DOE/CE/0078
Previous No. DOE/FE-0033 DRAFT

ENERGY MATERIALS COORDINATING COMMITTEE (EMACC)

Fiscal Year 1983

March 1984

ANNUAL TECHNICAL REPORT

U.S. Department of Energy
Assistant Secretary
Conservation and Renewable Energy
Division of Energy Conversion and Utilization Technologies

DISCLAIMER

This report has been reproduced directly from the best available copy.

Available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161.

Price: Printed Copy A11
Microfiche A01

Codes are used for pricing all publications. The code is determined by the number of pages in the publication. Information pertaining to the pricing codes can be found in the current issues of the following publications, which are generally available in most libraries: *Energy Research Abstracts, (ERA); Government Reports Announcements* and Index (*GRA* and I); *Scientific and Technical Abstract Reports (STAR);* and publication, NTIS-PR-360 available from (NTIS) at the above address.

DOE/CE/0078
Previous No. DOE/FE-0033 DRAFT
Dist. Category UC-25

ENERGY MATERIALS COORDINATING COMMITTEE (EMACC)

Fiscal Year 1983

March 1984

ANNUAL TECHNICAL REPORT

U.S. Department of Energy
Assistant Secretary
Conservation and Renewable Energy
Division of Energy Conversion and Utilization Technologies
Washington, D.C. 20545

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

APPENDICES

APPENDICES (Continued)

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 meetings/workshops on selected topics involving both DOE and major contractors. 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 membership is listed in Table I.

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 summarized EMaCC activities for FY 1983 and describes the materials research programs of various offices and divisions within the Department.

James J. Eberhardt
Office of Energy Systems Research
Office of Conservation and Renewable Energy
Chairman of EMaCC, FY 1983

Fiscal Year 1983 Activities

1. The following meetings were held:

Date	Topic	Speaker
March 25, 1983	Economic Impacts of Fracture in the U.S. Economy	Jules Duga
April 29, 1983	Overview of BES Materials Science Program	Louis C. Ianniello
June 10, 1983	Overview of Energy Conservation and Utilization Technology Program	James J. Eberhardt
	COMAT Welding Task Group Presentation	Stanley M. Wolf
September 23, 1983	Fuels and Core Materials Activities for Breeder Reactor Programs	Andrew Van Echo
	Materials and Structures Technology	Claude Beals
November 18, 1983	Passive and Hybrid Solar Materials Research Program	David Pellish
	Materials Research in Japan	Robert J. Gottschall
December 13, 1983	Review of Fossil Energy Materials Research	Stanley J. Dapkunas
	Report on International Symposium on Ceramic Components for Engines	Robert B. Schulz Robert J. Gottschall

2. EMaCC members participated in the Interagency Working Group on Ceramics for Heat Engines held in Dearborn, Michigan on November 17, 1983.
3. As in 1982 EMaCC served as the mechanism of gathering input for the 1983 COMAT survey of materials research in DOE.
4. EMaCC continued its function as a mechanism for Updating a Summary of DOE Funding in Rapid Solidification Technology (RST) for the COMAT-RST working group.
5. EMaCC again provided a summary of FY 83 DOE-sponsored Materials Research.

TABLE I
MEMBERSHIP LIST
DEPARTMENT OF ENERGY
ENERGY MATERIALS COORDINATION COMMITTEE
DECEMBER 1983

ORGANIZATION	REPRESENTATIVE/ ALTERNATE	ROUTE SYMBOL	ROOM/BLDG.	PHONE NUMBER
CONSERVATION AND RENEWABLE ENERGY				
Adv. Conservation Technology/ Electrochemical Energy Storage	Stanley S. Ruby	CE-141	5E-036/FORSTL	252-1486
Energy Systems Research/Energy Conversion and Utilization Technology	James J. Eberhardt	CE-142	5E-091/FORSTL	252-1499
Industrial Programs/Waste Energy Reduction	Jerome F. Collins	CE-121	6G-056/FORSTL	252-2366
Technology Development and Analysis/Office of Vehicle Engine R&D	Robert B. Schulz	CE-131	GB-096/FORSTL	252-8064
Renewable Technology/Biomass Energy	Beverly J. Berger	CE-321	5F-043/FORSTL	252-6750
Renewable Technology/ Geothermal Energy	Leon Lehr	CE-324	5G-046/FORSTL	252-8076
Solar Electric Technology/ Oceam Energy Systems	William E. Richards	CE-332	5H-032/FORSTL	252-5517
Solar Electric Technologies/ Photovoltaics Energy	Anthony Scolaro	CE-333	5E-066/FORSTL	252-5548
Solar Electric Technologies	Louis V. Divone	CE-336	5E-080/FORSTL	252-5540
Building Energy R&D/ Buildings System	William Gerken	CE-111	GF-253/FORSTL	252-9187

TABLE I (CONTINUED)

ORGANIZATION	REPRESENTATIVE/ ALTERNATE	ROUTE SYMBOL	ROOM/BLDG.	PHONE NUMBER
CONSERVATION AND RENEWABLE ENERGY (CONTINUED)				
Industrial Programs/Waste Energy Reduction	Albert J. Hayes	CE-121	6G-032/FORSTL	252-2378
Solar Heat Technologies/ Passive and Hybrid Solar	David Pellish	CE-312	5H-047/FORSTL	252-8110
Solar Heat Technologies/ Solar Thermal	Frank Wilkins	CE-314	5H-041/FORSTL	252-1684
Solar Electric Technology/ Photovoltaics Energy	Morton B. Prince	CE-332	5E-066/FORSTL	252-1725
DEFENSE PROGRAMS				
Inertial Fusion/Fusion Research	Carl B. Hilland	DP-232	C-404/GTN	353-3687
Nuclear Materials Production/ Materials Processing	Louis R. Willet	DP-132	A-203/GTN	353-4959
Waste & Byproducts Management/ R&D & Byproducts	Ray D. Walton, Jr.	DP-123	A-255/GTN	353-3388
Weapons Research, Development & Testing/Weapons Research	Yo Taik Song	DP-225.2	B-310/GTN	353-5350
Weapons Research, Development & Testing/Weapons Research	Paul O. Matthews	DP-225.2	B-310/GTN	353-5492
ENERGY RESEARCH				
Basic Energy Sciences/ Materials Sciences	Louis C. Ianniello	ER-13	J-917/GTN	353-3427

TABLE I (CONTINUED)

ORGANIZATION	REPRESENTATIVE/ ALTERNATE	ROUTE SYMBOL	ROOM/BLDG.	PHONE NUMBER
Development & Technology/ Component Development	Donald S. Beard	ER-531	J-220/GTN	353-4958
Health & Environmental Research/Physical and Technological	Gerald Goldstein	ER-74	E-223/GTN	353-5348
Materials Sciences/Metallurgy and Ceramics	Robert J. Gottschall	ER-131	J-321/GTN	353-3428
Materials Sciences/Solid State Physics and Materials Chemistry	Mark C. Wittels	ER-132	J-325/GTN	353-3426
Materials Sciences/Metallurgy and Ceramics	Stanley Wolf	ER-131	J-323/GTN	353-3428
FOSSIL ENERGY				
Office of Technical Coordination	S. J. Dapkunas	FE-14	B-127/GTN	353-2790
Office of Advanced Energy Conversion	John Fairbanks	FE-22	C-117/GTN	353-2822
Surface Coal Gasification	N. L. Jenson	FE-24	E-136/GTN	353-2722
Office of Coal Mining	J. L. Jenson	FE-24	C-133/GTN	353-2722
NUCLEAR ENERGY				
Breeder Reactor Programs/ Space Reactor Projects	Chester M. Purdy	NE-54	F-414/GTN	353-4486
Breeder Reactor Programs/ Breeder Technology Projects	Andrew Van Echo	NE-53	F-421/GTN	353-3930
Converter Reactor Deployment/ High Temperature Reactor Development	J. Edward Fox	NE-15	E-480/GTN	353-4162

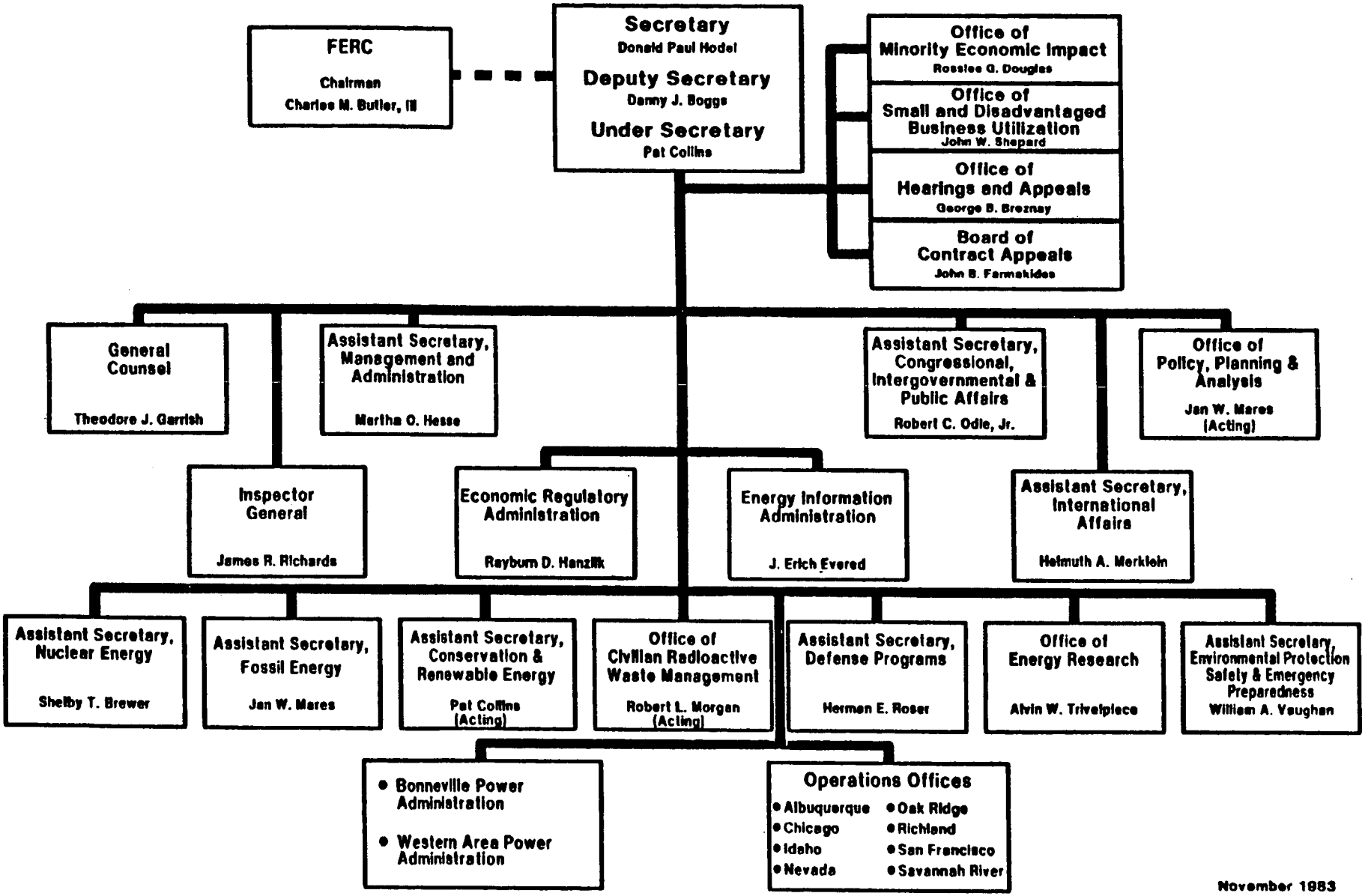
TABLE I (CONTINUED)

