural Ceramics, Fatigue

93. Fracture Behavior of Toughened Ceramics FY 1985 $ 190,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - V.J. Tennery, 615-574-5123

The objective of this project is to determine key mechanical properties such as fracture strength, fracture toughness, and subcritical crack growth as functions of time and environmental exposure and conduct detailed microscopic analysis of exposed ceramics to determine phase and composition changes. Physical models of the observed toughening behavior of the ceramics will be formulated.

Keywords: Fracture Toughness, High Temperature, Crack Growth, Structural Ceramics, Microstructure

94. Time-Temp Properties of Advanced Ceramics FY 1985 $ 85,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832
AMMRC Contact - N. Katz, 617-923-5415

Stepped temperature stress rupture (4 point bending) tests on specimens (SiC and Si_3N_4) will be performed and tensile testing will be initiated.

Keywords: Flexural Strength, Time-Dependent Behavior, High Temperature

95. Corrosion/Erosion Effects | FY 1985 $ 240,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832

A joint effort with NASA is planned in which AGT ceramic material specimens tested in combustion rigs at NASA Lewis Research Center will be made available to this project for detailed analysis and characterization.

Keywords: Corrosion, Erosion, Microstructures, Gas Turbine Engines

96. Environmental Effects in Toughened Ceramics | FY 1985 $ 125,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - V.J. Tennery, 615-574-5123
University of Dayton Contact - N. Hecht, 513-229-4341

The objective of this project is to determine the water vapor and other environmental degradation processes operative in PSZ and DTA toughened ceramics using the dynamic fatigue measurement technique. Flexure strength will be measured over a wide range of stressing rates, temperature and atmospheric conditions to quantitatively determine relevant fatigue parameters.

Keywords: Fatigue, Transformation-Toughened Ceramics, Flexure Strength, Microstructure, Environmental Effects

97. Static Behavior of Toughened Ceramics | FY 1985 $ 120,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832
University of Illinois Contact - M.K. Ferber, 217-333-1770

This project employs the interrupted static fatigue (ISF) method for determining retained fracture strength of ceramic specimens as a function of stress, time, and temperature. The results of these tests will be analyzed and fatigue life calculated. Microstructural analyses of specimens previously fatigued and fractured will be performed.

Keywords: Fatigue, Fracture Strength, Toughened Ceramics, Microstructure

98. High Temperature Fracture Toughness Measurement | FY 1985 $ 150,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - V.J. Tennery, 615-574-5123
University of Washington Contact - R.C. Bradt, 206-543-2613

In order to determine fracture resistance, critical analysis of known measurement techniques will be performed and new approaches identified. Using selected ceramic material specimens (including beta-SiC, sintered alfa-SiC, sintered Si_3N_4) and two ceramic matrix composites in which the matrix is SiC, Si_3N_4, Al_2O_3, ZrO_2, or MAS, the measurement techniques will be verified.

Keywords: Fracture Toughness, Structural Ceramics, Monolithic Composites, Microstructure

99. High Temperature Tensile Testing — FY 1985 $ 100,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832
N.C. A&T University Contact - J. Sankar, 919-379-7620

The objective of this project is to design and fabricate ceramic specimens, grips, and extensometer. Conventional mechanical testing machines will be used for uniaxial tensile testing which include fast fracture, and static and/or dynamic fatigue and high temperature uniaxial tensile testing of SiC and Si_3N_4 will be done.

Keywords: High Temperature, Fracture Mechanics, Fatigue, Silicon Nitride, Silicon Carbide

100. Standard Tensile Test Development — FY 1985 $ 90,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832
National Bureau of Standards Contact - Sheldon M. Wiederhorn, 301-921-2901

The objective of this project is to construct test fixtures for high temperature tensile testing of sintered SiC to withstand high temperature creep. Experimental creep data on model materials using tensile, compressive, and bending test techniques will be collected and provide test fixtures and test specimens, or their design to collate from laboratories to obtain the degree of interlaboratory scatter expected from creep studies.

Keywords: Tensile Strength, Creep, High Temperature, Structural Ceramics

101. Needs Assessment — FY 1985 $ 80,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D.R. Johnson, 615-576-6832

A draft assessment of the material characterization measurements and techniques needed for manufacturing of reliable ceramic components, based on literature search and internal DOE/ORNL working group meetings will be completed. The draft will be submitted to selected outside reviewers for additional comments.

Keywords: Characterization, Component Qualifications, Nondestructive Evaluation

102. Non-Destructive Characterization

FY 1985
$ 70,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - V.J. Tennery, 615-574-5123

As selected NDE techniques are developed and applied to ceramic specimens (first to monolithic ceramic mechanical test specimens and then ceramic composites) from ORNL and contractor research, comparison of mechanical properties will be made for the purpose of correlation.

Keywords: Non Destructive Evaluation, Property Correlations, Structural Ceramics, Composites

103. Standard Reference Material

FY 1985
$ 110,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832
National Bureau of Standards Contact - Allen Dragoo, 301-921-2901

The domestic powder chosen for characterization as a part of the IEA agreement, Annex II, will be extensively characterized by the National Bureau of Standards and a standard reference powder developed.

Keywords: Technology Transfer, Characterization, Powder, Structural Ceramics

104. Oxide Matrix Composites

FY 1985
$ 345,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - T.N. Tiegs, 615-574-5173

The initial assessment of Al_2O_3 whisker composites will be completed.

Keywords: Oxide Matrix, Composites, Whisker Composites, Silicon Carbide

105. Toughened Ceramics Adiabatic Diesel Engines

FY 1985
$ 147,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - P.F. Becher, 615-574-5157
Ceramatec Contact - Raymond Cutler, 801-486-5071

Toughened ceramics for use in adiabatic diesel engines will be developed via layering chemical compositions to achieve compressive surface stresses.

Keywords: Toughened Ceramics, Diesel Engines, Stresses

106. Fiber Reinforced Silicates

FY 1985
$ 130,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - T.N. Tiegs, 615-574-5173
GE, VFSC Contact - Robert C. Rosenberg, 215-354-1000

The fabrication of mullite-silicon carbide whisker composite specimens by liquid phase sintering process will be completed.

Keywords: SiC Whiskers, Composites, Fibers, Fatigues

107. Adherence Coatings Deposited on Substrates — FY 1985: $ 4,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - C.J. McHargue, 615-574-4344
University of Tennessee Contact - J.E. Stoneking, 615-974-2171

The draft final report will be submitted for publication in the open literature.

Keywords: Adherence Coatings

108. Effects of Translucence on Diesel Engines — FY 1985: $ 43,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D.R. Johnson, 615-576-6382
ITI Contact - T. Morel, 312-789-0003

The objective of this project is the evaluation of the effects of translucence on diesel engines that use ceramics for heat barriers.

Keywords: Structural Ceramics, Translucence, Diesel Engines

109. Materials Characterization Development — FY 1985: $ 130,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D.R. Johnson, 615-576-6832
AMMRC Contact - J.W. McCauley, 617-923-5364

Set quantifiable powder characteristics and properties to measure will be established.

Keywords: Materials Characterization, Powder

110. Computer-Tomography — FY 1985: $ 50,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D.R. Johnson, 615-576-6832
ANL Contact - W.A. Ellingson, 312-972-5068

This project involves X-ray beam hardening correction and calibration development for computer-tomography applications to structural ceramics.

Keywords: Computer-tomography, X-ray Beam Hardening, Structural Ceramics

111. Ceramic Durability Evaluation FY 1985 $ 100,000

DOE Contact - Saunders B. Kramer, 202-252-8012
NASA Contact - Sunil Dutta, 216-433-3282
Garrett Turbine Engine Co. Contact - K.W. Benn, 602-231-4373

Commercially available silicon carbides and silicon nitrides under extended thermal exposures of up to 2500 degrees F for 3500 hours will be evaluated.

Keywords: Time-Dependent Behavior, Silicon Carbide, Silicon Nitride, Gas Turbine Engine, High Temperatures

112. High Temperature Creep Evaluation FY 1985 $ 44,000

DOE Contact - Patrick L. Sutton, 202-252-8012
NASA LeRC Contact - R.H. Titran, 216-433-3200

Creep properties of both commercial alloys and new experimental alloys will be characterized over a temperature range spanning the proposed operating temperature of the Stirling engine. The effects of brazing cycle alloy composition on creep-ruptured properties will be evaluated.

Keywords: Alloy Development, Creep Rupture, High Temperature Stirling Engine

113. Ceramic Corrosion Evaluation FY 1985 $ 60,000

DOE Contact - Patrick L. Sutton, 202-252-8012
NASA LeRC Contact - Carl A. Stearns, 216-433-5500

Silicon carbide and silicon nitride specimens will be tested in a combustion rig simulating engine conditions. The combustion flow will be seeded with various impurities.

Keywords: Ceramics, Silicon Nitride, Silicon Carbide

114. Ceramic Component Technology FY 1985 $ 90,000

DOE Contact - Saunders B. Kramer, 202-252-8012
NASA LeRC Contact - Alex Vary, 216-433-6019

NDE methods under study are x-ray, radiography, ultrasonics, scanning laser acoustic microscopy, thermo-acoustic microscopy.

Keywords: Ceramics, NDE

115. International Exchange Agreement FY 1985 $ 50,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832

The major goal is to foster the development of voluntary consensus standards for ceramic materials for advanced engines and other conservation applications through international cooperation and collaboration with appropriate professional societies.

Keywords: Technology Transfer, International, Structural Ceramics, Advanced Heat Engines

116. Specimens and Hardware for IEA — FY 1985 $ 50,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832

GTE is providing commercially available fine powder and test bars to be characterized under Annex II, IEA agreement with Sweden and West Germany.

Keywords: Technology Transfer, International

117. Technical Support and Monitoring Contracts — FY 1985 $ 250,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832

This task provides expert technical support and technical program monitoring by cognizant researchers who support industrial and university subcontracts.

Keywords: Technology Transfer, Subcontracts, Industry, Universities

118. Technology Assessment and Planning — FY 1985 $ 30,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832

This task involves extensive interaction with private industry, other government laboratories and universities.

Keywords: Planning, Assessment

119. Technology Transfer — FY 1985 $ 120,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - D. Ray Johnson, 615-576-6832

The approach to technology transfer is the involvement of private industry in planning and implementation of the program by means of assessment and coordination activities and by having most of the work done in private industry by means of subcontracts.

Keywords: Technology Transfer, Private Industry, Subcontracts

120. Advanced Gas Turbine Engine Technology (AGT-100) FY 1985
$4,860,000

DOE Contact - Saunders B. Kramer, 202-252-8012
NASA LeRC Contact - P. Kerwin, 216-433-3409
GM/Allison/Pontiac Contact - H.E. Helms, 317-242-5335

The task seeks to demonstrate improved fuel economy, reduced emissions, and alternate fuel capability. Ceramic materials will be developed for most or all of the hot section components. Efforts include material characterizations, process development, and component design and test.

Keywords: Structural Ceramics, Component Design, Monolithic Fabrication, Component Test, Gas Turbine, Rotor, Stator, Combustion

121. Advanced Gas Turbine Engine Technology (AGT-101) FY 1985
$4,900,000

DOE Contact - Saunders B. Kramer, 202-252-8012
NASA LeRC Contact - T.V. Strom, 216-433-3408
Garrett/Ford Contact - E.E. Strain, 612-231-2797

The task seeks to demonstrate improved fuel economy, reduced emissions, and alternate fuel capability. Ceramic materials will be developed for most or all of the hot section components. Efforts include material characterizations, process development, and component design and test.

Keywords: Structural Ceramics, Component Design, Gas Turbine, Rotor, Stator, Combustor

122. HTML Pre-Operational Support FY 1985
$ 160,000

DOE Contact - Anne Marie Zerega, 202-252-8053
ORNL Contact - V.J. Tennery, 615-574-5123

Pre-operational support includes the planning and management activities associated with the construction phase of HTML.

Keywords: High Temperature, User/Facility, Research Laboratory, Construction

123. Capital Equipment for Advanced Materials Development Program
FY 1985
$1,900,000

DOE Contact - Robert B. Schulz, 202-252-8055
ORNL Contact - V.J. Tennery, 615-574-5123

The following equipment will be purchased: NDE X-ray Tomography System, Electron Microscope, Powder Characterization Equipment and Instrumentation, Laser Raman Microscope, Ceramic Test Specimen Machining and Preparation Equipment, Ceramic Injection Molding Unit, Ceramic Hot Isostatic Processing (HIP) Unit.

Keywords: Capital Equipment

OFFICE OF ENERGY STORAGE AND DISTRIBUTION (OESD)

This office supports generic research of a long-term, high-risk, high-payoff nature aimed at stimulating innovation in conservation technology. The research is both broadly based and multi-sectoral, providing a technology base for the other conservation programs. The office covers research in Energy Storage Technology and Electric Energy Systems.

Energy Storage Technology

The principal function of the OESD is to foster more efficient and more economical use of intermittent energy sources. A vital part of this R&D effort is the development of new and improved materials. Activities include materials development, fabrication, characterization and compilation of data bases. Described below are the materials R&D efforts of the four subprograms of the Division: Batteries and Electrochemistry; Chemical and Hydrogen Storage; Thermal Storage; and Mechanical Energy Storage.

124. Ceramics Research

FY 1985
$1,000,000

DOE Contact - A. Landgrebe, 202-252-1483
LBL Contact - E. Cairns, 415-486-5028
SNL Contact - R. Clark, 505-844-6332

Sodium/sulfur and lithium/iron sulfide batteries operate at temperatures of several hundred degrees C. Materials for current collectors, separators, seals, and coatings to prevent corrosion are of concern. New superconducting ionic materials are being developed. Of special importance is the development of processing techniques to toughen beta alumina electrolytes and to make parts with more reproducible properties for use in sodium/sulfur batteries.

Keywords: Alloy Development, Alternate Materials, Corrosion, Joining Methods, Fast Ion Conductors and Solid Electrolytes, Batteries

125. Metals and Alloys

FY 1985
$900,000

DOE Contact - A. Landgrebe, 202-252-1483
LBL Contact - E. Cairns, 415-486-5028
LLNL Contact - 415-422-8575

Aluminum alloys are being prepared and characterized for use as negative electrodes in aluminum/air batteries. Alloys of platinum are being studied for use as electrocatalysts in fuel cells and aluminum/air batteries.

Keywords: Alloy Development, Alternate Materials, Batteries

126. Organometallic Compounds

FY 1985
$ 300,000

DOE Contact - A. Landgrebe, 202-252-1483
Eltech Systems Corporation Contact - L. Gestaut, 216-357-4041

Macrocyclic compounds of transition metals are being investigated for use as electrocatalysts for use as air electrodes in fuel cells, and in aluminum/air and iron/air batteries.

Keywords: Alternate Materials, Fuel Cells, Batteries

127. Polymers — FY 1985 $ 180,000

DOE Contact - A. Landgrebe, 202-252-1483
LBL Contact - E. Cairns, 415-486-5028
Univ. of Pa. Contact - G.C. Farrington, 215-898-5000

Electronically and ionically conducting polymers are being synthesized, prepared as films, and characterized for use as electrodes and electrolytes in storage batteries and fuel cells.

Keywords: Polymers, Fast Ion Conductors and Solid Electrolytes, Batteries

128. High Temperature Water Electrolysis — FY 1985 $ 200,000

DOE Contact - M. Gurevich, 202-252-1507
Westinghouse R&D Center Contact - E. Buzzell, 412-256-1952

Progress in FY 1985 included the introduction of structural and compositional changes into the HTE cell cathode resulting in improved overall cell performance. The rate limiting reaction mechanism at the cathode was identified and dopants were introduced to enhance mixed conductivity (ionic-electronic) offsetting these limitations. Cells have been operated at up to 90% conversion rates of steam to H_2 and O_2 with voltage-current density showing log linear behavior. Future work will address the intercell connect design and its optimization.

Keywords: Solid Oxide Electrolytes, Ceramics, Surface Characterization, Energy Storage and Conversion, Hydrogen Production

129. Hydrogen Embrittlement of Pipeline Steels — FY 1985 $ 45,000

DOE Contact - M. Gurevich, 202-252-1507
Battelle Columbus Laboratories Contact - John Holbrook, 614-424-4347

Investigations at Battelle and Brookhaven have further quantified H_2 embrittlement effects on pipeline steels under expected operating conditions and have also identified gaseous additives that can inhibit these effects. Recent testing has shown that fatigue crack growth is accelerated in hydrogen especially under high stress conditions and that sustained load subcritical crack growth can be a problem if hard spots are present in the pipeline. Oxygen, sulfur dioxide and carbon monoxide have been shown to provide strong inhibition or elimination of the above effects. The current thrust of the Battelle work is aimed at fully defining the mechanism of inhibition with the goal of identifying more practical additives without inherent environmental or institutional problems.

Keywords: Metals, Fatigue, Hydrogen Effects, Energy Transmission

130. Hydrogen Technology Evaluation Center

FY 1985
$ 100,000

DOE Contact - M. Gurevich, 202-252-1507
BNL Contact - P.D. Metz, 516-282-3123

A cost/economic characterization of a photovoltaics/ advanced electrolyzer (15 kW) interface for hydrogen production based on one year's operation in various system modes was completed.

The evaluation of a small metal hydride hydrogen compressor operating in the closed loop mode was completed and a report was issued by MIT Chemical Engineering Practice School Group.

A test program was initiated to evaluate a second metal hydride hyrdogen compressor (3 SFCM) operating in the open loop mode with hydrogen provided by the advanced technology electrolyzer (GE SPE). This project was a joint effort involving EPRI, PSE&G, Ergenics, Inc., and BNL.

Keywords: Hydrides, Polymers, Energy Storage, Hydrogen Production

131. Medium Temperature Solid Electrolytes: Proton Conductors

FY 1985
$ 125,000

DOE Contact - M. Gurevich, 202-252-1507
BNL Contact - F. Salzano, 516-282-4458

This is a collaborative effort between BNL and the Politecnico di Milano which is looking at several classes of materials for use as proton conducting electrolytes. Work in 1985 involved developing similar facilities at both laboratories in order to make comparative conductivity measurements. Aluminum phosphate and barium sulfate have now been characterized and show a pressure/ temperature dependence of conductivity as a function of material compaction density. Future work will involve a mechanistic study of ion conduction in highly stable salts in the 300-600°C range as well as looking at alternative electrolytes including " alumina fabricated in a parallel program at the University of Pennsylvania.

Keywords: Solid Electrolytes, Ceramics, Microstructure, Hydrogen Production

132. Anode Depolarization Studies

FY 1985
$ 15,000

DOE Contact - M. Gurevich, 202-252-1507
Texas A&M University Contact - J. Bockris, 713-845-5335
BNL Contact - F. Salzano, 516-282-4458
University of Virginia Contact - G. Stoner, 804-924-3277

The objective has been to investigate whether an anode depolarizing agent could be used to reduce the overvoltage required to produce hydrogen (to within the 1.0 volt range) at the same time producing an alternate (valuable) product at the anode. The original investigations looked at coal and coal derivatives as the depolarizing agent, but the activity or current densities achievable were extremely low to the point of being impractical. Texas A&M completed a study characterizing the anodic products and reaction kinetics.

The BNL work was directed at identifying redox couples that could provide a two-step reaction sequence to accomplish the desired depolarizing effect followed by selective oxidation of a suitable organic material. The specific system being studied is the oxidation of toluene to benzoic acid using the Ce (III)/Ce (IV) redox couple of the anodic products based on coal, coal derivatives and waste products.

The University of Virginia work is directed at the upgrading of hydrocarbons via the conversion of alkanes to alcohols in electrochemical reactions involving depolarizing agents. The work is currently focused on an acetic acid/sulfuric acid electrolyte system using propane as a depolarizing agent to help define the basic process and reaction sequence.

Keywords: Organics, Transformation, Hydrogen, Alternate Fuels

133. <u>Materials for Advanced High-Temperature Molten Salt Storage</u>

<u>FY 1985</u>
$ 25,000

DOE Contact - M. Gurevich, 202-252-1507
SERI Contact - B. Goodman, 303-231-1005

Under subcontract to SERI, Rockwell International, in conjunction with their high temperature storage concept, conducted five-hundred-hour material corrosion tests on Incoloy 800, Inconel 600, and Nickel 201. The tests were run with part of the specimen submerged in molten carbonate salt and part of the specimen exposed to the salt vapor phase. Incoloy 800 and Inconel 600 demonstrated much better performance in the salt vapor phase than Nickel 201. In general, the corrosion rates were much higher than expected, in the range of 1mm/year to 6mm/year for these three alloys.

Keywords: Carbonate Salt, Corrosion, Alloys

134. <u>Water Electrolysis with Protonic β'' Alumina Electrochemical Cells</u>

<u>FY 1985</u>
$ 150,000

DOE Contact - M. Gurevich, 202-252-1507
University of Pennsylvania Contact - G. Farrington, (215) 898-8337

Research is addressing the preparation and evaluation of proton (or hydronium ion) conducting membranes suitable for use in medium temperature (300-600^{o}C) vapor electrolysis. Efforts to date have been concerned with the preparation of the hydronium " alumina crystals which involves a vapor phase ion exchange process with the sodium material. Initial investigations are aimed at characterizing the thermal behavior and stability of the hydronium material as a function of water vapor pressure, temperature and particle size. The system being studied is of the neodymium-ammonium-hydronium form with the neodymium used to block certain lattice sites allowing for proton conductivity. Assuming acceptable conductivity can be obtained, future work will address alternate methods to produce multi-crystalline material for use in cells.

Keywords: Fast Ion Conductors/Solid Electrolytes, Structure, Hydrogen Production

135. Metal-Assisted Cold Storage (MACS) of Hydrogen on Activated Carbon

FY 1985
\$ 140,000

DOE Contact - M. Gurevich, 202-252-1507
Syracuse University - J. Schwarz, 315-423-2807

The cryoadsorption of hydrogen on surface-modified activated carbon has been examined on a microscale at liquid nitrogen temperatures and pressures up to 1 atm absolute. Test results have shown that up to 2.2 wt % hydrogen can be stored on carbon coated with 5 wt % platinum catalyst at 77°K and 1 atm. Other carbons with higher surface area and greater alkalinity (uncatalyzed) have shown potentially higher storage capacities. Syracuse has recently scaled up and operated the macrobalance apparatus that will permit verification of the earlier results at a 100-fold increase in sample size and pressure. Subsequent work will involve identifying the optimum carbon/catalyst system that would be useful in the operating temperature-pressure ranges appropriate to a vehicle application.

Keywords: Hydrogen Storage, Catalysts

136. Hydrogen Production with Photoactive Semiconductor Catalysts

FY 1985
\$ 160,000

DOE Contact - M. Gurevich, 202-252-1507
Battelle Columbus Laboratories Contact - R. Schwerzel, FTS 976-5637

Research is being conducted to determine whether significant improvements in the performance of photoactive semiconductor catalysts for hydrogen production can be realized using metallized plasma-polymerized films. The main problem being addressed is to obtain films of suitable transparency and conductivity that exhibit stable long life, and are compatible with the semiconductor band gap requirements for photo-assisted electrolysis. The plasma-polymerization process is unique and allows for a variety of film properties not obtainable with conventional polymers. A metal/organic monomer combination of gold and Teflon has proved suitable for initial tests. Characterization of a number of single-crystal and powdered photocatalysts will be done using the advanced coatings prior to conducting the aqueous electrolysis experiments.

Keywords: Semiconductors, Catalysis, Plasma Synthesis, Coatings and Films

137. Electrochemical Techniques for H_2 Storage in Metal Hydrides

FY 1985
$ 50,000

DOE Contact - M. Gurevich, 202-252-1507
Stanford University Contact - R. Huggins, 415-497-4110

Stanford has developed a non-aqueous technique for investigating the electrochemical control of hydrogen absorption/desorption in metal alloys. The initial system studied involved a low melting organometallic salt ($NaAlEt_4$) saturated with NaH in which the H- ions act as hydrogen transmitters. The alloys used were Mg-Cu, Mg-Ni and MgAl which formed hydrides at 170°C and applied voltages of 200-300mV. While the feasibility of this approach was proven, the kinetics of the overall reaction were too slow for any practical system. Additional studies were done with a KBr/LiBr/LiF eutectic compound serving as an electrolyte. This system, while providing higher ionic conductivity, had some problems with side reactions. Stanford will continue to investigate alternate systems aiming for compatibility between electrolytes, H- ion carrier, alloy electrodes and useful operating P-C-T conditions.

Keywords: Hydrides, Hydrogen Storage

138. Advanced Hydrogen Storage - Modified Vanadium Hydrides

FY 1985
$ 125,000

DOE Contact - M. Gurevich, 202-252-1507
Allied Corporation Contact - G. Libowitz, 201-455-4571

Allied is investigating the general family of modified vanadium hydrides which are easily activated and can take up to 3.8 to 4.0% hydrogen by weight. Desorption of the hydrogen at conditions compatible with practical applications as well as cost of the pure vanadium are the problems being addressed. These are monohydride-dihydride systems and the approach is to try and bring the two P-C-T plateaus closer together by the addition of substitutional metals such that the hydrogen can be desorbed at pressures above 1 atm at temperatures in the 175°C range. Systems being studied include V-Ti-Fe, and V-Ti-Fe-Mn. It was hoped an optimum V-Ti-Fe compound would be identified that would permit the use of low-cost ferrovanadium ore with minimal processing. Research thus far has shown that while some adjustment of the isotherms is possible, the addition of amounts of Fe above a certain level reduces storage capacity to well below the 4% level limiting the prospects of the approach.

Keywords: Hydrides, Metals, Hydrogen Storage

139. Analysis of Zeolite Augmented Ice Storage

FY 1985
$ 5,000

DOE Contact - Eberhart Reimers, 202-252-5855
PNL Contact - Landis Kannberg, 509-375-3919

A facility is being constructed to test the concept of using solar regenerated zeolites for augmenting the chill obtained from seasonally stored ice by using the heat of sublimation rather than simply the heat of fusion. The facility is being constructed at the New Mexico Solar Energy Institute and will involve the night time sublimation ice for generating chilled water for space cooling the next day. During the day the zeolite is dessicated by heating with solar energy. Testing includes evaluation of the cyclic absorptive capacity of several types of zeolites and the performance of various zeolites under widely varying operating conditions.

Keywords: Transformation, Microstructure, Diffusion

140. Geochemical Stability of Sandstones — FY 1985 $ 15,000

DOE Contact - Eberhart Reimers, 202-252-5855
PNL Contact - Landis Kannberg, 509-375-3919

Laboratory testing is being conducted to determine the effects of flow at 150 degrees C water of varying water quality through porous sandstones, primarily the Ironton/Galesville sandstone from St. Paul, Minnesota. The testing is being used to determine the degree and rate of changes in sandstone hydraulic and mechanical properties as a result of mineral dissolution and precipitation that occurs when hot chemically altered fluids flow through the sandstone. The testing is being conducted in conjunction with field testing at St. Paul, Minnesota. Results will be used to determine the degree and type of water treatments required to control geochemical alteration of rock properties.

Keywords: Strength, Microstructure, Cements

141. Composite High Temperature Thermal Storage Media — FY 1985 $ 150,000

DOE Contact - Eberhart Reimers, 202-252-5855
IGT Contact - Randy Petri, 312-567-3985

The objective of this project is to develop a prototype fabrication process for impregnating ceramic powder (MgO, $NaALO_2$, $LiAlO_2$) with carbonate salts (eutectic mixtures of Na, Ba, Li and K) to form a thermal storage pellet which retains some compressive strength (because of surface tension forces) when the salt is melted. This allows a packed bed, direct contact heat storage material with storage in latent as well as sensible heat. Physical and chemical studies are performed of the prototype pellets and thermal cycling to determine weight and strength loss over product life. Problems of powder size, method of fabrication, chemical reactions with heat exchange gases, strength, loss of weight, composite heat capacity, and safety and toxicity issues are addressed. It is expected that a pellet fabrication process to produce a successful 710 degrees C and possibly a 858 degrees C storage media will be developed.

Keywords: Composites, Materials Characteristics

142. Formation of Encapsulated Metallic Eutectic Thermal Storage Alloy

FY 1985
$ 50,000

DOE Contact - Eberhart Reimers, 202-252-5855
Ohio State University Contact - Prof. Robert Rapp, 614-422-2491

The purpose of this project is to develop a prototype fabrication process for encapsulating carbonate salt pellets with a metallic coating to form a thermal storage pellet which retains some compressive strength (because of tension forces) when the salt is melted. This allows a packed bed, direct contact heat storage material with storage in latent as well as sensible heat. An effective way of producing pellets in mass and of the right size and uniformity is being studied. A pellet fabrication process to produce a storage media in the range of 700 - 800 degrees C is under development.

Keywords: Composites, Materials Characteristics

143. Solid State Radiative Heat Pump

FY 1985
$ 50,000

DOE Contact - Eberhart Reimers, 202-252-5855
LBL Contact - Roland Otto, 415-486-5289

The objective of this project is to evaluate the feasibility of the solid state radiative heat pump concept. This concept employs a large-area thin-film semiconducting device to convert thermal energy to infrared heat radiation (heating), and vice versa (cooling), utilizing input electricity. The theoretical evaluation is to be based on the fundamental solid state physics of narrow-band semiconductors. Experimental research is to be focused on identification of promising materials and measurement of their relevant properties. One such material under investigation is indium antimonide (InSb). The approach is to start with an analysis of ideal photo-diode equations. For specific diode voltages, the radiative heat transfer can be calculated as a function of wavelength. Measurement of thermal radiation emission as a function of electric and magnetic field intensity and polarity will be carried out on the candidate semiconductor materials.

Keywords: Catalyst, Metals, Semiconductors, Microstructure, Transformation, Surface Characterization and Treatment, Energy Storage

144. Use of Micro Particles as Heat Exchangers and Catalysts

FY 1985
$ 50,000

DOE Contact - Eberhart Reimers, 202-252-5855
LBL Contact - Roland Otto, 415-486-5289

The focus of this project is on the issue of heat transfer between particles and gas since this was identified as important in understanding a broad range of energy storage and conversion systems. The first objective of the project was to investigate heat transfer mechanisms as a function of particle size and state of the gas. The goal of this study is to determine under what circumstances the particle temperature is moderately independent of the gas temperature and conversely those conditions when the particle temperature is "pinned" to the gas temperature. These two examples define the extremes in particle temperature and therefore delineate the range of applications of the process. Studies of the steady state heat fluxes in radiantly heated particle suspensions were initiated. Simplified analytic solutions of the heat transfer between very small particles and gas were formulated. These analytical solutions facilitated rapid evaluation of the factors influencing the steady state temperatures and heat transfer rates between radiantly heated particles and the gas. Experiments include using iron, iron oxide particles, and carbonaceous particles in conjunction with possible reversible gas phase energy storage reaction couples such as SO_2/SO_3.

Keywords: Catalyst, Metals, Semiconductors, Microstructure, Transformation, Surface Characterization and Treatment, Energy Storage

145. <u>Formation and Dissolution of Gas Clathrates</u> <u>FY 1985</u> $ 50,000

DOE Contact - Eberhart Reimers, 202-252-5855
ORNL Contact - Jim Martin, 615-574-3784

This project is investigating the conditions required for cyclic formation and dissolution of gas clathrates for cool thermal energy storage for air conditioning applications. Specifically, gas clathrates of common refrigerants are under investigation so that residential and commercial heat pump cool storage with direct contact heat transfer between the refrigerant and the storage media (the clathrate) is achieved. This class of inclusion compounds can provide a "warm ice" which provides cool storage at thermodynamically more efficient temperatures 15 - 20 degrees F above ice freezing temperature and with a latent heat of fusion approaching that of ice. In a laboratory scale test loop, the conditions of a heat pump/cool storage system are being achieved so that rates of formation, water/refrigerant mixing requirements, clathrate phase diagram data, and practical heat pump problems imposed by use of this storage media can be experimentally studied. It is expected that the preliminary favorable economics of this storage system will be modified by realistic requirements for a prototypical system as a result of this program.

Keywords: Clathrates, Materials Characteristics

146. <u>Evaluation of Advanced Thermal Energy Storage Media</u>

<u>FY 1985</u>
$ 250,000

DOE Contact - Eberhart Reimers, 202-252-5855
ORNL Contact - J. F. Martin, 615-576-3977

The purpose of this research is to develop dual temperature TES media for heat and cool storage and to evaluate heats of mixing and crystallization in multicomponent solutions. Clathrates suitable for dual temperature storage are being identified through molecular modeling with the use of a computer. In addition, phase behavior of selected singly-complexing and multiply-complexing ammoniated salts in phase regions appropriate to dual temperature storage are being determined.

Keywords: Clathrates, Materials Characteristics

Electric Energy Systems Division

The EES program supports R&D to expedite the development of high-risk, long-term payback technologies which have a significant potential for improving the reliability, efficiency, and safety of the nation's electrical energy system. Research is also conducted in technologies for integrating new electrical energy sources (dispersed generation and storage) into the grid.

147. High-Voltage Breakdown Strengths of Insulating Gases and Liquids
FY 1985
$ 520,000

DOE Contact - Russell Eaton, 202-252-4844
ORNL (Contract No. W-7405-eng-0026) Contact - Lucas Christophorou, 615-574-6199

The factors influencing the breakdown strengths of gaseous and liquid dielectrics are being analyzed from a fundamental physiochemical point of view. Mixtures of gases with superior insulating properties are being sought.

Keywords: Insulators (Gaseous), Energy Transmission

148. Factors Influencing Aging in Extruded Dielectrics FY 1985
$ 150,000

DOE Contact - Russell Eaton, 202-252-4844
Battelle-Columbus Contact - Mike Epstein, 614-424-6424

Develop an understanding of the factors influencing aging of extruded dielectrics used for underground transmission cable systems. Several advanced techniques will be applied either simultaneously or sequentially to help identify aging mechanisms. These techniques include thermally stimulated currents, mechanical spectroscopy, and differential scanning calorimetry.

Keywords: Insulators, Organic Polymers, Energy Transmission

149. Threshold and Maximum Operating Electric Stresses for Selected High Voltage Insulations FY 1985
$ 150,000

DOE Contact - Russell Eaton, 202-252-4844
Cable Technology Lab. (Contract No. DE-AC02-80RA50156) Contact - Carlos Katz, 201-846-3220

The objective of this project is to determine threshold voltages and maximum operating electric field strengths for selected high voltage insulation systems. Threshold voltages will be used to predict long range performance of cables and other insulation systems.

Keywords: Insulators, Aging, Energy Transmission

150. Multifactor Aging and Evaluation of Polymeric Materials

FY 1985
$ 220,000

DOE Contact - Russell Eaton, 202-252-4844
ORNL (Contract No. W-7506-eng-006) Contact - Steinar Dale, 615-574-4829

The aging of polymeric film materials is being studied. The aging will be done under combined mechanical, electrical, and thermal stresses, as well as under single stress application. The materials will be periodically analyzed for characteristic changes.

Keywords: Insulators, Polymeric Films, Multifactor Aging

151. Solid Dielectrics and Interfacial Breakdown

FY 1985
$ 150,000

DOE Contact - Russell Eaton, 202-252-4844
ORNL Contact - Steinar Dale, 6150-574-4829

An investigation of electron and ion transports across interfaces between a solid dielectric and metal is underway. Effects of electric fields, impurities, defects, and microstructures at the interfaces will be studied.

Keywords: Solid Dielectrics

152. Investigation of Interfacial Phenomena in Compressed Gases

FY 1985
$ 75,000

DOE Contact - Russell Eaton, 202-252-4844
ORNL Contact - Steinar Dale, 615-574-4829

The objective of this project is to investigate the initiation and propagation mechanisms of surface discharges along insulators in compressed gases. Measurements will be made of the secondary yield coefficients from insulator surfaces in the N_2 and SF_6. Models of the discharge propagation will be made.

Keywords: Insulators, Gaseous Dielectrics, Interfacial Phenomena

153. Interfacial Aging Phenomena in Power Cable Insulation Systems

FY 1985
$ 150,000

DOE Contact - Russell Eaton, 202-252-4844
ORNL Contact - Steinar Dale, 615-574-4829

The aging of semi-conducting/polymer insulator interfaces is under investigation. Phase II will be initiated using purified materials of semiconducting shields. Union Carbide has agreed to supply the required varieties of materials.

Keywords: Insulators, Extruded Polymeric Materials

154. Study of Dynamic Insulation with Advanced Metal Oxide (ZnO) Materials

FY 1985
$ 100,000

DOE Contact - Russell Eaton, 202-252-4844
ORNL Contact - Steinar Dale, 615-574-4829

The performance of ORNL-developed sol-gel ZnO material in overhead line insulators is being determined. The performance will be compared with that of insulators having commercial ZnO material previously studied in FY 84 and FY 85.

Keywords: Insulators, Metal Oxide Materials

155. Development of Amorphous Ferromagnetic Alloy for Motors and Transformers

FY 1985
$ 150,000

DOE Contact - Russell Eaton, 202-252-4844
ORNL Contact - Steinar Dale, 615-574-4829

The investigation of micro-alloying of FeO- and Ni-based metallic glasses will continue. A major effort will be to develop an understanding of the mechanism by which cerium additions affect the mechanical and magnetic properties. Other elements which can improve the embrittlement problem in metallic glasses will also be investigated.

Keywords: Amorphous Ferromagnetic Alloys

156. AC Superconducting Power Transmission Cable Development

FY 1985
$1,500,000

DOE Contact - Russell Eaton, 202-252-4844
BNL (Contract No. ET-76-C-02-0016) Contact-E. Forsyth, 516-282-4676

The purpose of this project is to develop an underground AC superconducting cable system (138 kV, 4000A) based upon a flexible cable employing a Nb_3Sn tape and an insulation system consisting of a synthetic tape impregnated with supercritical helium (refrigerant). Optimized polymeric film tapes for superconducting and conventional cable systems will also be developed.

Keywords: Superconductors, Insulators (Organic Polymers), Energy Transmission

Active Heating and Cooling Division

This program funds R&D projects with industry and academic institutions directed towards the development of cost-effective, reliable and publicly acceptable active solar heating and cooling systems. A major emphasis of the program is to ensure that the information derived from these projects is made available to all of the members of the solar research, manufacturing and construction communities who will benefit from it.

157. Influence of Combined Stresses on Degradation of Polymeric Coverplate Materials

FY 1985
$ 300,000

DOE Contact - John Goldsmith, 202-252-8171
NBS Contact - David Waksman, 301-921-3114

The objectives are to (1) characterize the moisture degradation mechanisms occuring in polymeric cover materials and develop evaluation procedures for such materials when used in humid environments, (2) determine the relationships between microstructural and engineering properties of cover materials and investigate the use of micro-level changes as a tool for the early detection of materials degradation, and (3) develop mathematical models which can be used in conjunction with short-term accelerated aging test data to predict the service life of polymeric materials. This information is used to assess the suitability of polymeric materials for use in low cost, higher performance solar collectors.

Keywords: Polymers, Material Degradation, Solar Collectors

158. Thin Film Materials Research

FY 1985
$ 625,000

DOE Contact - John Goldsmith, 202-252-8171
SAN Operations Office Contact - Robert LeChevalier, 415-273-6362

The objective is to identify appropriate materials for glazing, laminates for absorbers, adhesives and fabrication techniques to make a practical, durable and low-cost thin film collector.