ORGANIZATION	REPRESENTATIVE/ ALTERNATE	ROUTE SYMBOL	ROOM/BLDG.	PHONE NUMBER
Naval Reactors/Reactor Materials	Robert H. Steele	NE-60	4E-38/GTN	557-5561
Support Programs/Safety Quality Assurance & Safeguards	Benjamin C. Wei	NE-74	E-427/GTN	353-3927
Terminal Waste Disposal and Remedial Action/Waste Repository Deployment	Warren K. Eister	NE-22	G-456/GTN	353-3188
Uranium Enrichment & Assessment/ Enrichment Expansion Projects	Arnold P. Litman	NE-34	A-188/GTN	353-5777
Converter Reactor Deployment/ Nuclear Regulation and Safety	Arthur S. Mehner	NE-12	E-463/GTN	353-2940
Breeder Reactor Programs/ Breeder Technology Projects	Claude C. Beals	NE-53	F-418/GTM	353-4329
RADIOACTIVE WASTE				
Waste Systems Development	Mark Frei	RW-23	J-413/GTN	353-3017
Engineering and Licensing	Carl Conner	RW-33	7F-045/FORSTL	252-2439

PROGRAM DESCRIPTIONS

The following text briefly describes the materials research programs of the Department of Energy. It is organized by office and organizational charts are provided to allow easy identification of the materials research programs of each office. These program descriptions have been prepared from inputs submitted by many different EMaCC members. For this reason they vary somewhat in format and detail. More detailed summaries of individual materials projects sponsored by the Department are provided in the Appendices, which are also organized by office. It is important to note that this report is not a comprehensive summary of the Department's programs, but rather a compilation of the programs of those offices that submitted inputs.

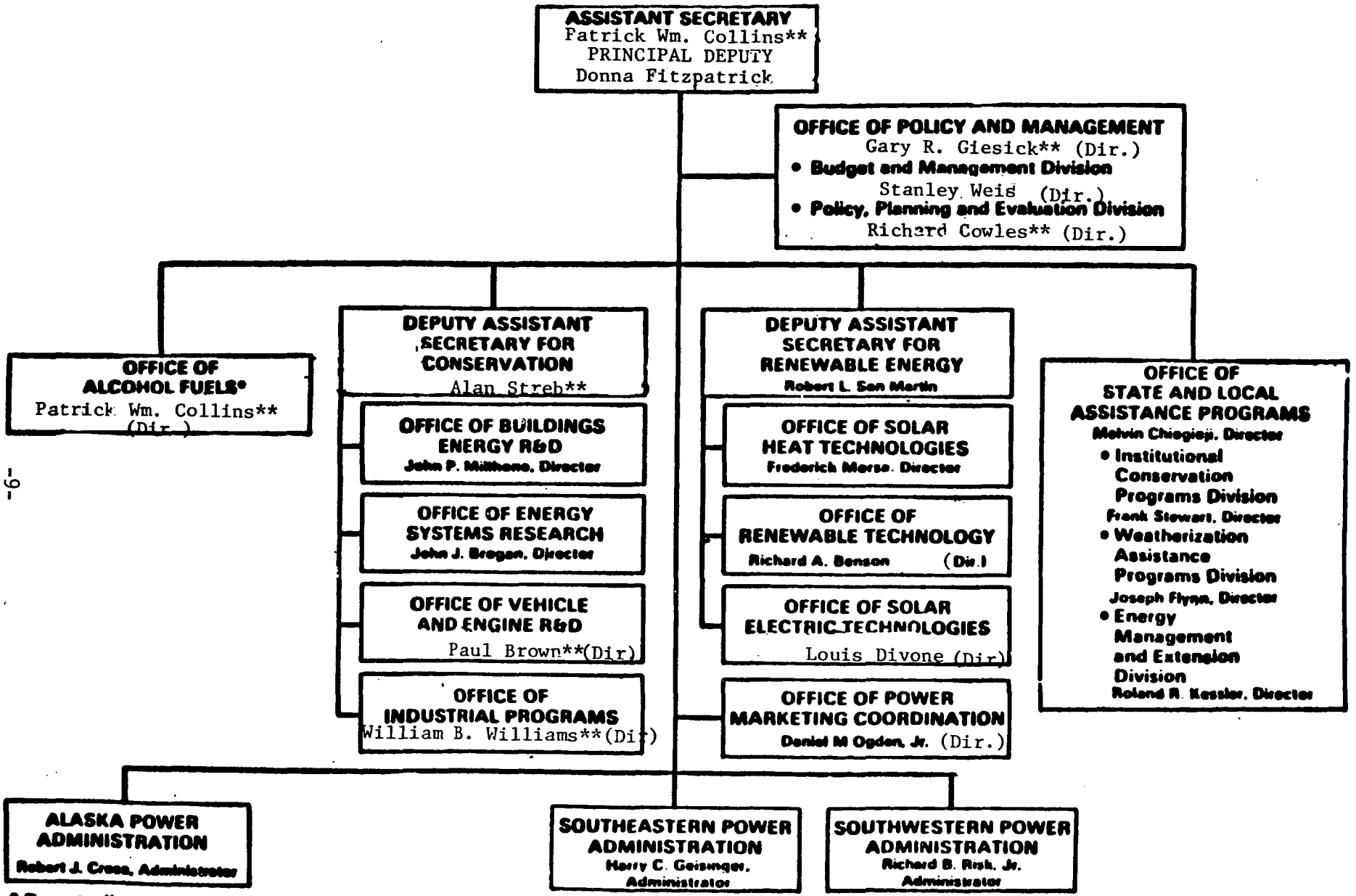
THE DEPARTMENT OF ENERGY



November 1983

Office of the Assistant Secretary for Conservation and Renewable Energy

** Acting



* Reports directly to the Secretary on matters relating to P.L. 96-294.

January 1984

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.

PROGRAM SUMMARIES

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

	1983
1. Energy Conservation	$30,106,000
a. Office of Energy Systems Research	$11,135,000
(1) Energy Storage Division	6,190,000
(2) Energy Conversion and Utilization Technologies Division	2,395,000
(3) Electric Energy Systems Division	2,550,000
b. Office of Building Energy Research and Development	$2,408,000
c. Office of Industrial Programs	$ 1,608,000
d. Office of Vehicle and Engine R&D	$14,955,000
2. Renewable Energy	$29,960,500
a. Office of Solar Heat Technologies	$ 5,962,000
(1) Active Heating and Cooling Division	2,592,000
(2) Passive and Hybrid Solar Energy Divison	1,755,000
(3) Solar Thermal Technology Division	1,615,000
b. Office of Solar Electric Technologies	$21,685,000
(1) Photovoltaic Energy Technology Division	21,600,000
(2) Wind Energy Technology Division	85,000
c. Office of Renewable Techology	$ 1,888,500
(1) Geothermal and Hydropower Division	1,778,500
(2) Energy from Municipal Waste Division	50,000
(3) Biomass Energy Technology Division	60,000
d. Office of Alcohol Fuels	$ 425,000

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 1983 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 Appendices.

E N E R G Y C O N S E R V A T I O N

OFFICE OF ENERGY SYSTEMS RESEARCH		$11135K	
Energy Storage Division			$6190
Materials Synthesis, Deposition, Growth or Forming		$ 3845	
Ceramics Research	800		
Metals and Alloys	1200		
Organometallic Compounds	500		
Polymers	200		
Chemically Bonded Ceramic Heat Storage Materials	100		
Composite High Temperature Thermal Storage Media	445		
Superconducting Magnetic Energy Storage	600		
Materials Properties Characterization or Testing		$ 2085	
High Temperature Electrolysis	270		
Hydrogen Embrittlement of Pipeline Steels	250		
Photovoltaic/Advanced Water Electrolysis Test	600		
Materials for Advanced High Temperature Molten Salt Storage	95		
Geochemical Stability of Sandstones	100		
Formation and Dissolution of Gas Clathrates	250		
Advanced Thermal Energy Storage Technologies Project	240		
Directory of New Materials	280		
Device or Component Fabrication or Testing		$ 220	
Prototype Flywheels	80		
Elastomeric Storage	140		
Instrumentation and Facilities		$ 40	
Analysis of Zeolite Augmented Ice Storage	40		
Energy Conservation and Utilization Technologies Division			$2395
Materials Synthesis, Deposition, Growth or Forming		$ 885	
Reactive Metallic Brazes for Ceramic-Ceramic and Ceramic-Metal Joints	135		
Assessment of Electromagnetic Joining of Ceramics	41		
Recovery and Reuse of Plastic Scrap via Separation and Bonding	193		
Recovery and Reuse of Plastic Scrap via Decomposition	166		
Assessment of the Economic Viability of Recovery and Reuse of Plastic Scrap	55		
Cubic Boron Nitride and Diamond-Like Carbon Coatings	60		
SiC-Whisker Reinforced Alumina	72		
Magnetron-Sputtered Adherent Amorphous Metal Wear-Resistant Coatings	30		

Supercritical Fluid Equations of State	$ 10		
Laser Surface Modifications of Ceramics	33		
Assessments of R&D Opportunities for ECUT in Superalloys and Metal Forming	40	(FY 82 carryover)	
Solid Lubricants Deposited from the Gas Phase	25		
Ion Implantation of Zirconia	25		
Materials Properties, Characterization, and Testing		$1450	
Ordered Metallic Alloys	363		
Modeling of Solid Ceramic Joints	102		
Aging of Rigid Urethane Foam Insulation	100		
Plastic-Coated Low-Temperature Heat Exchangers	33		
Materials by Design	220		
Coatings for High-Temperature Energy Conversion Systems	43		
Friction and Wear of Ceramics at Elevated Temperatures	211		
Observations of "Hot Spots" on Ceramics and Development of Theory	25		
Lubricant Qualities of the Constituents of Base Stock Oil	195		
Heats of Adhesion of Molecular Constituents of Base Stock Oils	83		
Tribological Testing of Ceramics Under Oscillatory Sliding at High Temperatures	25		
Identification of Tribological Research and Development Needs for Lubrication of Advanced Heat Engines	50		
Instrumentation and Facilities		$ 60	
Instruments for Harsh Environments	50		
Assessment of X-ray Methods for Investigations of Ceramic Wear Surfaces	10		
Electric Energy Systems Division			$2550
Materials Properties Characterization, and Testing		$1100	
High-Voltage Breakdown of Insulating Gas	600		
Aging Process Solid Dielectrics	250		
Threshold and Maximum Operating Electric-Stress for Selected High Voltage Insulations	250		
Device or Component Fabrication or Testing		$1450	
AC Superconducting Power Transmission Cable Development	1450		

OFFICE OF ENERGY SYSTEMS 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. The Office consists of three divisions: Energy Storage, Energy Conversion and Utilization Technologies (ECUT), and Electric Energy Systems.

Energy Storage Division

The principal function of the Energy Storage Division is to foster more efficient and more economical use of intermittant 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 Synthesis, Deposition, Growth or Forming

Ceramics Research - DOE Contact A. Landgrebe, 202-252-1483

- Superconducting ionic materials
- Materials for electrochemical corrosion prevention in batteries

Metals and Alloys - DOE Contact A. Landgrebe, 202-252-1483

- 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

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

Polymers - DOE Contact A. Landgrebe, 202-252-1483

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

Chemically Bonded Ceramic Heat Storage Materials - DOE Contact Imre Gyuk, 202-252-1508
MCA Inc. Contact Dennis Brosnan, 803-843-6444

- Olivine brick heat storage media development

- Fabrication techniques for large monolithic segments with cast integral heating elements

Composite High Temperature Thermal Storage Media - DOE Contact Imre Gyuk, 202-252-1508
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

Superconducting Magnetic Energy Storage - DOE Contact R. Shivers, 202-252-1488

- Development of low-cost polyester-glass support structure for cryogenic service
- Development of high purity aluminum stabilizer conductor

Materials Properties Characterization or Testing

High Temperature Electrolysis - DOE Contact M. Gurevich, 202-252-1507
Westinghouse R&D Center Contact Nick Maskalick, 412-256-2020

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

Hydogen 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

Photovoltaic/Advanced Water Electrolysis Test - DOE Contact M. Gurevich, 202-252-1507
Brookhaven National Laboratory Contact A. Mezzina, 516-282-3920, and P. Meta, 516-282-4091

- Problems under investigation relate to establishing performance, cost, and reliability factors as influenced by insolation, electricity, costs, and water management requirements for SPE units

- Determination of JV relationships, hydrogen output and down-time is undertaken

Materials for Advanced High Temperature Molten Salt Storage - DOE Contact M. Gurevich, 202-252-1507
SERI Contact Werner Luft, 303-231-1202

- Various alloys and fused cast refractories are being identified as internal thermal insulation for high temperature molten-salt storage
- Compatibility of alloys and ceramics with molten salt is under investigation

Geochemical Stability of Sandstones - DOE Contact R. Shivers, 202-252-1476
Pacific Northwest Laboratory Contact
Landis Kannberg, 509-375-3919

- Laboratory testing the effects of 150^{o}C water flow through porous sandstones
- Determination of the degree and rate of change in sandstone hydraulic and mechanical properties

Formation and Dissolution of Gas Clathrates - DOE Contact Imre Gyuk, 202-252-1508
ORNL Contact Mark Ternes, 615-574-0749

- Study of the conditions required for cyclic formation and dissolution of gas clathrates for cool thermal energy storage for air conditioning applications

Advanced Thermal Energy Storage Technologies Project - DOE Contact Imre Gyuk, 202-252-1480
Lawrence Berkeley Laboratory Contact 415-486-5028

- Materials with abnormally high heat capacities or large entropy change reactions under investigation
- Solid state radiative heat pump feasibility evaluation involving the identification of narrow-band semiconductors and measurement of thermal radiation emission
- Microparticles as advanced medium for heat exchange and catalysis

Directory of New Materials - DOE Contact R. Shivers, 202-252-1476
ORNL Contact J. Martin, 615-576-3977

- Evaluation and compilation of physical properties of high strength fibers

Device or Component Fabrication or Testing

Prototype Flywheels - DOE Contact R. Shivers, 202-252-1488
ORNL Contact J. Martin, 615-576-3977

- Composites of kevler, glass, and graphite fibers with various matrix materials for flywheel fabrication

Elastomeric Storage - DOE Contact R. Shivers, 202-252-1488
ORNL Contact J. Martin, 615-576-3977

- Fabrication of elastomers for prototype storage systems
- Materials development for low fatigue characteristics

Instrumentation and Facilities

Analysis of Zeolite Augmented Ice Storage - DOE Contact R. Shivers, 202-252-1476
Pacific Northwest Laboratory 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.

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 1983 in two projects, the Materials Project and the Tribology Project. Both projects are managed for ECUT by the Oak Ridge National Laboratory (ORNL). 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, building insulation, coatings (metal, ceramic, and plastic), ceramic composites, and materials structures theory. Materials research in the Tribology Project is in the areas of wear of oil lubricated steels and the friction and wear of ceramics at high temperatures. The DOE contact for all projects is James Eberhardt, 202-252-1484.

Materials Synthesis, Deposition, Growth or Forming

Reactive Metallic Brazes for Ceramic-Ceramic and Ceramic-Metal Joints - ORNL Contact Artie Moorhead, 615-574-5153

- Development and testing of reactive metal brazes for joining SiC to SiC and PSZ to ductile iron

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

Assessment of Electromagnetic Joining of Ceramics - DHR, Inc. Contact Richard Silberglitt, 703-556-8660

- Assessment of the potential of using radio-frequency radiation to effect solid bonds between a ceramic piece and another ceramic or a metal piece

Recovery and Reuse of Plastic Scrap via Separation and Bonding - Plastics Institute of America Contact Lincoln Hawkins, 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 - ORNL and University of Tennessee Contact Jim Kinstle, 615-574-3390

- Investigations of technologies for reuse of or recovery of value from plastic via methods involving the molecular decomposition of the plastics
- FY 1983 activities concerned with an assessment of the state of the art and planning of future work

Assessment of the Economic Viability of Recovery and Reuse of Plastic Scrap - ORNL Contact Randy Curlee, 615-576-4864

- Assessment to determine if recovery and reuse of plastic scrap in general will be economically feasible over the next twenty years

Cubic Boron Nitride and Diamond-Like Carbon Coatings - ORNL Contact Dave Stinton, 615-574-4556

- Attempts to produce coatings of cubic BN and diamond-like C coatings via plasma-assisted chemical vapor deposition

SiC-Whisker Reinforced Alumina - ORNL Contact George Wei, 615-574-5129

- Development of a ceramic composite produced by dispersing silicon carbide whiskers (ARCO) in an alumina matrix

Magnetron-Sputtered Adherent Amorphous Metal Wear-Resistant Coatings - Jet Propulsion Laboratory Contact Satish Khanna, 213-792-4489

- Deposition and testing of adherent Mo-Ru-B or W-Be-B amorphous metal coatings via magnetron sputtering
- Prove feasibility of approach

Supercritical Fluid Equations of State - NBS Boulder 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

Laser Surface Modifications of Ceramics - ORNL Contact Jagdish Narayan, 615-574-5508

- Investigations of the effects induced by pulsed laser irradiations 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

Assessments of R&D Opportunities for ECUT in Superalloys and Metal Forming - DHR, Inc. Contact Richard Silberglitt, 703-556-8660

- Assessment to identify possible research and development opportunities appropriate for ECUT support in the areas of superalloys and metal forming

Solid Lubricants Deposited from the Gas Phase - The Pennsylvania State University Contact Larry Duda, 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

Ion Implantation of Zirconia - Georgia Institute of Technology Contact Joe Cochran, 404-894-2851

- Implantation of Zr^+ ions into the surface of Y-stabilized cubic-ZrO_2 followed by appropriate heat treatment to precipitate excess ZrO_2
- Assess effects of hardness, fracture toughness, and wear resistance

Materials Properties, Characterization, and Testing

Ordered Metallic Alloys - ORNL Contact Chain Liu, 615-574-4459

- Development and determinations 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

Modeling of Solid Ceramic Joints - Norton Company Contact Jim Hannoosh, 617-863-1000, ext. 3882

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

Aging of Rigid Urethane Foam Insulation - Massachusetts Institute of Technology Contact Leon Glicksman, 617-253-2233

- Development and experimental verification of models for heat transfer and gas diffusion in rigid urethane foam insulation
- Purpose is to understand mechanisms of degradation of insulating properties over time

Plastic-Coated Low-Temperature Heat Exchangers - Argonne National Laboratory Contact Paul Roach, 312-972-8146

- Exposure tests to determine how thin a plastic coating can be deposited onto steel heat exchanger tubes to withstand sulfuric acid condensed from cumbustion effluent gases below 200°C
- Work to date concentrated mainly on various commercial fluorocarbon (e.g., Teflon) coatings

Materials by Design - ORNL Contact Joe Carpenter, 615-574-4571

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

Coatings for High Temperature Energy Conversion Systems - Lawrence Berkeley Laboratory Contact Al Levy, 415-486-5822

- Friction and wear tests to 1400°F of candidate coatings for use on the top piston rings of the adiabatic diesel engine