Keywords: Organics, Composites, Adhesives and Bonding Agents, Solar Collectors

159. Sorption Studies of Desiccant Materials

FY 1985
$ 120,000

DOE Contact - John Goldsmith, 202-252-8171
SERI Contact - Frederica Zangrando, 303-231-1761

The objective is to measure adsorption/desorption characteristics of promising desiccant materials as a function of physical properties, geometry, and operating environment. A gas chromatograph is used to determine these properties for gramma-manganese dioxide and silica gel under isothermal and adiabatic conditions. The data from this project will be used to validate performance models and to identify the suitability of various materials for use in advanced solar desiccant dehumidifiers.

Keywords: Surface, Instrumentation or Technique Development

160. Heat and Mass Transfer Analysis of Advanced Dehumidifiers

FY 1985
$ 300,000

DOE Contact - John Goldsmith, 202-252-8171
SERI Contact - Ahmad Pesaran, 303-231-7636

The objective is to extend, improve, and validate the solid-side resistance model of packed dehumidifier to more advanced, cost-effective dehumidifier geometries for incorporation in performance prediction and design tools. Detailed information on mass transfer as a function of particle size and shape, water loading, particle diffusion coefficient, and geometry will be developed. The initial focus will be on silica gel desiccants.

Keywords: Surface, Predictive Behavioral Modeling

161. Research on Liquid Desiccant Materials

FY 1985
$ 100,000

DOE Contact - John Goldsmith, 202-252-8171
ANL Contact - Jack Parks, 312-972-4334

The objective is to identify and evaluate candidate organic liquids on multi-component liquid mixtures for use in the Liquid Desiccants that can be regenerated by Liquid-Liquid Phase Separation (LIQDES-RELLPS) concept. Specific materials to be investigated must have low critical solution temperatures. Candidate materials include amines, amides, and amide polymers, and in particular N-cyclohexyl-2-pyrrolidone (CHP)-water mixture.

Keywords: Organics, Predictive Behavioral Modeling

162. Solar Collector Materials Exposure Testing

FY 1985
$ 70,000

DOE Contact - John Goldsmith, 202-252-8171
LANL Contact - Robert Jones, 505-667-6441

The objective is to develop a database of information on the response of various solar collector materials to long-term exposure to solar radiation, elevated temperatures, and moisture. In particular, glazings and absorber materials will be tested at the high altitude exposure test facility. Information on insolation, temperature, humidity, and ultraviolet radiation will be collected and analyzed. The results will be used to aid in correlating short-term and accelerated tests and in developing degradation prediction models.

Keywords: Polymers, Organics, Metals: Non-Ferrous and Ferrous, Coatings and Films

163. Low Cost Process for the One Step Synthesis of U.V. Inhibitor

FY 1985
$ 395,000

DOE Contact - John Goldsmith, 202-252-8171
Helix Associates Contact - Walter Heldt, 302-738-6581

Transparent films require the use of additives to inhibit their degradation as a result of exposure to sunlight (the U.V. component). One of the best known long life additions is tetrahydroxybenzophenone. Extremely high cost has limited the application of this material. This research seeks to develop a low cost one step synthesis of this compound. (This is a Small Business Innovation Program project which is managed by this office.)

Keywords: UV Inhibitors, Manufacture, Materials Degradation, Solar Collectors

164. Development of Improved Desiccant Materials

FY 1985
$ 225,000

DOE Contact - John Goldsmith, 202-252-8171
ANL Contact - Anthony Fraioli, 303-972-7550

The objective is to determine whether lower absorption energetics due to MnO_2 would adversely affect the rates of water take-up. Analysis of powder samples for surface area measurements by gas absorption techniques, water vapor adsorption by gravimetric techniques, x-ray diffraction and scanning electron microscopy are required. Methods to measure and compare adsorption equilibrium rate data for the adsorption of water on MnO_2 and silica gel are developed.

Keywords: Crystalline Material, Surface Effect, Solar Cooling

165. Research and Development on Stainless Steel Thin Material Collectors

FY 1985
$ 320,000

DOE Contact - John Goldsmith, 202-252-8171
BNL Contact - William Wilhelm, 516-282-4708

The objective of this project is the development of a thin foil stainless steel/copper foil absorber-heat exchanger solar collector which is ultrasonically welded and capable of withstanding temperatures > 150 degrees C. Target foil thickness is in the range of 3 mils for use in non-pressurized collector.

Keywords: Metals, Composites, Non-Destructive Evaluation, Material Degradation, Solar Collectors

Passive and Hybrid Solar Energy Division

The objective of the Passive and Hybrid Solar Energy Program is to expand the generic technology base of solar thermal energy, which will allow the private sector to develop passive and hybrid solar systems capable of meeting the range of space conditioning and lighting energy demand typical of American residential and non-residential structures.

The initial thrust of materials R&D projects was to develop toward commercialization of passive solar materials and components that incorporate present technology to meet individual specific building related problems.

The recent phase of passive materials R&D projects was undertaken to systematically explore advanced materials and components as well as thermal processes that have the potential to greatly enhance the thermal performance of passive buildings.

System studies employing realistic estimates for the properties of new candidate materials show that: (1) the efficiency of passive heating systems can be raised to the point where any exterior surface of a building (not just its south wall) can be designed to provide double the efficiency of current designs; and (2) the passive aperture, transport and storage components can be controlled so as to reject thermal energy in the summer.

166. Optical Switching Apertures — FY 1985 $ 100,000

DOE Contact - Dave Pellish, 202-252-8110
SERI Contact - Dave Bensen, 303-231-1162

The objective of this project is to evaluate the feasibility of using solid state electrochromic coatings to control transmittance through apertures in passive solar heated buildings. The emphasis is to develop process and film parameters that are adaptable to large scale architectural window processing. Durability and optical properties of multilayer, absorbtive coatings will be evaluated and optimized.

Keywords: Coatings

167. Optical Switching Materials — FY 1985 $ 100,000

DOE Contact - Dave Pellish, 202-252-8110
LBL Contact - Carl M. Lampert, 415-486-6093

This program provides scientific coordination, materials analysis, and guidance for all DOE contractors in the area of solar optical switching devices. This program is also aimed at research and synthesis of new electrochromic materials with broad band and response characteristics not seen in existing materials (WO_3, IrO_2, MoO_3, etc.). Studies have focused on electrochromic NiO_x. Another part of this program is to identify and synthesize potential compounds that exhibit photochromic or thermochromic properties useful for passive solar apertures. This research does not deal with critical, strategic, or essential materials.

Keywords: Coatings and Films, Microstructure, Sputtering, Switchable Glazings, Surface Characterization and Treatment, Energy Transmission

168. Transparent Insulating Materials — FY 1985 $ 100,000

DOE Contact - Dave Pellish, 202-252-8110
LBL Contact - Arlon Hunt, 415-486-5370

This program investigates the optical, thermal, and structural properties of silica aerogel, a microporous material that has potential for use as an insulating material in glazing systems. Research is being performed on the formation, growth, and drying of the material; on methods for protecting the material from environmental stresses; and on methods for simplifying the synthesis process which is now based on supercritical drying. Results of this research will be clarification of the relationship between optical and thermal properties of the aerogel and its chemistry and structure. The intent is to optimize thermal and optical properties so that the material can be used as a component in a highly insulating window system. This research does not deal with critical, strategic, or essential materials.

Keywords: Insulating Materials, Microstructure, Glazing Thermal Performance

169. Phase Change Thermal Storage Materials — FY 1985 $ 100,000

DOE Contact - Dave Pellish, 202-252-8110
SERI Contact - Dave Bensen, 303-231-1162

Solid state phase change materials (SS PCM's) are being studied for use in thermal energy storage components of passive solar heated buildings. The polyalcohols pentaerythritol ($C_5H_{12}O_4$), trimethylol ethane ($C_5H_{12}O_3$), neopentyl glycol ($C_5H_{12}O_2$) and closely related compounds are the focus of the on-going research. The project objectives are to improve upon the understanding of the solid state phase transformations in these materials and to develop improved SS PCM's based upon this understanding. Possible improvements include enhanced properties, optimized transformation temperatures or more convenient forms (such as composites) for use in buildings.

Keywords: Composites, Phase Change Materials

170. Daylight Enhancement — FY 1985 $ 100,000

DOE Contact - Dave Pellish, 202-252-8110
LBL Contact - M. Rubin, 415-486-7124

The objective of this program is to identify, develop, and characterize light guide materials and systems to collect and transmit sunlight and daylight within buildings to reduce electric lighting requirements. Studies have concentrated on several types of solid and hollow light guides for various collector optics configurations. Estimations of net usable light flux for several building types is being studied. This research does not deal with critical, strategic or essential material.

Keywords: Polymers, Glasses, Fibers, Bulk Characterization, Energy Transmission

171. Low-Emittance, High-Transmittance Materials — FY 1985 $ 100,000

DOE Contact - Dave Pellish, 202-252-8110
LBL Contact - Mike Rubin, 415-486-7124

The objective of this program is to conduct research to develop the next generation of low-emittance, high-transmittance coatings for the control of radiant heat transfer in buildings. Low-emittance coatings should combine the best optical performance of multilayer interference films and the durability of nitride and oxide semiconductors.

Studies are aimed at the development of refractory optical materials (TiN and TiN_xO_y). These materials are synthesized by reactive sputtering and PCVD and analyzed for their optical and chemical properties. This research does not deal with critical, strategic, or essential materials.

Keywords: Coatings and Films, Microstructures, Sputtering, Surface Characterization and Treatment, Energy Transmission, Polycrystalline Materials

Solar Thermal Technology Division

Solar Thermal Technology is developing central receivers, parabolic dishes, and parabolic troughs to concentrate the sun's energy. This concentrated energy can then be used for industrial process heat, generating electricity, or producing fuels and chemicals. The combination of concentrated direct solar flux (to 2000 suns) and high temperature (to 2000°F) cause unique materials problems that are now being characterized in areas of heat transfer fluids, metals, ceramics and windows. In addition, the solar caused degradation of silvered polymers is also being studied with the objective being a highly reflective, environmentally stable, low cost reflector. The DOE contact is Frank Wilkins, 202-252-1684.

172. Silver/Polymer Reflector Research — FY 1985 $ 880,000

DOE Contact - Frank Wilkins, 202-252-1684
SERI Contact - Paul Schissel, 303-231-1226

Applied research is being conducted to develop silver/polymer reflector films that are resistant to ultraviolet and pollutant degradation, cleanable, have specular reflectances of 90% or more (within a 2-5 mrad. cone angle) and useful lives of at least 5 years.

The rationale for the research is that solar concentrators account for about 50% of the installed cost of a solar thermal system. Polymers are a high priority research activity because they offer the potential for substantially reducing the life cycle costs of concentrators and, hence, for solar thermal systems. Silver/polymer reflectors offer the advantages of lighter weight, reduced cost, and design flexibility compared with silvered glass.

This research focuses on studying, testing, characterization and evaluating polymer-coated silver mirrors. Silver is being deposited onto candidate commercially available polymers or polymers modified by laboratory procedures to meet performance requirements. Research is also being conducted to develop an understanding of degradation mechanisms in candidate polymer/silver combinations in simulated solar environments.

One expected result is the identification of at least one silvered polymer that meets the solar thermal requirements - useful life of at least 5 years specular reflectance of at least 90% within a 2-5 mrad. cone angle and resistant to UV and pollutant degradation.

As of the end of FY 1985, SERI had identified three promising reflecting films: ECP-300x, silvered polyacrylonitrile and silvered polymethylmethacylate.

Applied reseaerch is also being conducted on optically transmitting and structural polymer materials for solar thermal technology applications. The problems being investigated are: identification, testing and evaluation of chemically bound stabilizers to improve the durability of polymers in solar thermal applications; and identification, testing and evaluation of additives for polymers that act as ultraviolet (UV) absorbers and quenchers of excitation energy.

The many attractive features of polymers (e.g., lightweight and low-cost) can be exploited for solar thermal applications only if polymers are able to withstand the stresses of environmental and solar exposure.

The research focuses on the testing, characterization and evaluation of low-cost transmitting and structural polymer materials. Concurrently, research is being conducted to identify or develop and then evaluate chemically bound stabilizers (UV-absorbers, antioxidants, quenchers, etc.) to improve the durability of polymers in solar thermal applications. Modifications of polymers is proceeding along two main approaches - bulk stabilization and surface modification. Candidate polymer/coating or laminate combinations with stabilizer additives are being identified and evaluated regarding their performances.

The expected result of this part of the research is the development of durable, low-cost, lightweight transmitting and structural polymer materials for solar thermal applications - materials with a useful life of 5-10 years.

Keywords: Polymers, Coatings and Films, Surface Characterization and Treatment, Corrosion, Radiation Effects, Reflectors, UV Degradation

173. <u>High Temperature Materials</u> — <u>FY 1985</u> $ 620,000

DOE Contact - Frank Wilkins, 202-252-1684
SERI Contact - Gordon Gross, 303-231-1228

The aim of this research is to produce information needed to select the best materials and methods of application for testing the feasibility of the direct absorption receiver, as well as information needed to evaluate other advanced, innovative receiver concepts. The research consists of the following:

- <u>Carbonate Salt Working Fluids/and Container Materials Properties</u> - The radiative absorptance and transmittance of eutectic Lithium-

Sodium-Potassium Carbonate salts are being measured from 500°C to 900°C. Measurements are being carried out using an integrating sphere specifically designed for accurate measurement of radiative properties of liquids and solids at very high temperatures.

- Accelerated Testing of High Temperature Materials for Molten Salt Applications - The research seeks to identify and define the kinds of failures encountered in metal receiver tubes and to relate those failures to the radiative, thermal, and mechanical stresses to which the tubes have been subjected. After historical and statistical correlation of the stresses and the observed effects, the researchers will analyze the information to produce mathematical models of the combined stresses and resultant effects. These models will later serve as the basis for development of accelerated tests for containment materials and molten salts. By the end of FY 1985, the collection of historical data on failure or degradation of tubes and coatings in cavity receivers will be completed.

- Cyclic Heating Effects Research - Research will investigate durability of ceramic and metallic parts under cyclic heating conditions to determine presence of mechanical and corrosion effects that are not found under steady temperatures. Alumina and high alloy (mostly Ni) coupons are to be exposed to alternate high and low temperature molten carbonates (900°C and 500°C) to determine whether the cyclic heat accelerates corrosion.

The expected result of this research is an experimentally verified data base on materials for high temperature direct adsorption and innovative receivers -- materials for thermal fluids, containment systems, heat exchangers, etc.

Keywords: Ceramics, Thermal Fluids, Alloys, Corrosion, Radiation Effects

174. Photo-Enhanced Degradation of Materials — FY 1985 $ 120,000

DOE Contact - Frank Wilkins, 202-252-1684
SERI Contact - Gordon Gross, 303-231-1228

Research is being conducted to investigate high intensity (high flux) photo-enhanced degradation of materials, and identify possible changes in coatings to reduce effects of high solar fluxes. Quantitative correlations between high solar fluxes (over 100 suns) and degradation of materials will be produced. The research will also reveal any differences between the degradation produced by oven heating and that produced by the radiant flux. This research will address theoretical and experimental treatment of the high flux photoeffects. It will use surface analysis methods to give detailed understanding of the changes produced in the surfaces of the materials that were irradiated.

Keywords: Photodegradation, Irradiation Effects

175. Front Surface Reflector on Metal Substrates

FY 1985
$ 100,000

DOE Contact - Frank Wilkins, 202-252-1684
SERI Contact - Gordon Gross, 303-231-1228

This research is aimed at identifying ways to use stainless steel as a substrate for silver mirrors and for black chrome absorbers. Stainless steel offers many, well known advantages in solar thermal applications. As a mirror substrate it would offer desirable structural properties while being free of corrosion effects but could attack the silver reflector film.

The research is organized into two activities.

- Substrate Surface Smoothness - An internal SERI survey and analytical effort to select the stainless steel and surface treatments is being supplemented by a subcontract to identify the factors that control the smoothness of a stainless steel surface. Electrochemical and mechanical polishing research is being followed by metallographic and optical studies of surfaces on stainless steel. The aim will be to establish the limits of smoothness for the material.

- Substrate Undercoatings for Stainless Steel - This activity is exploring the use of leveling polymers, which make very smooth point surfaces, to the formation of a specular base for silver deposited on a stainless steel substrate. SERI efforts are aided by the University of Denver.

The expected results of this research are silver/stainless steel reflectors for use in fabricating concentrating solar collectors (especially troughs).

Keywords: Stainless Steel, Surface Characterization and Treatment

176. High Temperature Windows

FY 1985
$ 75,000

DOE Contact - Frank Wilkins, 202-252-1684
SERI Contact - R. Gerald Nix, 303-231-1757

The research is aimed at identifying and optimizing coatings to prevent the devitrification of transparent high-temperature window materials for use in solar thermal receivers. Another objective is to define and understand the failure mechanisms for materials subjected to high radiant fluxes, especially devitrification of transparent materials. Actual service life of materials used in receivers is a function not only of temperature, but also of the radiant flux level to which the material is exposed. This research is necessary to define the mechanisms for the photoenhanced degradation of materials, so that the effect can be mitigated.

The research is directed toward the further definition of damage mechanisms which cause window failure, the development of coatings for inhibiting failure, and the development of chemical techniques for welding the joints of window assemblies. Other areas which are to receive limited attention are definition of the capabilities of alumina (Vistal) tubes to be used in direct flux receivers and investigation of the possibilities for acquiring sapphire and spinel windows in practical sizes and configurations. Research is also being directed toward extending fundamental understanding of interactions between high level solar fluxes and ceramic materials, design of material systems and composites which give improved performance, and solar testing to support these activities. Attention is also being given to quantifying material behavior through modeling and measurement of critical material properties (transmissivity, absorptivity and emissivity) in a solar beam.

The expected results of this research are the identification of materials for use in fabricating durable windows for solar thermal receivers and demonstration of the technical feasibility of such window materials for high temperature solar thermal applications (e.g., fuels and chemicals processes).

Keywords: Windows, Devitrification, Mosaic Structures, Photodegradation, Receivers

177. <u>Composite Materials for Concentrators</u> <u>FY 1985</u>
$ 79,000

DOE Contact - Frank Wilkens, 202-252-1684
SERI Contact - L. Marty Murphy, 303-231-1050

The objective of this research (being conducted by the University of Arizona and Science Applications, Inc.) is to determine the feasibility of designing and building durable, low-cost heliostats fabricated from advanced composite materials and wood laminates.

One of the major thrusts of the Solar Thermal Research Program is conducting research to identify and show the technical feasibility of innovative durable, low-cost concentrators. Since concentrators account for approximately 50% of the capital cost of a solar thermal system, one way to reduce the delivered cost of energy significantly is to reduce the costs of the concentrators.

Three conceptual designs for stretched membrane heliostats are being investigated:

- laminated wood ring with double polymer membranes;
- graphite fiber reinforced wooden core ring with double polymer membranes; and
- open-weave graphite fiber "fishnet" membrane to support thin glass reflector panels mounted on a frame.

The conceptual designs are being subjected to a computer-based structural analysis to predict their stress-strain behavior. Scale models are to be

fabricated for each of the three conceptual designs and subjected to various mechanical tests (e.g., plane bending stiffness, torsional stiffness, etc.).

The expected results of the research is the identification of at least one conceptual design for a durable, lightweight and potentially low-cost stretched membrane heliostat fabricated from composite materials and to establish (experimentally) the technical feasibility of that concept.

Keywords: Polymer Membrane, Stretched Membrane, Composite Materials, Wood Laminate, Heliostat

Photovoltaic Energy Technology Division

The primary goal of the national photovoltaic program is to reduce the uncertainties surrounding photovoltaic technology, so that the private sector may make informed investment decisions in this area. Successful uncertainty reduction will require advances in several areas of materials technology.

178. Amorphous Silicon for Solar Cells

FY 1985
$8,000,000

DOE Contact - Morton B. Prince, FTS 252-1725
SERI Contact - Ed Sabisky, FTS 327-1483

This project performs applied research upon the deposition of amorphous silicon alloys to improve solar cell properties. Efficient solar energy conversion is hindered by improper impurities or undesired structure in the deposited films and the uniformity of the films over large (1000 cm^2) areas. The films are deposited by plasma enhanced chemical vapor deposition (glow discharge), thermal chemical vapor deposition and sputtering. The long term goal of this effort is to develop the technology for 12% efficient solar cells with an area of about 1000 cm^2. Achieving that goal should enable amorphous silicon to be a cost-effective electrical generator.

Keywords: Amorphous Materials, Coatings and Films, Semiconductors, Chemical Vapor Deposition, Sputtering and Solar Cells

179. Polycrystalline Thin Film Materials for Solar Cells

FY 1985
$3,600,000

DOE Contact - Morton B. Prince, FTS 252-1725
SERI Contact - Kenneth Zweibel, FTS 327-7141

This project performs applied research upon the deposition of $CuInSe_2$ and CdTe thin films for solar cells. Research centers upon improving solar cell conversion efficiency by depositing more nearly stoichiometric films, by controlling interlayer diffusion and lattice matching in heterojunction structures and by controlling the uniformity of deposition over large (1000 cm^2) areas. The films are deposited by chemical and physical vapor deposition, electrodeposition and sputtering. The long term goal for this effort is to develop the technology for 15% efficient solar cells with areas of about 1000 cm^2. Achieving this goal would enable polycrystalline thin film material to be a cost-effective electrical generator.

Keywords: Coatings and Films, Semiconductors, Chemical Vapor Deposition, Physical Vapor Deposition, Electrodeposition, Sputtering and Solar Cells

180. Growth of Silicon Ribbons for Solar Cells

FY 1985
$4,000,000

DOE Contact - Morton B. Prince, FTS 252-1725
JPL Contact - Andrew Morrison, FTS 792-7200

This project performs applied research upon the growth of silicon ribbons from a melt. Research centers upon understanding, from a physical perspective, exactly what happens during the growth of silicon ribbon. Questions to be answered include: what stresses do the sharp temperature gradients, inherent in high speed crystal growth, impose upon the ribbon; which stress relief modes improve solar cell performance and how can they be enhanced; how can buckling be prevented; and what is an acceptable level of residual strain. Attaining an understanding of the fundamentals of ribbon growth should enable the development of appropriate ribbon growth techniques necessary for highly efficient, cost-effective crystal silicon solar cells.

Keywords: Semiconductors, Crystal Growth, Solar Cells

181. Deposition of III-V Semiconductors for High-Efficiency Solar Cells

FY 1985
$3,500,000

DOE Contact - Morton B. Prince, FTS 252-1725
SERI Contact - John Benner, FTS 327-1396

This project performs applied research upon deposition of III-V semiconductors for high efficiency solar cells, both thin film for flat plate applications and multilayer cells for concentrator applications. Research centers upon depositing layers precisely controlled in terms of composition, thickness and uniformity and studying the interfaces between the layers. The materials are deposited by chemical vapor deposition, liquid phase epitaxial growth and molecular beam epitaxial growth. The long term goal of this area is to develop 35% efficient concentrator cells and 20% 100 cm^2 one-sun cells for flat plate applications. Achieving these goals would enable systems using these technologies to be cost-effective electrical generators.

Keywords: Semiconductors, Chemical Vapor Deposition, Solar Cells (Liquid Phase Epitaxial Growth, Molecular Beam Epitaxial Growth)

182. Materials and Device Characterization

FY 1985
$3,000,000

DOE Contact - Morton B. Prince, FTS 252-1725
SERI Contact - Larry Kazmerski, FTS 327-1115
JPL Contact - Ram Kachare, FTS 792-4583

This project measures and characterizes materials and device properties. The project performs surface and interface analysis, electro-optical characterization and cell performance and material evaluation to study critical material/cell parameters like impurities, layer mismatch and other defects that limit performance and lifetime. Techniques that are used include deep level transient spectroscopy, electron beam induced current, secondary ion mass spectroscopy, scanning electron microscopy and scanning transmission electron microscopy.

Keywords: Semiconductors, Nondestructive Evaluation, Surface Characterization, Microstructure and Solar Cells

183. High-Efficiency Crystal Silicon Solar Cells FY 1985 $1,800,000

DOE Contact - Morton B. Prince, FTS 252-1725
JPL Contact - Ram Kachare, FTS 792-4583

This project performs applied research upon crystal silicon devices to improve solar-to-electric conversion efficiency. The project employs new coatings and/or dopants and other treatments to reduce electron-hole recombination at cell surfaces or in the bulk material. This project should attain an 18% efficient one-sun crystal silicon solar cell by the end of FY 1984 and a 20% efficient one-sun crystal silicon solar cell by the end of FY 1986. This result will be a major step in proving that crystal silicon can be a cost-effective generator of electricity.

Keywords: Semiconductors, Solar Cells

Geothermal Technology Division

The primary goal of the geothermal materials program is to ensure that the private sector development of geothermal energy resources is not constrained by the availability of technologically and economically viable materials of construction. This requires the performance of high risk GTD-sponsored materials R&D.

184. High Temperature Elastomers for Dynamic Sealing Applications

FY 1985
$ 125,000

DOE Contact - R. LaSala, 202-252-8077
BNL Contact - L.E. Kukacka, 516-282-3065

This project performs applied research to optimize a Y-267 EPDM elastomer formulation, developed earlier by GTD for static seal applications, for use in dynamic seal applications at temperatures up to 260 degrees C. Elastomers for these conditions do not currently exist, and a successful development could substantially reduce drilling and completion costs. The effects of compositional changes on the properties of the elastomer are being determined, and the formulation optimized to yield the specific sealing requirements. Prototype and full-scale testing is performed. Achieving the goal will result in significant improvements in the cost and reliability of geothermal components.

Keywords: Organics, Material Degradation, Stress, Drilling, High Temperature Service, Seals and Bearings

185. Advanced Materials for Lost Circulation Control

FY 1985
$ 75,000

DOE Contact - R. LaSala, 202-252-8077
BNL Contact - L.E. Kukacka, 516-282-3065

This project is investigating hydrothermally stable and pumpable chemical systems for use as lost circulation control materials. Control of lost circulation problems is a major contributor to the cost of geothermal wells, and high temperature materials that will yield permament repairs that can be made without removal of the drill string in order to set casing and cement, do not exist. The investigations include laboratory studies of interactions between bentonite-based drilling muds, reactive solid additives, and chemical fluids. The pumpability characteristics of the slurries and the properties of the cured materials are also determined. Success will result in significant reductions in drilling and completion costs.

Keywords: Organics, Fibers, Glass Ceramics, Strength, Bulk Characterization, Drilling, High Temperature Service

186. Pitting Resistant Steels FY 1985 $ 50,000

DOE Contact - R. LaSala, 202-252-8077
BNL Contact - D. van Rooyen, 516-282-4050

This project studies the mechanism whereby high corrosion resistance is obtained through alloying of stainless steels with molybdenum combined with nitrogen. Corrosion of tubulars is a major problem in geothermal systems, and the use of high chrome steels and nickel alloys is uneconomical. The work involves research to determine the required combinations of Mo and N needed to yield the required pitting resistance for specific environments. Achieving this goal will result in cost-effective alternatives for high chrome and nickel alloys in geothermal plants.

Keywords: Alloys, Coatings, Metals, Corrosion, Diffusion, Fatigue

187. In-Situ Conversion of Drilling Fluids into Cements FY 1985 $ 30,000

DOE Contact - R. LaSala, 202-252-8077
BNL Contact - L. E. Kukacka, 516-282-3065

This applied research program involves studies of high temperature interactions between drilling mud constituents, reactive solid additives, and chemical fluids. Poor well completions occur due to the inability to displace drilling fluid from behind the well casing. If the goals of the program are attained, lower well completion costs and extended well life will be accrued.

Keywords: Cement, Glass Ceramics, Strength, Bulk Characterization, Drilling, High Temperature Service.

188. Geothermal Waste Utilization and Disposal FY 1985 $ 135,000

DOE Contact - R. LaSala, 202-252-8077
BNL Contact - L. E. Kukacka, 516-282-3065

This program involves the development of processes for converting toxic constituents of geothermal wastes into nonleachable forms which can be used as general construction materials. Before the large-scale development of geothermal energy can occur, environmentally and economically acceptable methods for the disposal of large quantities of waste must be developed. The program involves the selection of encapsulating or concentrating materials, and the fabrication and evaluation of waste forms. A successful program will result in significant improvements in the economic and environmental aspects of geothermal energy.

Keywords: Cements, Polymers, Bonding Agents, Material Degradation, Bulk Characterization, Waste Management

189. Materials for Non-Metallic Heat Exchangers FY 1985
$ 100,000

DOE Contact - R. LaSala, 202-252-8077
BNL Contact - L. E. Kukacka, 516-282-3065

This project is investigating thermally conductive polymer-based composites for use as corrosion resistant materials of construction for shell and tube heat exchangers in binary geothermal processes. Corrosion of the brine side of tubing in shell and tube heat exchangers has been a major problem in the operation of binary geothermal processes. Compared to the cost of high alloy steels, a considerable economic benefit could result from the utilization of a proven corrosion resistant polymer concrete material if sufficient heat transfer properties can be derived. The work consists of determinations of the effects of compositional and processing variables on the thermal properties of the composite, and measurements of the physical and mechanical properties after exposure to hot brine and isobutane. If the goals of the program are attained, the cost of geothermal power will be reduced considerably.

Keywords: Composites, Polymers, Corrosion, Strength, Extrusion, High Temperature Service

190. Corrosion Resistant Elastomeric Liners for Well Casing FY 1985
$ 150,000

DOE Contact - R. LaSala, 202-252-8077
BNL Contact - L. E. Kukacka, 516-282-3065

This program investigates the effectiveness of Y-267 EPDM elastomers as corrosion resistant liners on carbon steel well casing. Currently, casing corrosion is a major problem at many geothermal sites, and although the use of high chrome steels and nickel alloys extend casing life considerably, they cost 6 to 15 times as much as carbon steel. The R&D consists of the identification and evaluation of high temperature chemical bonding agents, development of lining methods, and performance of downhole corrosion tests on prototype sections. If successful, the cost of geothermal wells will be considerably reduced.

Keywords: Bonding Agents, Organics, Corrosion, Joining, Material Degradation, Casting, High Temperature Service

191. Advanced High Temperature Geothermal Well Cements

FY 1985
$ 100,000

DOE Contact - R. LaSala, 202-252-8077
BNL Contact - L. E. Kukacka, 516-282-3065

Lightweight chemically and thermal resistant well cements are needed to reduce the potential for lost circulation problems during well completion operations. Materials designed for temperatures > 300 °C will be needed as higher temperature resources are developed. Cements resistant to brines containing high concentrations of of CO_2 at temperatures > 200 °C are also needed. Emphasis should be placed on high temperature rheology, phase chemistry, and the mechanical, physical, and chemical resistance properties of the cured materials.

Keywords: Cements - High Temperature, Material Degradation, Strength, Transformation, Bulk Characterization, Drilling, High Temperature Service

192. Corrosion in Binary Geothermal Systems FY 1985 $ 50,000

DOE Contact - R. LaSala, 202-252-8077
BNL Contact - L.E. Kukacka, 516-282-3065

This program yields corrosion data from laboratory and plant tests for metals presently used in binary plants and other more potentially resistive metals and nonmetals. In operating binary processes, brine leakage into the organic working fluid side of the plants has resulted in unanticipated corrosion problems. Data are not available on the effects of salt, oxygen, and water impurities in isobutane and/or isopentane on the corrosion rates of metals. The work involves the exposure of test coupons in operating plants and in a laboratory test loop in which the levels of water, oxygen and salt can be varied. When completed, the programs will yield quantitative information regarding the extent of corrosion that will occur upon contamination of the binary side of a plant, thereby allowing designers materials options.

Keywords: Alloys, Metals, Corrosion

193. High Temperature Cathodic Protection Systems FY 1985 $ 50,000

DOE Contact - R. LaSala, 202-252-8077
BNL Contact - L.E. Kukacka, 516-282-3065

This project involves the development of methods for using electrochemical techniques in high temperature environments for the exterior protection of well casing and other geothermal components. Corrosion of carbon steel components is a serious problem in geothermal environments, and almost any alternative to the use of high alloy steels will be economically attractive. The work includes laboratory and field measurements of the electrochemical parameters required to protect well casing from external attack, design of protective equipment, and prototype testing. If successful, the program will yield electrochemical data which demonstrate the feasibility of using cathodic protection in geothermal processes.

Keywords: Metals, Corrosion, Electrochemical, High Temperature Service

194. Biochemical Concentration and Removal of Toxic Components from Geothermal Wastes FY 1985 $ 35,000

DOE Contact - R. LaSala, 202-252-8077
BNL Contact - L.E. Kukacka, 516-282-3065

This program involves the development of biochemical processes which can be used for the concentration and subsequent removal of toxic components from geothermal waste streams. Before the large-scale development of geothermal energy can occur, environmentally and economically acceptable methods for the disposal of large quantities of potentially toxic wastes must be developed. The wastes can also provide a valuable source of strategically important metals. The work involves the identification of biosystems which efficiently select and accumulate the toxic materials of interest. This involves extra- and intra-cellular fractionation, and the entities responsible for the selective interaction with the metals are being chemically characterized. The methodology requires identification and management of natural sources, i.e., isolation, culturing, and identification of microorganisms as well as the chemical isolation and characterization of active entities.

Keywords: Toxic Metal Removal, Absorption, Surface, Solidification, Industrial Waste Recovery

195. Field Tests of Advanced Monitoring Instruments — FY 1985 $ 185,000

DOE Contact - G. J. Hooper, 202-252-4153
PNL Contact - D. W. Shannon, 509-376-3139

This project involves field testing advance instrumentation to monitor brine chemistry, corrosion, scaling and suspended solids in geothermal waters to be used in geothermal power plants, with emphasis on wastewater treatment and injection systems. Advanced instruments are strategically located on selected geothermal power plants, and the results of the tests are monitored in order to detect adverse plant conditions. Current field tests associated with binary technology are being completed. Similar field tests will be initiated on a geothermal flash plant. Tests associated with the binary plant have already resulted in savings of many thousands of dollars in avoided well and equipment failures on the plant where the test equipment was installed. Through the development of this system, a similar system has been incorporated at the Heber Plant. It is expected that test results from a flash plant will also produce improved plant reliability and a reduction in cost through early detection of adverse plant conditions.

Keywords: Composites, Corrosion, High Temperature Service

196. Particle Measurement In-Line Instrument — FY 1985 $ 275,000

DOE Contact - G. J. Hooper, 202-252-4153
PNL Contact - D. W. Shannon, 509-376-3139

This project involves the development and testing of instruments to measure the total amount of solid material pumped into geothermal injection wells and to characterize these suspended solids by measuring the particle counts in each size range vs. time and total fluid injection. The need for improved continuous on-line instruments to detect adverse plant conditions is clear. Many of the plant shutdowns are often caused by components failing due to factors relating to the chemical nature of the brines.

Currently two promising instruments are being examined, one based on a laser technique and the other using a sonic technique to characterize and measure these parameters. Successful development and testing of these instruments will result in improved plant reliability and a reduction in plant operation cost.

Keywords: Composites, Corrosion, High Temperature Service

Biofuels and Municipal Waste Division

The goal of the Energy From Municipal Waste (EMW) Division is to provide the technical information base from which industry can develop future technologies for the recovery of liquid and gaseous fuels and other usable energy products and materials from municipal solid waste, and to increase the energy efficiency of municipal wastewater treatment processes. DOE contact is Christopher Kouts, 202-252-1697.

197. Refuse Derived Fuel (RDF) Binder Research — FY 1985 $ 230,000

DOE Contact - Donald Walter, 202-252-6104
ANL Contact - Ole Ohlson, 312-972-5593

The objective of this research study is to develop innovative densified refuse derived fuel (RDF) concepts for the processing of municipal solid waste (MSW) that can produce fuels of a desired quality, at lower cost, and with greater consistency than the RDF currently available. Research is aimed at improvement of previous work by examining the use of more appropriate binders for use in producing improved pelletized or briquetted densified RDF that are easily transportable and stable under long term storage conditions. Environmentally acceptable potential chemical binders are being identified and process concepts, including their economics, are being evaluated. In addition, alternative soil compaction techniques are being examined for producing an acceptable quality densified product.

Keywords: Alternate Fuels, Materials Degradation

OFFICE OF ENERGY RESEARCH

The Director of Energy Research is responsible for three major outlay programs: Basic Energy Sciences, High Energy and Nuclear Physics, and Magnetic Fusion Energy. The Director of Energy Research also advises the Secretary on DOE physical research programs, the Department's overall energy research and development activities, grants, and other forms of financial assistance. The Director also carries out additional duties assigned to the office related to basic and advanced research, and monitors the well-being and management of the multiprogram laboratories under the jurisdiction of the Department.

Four multiprogram and seven single-purpose laboratories are administratively assigned to the Office of Energy Research. The multiprogram facilities are Argonne National Laboratory, Oak Ridge National Laboratory, Brookhaven National Laboratory, and Lawrence Berkeley Laboratory. The single-purpose or specialized laboratories are the Bates Linear Accelerator Facility at the Massachusetts Institute of Technology, the Ames Laboratory at the Iowa State University, the Fermi National Accelerator Laboratory, the Notre Dame Radiation Laboratory, the Princeton University Plasma Physics Laboratory, the Michigan State University Plant Research Laboratory, and the Stanford Linear Accelerator Center. The multiprogram laboratories conduct significant research activities for other DOE programs (e.g., Conservation, Nuclear, etc.) and other Federal agencies, while the seven specialized laboratories are funded almost totally by the Office of Energy Research.

The Office of Energy Research conducts materials research in the following offices and divisions:

Office of Basic Energy Sciences: Division of Engineering and Geosciences; Division of Materials Sciences

Office of Fusion Energy

Small Business Innovation Research Program

Office of Health and Environmental Research: Division of Physical and Technologies Research

Office of Basic Energy Sciences

Division of Materials Sciences

This basic research program has several roles. One is to increase the understanding of materials properties, behavior, and phenomena in those classes of materials that either currently or in the future might be important to the mission of the Department of Energy. Another concerns the development of new forefront analytical instruments and facilities that are used to probe the structure and behavior of matter. Thus this program carries a major responsibility for many of the nation's premier research facilities including several neutron sources, a synchrotron radiation source, processing facilities, and frontier electron microscopes. Some of the materials research has a specific relationship to an identified energy technology (e.g., photovoltaic phenomena for solar energy conversion, fast-ion diffusion for solid electrolytes in fuel cells and batteries, etc.); some is related to many energy technologies simultaneously (e.g., hydrogen embrittlement, corrosion, high temperature structural metals and ceramics, etc.); and some important to fundamental understanding of new experimental and theoretical research tools.

This research is conducted at DOE laboratories, universities, and to a lesser extent at industrial laboratories by metallurgists, ceramists, solid state physicists, and materials chemists in about 100 different institutions.

There are three subprograms:

- Metallurgy and Ceramics seeks to understand the synergistic relationship between properties/behavior, structure, and processing parameters of materials.

- Solid State Physics is concerned with understanding the interactions of electrons, atoms, and defects and their role in determining the structure and properties of condensed matter.