Friction and Wear of Ceramics at Elevated Temperatures - ORNL Contact Charlie Yust, 615-574-4812

- Measurements of the friction coefficient and wear rates and investigations of the wear mechanisms of ceramics during pin-on-disk tests of ceramics run against themselves and other ceramics up to 1200°F
- 5 X 5 matrix test consisting of a SiC, a Si_3N_4, a PSZ, a toughened Al_2O_3, and an untoughened Al_2O_3

Observations of "Hot Spots" on Ceramics and Development of Theory - 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 - 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

Heats of Adhesion of Molecular Constituents of Base Stock Oils - Martin Marietta Laboratories Contact Frances Lockwood, 301-247-0700, ext. 285

- Heats of adhesion of molecular fractions of base stock oils on steel are determined by measuring the angle of wetting of a drop on the steel immersed in water
- Joint effort with NBS-Gaithersburg which supplies the oil fractions

Tribological Testing of Ceramics Under Oscillatory Sliding at High Temperatures The Pennsylvania State University Contact Norm McMillan, 814-863-0180
DHR, Incorporated Contact Le Khac Hien, 703-556-8660

- Tests of the friction and wear of ceramics undergoing linear oscillatory sliding under conditions similar to those at the piston ring/cylinder liner interface of an adiabatic diesel engine
- Jointly funded with the U.S. Army Tank and Automotive Command (TACOM) through a contract with the Carborundum Company

Identification of Tribological Research and Development Needs for Lubrication of Advanced Heat Engines - Technology Assessment and Transfer Contact Larry Fehrenbacher, 301-856-1022

- Assessment to identify R&D needs for lubrication of advanced heat engines
- Concentrates on needs of the adiabatic diesel engine

Instrumentation and Facilities

Instruments for Harsh Environments - NBS Gaithersburg Contact Ken Kreider, 301-921-3281

- Develop thin film sensors for less instrusive temperature measurements inside combustion chambers
- Oxide layer grown on MCrAlY deposit adhering to Fe substrate to insulate substrate from thermocouple (e.g., Pt:Pt/Rh) junction and leads subsequently sputter-deposited on the oxide layer

Assessment of X-ray Methods for Investigation of Ceramic Wear Surfaces - Virginia Polytechnic Institute and State University Contact Charles Houska, 703-961-5652

- Determine the potential of x-ray diffraction and fluorescence methods for nondestructive analysis of the near-surface wear regions of ceramics
- Considers conventional x-ray sources as well as the Brookhaven Light Source

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 R. Eaton, 202-252-4844.

Materials Properties Characterization and Testing

High Voltage Breakdown of Insulating Gas - ORNL Contact Lucas Christophorou, 615-574-6199

- Physiochemical factors of breakdown strength of gaseous dielectrics

Aging Process in Solid Dielectrics - Battelle Columbus Contact Mike Epstein, 614-424-6424

- Insulating aging characteristics of solid dielectrics for underground cable transmission
- Testing procedures to predict insulation life for rated service

Threshold and Maximum Operating Electric Stresses for Selected High Voltage Insulations - Cable Technology Lab Contact Carlos Katz, 201-846-3220

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

Device or Component Fabrication or Testing

AC Superconducting Power Transmission Cable Development - Brookhaven Contact E. Forsyth, 516-282-4676

- Development of underground ac superconducting cable system (138 MV, 4000 A) employing Nb_3Sn tape
- Insulation system will consist of synthetic tape impregnated with supercritical helium

OFFICE OF BUILDING ENERGY RESEARCH AND DEVELOPMENT		$2408 K
Materials, Properties, Characterization, and Testing		$1498
Unguarded Flat Insulation Nichrome Wire Screen Tester	75	
Settled Density Studies of Loose-Fill Insulation	75	
Assessment of Reflective Insulation Material	25	
Heat Flow Modeling	75	
Gas Diffusion and Effective Conductivity of Foam-Insulation Versus Age	90	
Corrosiveness of Thermal Insulating Materials	30	
Condensing Heat Exchanger System	450	
Advanced Insulation for Appliances	128	
Non-Azeotropic Refrigerant Mixtures	550	
Device or Component Fabrication or Testing		$ 660
Improved Standard Reference Materials	150	
Smoldering Combustion Hazards of Thermal-Insulating Materials	50	
Environmental Cycling of Cellulosic Insulation	25	
Mercury Isotope Separation Process	220	
Mercury Isotope Enrichment	140	
Zeeman Effect on Lamp Gas Plasma	75	
Instrumentation and Facilities		$ 250
Technical Interaction Promotion	50	
Absorption Fluid Pairs Research	200	

OFFICE OF BUILDING ENERGY RESEARCH AND DEVELOPMENT

The Office of Building Energy Research and Development 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 programs.

Materials Properties Characterization or Testing

Unguarded Flat Insulation Nichrome Wire Screen Tester - DOE Contact Bill 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 Bill 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

Assessment of Reflective Insulation Material - DOE Contact Bill Gerken, 202-252-9191
ORNL Contact David McElroy, 615-574-5976

- Technical assessment of reflective properties of multilayered materials fabricated from aluminum sheets
- Calculational model development of thermal resistance properties

Heat Flow Modeling - DOE Contact Bill 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 Bill 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 Bill 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

Condensing Heat Exchanger System - DOE Contact Danny C. Lim, 202-252-9130
Brookhaven Contact Bud Woodworth, 516-282-2361

- Ceramics, stainless steel, and plastics investigated for feasibility of use in heat exchangers for condensing oil- and gas-fired heating systems
- Experimental evaluations of corrosion rates and stress resistance properties

Advanced Insulation for Appliances - DOE Contact Ronald Fiskum, 202-252-9130
ORNL Contact Fang Chen and David McElroy, 615-574-0712

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

Non-Azeotropic Refrigerant Mixtures - DOE Contact R. 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

Device or Component Fabrication or Testing

Improved Standard Reference Materials - DOE Contact Bill Gerken, 202-252-9191
NBS Contact Brian Rennex, 301-921-3501

- 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 Bill 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

Environmental Cycling of Cellulosic Insulation - DOE Contact Bill Gerken, 202-252-9191
NBS Contact Sanford Davis, 301-921-3744

- Determination of temperature and relative humidity effects on the smoldering and critical radiant flux performance of manufactured product treated for fire retardancy
- Simulation of typical attic conditions in eleven U.S. cities

Mercury Isotope Separation Process - DOE Contact Robert Boettner, 202-252-9136
GTE Sylvania Contact Bill Staubitz, 617-777-1900

- Investigation of Hg isotopes used as fill gas in discharge lamps aimed at determining efficiency improvement in fluorescent lamps that have altered isotope composition
- Development of effective separation process, construction and operation of a laboratory scale reactor

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

Instrumentation and Facilities

Technical Information Exchange - DOE Contact Bill Gerken, 202-252-9191
ORNL Contact David McElroy, 615-574-5067

- Improved technical data on insulation science and technology via communications vehicles, e.g., meetings, etc.

Absorption Fluid Pairs Research - DOE Contact Fiskum, 202-252-9130
ORNL Contact George Privon, 615-574-1813

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

OFFICE OF INDUSTRIAL PROGRAMS		$1608 K	
Division of Waste Energy Reduction			$1400
Materials Synthesis, Deposition, Growth or Forming		$ 500	
High Temperature Ceramic Materials Development for Industrial Waste Heat Recovery	$2,500		
Materials Properties, Characterization or Testing		$ 900	
High Temperature Ceramic Data Base	900		
Division of Improved Energy Productivity			$ 208
Materials Synthesis, Deposition, Growth or Forming		$ 208	
Corrosion Resistant Amorphous Metallic Coatings	208		

OFFICE OF INDUSTRIAL PROGRAMS

The Office of Industrial Programs 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.

Division of Waste Energy Reduction

The Division of Waste Energy Reduction conducts: research to recover high-temperature waste heat and to upgrade low grade waste heat for industrial applications; combustion research to develop systems for high efficiency conversion of industrial heaters and boilers to solid fuels; and research to improve utilization of industrial wastes as fuels, feedstocks, or recovered materials.

Materials Synthesis, Deposition, Growth or Forming

High Temperature Ceramic Materials Development for Industrial Waste Heat Recovery - DOE Contact J. W. Osborne, 202-252-2085
ORNL Contact A. C. Shaffhauser, 615-574-4826

- Develop high temperature ceramic materials for heat exchanger/recuperators operating in corrosive gas streams

Materials Properties, Characterization or Testing

High Temperature Ceramic Data Base - DOE Contact J. W. Osborne, 202-252-2085
Idaho National Engineering Laboratory
Contact C. H. Allen, 208-526-0250

- Establish data base on properties, lifetimes, failure experience, shape sensitivities to waste streams; service life performance predictability; and heat exchanger service requirements affecting materials selection

Division of Improved Energy Productivity

The Division of Improved Energy Productivity conducts research to improve and create new energy conserving processes for: ore reduction, base metals, and basic shape processing; sensing and control instrumentation; and concentration, evaporation, separation, and reaction processes and food production and processing.

Materials Synthesis, Deposition, Growth or Forming

Corrosion Resistant Amorphous Metallic Coatings - DOE Contact R. G. Massey, 202-252-2079
JPL Contact Dr. Satish Khanna, 213-354-4489

- Develop a magnetron sputtering technique to deposit amorphous corrosion-resistant metallic coatings on steel substrates

OFFICE OF VEHICLE AND ENGINE R&D		$14955K
Materials Synthesis, Deposition, Growth or Forming		$ 3211
Thermal Wear Coatings	180	
Ceramic Composites	190	
SiC Powder Synthesis	120	
High Temperature Coating Study to Reduce Contact Stress Damage of Ceramics	75	
Processing of Sinterable Transformation Toughened Ceramics	120	
Synthesis of High Purity Sinterable Silicon Carbide and Silicon Nitride	250	
Development of Ceramic Matrix Composites	360	
Sintering of Silicon Nitride	135	
Transformation Toughened Ceramics	183	
Joining of Ceramics	200	
Dispersion Toughened Ceramics	249	
Development of Thermal Barrier Coatings	87	
Ceramic Component Technology	196	
Cast Iron Alloy Containing Nonstrategic Element	175	(FY 82 carryover)
Improved Cast Cylinder Alloys	491	(FY 82 carryover)
Advanced Materials-Intermetallic Processing	200	
Materials Properties, Characterization or Testing		$ 1429
Static Fatigue Behavior of Toughened Ceramics	175	
Characterization of Chrome Oxide Based Ceramic Coatings for Advanced Heat Engines	120	
Studies of Dynamic Contact of Ceramics and Metals for Advanced Heat Engines	120	
Experimental Evaluation of Environmental Effects in Toughened Ceramics	100	
Advanced Transformation Toughened Ceramics	135	
Time Dependent Properties of Structural Ceramics	90	
Ceramic Durability Evaluation	126	
Long Term Stability and Properties of Zirconia Ceramics	136	
High Temperature Ceramic Interface Study	92	
Friction and Wear Characteristics of Load Bearing Materials	160	
High Temperature Creep Evaluation	65	
Alloy Properties in High-Pressure Hydrogen	110	
Device or Component Fabrication or Testing		$10315
Component Life Prediction Methodology	105	
Experimental Life Testing	220	
Advanced Gas Turbine Engine Technology (AGT-100)	4768	
Advanced Gas Turbine Engine Technology (AGT-101)	5222	

OFFICE OF VEHICLE AND ENGINE R&D

The Office of Vehicle and Engine R&D (OVERD) 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 fuel efficiency and to develop technology for heavy-duty diesel operation under uncooled minimum friction conditions, including waste heat utilization.