- Materials Chemistry focuses on understanding the chemical properties of materials and their relationship to composition, structure, and specimen environment.

The DOE contact for this Division is Dr. Louis Ianniello, 301-353-3427. For specific detailed information, the reader is referred to DOE publication Materials Sciences Programs Fiscal Year 1985 (DOE/ER-0143/3 dated September 1985). This publication contains: summaries of all funded grant programs in universities and private sector organizations; summaries of all Small Business Innovation Research Programs; Collaborative Research Centers (descriptive information); cross cutting indices: investigators, materials, techniques, phenomena, environment. Limited copies may be obtained by calling 301-353-3428.

Division of Engineering and Geosciences

198. Damage Accumulation by Crack Growth Under Combined Creep and Fatigue

FY 1985
$ 56,000

DOE Contact - Oscar P. Manley, 301-353-5822
Battelle-Columbus Laboratories Contact - C.E. Jaske, 614-424-4417

The objective of this study is to develop and evaluate methods for assessing creep/fatigue crack growth under inelastic straining. A fracture-mechanics approach implementing the J integral for fatigue and the C* integral for creep is being employed. A crack-tip-zone interaction model is used to account for the interactions between creep and fatigue during crack growth at high temperatures. Experimental studies on Type 316 stainless steel 593 and 649 degrees C are continuing. Experiments similar to those previously performed on Type 316 stainless steel are being conducted on modified 9Cr-1Mo steel at 538 and 593 degrees C. The range of the cyclic J integral has been shown to be a good parameter for characterizing fatigue-crack-growth rates when creep effects are negligible. The C* integral has been shown to be a good parameter for characterizing creep-crack-growth rates under static or slowly varying loading with steady state creep across the remaining uncracked ligament. Use of the MENT specimen configuration has been shown to provide a relatively simple and economic means of measuring creep-crack-growth at low propagation rates (near 1 mm per year). The general approach is being evaluated for cases where creep-fatigue damage may occur during dwell periods at some fraction (0 to 1.0) of the maximum cyclic load.

Keywords: Metals: Ferrous Including Steels, Creep, Fatigue

199. Electrochemical Wear Mechanism and Deposit Formation in Lubricated Systems — FY 1985 $ 93,000

DOE Contact - Oscar P. Manley, 301-353-5822
Electrochemical Technology Corp. Contact - T.R. Beck, 206-632-5965

The objective of this research is to measure and determine the importance of electrokinetic- or zeta- corrosion and deposit formation in lubricated rolling and sliding systems. The approach of the present research is to compare measurements of wear for rolling and sliding lubricated systems and to calculate zeta corrosion rates based on extensions of the valve wear model. The main challenge is distinguishing wear by zeta corrosion from abrasive and adhesive wear. Required physical properties were measured for eight common lubricating oils and measurements were made of wall current density generated and size of wear scars. The wear scars consist of furrows with parallel scratches and furrows with micropits. With a nylon cloth attached to the shaft wear scars are about the same size but virtually all pitted furrows. Zeta corrosion caused by passage of metal surface roughness or the roughness of the nylon weave over the journal surface is indicated. Experiments to distinguish unambiguously zeta corrosion are underway.

Keywords: Corrosion-Aqueous, Lubrication, Wear

200. Engineering Analysis of Elastic-Plastic Fracture — FY 1985 $ 175,000

DOE Contact - Oscar P. Manley, 301-353-5822
Idaho National Engineering Laboratory Contact - W.G. Reuter, 205-526-0111

The objective is to improve design and analytical techniques for predicting the integrity of flawed structural components. The research is primarily experimental, with analytical evaluation guiding the direction of experimental testing. Tests are being conducted on a material (a modified ASTM A-710) exhibiting a range of fracture toughness but essentially constant yield and ultimate tensile strength. As test temperature increases, the specimen configuration-fracture toughness relationship complies initially with requirements for linear elastic-fracture mechanics and extends beyond the range of a J-controlled field. Presently, compact tension (3-point bend specimens will also be used in the future) are being used to develop state-of-the-art fracture mechanics data on the lower shelf (K_{Ic}), transition zone (J_{Ic}, J-R curves, etc.), and on the upper shelf (J_{Ic}, J-R curves, etc.). Results from the lower shelf and transition region are being used to predict failure conditions for specimens containing surface flaws. Predictions are then compared with experimental test data. These comparisons are presently underway for 6.4 and 12.7 mm thick surface-flawed specimens. Metallographic techniques are being used to measure crack tip opening displacement for comparison with analytical models. Laser interferometry and infrared thermography techniques will be used to evaluate and quantify the deformation in the crack region.

Keywords: Fracture, Metals: Ferrous Including Steels

201. <u>Continuous Damage Theory</u> <u>FY 1985</u>
$ 43,000

DOE Contact - Oscar P. Manley, 301-353-5822
University of Illinois Contact - D. Krajcinovic, 312-996-7000

The study centers on the phenomenological description of the nucleation and growth of microdefects in a metallic solid and their influence on the mechanical response. The analytical work will proceed within the scope of the Continuous Damage Mechanics, according to which the distribution and density of microdefects can be represented by a set of appropriately selected internal variables.

Present investigations focus on the basic aspects and definitions to prepare the groundwork and reconcile several different models. It was, for example, found that in case of a general microcrack field a distinction must be made between the microcrack distribution and the damage consistent representation of a field of flat microcracks. The projection of these vectors on a plane through the observed point is a physically reasonable measure of damage.

Subsequently the focus will shift to the investigation of the interaction of viscuous effects (reflecting the boundary slip) and the brittle effects (growth of microcracks). The established continuum model will be used to study problems such as creep rupture, fatigue, etc.

Keywords: Metals: Ferrous Including Steels, Fracture, Fatigue, Creep

202. <u>Loss Characteristics of Cord-Rubber Composites</u> <u>FY 1985</u>
$ 75,000

DOE Contact - Oscar P. Manley, 301-353-5822
University of Michigan Contact - S.K. Clark, 313-764-4256

The research is divided roughly into two phases, the first being completion of data acquisition on the loss characteristics of cord-rubber composites under both uniaxial and multiaxial stress states. This effort will utilize information currently available as well as measurements made here. The effects of prestrain, frequency, strain amplitude, and temperature will be included in the assessment of the viscoelastic properties of these materials.

The major activity during the latter part of the work will be analysis and measurement of the rolling loss of a relatively simple pneumatic tire. The tire geometry will be essentially cylindrical in form, similar to the type of tire used in vehicles transversing soft or marshy terrain. These are essentially cylindrical rollers, but with end closures making it possible to inflate them. Analysis will be carried out using the viscoelastic material properties previously obtained, as well as finite element codes suitable for this type of problem. Comparison of calculated and measured rolling resistance values will give valuable insight into the types of finite element models best suited for this computation, and should give confidence to the tire industry in its efforts to apply finite element techniques to the calculation of tire operating properties.

Keywords: Composites

203. <u>A Study of the Chemical Mechanism in Lubrication</u> <u>FY 1985</u> $ 60,000

DOE Contact - Oscar P. Manley, 301-353-5822
NBS Contact - S.M. Hsu, 301-921-3113

Chemical mechanisms in concentrated contacts under lubricated conditions are largely not understood. This project will study systematically the nature and the extent of influence of chemical reactions in the contact zone on friction and wear. Surface topography of worn surfaces will be characterized to predict oil film thickness under different speed, load ranges in a NBS-developed four-ball wear tester. Micro-asperity temperatures and the wear film temperatures of the oil film will be calculated using Archard-Jaeger equations as well as finite-element analysis techniques. Pure model structures will be used as lubricants to test the effects of chemical functional groups on friction and wear. Chemical kinetic studies on tribochemical reaction rate constants for various classes of compounds under wearing conditions will be compiled. A theoretical model linking elastohydrodynamic theories to tribochemical rate constants with materials properties will be attempted to predict lubrication effectiveness a priori.

Keywords: Lubricants, Tribology

204. <u>Effects of Crack Geometry and Near-Crack Material Behavior on Scattering of Ultrasonic Waves for QNDE Applications</u> <u>FY 1985</u> $ 59,000

DOE Contact - Oscar P. Manley, 301-353-5822
Northwestern University Contact - J.D. Achenbach, 312-491-5527

This project is concerned with applications of the scattered field approach to the detection of a cracklike flaw, and to the determination of its location, size, shape, and orientation. Interior, as well as surface-breaking and near-surface cracks are considered. The usual mathematical modeling of ultrasonic wave scattering by cracks is adjusted to account for several typical characteristics of fatigue and stress-corrosion cracks, and the environment of such cracks. Effects due to crack-face roughness, crack-closure and crack-face interactions are considered, as well as global anisotropy. Local anisotropy and inhomogeneity due to near-tip voids, and the effect of a zone of plastic deformation near a crack tip will also be investigated. Parametrical studies are expected to display the masking of characteristic "crack-like" features of the scattered field by a spectrum of signals due to deviations from an idealized crack geometry and idealized material behavior. Progress has been made on the effects of crack-face interactions and global anisotropy.

Keywords: Metals: Ferrous and Non-Ferrous, Fracture, NDE

205. <u>Mechanical Interactions of Rough Surfaces</u> <u>FY 1985</u> $ 130,000

DOE Contact - Oscar P. Manley, 301-353-5822
SKF Industries Inc. Contact - J.I. McCool, 215-265-1900

This program is aimed at developing fundamental information and resolving a number of issues that impact the design of mechanical systems in which surface microtopography per se or events which occur on the microgeometric scale play a critical role.

In Task I, an apparatus designed and built by SKF is being used to provide optical interferograms of the lubricated contact of rough surfaces along with measurements of the traction transmitted under conditions of combined rolling, sliding, and spinning. These tests will serve to explore the limitations of predictive models of film thickness, traction, and the frequency of asperity contact interactions and micropitting in the so called partial EHD regime wherein the thickness of the lubricant film separating the bodies is of the same order as the surface roughness amplitude.

The objective of Task II is to develop guidelines and techniques for the digital processing of surface roughness data generated in analog form by a stylus profile instrument.

Issues to be addressed are: filter bandpass selection, record length and sample spacing, spatial vs. frequency domain estimation, type of digital filtering, and the effects of preprocessing.

Keywords: Tribology

206. <u>Improvement of Reliability of Welding by In-Process Sensing and Control</u> <u>FY 1985</u> $ 145,000

DOE Contact - Oscar P. Manley, 301-353-5822
MIT Contact - K. Masubuchi, 617-253-6820

The main focus of this project is to develop closed-loop control of welding variables in a cost-effective approach to improving weld quality. This research program includes the following tasks: demonstration of the measurement of weld size using mechanical impedance as a sensing technique for one of the two weld geometry measurements; demonstration of a single variable control system using the above measurement; demonstration of the ability to gain independent control of two weld geometry measures as described, for example, by the front and back bead widths of the weld metal; demonstration of closed-loop geometry control with these two control variables; expand the variables to be controlled from two geometry measures to include temperature history of the weldment; implement the geometry control system on a mechanized welding system; and provide one formal framework for implementation of welding control.

Keywords: Welding

207. Crack Characterization With Ultrasonic NDE — FY 1985 — $ 110,000

DOE Contact - Oscar P. Manley, 301-353-5822
Idaho National Engineering Laboratory Contact - J.A. Seydel, 208-526-0111

The purpose of this research is to develop the instrumentation and analytical models that can predict and identify the frequency dependence of the amplitude and phase of ultrasonic echoes from defects. The approach treats the transducer/media/defect combination as a linear system which allows separation of the individual contributions to the signal detected at the transducer. A model based on the numerical solution of the partial differential wave equations has been developed to provide "snapshots" of the transducer field both before and after it has interacted with the flaw. This information is then compared to experimental data collected at a large number of transducer positions. Since the objective is to characterize defects, a number of techniques are being developed to display frequency-domain information which relates to the type of defect. One method is to display the phase and amplitude spectra values as a function of frequency and transducer position.

Keywords: Fracture, NDE

208. High Frequency Transducers — FY 1985 — $ 110,000

DOE Contact - Oscar P. Manley, 301-353-5822
Stanford University Contact - G.S. Kino, 415-497-0205

This year, a new theory has been developed for cross-coupling in acoustic transducer arrays, used for acoustic imaging. Cross-coupling changes the pulse response and the angular response of the arrays. This entirely new theoretical technique is applicable to acoustics devices for NDT, medical and sonar arrays, as well as to electromagnetic and antenna arrays. Techniques for reducing cross-coupling have also been suggested and tried with some success.

New developments have been made of air transducers operating at 1 and 2 MHz in air. These are used for precision measurements of distance in air. This is of great importance for diamond turning, robotic applications, nondestructive testing, and profile measurements in precision manufacturing.

Keywords: NDE

209. A Composite, Multiviewing Transducer FY 1985 $ 250,000

DOE Contact - Oscar P. Manley, 301-353-5822
Iowa State University Contact - D.O. Thompson, 515-294-5320

The objective of this project is to demonstrate a composite, multiviewing ultrasonic transducer suitable for detecting, characterizing, and reconstructing flaws in structural materials for various applications. Development of this transducer utilizes a combination of recent advances in ultrasonic scattering and inversion theories with new concepts in transducer configurations and excitation methods. An experimental model of a composite transducer has been used as an aid in developing the semi-automated data acquisition and protocol. It has been determined that seven transducer elements which are multiplexed using both pulse-echo and pitch-catch modes are sufficient to produce good flaw reconstructions. Effects of limited aperture on the reconstruction have also been examined. The reconstruction protocol fits the acquired data to an "equivalent" ellipsoid of general shape (3 axes, 3 angles), a shape that is compatible with a fracture mechanics description of growing flaws and thus suitable for failure prediction. Criteria have also been established for individual transducer selection using experimentally determined scattering results. It is suggested that this procedure may form an approach for the further development of new transducer standards.

Keywords: NDE

Office of Health and Environmental Research

The Office of Health and Environmental Research supports a broad multidisciplinary program in basic and applied life sciences research for the purpose of achieving a comprehensive understanding of the health and environmental effects associated with energy technologies. Research is conducted to characterize and measure energy-related hazards, study transport and transformations in the environment, determine the biological and ecological response and define the potential impact on human health. In addition, new applications of nuclear science and energy technologies are developed for use in the diagnosis and treatment of human disease. Materials interests are primarily in development of sensors for radiation and chemical detection.

Division of Physical and Technological Research

The Physical and Technological Research Division conducts physical, chemical, and instrumentation research related to the health and environmental aspects of energy technology development. Included are support of physical and chemical characterization studies, atmospheric sciences research, research on measurement and dosimetry techniques, and fundamental radiation biophysics.

210. Development of Mercuric Iodide and Other New Concepts for the Detection and Spectroscopy of Ionizing Radiation FY 1985
$ 260,000

DOE Contact - G. Goldstein, 301-353-5348, FTS 233-5348
University of Southern California Contact - G. Huth, 213-822-9184

Crystalline mercuric iodide and other semiconductor compounds are developed for detection and spectroscopy of ionizing radiation. Successful development will enable fabrication of high resolution, room temperature x-ray spectrometer systems which can be used in radiation research, space sciences, elemental analysis, and other applications. Current research includes studies of crystal growth techniques, basic physics of the interaction with x-rays, detector design, low noise electronics packages, and potential biomedical applications.

Keywords: Semiconductors, Radiation Effects, Instrumentation or Technique Development

211. Semiconductor Radiation Detector Technology FY 1985
$ 360,000

DOE Contact - G. Goldstein, 301-353-5348, FTS 233-5348
LBL Contact - F. S. Goulding, 415-486-6432, FTS 451-6432

This project is designed to develop the technology of radiation detectors with emphasis on semiconductor and other solid-state detectors. The work includes basic detector material studies, development of new types of detectors, and specialized electronic signal processing techniques. The foundation of modern spectroscopy using semiconductor detectors has been laid by this project. Recent work has focused on native defects in germanium and silicon and on defects produced by radiation damage and the relationship of these defects and detector performance. Work is in progress on multielement silicon detectors and "on-chip" techniques for readout from these detectors. Recent work has also resulted in some very significant developments in signal processing that improves both the energy resolution and counting-rate performance of spectrometers. The results produced by this project are rapidly used by a number of United States companies involved in materials, detector, and spectrometer systems development.

Keywords: Semiconductors, Radiation Effects, Instrumentation and Technique Development

212. Avalanche Photodiodes for Positron Emission Tomography FY 1985
$ 248,000

DOE Contact - G. Goldstein, 301-353-5348, FTS 233-5348
Radiation Monitoring Devices Contact - G. Entine, 617-926-1167

Modern nuclear medicine instruments provide fast and accurate data for clinical diagnosis and medical research. Many of these instruments, including Positron Emission Tomography (PET) scanners, require an array of radiation sensors which consist of a photomultiplier tube coupled to a scintillator crystal. The cost and complexity of this valuable instrument could be significantly reduced if the phototubes could be replaced by a solid state sensor. Standard solid state devices do not have enough sensitivity to be used in such applications.

This research demonstrated the feasibility of using a new sensor, the large area avalanche photodiode for PET applications. This new sensor has an internal signal gain which provides higher sensitivity than standard sensors. Research will continue to investigate and improve the avalanche photodiodes by increasing their sensitivity. Devices of suitable size and shape will be fabricated and tested for state-of-the-art PET instruments. Both of these areas represent significant commercial markets. By developing a new solid state photosensor of this type, a significant reduction in PET scanner size and complexity will be possible. This will make the instruments more practical, reliable, and less costly for both research and medical diagnostics. This would accelerate the propagation of these valuable instruments to a larger number of facilities. These detectors are also well suited to high energy physics research for applications where phototubes cannot be used, such as in high magnetic fields, or when the bulk of the phototubes makes large arrays impractical to assemble.

Keywords: Semiconductors, Surface, Instrumentation or Technique Development

<u>Office of Fusion Energy</u>

213. <u>Plasma Materials Interaction and High Heat Flux Component Development Programs</u> <u>FY 1985</u>
$5,140,000

DOE Contact - M.M Cohen, 301-353-4253
SNL Contact - W. Gusster, 415-422-1648

<u>Strategy</u>

The strategy of the PMI and HHF programs are to develop and maintain a basic long range technological capability which can be utilized by <u>all</u> confinement communities. Focusing of this technology is accomplished through performance of specific component development projects on present and future confinement facilities and experiments. This program represents a vital resource utilized by all confinement concepts.

Existing fusion plasma experimental devices do not operate under conditions which allow for development and testing of plasma interactive materials necessary for future devices. This program develops and utilizes modest off-line facilities (such as PISCES and PMTF) for materials testing and development for future devices with careful consideration being given to the relation between developmental testing in off-line devices to materials operation in actual devices.

The PMI Program participates in on-going and future fusion plasma experiments to the degree required to support the experimental programs of all confinement schemes and to carry out the materials program objectives. Examples of this type of activity are: (1) the on-going joint D&T/TFTR program to develop improved coatings and determine projected tritium inventories for TFTR with and without coatings; (2) the development of halo scraper for TMS; and (3) the development of diagnostics for the alternate concepts program. The technical assessment of critical issues and problem areas in the PMI field is given in UCLA-PPC765, 815, January 1984.

This program interacts, cooperates, and participates with programs in other countries where mutually beneficial. Examples of such cooperations are: (1) the Alt I program; (2) the JET beryllium (Be) limiter fabrication; and (3) the utilization of the ORNL surface cleaning station in TEXTOR and JET (in the future). A joint U.S./Japan workshop on PMI data needs for an ignition device is scheduled for June 1985. A programmatic strategy for international collaboration in the PMI area is given in UCLA-PPG816, "Strategy for International Collaboration in the Area of Plasma Materials Interaction and High Heat Flux Materials and Component Development."

Radiation Interaction Materials Program

The central issue for this program is to establish the theoretical and experimental basis to characterize and predict the special effects of the fusion reactor neutron environment on materials and to develop new and improved materials to meet the requirement of fusion. The basic strategy is to conduct a program of materials research and development with a primary focus on radiation effects, making optimum use of existing irradiation testing facilities and to develop and use such special facilities that are required to adequately approximate the fusion reactor environment. Increased effort will be placed on theoretical understanding and computer modeling of radiation damage effects in materials to aid in assessment of end-of-life effects and in the development of reduced activation, radiation tolerant materials.

International collaboration is a significant aspect of these program elements including present U.S.-Japan on the use of HFIR, ORR, and the RTNS-II and multinational collaboration under the IEA Implementing Agreement on Radiation Damage in Fusion Materials. Future plans are discussed on expanded use of HFIR and FFTS (MOTA) fission reactors and a restart of the now frozen action to establish international collaboration to construct and operate an FMIT-like test facility.

The neutron interactive materials program is organized in five sub-elements: Alloy Development for Irradiation Performance (ADIP), Damage Analysis and Fundamental Studies (DAFS), Special Purpose Materials (SPM), Analysis and Evaluation (A&E), and Radiation Facilities Development and Operation (RF).

214. Alloy Development for Irradiation Performance (ADIP) FY 1985

$4,270,000

DOE Contact - T.C. Reuther, 301-353-4963
ORNL Contact - A. Rowcliffe, FTS 624-5057

The scope of the ADIP program covers R&D on structural alloys and is focused on neutron irradiation efforts. Principal materials are developmental variations of austenitic stainless and 9-12Cr ferritic/martensitic starts and vanadium alloys. Reduced activation alloys are a priority development goal.

Keywords: Alloy Development, Neutron Radiation Effects, Reduced Activation Alloys, Steels

215. Damage Analysis and Fundamental Studies (DAFS) FY 1985 $1,990,000

DOE Contact - T.C. Reuther, 301-353-4963
Hanford Engineering Development Laboratory Contact - D.G. Doran, FTS 444-3187

The scope of the DAFS program is to establish the mechanistic basis to evaluate and project the effect of the fusion radiation environment from currently available irradiation facilities, to do dosimetry and damage analysis and in general to establish the fundamental response of materials to the fusion environment.

Keywords:

216. Special Purpose Materials (SPM) FY 1985 $1,100,000

DOE Contact - M.M. Cohen, FTS 233-4253
ORNL Contact - J.L. Scott, 624-4834

The scope of SPM covers radiation effects on magnet system materials (superconductor, stabilizer, insulator) ceramic applications for insulators, diagnostics, etc., Be for neutron multipliers, etc.

Keywords:

217. Tritium Breeding Materials FY 1985 $ 800,000

DOE Contact - M.M. Cohen, 301-353-4253
ANL Contact - C.E. Johnson, FTS 972-7533

The scope of the Tritium Breeding Materials program is focused on establishing the properties, behavior, and tritium breeding and release characteristics of lithium bearing oxides. It includes in-reactor and post-irradiation studies and laboratory preparations and characterization.

Keywords:

218. Analysis and Evaluation FY 1985 $ 150,000

DOE Contact - T.C. Reuther, 301-353-4963
McDonnell Douglas Astronautics Co. Contact - J. Davis, FTS 314/234-4826

The scope of the Analysis and Evaluation program is to provide a bridge between the materials and design communities. This task develops and publishes the Materials Handbook for Fusion Energy Systems.

Keywords:

219. Radiation Facilities Operation FY 1985 $3,900,000

DOE Contact - M.M. Cohen, 301-353-4253
LLL Contact - C. Henning, FTS 532-0235

This task covers the U.S. share of the joint U.S./DOE and Japanese operations of RTNS-II, or 14 MeV DT neutron source.

Keywords:

220. Operation of Oak Ridge Research Reactor FY 1985 $2,000,000

DOE Contact - T.C. Reuther, 301-353-4963
ORNL Contact - J.L. Scott, FTS 624-4834

This task covers the operating cost of the ORR for Energy Research users.

Keywords:

Small Business Innovation Research Program

The Small Business Innovation Research (SBIR) program was established in compliance with the Small Business Innovation Development Act of 1982, Public Law 97-219. The program is designed for implementation in a three-phase process, with Phase I determining, insofar as possible, the scientific or technical merit and feasibility of ideas proposed for investigation. The period of performance in this initial phase is about 6 months and awards are limited to $50,000. Phase II is the principal research or research and development effort, and awards can be as high as $500,000 for work to be performed in periods of up to 2 years. Under Phase III, commercial applications of the research or research and development are to be pursued by small businesses with non-Federal capital or, alternatively, Phase III may involve follow-on non-SBIR Federal contracts for products or processes desired by the Government.

The materials-related projects, like all other projects in the DOE SBIR program, were selected using the specific evaluation criteria listed in the program solicitation. Conclusions were reached on the basis of detailed reports returned by reviewers drawn from DOE laboratories, universities, private industry, and government. In the case of Phase II, if several proposals were judged to be of approximately equal technical merit, preference was given to those proposals that had demonstrated third phase, non-Federal capital commitments.

The work supported in this program represents high-risk research, but the potential benefits are also high if the objectives are met. Brief descriptions of all DOE SBIR projects (not just those of interest in materials research) are given in the following publications: Abstracts of Phase I Awards, 1985 (DOE/ER-0181/2), Abstracts of Phase II Awards, 1984 (DOE/ER-0209), and Abstracts of Phase II Awards, 1985 (DOE/ER-0209/1). Copies of

The Office of Nuclear Energy conducts research projects in the Office of Converter Reactor Development, the Office of Terminal Waste Disposal and Remedial Action, the Office of Uranium Enrichment, the Breeder Reactors Program, and the Office of Naval Reactors. Summarized below are the areas of research in which the Department is currently engaged.

- Conducts the Light Water Reactor R&D Program to improve the operation and availability of LWR's, extending plant lifetimes, enhancing plant safety (utilizing Three Mile Island information, as appropriate) and improving plant licensability, and plans and carries out R&D to provide base technology in High Temperature Reactors.

- Conducts R&D programs which support the development of converter reactors to exploit state-of-the-art and encouraging technologies to meet future requirements. This includes advanced LWRs, HTGRs, and innovative LMRs.

- Develops advanced Breeder Reactor Technology to determine the optimum economic, environmental, and safety qualities in plants, systems, and components preparatory to commercial application in the power plant market.

- Conducts programs to develop and apply Advanced Nuclear System technology to space and terrestrial application requirements including defense applications.

- Conducts the Naval Reactor Program to meet the nation's military requirements.

- Conducts programs to fulfill the Federal Government's responsibility for providing uranium enrichment services and for supporting low-level waste management and waste technology development.

- Conducts programs to fulfill the department's responsibilities for remedial action to protect public health and safety or to fulfill specific legislative requirements.

- Determines obstacles which stand in the way of increased use of Nuclear Energy and the steps needed to overcome them and implements other programs as directed by the Secretary.

Office of Converter Reactor Deployment

The overall mission of this office is to undertake activities which will resolve technical and institutional obstacles to the further deployment of converter reactors by private industry. This office includes the following divisions: High Temperature Reactor Development; Light Water Reactor

Projects; Nuclear Regulation and Safety; and Nuclear Reactor Economics and Financing. The major materials interests of this office include those required for the following reactor applications: fuels; fuel cladding; moderators; structural components; and heat exchangers.

Division of High Temperature Reactor Development

The objective of this division is to develop the base technology, systems concepts, and reactor designs which will permit the Government, in cooperation with utilities and private industry, to commercialize the High Temperature Reactor. The materials interests of this division include those required for the development of coated particles fuels, graphite moderator and reflector blocks, graphite core support blocks and posts, pre-stressed concrete reactor vessels, thermal barrier pads and insulation, and heat exchanger tubing and tube sheets. The DOE contact for these projects is J.E. Fox, 301-353-3985.

221. Fuel Process Development — FY 1985 $ 695,000

DOE Contact - J.E. Fox, 301-353-3985
GA Technologies Contact - O.M. Stansfield, 619-455-2895

This work includes establishing, characterizing, and qualifying fabrication processes and equipment for the preparation of microsphere fuel particles of uranium-oxycarbide (UCO) coated with layers of pyrolytic carbon (2) and silicon carbide (1). Major processing operations include solution mixing, kernel forming, drying, calcining, and sintering. Coatings are applied in a fluidized-bed furnace at temperatures up to 1600 degrees C. The objective is to develop kernel fabrication and coating specifications, which have very low defective particle yields.

Keywords: Fuels, Ceramics, Sintering, Coatings, Chemical Vapor Deposition

222. Fuel Materials Development — FY 1985 $ 510,000

DOE Contact - J.E. Fox, 301-353-3985
GA Technologies Contact - O.M. Stansfield, 619-455-2895

This work includes development of the technology base required to design, qualify, and license the fuel systems for near-term steam cycle/cogeneration and advanced process heat HTRs. These efforts are focused primarily on the low enriched uranium-oxycarbide/thorium-oxide fuel system, with limited work on advanced fuels. Major elements of the work include the preparation, testing, and evaluation of irradiation experiments, performance of post-irradiation fission product release tests, development and verification of fuel performance models, and preparation and updating of fuel specifications and a design data manual.

Keywords: Fuel, Ceramics, Coatings, Microstructure, Radiation Effects, Diffusion, High Temperature Service

223. Fuel Development and Testing

FY 1985
$ 880,000

DOE Contact - J.E. Fox, 301-353-3985
ORNL Contact - M.J. Kania, 615-576-4856

This work supports development of the technology base required to design, qualify, and license the fuels systems for near-term steam cycle/cogeneration and advanced process heat HTRs. These efforts are focused primarily on the low enriched uranium-oxycarbide/thorium-oxide fuel system, with limited work on advanced fuels. Major elements of the work include services associated with the design, assembly, and irradiation of fuel capsules, and post-irradiation examination work in support of qualification and licensing of the reference fuel system.

Keywords: Fuel, Ceramics, Coatings, Microstructure, Radiation Effects, Diffusion, High Temperature Service

224. Graphite Development

FY 1985
$ 950,000

DOE Contact - J.E. Fox, 301-353-3985
GA Technologies Contact - H. Jones, 619-455-2360

This work includes the selection, characterization, and qualification of graphite materials for applications in HTRs. These efforts are focused on the development of an improved fundamental understanding of the behavior of graphite under representative HTR environmental and loading conditions. Major goals of this work are to develop high strength graphites with sufficient stability under irradiation to be qualified for core components, and with sufficient oxidation resistance to be qualified for reflector components. The major elements of this work are the identification, selection, and characterization of candidate materials, and the development of graphite materials behavior and failure criteria required for reliable design analyses.

Keywords: Graphite, Ceramics, Irradiation Effects, Strength, Corrosion, High Temperature Service

225. Graphite Development and Testing

FY 1985
$ 845,000

DOE Contact - J.E. Fox, 301-353-3985
ORNL Contact - W.P. Eatherly, 615-574-5220

This work supports the selection, characterization, and qualification of graphite materials for applications in HTRs. These efforts are focused on the development of an improved fundamental understanding of the behavior of graphite under representative HTR environmental and loading conditions. Major goals of this work are to develop high strength graphites with sufficient stability under irradiation to be qualified for core components, and with sufficient oxidation resistance to be qualified for reflector components. The major elements of this work include characterization of the mechanical, physical, and chemical properties of candidate graphites and determinations of the effects of irradiation on mechanical and physical properties.

Keywords: Graphite, Ceramics, Irradiation Effects, Strength, Corrosion, High Temperature Service

226. Metals Technology Development — FY 1985 $1,055,000

DOE Contact - J.E. Fox, 301-353-3985
GA Technologies Contact - D.I. Roberts, 619-455-2560

This work includes testing activities to characterize and qualify the metallic materials selected for applications in the near-term steam cycle/cogeneration HTR system, and development efforts to provide the base technology required for selection of alloys for advanced HTR systems. Both tasks involve major evaluations of the effects of extended high temperature exposure in simulated helium environments on structural integrity. Other significant objectives of the work are to identify the database required for code qualifications, determine the welding and heat treating procedures for all bimetallic joints, and evaluate the friction and wear behavior of candidate protective coatings. Principal alloys include 2 1/2 Cr-1 Mo steel, Alloy 800H, Hastelloy X, Inconel 718, and developmental Ni-base alloys.

Keywords: Alloys, Coatings, Strength, Corrosion, Erosion and Wear, Joining, Microstructure, High Temperature Service

227. Structural Materials Development — FY 1985 $ 585,000

DOE Contact - J.E. Fox, 301-353-3985
ORNL Contact - P.L. Rittenhouse, 615-574-5103

This work includes testing activities to characterize and qualify the metallic materials selected for application in HTGR-SC/C plant components and structures. The emphasis of the work is to support the design of components which operate in the primary coolant circuit, where the service temperatures are the highest and the materials may be adversely affected by trace amounts of impurities in the helium coolant. The primary testing activities include evaluations of the effects of extended high temperature exposures in simulated helium and air environments on mechanical properties, development of steam generator tube welding procedures, and determination of the fracture toughness of concrete reactor vessel penetration steels.

Keywords: Alloys, Strength, Corrosion, Joining, Microstructure, High Temperature Service

228. Advanced Gas Reactor Materials Development — FY 1985 1,070,000

DOE Contact - J.E. Fox, 301-353-3985
General Electric Co. Contact - O.F. Kimball, 518-385-1427

This work includes the identification, evaluation, and development of the high temperature alloys required for application in advanced HTRs that will operate at temperatures above 750 degrees C. The primary activity is operation of a major alloy testing laboratory specifically designed for extended high temperature exposures of mechanical property specimens and corrosion samples in simulated helium reactor environments. Major work elements include screening mechanical property and corrosion testing of commercially available and developmental candidate alloys, selection of candidate reference alloys for continued testing, and the generation of a database for development of high temperature design criteria and code qualification rules.

Keywords: Alloys, Strength, Corrosion, Joining, Microstructure, High Temperature Service

Division of Light Water Reactor Projects

The mission of the Division of Light Water Reactor Projects is to develop and demonstrate advanced technology for use in light water reactors in accord with national policies and goals. Although no separately identified materials program exists within the projects being sponsored by the division, materials testing and developmentwork is underway within several projects of the division's extended burnup program. DOE contact is P.M. Lang, 301-353-3313.

Office of Terminal Waste Disposal and Remedial Action

Division of Storage and Treatment Projects

The mission of the Division of Storage and Treatment Projects is to facilitate development of a reliable national system for managing low-level waste and to develop acceptable technologies for the treatment and immobilization of nuclear fuel cycle and special types of radioactive waste.

229. Technical Support to West Valley Demonstration Project

FY 1985
$2,500,000

DOE Contact - H.F. Walter, 301-353-4728
PNL Contact - H.C. Burkholder, 509-375-2860

Provide technical assistance in supernate treatment and borosilicate glass formulation for West Valley Demonstration Project waste.

Keywords: Radioactive Waste Host

230. Materials Characterization Center Testing at West Valley Formulation Glass

FY 1985
$ 200,000

DOE Contact - H.F. Walter, 301-353-5510
PNL Contact - J.E. Mendel, 509-375-2905

Evaluate, using various MCC test methods, samples of glass having the expected composition of West Valley borosilicate glass incorporating high-level waste.

Keywords: Radioactive Waste Host

231. <u>Nuclear Waste Treatment</u> FY 1985 $6,500,000

DOE Contact - J.B. Zorn, 301-353-4728
PNL Contact - H.C. Burkholder, 509-375-2860

Develop acceptable technologies for treatment and immobilization of waste from the nuclear fuel cycle and special waste.

Keywords: Radioactive Waste Host

232. <u>West Valley Joule Heated Ceramic Melter Design and Fabrication</u> FY 1985 $ 0

DOE Contact - T.W. McIntosh, 301-353-4728
PNL Contact - H.C. Burkholder, 509-375-2860

Working closely with the West Valley Demonstration Project, design and fabricate a liquid fed joule heated ceramic melter capable of making about 0.8 cubic meters per day of borosilicate glass incorporating West Valley high-level waste. Specific components include the melter, the canister loading and unloading turntable, and the enclosing turntable shroud.

Keywords: High Temperature Service, Radioactive Waste Host

233. <u>Special Waste Form Lysimeter for Arid Regions</u> FY 1985 $ 250,000

DOE Contact - J.L. Smiley, 301-353-4728
EG&G Idaho Contact - E. Jennrich, 208-526-9490

Conduct waste form leaching tests in a field facility in order to determine typical source terms generated by commercial solidified low-level waste in an arid climate, identify the chemical and physical processes that control the concentrations of radionuclides in the surrounding soil, and determine methods for representing the source term boundary conditions for transport models.

Keywords: Radioactive Waste Host

234. <u>Special Waste Form Lysimeter for Humid Regions</u> FY 1985 $ 250,000

DOE Contact - J.L. Smiley, 301-353-4728
EG&G Idaho Contact - E. Jennrich, 208-526-9490

Conduct waste form leaching tests in a field facility in order to determine typical source terms generated by commercial solidified low-level waste in a humid climate, identify the chemical and physical processes that control the concentration of radionuclides in the surrounding soil, and compare radionuclid emigration from solidifed commercial low-level waste in order to evaluate the benefits of solidification.

Keywords: Radioactive Waste Host

Office of Uranium Enrichment

The specific statutory authority which established the Department of Energy's role in the enrichment of uranium is the Atomic Energy Act of 1954, as amended. The goal of the uranium enrichment program is to meet the requirements of domestic and foreign customers and the United States Government for uranium enrichment services in an economical, reliable, safe and environmentally acceptable manner. The Office of the Deputy Assistant Secretary for Uranium Enrichment, reporting to the Assistant Secretary for Nuclear Energy, is responsible for the management of DOE resources to attain the uranium enrichment goal. Uranium enrichment is composed of four major offices: Marketing and Business Operations, Operations and Facility Reliability, Technology Deployment and Strategic Planning, and Advanced Technology Projects and Technology Transfer. Operations and Facility Reliability is responsible for overseeing all aspects of the gaseous diffusion plants including the electrical power contracts which are a major cost element. The Technology Deployment and Strategic Planning Office is responsible for integrating production, business, marketing and technology development plans into a single strategic plan for the uranium enrichment enterprise. This includes working with the private sector to determine optimum means of financing new technology deployment. This Office is also responsible for the orderly termination and search for alternative uses for the canceled Gas Centrifuge Enrichment Plant (GCEP) project and the Advanced Gas Centrifuge (AGC) equipment and facilities. The Office of Advanced Technology Projects and Technology Transfer is responsible for all research/development/demonstration and generation of production plant concepts for the Atomic Vapor Laser Isotope Separation (AVLIS) technology.

Revenues received by DOE for the enrichment of uranium are retained and used for the specific purposes of offsetting costs incurred by the Department in providing uranium enrichment service activities as authorized by Section 201 of Public Law 95-238, not withstanding the provisions of Section 3617 of the Revised Statutes (31 USC 484). The sum appropriated is reduced as uranium enrichment revenues are received during a fiscal year so as to result in a final fiscal year appropriation estimated at $0. Total obligations for all uranium enrichment activities in FY 1985 was $1.678 billion and is expected to be $970 million in FY 1986.

Materials activities within the Office of Uranium Enrichment are varied and for the most part, especially the test results, classified Restricted Data. The following summarizes most of these activities for the purpose of this report. The total outlay in FY 1985 was $62,848,000. The DOE contact is A.P. Litman, 301-353-5777.

235. Gaseous Diffusion: Barrier Quality

FY 1985
$1,085,000

Studies of the short- and long-term changes in the separative capability of the diffusion barrier. Methods to recover and maintain barrier quality and demonstration in the production facilities. This activity is a long-term undertaking and will be maintained at the appropriate levels of effort in the future.

236. Gaseous Diffusion: Barrier Science

FY 1985
$1,020,000

Fundamental aspects of the diffusion barrier, Work on barrier theory is performed and assistance is given to the barrier quality activities. This activity will be completed in FY 1985.

237. Gaseous Diffusion: Materials and Chemistry Support

FY 1985
$2,874,000

Routine materials and chemistry support of the diffusion plants. Characterization of contaminant-process gas cascade reactions, physical/chemical properties of UF_6 substances, corrosion of materials, failure analyses, trapping technology, alternative materials replacement.

238. Gas Centrifuge

FY 1985
$33,469,000

The program for enrichment of uranium by means of the gas centrifuge process was terminated by the Secretary of Energy in June 1985. Immediately thereafter, construction ceased on GCEP in southern Ohio, and all development of the AGC was terminated. Current activity is dedicated to decommissioning and decontamination of manufacturing and development facilities, disposal of surplus materials and equipment, and final document of progress through termination.

Prior to program termination, materials related activities in support of the AGC were:

	FY 1985
Rotor Tubes	$14,492,000
Caps and Baffles	2,386,000*
Advanced Classified Materials	5,000,000
Characterization of Test Specimens	11,591,000

Approximately 1,200 gas centrifuges have been retained for possible use in enrichment of isotopes other than uranium. Centrifuge facilities at the gaseous diffusion plant site in Oak Ridge, Tennessee, are being retained in operating condition until it is determined whether they will be needed for alternate enrichment activity. Also alternate sources of funding are being sought in order to provide effective technology transfer of unclassified portions of the centrifuge technology.

* End Caps, Transitions, and Column

239. AVLIS

The AVLIS process is based on utilizing the differences in the electronic spectra of atoms of uranium isotopes to induce the selective absorption required for isotopic separation. The process utilizes the controlled vaporization of uranium atoms followed by selective excitation and ionization of uranium 235 using tunable lasers in the visible regions of the spectrum. The resulting plasma of uranium enriched in uranium 235 ions can then be removed from the vapor using electromagnetic methods. In June 1985, DOE selected AVLIS for further development and possible future deployment into the uranium enrichment enterprise. The primary emphasis for AVLIS in FY 1985 was to provide a significant demonstration for this selection decision. Available resources were focused to this goal and also to the operation of existing testbeds to conduct and evaluate key subsystems. In FY 1986, AVLIS will continue the development and operation of the first phase of a Laser Demonstration Facility, which is a copper vapor laser pumped dye laser system. In addition, a one-half scale separator facility will be operated to provide component development and design data for a full scale Separator Demonstration Facility (SDF). The SDF atomic vapor source will be tested and operated for extended periods of time. Most of the AVLIS materials activities in FY 1985 revolved around the process separator development.

Separator Technology Development — FY 1985: $24,200,000

Coating development for various substrates to contain uranium and development/demonstration of engineering subcomponents. Approximately $14,000,000 of the amount shown was and will be used for materials selection, property evaluation, analysis and testing in a full scale AVLIS environment.

Keywords: Enrichment, Gaseous Diffusion, Uranium, Gas Centrifuge, Laser Isotope Separation

Office of Reactor Systems, Development and Technology

Division of Special Applications

The Division of Special Applications is responsible for the development, system safety and production of radioisotope thermoelectric generators (RTG) and dynamic power systems for NASA and DoD space and terrestrial applications and advancing base technologies for these power systems. Thus, applied materials research programs are supported in the areas of thermoelectric materials and devices, high temperature heat source materials, materials systems compatibility and safety related materials characterization and testing.

240. Development of Improved Thermoelectric Materials for Space Nuclear Power Systems — FY 1985: $ 850,000

DOE Contact - W.J. Barnett, 301-353-3097 (FTS 233-3097)
General Electric Co. Contact - P.D. Gorsuch, 215-354-5047

The prime objective of this program is to optimize the thermoelectric performance of silicon-germanium type materials by a systematic study of compositional (i.e., alloy and dopant additions) and processing parameters (i.e., powder preparation techniques, including rapid solidification powder particle size, hot pressing, variables, etc.). Property characterization shall include the following: electrical resistivity, Seebeck voltage, thermal conductivity, Hall effect and density measurements. Structural characterization shall employ the following evaluation techniques: optical microscopy, x-ray diffraction, SEM, STEM, EDAX, ESCA and EXAFS. A statistical experimental design shall be employed. The goal is an average figure of merit, Z, of 1 X 10^{-3} $^{o}C^{-1}$ over the temperature range of 300^{o}C to 1000^{o}C.

Task 2 of this program is comprised of exploratory studies of advanced refractory candidate thermoelectric materials. The goal is a potential average figure of merit, Z, of 1.3 X 110^{3} $^{o}C^{1}$ over the temperature range of 300^{o}C to 1000^{o}C. Principal candidates include beta-boron and boron carbide.

Improved thermoelectric materials are required to enhance the performance of advanced radioisotope thermoelectric generators, the primary space power system employed in NASA spacecraft for deep space exploration.

Keywords: Semiconductors, Consolidation of Powder, Solidification-Rapid, Structure, Thermoelectric

241. Development of an Improved Process for the Manufacture of DOP-26 Iridium Alloy Blanks — FY 1985: $ 525,000

DOE Contact - W.J. Barnett, 301-353-3097 (FTS 233-3097)
ORNL Contact - R.L. Heestand, 615-574-4352 (FTS 624-4352)

An iridium alloy, DOP-26 (i.e., Ir-0.3 wt.% W with Th and Al dopant additions), serves as the fuel clad or capsule material for isotope heat sources employed in recent and contemporary space power systems for NASA deep space missions such as Voyager and Galileo. This program is aimed at the development of an improved process route for the production of DOP-26 iridium alloy sheet, namely a consumable arc cast/extrusion/"warm" rolling route. Thermomechanical process parameters shall be optimized with respect to uniformity of product grain morphology.

It is anticipated that the consumable arc cast/extrusion route process will replace the currently employed arc drop cast ingot/warm roll sheet process and shall yield a significant improvement in process yields and product quality. A prime goal for the new process is a 50% reduction in reject rate (i.e., from 30% to 15% or below) due to ultrasonic indications (i.e., laminar type defects).

Keywords: Metals - Non-ferrous, Extrusion, High Temperature Service

242. Carbon Bonded Carbon Fiber Insulation Manufacturing Process Development and Product Characterization

FY 1985
$ 330,000

DOE Contact - W.J. Barnett, 301-353-3097 (FTS 233-3097)
ORNL Contact - W.P. Eatherly, 615-574-5220 (FTS 624-5220)

Carbon-bonded carbon fiber (i.e., CBCF) type thermal insulation material is employed in Isotopic General Purpose Heat Source Module assemblies for use in current GPHS-RTG (i.e., radioisotope thermoelectric generator) which will power the spacecraft for the NASA Galileo and ESA Ulysses missions. This CBCF process development program is intended to accommodate a replacement carbon fiber (note: present specified fiber is no longer available), improve process controls, and optimize process parameters. The product shall meet prior flight quality CBCF specification. Product characterization shall include chemical purity, density, compressive strength, and thermal conductivity. A valid correlation shall be developed between thermal conductivity and thermal diffusivity of both new and previously produced CBCF products.

Keywords: Insulators/Thermal, High Temperature Service, Fibers

243. Characterization of State-of-the-Art Thermoelectric Device/Materials and Exploratory Studies of Rare Earth Sulfide Thermoelectric Materials

FY 1985
$ 400,000

DOE Contact - W.J. Barnett, 301-353-3097 (FTS 233-3097)
Iowa State University Contact - B. Beaudry, 515-294-1366

This program is concerned with the evaluation and characterization of state-of-the-art Si-Ge/GaP and other "improved" silicon-germanium type thermoelectric materials. Also the compatibility of materials employed in the manufacture of the multicouple (i.e., close packed arrays of couples) device is being studied. Long-term stability of thermal and electrical properties of thermoelectric materials and devices will be studied.

In addition, exploratory studies of the thermoelectric properties of rare earth chalcogenides are being studied. Fabrication techniques are being developed. Particular attention is being directed toward rare earth ternary sulfides.

Improved thermoelectric materials are required to enhance the performance of advanced radioisotope thermoelectric generators, the primary space power system employed in NASA spacecraft for deep space exploration.

Keywords: Semiconductors

Office of Space Reactor Projects

Investigation of fundamental material properties and resolution of compatibility issues are critical for the successful development of space nuclear reactor power systems. Feasibility of using refractory metals in a reactor concerns the material transport fluid/cladding/fuel chemical interaction. Knowledge of the creep strength, ductility, fracture toughness, and fabricability of refractory alloys is an important factor for this selection. The candidate structural materials include molybdenum, noibium, tantalum, and tungsten-based alloys.

One objective is the measurement of the high temperature creep strength and the DPTT of refractory alloy, wrought and weldment specimens, for use in early structural alloy selection decisions. A second objective is to analyze the available high temperature creep data for candidate refractory alloys.

Office of Breeder Technology Projects

The applied research and development technology activities, conducted at several national laboratories, industrial organizations, universities, and through bilateral and trilateral technology programs and exchanges with foreign nations, relate to current and advanced reactor systems. The scope of these activities include the following areas: fuel cycles; design and performance of high quality core components for fuels, blanket, and control systems; development of the structural materials used in these components and systems; development and demonstration of equipment, processes, and procedures for fabricating, processing, handling, and producing mixed oxide bearing fuels, materials, and components; sodium technology; standards and quality assurance; assuring a reliable high quality economical fuel supply for LMRs; destructive and non-destructive testing, examination, and evaluation of core components and the facilities and capabilities for conducting such examinations; responsibility for engineering and supporting facilities; associated safety, safeguards, and non-proliferation; maintaining competent capabilities in the several contractor organizations that conduct the pertinent R&D activities and programs. These activities are responsive to the administration's policies and goals and to the DOE programs that support them.

In-reactor and out-of-reactor property evaluations are being conducted on core materials, clad/ducts, fuels, and absorber materials. Through irradiation testing in FFTF and EBR-II, the Fuels and Core Materials Program is developing, qualifying, and verifying the use of reference, improved, and advanced mixed oxide fuels and boron carbide absorbers, including full size driver and blanket fuel, and absorber element pins and assemblies-same for carbide fuels. Fabrication development, evaluation, qualification, and verification (raw material processing, melting, hot working, cold working, and finishing) are conducted on reference, improved, and advanced alloys including in-reactor qualification of pins, ducts, and assemblies; surveillance assemblies of reference materials now in FFTF Core 1. Improved and advanced materials are being tested for use in future cores.

The objectives of the Materials and Structures Program are to develop procedures that will assure economic and safe components and systems while providing designers with sufficient flexibility in components and systems design to facilitate optimization. Materials being evaluated are low alloy and stainless steels as well as ferrous superalloys. Major areas include materials characterization, radiation effects, mechanical properties, joining methods, non-destructive testing, tribology, corrosion and wear, and materials data documentation. The DOE contact for the Fuels and Core Materials Division is Dave Nulton, 301-353-5004, and Nick Grossman, 301-353-3405 for the Materials and Structures Program. Project summaries were not submitted.

Office of Naval Reactors

The Materials Research and Development Program is in the Reactor Materials Division under the Deputy Assistant Secretary for Naval Reactors. The program supports the development and operation of improved and longer life reactors and pressurized water reactor plants for naval nuclear propulsion. The objective of the materials program is to develop and apply in operating service materials capable of use in the high power density and long life required of naval ship propulsion systems. This work includes irradiation testing of reactor fuel, poison, and cladding materials in the Advanced Test Reactor at the Idaho National Engineering Laboratory. This testing and associated examination and design analysis demonstrates the performance characteristics of existing materials as well as defining the operating limits for new materials.

Corrosion, mechanical property, and wear testing is also conducted on reactor plant structural materials under both primary reactor and secondary steam plant conditions to confirm the acceptability of these materials for the ship life. This testing is conducted primarily at two Government laboratories: Bettis Atomic Power Laboratory in Pittsburgh; and Knolls Atomic Power Laboratory in Schenectady, New York.

One result of the work on reactor plant structural material is the issuance of specifications defining the processing and final product requirements for materials used in naval propulsion plants. These specifications also cover the areas of welding and non-destructive testing.

Funding for this materials program is incorporated in naval projects jointly funded by the Department of Defense and the Department of Energy. This funding amounts to approximately $60 million in FY 1985 including over $30 million as the cost for irradiation testing in the Advanced Test Reactor. The Naval Reactors contact is Robert H. Steele, FTS 557-5565.

Office of Storage and Transportation Systems

244. Development of Criteria for Nuclear Spent Fuel Storage in Air

FY 1985
$ 600,000

DOE Contact - D.E. Shelor, 202-252-9433
PNL Contact - E.R. Gilbert, 509-375-2533

This project performs applied research to characterize the oxidation behavior of commercial UO_2 spent nuclear fuel. In case a few spent fuel assemblies containing fuel rods with undetected reactor induced breached cladding are placed into dry storage, this research will assure that dry storage conditions will not permit significant oxidation of the exposed UO_2. Laboratory tests are being conducted to determine the oxidation behavior of spent fuel and unclad UO_2. The tests are in the range of 135 to 230°C and the test matrix was statistically designed to provide data to determine acceptable fuel temperatures and storage criteria. Test variables also include an imposed gamma field, typical of that in a dry storage cask, and moisture and burnup levels bracketing those encountered in a dry storage cask.

Keywords: Spent Fuel, UO_2 Oxidation, Interim Dry Storage, Fuel Degradation

245. Development of Zircaloy Deformation and Creep Rupture Models for Predictive Cladding Behavior During Interim Dry Storage

FY 1985
$ 80,000

DOE Contact - D.E. Shelor, 202-252-9433
PNL Contact - E.R. Gilbert, 509-375-2533

This project predicts the temperature-time conditions that commercial LWR spent fuel can be exposed to during interim dry storage without undergoing significant creep rupture of the Zircaloy fuel cladding. It uses the existing data base on nonirradiated Zircaloy cladding to develop theoretical models for deformation and creep rupture for spent fuel interim dry storage conditions, and uses the models to predict the envelope of acceptable temperature-time storage conditions. Models of deformation include diffusional creep, grain boundary sliding, and diffusion controlled dislocation creep. Models of degradation by creep include transgranular cracking, triple point cracking, and cavitation. A comparison of predictions with the Federal Republic of Germany deformation and creep rupture data on spent fuel rods and irradiated Zircaloy cladding provide a means of verifying the predictions for these prototypic cases.

Keywords: Cladding Rupture, Spent Fuel, Zircaloy Cladding

246. Behavior of Water-Logged Spent Fuel During Interim Dry Storage

FY 1985
$ 80,000

DOE Contact - D.E. Shelor, 202-252-9433
PNL Contact - E.R. Gilbert, 509-375-2533

This project performs tests with water-logged spent nuclear fuel to determine their behavior under dry storage conditions. Spent fuel rods with reactor breaches tend to become water-logged. The tests with water-logged spent fuels are designed to determine the moisture inventories and moisture release characteristics from Zircaloy-clad UO_2 during dry storage system drying operations. The tests are performed in the temperature range of 100 to 400oC. The results are expected to reveal if sufficient moisture is released to the storage system to react with Cesium and form products corrosive to the storage system components and seals.

Keywords: Spent Nuclear Fuel, Water-Logged Spent Fuel, Moisture Release

Basalt Waste Isolation Project Waste Package Materials Development

247. Metal Barriers Development for Nuclear Waste Packages

FY 1985
$ 1,780,000

DOE Contact - P.E. Lamont, 509-376-6117
Rockwell Hanford Operations Contact - T.B. McCall, 509-376-7114

The objective of the waste package container materials program is to identify and characterize a waste package container material that will provide reasonable assurance of nuclear waste containment for 1000 years in a repository mined in basalt. Materials being considered include low carbon steel, Fe9Cr1Mo steel, copper and 90-10 cupronickel. Investigations include uniform and pitting corrosion testing and testing for environmentally assisted cracking under air-steam, hydrothermal and irradiated conditions expected for a repository constructed in basalt. Data will be used to provide a mechanistic understanding of container degradation and to establish waste package container design requirements.

Keywords: Metals, Ferrous and Non Ferrous, Radioactive Waste Host, Corrosion, Aqueous; Radiation Effects, Nuclear Waste Disposal, Predictive Behavioral Modeling

248. Packing Materials Development for Nuclear Waste Packages

FY 1985
$1,280,000

DOE Contact - M.S. Furman, 509-376-7062
Rockwell Hanford Operations Contact - P.F. Salter, 506-376-7207

Crushed basalt and sodium bentonite clay composites are being investigated for use as a packing material around nuclear waste containers which will retard/limit long term radionuclide release from the waste package under conditions expected for a repository constructed in basalt.

249. Waste Package Materials Integrated Testing

FY 1985
$ 2,850,000

DOE Contact - M.J. Furman, 509-376-7062
Rockwell Hanford Operations Contact - P.F. Salter, 509-376-7207

The objective of the waste package integrated testing program is to investigate waste package component interactions related to controlling release of radionuclides from the waste package. This information is required in order to determine if the waste package will meet assigned radionuclide release rate design objectives systems. The systems studied include various combinations of the following components: fully radioactive waste forms (spent fuel or borosilicate glass), metal container, packing, basalt host rock and groundwater. The tests are conducted under hydrothermal conditions expected for a repository mined in basalt using Dickson, Parr and flow-through autoclaves. Parameters evaluated during testing include bulk solution composition, radionuclide concentrations, solid phase alteration and system redox conditions. Concentration data are used directly in models analyzying radionuclide release from the waste package; other data collected are used in evaluating the long term (10,000 year) controlled release performance of the waste package.

Keywords: Radioactive Waste Host, Nuclear Waste Disposal, Solubility, Spent Fuel Dissolution, Glass Dissolution, Glass & Refractory Ceramics, Predictive Behavioral Modeling

250. Waste Package Container Welding and NDE Process Development

FY 1985
$ 70,000

DOE Contact - P.E. Lamont, 509-376-6117
Rockwell Hanford Operations Contact - T.B. McCall, 509-376-7114

The objective of this program is to develop a remote welding and non-destructive examination process for waste package containers which will ensure the integrity of the welds such that they have the same corrosion resistance as the base metal in the expected nuclear waste repository environment. The sealed container is being designed to achieve a lifetime of 1000 years for containment of high level nuclear waste. The candidate materials include low carbon steel, cupronickel and copper.

Keywords: Radioactive Waste Host, Metals, Joining/Welding, NDE

251. Waste Package Packing Fabrication Process Development

FY 1985
$ 100,000

DOE Contact - P.E. Lamont, 509-376-6117
Rockwell Hanford Operations Contact - R.B. McCall, 509-376-7114

The objective of this program is to develop a fabrication and emplacment process for waste package packing which will ensure that the packing will meet its post-closure performance requirements. These requirements include structural integrity to limit the flow of groundwater around the nuclear waste container to values sufficiently low to ensure mass transport is dominated by diffusion. The packing consists of a mixture of crushed basalt rock and sodium bentonite clay. The material will be mixed with water and formed into compacted rings and cylinders to envelope the nuclear waste container and provide an engineered barrier between the container and the mined repository borehole wall.

Keywords: Radioactive Waste Host, Nuclear Waste Disposal, Clay, Basalt, Consolidation, Composites (Packing)

252. High Temperature PH and EH Probe Development FY 1985
$ 150,000

DOE Contact - M.J. Furman, 509-376-7062
Rockwell Hanford Operations Contact - P.F. Salter, 509-376-7207

The objective of this program is to develop high temperature (100-300oC) pH and Eh probes for use in the engineered barriers integrated testing program in order to directly measure pH and Eh in the systems studies. Ytrium doped zirconia is being investigated for the pH probe and platinum for the Eh probe. A reference electrode also is being developed for the system. These probes are being designed for use in permeameters and high temperature autoclaves currently in use in the waste package materials testing program. The probes are also being designed for use in fully radioactive experiments requiring hot cells.

Keywords: Instrumentation or Technique Development, Hydrothermal, Redox Probe, Nuclear Waste Disposal, pH Probe, Electrochemical

Office of Geological Repositories Nevada Nuclear Waste Storage Investigations Project (OGR/NNWSI)

The primary goal of the OGR/NNWSI materials program is the development of Tuff specific waste packages that meet the performance requirements of the NRC criteria and are cost effective. This goal requires the definition of physical and chemical conditions of the site, selection of package materials, waste package design activity, prototype waste package fabrication, and performance testing.

253. Waste Package Environment FY1985
$ 590,000

DOE Contact - D.L. Vieth, 702-295-3662
LLNL Contacts - L. Ballou, 213-422-4911; V. Obersby, 213-423-2228

Characterize the time-dependent behavior of the hydrogeologic environment in which the waste packages will reside in order to establish the envelope of conditions that define package design parameters, materials testing conditions, and boundary conditions for performance analysis.

Keywords: Radioactive Waste Host

254. Waste Form Testing FY 1985
$ 1,550,000

DOE Contact - D.L. Vieth, 702-295-3662
LLNL Contacts - L. Ballou, 213-422-4911; V. Oversby, 213-423-2228

Characterize the behavior of and determine the radionuclide release rates for the various waste forms in the geological tuff environment and as modified by corrosion products in the Metal Barrier Testing.

Keywords: Radioactive Waste Host

255. Metal Barrier Testing FY 1985
$ 1,750,000

DOE Contact - D.L. Vieth, 702-295-3662
LLNL Contacts - L. Ballou, 213-422-4911; R.D. McCright, 213-423-7051

Characterize the behavior of and determine the degradation modes and rates for candidate metallic barrier materials in the environment. This information is needed to establish the data base to support license applications predictions of containment of radioactivity for times required by NRC 10 CFR 60.

Keywords: Materials Degradation, Radioactive Waste Host

256. Other Engineered Barrier Waste Package Components FY 1985
$ 325,000

DOE Contact - D.L. Vieth, 702-295-3662
LLNL Contacts - L. Ballou, 213-422-4911; V. Oversby, 213-423-2228

Characterize the properties and behavior of other engineered barrier waste package components that may be present in a repository. This information is needed to establish the predicted performance of other materials, such as packing materials, that may be present to assist waste forms and metal barriers in meeting NRC 10 CFR 60 performance requirements.

Keywords: Radioactive Waste Host

257. Waste Package - Performance Assessment FY 1985
$ 600,000

DOE Contact - D.L. Vieth, 702-295-3662
LLNL Contacts - L. Ballou, 213-422-4911; V.K. Eggert, 213-423-6779

Provide a quantitative prediction of long-term waste package performance. This information, including uncertainties, is needed to provide feedback to design optimization studies, to demonstrate compliance with NRC performance objectives for the Waste Package Subsystem, and to provide a source term for the Engineered Barrier System and the Total System performance assessments required by NRC 10 CFR 60 and EPA 40 CFR 191.

Keywords: Radioactive Waste Host

258. Research on Modeling of Radionuclide Migration in a Fractured Rock Matrix

FY 1985
$ 530,000

DOE Contact - D.L. Vieth, 702-295-3662
LLNL Contacts - D. Emerson, 213-422-6504; T. Wolery, 213-423-5789

Further develop the geochemical modeling code EQ3/6 for use in long-term predictions of radionuclide release from a nuclear waste repository.

Keywords: Radioactive Waste Host, Computer Modeling

259. Spent Fuel Storage in Crystalline Rock

FY 1985
$ 800,000

DOE Contact - D.L. Vieth, 702-295-3662
LLNL Contact - W. Patrick, 213-422-6495

Demonstrate the feasibility of short-term storage and retrieval of spent, unreprocessed fuel; to measure the response of a crystalline rock mass to simulated repository conditions and use these data to validate thermal and thermomechanical models; and to compare the effects of heat alone and heat in combination with intense ionizing radiation on a crystalline rock mass.

Keywords: Radioactive Waste Host

260. Rockmass Analysis - Yucca Mountain Media

FY 1985
$ 321,000

DOE Contact - D.L. Vieth, 702-295-3662
SNL Contact - S. Bauer, 505-846-9645

Evaluate intact and rockmass thermomechanical properties based on analysis of available laboratory and field experiments and finite element analyses. This information will be used to recommend rock properties for calculations that support the conceptual design, Environmental Assessment (EA), and Site Characterization Plan (SCP).

Keywords: Radioactive Waste Host

261. Field Tests - Welded Tuff - G-Tunnel - NTS

FY 1985
$ 929,000

DOE Contact - D.L. Vieth, 702-295-3662
SNL Contact - R.M. Zimmerman, 505-846-0187

G-Tunnel on the Nevada Test Site (NTS) contains welded tuffs that have stress states and thermal and mechanical properties similar to those of welded tuffs in Yucca Mountain, the prospective site for a radioactive waste repository. Until field experiments can be carried out in the exploratory shaft (ES) in Yucca Mountain, field testing is being conducted in G-Tunnel to provide information and test results under conditions similar to those at the ES.

Keywords: Radioactive Waste Host

262. Tuff-Laboratory Properties

FY 1985
$ 683,000

DOE Contact - D.L. Vieth, 702-295-3662
SNL Contact - F.B. Nimick, 505-844-6696

Develop, through laboratory measurements, a data base for the bulk, thermal, and mechanical properties of tuff. The data base will include the spatial variation of these properties and the variations of the properties that result from variations in environmental parameters (e.g., temperature, pressure, and moisture content).
Keywords: Radioactive Waste Host

263. Sealing Materials Evaluation

FY 1985
$ 220,000

DOE Contact - D.L. Vieth, 702-295-3662
Penn State University Contact - D.M. Roy
LLNL Contact - C. Duffy, 505-843-5154

Develop sealing materials for fractures, boreholes, and access shafts and drifts and assess their chemical stability and possible effects upon water chemistry. In particular, determine how changes in mineralogy or dissolution may affect the permeability of the seals and if interaction between water and seals can change the water chemistry in such a way as to increase waste-element solubility.

Keywords: Radioactive Waste Host

264. Waste Package - Design, Fabrication and Prototype Testing

FY 1985
$ 400,000

DOE Contact - D.L. Vieth, 702-295-3662
LLNL Contacts - L. Ballou, 213-422-4911; E. Russell, 213-423-6398

Develop, analyze, fabricate, and test waste package designs that incorporate qualified materials which are fully compatible with the repository design. This work supports license application by demonstrating conformance with requirements for safe handling, emplacement, possible retrieval, and credible accident conditions per NRC 10 CFR 60 and 10 CFR 71 in a cost-effective manner.

Keywords: Waste Package Development

265. Waste Package Environmental Field Tests

FY 1985
$ 665,000

DOE Contact - D.L. Vieth, 702-295-3662
LLNL Contacts - L. Ballou, 213-422-4911; J. Yow, 213-423-3521

Develop a detailed engineering test plan for the waste package environment in situ testing program and evaluate, design, fabricate, and test thermomechanical and hydrologic instrumentation for waste package in situ test measurements.

Keywords: Instrumentation Development

Salt Repository Project

The Salt Repository Project has sponsored a Waste Package Program at PNL that has the objective of conducting nuclear waste package component development and interactions testing, and applying the resulting database to the development of predictive models describing waste package degradation and radionuclide release.

266. Waste Form Evaluation Task

FY 1985
$ 465,000

DOE Contact - K.K. Wu, FTS 976-5916
PNL Contact - D.J. Bradley, 509-375-2587

Since reprocessing of commercial spent fuel is not currently being pursued, the primary form to be considered for repository disposal is unreprocessed spent fuel.

The primary objective of this task is to evaluate and understand radionuclide release from spent fuel in a realistic salt repository environment.

Keywords: Radionuclide Release

267. Waste Package Environment Studies

FY 1985
$ 525,000

DOE Contact - K.K. Wu, FTS 976-5916
PNL Contact - D.J. Bradley, 509-375-2587

The purpose of this task is to help define the most probable range of environments to be encountered by a high level nuclear waste package emplaced in a repository in salt, and to determine solubilities of radionuclides in these environments. Factors that contribute to failure of the waste package container and those contributing to radionuclide release after containment failure are considered in the near field of the container (within approximately 1 meter of the package). Definition of the expected range of near field environmental conditions is needed by container materials and waste form testing tasks, and is essential in performance assessment activities.

Keywords: Radioactive Waste Host

268. Metal Barrier Testing

FY 1985
$ 895,000

DOE Contact - K.K. Wu, FTS 976-5916
PNL Contact - D.J. Bradley, 509-375-2587

The objective of this task is to test and evaluate selected materials for potential application as long-lived nuclear waste package structural/containment barriers. Candidate materials have been selected by means of corrosion and environmental-mechanical screening studies. The uniform corrosion rate and stress-corrosion-cracking susceptibility of a low-carbon cast steel is currently being determined in simulated intrusion and inclusion brine environments. Ultimately, accelerated testing methods will be employed, using environments relevant to anticipated repository conditions, to enable predictions to be made of barrier longevity. The resulting data will be useful to the WPP modeling task for development of predictive models and to waste package designers.

Keywords: Corrosion, Radioactive Waste Host

269. Repository Seal Materials Development Task — FY 1985 $ 50,000

DOE Contact - R.B. Lahoti, 976-5916
Army Corps of Engineers Contact

Laboratory experiments will be designed and conducted leading to the identification of specific compositions and/or forms of the candidate sealing materials (salt, cementitious materials, and earthen materials) that appear, on the basis of performance criteria generated in another project and other considerations, to be acceptable for use as a seal component in penetrations in the salt repository. The justification for selection of material compositions and/or forms will require considerations of emplacement technology, longevity, and interactions with the penetration containing units (host rock or liner) in addition to engineering property considerations.

Keywords: Radioactive Waste Host

Sandia National Laboratories: Brittle Fracture Technology Program

The objective of this program is to qualify alternate materials (other than stainless steel) for use in nuclear spent fuel cask construction. Candidate materials include nodular cast iron and ferritic steel. The main technical issue which must be addressed is the application of fracture mechanics to cask analysis and design. Materials, such as nodular cast iron, exhibit a ductile/brittle failure mode transition. Hence, a cask constructed out of this material may be susceptible to brittle fracture under certain environmental and loading conditions. The application of fracture mechanics can provide the cask analyst/designer the ability to guarantee ductile cask material response to design loadings.

270. Microstructure Investigation of Nodular Cast Iron — FY 1985 $ 25,000

DOE Contact - F.Falci, 8-233-5466
SNL Contact - K.B. Sorenson, 505-844-5360

Standard metallography techniques are being used to quantify graphite nodule size and spacing in sample test specimens used for obtaining fracture toughness values. A strong correlation is evident between nodule size and spacing and fracture toughness. Similar studies were done to establish the effect of nodule size and spacing on tensile properties (tensile strength and ductility).

Keywords: Fracture Toughness

271. Composition Investigation of Nodular Cast Iron FY 1985 $ 25,000

DOE Contact - F.Falci, 8-233-5466
SNL Contact - K.B. Sorenson, 505-844-5360

The investigation concluded that compositional features controlled the tensile behaviors of nodular cast iron, particularly nickel and silicon. Compositional features had no apparent effect on fracture toughness.

The conclusion drawn from the above two studies was that fracture is a phenomena controlled by microstructural features, whereas tensile properties (ductility) are controlled by compositional features. There is no apparent mechanistic link between fracture toughness and ductility.

Keywords: Microstructure

272. Generate Material Property Database for Nodular Cast Iron FY 1985 $ 140,000

DOE Contact - F.Falci, 8-233-5466
SNL Contact - K.B. Sorenson, 505-844-5360

Existing material property data for nodular cast iron is being assimilated into a common format. Data sources include technical reports and industry (foundries and cask vendors).

In addition, testing is being performed to fill in gaps of the existing database. Significant lack of data includes fracture toughness values as a function of strain rate and temperature. The main focus of the testing program is to generate fracture toughness values for nodular cast iron.

Keywords: Database, Fracture Toughness

273. Investigate the Feasibility of Using Depleted Uranium as a Structural Component in Cask Construction FY 1985 $ 5,000

DOE Contact - F.Falci, 8-233-5466
SNL Contact - K.B. Sorenson, 505-844-5360

A brief literature search was conducted to determine the feasibility of using DU as a structural component in cask body construction. Sandia has performed a study (1982) to identify material properties pertinent to structural considerations. The material may be suitable for this application. It exhibits a relatively strong toughness and high tensile strength. A 2 percent Mo alloy exhibits better mechanical properties than unalloyed DU.

An extensive testing program would be required to qualify this material for cask construction. Fracture toughness values as a function of strain rate and temperature need to be generated.

Keywords: Radioactive Waste Host

274. Evaluate Current NDE Methods for Applicability to Thick Section Nodular Cast Iron

FY 1985
$ 130,000

DOE Contact - F.Falci, 8-233-5466
SNL Contact - K.B. Sorenson, 505-844-5360

Sandia has contracted with the National Bureau of Standards to perform an evaluation of current NDE procedures. The nature of nodular cast iron requires a study limited to this candidate material. The nodularity of the graphite tends to inhibit NDE sensitivity. The thick-walled nature of the casks pose additional restrictions on the sensitivity of NDE procedures.

Keywords: Nondestructive Evaluation

OFFICE OF DEFENSE PROGRAMS

The Assistant Secretary for Defense Programs directs the Nation's nuclear weapons research, development, testing, production, and surveillance programs. In addition, the Assistant Secretary coordinates a safeguards and security program to provide accountability and physical protection of special nuclear materials, including research and development for improvements, testing, evaluation, and implementation of safeguards systems. Additional responsibilities include management of the inertial fusion development and nuclear materials production programs, classification and declassification of sensitive weapons information, and analysis and coordination of international activities related to nuclear technology and materials.

Materials activities in Defense Programs are concentrated in the Offices of Inertial Fusion, Military Application, and Nuclear Materials Production.

Office of Inertial Fusion

Applied research and development oriented toward producing controlled thermonuclear fusion reactions in a laboratory environment for military and energy applications.

275. Target Fabrication — FY 1985 $1,500,000

DOE Contact - Carl B. Hilland, 301-353-3687
LNL Contact - Richard Mah, 505-667-3238
KMS Fusion, Inc. Contact - Timothy Henderson, 313-769-8500, ext. 302
LLNL Contact - W. Hatcher, 415-422-1100

Hydrocarbon polymer (CH) is applied by plasma polymerization to glass microspheres to act as an ablator. These targets represent a unique fabrication capability that combines micromachining, plasma etching, and plasma polymerization. The targets are filled with a deuterium-tritium gas mixture during the process of making the glass microspheres. The targets are irradiated with a laser or particle beam to produce a fusion burn for various military and energy applications. Other techniques are classified.

Keywords:

276. Laser Materials and Optical Components — FY 1985 $1,500,000

DOE Contact - Carl B. Hilland, 301-353-3687
LLNL Contact - E. Storm, 415-422-0400
KMS Fusion, Inc. Contact - A. Glass, 313-769-8500
University of Rochester Contact - R. McCrory, 716-275-5286

This project is concerned with developing Nd:glass amplifier discs and optical components for kilojoule-class laser systems. The optical components include lenses, frequency-conversion crystals, anti-reflective coatings, and mirrors.

Keywords: Coatings and Films

Office of Military Applications

Solid State Sciences Directorate, 1100

Ion Implantation and Radiation Physics Research Department, 1110

277. Ion Implantation Studies for Friction and Wear FY 1985 $ 250,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL (Contract No. DE-AC04-76DP00789) Contacts - D.M. Follstaedt, 505-844-2102; S.T. Picraux, 505-844-7681; L.E. Pope, 505-844-5041

Ion implantation is used to modify the surface and near-surface regions of metals and these implantation-modified materials are evaluated for their improved friction and wear characteristics. Of particular interest is the implantation of Ti + C into stainless steels to concentrations sufficient to form amorphous layers in the near-surface region. These amorphous layers have been found to yield significantly improved friction and wear behavior for stainless steels, independent of the structure and composition of the starting material.

Keywords: Ion Implantation, Friction, Wear, Amorphous Metals

278. Silicon-Based Radiation Hardened Microelectronics FY 1985 $ 500,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL (Contract No. DE-AC04-76DP00789) Contacts - H.J. Stein, 505-844-6279; K.L. Brower, 505-844-6131

Optical and electrical measurements, in conjunction with electron paramagnetic resonance and related techniques are used to determine the fundamental defect structures and materials properties required for radiation-hardened Si-based microelectronics. Recent studies have concentrated on amorphous silicon nitride, which is the charge storage medium for radiation-hard nonvolatile semiconductor memories, and defects at the Si-SiO_2 interface, which markedly affect the radiation tolerance of MOS devices. Relationships between the materials composition, chemical bonding, and defect configurations and the electrical performance are evaluated to permit long-term prediction of the performance of devices in a radiation environment and to develop new structures with particular properties.

Keywords: Silicon Nitride, Silicon, Silicon Dioxide, Defects

Condensed Matter and Surface Science Department, 1130

279. Shock Chemistry — FY 1985 $ 500,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - R.A. Graham, 505-844-1931

Both organic and inorganic solids are being investigated to determine the influence of molecular structure on shock-induced bond scission, and the influence of line and point defects on the observed enhanced, shock-induced solid state reactivity. The work also provides insights about the nature of the shock process itself.

Keywords: Organic Solids, Inorganic Solids, Molecular Structure, Shock

280. Initiation of Granular Explosives — FY 1985 $ 350,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - R.E. Setchell, 505-844-5459

Experimental and theoretical efforts are being directed at developing a fundamental understanding of the mechanisms involved in the shock wave initiation and growth to detonation of heterogeneous granular explsives. Materials of current interest include hexanitrostilbene and PBX 9404.

Keywords: Shock Waves, Granular Explosives

281. Strained-Layer Superlattices for IR Detectors — FY 1985 $ 300,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - G.C. Osbourn, 505-844-8850

Strained-layer superlattices based on the InAs/InSb/AlSb systems are being investigated as attractive alternatives to the difficult HgCdTe alloys for IR detector applications in the 8-12 micron and 3-5 micron wavelength ranges.

Keywords: IR Detectors, Superlattices

Solid State Research Department, 1150

282. Materials Growth by MOCVD — FY 1985 $ 150,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL (Contract DE-AC04-76DP00789) Contact - R.M. Biefield, 505-844-1556

The growth of a number of novel compound semiconductors and device structures is being explored by MOCVD. The primary effort is on the growth of GaP/GaAsP strained layer superlattices (SLSs) both conventionally and modulation doped for application in a variety of typical and novel device structures. Preliminary work is also being done in the InGaP and InSb/InAsSb alloys.

Keywords: Semiconductors, Superlattices, Dopants

283. Materials Growth by MBE

FY 1985
$ 300,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - T.J. Drummond, 505-844-9677

The major efforts here center on the AlGaAs/AlAs system and the InGaAs system. Detailed studies of the mobilities and optical properties of devices fabricated from these materials have led to new understandings of the band offset and band alignment rules. New devices including bistable optical switches, rad-hard photodiodes, and the first p-channel SLS MODFET have been grown.