Another, the Advanced Materials Development Program, 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 engines) has been delegated to the NASA-Lewis Research Center. Project management of the Ceramic Technology for Advanced Heat Engines Program (Advanced Materials Development Program) has been assigned to the Oak Ridge National Laboratory (ORNL). The Army Materials and Mechanics Research Center (AMMRC) support is now part of the Ceramic Technology Program 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 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/processing; data base/life prediction; and design methodology. To support the advanced materials 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 OVERD materials research projects unless otherwise noted.

Materials Synthesis, Deposition, Growth or Forming

Thermal Wear Coatings - ORNL Contact V. J. Tennery, 615-574-5123

- Determination of process requirements of stabilized zirconia coatings on engine alloy substrates using CVD and sol-gel techniques

Ceramic Composites - ORNL Contact V. J. Tennery, 615-574-5123

- Processing and mechanical properties experimentation of dispersion toughened SiC and transformation toughened alumina/zirconia composites

SiC Powder Synthesis - ORNL Contact V. J. Tennery, 615-574-5123

- Investigation of SiC powder synthesis flow sheets to produce sinterable powder superior to state-of-the-art

High Temperature Coating Study to Reduce Contact Stress Damage of Ceramics - ORNL Contact D. Ray Johnson, 615-576-6832

- Investigation of physical vapor deposition of fully stabilized zirconia coatings on silicon carbide and silicon nitride
- Coatings are to reduce strength degradation due to static contact stresses and sticking

Processing of Sinterable Transformation Toughened Ceramics - ORNL Contact P. F. Becher, 615-574-5157

- Synthesis of high-purity, pressureless-sinterable powders of partially stabilized zirconia (PSZ)

Synthesis of High Purity Sinterable Silicon Carbide and Silicon Nitride - ORNL Contact E. L. Long, Jr., 615-574-5172

- Development of low cost, high purity sinterable SiC and Si_3N_4 powder

Development of Ceramic Matrix Composites - ORNL Contact D. Ray Johnson, 615-576-6832

- Development of whisker, short fiber, or particulate toughened ceramic matrix composites
- Fabrication of near-net-shape processes

Sintering of Silicon Nitride - ORNL Contact D. Ray Johnson, 615-576-6832
AMMRC Contact George Gazza, 617-923-5410
GE Contact C. D. Greskovich, 518-385-8691

- Improved sintering processes for Si_3N_4 ceramics for high temperature applications

Transformation Toughened Ceramics - DOE Contact Edgar Gregory, 202-252-8055
NASA Contact Richard B. Lancashire,
216-433-4000, ext. 489
GE Contact Solomon Musikant, 215-962-5825

- Feasibility demonstration of transformation toughening (TT) in ceramics
- Systems include mullite, alumina, and SIALON
- Alloys of HfO_2-ZrO_2 are toughening agents

Joining of Ceramics - DOE Contact Edgar Gregory, 202-252-8055
NASA Contact Richard B. Lancashire, 216-433-4000, ext. 489
ORNL Contact A. J. Moorhead, 615-574-5153

- Development and characterization of brazing filler metals for ceramic to ceramic or metal joining
- Formulation and melting on Al_2O_3, zirconia, and alpha SiC

Dispersion Toughened Ceramics - DOE Contact Edgar Gregory, 202-252-8055
NASA Contact Richard B. Lancashire,
216-433-4000, ext. 489
ORNL Contact A. J. Moorhead, 615-574-5153

- Development and characterization of ceramic matrix composites containing a dispersed metallic phase of Cr, Ni and Pt
- Processing by powder preparation, densification, and heat treatment

Development of Thermal Barrier Coatings - DOE Contact Edgar Gregory, 202-252-8055
NASA Contact Murray M. Bailey,
216-433-4000, ext. 5181
Allison Gas Turbine Operations Contact
David L. Clingman, 317-242-4535

- Yttria-stabilized zirconia TBC systems prepared by plasma spray for valves, fire deck, and piston dome of a single-cylinder diesel engine

Ceramic Component Technology - DOE Contact Saunders Kramer, 202-252-8000
NASA Contact T. J. Miller, 216-433-4000, ext. 6153

- Ceramic fabrication by hot isostatic pressing (HIP) for advanced fabrication techniques development
- NDE such as acoustic microscopy employed for evaluation

Cast Iron Alloy Containing Nonstrategic Elements - DOE Contact Patrick Sutton,
202-252-8012
NASA Contact C. M. Scheuerman, 216-433-4000, ext. 398
United Technologies Research Center Contact F. D. Lemkey, 203-727-7318

- Identification of alloy based on Fe-Cr-Mn(Mo)-Al-C(N) system containing austenitic iron solid solution matrices
- Application to Stirling engine cylinder and regenerator housings

Improved Cast Cylinder Alloys - DOE Contact Patrick Sutton, 202-252-8012
NASA Contact C. M. Scheuerman, 216-433-4000, ext. 398
AiResearch Casting Company Contact M. Woulds, 213-323-9500, ext. 6905

- Exploration of existing or experimental castable alloys for heater head service at 820°C
- Effort is to meet performance requirement and reduce cast and strategic materials

Advanced Materials - Intermetallic Components Processing - DOE Contact Patrick Sutton, 202-252-8012
NASA Contact Joseph R. Stephens, 216-433-4000, ext. 6676

- Investigation of techniques to produce iron and nickel aluminides in large quantities for high temperature corrosive applications

Materials Properties, Characterization or Testing

Static Fatigue Behavior of Toughened Ceramics - ORNL Contact V. J. Tennery, 615-547-5123

- Determination of static fatigue life of partially stabilized zirconia and dispersion toughened alumina

Characterization of Chrome Oxide Based Ceramic-Coatings for Advanced Heat Engines - ORNL Contact E. L. Long, Jr., 615-574-5172

- Characterization of microstructure and mechanical properties of chrome oxide based ceramic coatings on cast iron cylinder liners for adiabatic diesel engines

Studies of Dynamic Contact of Ceramics and Metals for Advanced Heat Engines - ORNL Contact E. L. Long, Jr., 615-574-5172

- Friction and wear properties of specific ceramics and metals for heat engines

Experimental Evaluation of Environmental Effects in Toughened Ceramics - ORNL Contact M. K. Ferber, 615-576-6740

- Evaluation of combustion product water vapor on slow crack growth in commercially available PSZ and ceramic matrix/PSZ composites

Advanced Transformation Toughened Ceramics - ORNL Contact D. Ray Johnson, 615-576-5832
AMMRC Contact L. J. Schider & R. N. Katz, 617-923-5415
U. of M. Contact T. Y. Tien, 313-764-9449

- Extent of overaging and loss of strength at long durations at high temperatures in transformation toughened zirconia

Time Dependent Properties of Structural Ceramics - ORNL Contact D. Ray Johnson, 615-576-6832
AMMRC Contact G. D. Quinn, 617-923-5258

- Characterization of time dependence under load of the strength of high performance ceramics
- Stepped temperature stress rupture testing

Ceramic Durability Evaluation - DOE Contact Saunders Kramer, 202-252-8000
NASA Contact Sunil Dutta, 216-433-4000, ext. 6111
Garrett Turbine Engine Company Contact K. W. Benn, 602-231-4373

- Evaluation of commercially available silicon carbides and silicon nitrides under 2500°F for 3500 hours for automotive turbine engines

Long Term Stability and Properties of Zirconia Ceramics - DOE Contact Edgar Gregory, 202-252-8055
NASA Contact Richard B. Lancashire, 216-433-4000, ext. 489
IIT Research Institute Contact David C. Larsen, 312-567-4437

- Physical, mechanical, and thermal properties characterization of zirconia ceramics for diesel engines
- Measurement of flexure strength, fracture toughness, thermal expansion, microstructure, etc.

High Temperature Ceramic Interface Study - DOE Contact Edgar Gregory, 202-252-8055
NASA Contact Richard B. Lancashire, 216-433-4000, ext. 489
Garrett Turbine Engine Company Contact David W. Richerson, 602-231-3659

- Evaluation of transformation toughened zirconium oxide (TTZ) for adiabatic diesel engine conditions
- Measurements of friction, strength retention, fracture toughness, etc.