Keywords: Optical Properties, Mobility

284. Conducting Organic Materials

FY 1985
$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - D.S. Ginley, 505-844-8863; P.J. Nigrey, 505-846-8985

A variety of charge transfer organic superconductors and polymeric organic conductors are being synthesized. Potential applications lay in areas of catalysis, batteries, conductors, and sensors. Synthesis efforts center on using wet chemical and electrochemical techniques to make novel materials with unique structural and chemical properties.

Keywords: Superconductoers, Organic Materials, Polymers

285. Passivation of Semiconductor Grain Boundaries and Defects

FY 1985
$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - D.S. Ginley, 505-844-8863

Extensive work has been done on the chemistry and kinetics of the passivation of polycrystalline silicon grain boundaries and devects with monatomic hydrogen. One-D and Two-D models have been demonstrated as has been their utility for process optimization. The first detailed infrared spectra of grain boundary hydrogen has been obtained and its dependence on treatment conditions evaluated. The extension of the passivation process to other materials systems is being evaluated.

Keywords: Semiconductors, Grain Boundary, Defects

Organic and Electronic Materials Department 1810

Chemistry of Organic Materials Division, 1811

286. Polysilanes, Photoresists, and Non-Charring Dielectrics

FY 1985
$ 150,000

DOE Contact - W.G. Collins, 301-353-5494 (FTS 233-5494)
SNL (Contract No. DE-AC04-76DP00789) Contacts - R.L. Clough, 505-844-3492; J.M. Zeigler, 505-844-0324; L.A. Harrah, 505-844-6847

Some alkyl substituted polysilanes undergo depolymerization-volatilization when irradiated with UV light. These new polymers are being investigated as potential positive-working non-solvent-developed photoresists for use in microelectronic circuit manufacture. Emphasis is being placed on developing an understanding of the polymer photochemistry and on answering application-oriented questions of achievable resolution, etchant stability, and e-beam patternability. Significant progress has been made in testing of polysilanes with a variety of alkyl substituents, and successful candidate materials have been identified. Polysilanes with a different structure, together with polysilane-polysiloxane copolymers, are being synthesized for use as potential non-charring encapsulants and molding compounds with higher strength than the corresponding silicones. Both of these applications require meltable crosslinkable materials and current efforts are directed toward polysilanes with these properties.

Keywords: Polymers, High Temperature Materials

287. Sulfonated Aromatic Polysulfones

FY 1985
$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - R.L. Clough, 505-844-3492; C. Arnold, Jr., 505-844-8728; R.A. Assink, 505-844-6372

Sulfonated aromatic polysulfones are being synthesized and evaluated as chemically-stable, thin-film cation-permeable membranes for batteries. The new materials have been shown to exhibit significantly enhanced coulombic efficiencies and stabilities compared with inexpensive commercial membranes, but have a large cost advantage compared with fluorinated materials. Aging and resistivity tests are continuing. To create an improved membrane, an attempt is being made to impregnate the polysulfone into a microporous material.

Keywords: Polymers, Coatings and Films, Batteries

288. Radiation Hardened Dielectrics

FY 1985
$ 150,000

DOE Contact - W.G. Collins, 301-353-5494 (FTS 233-5494)
SNL Contacts - R.L. Clough, 505-844-3492; S.R. Kurtz, 505-844-5436; C. Arnold, Jr., 505-844-8728

Polymer dielectrics are being developed that display a minimum radiation-induced conductivity (RIC). These materials will be used in capacitors and cables exposed to high dose rate radiation so that little charge is lost due to RIC in this environment. Emphasis is placed on material preparation, testing, and the study of charge carrier transport and generation mechanisms. X-ray and electron induced photoconductivity measurements, optical and magnetic measurements, and chemical analysis techniques are utilized in this work. Mylar doped with an electron acceptor complex (TNF) has been shown to be a very effective rad-hard material. Studies on the aging behavior of this material are underway. A large production run on the material has been completed, and another is planned. Capacitors made from this material have been fabricated and successfully tested.

Keywords: Radiation Effects, Polymers, Weapons

Physical Chemistry and Mechanical Properties of Polymers Division, 1812

289. Effects of Material and Processing Variables on the Mechanical and Thermal Expansion Behavior of Graphite/Epoxy and Kevlar/Epoxy Composites

FY 1985
$ 300,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - L.A. Harrah, 505-844-6847; T.R. Guess, 505-844-5604

Two types of high performance composites are being investigated for a number of Sandia programs. Graphite/epoxy has the high specific stiffness and low coefficient of thermal expansion that make it a prime contender for the dimensionally stable platforms for pointing and tracking components being developed as part of the SDI Program. Both graphite/epoxy and Kevlar/epoxy are being considered as a lightweight composite case for the advanced strategic bomb because of high specific strength and impact resistant properties. These same two materials are being characterized to assess the vulnerability of solid-fuel, composite rocket motor cases. The research on these two classes of composites falls into three broad categories: (1) processing; (2) material properties testing; and (3) mathematical modeling. The processing of composite materials and structures involves many variables and we are trying to determine the influence of process variables (such as time, temperature, pressure, layup, resin system, etc.) on visual appearance, residual stresses, CTE, mechanical properties, and dimensional and environmental stability of finished parts. Material properties testing involves characterization of mechanical and CTE properties as a function of processing parameters, fiber and matrix type, layup pattern, and thermal conditioning history. The mathematical modeling concentrates on the nonlinear bending behavior of Kevlar composites that results from the low compressive strength of the Kevlar fiber. The goal of the modeling is to develop a constitutive model that can be incorporated into structural analysis computer codes.

Keywords: Processing, Composite Materials, Graphite/Epoxy, Kevlar/Epoxy, Coefficient of Thermal Expansion, Residual Stresses, Mechanical Properties, Nonlinear Bending Behavior

290. The Chemical Characterization of Plasma Deposited Thin Films

FY 1985
$ 150,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - L.A. Harrah, 505-844-6847; R.J. Buss, 505-844-7494

The process by which plasma deposited thin films of organic and inorganic material are formed is being studied in order to expand our control of the material properties of the films. Current understanding of the mechanism is so poor that it is almost impossible to alter the film in desirable ways without extensive experimentation. This situation is becoming intolerable with the rapidly expanding applications of these films. This project is a combined effort to answer specific programmatic needs while building a sufficient fundamental understanding of the process mechanism that future questions will be more easily answered. Among the immediate problems being studied are the observed embrittlement of carbon-hydrogen films on exposure to air, the production of a thin film dielectric which can planarize a rough substrate and has good thermal stability, and the control of gas permeation through the films. The method used here is a molecular beam technique which allows control of the plasma-species participating in the deposition. The plasma-beam apparatus is a new facility unique to Sandia which has already answered several mechanistic questions about the deposition process and has yielded results which suggest solutions to the aging problem. It is expected that this project will result in the production of improved thin films for the current applications and will also lead to the use of these films in a variety of new ways.

Keywords: Plasma Chemistry, Plasma Polymerization, Thin Films, Molecular Beam, Glow Discharge, Coatings

291. Materials Structure and Properties by NMR Spectroscopy

	FY 1985
	$ 70,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - L.A. Harrah, 505-844-6847; R.A. Assink, 505-844-6372

NMR studies are being used to characterize the microstructure and reaction kinetics of polymers and the transport characteristics of polymeric membranes. Magic angle spinning high resolution Si solid NMR spectroscopy is being used to define the structure of rigid polymers formed by plasma deposition. The silicon was found to be incorporated primarily as mono, di, tri, and tetrafunctional methylsiloxane groups. The heat aging behavior of these polymers is being understood in terms of the change in functionality of the silicon atom as additional oxygen is incorporated into the material. Fourier transform 1H studies at high fields are being used to follow the reaction kinetics of sol-gels prepared from various reactants. An expanded kinetics model is being developed and tested. The mobility of the fluid phase in ionic membranes is being studied by pulsed decay experiments. The electrical transport properties of the membrane are being related to the fluid phase mobility and the membrane's structure.

Keywords: Polymers, Organics, Coatings, Films

292. Electron and Photon Stimulated Desorption from Organic Surfaces

	FY 1985
	$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - L.A. Harrah, 505-844-6847; J.A. Kelber, 505-844-3408

Neutral and ionic species desorbed by low energy (<1000 eV) electron or photon bombardment of organic surfaces under ultra high vacuum conditions are measured as a function of the wavelength of the exciting radiation. Desorbed species are detected using a quadropole mass analyzer or by monitoring laser-induced fluorescence. The target materials are condensed thin films of hydrocarbon and partially substituted hydrocarbon molecules (e.g., CH_4 and CH_3F). The purpose of these experiments is to understand the nature of the radiation-induced processes which lead to bond rupture by observing ion and neutral appearance potentials and cross sections. The effects of chemical structure on the bond rupture and desorption processes are observed through a systematic variation of the chemical structure of the target material.

Keywords: Electron Stimulated Desorption, Photon Stimulated Desorption, Desorption, Organic

293. Surface Chemistry and Bond of Plasma-Aminated Polyaramid Filaments

FY 1985
$ 50,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - L.A. Harrah, 505-844-6847; R.E. Allread, 505-846-5538

The mechanical properties of fiber-matrix composites are limited by poor adhesion between the resin matrix and the fiber reinforcement. We have shown that plasma modification of the fiber surface can lead to chemical bonding between the curing resin system and the reinforcing fiber phase with a much higher fiber-matrix adhesion. Amine functionality has been introduced onto poly(p-phenylene terephthalimide) fibers by amine and ammonia plasma treatments. Composites formulated from these treated fibers show substantially increased transverse strength and improved moisture resistance in aging experiments. The stability of treated fibers before incorporation into composites is being investigated to establish processing requirements. These materials are being considered for structural applications and as materials for printed wiring boards. Similar studies will be carried out on other fiber-matrix pairs of interest in high performance composites.

Keywords: Composites (Structural), Fibers, Insulators/Dielectrics (Polymeric), Molding, Weapons

Physical Properties of Polymers Division, 1813

294. Microcellular Foams for X-ray Laser

FY 1985
$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - P.B. Rand, 505-844-7953

Ultra-low density (<0.005 g/cc) microcellular foams have been developed for the Narya pulsed-power-driven x-ray laser development program. These foams, which are molded into rods, have been successfully used in gas puff implosion experiments on the Proto-II accelerator.

Keywords: X-Ray, Laser, Accelerator

295. <u>Cure Kinetics of Thermosets By DSC</u>

FY 1985
$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - M.R. Keenan, 505-844-6631

Isothermal differential scanning calorimetry (DSC) has been used to obtain the cure kinetics of a commercial epoxy film adhesive. The kinetic model can be used to determine cure times and temperatures at lower temperatures. Good correlation was obtained with mechanical property measurements.

Keywords: Thermosets, Films

296. <u>Creep Rupture of Kelvar Composites</u>

FY 1985
$ 300,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - R.H. Ericksen, 505-844-8333

We have found a variation in stress-rupture life of fibers from nominally identical Kevlar 49. There is evidence that long fiber life correlates with high initial modulus, a relationship that will provide further insight into microstructural features controlling stress-rupture.

Keywords: Fibers, Polymers, Fracture, Creep

<u>Electronic Property Materials Division, 1815</u>

297. <u>High Electric Field Varistors</u>

FY 1985
$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - R.G. Kepler, 505-844-7520; G.E. Pike, 505-844-7562

ZnO varistors are polycrystalline materials which switch from insulators to conductors with increasing applied voltages. New varistors are being made from fine powders precipitated from ZnCl solutions. This powder is then sintered at a low temperature near 700 degrees C. Since the switching is controlled by the grain boundaries, the small size powder yields a high switching electric field, from 30 to 100 kV/cm.

Keywords: Powder Synthesis, Consolidation of Powder

298. <u>Microelectronic Aluminum Metallizations</u>

FY 1985
$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - R.G. Kepler, 505-844-7520; J.S. Arzigian, 505-846-2465

Aluminum and aluminum alloy thin films processed in both a research type ultra high vacuum electron beam evaporator, and in microelectronic-oriented production equipment are being studied for small geometry, multiple level integrated circuit metallizations. Accelerated aging tests, in-situ failure analysis using a cryopumped SEM and electrical characterization techniques are used to evaluate the electromigration resistance, patternability, compatibility of these films for VLSI devices. Alternative metallizations departing from the traditional aluminum alloys are also being evaluated.

Keywords: Metals: Non-Ferrous, Electromigration, Semiconductor Devices

299. High Resistivity Thin Film Polycrystalline Silicon FY 1985
$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - R.G. Kepler, 505-844-7520; W.K. Schubert, 505-846-2466

Resistivity measurements, spreading resistance profiles, and transmission electron microscope examinations have been conducted on thin films of high resistivity polycrystalline silicon such as is used to manufacture integrated circuit resistors. The goal of this work is to gain a better understanding of processing effects on the electrical properties and thus enable tighter process control. We have found ion implantation and thermal annealing steps to be critical steps through their effects on dopant diffusion in the grain boundaries and grain growth processes. Understanding gained has allowed the development of tighter process specifications. Work is continuing to understand microscopically what is happening in the grain boundaries and to perhaps tailor the dopant diffusion process.

Keywords: Semiconductors, Grain Boundaries and Grain Growth, Ion Implantation, Diffusion

Materials Characterization Department, 1820

Analytical Chemistry Division, 1821

300. Development of Automated Methods for Chemical Analysis FY 1985
$ 350,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - N.E. Brown, 505-844-2747

New automated methods for chemical analysis of materials are being developed to meet new or anticipated needs and to improve accuracy and efficiency. New facilities include a new automated multichannel electronic recording emission spectrometer which will be used for metals and alloy analysis in support of numerous weapons programs. Another new facility is an automated optical densitometer used for analysis of photographic spectra. The densitometer provides the new capability of converting qualitative photographic data into quantitative figures. New software programs for data reduction and search/match routines are being developed for the gas chromatography/mass spectroscopy to enhance our ability to identify and quantify unknown contaminants in weapons systems.

Keywords: Automation, Chemical Analysis

301. Thermomechanical Treatment of U Alloys

FY 1985
$ 80,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - K.H. Eckelmeyer, 505-844-7775

Strengthening mechanisms are being investigated in U-Ti and U-Nb alloys with the goals of simplifying processing procedures and increasing strength-ductility combinations. It has been found that decreasing Ti content from the conventional 0.75% to 0.60% results in a factor of 3 decrease in the quench rate required to suppress diffusional decomposition of the γ-phase and get age-hardenable martensite, thus enabling processing of thicker parts and minimizing quenching-induced residual stresses. A deformation strengthening mechanism has also been developed whereby parts of any thickness can be processed to yield strengths as high as 125 ksi without the need for quenching. In addition, a combined solid solution-deformation strengthening approach has been developed which permits yield strengths as high as 165 ksi to be obtained with reductions-in-area in excess of 45%. This represents significant simultaneous increases in both yield strength and ductility (from 130 ksi and 32%, respectively), a very unusual metallurgical accomplishment.

Keywords: U-Alloys, Strengthening Mechanisms, Thermomechanical Processing

302. Advanced Methods for Electron Optical, X-Ray, and Image Analysis

FY 1985
$ 270,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - W.F. Chambers, 505-844-6163

Advanced methods of automated electron and x-ray instrumental analysis are being developed to improve resolution, accuracy, and efficiency and to allow us to undertake and solve more difficult problems. Advances in our in-situ electron diffraction pattern search/match routine (for approximately 30,000 diffraction patterns) has resulted in the identification of an intermetallic phase in a weldment that another weapons lab could not identify. A new program has been initiated for FY 85 to develop an advanced image analysis system which will be used for quantification of geometric, structural, and chemical information and also for image enhancement. This capability will permit more accurate determinations of processing/structure, composition/property relationships.

Keywords: Automation, Electron Optics, Transmission Electron Microscopy, X-Ray Analysis, Electron Diffraction

303. Advanced Methods for Surface and Optical Analysis

FY 1985
$ 240,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - J.A. Borders, 505-844-8855

New facilities, methods, and software are being developed to improve our capabilities for surface and optical analysis. Recent accomplishments include improved software for data acquisition and reduction for the laser

Raman microprobe, which is being used for glass structure studies and contaminant identification. Another accomplishment is improvement in the multivariate least squares software package for quantitative Fourier transform infrared spectroscopy. This allows quantitative analysis of infrared spectra of mixtures with overlapping peaks and non-Beer's Law behavior. Improvements planned for FY 85 include an upgrade of the data acquisition and reduction system for the x-ray photoelectron spectrometer, which is used for surface analysis on a broad range of materials, and the design and fabrication of a traversing stage for the laser Raman system. This will enable us to do molecular mapping, an important capability for contamination identification.

Keywords: Laser Raman Spectroscopy, Fourier Transform Infrared Spectroscopy, X-Ray Photoelectron Spectroscopy

304. Design and Fabrication of a Gamma-Ray Attenuation Spectrometer

FY 1985
$ 150,000

DOE Contract - R.E. Lushbough, 301-353-3912
SNL Contact - W.D. Drotning, 505-844-7934

A new system based on the attenuation of monochromatic gamma rays from a cadmium radioisotope is being developed to analyze special materials for a strategic defense initiative program. This is a non-destructive method that will yield quantitative elemental analysis with an estimated precision of approximately 1/2%. Preliminary measurements have demonstrated feasibility, and calibration standards are presently being analyzed. An automated stage has been designed and is presently being built that will allow the samples to be scanned for homogeneity. This system will act as a backup for photoradiography, which is faster but less quantitative.

Keywords: Gamma-Ray Spectrometer, Non-Destructive Analysis

305. Infrared Reflectometer Development

FY 1985
$ 150,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - H.L. Tardy, 505-846-6548

An infrared reflectometer system is being developed for the purpose of making absolute spectral reflectance measurements in the wavelength range, 2-15 microns. The spectral reflectance is used to calculate the thermal emittance of a wide range of materials used in weapons systems. Examples of applications of these measurements include: materials for strategic defense initiative programs; composite materials for reentry vehicle construction; surfaces of calorimeters used in nuclear testing; and tokamak fusion reactor wall materials. The reflectometer is being designed for high throughput in order to facilitate rapid development of materials with desired thermal emittance properties.

Keywords: Infrared Reflectometer, Reflectance Emittance

Metallurgy Department, 1830

Cleaning and Coating Technology Division, 1831

306. Plasma Deposition of Amorphous Metal Alloys — FY 1985 $ 130,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - A.K. Hays, 505-844-9996

A technique is being developed to deposit amorphous metal alloys using a radio frequency discharge. Amorphous metals can be formulated that have outstanding strength, corrosion resistance, and abrasion resistance. Their use in industrial applications has been limited by the techniques presently employed to obtain them (rapid-solidification, sputtering, etc.). Present studies include the plasma-deposition of amorphous Ni-P-C films from $Ni(CO)_4$ and PH_3 in a H_2 carrier gas. Future work will include the development of a technique to deposit amorphous metal alloys using plasma- enhanced chemical vapor deposition.

Keywords: Coatings and Films, Metallic Glasses, Plasma Synthesis, Radio Frequency Synthesis

307. Electrophoretically-Deposited Coatings — FY 1985 $ 110,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - A.K. Hays, 505-844-9996; D.J. Sharp, 505-844-8604

Electrophoresis as a technique has been used for some time to apply organic and ceramic coatings to large, irregularly-shaped objects. Our research has been directed towards the application of electrophoretically-deposited organic and organic/ceramic composite coatings as insulators and IEMP hardeners for electronic component packages. Present systems under study are acrylic/fluorocarbon co-polymers and acrylic/titanium dioxide composites. Future work will include the development of insulator/ conductor composites.

Keywords: Coatings and Films, Insulators/Dielectrics - Polymeric, Insulators/ Dielectrics - Ceramic, Electrophoretic-Deposition

308. Near-Net-Shape Processing of Nickel-Based Alloys — FY 1985 $ 150,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - A.K. Hays, 505-844-9996; A.W. Mullendore, 505-844-6833

Near-net-shape processing allows for reductions in cost, time, and raw material usage in metallurgical processing. A technique is being developed to produce nickel-based alloys from the chemical vapor deposition of $Ni(CO)_4$ and selected metalloid hydrides. Future work will include the characterization of these alloys with respect to mechanical properties and microstructure.

Keywords: Metals - Ferrous, Including Steels, Coatings and Films, Chemical Vapor Deposition

309. High Temperature Semiconductors FY 1985 $ 20,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - A.K. Hays, 505-844-9996; A.W. Mullendore, 505-844-6833

Present microelectronics using silicon or germanium have limited use temperatures due to the fact that these materials are intrinsic conductors at temperatures above 500 degrees C. Boron-based compounds have been suggested for use as high temperature semiconductors. Present studies include the growth of single crystals of B_4C using CVD. Future work will be directed towards the development of a technique for growing boron carbide crystals suitable for device fabrication.

Keywords: Coatings and Films, Semiconductors, Chemical Vapor Deposition

310. Surface Modification of Coating Morphology Using Ion Bombardment FY 1985 $ 40,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - A.K. Hays, 505-844-9996; D.J. Sharp, 505-844-8604

Many coatings applications require fine-grain size materials. A technique is being developed to modify coating morphology of sputtered films by ion bombardment during deposition. This technique is presently capable of producing Be films with 20 nm grain size. Future work will include the development of techniques to reduce stress in these as-deposited films.

Keywords: Coatings and Films, Surface Modification, Sputtering

311. Optical Diagnostics for Metallurgical Processing FY 1985 $ 440,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - A.K. Hays, 505-844-9996; H.C. Peebles, 505-844-1647

Optical diagnostics are being developed to map the temperature, composition, and velocity profiles as a function of time of species present in the atmosphere during standard metallurgical processes (e.g., welding, vacuum arc remelting, and plasma spraying). This information is necessary to obtain a scientific understanding of the phenomena that govern these processes. Present efforts include the study of laser light extinction by the plume formed during the Nd:YAG laser welding of aluminum. Future plans include developing optical diagnostics for plasma spraying and vacuum arc remelting.

Keywords: Optical Diagnostics, Welding

312. Plasma Removal of Metal Oxides FY 1985 $ 115,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - A.K. Hays, 505-844-9996; R.R.Sowell, 505-844-1038

Metal oxide formation during glass-to-metal sealing processes often hinders further component fabrication processes such as metal joining. A technique is being developed to remove these oxides using plasma etching. The specific application involves cleaning metal oxides off of Inconel 718 by plasma etching with fluorocarbons. Future work will include the identification of the volatile species responsible for this process.

Keywords: Plasma Etching, Refractory Ceramics (Oxides)

Physical Metallurgy Division, 1832

313. Toughness of Ductile Alloys — FY 1985 $ 350,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - R.J. Salzbrenner, 505-844-5041; J.A. VanDenAvyle, 505-844-1016

The elastic-plastic fracture toughness (J_{IC}) has the potential to allow a fracture-related material property to be used in the design of structures using ductile alloys. For this to come about, valid testing procedures need to be developed and candidate materials need to be studied. Single specimen J-testing procedures are being studied and the fracture behavior of ductile cast irons is being examined. The goal of the current work is to have the fracture behavior of this alloy well enough characterized and understood that nuclear material shipping casks can be designed with it using a fracture toughness methodology.

Keywords: Metals - Ferrous, Fracture, Predictive Behavioral Modeling

314. Analytical Electron Microscopy of Engineering Alloys — FY 1985 $ 150,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - A.D. Romig, 505-844-8358

Analytical Electron Microscopy (AEM) allows the local chemistry with high resolution within a thin foil to be determined. This cannot be done in engineering (complex) alloys in a straightforward manner because of the difficulty in interpreting x-ray peaks in multicomponent systems. Techniques have been developed using Monte Carlo simulations on a computer to sort out all of the measured effects and allow quantitative analysis. This has been applied to uranium alloys (where the high Z values create problems) and in stainless steel weldments. These quantitative measurements allow diffusion properties to be measured and, in turn, the kinetics of such metallurgical phenomena as precipitation to be determined.

Keywords: Metals - Ferrous and Non-Ferrous, Joining and Welding, Transformation, Electron Beam Methods, Weapons

315. Friction and Wear of Modified Surfaces — FY 1985 $ 230,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - R.J. Bourcier, 505-844-6638; A.D. Romig, 505-844-8358

The improvement of friction and wear behavior using surface modification has been a very productive approach that includes many traditional methods (e.g., carburizing or nitriding). Recent work in ion implantation has shown that this technique can both decrease friction and improve wear, although the mechanism by which this occurs is not understood. It is known that an amorphous layer is formed and current work is aimed at understanding the metastable metallurgy of near-surface regions. Microhardness historically has been used to characterize these modified surfaces but this has been without a thorough understanding of low-load indentation testing. Finite element modeling techniques are being used to help separate artifacts caused by very low loads from the influence of a modified surface layer. Successful modeling will allow us to begin to model the friction process itself. Work has been conducted on nitrogen-implanted stainless steel and aluminum-implanted nickel.

Keywords: Metals - Ferrous and Non-Ferrous, Erosion/Wear/Tribology, Ion Implantation, Weapons

316. Alloy Deformation Response and Constitutive Modeling FY 1985
$ 300,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - W.B. Jones, 505-844-4026; R.J. Bourcier, 505-844-6638

All complex structures are now designed using finite element computer codes which can now handle both exotic geometries and plastic/creep deformation. Constitutive models which embody both time-dependent and time-independent inelastic behavior need to be developed which have a basis in the metallurgy and dislocation substructural characteristics of the alloys used. Also important is the long time microstructural stability of alloys and how to incorporate this into the models. Stainless steels are being studied using both uniaxial and biaxial testing techniques in order to characterize alloy response. Models are being developed which represent the deformation mechanisms operating and can be formulated for inclusion into finite element codes.

Keywords: Metals - Ferrous, Creep, Fatigue, Nuclear Reactors, Predictive Behavorial Modeling, Weapons

Process Metallurgy Division, 1833

317. Vacuum Arc Remelting FY 1985
$ 75,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - F.J. Zanner, 505-844-7073

Both fluid flow and arc plasmas during vacuum arc remelting are being studied with the goal of reducing inhomogeneities and defects in structural alloys and uranium alloys. Improvements in the control of melting and solidification are being incorporated into production processes to increase production yields and improve the ingot quality. This work involves experimental verification of models. Currently the heat energy balance in the plasma arc is being evaluated on the basis of boundary temperatures. Future work will include spectrographic studies to characterize the plasma.

Keywords: Metals - Ferrous, Non-Ferrous, Solidification-Conventional

318. Toughness of Inertia Welds

FY 1985
$ 60,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - G.A. Knorovsky, 505-844-1109

The fracture toughness of alloy steel inertia welds is being determined with the goal of optimizing weld schedules as a function of alloy chemistries. Initial screening experiments have utilized impact type specimens and have shown that minor impurity levels have a pronounced influence on fracture toughness at excessive weld energies. Production weld schedules have been adjusted to minimize the effect of compositional differences. Future work will involve the use of valid plane strain fracture toughness specimens for selected composition-weld energy combinations.

Keywords: Metals - Ferrous, Joining/Welding, Fracture

319. Metallurgical Characterization of TiCode 12 Resistance Welds

FY 1985
$ 40,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - G.A. Knorovsky, 505-844-1109

TiCode 12 is the primary candidate material for canisters containing radioactive Defense High Level Waste. A metallurgical study has been performed to determine the effect that resistance upset welding has on this material. One purpose was to determine whether extensive corrosion tests would be required to qualify these welds. Analysis of the phases present, and their relative amounts, suggest that weld properties should be similar to that of the base metal and additional testing is not proposed.

Keywords: Metals - Non-Ferrous, Corrosion-Aqueous, Joining/Welding, Microstructure

320. Aluminum Laser Welding

FY 1985
$ 80,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - M.J. Cieslak, 505-846-7500

Designers are selecting aluminum alloys for many new components. Welding methods for joining these alloys are limited, particularly where heat input must be minimized. Laser welding processes are being characterized. Current emphasis is on determining the role of metal evaporation on composition, mechanical properties, and hot-cracking. Future work will be directed towards minimizing melt-freeze cycles during welding and is dependent on the development of improved laser systems.

Keywords: Metals - Non-Ferrous, Joining/Welding, Solidification-Conventional

321. Low Temperature, Solid State Welds of Copper FY 1985
$ 60,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - F.M. Hosking, 505-844-8401

Assembly of copper flexible circuits often requires sequential joining processes and/or rework. To produce joints that resist damage during subsequent soldering or de-soldering operations, a study of the mechanical properties of solid state welds of copper produced with indium or indium-silver alloy interlayers has been evaluated. Mechanical tests and fractographic analysis indicate that this process produces high quality joints. The resistance to thermal damage is increased by raising process temperatures so that indium is diffused into the base metal.

Keywords: Metals - Non-Ferrous, Joining/Welding, Fracture

322. Dissimilar Metal Welds FY 1985
$ 120,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - M.J. Cieslak, 505-846-7500; G.A. Knorovsky, 505-844-1109

Weapon components typically include several alloys that must be welded to one another. As high performance alloys are incorporated into new designs, significant welding problems are encountered. Studies have been initiated to define the solidification mechanics in complex alloy systems with the goal of avoiding compatibility problems, particularly hot-cracking. Studies involving CO laser welding of high alloy martensitic steels to martensitic stainless steels have been completed. Additional studies are in progress involving pulsed Nd:YAG laser welding of Kovar to a number of ferrous and nickel-based alloys. Future studies will emphasize the welding compatibility of precipitation strengthened nickel-based alloys.

Keywords: Metals - Ferrous and Non-Ferrous, Joining/Welding, Solidification-Conventional

323. Welding of Nickel-Based Alloys FY 1985
$ 225,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - M.J. Cieslak, 505-846-7500; G.A. Knorovsky, 505-844-1109

The combination of advanced design requirements and recent progress in glass-to-metal sealing technology has stimulated a program to obtain higher strength hermetic seals than is afforded by conventional austenitic stainless/steel-borosilicate glasses. Both solid solution strengthened and precipitation strengthened nickel-based alloys are being considered as replacements for stainless steel. Studies have been initiated to identify the constituents responsible for hot-cracking in these classes of alloys. Initial results indicate that solidification in these alloys generally terminates with the formation of one or more topologically-close-packed phases. Fundamental alloy studies remain to be completed for both Inconel 625 and Inconel 718 to determine the roles of minor alloying components.

Also, future work will include solidification studies in the Ni-Cr-Mo system.

Keywords: Metals - Non-Ferrous, Joining/Welding, Solidification-Conventional

324. Plasma Arc Welding | FY 1985 $ 230,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - P.W. Fuerschbach, 505-846-2464; J.L. Jellison, 505-844-6397

Few fusion welding processes are suitable for joining aluminum alloys in the vicinity of heat sensitive components. Initial experiments suggest that plasma arc welding can markedly reduce heat input compared to conventional gas tungsten arc welding. A design specification has been developed for a variable polarity plasma arc welding power supply. Future studies will evaluate cathodic cleaning, welding efficiency, and arc stability as a function of the current-voltage characteristics.

Keywords: Metals - Non-Ferrous, Joining/Welding, Solidification-Conventional

325. Laser Welding | FY 1985 $ 150,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - J.L. Jellison, 505-844-6397

Pulsed Nd:YAG laser welding is a complex process both in terms of the number of control parameters and materials-process interactions. To improve the understanding of the process with the ultimate goal of developing weld schedules on the basis of process modeling, process characterization studies are being conducted. These include calorimetry experiments, plume characterization studies, and experimental validation of heat transfer codes. Future work will continue to emphasize beam-plume interactions and will include the development of a weld pool reflectivity test.

Keywords: Joining/Welding, Process Modeling

326. Electrode Gap Controller | FY 1985 $ 75,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - F.J. Zanner, 505-844-7073

One of the fundamental variables controlling vacuum arc remelting (VAR) is electrode gap. The electrode gap strongly influences arc plasma uniformity, melting rate, and fluid flow in the melt. Current VAR equipment does not permit direct control of electrode gap; electrodes are simply advanced at a rate that is believed to correspond to melting rate. Recent SNLA research has shown that the frequency of drop shorts is inversely proportional to the electrode gap. Drop shorts are signatures on the voltage waveform that result from the transfer of metal during VAR. Statistically designed experiments are being conducted to evaluate the influence of arc power, gas pressure, and electrode gap on the frequency of drop shorts. Future work will continue to refine a control algorithm based on the relationship between electrode gap and drop short frequency. This experimental verification will involve both uranium and structural alloys.

Keywords: Metals - Ferrous and Non-Ferrous, Melting, Process Control

Surface Metallurgy Division, 1834

327. Deposition of Amorphous Materials With a Dual Beam Ion System

FY 1985
$ 80,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - J.K.G. Panitz, 505-844-8604

Amorphous films can reduce friction, wear, and corrosion susceptibility. A dual beam system has been developed to sputter-deposit amorphous film material onto selected substrates with concurrent ion bombardment with inert and reactive gas ions (hydrogen and argon have been used). Preliminary coatings have been deposited, and system parameters have been defined. The mechanical properties of the sputter-deposited amorphous material, specifically hardness, are dependent on the conditions of deposition. Future work will emphasize the development of hard, wear resistant coatings for mechanical applications.

Keywords: Metallic Glass, Erosion/Wear/Tribology, Coatings and Films

328. Modification of Mechanical Properties by Ion Implantation

FY 1985
$ 25,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - L.E. Pope, 505-844-5041; D.M. Follstaedt, 505-844-2102; S.T. Picraux, 505-844-7681; J.A. Knapp, 505-844-2305

Stainless steel parts which undergo relative motion and which function in inert atmospheres have large coefficients of friction and can experience severe wear, specifically galling. The dual implantation of titanium and carbon into stainless steels produces an amorphous film on the surface which decreases both the friction coefficient and the wear rate; the implantation process is effective for austenitic and maretnsitic stainless steels and permits self-mating wear couples, 304 rubbing on 304 stainless steel, for example. Future work will emphasize the implantation of other elements and will attempt to optimize the chemical composition for maximum wear performance.

Keywords: Ion Implantation, Coatings and Films, Erosion/Wear/Tribology, Structure, Surface

329. Development of Materials for Magnetic Fusion Reactors FY 1985
$ 500,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - M.F. Smith, 505-846-4270; J.B. Whitley, 505-844-5353; J.M. McDonald, 505-846-7735

Materials used in magnetically confined fusion energy devices experience severe environments. Two materials have been developed for these applications. A beryllium limiter assembly was designed, fabricated, delivered to the ISX-B tokamak experiment at Oak Ridge National Laboratory. Performance has met design expectations. Secondly, a low-pressure chamber plasma spray process has been successfully developed to deposit ceramic/metal (SiC/Al) coatings. The ceramic/metal coatings may be used for low atomic number, low activation armor coating for first wall surfaces or for a graded thermal expansion transition coating to accommodate large thermal expansion differences. Tests to evaluate these materials are continuing.

Keywords: Magnetic Fusion, Coatings and Films

330. <u>Ion Beam Reactive Deposition System</u> — <u>FY 1985</u> $ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - D.E. Peebles, 505-844-1647

The properties of deposited films depend on stoichiometry, temperature of deposition, system pressure, and ionization state. A system has been constructed for reproducible reactive ion beam deposition of compound films; the system can control stoichiometries, energy input of each ion/atom/molecule, gas phase composition, and deposition rates. The system will be used to study mechanisms of compound film formation in addition to friction and wear responses of films for wear parts. Future studies will involve deposition of TiN, but eventually this method will be used to study complex film deposition of compounds not readily obtainable by current deposition methods.

Keywords: Coatings and Films, Erosion/Wear/Tribology, Surface

331. <u>In-Situ Friction, Wear, and Electrical Contact Resistance Systems</u> — <u>FY 1985</u> $ 80,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - L.E. Pope, 505-844-5041; D.E. Peebles, 505-844-1647

Friction, wear, and electrical contact resistance can depend critically on the surface composition of the outer 2.5 nm of material. The surface composition is easily masked by exposure to ambient conditions between testing and analysis. A device has been assembled in a scanning Auger analytical system to complete oxcillatory or unidirectional sliding friction experiments while monitoring electrical contact resistance. Auger surface analysis is completed in-situ. A gas handling/introduction capability has been added for atmosphere control; the dynamic gas partial pressure can be controlled from 10^{10} to 10^{5} torr or at static pressures up to one atmosphere. Future modifications will allow kinetic friction coefficients to be measured in-situ.

Keywords: Surface, Erosion/Wear/Tribology, Structure

Chemistry and Ceramics Department, 1840

332. Ceramic Processing

FY 1985
$2,580,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - R.K. Quinn, 505-844-1933

High purity, homogeneous ceramic powders are being prepared by sol-gel chemistry techniques. Materials prepared include ZrO_2, PNZT, ZnO, Al_2O_3, and titanate catalyst supports. The first three materials are utilized in ceramic electronic components at Sandia. Alumina is being toughened by coprecipitation with ZrO_2. The catalysts are used in our coal liquefaction program currently, and may find more general application. Novel glasses are also being prepared by sol-gel techniques. Our studies include basic research on precursors as well as applied development. Experimental techniques include small angle x-ray scattering, nuclear magnetic resonance, and several spectroscopic techniques to characterize precursor solutions and products. Glasses have been successfully evaluated on solar thermal receiver tubes and on photovoltaic cells. Dielectric barriers for a number of weapon applications have also been developed and are being evaluated.

Keywords: Ceramics, Glasses, Chemistry, Surface Treatment

333. Fracture of Ceramics

FY 1985
$ 680,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contact - F.P. Gerstle, Jr., 505-844-4304

The fracture properties of ceramics often limit their application in weapon and energy systems. Our program includes basic research to better understand fracture processes and to develop tougher ceramics based on this understanding. The effects of microstructure in glass ceramics, phase separation in glasses, and of the environment are presently being studied. Basic studies on the effect of environment in crack propagation of glasses have led to an atomistic model which explains the chemical interaction between a wide range of environments and strained silicate bonds in glasses. A program to develop tough ceramic composites and glass ceramics is also underway.

Keywords: Ceramics, Glasses, Fracture, Strength, Corrosion

334. Glass and Glass-Ceramic Development

FY 1985
$2,500,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
SNL Contacts - F.P. Gerstle, Jr., 505-844-4304; R.K. Quinn, 505-844-1933

A family of glass ceramics is being developed to match the thermal expansion of a number of metal systems. We have developed a lithium silicate glass ceramic which is being used to make hermetic seals to Inconel alloys for actuator headers. A family of phosphate-based glasses are being used to form seals to Al, Cu, and stainless steels. We have also developed a new glass which is very corrosion resistant to Li ambient temperature battery environments. This glass is presently being used in batteries (active and reserve) and has an expected life of five years. We are developing new glasses with the goal of a 10 year life. Transformation toughened glass ceramics based on the precipitation of metastable ZrO_2 in a glass matrix have been developed. The objective of this program is to develop tougher glass ceramics for electrical insulator applications.

Keywords: Ceramics, Glasses, Electrical Insulators, Corrosion

335. Corrosion

FY 1985
$1,150,000

DOE Contact - R.E. Lushbough, 301-353-3912
SNL Contacts - R.B. Diegle, 505-846-3450; N.R. Sorensen, 505-844-1097

Glassy alloys can exhibit exceptionally good corrosion resistance. We are conducting a program to determine how certain glassy alloys derive this resistance to corrosion and why they require less alloyed chromium than conventional stainless steels. This understanding could lead to better utilization of chromium in conventional stainless alloys. By using ion implantation, we are also separating and identifying the relative contributions of alloy structure and composition to corrosion behavior. We have shown that P is detrimental to corrosion resistance at low Cr levels because it stimulates dissolution but the alloy cannot passivate. However, P is beneficial at higher Cr levels because this enhanced dissolution actually promotes passive film formation.

Studies are also underway to characterize a number of alloy systems for both weapon and energy applications. Titanium alloys are being studied in nuclear waste disposal environments; Inconel and Hastelloy materials are being investigated for use in molten glass and in high temperature gaseous environments to support our glass header development program; carbon and stainless steels are being studied in battery environments.

Keywords: Metals, Amorphous Materials, Glassy Alloys, Corrosion

Lawrence Livermore National Laboratory

336. Powder Metallurgy

FY 1985
$ 250,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
SNL Contacts - J.A. Brooks, 415-422-2051; J.E. Smugeresky, 415-422-2910; J.W. Zindel, 415-422-2051

The installation of two gas atomizers, and a spark erosion system for the production of fine metal powders has further expanded our powder metallurgy capabilities. Emphasis is being placed on the effect of atomization parameters on material characteristics and the development of alloy systems utilizing rapid solidification processing. Studies on spark erosion are emphasizing the effect of processing parameters on powder size distribution, surface morphologies, and production rates of micron size particles.

Metallurgical studies are being conducted on a variety of alloy systems. The relationship between strength, toughness, microstructure, and fracture modes of blended elemental PM titanium alloys is being studied to optimize HIP cycles and heat treatments for improved properties of near-net-shape processed components. The relationships between starting powder size and sintering parameters on the microstructure, permeation and filtration characteristics of porous stainless steel compacts is being established. The dynamic compaction of Al-Si alloys has produced fully dense compacts, retained metastable microstructures of the original powder, and has provided further insight into the mechanisms at inter-particle bonding. The effect of particle size distribution and morphology on the quality of compacts is also being established. The new atomization facilities will also be utilized to produce powders for matrix composites.

Keywords: Alloys, Rapid Solidification, Metals, Near-Net-Shape Processing, Shock Wave Compaction

337. Advanced Electrodeposition Studies — FY 1985 $ 150,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
SNL Contacts - R.W. Carling, 415-422-2206; J.E. Farmer, 415-422-3418; H.R. Johnson, 415-422-2822

Engineering applications, electroanalytical development, and fundamental studies are being pursued in the area of electrodeposition of metals from both aqueous and nonaqueous media. Electrodeposition of a variety of metals is being studied with a focus on the relationship between critical process variables and the mechanical properties of the deposit; as well, the role surface active agents play in this process is being determined. To this end, an in-situ, real-time monitor for organic additives has been developed that will allow bath examination and control during deposition. Techniques involving AC impedance, laser Raman, and Fourier transform infrared spectroscopy are providing the fundamental information necessary to permit process improvements and new and improved techniques for electrodeposition.

Keywords: Metals, Electrodeposition, Mechanical Properties, Aqueous and Non-Aqueous Electrolytes, Spectroscopy, Organic Additives

338. Metal Forming — FY 1985 $ 250,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
SNL Contacts - J. Lipkin, 415-422-2417; T.C. Lowe, 415-422-3187

Fundamental understanding of nonelastic deformation processes is being developed through crystal plasticity modeling and experimentation. This work focuses upon large-strain phenomena and anisotropy which are important in metal forming and failure processes. Experimental and model results are applied directly to process development and to metal forming problems through the Interagency Metal Forming Working Group (established under this program). Recent work has revealed a new understanding of microstructure texture evolution and anisotropy. In particular, strain rate sensitivity has been found to influence texture evolution in shear. This result impacts how yield surfaces, anisotropy, and material rotations are represented in phenomenological models for finite element analysis. Large-strain expriments examining axial effects during shear have been compared with both physical model and phenomenological model predictions for the purpose of improving our ability to predict failure due to strain localization.

Keywords: Metals: Ferrous and Nonferrous, Fatigue, Fracture, Near-Net-Shape Forming

339. Helium Induced Crack Growth in Metals and Alloys — FY 1985 $ 700,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
SNL Contacts - S.L. Robinson, 415-422-2209; S.H. Goods, 415-422-3274; J.E. Costa, 415-422-2352

The effect of helium on the low temperature mechanical properties of fcc metals is being investigated experimentally. Tritium decay is used to introduce helium into metals without inducing radiation damage into the metal. A variety of experimental techniques are employed to study the resultant tritium and helium effects including transmission electron microscopy, autoradiography, tritium imaging, and thermal desorption spectroscopy. Mechanical properties of materials containing helium are studied in an effort to understand the plastic flow and fracture of metals as functions of helium concentration and distribution within the solid. The chemical similarity of tritium to hydrogen makes these techniques relevant to a wide variety of technologies. Slow crack growth experiments at ultra-high hydrogen pressures are also being conducted to determine the effects of mechanical processing, microstructure, and welding on the resistance of advanced materials to hydrogen-induced cracking. The observed effects of hydrogen on crack growth kinetics and thresholds are being used to identify mechanisms and evaluate models of hydrogen embrittlement.

Keywords: Metals: Ferrous and Non-Ferrous, Crystal Defects/Grain Boundaries, Fracture

340. Welding Science and Technology — FY 1985 $ 550,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
SNL Contacts - J.A. Brooks, 415-422-2051; K.W. Mahin, 415-422-2051; J.R. Spingarn, 415-422-3307

Considerable effort is being directed toward developing a science-based methodology for designing, analyzing, and optimizing welding processes in order to control weld geometry, distortion, and microstructure, thereby improving both the fundamental understanding of the complex welding process, and the performance of welded structures. The studies include modeling of heat transfer, coupling thermal and mechanical computer codes to allow simultaneous calculation of both temperature and stress as a function of time throughout the weld, and the modeling of microsegregation during weld solidification. The computer generated results are being compared to experimental measurements of important parameters, including microanalytical analysis of elemental segregation.

Additional welding metallurgy activities include the evaluation of alloy modifications to improve the weldability of specific alloys, the evolution of weld microstructure during solidification and cooling, the study of weldment cracking mechanisms, the weld microstructure property relationships, the measurement and modeling of mechanical properties of brazed joints, and the design, testing, and analysis of joints in composite materials. In solid state welds, the current emphasis includes establishing specifications for weld evaluation and acceptance, and improved NDE techniques to verify weld quality. Alloy systems of current interest include austenitic and martensitic stainless steels (single phase and precipitation hardenable), powder processed alloys, and model binary alloy systems.

Keywords: Joining/Welding, NDE, Microstructure, Metals, Transformation, Solidification, Modeling

341. <u>Composites: Stability, Compatibility and Joining</u> <u>FY 1985</u>
$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
SNL Contacts - J.B. Woodard, 415-422-3115; B.C. Odegard, 415-422-2789; J.R. Spingarn, 415-422-3307

The stability, compatibility, and joining of polymer matrix composite materials are being investigated in conjunction with efforts at Sandia National Laboratories, Albuquerque. The work focuses on graphite fiber reinforced composites and includes both thermosetting and thermoplastic matrix materials. The measurements of moisture saturation levels for several resin systems has agreed well with previous investigators. Characterization of water adsorption sites in thermosetting matrix materials will be studied by autoradiography after exposure of samples to tritiated water. The influence of matrix materials and post cure thermal processing on adsorption sites and the coefficient of moisture expansion will be investigated. Condensible volatile materials in resins considered for space applications are being identified. Coatings for composite materials are under investigation to enhance stability for special design needs (e.g., mirrors). Thermoplastic matrix materials will be studied to determine the influence of matrix crystallinity upon performance. The influence of galvanic corrosion upon composite/metal joints is also under investigation to assess long term storage effects.

Joining of composite materials is being studied and includes mechanical fasteners, adhesives and the welding of thermoplastics. Techniques are being developed to measure the fracture toughness of adhesive bonds and predict the strength of mechanically fastened joints.

Keywords: Composites, Joining/Welding, Fibers, Corrosion, Coatings

342. <u>New Surface Spectroscopy</u> <u>FY 1985</u>
$ 200,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
SNL Contacts - R.W. Carling, 415-422-2206; D.A. Nissen, 415-422-2767; M.C. Nichols, 415-422-2906; M.R. McClellan, 415-422-2598; B.E. Mills, 415-422-3230

New spectroscopic techniques are being developed for special applications. For example, a micro-fluorescence spectrometer is being assembled using a rotating anode source. This unit will permit the examination of very small areas for elemental composition and do it in an automated way to provide coverage of large areas with high resolution. A high resolution electron energy spectrometer (HREELS) has been built and is now being used to investigate adsorption of oxygen and water vapor on uranium. This work will add insight into the mechanisms governing the oxidation and corrosion of metals used within the DOE complex.

Keywords: Spectroscopy, Elemental Composition, Actinides, Gas-Solid Reactions

343. <u>Materials Modification by Ion Beams</u> <u>FY 1985</u>
$ 263,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LLNL Contact - R.G. Musket, 415-422-0483, FTS 532-0483

Research on the applications of ion implantation and ion-beam mixing for the modification of the surface properties of materials was continued. Efforts were concentrated on three materials development activities and the establishment of an ion implantation facility. Aluminum ion implantation into 304L stainless steel combined with post-implant selective oxidation treatments was shown to provide surface oxides highly enriched in Al_2O_3. Such surfaces will be evaluated with regard to their ability to reduce the permeation of tritium. A new hydriding apparatus was successfully employed to study the hydriding behavior of uranium specimens implanted with the following ions: oxygen, nitrogen, carbon, neon, and aluminum. In all cases, the hydriding process was modified relative to that for the non-implanted specimens. Details of the formation of Al_2O_3 layers inside aluminum by oxygen ion implantation were investigated. The C&MS 200 keV, 1.5 mA ion implanter was installed and became fully operational.

Keywords: Actinides, Hydrogen Attack, Insulators/Dielectrics - Ceramic, Metals: Ferrous, Corrosion - Gaseous, Ion Implantation

344. <u>Weld Modeling</u> <u>FY 1985</u>
$ 120,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LLNL Contact - K.W. Mahin, 415-423-0740, FTS 532-0740

The overall objective of this program is to develop a general weld model for the prediction of penetration and distortion in fusion welds. The material under investigation is 304 SST. The research has had two main thrust areas: (1) to evaluate and modify existing "state-of-the-art" finite elements codes to model the problem; and (2) to differentiate between errors due to coding problems vs. lack of accurate experimental input data. The approach has been to select a well-defined axisymmetric 2-D problem, design experiments to provide input for the codes, as well as code verification, and to evaluate code predictions. Vaporization has been incorporated vaporization into the heat transfer model to improve the predictions within the stress code. The 2-D modeling work has been extended to 3-D using infrared spectroscopy techniques to generate the experimental data required for code verification. Future improvements will include modification of the heat transfer and stress code to allow simultaneous calculation of both temperature and stress at each time step and generation of controlled experimental mechanical stress data to better account for the cyclic thermal history of the weld.

Keywords: Joining Development, Modeling

345. Synchrotron Radiation Studies | FY 1985 $ 225,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LLNL Contacts - J.H. Kinney and Q.C. Johnson, 415-422-6669, FTS 532-6669

The near-edge structure in the x-ray absorption coefficient of an element (XANES) is affected by chemistry and local environment. Experiments during the past year have demonstrated that this property can be exploited in x-ray imaging both to identify and enhance the detectability of different chemical states of the same element. Chemical contrast images have been obtained by digital subtraction of absorption images taken at carefully selected x-ray energies. Using XANES differencing in conjunction with a high-resolution detector operated in a computed tomography mode should allow three-dimensional mapping of trace elements and their chemical phases in small samples. This capability should provide especially useful in the materials and biological sciences.

Keywords: X-Ray Imaging, Tomography

346. Metal Deformation Modeling | FY 1985 $ 120,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LLNL Contact - E.C. Flower, 415-423-1572, FTS 532-1572

The purpose of this study is to develop LLNL existing finite element methods (FEM) codes (NIKE/DYNA) to accurately predict metal deformation during a forming operation. Forming operations require that the code account for non-isothermal, large, elastic/plastic deformation, and friction. The constitutive material models which exist, NIKE and DYNA, can predict first order results, such as a final dimension and values for effective plastic strains. Improved material models which are computationally efficient and address adiabatic heating, prior strain-hardening and strain localization are being assessed. The intent is to develop this computer-aimed-simulation technology and transfer this analytical tool within DOE/MA complex while moving toward a total synthesis of design and manufacture. Metal deformation modeling has been extended to include modeling of two-phase materials and residual stresses due to non-uniform plastic deformation.

Keywords: Metals, Modeling, Metalforming, Deformation

347. Rapid Solidification Processing of Alloys FY 1985
$ 380,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LLNL Contact - L.E. Tanner, 415-423-2653, FTS 532-2653

This research program is aimed at developing a comprehensive understanding of the phase relations, phase transformations, structure, morphology, and related physical properties of metallic alloys that have been rapidly solidified from the melt. One important objective is the generation of new understanding of the mechanisms by which fine-scale microdispersions of one phase in another can be formed in eutectic and monotectic systems, and emphasis will be expanded to include other systems similar to Al-Be in which metastable liquid phase separation is expected to occur. Other areas of study will include: (1) alloys that form amorphous solids, to include the thermodynamic and structural aspects of solid-state reactions that lead to glassy metallic alloys; and (2) further investigation of the formation and structure of metastable quasi-crystalline phases in systems other than Al-Mn.

Keywords: Rapid Solidification Processing, Phase Transformation Mechanisms

348. Microstructure of Stainless Steel Welds FY 1985
$ 70,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LLNL Contact - J.W. Elmer, 617-253-6474 (MIT)

The technical objective of this investigation is to study the effects of solidification velocity on microstructure over a cooling rate range extending from 10^2 K/s to 10^6 K/s for stainless steels. The intent of this research is to develop a relationship between solidification velocity and microstructure that will provide predictive capabilities that do not presently exist and to advance the solidification theory of stainless steels.

The investigation is being approached in three phases: (1) development of a method to reproducibly vary solidification velocity in a weld over a large solidification-rate range; (2) modeling the findings from (1) to determine the actual solidification velocities based on material properties, welding parameters and weld bead geometry; and (3) experimentally establishing the solidification velocity-composition-microstructure relationships for stainless steel welds.

Keywords: Stainless Steel, Welding, Solidification, Predictive Behavioral Modeling

349. Powder Metallurgy FY 1985
$ 125,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LLNL Contact - C.E. Witherell, 415-422-8341, FTS 532-8341

In contrast to traditional pyro-metallurgical routes to producing engineering metals and alloys, powder technology deals with solid-state processes for consolidation and densification of particulate materials. These approaches offer superior control over microstructure, affording significantly improved properties. Some materials, like tungsten, cermets, rapidly-solidified glassy (amorphous) metals, most dispersion-strengthened alloys, and most ceramics require them.

The intent of this project was to explore the potential usefulness of several powder technology approaches for applications of increasing interest to LLNL. Because many high performance materials can be made no other way, powder technology is becoming increasingly important to our work at LLNL. For this purpose, powder processing facilities have been set up and tested. These have included powder preparation methods, such as plasma generation, EDM generation, etc., and compaction methods. A number of test specimens have been prepared.

Keywords: Non-Ferrous Metals, Powder Metallurgy

350. Coating Adhesion — FY 1985 $ 70,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LLNL Contact - R.S. Rosen, 415-422-9559, FTS 532-9559

The objectives of this work is to obtain a fundamental understanding of the role of the chemistry and structure of the interface between substrate and metal coating on the metal film formations, growth, and adhesion. This includes a knowledge of oxides and contaminants in this interface. Well characterized surfaces have been prepared and subsequently coated and analyzed "in-situ," using modern surface analytical tools. The role of oxides, impurities, and mobility (affected by substrate temperature) on the film formation and adhesion is being studied.

Keywords: Coatings and Films, Surface

351. Dislocation Structures and Reversed Strains — FY 1985 $ 60,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LLNL Contacts - G.F. Gallegos and M.E. Kassner, 415-422-7002, FTS 532-7002

Some studies have shown that the behavior of yield surfaces are not limited to the two classic effects of expansion (isotropic hardening) and translation (kinetic hardening) in stress space. The independent variables, temperature, and strain may be significant in describing distortion of yield surfaces, yet no work appears to have been performed on metal about 0.5 T_m, where T_m represents absolute melting temperature. Descriptions of the distortion over wide ranges of temperature and strain are important in characterizing materials which are subject to loading histories where strain reversals are encountered.

Yield surfaces are generated by straining a material at known biaxial stress states which can be achieved by applying a simultaneous tension/torsion to a thin-walled tubular specimen. Special grips aheve been designed and fabricated which can have a simultaneous tension/torsion load, while being heated to temperatures of 900°C, under vacuum or inert gas purge to minimize oxidation. Methods to precisely measure strains have been developed.

The degree of yield surface distortion after the combination of large forward and small reverse strains at temperatures in excesses of 0.5 T_m in 304 stainless steel is under investigation. This study will test the classic metallurgical assumptions of isotropic and kinematic hardening that were recently placed in question by an "adjacent" study by the principal investigators. Determining the degree of distortion is critical to the development of constitutive equations that would model material behavior over a wide range of temperatures, such as those required by the Weld Modeling project to predict residual in welds. Such weld models would be of great value in ensuring reliability in the fabrication of weapons components.

Keywords: Stainless Steel, Deformation Mechanisms, Constitutive Equations, Multiaxial Deformation

352. Weld Library Generation | FY 1985 $ 70,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LLNL Contact - K.W. Mahin, 415-423-0740, FTS 532-0740

A weld library is being built from existing welding files and storing this library on a computer database. In addition to collecting data, the project involves statistical comparison of data files to try and generate trends in parameters for given materials and shapes. The NPL database was used to develop a program by which the main library could be stored on the Octopus system and downloaded to an IBM PC for changes. The availability of statistical packages for either the IBM or the Octopus system is being investigated.

This database will be shared with similar databases being developed at other DOE laboratories. The goals of such a library are to minimize development time and to preserve our welding technology.

Keywords: Database, Fusion Welding, Ferrous - Non-Ferrous Metals

353. Electron Beam Welder Data Acquisition System | FY 1985 $ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LLNL Contact - K.W. Mahin, 415-422-0740, FTS 532-0740

Work has continued to bring a computer based data acquisition system on-line for the new Hamilton Standard Electron Beam welder. The purpose of this work is to provide real time histories of welds made both for development and production, and an early detection system for machine malfunctions or deterioration, to minimize the amount of redevelopment work necessary for welds made once or twice a year or less frequently, and to serve as a research database for the correlation of defects with machine or material variations.

Eight different welding parameters are monitored, including High Voltage, Beam and Filament Currents, Focus, and Travel Speed. The system is designed to take data simultaneously on all 8 channels at a rate of 1 kHz. Statistical analysis and comparison of data is done on an IBM PC and representative "calibration" runs for each weld are stored for future comparison.

This work at LLNL will be coordinated with other efforts currently ongoing at other labs within the complex. The final goal will be to devise a system whereby parameter transfer between the labs is optimized and development and problem time minimized.

Keywords: Electron Beam Database

354. Deformation of Aluminum to Large Strains — FY 1985 $ 50,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - M. E. Kassner, 415-423-2329, FTS 543-2329

The dislocation microstructure of aluminum is being examined after transient and steady-state deformation at temperatures ranging from ambient to $0.8T_m$. Large strain deformation is permitted by torsional deformation. The microstructural information at uniquely large strains provides strong new insight into the fundamental mechanisms of plastic flow over the temperature range. In addition, an understanding of the development of microstructure during various thermal-mechanical processes is being developed.

Testing is being performed on the Stanford Torsion Testing machine. Specimens are deformed to various transient and steady-state (large) strains and quenched. The microstructures are examined by optical microscopy as well as by TEM. The average subgrain size, forest dislocation density, and subgrain misorientation angle are determined. By examining the dependence of these variables with strain during steady-state (where both flow stress and strain-rate are constant), the conflicting theories of the rate-controlling mechanism in creep can be evaluated in a new light. The experimental procedures for this project are proven and work is progressing on the strain measurements.

This project provides an understanding of the microstructural evolution during large strain deformation of aluminum. The large strain thermal-mechanical processing as, for example, extrusion of aluminum, is central to the production of very many parts of significance to the DOE.

Keywords: Non-Ferrous Metals, Microstructure, Subgrain, Extrusion, Predictive Behavioral Modeling

355. Corrosion of 7050 Aluminum FY 1985

$ 60,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - R. Glass 415-423-7140, FTS 533-7140

It has been proposed that 7050 aluminum, a high strength aluminum alloy, be used for the W-87 aft support ring. In this application, extruded ring material will be subjected to subsequent thermomechanical treatment for installation. The installation process will introduce stresses into the ring. Electrochemical techniques have been used to evaluate the effect of heat treatment and stress (to 90% of Y.S.) on the corrosion behavior of 7050-XX aluminum in deaerated 3.5% NaCl solutions. Specimens, which were machined from extruded ring material, were examined in the as-received condition and following heat treatment at 580°F for 0.5 min.

Results indicate that within this stress range, using the given experimental method, medium, timescales, that there is no significant trend for the effect of stress on the electrochemical-corrosion behavior for the materials examined. The heat-treated specimens have lower uniform corrosion rates than the as-received forms, but are more susceptible to pitting. However, pitting is not spontaneous for either material in this environment. In addition to investigating the variables of stress and heat treatment, the behavior of specimens machined from three different orientations within extruded ring material has also been compared. The results have been documented in a Laboratory report, UCID-20597 (November 1985).

Keywords: Corrosion, Aqueous

356. Electrochemical Oxidation FY 1985

$1,100,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - R.R. McGuire, 415-422-7792, FTS 532-7792

The purpose of this work is to explore the electrochemical oxidation of nitrogen tetroxide (N_2O_4) to nitrogen pentoxide (N_2O) in 100% nitric acid. The resulting nitration agent is being used to synthesize explosive and propellant ingredients. The electrolysis technique is being scaled up to explore engineering and economic aspects of the process.

Keywords: Electrochemical Oxidation, Nitrogen Pentoxide, Explosives

357. Microstructure Research FY 1985

$ 300,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - Tomas Hirschfeld, 415-422-6364, FTS 532-6464

Structures and devices in the same range 100A-100 are too small for the traditional engineering techniques and too large for the methods of chemistry. The success of microelectronic design and fabrication procedures in this size range has suggested their extension to material science and device technology.

The project focuses on a basic research effort and a feasibility demonstration effort run in parallel. The first studies the effects of size scale on physiochemical and engineering processes and uses them to create guidelines for work in the micro domain. Design studies for structures and devices are then undertaken. The feasibility demonstration effort assembles materials and devices following this guidance in response to indicated needs in the programs. Some of this year's engineered microdevices are a sensor for insulator and gasket degradation, a sensor for evolved hydrogen, selective sensors for evolved gases and vapors, and a universal sensor for organic vapors in an enclosure.

Keywords: Semiconductors, Coatings and Films, Metals, Catalysts, Diffusion, Surface Characterization, Sensors, Degradation, Performance Monitoring, Gas Monitors.

358. <u>Pu Metallurgy</u> <u>FY 1985</u> $ 240,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - P.H. Adler, 415-423-4417, FTS 533-4417

Both the basic mechanisms responsible for the > and >x phase transformation in Pu alloys, as well as, utilization of one or more of these first-order transitions in achieving a dense, ductile - Pu alloy are being investigated. It has been shown that despite the 20-25% volume change associated with the --> transformation, it is geometrically possible for this transformation to occur martensitically. Subsequent computer calculations predict a (.817, .538, .208) x habit and a [.947, .269, .174]x shape strain of magnitude 0.324 for -> transformation where (001)[100]x twinning is the favored lattice-invariant deformation. For - transformation a (.255, .844, .471)X habit and [.822, .446, .355]X shape strain of magnitude 0.417 is predicted with slip on (111)[101]x as the favored lattice-invariant shear system. Sterographic plots of these crystallographic predictions indicate that transformation plasticity via a deformation-induced -> transformation will require the operation of more than on lattice correspondence, and will likely require additional deformation mechanisms to provide the sufficient five independent deformation systems to accommodate an arbitrary shape formation.

Keywords: MartensiticTransformation, Plutonium, Alloys, DeformationPlasticity

359. <u>Pu Alloy Characterization</u> <u>FY 1985</u> $ 220,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - P.H. Adler, 415-423-4417, FTS 533-4417

Based on the Pu-Ga and Pu-Fe binary phase diagrams and an isopleth section (Pu-3.35a/oGa-Fe), the Pu-Ga-Fe ternary phase diagram has been developed up to 10a/oGa and 10a/oFe, over the temperature range 425^{o}C to 600^{o}C. Critical experiments have demonstrated very little refinement of the ternary diagram is required. Close inspection of the ternary diagram reveals equilibrium and non-equilibrium temperature-composition-phase field relationships heretofore unknown and, as such, provides information useful for the design and production of nuclear weapons. The ternary diagrams have, also, provided a theoretically plausible explanation for the observed accelerated stabilization rate of Fe containing Pu-Ga alloys viz., that small amounts of dissolved Fe at high temperatures result in biasing high Ga regions of cored grains, i.e., grain centers, towards melting thus providing temporary fast diffusion paths for Ga. Preliminary calculations based on a rule-of-mixtures model predict a 2-3 order of magnitude reduction in the time necessary to attain complete homogenization consistent with experimental observations.

Keywords: Plutonium Alloys, Gallium, Iron, Homogenization, Phase Diagram

360. Pu Sputtering FY 1985
$ 360,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - H.F. Rizzo, 415-422-6369, FTS 542-6369

This is a study to explore the glass forming ability of various elements with plutonium by sputtering. Composite targets of Fe, Ta, V, Os, Re, Co, and Si with plutonium have been sputtered and the resulting binary coating compositions are being examined by x-ray and metallographic techniques. All these binary systems show strong evidence for the formation of glassy alloys of plutonium. Oxidation experiments (one torr water vapor at 90°C) confirmed the outstanding oxidation resistance of Pu-Si, Pu-Ta, and Pu-Fe glassy alloy coatings. These same sputtered coatings also resisted hydriding when exposed to one atmosphere of hydrogen. Scanning Calorimetry (DSC) measurements will be made to determine the stability and transformations of the plutonium metastable alloys as a function of composition for systems studied. The results of this study should provide the necessary criteria to predict the glass forming ability of various Pu alloys. A related study for preparing sputtered deposits from a Pu-4 at.% Ga alloy target established the sputtering parameters that control the loss of Ga from sputtered coatings.

Keywords: Amorphous Materials, Alloys, Plutonium, Sputtering, Corrosion, Microstructure

361. Directed Energy Surface Processing FY 1985
$ 212,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - E.N. Kaufmann, 415-423-2640, FTS 543-2640

The use of directed energy beams such as lasers, electron beams and ion beams to rapidly melt metal surfaces which then cool rapidly enough to retain crystal structures and microstructures not attainable by equilibrium means is being pursued. New surface alloys prepared in this way may display superior corrosion and fatigue resistance and be less susceptible to attack by hydrogen, liquid metals, etc. Alloys involving Uranium and Beryllium are of particular interest. Retention of the BCC gamma phase of U at low alloy concentrations is one objective. Developing high specific strength alloy precursors in the Be, Al, Li family is another potential benefit of these studies.

Keywords: Metallic Glasses, Surface Structure, Electron Beam Methods, Ion Implantation, Laser Melting, Solidification-Rapid

362. Formation of Metastable Surface Alloys

FY 1985
$ 193,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - E.N. Kaufmann, 415-423-2640, FTS 543-2640

Using laser and electron beam surface melting and rapid solidification under the controlled conditions obtainable with these tools, quantitative data is gathered on such solidification phenomena as maximum growth rate of crystalline phases and nucleation time for crystallization transformations. These coupled with auxiliary measurements of glass crystallization temperatures and simulation of sample thermal history using advanced codes, allows comparison with the theories applicable to the kinetic factors determining actual microstructures. These in concert with the equilibrium phase diagram and estimates of metastable phase available lead to predictive understanding of the rapid solidification process.

Keywords: Metallic Glasses, Surface Structure, Electron Beam Methods, Ion Implantation, Laser Melting, Solidification-Rapid

363. Pu Laser Welding

FY 1985
$ 25,000

DOE Contact - R.E. Lushbough, 301-353-3912
Contact-H. Weiss, 415-422-6268, FTS 532-6268

Isopressed X-Plutonium was welded in short sections on small cylinders. The object was to obtain material to characterize the fracture surface of welded material.

Keywords: Laser Welding, Plutonium, Microstructure

364. Adhesives Evaluation

FY 1985
$ 40,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - D. Mark Hoffman, 415-422-7759, FTS 532-7759

Short term screening tests to examine variables such as chemical structure and composition, curing behaviors, adhesion, and macromolecular architecture were used to select candidate commercial polyurethane adhesives for long-term durability of these adhesives if funding is available. This chemorheological methodology can identify the nature of the polymer degradation responsible for deterioration of adhesive mechanical properties with time.

Keywords: Adhesives and Bonding Agents, Polymers, Structures

365. Mechanics of Low Density Materials

FY 1985
$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - Richard Christensen, 415-422-7136, FTS 532-7136

Mechanics analyses are used to derive the effective elastic moduli for low density materials. Both open cell and closed cell geometric models are employed in the case of isotropic media. The five independent effective moduli are derived for a low density transversely isotropic medium. Compressive strength, as defined by elastic stability, is also derived for open cell and closed cell isotropic materials. The theoretical results are compared with some experimental results, and also are assessed with respect to previous work.

Keywords: Composites (structural) Polymers

366. Polymeric Materials Computer Modeling — FY 1985: $ 60,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - Robert Cook, 415-422-6993, FTS 532-6993

A model of polymeric materials has been developed which includes many of the features of condensed phase polymer chain dynamics, central among them chain relaxation via both conformational motion and crack formation. The stress-strain behavior of the model has been examined using molecular dynamics simulations, finding qualitative agreement with the observed experimental behavior of polymeric materials. Particular attention is paid to the role of chain relaxation.

Keywords: Polymers, Fracture

367. Lifetime Prediction Theory for Polymeric Materials — FY 1985: $ 60,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - Robert Cook, 415-422-6993, FTS 532-6993

A simple kinetic theory of fiber failure has been developed that predicts not only the median lifetimes of fiber samples under constant load but also the dispersion in these lifetimes based upon the dispersion in the static strength of the fiber samples. The theory is applied to Kevlar fibers where data for lifetime under loads from 90 to 50 percent of static strength are known. The theory can also be readily adapted to deal with environmentally induced degradation of strength.

Keywords: Polymers, Fracture, Predictive Behavioral Modeling

368. Weapons Database Development — FY 1985: $ 200,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contact - D.D. Jackson, 415-422-8054, FTS 532-8054

A computer database system is under development to facilitate the analysis of stockpile life data so that the current condition of the stockpile can be assessed better, leading to predictions of its probable future condition. The database(s) will contain information on selected critical materials and components for LLNL-designed weapons and is being developed to provide feedback of surveillance data into the design lab and production complex.

For each weapon system, the following documents are being generated: (1) critical components document; (2) handbook-describes how the data will be displayed and handled; and (3) Surveillance and Stockpile Return Summary (SSRS). All three documents have been completed for the B83 weapons system. These same documents for the W84 and W70 weapons systems are well advanced and will be completed in FY 1986.

Keywords: Weapons, Stockpile, Database

369. Tritium Facility Upgrade — FY 1985: $ 480,000

DOE Contact - R.E. Lushbough, 301-353-3912
LLNL Contacts - G. Morris, 415-423-1770, FTS 543-1770; M. Holda, 415-422-7240, FTS 543-7240

The Tritium Facility Upgrade consists of two parts: a clean-up system ($3.3M) and an office/mechanical technician shop addition ($1.6M). The clean-up system is to consist of custom-made airtight boxes which enclose the high tritium systems of the building. The high pressure pump system will be completely rebuilt with a new minimum pressure of 30,000 psi. These boxes and all pump exhausts will be run into a conventional catalyst/zeolite molecular sieve clean-up system. The entire system will be passive and redundant. It is expected to cut tritium emissions by an order of magnitude and prevent large accidental releases. The office building will raise in-house occupancy from 17 to 31 people. Design continues this fiscal year and construction is to begin this year.

Keywords: Tritium Emmisions

Los Alamos National Laboratory

370. Fluidized Bed Coatings — FY 1985: $ 200,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - D.W. Carroll, 505-667-2145, FTS 843-2145

Techniques have been developed for low temperature deposition of tungsten, molybdenum, rhenium, and nickel on hollow substrates of spherical and cylindrical shapes. Ultra-thin, free-standing shapes have been fabricated.

Keywords: Coatings, Metals, Chemical Vapor Deposition

371. Materials Synthesis by Solid-State Combustion — FY 1985: $ 250,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R.G. Behrens, 505-667-8327, FTS 843-8327

Solid-state combustion is being investigated as a viable technology for rapid, high-temperature synthesis of alloys, ceramics, ceramic composites, and metals either as powders or as near-net-shape forms.

Keywords: Alloys, Ceramics, Composites, Metals, Near-Net-Shape Processing

372. Powder Preparation by Plasma Chemical Synthesis — FY 1985 $ 350,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - D.W. Carroll, 505-667-2145, FTS 843-2145

Plasma-assisted chemical vapor deposition is being developed as a technique for the production of ultrafine, ultrapure ceramic powders. Development work has extended this technology to ultrafine metal and metal alloy powders.

Keywords: Alloys, Ceramics, Metals, Chemical Vapor Deposition

373. Precision Tungsten Tubes — FY 1985 $ 170,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - D.W. Carroll, 505-667-2145, FTS 843-2145

A technique has been developed for producing precision tungsten tubes of various wall thicknesses in substantial lengths by chemical vapor deposition.

Keywords: Coatings, Metals, Chemical Vapor Deposition

374. Superhard Materials — FY 1985 $ 36,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

B_4C has been added to conventional W-Ni-Fe alloys to improve hardness, wear resistance, and resistance to deformation. These alloys have been developed to eliminate the use of critical materials such as cobalt in high hardness materials. Problems being investigated include optimum composition and processing to attain uniform microstructure, and characterization of fracture toughness and hardness.

Keywords: Alloys, Composites, Erosion and Wear, Strength, Hot Pressing, Cutting Tools and Bearings

375. Glass Fabrication Technology — FY 1985 $ 50,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contacts - J.M. Dickinson, 505-667-4365, FTS 843-4365 and R. Mah, 505-667-3238, FTS 843-3238

The technology under deveopment consists of casting and hot forming into hemispheres, disks, plates, sheets, and rods. Composition is controlled to yield good strength, hardness, nuclear requirements, or chemical durability. The forming process is optimized to yield precise shapes, for example by glass-blowing in a gravity-free environment. Silica, sodalime, and pyrex glasses are under investigation. Perfection of shape by surface forces in a high temperature microgravity experiment are being investigated in the space shuttle. A contract with the University of Missouri at Rolla and joint activities with KMS Fusion are being pursued to accomplish the shuttle experiment terrestrially.

Keywords: Amorphous Materials, Glasses, Near-Net-Shape Processing, Hot Forming, Space Shuttle, Microgravity Experiment

376. Slip Casting of Ceramics — FY 1985 — $ 218,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

The objective of this project is to improve the technology of slip casting of many ceramics including aluminum, magnesia, and thoria. The technology uses colloidal chemistry and powder characterization theory along with materials engineering. Bodies so formed are used in many energy technologies including nuclear reactors. Development problems include processing of powder to yield satisfactory sintering and shrinkage. Success may lead to improved materials with superior strength.

Keywords: Ceramics, Microstructure, Strength, Sintering Refractory Liners, Thoria, Transformation Toughened Ceramics, Thermal Shock

377. Whisker Growth Technology — FY 1985 — $ 265,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Silicon carbide whiskers are grown by a vapor-liquid-solid process which produces very long fibers. Research on this program is focusing on four areas: improving control over the process itself so as to obtain mono-sized whiskers of regular morphology; processing whiskers after growth to remove detritus and impurities, characterizing the whiskers and relating their properties to structural features; and growth of Si_3N_4 whiskers by the same process.

Keywords: Structural Ceramics

378. Development of Ceramic Matrix Whisker-Reinforced Composites

FY 1985
$ 250,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Structural ceramic materials, borosilicate glass, $MoSi_2$, and Si_3N_4-matrix composites reinforced with SiC whiskers produced at Los Alamos are being fabricated, primarily by hot pressing. Objectives are to achieve uniform microstructures of dispersed whiskers with low porosity which result in high fracture toughness. Ceramic whisker-reinforced ceramic matrix composites can potentially replace critical and strategic metals in high temperature applications.

Keywords: Ceramics, Whiskers, Composites, Metals, Fracture Toughness, High Temperature Service, Microstructure, Critical and Strategic Materials

379. New Hot Processing Technology

FY 1985
$ 210,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Hot pressing techniques are used to consolidate bodies of materials such as Al_2O_3, ZrO_2, UO_2, B_4C, copper, aluminum, and carbon. Applications are for Los Alamos and other National Laboratory programs, and include armor, ceramic components for nuclear reactor melt down experiments, nuclear shielding, and filters.

Keywords: Ceramics, Metals, Composites, Microstructure, Hot Pressing, High Temperature Service, Nuclear Reactors, Filters

380. Glass and Ceramic Coatings

FY 1985
$ 10,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

This project seeks to develop vitreous enamels and general ceramic coatings to provide radiation-hardened, electrical-insulating components for accelerator technology. Research involves synthesizing formulations to bond various metals, matching thermal expansion, and preserving electrical insulating qualities over very large areas.

Keywords: Enamels, Ceramic Coatings, Metals, Radiation Effects, High Temperature Service

381. Cold Pressing, Cold Isostatic Pressing and Sintering FY 1985
$ 175,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Cold pressing and cold isostatic pressing are used to consolidate ceramic and metal powders to support laboratory programs. Materials processed include UO_2, ThO_2, Al_2O_3, and MgO, and metals such as copper. End uses include plutonium processing hardware and fluxes, simulated fuel pellets, high temperature resistant ceramics for nuclear reactors, and metal filters.

Keywords: Cold Pressing, Sintering, Ceramics, Metals

382. Single Crystal Growth and Characterization FY 1985
$ 90,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Single crystal growth is carried out by techniques such as Czochralski, Bridgman-Stockbarger, Flux, Sublimation, and the various traveling heater or traveling solvent methods. Microstructure of single crystals contain imperfections such as voids and dislocations which depend on the growth mechanism and critically affect performance. The microstructures of single crystals are evaluated by metallographic techniques. Materials under investigation include WO_3, LiF with various dopants, CdTe and $BeAl_2O_4$. Crystals and analyses are supplied to programs involving end uses in laser technology, radiation damage studies, and detector fabrication.

Keywords: Semiconductors, Ceramics, Single Crystals, Radiation Effects, Single Crystal Imperfections, Lasers

383. Plasma-Flame Spraying Technology FY 1985
$ 170,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Free-standing shapes and metallic and ceramic coatings are fabricated by plasma spraying. Materials examined recently include Fe_3O_4, Al_2O_3, tungsten, and LiF, among others. Parts of this work involve investigation of ultrasonic-assisted densification to produce high density coatings. Applications include: radiochemical detectors; temperature, oxidation, and corrosion resistant coatings; and electrically insulating coatings.