Friction and Wear Characteristics of Load Bearing Materials - DOE Contact Edgar Gregory, 202-252-8055
NASA Contact Richard B. Lancashire, 216-433-4000, ext. 489
Westinghouse R&D Center Contact David J. Boes, 412-256-7387

- Friction and wear characteristics of specific carbide, nitride and oxide materials evaluated as candidates for use in high efficiency, heavy duty diesel engines
- Friction and wear characteristics of low friction coatings and solid lubricant infiltrated metallic bodies evaluated

High Temperature Creep Evaluation - DOE Contact Patrick Sutton, 202-252-8013
NASA Contact R. H. Titran, 216-433-4000, ext. 398

- Evaluation of effects of brazing cycle and alloy composition on creep-rupture properties at Stirling engine operating temperatures

Alloy Properties in High-Pressure Hydrogen - DOE Contact Patrick Sutton, 202-252-8012
NASA Contact R. H. Titran, 216-433-4000, ext. 398
ITT Research Institute Contact S. Bhattachargya, 312-567-4192

- Creep properties measured in Stirling engine alloys at high-pressure in Hz and compared to tests in air

Device or Component Fabrication or Testing

Component Life Prediction Methodology - ORNL Contact D. Ray Johnson, 615-576-6832
AMMRC Contact E. M. Lenoe, 617-923-5427

- Development of code for component life prediction

Experimental Life Testing - ORNL Contact D. Ray Johnson, 615-576-6832
AMMRC Contact E. M. Lenoe, 617-923-5427
Ford Contact R. K. Govila, 313-323-1742

- Evaluation of ceramic-metal joints
- Materials properties determination and validation of design methodology

Advanced Gas Turbine Engine Technology (AGT-100) - DOE Contact Saunders Kramer, 202-252-8000
NASA Contact P. T. Kerwin, 216-433-4000, ext. 6770
Allison/Pontiac Contact H. E. Helms, 317-242-5335

- Ceramic materials characterization, process development, and component design and testing for advanced gas turbine engines

Advanced Gas Turbine Engine Technology (AGT-101) - DOE Contact Saunders Kramer, 202-252-8000
NASA Contact R. S. Palmer, 216-433-4000, ext. 6653
Garrett/Ford Contact E. E. Strain, 602-231-2797

- Ceramic materials characterization, process development, and component design and testing for advanced gas turbine engines

OFFICE OF SOLAR HEAT TECHNOLOGIES		$5692K	
Active Heating and Cooling Division			$2592
Materials Synthesis, Deposition, Growth or Forming		$ 375	
Thickness Insensitive Paint Research	75		
Advanced Glazing Materials for Flat Plate Collectors	300		
Materials Properties, Characterization or Testing		717	
High Performance Polymer Film Solar Collector	317		
Investigating Specific Materials Properties of Solid Desiccants	160		
Phase Change Materials	70		
Development of Improved Desiccant Materials	70		
Inhibitors/Buffers for Glycol Based Heat-Transfer Fluids	100		
Device or Component Fabrication or Testing		1400	
Research on Advanced Collectors	200		
Environmental Degradation of Polymeric Cover-Plate Materials	250		
Measurement Techniques for Evaluating Reflector Materials	50		
PRDA for Thin Film Collectors	600		
Flame Spread of Combustible Glazing Materials	100	(FY 82 carryover)	
Development of Thermal Energy Storage Devices Using Cross-Linked High Density Polyethylene and Polypropylene	200		
Instrumentation and Facilities		100	
Systems Effectiveness Research	100		
Passive and Hybrid Solar Energy Division			$1755
Materials Synthesis, Deposition, Growth or Forming		241	
Variable Transmittance Electrochromic Windows for Passive-Solar Application	146		
Optics and Materials Research for Controlled Radiant-Energy Transfer in Buildings	95		
Materials Properties, Characterization or Testing		493	
Liquid Desiccant Regenerable by Liquid-Liquid Phase Separation	100		
Phase-Change Materials for Use in Passive and Hybrid Solar Systems	80		

Ceramics Properties Testing for Passive Solar Application	$ 42		
Glazing Materials Development for Radiative Cooling	110		
Phase-Change Materials for Use in Passive Solar-Residential Housing	161		
Device or Component Fabrication or Testing		$1012	
Passive Solar Window Module	90		
Water Thermal Storage System	53		
Silicone Southwall Glazing System	59		
Dual-Effect Regenerative Evaporation Cooler	94		
Vapor Compression Dehumidification for Passive and Hybrid Cooling	96		
Insulating Curtain	81		
Automatic Control Damper for Trombe Wall	25		
Rolling Insulating Curtain System	125		
Insulating Glazing System	86		
Low Cost Thermal Window Shutter	59		
Solar Assisted Commercial Greenhouse	92		
Honeycomb Thermal Insulating Curtains	42		
Heat Flux Movable Insulation Controller	15		
Passive Solar Greenhouse Design	95		
Division of Solar Thermal Technology			$1615
Materials Synthesis, Deposition, Growth or Forming		660	
Silver/Glass Mirror Research	60		
Silver/Polymer Reflector Research	250		
Polymer Synthesis and Characterization	350		
Materials Properties, Characterization or Testing		955	
High Temperature Thermal Fluids/Containment	230		
High Temperature Windows	150		
High Temperature Materials	75		
Ceramic Materials Research	500		

OFFICE OF SOLAR HEAT TECHNOLOGIES

The Office of Solar Heat Technologies conducts R&D aimed at providing a technological base from which low-cost, reliable solar energy source systems can be generated. The Office contains three divisions: Active Heating and Cooling; Passive and Hybrid Solar Energy; and Solar Thermal Technology.

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 community who will benefit from it.

Materials Synthesis, Deposition, Growth or Forming

Thickness Insensitive Paint Research - DOE Contact John Goldsmith, 202-252-8171
LANL Contact Don Neeper, 505-667-6441

- Development of thickness insensitive paint with absorptivity > 0.9 and emissivity > 0.1
- Chemical conversion of standard leafing flake materials in combination with different binders is investigated

Advanced Glazing Materials for Flat Plate Collectors - DOE Contact John Goldsmith, 202-252-8171
SERI Contact Larry Flowers, 303-327-1081

- Development of improved polymeric materials for low cost collectors
- Advanced glazings for flat plate collectors and evaluation of surface treatment of polymeric films using F_2 to stabilize inexpensive materials and/or improve optics
- Evacuated glass tube materials development

Materials Properties, Characterization or Testing

High Performance Polymer Film Solar Collector - DOE Contact John Goldsmith, 202-252-8171
BNL Contact William Wilhelm, 516-282-4708

- Evaluation of adhesive bonded absorber laminates
- Evaluation of laminates fabricated by both melt bonding and dispersion coating methods
- Evaluation of bare metal foil collectors

Investigating Specific Materials Properties of Solid Desiccants - DOE Contact John Goldsmith, 202-252-8171
SERI Contact Frank Kreith, 303-231-1109

- Optimization of solid desiccant dehumidifier by exploring the sorption hysteresis behavior of desiccants

Phase Change Materials - DOE Contact John Goldsmith, 202-252-8171
NBS Contact Robert Dikkers, 301-921-3285

- Mathematical modeling of loss in energy storage capacity with thermal cycling of phase change material.
- Demonstration of model's sensitivity to maximum and minimum cycling temperatures and heating and cooling rates

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

- Effects of lower absorption energetics due to MnO_2 on rates of water take-up
- Development of methods to measure absorption equilibrium rate data on MnO_2 and silica gel

Inhibitors/Buffers for Glycol Based Heat Transfer Fluids - DOE Contact John Goldsmith, 202-252-8171
NBS Contact Robert Dikkers, 301-921-3285

- Effectiveness of buffers/inhibitors in decelerating corrosion attack of metallic containment systems of glycol based heat transfer fluids

Device or Component Fabrication or Testing

Research on Advanced Collectors - DOE Contact John Goldsmith, 202-252-8171
ANL Contact William Schertz, 312-972-6230

- Construction and testing of advanced compound parabolic concentrating collector
- Improved mirror reflectance, improved optical absorption and redesigning of manifold for steam generation

Environmental Degradation of Polymeric Cover Plate Materials - DOE Contact John Goldsmith, 202-252-8171
NBS Contact Robert Dikkers, 301-921-3285

- Characterization of moisture degradation mechanisms in polymeric cover materials
- Microlevel changes as a tool for early detection of degradation
- Modeling of short term accelerated aging test data

Measurement Techniques for Evaluating Reflector Materials - DOE Contact John Goldsmith, 202-252-8171
NBS Contact Robert Dikkers, 301-921-3285

- Evaluation of reflector materials which can increase solar flux by collectors

PRDA for Thin Film Collectors - DOE Contact John Goldsmith, 202-252-8171
San Francisco Operation Office Contact
C. J. Dankowski, 415-273-7948

- Program research and development announcements for identification of glazing materials, laminates, adhesives, and fabrication techniques for durable thin film collector

Flame Spread of Combustible Glazing Materials - DOE Contact John Goldsmith, 202-252-8171
NBS Contact Robert Dikkers, 301-921-3285

- Characterization of flame spread in materials subjected to ASTM D635 fire tests

Development of Thermal Energy Storage Devices Using Cross-Linked High Density Polyethylene and Polypropylene - DOE Contact John Goldsmith, 202-252-8171
ANL Contact William Schertz, 312-972-6230

- Disassembly of prototype latent heat storage device to evaluate properties of the latent heat storage material

Instrumentation and Facilities

Systems Effectiveness Research - DOE Contact Bob Hassett, 202-252-8163
LANL Contact Don Neeper, 305-667-6441

- High altitude exposure facility used for prediction of field corrosion, fluid performance and prevention of system problems

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 passive solar materials and components that incorporate present technology to meet individual specific building related problems.

In the recent phase of passive materials R&D, projects were 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 used to heat the building in any U.S. climate; (2) passive systems can be designed which provide double the efficiency of current designs; and (3) the passive aperture, transport, and storage components can be controlled so as to reject thermal energy in the summer. David Pellish is the Program Manager and DOE contact for all the following projects, 202-252-8110. Steve Sargent is the SERI contact, 303-231-1366.