Keywords: Coatings, Metals, Ceramics, Plasma-Flame Spraying, High Temperature Service, Surface Characterization and Treatment

384. Electroplating Low Atomic Number Materials FY 1985
$ 0

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

Aqueous solutions presently limit the metals that can be electroplated. This project will look at electroplating low atomic number metals (aluminum and beryllium) by using non-aqueous plating baths. These new baths will include solvents and fused salts. Applications include: weapons components and ICF target fabrication.

Keywords: Electroplating, Aluminum, Beryllium, Coatings, Metals

385. Super-Hard Parylene Coating Development FY 1985
$ 80,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

Use of a unique plasma cross-linking technique during the deposition of thermally pyrolyzed p-xylylene monomer in an inert atmosphere yields a highly cross-linked, hard, polymer product. This new polymer has a thermal stability, in an inert atmosphere, of greater than 500°C.

Keywords: Polymer Coating, Parylene, Encapsulant

386. Three New Conducting Polymers FY 1985
$ 240,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

One polyphenylguinoxaline and two polypyrrones, heretofore unknown materials, have been synthesized and all show unique electrically conductive properties when treated with appropriate doping agents. These new polymers all show better thermal stability than polyacetylene.

Keywords: Polyphenylguinoxaline, Polypyrrone, Conducting Polymers

387. New Highly Conductive Doped Polyacetylene FY 1985
$ 200,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

A new, unique, cesium electride has been found to induce a high level of electrical conductivity in polyacetylene films. This dopant has also been found to significantly improve the stability of polyacetylene.

Keywords: Conducting Polymers, Polyacetylene

388. Liquid Crystal Polymer Development FY 1985
$ 75,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

Conventional liquid crystal polymers possess high strength in only one direction. Working with theoretical physicists, an attempt will be made to synthesize a liquid crystal polymer with strength in three dimensions. This will be a unique polymer with a number of possible applications.

Keywords: Liquid Crystal Polymers

389. Surface Property Modified Plastic Components — FY 1985 $ 70,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

The surface properties of plastic components can be modified by a solvent infusion process. This process may be used to improve the biocompatibility properties of such plastics as acrylics and silicones.

Keywords: Acrylics, Silicones, Polymers, Surface Properties

390. High-Z Loaded Parylene Polymer Coatings — FY 1985 $ 70,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

High-Z metals such as gold can be infused into parylene coatings using organometallic-solvent systems. Both uniformly loaded and graded Z coatings can be prepared by this method.

Keywords: Parylene, Metal Doped Polymers

391. Low-Density, Microcellular Plastic Foams — FY 1985 $ 400,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

Microstructural polyolefin foams with densities between 0.01 g/cc and 0.2 g/cc are manufactured by a nonconventional foaming process. Foams are open-celled and have large surface areas. This process is being expanded to other polymeric materials for a wide variety of applications.

Keywords: Foams, Polyolefins, Polyurethanes, Silicones, Polyesters

392. Radiochemistry Detector Coatings — FY 1985 $ 250,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

Under investigation is a technique to use physical vapor deposition of metallic and nonmetallic coatings for radiochemical detectors.

Keywords: Coatings and Films, Physical Vapor Deposition, Radiochemical Detectors

393. Target Coatings

FY 1985
$ 700,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

The objective of this project is the development of single and multilayer metallic and nonmetallic thin film coatings, smooth and uniform in thickness. Substrates are planar and nonplanar and made of metal, glass, or plastic. Coatings may be bulk density or fractional bulk density and may also be free standing.

Keywords: Coatings and Films, Physical Vapor Deposition

394. Physical Vapor Deposition and Surface Analysis

FY 1985
$ 600,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

This research involves physical vapor deposition and sputtering to produce materials for structural applications, corrosion resistance, optical properties, and thin film transducers. Materials being developed include doped, in-situ laminates of aluminum and Al_xO_y having high strength and smooth surface finish.

Keywords: Coatings and Films, Physical Vapor Deposition, Sputtering, Ion Plating, Corrosion, Nondestructive Evaluation

395. High Energy Density Joining Process Development

FY 1985
$ 400,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

The Project is studying microcomputer technology and signal analysis for process control, and multiaxis, programmable component manipulation for high-voltage electron beam welding. A high voltage electron beam welder has been modified and a spectrometer obtained for beam/target interaction studies. A high-voltage electron beam welder is now operational for fabrication of products in the fissile material area.

Real time diagnostics of laser welding efficiency are thus under investigation. Plasma effects on laser welding efficiency are being studied. Photodiode, acoustic, light-spectral and electron current measurements have been made and are being correlated with high speed cinematography and resultant weld geometry.

Keywords: Welding, Laser, Electron Beam, Diagnostics

396. Arc Welding Process Development FY 1985
$ 150,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Video monitoring and Varistraint testing have been established as techniques to investigate crack-susceptibility of gas-tungsten-arc welds. With emphasis directed toward dissimilar metal welds between 304L stainless steel and Inconel 625.

Keywords: Welding, Hot Cracks, Stainless Steel, Inconel, Varistraint, Video

397. Superplastic Forming FY 1985
$ 150,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Superplastic forming of titanium and uranium alloys is being investigated. Demonstration components made with titanium alloys will be completed. Fine grained U-6 wt% Nb (2 m grain size) has been shown to exhibit superplasticity and will be evaluated in biaxial forming.

Keywords: Superplastic Forming, Near-Net-Shape, Titanium, Uranium Alloys

398. Actinide Alloy Development FY 1985
$1,331,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - D.C. Christensen, 505-667-2556, FTS 843-2556

The aim of this project is the development of new alloys of plutonium. Research involves casting, thermomechanical working, sputtering, and stability studies. Measurements of resistivity, thermal expansion and bend ductility are made to evaluate fabrication processes and alloy stability.

Keywords: Radioactive Materials, Plutonium Alloys, Ductility, Thermal Expansion, Electrical Resistivity, Stability

399. Surface Studies FY 1985
$ 250,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - H.K. McDowell, 505-667-4686 FTS 843-4686

Studies of surface structures and atomic and electronic properties of uranium alloys and intermetallics, NO_2 and ThO_2 single crystals, heavy fermion system, and palladium/hydrogen systems are underway in order to develop essential atomic-level understanding of surface properties of materials and physical and chemical processes. Problems being investigated are: surface modification, synchrotron radiation studies of uranium, UPt_3

surface properties, valence bands of UO_2, residues on electropolished/oxidized uranium, and use of MeV ion beams to probe surface structure. Techniques used are: Low Energy Electron Diffraction (LEED), Auger and Loss Spectroscopies, Ion-Scattering Spectroscopy (ISS), Ultraviolet Photoelectron Spectroscopy (UPS), Synchrotron Radiation, and MeV-ion-beam scattering.

Keywords: Alloys, Radioactive Materials, Microstructure, Surface Characterization and Treatment

400. Tritiated Materials — FY 1985 $ 450,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - D.H.W. Carstens, 505-667-5849 FTS 843-5849

Advanced research and development efforts are focused on low-Z, tritiated materials with the emphasis on Li(D,T) (salt) and other metal tritides. New methods for preparing, fabricating, and containing such compounds are under investigation.

Keywords: Tritium, Li(D,T), Tritiated Materials, Radioactive Materials

401. Actinide Surface Properties — FY 1985 $ 690,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - D.C. Christensen, 505-667-2556, FTS 843-2556

The project involves the characterization of actinide metal, alloy and compound surfaces using the techniques of x-ray photoelectron spectroscopy, Auger analysis, ellipsometry and Fourier-transform infrared spectroscopy. Surface reactions, chemisorption, attack by hydrogen, nature of associated catalytic processes are being studied.

Keywords: Actinides, Hydrides, Surface Characterization, Hydrogen Effects, Radioactive Materials

402. Mechanical Properties and Alloy Development — FY 1985 $ 340,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - S.E. Bronisz, 505-667-4665, FTS 843-4665

Research centers on thermomechanical processing of plutonium alloys to optimize mechanical properties. Complex microstructures, grain refinement, and deformation-induced transformations are of interest.

Keywords: Alloys, Radioactive Materials, Microstructure, Strength, Transformation

403. Mechanical Properties of Uranium FY 1985
$ 70,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - S.E. Bronisz, 505-667-4665, FTS 843-4665

The mechanical properties of U-6 wt% Nb and pure U at high strain rates are being evaluated. The effects of crystallographic texture on high rate (shock regime) uranium deformation are under investigation.

Keywords: Alloys, Radioactive Materials, Microstructures, Strength

404. Phase Transformations in Pu and Pu Alloys FY 1985
$ 375,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - S.E. Bronisz, 505-667-4665, FTS 843-4665

In order to enhance the understanding of the mechanisms, crystallography, and kinetics of transformations in plutonium and alloys, pressure and temperature dilatometry, optical metallography, and x-ray diffraction techniques are being employed.

Keywords: Alloys, Radioactive Materials, Microstructure, Transformation

405. High Strain Rate Testing FY 1985
$ 595,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - P.S. Follansbee, 505-667-8021 FTS 843-8021

Testing of metals at rates up to, but not including, the shock-wave regime is underway in order to elicit fundamental understanding of changes in mechanism as a function of deformation rate.

Keywords: High Strain Rate, Metals, Microstructure

406. Neutron Diffraction of Pu and Pu Alloys FY 1985
$ 180,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - S.E. Bronisz, 505-667-4665, FTS 843-4665

Plutonium and its alloys are being studied by nuetron diffraction at the Los Alamos WNR pulsed neutron source. A time-of-flight technique is used to measure diffraction at elevated temperatures and pressures.

Keywords: Alloys, Radioactive Materials, Transformation, Microstructure

407. Powder Characterization FY 1985
$ 90,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Processing of metal or ceramic powders critically depends on the characterization of the powder being used. This project characterizes starting powders; for example, RF plasma SiC, commercial powders of ThO_2, tungsten, copper, Si_3N_4, MgO and Al_2O_3. Properties determined include particle size and distribution, morphology, state of agglomeration, zeta potential, and surface area.

Keywords: Metal Powder, Ceramic Powder, Particle Size, Zeta Potential

408. Polymers and Adhesives FY 1985
$ 905,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - W.A. May, Jr., 505-667-6362 FTS 843-6362

This task includes the development of fabrication processes, and the evaluation and testing of commercial plastic materials for weapons programs as well as development of plastic-bonded composites, cushioning materials, and compatible adhesives. Included in the work is the design of applications of commercial and developmental plastics fabrication techniques to specific weapons-related materials and components for the purpose of improving efficiency and economy of weapons design.

Keywords: Adhesives, Composites, Polymer Strength, Near-Net-Shape Processing, Surface Characterization, Treatment

409. Salt Fabrication FY 1985
$ 324,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.E. Nasise, 505-667-1459, FTS 843-1459

Research focuses on the development and evaluation of fabrication processes of lithium tritide such as hot pressing and hot isostatic pressing to near-net-shape to improve part shape versatility, density, and surface quality and also, component integrity studies involving radiation induced growth and outgassing.

Keywords: Tritium, Hydrides, Radioactive Materials, Near-Net-Shape Processing

410. Ceramic Technology FY 1985
$ 56,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Castable ceramics are used to fabricate bodies for energy technologies. Typical materials are based on alumina or magnesia with a cement binder, and parts fabricated include molds, crucibles, liners, and electrical insulators.

Keywords: Ceramics, Cements, Sintering, Refractory Liners

411. Glass and Ceramic Sealing, Metallizing Technology — FY 1985 $ 65,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Seals are formed to join ceramic components, and ceramic and metal components, which are used in experimental devices for energy technologies. One component now under development is an alumina assembly consisting of a large number of oval tubes joined together to form an arc of accelerator path. These segments will be metallized, with conductive paths separated by insulating layers, and both ends of the segment will be joined to metal rings for brazing to the metal portion of the accelerator. Due to the size and complexity, sealing and metallizing will be graded in melting point to permit sequential processing and assembly.

Keywords: Ceramics, Coatings and Films, Glasses, Metals, Joining, Graded Melting Temperature, Accelerator, Metallizing

412. Microwave Sintering/Processing — FY 1985 $ 45,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

In this program, techniques of bonding and sintering ceramics are being investigated. Materials under study include Al_2O_3 and glass. The method involves the use of very high frequency microwaves which suscept directly to the area in which the heat is needed. It has potential technical advantages related to heat distribution effects and cost advantage because only the part is heated. Problems to be investigated include the control of the heating and its effect on microstructure.

Keywords: Ceramics, Sintering, Microwaves, RF Heating

413. Injection Mold Process for Making Snap-On Fittings — FY 1985 $ 50,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

High-strength, snap-on tube fittings are made from carbon-fiber reinforced polyether ether ketone, polycarbonate and nylon by an injection molding process. Fittings are functionally equivalent to brass counterparts.

Keywords: Snap-On Fittings, Nylon Composites, Injection Molding

414. Composite Spring Support Structures FY 1985
$ 300,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - R. Mah, 505-667-3238, FTS 843-3238

Composite spring support structures can be fabricated from filament-wound, carbon-fiber epoxy composites. Such spring structures can support relatively heavy masses and show a high degree of self-centering characteristics in levitation configurations.

Keywords: Composites, Springs

415. Solid State Bonding FY 1985
$ 100,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - J.M. Dickinson, 505-667-4365, FTS 843-4365

Initial experimentation has been conducted on aluminum solid state bonding for seamless ICF targets. A new system has been procured to evaluate bond load modulation and ion bombardment cleaning. Bonding technique optimization will be investigated. Emphasis on aluminum and beryllium will continue with primary application to pure fusion experiments.

Keywords: Joining, Solid State Bonding, Sputtering

416. Nondestructive Evaluation FY 1985
$ 450,000

DOE Contact - R.E. Lushbough, 301-353-3912, FTS 233-3912
LANL (Contract No. W-7405-ENG-36) Contact - A. Wilson, 505-667-6404, FTS 843-6404

The nondestructive evaluation techniques that produce quantitative estimates of material properties are under development. Multivariate analysis is applied to welding processes. Tomographic techniques are used to extend radiographic inspections.

Keywords: Nondestructive Evaluation, Radiography, Acoustic Emission

OFFICE OF FOSSIL ENERGY

The mission of the Fossil Energy Program is to develop technologies that will increase domestic production of oil and gas or that will permit the Nation to shift from oil or gas to more abundant coal. Specifically, the Fossil Energy role is to develop technologies to support the following objectives:

- Provide a capability to convert coal to liquid and gaseous fuels;
- Increase domestic production of coal, oil, and gas;
- Ensure that current and new facilities that burn coal can do so in an economically viable and environmentally acceptable manner; and
- Allow more efficient and more economically attractive utilization of fossil energy resources.

The Fossil Energy activity includes fourteen major programs, which are grouped under seven program offices. One of these seven is the Advanced Research and Technology Development Program of the Office of Technology Coordination, which is the central point of contact for inquiries from universities concerning the Fossil Energy program.

Project execution and technical monitoring are administered in five energy technology centers and selected national laboratories.

Office of Technical Coordination

Advanced Research and Technology Development Program

The objectives of the Advanced Research and Technology Development program are to assess and identify long-range advanced research needs in coal processing, fossil fuels utilization and extraction, materials, components, and instrumentation; to provide oversight of on-going advanced research in fossil energy so as to ensure balance and proper priorities; to initiate and fund projects involving new, exploratory concepts or goal-oriented basic research; to manage the Materials Research and University Coal Research programs; and to provide policies for, and overview of, Fossil Energy-supported university activities. The Advanced Research and Technology Development program also is designed to provide an effective communications channel between the Fossil Energy program and academic institutions; to encourage these institutions to become involved in programs related to the DOE Fossil Energy mission; and to manage programs concerned with providing an adequate technical base for development of commercial construction materials and instrumentation for Fossil Energy pilot plants and demonstration plants.

The program supports workshops to identify research needs in all fossil energy technologies and manages related training programs for faculty and students at Energy Technology Centers.

417. Evaluation of the Feasibility of Pressure Quenching to Produce Hard Metastable Materials — FY 1985 $ 0

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
R&D Associates (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 22X-72819C) Contact - H.L. Weisberg, 213-822-1715

The purpose of this research is to design, build, and test a novel high-pressure press system to explore the scientific possibilities of "pressure quenching" of materials, that is, the retention at ambient conditions of metastable material phases normally observed only under extremely high pressures. The device will be capable of exerting pressures up to 60,000 atmospheres on small specimens of solids at room temperature and releasing the pressure so rapidly, on the order of 10 usec or less, that the high-pressure phases will be retained. It is possible that new materials, hitherto never seen, will result. Specific experiments on selected materials will be undertaken to demonstrate the capability of producing such materials.

Keywords: High Pressure, Materials, Decompression

418. Investigation of Candidate Alloys for Advanced Steam Cycle Superheaters and Reheaters — FY 1985 $ 200,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ORNL (Contract No. DE-AC05-84OR21400) Contact - R.W. Swindeman, 615-574-5108; FTS 624-5108

The purpose of this project is to develop an austenitic stainless steel with improved high-temperature mechanical properties and corrosion resistance for use in superheaters and reheaters in advanced steam cycles. After consultation with boiler manufacturers and industrial suppliers of alloys for superheaters and reheaters, the alloy performance criteria will be established. Factors to be considered will be strength, ductility, corrosion resistance, high-temperature stability, fabricability, inspectability, and cost. The availability and performance of existing alloys will be reviewed and compared to the criteria. A program plan will be developed that identifies the needed research to qualify existing alloys, modify existing alloys, or develop new alloys. Knowledge gained in recent years in basic materials science concerning alloy design and the relationship between microstructural phases and mechanical properties will be used to the fullest extent to select compositions expected to meet the criteria. Industrial subcontractors will supply pilot heats of these alloys, and ORNL and university subcontractors will perform experimental work to screen and evaluate the alloys. Exploratory studies of fabrication methods, joining methods, and surface treatments will be undertaken on the most promising alloys. Based on the results of these exploratory studies and strength and corrosion tests, the number of candidate alloys will be reduced for more detailed studies of the effect of composition and microstructure on both the short-term and long-term properties.

Keywords: Steam Cycle, Materials, Corrosion, Mechanical Properties

419. <u>Consolidation of Rapidly Solidified Aluminide Metal Powders</u>

<u>FY 1985</u>
$ 246,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Idaho National Engineering Laboratory (Contract No. DE-AC07-76ID01570)
Contacts - A.D. Donaldson, J.E. Flinn, R.N. Wright, FTS 583-2627

The purpose of this project is to determine the most effective means of, and associated parameters for, consolidating rapidly solidified nickel-iron aluminide powders. Three consolidation techniques will be explored for the rapid solidification process (RSP) powders: hot extrusion (baseline), hot isostatic pressing (HIP), and dynamic (i.e., explosive) methods. The investigation of these consolidation techniques will emphasize the influence of pressure, temperature, and time on RSP structures. Structure/property assessments will be performed on the consolidated materials. In particular, thermal stability, mechanical properties, and oxidation response will be determined. The RSP aluminide powders and extrusions will be obtained from outside sources. Limited atomization investigations will be performed at the Idaho National Engineering Laboratory to assess RSP parameters for the aluminide powders. Compositions of the aluminide powders will be based on Oak Ridge National Laboratory's assessment, and initially will involve Ni-80, Fe-10, Al-10, B-0.02 (all in wt. %), with and without microalloying additions, e.g., hafnium.

Keywords: Aluminides, Powders, Consolidation

420. <u>Investigation of Electrospark Deposited Coatings for Protection of Materials in Sulfidizing Atmospheres</u>

<u>FY 1985</u>
$ 35,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Hanford Engineering Development Laboratory (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc. Subcontract No. 10X-21664V)
Contact - R.J. Johnson, 509-376-0715

The purpose of this task is to examine the use of the electrospark deposition coating process for the application of corrosion-, erosion-, and wear-resistant coatings to candidate superheater alloys. Materials to be deposited may include MCrAl, MCrAlY, highly wear-resistant carbides, and other hardsurfacing materials.

Keywords: Coatings, Materials

421. <u>Short Fiber Reinforced Structural Ceramics</u>

<u>FY 1985</u>
$ 260,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
LANL (Contract No. W-7504-eng-36) Contacts - G.F. Hurley, F.D. Gac, 505-667-9498; FTS 843-9498

The purpose of this study is to investigate the utility of whisker reinforcement technology for producing structural ceramic composites of improved strength and fracture toughness. The program consists of two technical tasks. The first is to optimize an existing Los Alamos whisker growth process to produce alpha-phase silicon nitride whiskers and beta-phase silicon carbide whiskers of uniform size, optimum strength, and in quantities suitable for composite use. The second task will involve evaluating the contribution of the whiskers in selected ceramic-matrix composites.

Keywords: Ceramics

422. Fabrication of Fiber-Reinforced Composites by CVD Infiltration

FY 1985
$ 340,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ORNL (Contract No. DE-AC05-84OR21400) Contact - D.P. Stinton, 615-574-4456; FTS 624-4556

The purpose of this task is to develop a ceramic composite having higher than normal toughness and strength yet retaining the typical ceramic attributes of refractoriness and high resistance to abrasion and corrosion. The desired toughness and strength are on the order of 20 MPa $\cdot$ $m^{1/2}$ and 350 MPa, respectively. In addition, a practical process capable of fabricating simple or complex shapes is desired. The ceramic fiber-ceramic matrix composites are fabricated by infiltrating low-density fiber structures with vapors, which deposit as solid phases on and between the fibers to form the matrix of the composite. The goal is to demonstrate that a ceramic composite can be prepared using materials of high interest to the fossil community. SiC fibers and matrices of SiC and Si_3N_4 have been identified as being most promising. Fiber dimensions, geometry, packing density, binder type and concentrations, and other processing variables have been evaluated experimentally.

Initial experimental efforts focused on the use of a vacuum-forming molding process to form a low-density fiber bed suitable for vapor infiltration. Once the fiber bed was formed, dried, and heat treated, the matrix of the composite was formed by CVD using a high-temperature furnace. A novel scheme (patent applied for) of forcing the coating gases to flow through the fiber bed was tested in an attempt to increase the deposition rate over rates normally obtained when flowing the deposition gases across the surface to be coated. In addition, depending on the deposition reaction, a vacuum may be used to assist the flow of gases through the fibrous parts. Important variables of the CVD process, such as temperature, gas composition, flow rate, pressure, etc., are being systematically altered to maximize matrix density and to obtain a microstructure consistent with the goal of fabrication of high-toughness high-strength ceramic composites.

Keywords: Composites, Fiber-Reinforced, Ceramics

423. Transfer of CVD Infiltration Technology to Industry FY 1985
$ 100,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ORNL (Contract No. DE-AC05-84OR21400) Contact - D.P. Stinton, 615-574-4556; FTS 624-4556

An innovative joint research and development program with Babcock & Wilcox Research Laboratories (B&W) will be conducted to transfer AR&TD-developed CVD infiltration technology to B&W. This effort is supported about 50% by the AR&TD Fossil Energy Materials Program and 50% by B&W. Part of the work, including fabrication of dense fiber mats, will be conducted by B&W, Lynchburg, Virginia. The infiltration will be at ORNL with participation by B&W personnel.

Keywords: Composites, Fiber-Reinforced, Ceramics

424. Development of Advanced Fiber Reinforced Ceramics FY 1985
$ 180,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Georgia Institute of Technology, Georgia Tech Research Institute (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-43369C) Contact - T.L. Starr, 404-894-3678

The purpose of this research effort is to conduct a theoretical and experimental program to identify new compositions and processing methods to improve the physical and mechanical properties of selected fiber reinforced ceramics. The ceramic matrix material to be used is amorphous "fused" silica or modified silica glass and the focus will be the development of fiber reinforced silica. Parameters to be studied will include: (1) differences in elastic modulus between matrix and fiber; (2) differences in thermal expansion; (3) nature of interfacial bond; (4) densification of matrix; (5) nature of fiber fracture/pull-out; (6) fiber diameter and fiber length-to-diameter ratio; (7) fiber loading; and (8) fiber dispersion and orientation. A model will be developed based on the information generated in the experimental phase of the program.

Keywords: Ceramics, Composites, Fiber-Reinforced

425. Technical Monitoring of Coal Gasification Subcontracted Materials Projects for the AR&TD Fossil Energy Materials Program
FY 1985
$ 40,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ANL (Contract No. W-31-109-eng-38) Contact - W.A. Ellingson, 312-972-5068; FTS 972-5068

The purpose of this technical management activity is to assist DOE Oak Ridge Operations and Oak Ridge National Laboratory with technical monitoring of the subcontracts of the AR&TD Fossil Energy Materials Program which are related to high-temperature gaseous corrosion, corrosion of refractories and ceramics, and nondestructive evaluation methods.

Keywords: Technical Monitoring, Coal Gasification

426. Study of Damage Mechanisms in Coal Conversion Atmospheres Affecting the Fatigue and Creep Rupture Properties of Cr-Mo Steels

FY 1985
$ 150,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
University of California, Department of Materials Science (Contract No. DE-AC05-84OR21400), Martin Marietta Energy Systems, Inc., Subcontract No. 19X-27429C) Contacts - E.R. Parker, R.O. Ritchie, 415-642-0863

The purpose of this project is to evaluate the effects of high temperature service in adverse environments on the metallurgical properties (particularly on fatigue crack propagation and creep rupture properties) of weld metal and heat affected zone (HAZ) regions in thick section weldments of 3 Cr-Mo steels. The overall objective is to develop techniques for modifying the microstructures (in the HAZ and base plate) resulting from welding in order to provide adequate resistance to environmentally-induced damage while at the same time maintaining other desired mechanical properties.

Microstructures in the base metal, HAZ, and weld will be fully characterized in terms of microconstituents and phases. Damage in the form of microcavities or methane bubbles, situated in areas expected to be high-damage areas resulting from extended environmental exposure (e.g., to high pressure, high temperature hydrogen) and from welding, will be introduced. Fatigue crack growth characterization studies of weldments will be carried out to determine the influence of metallurgical features and environment on the fatigue crack growth rate from near-threshold to near-instability. Creep rupture testing will be done in order to investigate the influence of damage mechanisms in weldments that are time dependent in their effect on microstructure/mechanical property relationships.

Keywords: Damage Mechanisms, Creep, Fatigue, Materials

427. Microstructure and Micromechanical Response in Austenitic Stainless Steel Overlays on Low Alloy Steel Plate

FY 1985
$ 0

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
University of Cincinnati, Department of Materials Science and Metallurgical Engineering (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-22279C) Contact - J. Moteff, 513-475-3096

The purpose of this research is to provide sufficient information to establish correlations between the weld overlay process, postweld heat treatment, microstructure, micromechanical response and macroscopic mechanical behavior. Microhardness is being used to establish the material micromechanical behavior at various temperatures. This project will, in addition to furnishing an understanding of the reasons for existing weldment microcracking problems, help optimize the welding process and postweld heat treatment variables.

Keywords: Materials Processing, Materials Characterization

428. <u>The Fatigue Behavior of Chromium-Containing Ferritic Steels at Elevated Temperatures</u> <u>FY 1985</u>
$ 0

DOE Contact - S.J. Dapmunas, 301-353-2784; FTS 233-2784
University of Connecticut, Metallurgy Department (Contract No. DE-AC05-840R214000, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-22278C) Contact - A.J. McEvily, 203-486-2941

The objective of this research is to obtain a detailed understanding of the fatigue behavior of these alloys in terms of metallurgical and environmental effects. This understanding should provide a basis for the quantitative analysis of service lifetimes as well as for the optimization of the microstructure for fatigue resistance. Areas of research include fatigue crack initiation and propagation at elevated temperatures in chromium steels and their weldments with particular emphasis on the influence of oxidation.

Keywords: Materials Characterization

429. <u>Transformation, Metallurgical Response and Behavior of the Weld Fusion and Heat Affected Zone in Cr-Mo Steels for Fossil Energy Applications</u>
<u>FY 1985</u>
$ 100,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
University of Tennessee, Department of Chemical, Metallurgical, and Polymer Engineering (Contract No. DE-AC05-840R21400), Martin Marietta Energy Systems, Inc., Subcontract No. 12B-07685CX77) Contact - C.D. Lundin, 615-974-5310

The objective of this research is to develop fundamental information on the metallurgical behavior of the heat affected zone of welds in chromium-molybdenum alloys. This is being accomplished by: (1) documenting transformation behavior under the welding conditions that involve rapid heating and cooling; (2) determining the metallurgical transformation products in the heat affected zone and weld fusion zone; (3) determining the sensitivity of the materials to heat affected zone cracking; (4) determining the sensitivity of the materials to phenomena such as reheat cracking and/or hot cracking; and (5) determining the influence of the various heat affected zone regions on the creep rupture behavior.

Keywords: Materials Processing, Materials Characterization

430. <u>Investigation of Correlation of Carbide Size and Percentage with Mechanical Properties of High-Strength, Low Alloy Steels</u>
<u>FY 1985</u>
$ 0

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Westinghouse Electric Corporation Research and Development Center (Contract No. DE-AC05-840R21400, Martin Marietta Energy Systems, Inc., Subcontract No. 86X-22006C) Contact - B.J. Shaw, 412-256-1201

The purpose of this project is to examine the correlation between the size and percentage of carbides in high-strength low-alloy steels with the mechanical properties. Carbides from a set of at least 20 high-strength Cr-Mo steels will be analyzed by scanning transmission electron microscopy to determine the size, percentage, and type of carbides as a function of composition and tempering parameter. A model developed for characterization of the carbides will be used to develop correlations of composition and heat treatment with the following properties: (1) shift in the 54 J Charpy-V transition temperature due to temper embrittlement; (2) room-temperature yield strength and ultimate strength; (3) room-temperature Charpy-V impact energy; and (4) crack arrest threshold stress intensity.

Keywords: Materials, Mechanical Properties, Carbides

431. Hydrogen Attack in Cr-Mo Steels at Elevated Temperatures

FY 1985
$ 0

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Cornell University, Materials Science and Engineering Department (Contract No. DE-AC05-840R21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-07963C) Contact - Che-Yu Li, 607-256-4349

The objective of this program is to determine the kinetics of nucleation and growth of methane bubbles or cavities in 2 1/4 Cr-1 Mo steels at elevated temperatures under the influence of high pressure hydrogen and applied stress and to develop kinetic equations for estimating the number density and size distribution of grain boundary cavities as a function of time under conditions of interest to coal conversion processes. Currently, this is the only in-situ hydrogen attack work supported by the AR&TD Program. All other programs that address hydrogen attack involve autoclave exposure followed by an evaluation. The effect of constant stress and pressure on the nucleation and growth of methane bubbles in low alloy steels is studied. Models are being developed, based on experimental observations, to describe hydrogen attack in 2 1/4 Cr-1 Mo steel and the important metallurgical parameters are being identified.

Keywords: Hydrogen Effects

432. Analysis of Hydrogen Attack on Pressure Vessel Steels

FY 1985
$ 120,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
University of California at Santa Barbara, Department of Chemical and Nuclear Engineering (Contract No. DE-AC05-840R21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-22276C) Contact - G.R. Odette, 805-961-3525

The initial objectives of the program have been achieved and physical models have been developed that describe the initiation and development of methane damage in carbon steel, C-Mn-Si steels, 2 1/4 Cr-1 Mo steel, and weldments. Nelson diagrams have been predicted and appear to be reasonably consistent with available data. Additional work is needed to refine the analyses and confirm the adequacy of the basic thermodynamic information available in the literature. The model has been particularly useful in establishing the relative importance of microconstituents, deformation mechanisms, and fracure mechanisms to the hydrogen attack process. In this sense it will guide the development of modified low alloy steels for optimum resistance to hydrogen attack. The role that stress and plastic strain transients play in the hydrogen attack phenomena is being examined. Such information is vital because the current design rules for hydrogen service restrict the use of the Nelson curves to situations where the stresses do not exceed the primary stress intensities provided in the ASME Boiler and Pressure Vessel Code.

Keywords: Hydrogen Effects

433. Deformation and Fracture of Low Alloy Steels at High Temperatures

FY 1985
$ 0

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
University of Illinois, Department of Mechanical and Industrial Engineering (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-22239C) Contact - D.L. Marriott, 217-333-7237

The objective of this work is to investigate the microstructural changes and the mechanisms of damage accumulation that accompany, or arise from, high temperature deformation of a range of 2 1/4 Cr-1 Mo steels. The tests conducted under this program will provide a description of the microstructural changes in the chosen test materials under steady and cyclic loading. Progress toward understanding mechanisms of damage accumulation in the test materials for a spectrum of loading conditions should also result from this work. The results of the program will also provide a basis for the development of constitutive relations for correlation of damage and failure.

Keywords: Materials Characterization

434. Evaluation of 3 Cr-1.5 Mo Steel in a Simulated Coal Conversion Environment

FY 1985
$ 80,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Westinghouse Electric Corporation Research and Development Center (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 86X-47977C) Contact - B.J. Shaw, 412-256-1201

The purpose of this work is to develop a fracture mechanics characterization of candidate materials for coal gasification pressure vessels. The apparatus to be used for the fracture characterization has unique capabilities for in-situ testing of steels in high-pressure high-temperature H_2-H_2S environments. The study will be complemented with a physical metallurgical evaluation of the various degradation processes observed in the basic characterization. This effort will focus primarily on the simulated environmental properties of a candidate material (3 Cr-1.5 Mo-V steel) to be used in pressure vessel construction for coal gasification processes. The environments and conditions to which the steel will be exposed are (1) a mixture of gases including H_2 and about 1% max H_S and (2) 10.4 MPa pressure at 315°C (1500 psig at 600°F). This is a laboratory simulation of the coal gasification environment, which, in addition, includes $CO-CO_2$ and H_2-H_2O. Because the selected steel will ultimately be welded, the following metallurgical considerations must also be evaluated: (1) weldability of the base metal; (2) weld metal (composition, need for postweld heat treatment in field construction); and (3) HAZ. Thus, it will eventually be necessary to test both the weld metal and the HAZ, as well as the base metal, to ensure reliability. The current work will include the base plate metal only.

Keywords: Hydrogen Effects

435. Creep Rupture of High-Chromium Alloys in Mixed-Gas Environments
FY 1985
$ 115,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ANL (Contract No. W-31-109-eng-38) Contacts - W. A. Ellingson, K. Natesan-312-972-5068; FTS 972-5068

The purposes of this project are to (1) experimentally evaluate the uniaxial creep rupture behavior of selected high-chromium alloys (e.g., Incoloy 800H, Type 310 stainless steel) and weldments exposed to complex gas mixtures typical of coal conversion process environments, and (2) correlate the creep properties such as rupture life, rupture strain, and minimum creep rate with the chemistry of exposure environment, temperature, and alloy chemistry.

Keywords: Creep Rupture, High-Chromium Alloys

436. Investigation of the Weldability of Ductile Aluminides FY 1985
$ 50,000

DOE Contact - S. J. Dapkunas, 301-353-2784; FTS 233-2784
Colorado School of Mines, Center for Welding Research (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-27421C) Contact - G. R. Edwards, 303-273-3773

The purpose of this project is to study the weldability of nickel-iron aluminides. The major thrust of the project is to determine the role of microstructure in the intergranular cracking of aluminides, with special emphasis on weld cracking susceptibility. This project is a cooperative effort of Oak Ridge National Laboratory (ORNL) and Colorado School of Mines (CSM) and will be conducted as a PhD thesis project by a CSM student working at CSM and at ORNL.

Keywords: Joining Methods, Materials Characterization

437. Development of Iron and Nickel Aluminides FY 1985
$ 200,000

DOE Contact - S. J. Dapkunas, 301-353-2784; FTS 233-2784
ORNL (Contract No. DE-AC05-84OR21400) Contact - C. T. Liu, 615-574-4459; FTS 624-4459

New, improved alloys are needed for components in severe environments for applications such as coal gasifiers, fluidized bed combustors, and fuel cells. The purpose of this task is to design and test materials that will use Al_2O_3 as the main protective layer to prevent sulfidation attack and that will possess good mechanical properties at high temperatures. Aluminides based on the pseudobinary systems Ni_3Al-Fe_3Al and NiAl-FeAl will form the basis for development of materials with the required properties. Success in development of iron and nickel aluminides as structural materials could substantially improve the performance and reliability of advanced fossil energy conversion systems.

The approach of this task is to develop aluminides based on the pseudobinary system Ni_3Al-Fe_3Al. Iron will be macroalloyed to Ni_3Al for solid solution hardening at elevated temperatures and for corrosion resistance in sulfidizing environments. Boron and other elements will be employed for controlling the chemistry and cohesion of grain boundaries. The development of aluminides will also include the FeAl-NiAl system which contains 50 at.% Al for better oxidation and corrosion resistance.

Keywords: Strength, Intermetallics, Alloys

438. Joining of Advanced Aluminides FY 1985
$ 246,000

DOE Contact - S. J. Dapkunas, 301-353-2784; FTS 233-2784
Idaho National Engineering Laboratory (Contract No. DE-AC07-76ID01570) Contacts - A. D. Donaldson, D. E. Clark - FTS 583-2627

The objective of this project is to investigate weldability problems limiting the use of aluminides in welded structures. This includes weldability effects of minor alloying elements, process and process variable effects, solidification mechanics, filler material development, and extension to heavier sections.

Keywords: Joining, Aluminides

439. Pilot Plant Materials Testing and Failure Analysis FY 1985
$ 100,000

DOE Contact - S. J. Dapkunas, 301-353-2784; FTS 233-2784
ORNL (Contract No. DE-AC05-84OR21400) Contact - J. R. Keiser, 615-574-4453; FTS 624-4453

This task will provide screening data on the susceptibility to corrosion and stress-corrosion cracking of potential materials of construction for coal liquefaction plants. This task will also provide failure analyses and on-site examinations for the Wilsonville, Alabama, Advanced Coal Liquefaction Research and Development Facility and other coal conversion plants as needed.

Keywords: Corrosion, Liquefaction, Failure Analysis

440. Corrosion of Alloys for Internal and Heat Exchangers in Mixed-Gas Environments FY 1985
$ 110,000

DOE Contact - S. J. Dapkunas, 301-353-2784; FTS 233-2784
ANL (Contract No. W-31-109-eng-38) Contacts - W. A. Ellingson, K. Natesan, 312-972-5068; FTS 972-5068

The work being conducted under this project provides a basic understanding of the corrosion behavior of commercial and model alloys after exposure to multicomponent gas mixtures. The information generated also provides a rational basis for the extrapolation of corrosion rates as a function of temperature, alloy composition, and chemistry of the gas environments. The corrosion experiments (conducted by using a thermogravimetric technique in mixed gas atmospheres) on selected commercial high-chromium alloys and on model alloys fabricated with compositional variations will establish the role of different alloying elements on the mechanisms of scale development and on the breakaway phenomena leading to scale failure.

Keywords: Corrosion, Gasification

441. Corrosion of Alloys in FBC Systems FY 1985
$ 110,000

DOE Contact - S. J. Dapkunas, 301-353-2784; FTS 233-2784
ANL (Contract No. W-31-109-eng-38) Contacts - W. A. Ellingson, K. Natesan, 312-972-5068; FTS 972-5068

The purposes of this project are to (1) experimentally evaluate the high-temperature corrosion behavior of iron- and nickel-base alloys in gas environments with a wide range of oxygen, sulfur, and carbon potentials, (2) develop corrosion information in the temperature range 400 to 750°C in mixed-gas atmospheres using internally cooled tube specimens of selected commercial materials, (3) evaluate deposit-induced corrosion behavior of heat-exchanger and gas-turbine materials after exposure to multicomponent gas environments, and (4) develop corrosion rate expressions, based upon experimental data, for long-term extrapolation to component design lives.

Keywords: Corrosion, Fluidized Bed Combustion

442. A Mechanistic Study of Low-Temperature Corrosion on Materials in the Coal Combustion Environments FY 1985
$ 140,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
General Electric Company, Gas Turbine Division (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 86X-00224C)- Contact R.W. Haskell, 518-385-4226

The purpose of this work is to develop a mechanistic understanding of the low-temperature corrosion phenomena observed in the Long-Term Materials Test. The study will focus on: (1) a more detailed understanding of the corrosion morphology and interface chemistry on selected specimens after exposure to coal contaminants; (2) thermochemical calculations to establish the range of conditions for stability of the alloy phases, corrosion products, and chemical compounds formed; (3) specific laboratory tests to correlate the experimental results with predictions from the thermochemical calculations. Specimens will be characterized with scanning electron microscopy, electron microprobe analysis and x-ray diffraction. Specimens to be evaluated will include IN-738, FeCrAlY-coated IN-738, RT-22-coated IN-738, and two different CoCrAlY coatings on IN-738. The thermochemical calculations will include (1) the minimum partial pressure of SO_3 required to form a K_2SO_4-$CoSO_4$ liquid and an Na_2SO_4-K_2SO_4-$CoSO_4$ liquid and (2) the thermochemistry of low-temperature attack in the coal combustion environment on iron- and aluminum-rich coatings. Laboratory tests will be performed to determine the agreement between the experimental results and the thermochemical calculations and phase stability plots.

Keywords: Corrosion, Fluidized Bed Combustion

443. <u>Investigation of Corrosion Mechanisms of Coal Combustion Products on Alloys and Coatings</u>

<u>FY 1985</u>
$ 80,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
University of Pittsburgh (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-43346C) Contact - G.H. Meier, 412-624-5316

The objective of this research project is to investigate the formation and breakdown of protective oxide scales in mixed oxidant gases. The results of this research will support the development of improved heat exchanger materials for applications in (1) heat recovery systems for coal conversion plants (particularly gasification) and (2) coal-fired, industrial and utility boilers. The materials used in this study will be model alloys selected for their ability to form single oxides of chromium, aluminum, and silicon. The temperature range of interest is 500°C to 700°C and the test environments contain mixed oxidants (O_2, CO_2, SO_2, H_2S, and Cl_2). Specific objectives include determination of the effect of surface pretreatment and preoxidation on the structure and properties of oxide scales, and the correlation of these treatments and the resulting structures and properties with the breakdown of the scales in mixed oxidant gases. Loss of scale protection by mechanical means (cracking, spalling, etc.) and by transport of corroding species (S and Cl) will be considered.

Keywords: Corrosion

444. <u>Investigation of the Mechanisms of Molten Salt Corrosion of Candidate Materials for Molten Carbonate Fuel Cells</u>

<u>FY 1985</u>
225,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ORNL (Contract No. DE-AC05-84OR21400) Contact - H.S. Hxu, 615-576-4810; FTS 626-4810

This program focuses on the corrosion mechanisms of the anode and cathode current collectors in MCFCs. Thermochemical calculations with the SOLGASMIX-PV computer program will be used to establish equilibrium phase relationships. Differential thermal analysis and thermogravimetric analysis (DTA/TGA) studies of structural metals in Li_2CO_3-K_2CO_3 salts will be conducted to establish the phase stability diagrams of the elements Fe, Ni, and Cr in the salt. The resistance of Ni_3Al to a thin coating of Li_2CO_3-K_2CO_3 will be tested under reducing (anodic) and oxidizing (cathodic) conditions. Finally, salt purification techniques and analytical procedures will be developed to permit determinations of the solubilities of structural metal oxides (Fe_3O_4, Cr_2O_3, and NiO) in molten carbonate salt under anodic and cathodic conditions.

Keywords: Fuel Cells, Current Collectors

445. Erosion in Dual-Phase Microstructures FY 1985
$ 0

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
University of Notre Dame, Department of Metallurgical Engineering and Materials Science (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-43336C) Contact - T.H. Kosel, 219-239-5642

This research program is designed to provide a systematic investigation of the effects of microstructural variables in dual-phase metallic alloys comtaining large second-phase particles on erosion by solid particle impact. While considerable research has been done recently to investigate mechanisms of material removal in single-phase metals and ceramics, relatively little work has been done in the area of dual-phase microstructures.

The variables which are studied include microstructural variables such as second-phase particle size and volume fraction. Erosion variables include particle velocity, angle of impact, and erodent particle size and hardness. The materials investigated include a series of high Cr-Mo white cast irons with compositions tailored to provide a systematic variation of carbide volume fraction (CVF) with constant carbide and matrix composition. The effect of matrix hardness on erosion will be investigated by heat treating the as-cast alloys to transform the austenitic matrix to martensite.

Keywords: Erosion and Wear, Alloys

446. Evaluation of Advanced Materials for Slurry Erosion Service
FY 1985
$ 0

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Battelle-Columbus Laboratories (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 85X-69611C) Contacts- I.G. Wright, A.H. Clauer, 614-424-4377

The original aim of this project was to obtain erosion data on several candidate valve trim materials under a range of slurry erosion conditions that would be useful to valve and process engineers involved in materials selection and valve design. Reconstituted coal-derived slurries were used to erode candidate materials under a range of slurry velocity and impingement angle conditions. Characterization of the erosive slurries, ranking of the erosive resistance of cemented tungesten carbides and various ceramics, and service trials of an experimental carbide valve stem were completed.

The project continues to obtain erosion data on candidate valve trim materials under varied wear conditions, investigate several approaches to the development of new erosion-resistant materials, and characterize the erosion behavior of new materials. In addition, a suitable substitute erodent and liquid carrier combination is being developed for use in standardized laboratory materials evaluation and screening tests, which preferably will reduce levels of health risks and handling problems. This project will help to develop an understanding of materials behavior in slurry erosion.

Keywords: Erosion, Materials Characterization

447. Mechanisms of Erosion-Corrosion in Coal Combustion Environments

FY 1985
$ 215,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ORNL (Contract no. DE-AC05-84OR21400) Contact - J.R. Leiser, 615-574-4453; FTS 624-4453

This project involves the evaluation of erosion-corrosion of alloys by microscopic techniques. Selected alloys will be subjected to exposure in a flowing gas stream of erodent particles, and the degradation of the alloys will be followed by examination of the alloy surfaces by a scanning electron microscope. This technique should provide direct evidence of the erosion-corrosion modes of materials degradation in these systems.

Keywords: Erosion and Wear, Corrosion, Metals, Alloys

448. Study of Particle Rebound Characteristics and Material Erosion at High Temperature

FY 1985
$ 80,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
University of Cincinnati (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-89628C) Contact - W. Tabakoff, 513-475-2849

The purpose of this effort is to investigate the erosion processes and fluid mechanics phenomena that occur in fluidized-bed combustors, coal-fired boilers, cyclones, pumps, turbines, valves, and other coal combustion systems. The overall objective is to develop a quantitative model that will facilitate the prediction of erosion in systems operating in particle-laden environments. This investigation will at first be limited to ductile target materials. The experimental study of the impact and rebound characteristics will be performed with selected solid particles, possibly Al_2O_3 and SiO_2, with sizes from 5 to 200 mm. The target materials will be selected according to present and anticipated materials needs of coal combustion systems. Candidate materials will include stainless steel, INCO 718, Ti 6-4, and 2024 Al.

Keywords: Erosion and Wear, Corrosion, Metals, Alloys

449. Development of Nondestructive Evaluation Techniques for Structural Ceramics

FY 1985
$ 205,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ANL (Contract No. W-31-109-eng-38) Contact W.A. Ellingson, 312-972-5068; FTS 972-5068

The purpose of this project is to study and develop acoustic and radiographic techniques and possible novel techniques such as nuclear magnetic resonance, to characterize structural ceramics with regard to presence of porosity, cracking, inclusions, amount of free silicon, and mechanical properties, and to establish the type and character of flaws that can be found by NDE techniques. Both fired and unfired specimens will be studied, and correlations between NDE results and failure of specimens will be established.

Keywords: Nondestructive Evaluation, Ceramics

450. Effect of Flaws on the Fracture Behavior of Structural Ceramics

FY 1985
$ 100,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ANL (Contract No. W-31-109-eng-38) Contact - W.A. Ellingson, 312-972-5068; FTS 972-5068

The purpose of this work is to establish correlations between the composition, microstructure, and mechanical properties of structural ceramics (Si_3N_4 and SiC with controlled flaws) and measuring their mechanical properties (fracture stress, fracture toughness and elastic modulus). Subsequently, microstructures of the fracture surface will be evaluated in order to locate the critical flaws. Information obtained from these studies will help control processing of structural ceramics to result in improved mechanical properties. Furthermore, correlation of mechanical properties with NDE results will provide additional information which will help verify the ability of NDE to detect failure-initiating flaws.

Keywords: Nondestructive Evaluation, Ceramics, Flaws, Fracture

451. Joining of Silicon Carbide Reinforced Ceramics

FY 1985
$ 245,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Idaho National Engineering Laboratory (Contract No. DE-AC07-76ID01570) Contacts - A.D. Donaldson, R.M. Nielson, FTS 583-2627

The purpose of this project is to identify and to develop techniques for joining silicon carbide fiber-reinforced composite materials. Primary emphasis will be on composite materials with either a silicon nitride or a silicon carbide matrix; lesser emphasis will be placed on silicon carbide fiber-reinforced silica. The work will investigate oxynitride and oxide glass joining materials and joining techniques which promote the devitrification of these materials to produce glass-ceramics and joints which are both strong and tough. Joining of composite matrix materials will be studied, and the resulting information applied to the joining of the fiber-reinforced composites. The joining material, surface preparation, heat treatments, methods of binder application, joining technique, and joint configuration will be considered during joint design and fabrication. Microstructural examination of the joints will be conducted to investigate wetting, microstructure, mass transfer, and process parameter effects. Limited service environment scoping tests will be performed for selected composite joints. Practical joining techniques must be developed to fully realize the advantages of silicon carbide fiber-reinforced ceramic composite materials. Successful joining methods will permit the design and use of complex component shapes and the integration of component parts into larger structures.

Keywords: Joining, Ceramics, Composites

452. Nondestructive Evaluation of Advanced Ceramic Composite Materials

FY 1985
$ 246,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Idaho National Engineering Laboratory (Contract No. DE-AC07-76ID01570)
Contacts - A.D. Donaldson, J.B. Walter, FTS 583-2627

The purpose of this project is to develop an effective capability for nondestructive evaluation of ceramic fiber reinforced ceramic composites. The response of selected samples of sintered composite materials consisting of SiC fibers in SiC and Si_3N_4 matrices to both ultrasonic and radiographic techniques will be investigated. Experimental techniques and signal processing algorithms will be developed for (1) characterizing acoustic properties and sample morphology, including fiber size and distribution and the degree of bonding of the fibers to the matrix, (2) detecting flaws including cracks, porosity, fiber clusters, and bonding anomalies, and (3) detecting flaws in joints. The NDE techniques developed in this project will result in more effective and extensive use of advanced ceramic composite materials in fossil energy applications.

Keywords: Ceramics, Composites, Nondestructive Evaluation

453. Investigation of the Mechanisms of Failure of Ceramic Materials for Hot Gas Filtration

FY 1985
$ 15,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
United Kingdom Coal Research Establishment/Oak Ridge National Laboratory (Contract No. DE-AC05-84OR21400) Contact - R.A. Bradley, 615-574-6094; FTS 624-6094

High temperature ceramic filters used for removing particulates from gas streams have been under evaluation at the United Kingdom Coal Research

Establishment (UKCRE). These filters, also called "candles", have been tested at 950°C in gasification atmospheres. Cracks at the point of attachment to the manifold have been a drawback not only to the application of this specific ceramic design, but represent a phenomenon generic to most rigid ceramic filters. No detailed phenomenological explanation of the failure has been determined. This task is a cooperative project of the DOE Fossil Energy AR&TD Fossil Energy Materials Program and the UKCRE to develop an understanding of the mechanisms of failure of ceramic hot gas filtration materials and, thereby, provide a basis for material and system improvements.

Keywords: Ceramics, Filters, Failure

454. High Temperature Applications of Structural Ceramics FY 1985
$ 260,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
National Bureau of Standards, Center for Materials Science (Contract No. DE-A105-800R20679) Contacts - E.R. Fuller, S.J. Schneider, 301-921-2901

The objective of this study is to characterize the high temperature failure mechanisms and factors that influence their operation with an aim toward improving the properties of structural ceramics, especially silicon carbide and silicon nitride based materials, for use in coal conversion applications.

Keywords: Ceramics, Glasses, Materials Characterization

455. Development of Refractory Composites with High Fracture Toughness
FY 1985
$ 35,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ANL (Contract No. W-31-109-eng-38) Contacts - W.A. Ellingson, J.P. Singh, 312-972-5068; FTS 972-5068

Refractories that are high in chromic oxide content have demonstrated superior resistance to corrosion by a variety of coal slags. However, these refractories possess poor resistance to thermal shock damage. The objective of this program is to fabricate refractories with improved thermal shock properties without sacrificing corrosion resistance. The spinel phase $MgCr_2O_4$ has been selected as the model refractory composition to be studied. The second-phase additions to be explored for the possible beneficial effects on thermal shock properties include ZrO_2, $FeCr_2O_4$, W, Mo, SiC, and Si_3N_4.

Keywords: Refractories

456. High-Temperature Creep Behavior of Refractory Bricks FY 1985
$ 100,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Iowa State University, Engineering Research Institute, Department of Materials Science and Engineering (Contract No. DE-AC05-840R21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-07940C) Contact - T.D. McGee, 515-294-8619; FTS 865-9619

This research effort is a continuation of the study of creep of refractories used to line fossil fuel process vessels. The work will concentrate on those refractories intended for use at higher temperatures and under more severe conditions than can be tolerated by refractory concretes. Specifically, the research will focus on the creep behavior of high-chromia refractories suitable for lining the hot section of slagging gasifiers. Uniaxial creep experiments will be conducted in compression in air and mixed gases with very low oxygen partial pressures. The creep behavior of high-chromia refractories in uniaxial compression will be measured as a function of stress, oxygen partial pressure, and temperature. Oxygen partial pressures ranging from 21 kPa to 0.1 pPa will be used. Stress will be varied from 0.7 to 2 MPa. In addition, biaxial creep measurements will be made for selected refractories for which uniaxial creep measurements have been determined.

The creep data will be evaluated in cooperation with related work at the Massachusetts Institute of Technology to correlate the creep behavior of these refractories with a mathematical model.

Keywords: Ceramics, Glasses, Materials Characterization

457. <u>Investigation of the Effect of Slag Penetration on the Mechanical Properties of Refractories</u> <u>Fy 1985</u>
$ 135,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
National Bureau of Standards, Center for Materials Science (Contract No. DE-AI05-830R21349 Contact - S.M. Wiederhorn, 301-921-2901

The purpose of this task is to evaluate the effect of slag and microstructure on the fracture and deformation behavior of refractory materials and the development of a base of experimental data that can be used to model refractory degradation caused by slag penetration. The fracture and deformation behavior of model refractories will be determined as a function of applied load and temperature. Changes in density and microstructure will be evaluated for refractories which have been subject to creep deformation. Data will be evaluated in terms of mechanisms that have been developed to explain cavity formation, cavity coalescence and crack growth in ceramic materials and the models will be revised as appropriate. A model will be developed to predict the lifetimes of refractories in slagging gasifiers. In addition, a portion of the work will focus on a systematic compilation of data relating to slag properties and corrosion of refractories for advanced coal conversion systems.

Keywords: Corrosion, Slag, Refractories

458. <u>Corrosion of Refractories in Slagging Gasifiers</u> <u>FY 1985</u>
$ 125,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ANL (Contract No. W-31-109-eng-38) Contacts - W.A. Ellingson, S. Greenberg, 312-972-5068; FTS 972-5068

The effects of slag and flux composition on the corrosion of alumina and chromia refractories will be examined in a series of corrosion tests in which the viscosities rather than temperatures are kept constant. The viscosities of coal slags in atmospheres of low oxidizing potential will be determined, and the effects of fluxes will be investigated. An analytical model will be developed for predicting refractory performance as a function of slag composition, refractory composition, temperature, and other slag characteristics.

Keywords: Gasifiers, Corrosion

459. "Materials and Components in Fossil Energy Applications" Newsletter

FY 1985
$ 105,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Battelle-Columbus Laboratories (Contract No. DE-AC05-80ET10609) Contacts- E.E. Hoffman (DOE/ORO), 615-576-0735; FTS 626-0735 and I.G. Wright (BCL), 614-424-4377

The purpose of this task is to publish a periodic newsletter to address current developments in materials and components in fossil energy applications.

Keywords: Materials, Components

460. Three-Dimensional Residual Stress Characterization of Thick Plate Weldments with Advanced Instrumentation and Methodologies

FY 1985
$ 10,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Pennsylvania State University, Materials Research Laboratory (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-89603C) Contact - C.O. Ruud, 814-863-2843

This project is designed (1) to continue and expand previous work at Pennsylvania State University, (2) to involve the characterization of the three-dimensional residual stress field in an approximately 30-cm-thick (12-in.) V-groove weldment of 2 1/4 Cr-1 Mo steel, and (3) to evaluate various postweld heat treatment techniques and schedules proposed for the fabrication of large pressure vessels. This study is expected to provide the most accurate and detailed experimental residual stress analysis of large weldments to date and the needed information for accurate fracture mechanical calculation and finite-element modeling for these weldments.

Keywords: Materials Processing, Materials Characterization

461. Studies of Materials Erosion in Coal Conversion and Utilization Systems

FY 1985
$ 350,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
LBL (Contract No. DE-AC03-76SF00098) Contact - A.V. Levy, 415-486-5822; FTS 451-5822

The objective of this program is to determine the erosion-corrosion behavior of materials used in the flow passages of liquid slurries under conditions representative of those in coal liquefaction systems. From the understanding gained from testing different materials over a range of controlled operating conditions within and beyond those of currently acceptable practice, slurry flow operating parameter guidelines and improved performance, materials selection and design criteria will be developed. The information that will be gained from this program will be structured in a manner that will make it directly usable by coal liquefaction system designers.

Keywords: Corrosion, Erosion and Wear

462. Mechanisms of Galling and Abrasive Wear — FY 1985 $ 0

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
National Bureau of Standards, Center for Materials Science (Contract No. DE-AI05-83OR21322) Contact - L.K. Ives, 301-921-2943

This project is directed to developing an understanding of the wear mechanisms of materials associated with valves in coal conversion systems. This work addresses the mechanical and chemical effects experienced in closure regions of valves in coal conversion systems. It includes theoretical considerations of chemical reactions and effects of the working media on valve closure materials. Measurements are being performed to determine the static and kinetic coefficients of friction of the various combinations of test materials.

Keywords: Erosion and Wear

463. Thermomechanical Modeling of Refractory Brick Linings for Slagging Gasifiers — FY 1985 $ 125,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Massachusetts Institute of Technology (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-07862C) Contact - Oral Buyukozturk, 617-253-7186

The objective of this task is to study the failure mechanisms of refractory-brick-lined coal gasification vessels under transient temperature loadings. A thermomechanical model, which will include cyclic multiaxial nonlinear constitutive law, temperature-dependent heat conduction, and temperature-dependent creep laws, is to be developed for refractory brick and mortar. The model will be implemented in a finite-element program for predicting the stress and strain distributions in brick-mortar linings during the heatup and cooldown cycles. Through simulation and parameter studies, design recommendations will be made for vessel configuration, material property combinations, and optimum heating schedules.

Keywords: Refractory Liners

464. <u>Alkali Attack of Coal Gasifier Refractory Linings</u> FY 1985 $ 90,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Virginia Polytechnic Institute and State University, Department of Materials Engineering (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-43397C) Contact - J.J. Brown, Jr., 703-961-6777

This task will investigate the physical and chemical characteristics of alkali attack of coal gasifier linings under nonslagging conditions. Various refractories will be exposed to simulated coal gasification atmospheres containing alkali metals. Phase changes and compound formations that occur in the refractories will be evaluated and compared with theoretical calculations.

Keywords: Corrosion, Ceramics, Glassess

465. <u>Thermodynamic Properties and Phase Relations for Refractory-Slag Reactions in Slagging Coal Gasifiers</u> FY 1985 $ 95,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
Pennsylvania State University (Contract No. DE-AC05-84OR21400, Martin Marietta Energy Systems, Inc., Subcontract No. 19X-09006C) Contact- Arnulf Muan, 814-865-7659

The purpose of this program is to determine the chemical constraints affecting the performance of refractory materials under experimental conditions corresponding to those prevailing in slagging gasifiers.

Keywords: Thermodynamics, Refractory, Slag, Phase

466. <u>Oxide Electrodes for High-Temperature Fuel Cells</u> FY 1985 $ 226,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
PNL (Contract No. DE-AC06-76RL01830) Contact J.L. Bates, 509-375-2579; FTS 444-2579

The objective of this research is to find and develop highly electronically conducting oxides for use as cathodes in SOFCs. Specifically, the work involves determining the effects of rare earth (RE) and indium oxide additions on the electrical transport properties of $HfO_2(ZrO_2)-RE_xO_y-In_2O_3$. In addition, the study will develop an understanding of the crystallographic, microstructural, and phase equilibrium factors that influence the above properties. The compositions of the $HfO_2(ZrO_2)-RE_xO_y-In_2O_3$ are varied, and the electrical properties are measured relative to the phase equilibrium and crystallographic structures to determine the RE and In_2O_3 combinations that provide the highest electronic conductivity. The electronic conductivity, transference numbers, and Seebeck coefficient are measured as functions of temperature and oxygen partial pressure. An important part of this investigation involves the study of the stability of a particular oxide in the environments and temperature ranges of SOFC fabrication and operation as well as the compatibility of the oxide electrode with the other cell components. This latter criterion includes both chemical compatibility and relative thermal expansion coefficients.

Keywords: Fuel Cells

467. Management of the Fossil Energy Materials Program FY 1985
$ 340,000

DOE Contact - S.J. Dapkunas, 301-353-2784; FTS 233-2784
ORNL (Contract No. DE-AC05-84OR21400) Contacts - R.A. Bradley, P.T. Carlson, 615-574-6094; FTS 624-6094

The overall objective of the Advanced Research and Technology Development (AR&TD) Fossil Energy Materials Program is to conduct a fundamental, long-range research and development program that addresses, in a generic way, the materials needs of fossil energy systems and ensures the development of advanced materials and processing techniques. The purpose of this task is to manage the AR&TD Fossil Energy Materials Program in accordance with procedures described in the Program Management Plan approved by DOE.

This task is responsible for preparing the technical program implementation plan for DOE approval; submitting budget proposals for the program; recommending work to be accomplished by subcontractors and by ORNL; placing and managing subcontracts for fossil energy materials development at industrial research centers, universities, and other government laboratories; and for reporting the progress of the program.

Keywords: Management, Materials Program

Office of Surface Coal Gasification

468. Electroslag Component Casting FY 1985
$ 197,000

DOE Contacts - J.P. Carr (HQ), 301-353-5985; FTS 233-5985 and J.M. Hobday (METC), 304-291-4347; FTS 923-4347
ORNL (Contract No. DE-AC05-84OR21400) Contact - V.K. Sikka, 615-574-5112; FTS 624-5112

The Surface Gasification Materials Program electroslag casting (ESC) project is directed toward the development of ESC technology for use in coal conversion components such as valve bodies, pump housings, and pipe fittings (elbows, tees, etc.). The aim is to develop a sufficient data base to permit acceptance of ESC as an ASME Code (Section VIII) material and to transfer the ESC process technology to private industry. The task has four major areas of emphasis: (a) advancement of ESC technology; (b) preparation of castings (by commercial vendors); (c) testing of commercial ES castings for mechanical properties; and (d) participation with industrial component fabricators to demonstrate the ability to produce representative components for coal conversion systems by the ESC process.

Keywords: Alloys, Near Net Shape Processing, Alternative Fuels

469. Protective Coatings and Claddings: Application/Evaluation

FY 1985
$ 180,000

DOE Contacts - J.P. Carr (HQ), 301-353-5985; FTS 233-5985 and J.M. Hobday (METC), 304-291-43471 FTS 923-4347

ANL (Contract No. W-31-109-eng-38) Contact - D.J. Baxter, 312-972-5117; FTS 972-5117

The coating/cladding development activity will provide experimental evaluation and thermodynamic analysis of metallic protective coatings for coal gasifier waste heat steam generators and superheaters as well as the development of coating inspection methods. The evaluation of procedures for the field restoration of protective coatings at welds and damaged areas is included, as is the development of NDE techniques for verifying coating integrity and quality. These protective coatings will enable conventional ferritic steel boiler and superheater alloys to operate in contact with raw product gas at metal temperatures of about 480 to 540°C required for good plant efficiency.

Keywords: Coatings and Films, Nondestructive Evaluation, Corrosion, Alternative Fuels

470. Corrosion of Structural Ceramics in Coal Gasification Environments

FY 1985
$ 185,000

DOE Contacts - J.P. Carr (HQ), 301-353-5985; FTS 233-5985 and J.M. Hobday (METC), 304-291-4347; FTS 923-4347

ANL (Contract No. W-31-109-eng-38) Contact - T.E. Easler, 312-972-425; FTS 972-4250

This structural ceramics program will provide experimental data (corrosion resistance, effect of environment on mechanical properties) for SiC when exposed to coal gasification heat exchanger environments. In addition, this program will evaluate the corrosion resistance of specific SiC joining methods. The first phase of the program consists of running corrosion screening tests on alpha-SiC, NC-430, and CX-589. These materials will be tested as a function of: (1) fabrication method [slip cast and extruded as well as isostatic pressed (for SC-2 only)]; (2) status of surface (machined or as-received); (3) coal slag (acidic, basic, or no slag); and (4) temperature. Initial corrosion screening tests will be conducted for 200 h at 1250°C in simulated medium-BTu gasification environments. Longer-term (500 h and 1000 h) corrosion tests on those SiC materials that are best able to withstand the corrosive environments as shown by their performance in 200 h tests will be run subsequently.

Keywords: Ceramics, Near Net Shape Processing, Corrosion, Alternative Fuels

471. Materials Review and Component Failure Analysis FY 1985
$ 0

DOE Contacts - J.P. Carr (HQ), 301-353-5985; FTS 233-5985 and J.M. Hobday (METC), 304-291-43471 FTS 923-4347
ANL (Contract No. W-31-109-eng-38) Contact - D.R. Diercks, 312-972-5032; FTS 972-5032

This project is concerned with the review and evaluation of materials performance in coal gasification pilot and demonstration plants. The purposes of this task are threefold: (1) to review and evaluate materials selection and performance in new and on-going plants, including providing failure analysis support; (2) to assess the materials performance of components exposed to the various operating environments in plants that have been closed down or are to be dismantled; and (3) to document the results of these studies so as to provide guidance for future materials utilization in coal conversion systems.

Keywords: Alloys, Ceramics, Corrosion, Erosion and Wear, Alternative Fuels

Office of Oil, Gas, Shale, and Coal Liquids

472. Assessment of Materials Selection and Performance for Coal Liquefaction Plants FY 1985
$ 0

DOE Contact - J.A. Reafsnyder (ORO), 615-576-1051; FTS 626-1051
ORNL (Contract No. DE-AC05-84OR21400) Contact - A.R. Olsen, 615-574-1753; FTS 624-1753

Materials selection and performance data for coal liquefaction pilot plants are being collected, assessed, and compiled. In addition to pilot plant information, data from applicable research and development programs and other sources such as the American Petroleum Institute (API) and the National Association of Corrosion Engineers (NACE) are being assessed for applicability. This work draws on reviews of the SRC demonstration plant design and includes materials selection information for those plants. This compilation provides the identification and assessment of available materials data and identifies limited or missing materials data. This permits reviews of current research and development programs and planning of future efforts.

Keywords: Alloys, Corrosion, Erosion and Wear, Alternative Fuels

473. Materials Review and Support for the SRC-I Liquefaction Project
FY 1985
$ 0

DOE Contact - J.A. Reafsnyder (ORO), 615-576-1051; FTS 626-1051
ORNL (Contract No. DE-AC05-85OR21400) Contact - A.R. Olsen, 615-574-1753; FTS 624-1753

The objectives of this work are to provide assistance in the review of contractor documents for materials selection, to review and provide input to materials testing and failure analysis plans, and to compile materials information for specific processing steps to assist designers in making appropriate materials choices. The ORNL Fossil Energy Materials Program staff reviews materials-related items of SRC-I demonstration plant project.

Keywords: Alloys, Corrosion, Erosion and Wear, Alternative Fuels

474. Coal Liquefaction Pilot Plant Materials Testing and Failure Analysis
FY 1985
$ 0

DOE Contact - T.B. Simpson (HQ), 301-353-3913; FTS 233-2913; S.R. Lee (PETC), 412-675-6137; FTS 723-6137
ORNL Contact - J.R. Keiser, 615-574-4453

This project provides alloy screening data on the susceptibility to corrosion and stress-corrosion cracking of potential materials of construction for coal liquefaction plants. These data are obtained by performing in-plant coupon exposures, laboratory tests, and metallographic examinations. Alloys are ranked according to their corrosion resistance to the various process stream environments.

Keywords: Alloys, Corrosion, Alternative Fuels

475. Coating Studies For Coal Conversion FY 1985
$ 0

DOE Contacts - T.B. Simpson (HQ), 301-353-3913; S.R. Lee (PETC), 412-675-6137
ORNL Contact - A.J. Caputo, 615-574-4566

These studies are geared toward the development of chemically vapor deposited coatings which offer the hope of extending the life of valve trim materials in coal conversion applications.

Keywords: Chemical Vapor Deposition

476. Elastomer Test Programs FY 1985
$ 0

DOE Contacts - T.B. Simpson (HQ), 301-353-3913; S.R. Lee (PETC), 412-675-6137
ORNL Contact - J.R. Keiser, 615-574-4453

O-ring elastomers are being tested for use in coal liquids. Laboratory immersion tests are being performed at the Wilsonville Advanced Coal Liquefaction Research and Development Facility.

Keywords: Elastomers

Office of Coal Utilization

477. Electrode Surface Chemistry FY 1985
$ 200,000

DOE Contact - W.J. Huber, 304-291-4663; FTS 923-4663
LBL (Contract No. DE-AC03-76SF00098) Contact - P.N. Ross, 415-486-4000; FTS 451-4000

This project involves the synthesis of bimetallic catalysts by thermal annealing of platinum with refractory metals, refractory metal oxides, and refractory metal carbides. These alloys were analyzed and tested for catalytic activity.

Keywords: Catalysts, Performance/Endurance, Sintering/Surface Characterization and Treatment, Fuel Cells

478. <u>Development of Ternary Alloy Cathode Catalysts for Phosphoric Acid Fuel Cells</u>

<u>FY 1985</u>
$ 60,000

DOE Contact - W.J. Huber, 304-291-4663; FTS 923-4663
Giner (Contract No. DEN3-294) Contact - V. Jalan, 617-889-7270

This work involves the synthesis of binary and ternary platinum alloy catalysts. A selected few showed increased catalytic activity compared to platinum catalysts alone. Development quantities of catalysts have been supplied to the National Aeronautics and Space Administration (NASA) for evaluation.

Keywords: Catalysts, Performance/Endurance, Sintering/Surface Characterization and Treatment, Fuel Cells

479. <u>Organometallic Catalysts for Primary Phosphoric Acid Fuel Cells</u>

<u>FY 1985</u>
$ 0

DOE Contact - W.J. Huber, 304-291-4663
ECO Contact - F. Walsh, 617-964-7010

This work involves the synthesis of several metal-cobalt-organic liquid type catalysts which have shown increased catalytic activity when compared to platinum catalysts.

Keywords: Catalysts, Performance/Endurance

480. <u>Molten Carbonate Fuel Cell and Stack Technology Development</u>

<u>FY 1985</u>
$ 0

DOE Contact - F.D. Gmeindl, 304-291-4751
United Technologies Corporation Contact - A. Meyer, 203-727-2214

Materials which maintain springiness under molten carbonate fuel cells (MCFC) operating conditions with temperatures approaching 700°C are being evaluated for use in the construction of flexible flanges which maintain sealing pressures against electrolyte-filled ceramic matrices. Corrosion of 316 stainless steel and other alloys are being studied in a MCFC cathode gas/molten corbonate film environment for the effects of heat and forming operations on the corrosion rate and the nature of the protective layer under normal operation of the fuel cell and under the stress of thermal cycling. Also, ZrO_2 materials are being evaluated for use as gasket materials between gas manifolds and the MCFC stack.

Keywords: Fuel Cells, Performance/Endurance, Corrosion

481. Molten Carbonate Fuel Cell Component Technology Development

FY 1985
$ 0

DOE Contact - F.D. Gmeindl, 304-291-4751
Energy Research Corporation Contact - H. Maru, 203-792-1460

The objective of thes project is the improvement of anode creep resisance by filling the anode with lithium aluminate powders. Porosity can be improved by controlling particle synthesis and improving pressing and sintering methods. Catalysts are being developed for methane reforming in the anode compartment of the fuel cell. Also under development is a coating for separator plate materials which will meet the goals of over potential and resistance to corrosion and spalling after thermal cycling.

Keywords: Fuel Cells, Performance/Endurance, Catalysts, Coating

482. Alternative Molten Carbonate Fuel Cell Cathodes

FY 1985
$ 0

DOE Conatct - F.D. Gmeindl, 304-291-4751
ANL Contact - R.D. Pierce, 312-972-4450

Various ceramic materials (e.g., Li_2MnO_3, $LiFeO_2$, and ZnO) are being evaluated as possible alternatives to NiO for the cathode material in molten carbonate fuel cells because in-cell migration of NiO has been found to be excessive for long-term operation.

Keywords: Fuel Cells, Ceramics

483. High Temperature Solid Oxide Electrolyte Fuel Cell Power Generation System

FY 1985
$ 0

DOE Contact - C.M. Zeh, 304-291-4265
Westinghouse Electric Corporation R&D Center Contact - W. Feduska, 412-256-1951

A 5kW generator is under development, preceded by the qualification of submodule performance. Essential design features such sd the sealless generator concept, temperature profiles and oxide distribution will be demonstrated prior to the design and fabrication of the 5kW generator. Diffusion studies to determine potential life limiting factors ar underway.

Keywords: Fuel Cells, High Temperature

484. Advanced Fuel Cell Research

FY 1985
$ 0

DOE Contact - C.M. Zeh, 304-291-4265
ANL Contact - D.C. Fee, 312-972-8931

This work involves the development of a fabrication process for a monolithic fuel cell design composed of a "honeycomb" of small 1- to 2-mm diameter cells.

Keywords: Fuel Cells, Fabrication

Magnetohydrodynamics Program

Successful economic operation of commercial MHD power systems will depend to a large measure on the availability of reliable materials of construction, capable of extended service at MHD operating conditions. The primary objective of the Materials Program of the Office of MHD is the development of materials applicable to the unique operating environment of coal-fired MHD systems. Program effort is divided into two general categories: (1) research effort to provide a fundamental understanding of materials behavior and a basis for the development of particular materials properties for MHD systems; and (2) applied engineering development of MHD component materials.

The materials development effort within the Office of MHD is coordinated by the Program Manager for Materials Development through the Office of the Director. Development effort in the first category is managed by the Division of Research and Advanced System Development, and effort in the second category by the Division of Engineering Development.

Development of MHD Generator Electrode and Insulator Materials

The objectives of this area are to define the thermal, electrical, chemical, and fluidynamic environment of electrode materials and to develop electrode and insulator materials applicable to this environment. Service conditions include: temperatures up to 2000 degrees C, heat fluxes up to 300 w/cm^2, exposure to magnetic fields of 50,000-60,000 Gauss, exposure to strongly alkali chemical species and reducing gases, current densities up to 1 amp/cm^2, and sonic velocities.

Program effort is currently directed toward the development of alternative electrode concepts; the development of cold (externally cooled) metallic electrodes, hot (1200-1900 degrees K) refractory electrodes, and superhot (> 1900 degrees K) ceramic electrodes. Among the metals, Ni, Co, Cr, Fe, W, Ti, Ta, Nb, and their alloys have been evaluated. Among the refractories a number of spinels based on Al, Fe, La, Cr, and Mn have been evaluated. Key materials development contractors for this area are: Avco-Everett Research Laboratory, Westinghouse Electric Corporation, Battelle Northwest Laboratory, Massachusetts Institute of Technology, and Stanford University.

485. MHD Materials Development Testing, and Evaluation — FY 1985 $ 30,000

DOE Contact - T.W. Arrigoni, 412-675-5981 (FTS 723-5981)
PNL (Contract No. DE-AC06-76RL01830) Contact - P.E. Hart, 504-375-2905

PNL has been involved in the development and testing of hot composite ceramic electrodes and MHD channel insulator materials. The current effort has placed emphasis on the development of composite, multi-layered, high temperature electrodes of hafnium oxide/rare earth oxides/indium oxides with improved thermal shock resistance. These electrode materials are tested by direct exposure to hot molten coal slag.

Keywords: Ceramics, Composites, Electrodes, Insulators

486. UTSI MHD Development Testing FY 1985 $ 680,000

DOE Contact - C.A. Thomas, 412-675-5731 (FTS 723-5731)
University of Tennessee Space Institute (Contract No. DE-AC02-79ET10815)
Contact - N.R. Johanson, 615-455-0631

A major task in the MHD development testing, being conducted at the Coal-Fired Flow Facility (CFFF) at the University of Tennessee Space Institute, includes the evaluation of materials for use in MHD system superheaters and air heaters. Materials being evaluated include Croloy; Inconel; and 304, 316, 321. 446, and 26-1 stainless steels. Measurements of corrosion, fouling, and ash deposition are made for these materials under various conditions of a coal-fired MHD gas flow environment.

Keywords: Corrosion, Fouling, Superheaters

487. MHD Heat and Seed Recovery Technology FY 1985 $ 100,000

DOE Contact - R.F. Sperlein, 412-675-5985 (FTS 723-5985)
ANL (Contract No. W-31-109-eng-38) Contact - T. Johnson, 312-972-5964

A series of tests were conducted at Argonne National Laboratory to investigate critical factors affecting the formation and growth of seed/slag deposites in a coal-fired MHD steam plant. These deposites consist of eighty to ninety-five percent potassium sulfate, with the balance consisting of sulfates and carbonates of seed impurities. Simulated MHD channel exhaust gas was produced by burning a slurry of heating oil, potassium sulfate, and fly ash with preheated air. The deposits were formed on type 304 stainless steel tubes.

Keywords: Scale Growth, Deposits, Corrosion

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