Materials Synthesis, Deposition, Growth or Forming

Variable Transmittance Electrochromic Windows for Passive Solar Application - EIC Laboratories Contact R. David Rauh, 617-965-2716

- Develop thin film electrochromic window coatings which can be colored reversibly by the application of an electric current

Optics and Materials Research for Controlled Radiant Energy Transfer in Buildings - Tufts University Contact Dr. Ronald Goldner, 617-628-5000, ext. 2492

- Basic research in thin film electrochromism
- Identify and solve some of the key materials problems associated with controlling radiant energy transfer through the walls and windows of the building

Materials Properties, Characterization or Testing

Liquid Desiccant Regenerable by Liquid-Liquid Phase Separation - Argonne National Laboratory Contact Dr. William Schertz, 312-972-6230

- Determine the liquid/vapor phase diagrams and liquid/liquid phase diagrams of mixtures of water and new organic liquids
- Develop a liquid desiccant for dehumidification that is regenerable by low energy phase separation methods

Phase-Change Materials for Use in Passive and Hybrid Solar Systems - University of Dayton Research Institute Contact Val Salyer, 513-229-2113 and Don Duvall, 513-229-3618

- Define and evaluate the thermal performance of promising PCMs
- Determine environmental acceptability, cost, availability, and other potential problems of the best PCMs

- Conduct laboratory size thermocycling tests to estimate long-term durability of promising PCMs
- PCMs under consideration include: crosslinked crystalline polymers; simple organic compounds; and organic clathrates and semi-clathrates

Ceramics Properties Testing for Passive Solar Applications - Alfred University Contact Paul Johnson, 607-871-2473

- Determination, through laboratory and performance testing, of the optimum properties for ceramics for passive solar applications
- Performance of materials testing and computer modeling, and determination of material properties as a function of fabrication process

Glazing Materials Development for Radiative Cooling - Energy Materials Research Company Contact John Brookes & John Compton, 415-644-2244

- Develop and test a glazing material useful for sky radiative cooling
- Produce and test IR transparent, solar transparent, absorptive glazing samples, and absorptive emitter samples

Phase-Change Materials for Use in Passive Solar Residential Housing - National Association of Home Builders/Research Foundation Contact Paul Kando & Larry Zarker, 301-762-4200

- Evaluate the thermal performance of cycled PCMs
- Test PCMs for their dependability, long term storage ability, container integrity, ease of installation using conventional housing construction and materials
- Determine aesthetic acceptance of PCMs in building industry
- Discuss builder's concerns with PCMs in residential buildings (installation, added problems, selling, etc.)

Device or Component Fabrication or Testing

Passive Solar Window Module - Capitol Products Corporation Contact Gary Dodez & Frank Matunis, 717-766-7661

- Design, develop, and fabricate a passive solar window module that utilizes phase change storage
- Test and monitor performance of a variety of window module options including double and triple glazing, selective films, aluminized mylar shades, and several phase change materials

Water Thermal Storage System - Communico/Crinsco Contact Jay Nichols & Jim Nyle, 816-333-2100

- Development of a "Solar Heat Wall" water thermal storage system modular in design, which may be integrated into a variety of construction types
- Prototype fabrication, performance testing and detailed component design are involved in this development program

Silicone Southwall Glazing System - Dow Corning Contact Chuck Roth, 517-496-4275

- Developed a silicone southwall glazing system
- Established preliminary cost performance goals
- Conducted performance tests, including those for coatings, strength, transmission, flammability, and durability
- Evaluated market potential for glazing system including economics, various regional requirements, factors affecting purchase, and effective distribution strategies

Dual-Effect Regenerative Evaporative Cooler - Energy Alternatives, Inc. Contact J. O. Bradley, 702-293-3030

- Developed a two-stage evaporative cooler economically competitive with vapor compression air conditioning
- Conducted cost analyses and computerized performance simulations

Vapor Compression Dehumidification for Passive and Hybrid Cooling - Trinity University Contact Earle Doderer, 512-736-7515

- Develop and test an improved compression dehumidification system for use in buildings cooled by passive and hybrid means

Insulating Curtain - Thermal Technology Corporation Contact Mike Huntley, 303-466-1848

- Develop all interior, movable window insulating curtains
- Conduct performance and engineering field tests

Automatic Control Damper for Trombe Wall - Sunearth Solar Products Contact Howard Katz, 215-256-6648 & Don Prowler, 215-546-2314

- Adapt a flue draft damper for use in an insulated, unidirectional Trombe wall damper
- Conduct prototype tests
- Develop a user's manual
- Conduct cost studies

Rolling Insulating Curtain System - Star Technology Corporation Contact Doug Davis, 303-963-1969

- Develop, fabricate and test a multi-layer rolling insulating curtain system with a control system for automatic operation of the curtain
- Conduct thermal performance, safety and field tests on the curtain
- Design and construct a pilot production facility

Insulating Glazing System - Southwall Corporation Contact Charles Tilford, 415-962-1111

- Field test Superglass insulating system
- Develop production capability for sale to window manufacturers

Low-Cost Thermal Window Shutter - Solar Systems Design, Inc. Contact Robert Mitchell, 578-765-4020

- Design, fabricate, and test a low-cost "do-it-yourself" thermal window shutter
- Conduct thermal performance, flame, and durability tests
- Establish a production facility

Solar Assisted Commercial Greenhouse - Solar Central Contact Don Grieder & Wayne Roston, 513-828-1350

- Design, fabricate, and test prototype solar-assisted commercial greenhouse with an innovative glazing and insulating system
- Determine marketability of greenhouse, including cost, durability, ease of installation, retrofit opportunities, maintenance, and thermal performance

Honeycomb Thermal Insulating Curtain - Koolview Company, Inc. Contact Gerry Keodt, 608-238-3966

- Design, fabricate and test a honeycomb thermal insulating curtain that may be drawn across a window by the user
- Analyze the market potential for the curtain in various geographic regions of the United States
- Evaluate the cost and performance of the product in various geographic regions of the United States
- Develop a marketing plan for the curtain

Heat Flux Movable Insulation Controller - Intrel Contact James Kugrall, 603-883-4815

- Evaluate the technical and economic viability of a heat sensitive movable insulation controller
- Determine preliminary production, marketing, and delivery requirements

Passive Solar Greenhouse Design - Four Seasons Solar Products Corporation Contact Joseph Esposito, 516-694-4400

- Design, fabricate and test passive greenhouse design with improved glazing, ventilation, movable insulation, and thermal performance

Solar Thermal Technology Division

Solar Thermal Technology is developing central receivers, parabolic dishes, and parabolic troughs to concentrate the sun's energy to produce electricity or industrial process heat. The combination of concentrated direct solar flux (to 2,000 suns) and high temperature (to 2000^{o}F) causes solar unique materials problems that are now being characterized in areas of heat transfer fluids, 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 Synthesis, Deposition, Growth or Forming

Silver/Glass Mirror Research - DOE Contact Frank Wilkins, 202-252-1684
SERI Contact Gordon Gross, 303-231-1222

- Study effects of solar radiation on bonding at silver/glass interface
- Increase the environmental stability of mirrors in solar thermal applications

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

Polymer Synthesis and Characterization - DOE Contact Frank Wilkins, 202-252-1684
SERI Contact Gordon Gross, 303-231-1222

- Modify polymers using two approaches - bulk stabilization and surface modification
- Improve durability of polymers in solar thermal applications

Materials Properties, Characterization or Testing

High Temperature Thermal Fluids/Containment - DOE Contact Frank Wilkins, 202-252-1684
SERI Contact Gordon Gross, 303-231-1222

- Areas of study include corrosion mechanisms, oxidation, and the influence of absorption additives
- Characterize heat transfer fluid and ceramic structural material combinations that can operate at temperatures to 1100°C

High Temperature Windows - DOE Contact Keith Rose, 415-273-4265 (San Francisco office)
Georgia Institute of Technology Contact Dr. Robert Casanova, 404-894-3589

- Develop a coating (emphasis on boron-silica oxide polymer coating) that will inhibit devitrification of silica-based windows
- Through testing identify a transparent refracting window capable of withstanding the solar, chemical, and environmental environment of a receiver

High Temperature Materials - DOE Contact Keith Rose, 415-273-4265 (San Francisco office)
University of Houston Contact Dr. Lorin Van Hull, 713-749-1154

- Conduct photo-corrosion studies of Fe, Al, ceramics
- Acquire an understanding of photo-induced degradation in materials

Ceramic Materials Research - DOE Contact Frank Wilkins, 202-252-1684
Georgia Institute of Technology Contact Dr. Robert Casanova, 404-894-3589
SERI Contact Gordon Gross, 303-231-1222

- Identification, characterization of ceramic structural materials in high temperatures and high solar fluxes
- Identification of method to inhibit devitrification of silica of the non-transparent forms used for structural ceramic parts
- Development of advanced composite structures for high temperature/high flux solar thermal applications

OFFICE OF SOLAR ELECTRIC TECHNOLOGIES		$21685	
Photovoltaic Energy Technology Division			$21600
Materials Synthesis, Deposition, Growth or Forming		$16900	
Amorphous Silicon for Solar Cells	$7000		
Polycrystalline Thin Film Materials for Solar Cells	3200		
Deposition of High Purity Polycrystalline Silicon from Silane in a Fluidized Bed Reactor	1500		
Growth of Silicon Ribbon for Solar Cells	2200		
Deposition of III-V Semiconductors for High Efficiency Solar Cells	3000		
Materials Properties, Characterization or Testing		$ 2200	
Materials and Device Characterization	2200		
Device or Component Fabrication or Testing		$ 2500	
High Efficiency Crystal Silicon Solar Cells	2500		
Wind Energy Technology Division			$ 85
Materials Properties, Characterization or Testing		$ 105	
Wood Composite Material Fatigue	45		
Glass Reinforced Concrete for Wind Turbine Structures	40		

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. DOE Contact is Anthony Scolaro, 202-252-5548.

Materials Synthesis, Deposition, Growth or Forming

Amorphous Silicon for Solar Cells - SERI Contact Ed Sabisky, 303-231-1403

- 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 - SERI Contact Allan Hermann, 303-231-1311

- Chemical and physical vapor deposition, electrodeposition, and sputtering techniques are being investigated for depositing stoichiometric films of CuInSe, CdTe, and Zn_3P_2
- 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 - JPL Contact Andrew Morrison, 213-354-7200

- 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 - JPL Contact Andrew Morrison, 213-354-7200

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

Deposition of III-V Semiconductors for High Efficiency Solar Cells - 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, Characterization or Testing

Materials and Device Characterization - SERI Contact Larry Kazmerski, 303-231-1115
JPL Contact Ram Kachare, 213-354-4583

- 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 or Testing

High Efficiency Crystal Silicon Solar Cells - SERI Contact Joe Milstein, 303-231-7299
JPL Contact Ram Kachare, 213-354-4583

- Investigation of new coatings and/or dopants and other treatment that reduce electron-hole recombination at cell surfaces or in the bulk
- 18% efficient one sun crystal solar cell by end of FY '84 and 20% by end of FY '86

Wind Energy Technology Division

The R&D work of the wind program emphasizes the attainment of reduction in the cost of energy from wind systems through testing of blades and other wind system components and systems. Improved materials and bond techniques would increase the assurance of adequate fatigue margins and reduce rotor weight, favorably affecting all other subsystems.

Materials Properties, Characterization or Testing

Wood Composite Material Fatigue - DOE Contact Peter Goldman, 202-252-1776
NASA Contact T. Sullivan, 216-433-6943

- Characterization of static and cyclic fatigue properties of laminated Douglas fir veneer wood composite materials
- Data on wood grade, moisture content, butt joint gap, lamination clamping pressure, and test temperatures and humidity levels collected

Glass Reinforced Cement for Wind Turbine Structures - DOE Contact Peter Goldman, 202-252-1776
NASA Contact J. Faddoul, 216-433-6170

- Effectiveness of glass fiber reinforced cement in turbine structures evaluated

OFFICE OF RENEWABLE TECHNOLOGY			$1888.5K
Geothermal and Hydropower Division			$1778.5
(A) Geothermal Materials			$ 880
Materials Properties, Characterization or Testing		$815	
Alternate Materials of Construction	250		
Cementing of Geothermal Wells	60	(FY 82 carryover)	
Pitting-Resistant Alloys	150		
New Fluorocarbon Elastomers for Seals	155	(FY 82 carryover)	
Pump Bearing Materials Development	50	(FY 82 carryover)	
Shape Memory Alloy Seals	100	(FY 81 carryover)	
Geothermal Materials Compatibility and Failure Analysis	50		
Device or Component Fabrication or Testing		$ 65	
Elastomer Materials Technology Transfer	15		
Cathodic Protection of Well Castings	50	(FY '82 carryover)	
(B) Geochemical Engineering			$ 410
Device or Component Fabrication or Testing		$410	
Sampling and Analysis of Geothermal Fluids	10		
High Temperature Chemical Sensors for Geothermal Fluids	300		
Binary Cycles Fluid Case Study	100	(FY '82 carryover)	
(C) Hot Dry Rock			$ 163.5
Materials Synthesis, Deposition, Growth or Forming		$ 10	
Pressure Block Feed Thru Insulators	10		
Device or Component Fabrication or Testing		$141	
High Temperature Armor Cable	100		
High Temperature Connector	36		
High Temperature Pressure Transducers	5		
Instrumentation and Facilities		$ 12.5	
High Temperature Geophones	10		
High Temperature Accelerometers	2.5		

(D) Drilling and Completion			$ 325
Materials Synthesis, Deposition, Growth or Forming		$ 75	
High Temperature Particulate Plugging Agents	50		
Carbide Development	25		
Materials Properties, Characterization or Testing		$250	
Chemical and Elevated Temperature Effects on Clay-Based Drilling Fluids	50		
Aqueous Foams	200		
Energy from Municipal Waste Division			$ 50
Materials Properties, Characterization or Testing		$ 50	
Materials Corrosion in Municipal Waste-to-Energy Incinerator Systems	50		
Biomass Energy Technology Division			$ 60
Materials Properties, Characterization or Testing		$ 60	
Hydrogen Containment	60		

OFFICE OF RENEWABLE TECHNOLOGY

The Office of Renewable Technology consists of three divisions: the Geothermal and Hydropower Division; the Energy From Municipal Waste Division; and the Biomass Energy Technology Division.

Geothermal and Hydropower Division

This division supports high-risk, high-payoff R&D aimed at developing the basic technology needed for the private sector to more fully utilize geothermal energy resources for both electric power generation and direct heat applications. Materials R&D is being conducted within four subprograms: (A) Geothermal Materials; (B) Geochemical Engineering; (C) Hot Dry Rock; and (D) Drilling and Completion.

(A) Geothermal Materials

The Geothermal Materials Program is coordinated by The Brookhaven National Laboratory. DOE contact for all the following projects is Leon Lehr, 202-252-8076.

Materials Properties, Characterization or Testing

Alternate Materials of Construction - Brookhaven Contact Larry Kukacka, 516-282-2123

- Evaluation and development of alternate construction materials including elastomers and polymers
- Determination of engineering design requirements, economic evaluations, and demonstrations

Cementing of Geothermal Wells - Brookhaven Contact Larry Kukacka, 516-282-2123

- Development and testing of new and improved cements for geothermal well applications

Pitting-Resistant Alloys - Brookhaven Contact D. Van Rooyen, 516-282-4050

- Development and testing of metallic alloys and steels processing improved pitting-resistant properties

New Fluorocarbon Elastomers for Seals - Exfluor Research Contact E. Dumitru, 512-454-3812 or 512-471-5679

- Crosslinked and fluorinated elastomeric materials development and testing for high temperature service

Pump Bearing Materials Development - Solar Turbines International Contact D. Huey, 714-238-5609

- Durable pump materials development and testing
- Materials development to increase efficiency of heat extraction from wells

Shape Memory Alloy Seals - Rockwell International Contact W. Friske, 213-341-1000

- Nickel-Titanium (Nitinol) high temperature metallic seals development for down hole pump applications

Geothermal Materials Compatibility and Failure Analysis - Radian Corporation Contact P. Ellis, 512-454-4797

- Corrosion engineering support services and component failure analysis
- Geothermal well materials reference book

Device or Component Fabrication or Testing

Elastomer Materials Technology Transfer - L'Garde, Inc. Contact A. Hirasuna, 714-645-4880

- High temperature sealing materials using elastomers development

Cathodic Protection of Well Casings - Brookhaven Contact Larry Kukacka, 516-282-2123

- Feasibility study of cathodic protection for high-temperature well casings and above ground components

(B) Geothermal Engineering

The Geothermal Engineering Program is coordinated by The Battelle Pacific Northwest Laboratory; DOE contact for all the following projects is Leon Lehr, 202-252-8076.

Device or Component Fabrication or Testing

Sampling and Analysis of Geothermal Fluids - PNL Contact C. H. Kindle, 509-376-5904

- Standardization of accurate fluid and gas sampling/analysis methods via ASTM

High-Temperature Chemical Sensors for Geothermal Fluids - PNL Contact George Jenson, 509-376-9124

- Development of electrical and electrochemical probes for chemical environment measurements of high pressure/temperature conditions
- High temperature glass pH electrodes, geothermal CO_2 sensors and chemically sensitive semiconductor devices development

Binary Cycles Fluid Case Study - PNL Contact Donald Shannon, 509-376-3139

- Development and demonstration of advanced methods for monitoring geothermal power plants
- Testing of corrosion samples and NDE of heat exchangers

(C) Hot Dry Rock

The objective of this effort is to determine the technical feasibility of hot dry rock concepts. A major element of the program is the Phase II Energy Extraction System at the Fenton Hill Test Site, which consists of two wellbores drilled to a maximum depth of 15,000 feet and connected by a series of hydraulic induced fractures.

The Hot Dry Rock (HDR) Energy Extraction Demonstration Program is coordinated by Los Alamos National Lab; LANL contact is Bert Dennis, 505-667-5697. DOE contact for all the following projects is Allan Jelacic, 202-252-8022.

Materials Synthesis, Deposition, Growth or Forming

Pressure Block Feedthru Insulators - L'Garde Contact Allen Hirasuna, 714-645-4880

- Development of high temperature "boots" to electrically insulate wire terminations in cableheads and down hole instrumentation

Device or Component Fabrication or Testing

High Temperature Armor Cable - Rochester Corporation Contact George Philpott, 703-825-2111

- High temperature well logging armored instrumentation cable development for use in geothermal boreholes

High Temperature Connectors - Reynolds Corporation Contact Ralph Craig, 213-823-5491

- Testing of connectors at high temperature using machineable ceramic inserts to 320°C

High Temperature Pressure Transducers - Spartan Southwest Contact Lee Butler, 505-892-5300

- Development of potentiometer type pressure transducer for high temperature/pressure service

Instrumentation and Facilities

High-Temperature Geophones - Mark Products Contact Bill Haggert, 713-498-0600

- Development of high-temperature geophones rated at 250°C with corner frequencies of 30 Hz and useable at tilt angles up to 80°

High-Temperature Acceleromters - Bolt Beranek Newman Contact Carl Nicolino, 617-491-0091

- Development of accelerometers rated at 300°C for use in high-angled geothermal wellbores for microseismic fracture mapping

(D) Drilling and Completion

The Drilling and Completion Program is coordinated by Sandia National Lab; Sandia contact is James Kelsey, 505-844-6968. DOE contact is David Allen, 202-252-5335.

Materials Synthesis, Deposition, Growth or Forming

High Temperature Particulate Plugging Agents - Sandia Contact J. Kelsey, 505-844-6968

- Development of high temperature particular fracture plugging materials to improve circulation in geothermal wells

Carbide Development - Sandia Contact Charles Carson, 505-844-6477

- Development of non-stoichiometric tantalum carbides and niobium carbides to increase toughness and hardness

Materials Properties, Characterization or Testing

Chemical and Elevated Temperature Effects on Clay-Based Drilling Fluids - Texas Tech Contact M. Guren, 806-742-3110

- Fundamental understanding of clay particle morphology under conditions encountered during geothermal drilling activities

Aqueous Foams - Sandia Contact C. Carson, 505-644-6477

- Evaluating properties of aqueous foams at high temperature in geothermal brines

Energy from Municipal Waste Division

This division conducts long-range, generic research on processes and systems that use municipal wastes. Its aim is to develop the technological base for enhancing energy recovery, particularly in key municipal applications, such as water and wastewater treatment facilities.

Materials Properties, Characterization or Testing

Materials Corrosion in Municipal Waste-to-Energy Incinerator Systems - DOE Contact Christopher Kouts, 202-252-1697

- Examination of corrosion problems at waste burning sites for the development of short term test of properties of candidate materials

Biomass Energy Technology Division

The division supports long-term, high-risk research on biomass energy production and conversion. Materials research is conducted only to the extent that it will enhance the feasibility of using renewable biomass resources to displace conventional fossil fuels.

Materials Properties, Characterization or Testing

Hydrogen Containment - DOE Contact Carl Wallace, 202-252-1298

- Hydrogen permeation rates and design stresses evaluated for Tedlar and FEP-Teflon
- Identification of cost-effective transparent covering for reactors which have low H_2 and O_2 permeability

OFFICE OF ALCOHOL FUELS		$425K
Materials Synthesis, Deposition, Growth or Forming		$300
Catalyst Development for Methanol Dissociation and Synthesis	300	
Materials Properties, Characterization or Testing		$125
Membrane Development for Low Energy Separation	125	

OFFICE OF ALCOHOL FUELS

This office is sponsoring R&D aimed at providing the technology base needed for production of economically-competitive alcohol fuels. The current focus of the program is on long-term improvements in process technologies for the production of alcohol from biomass, for cellulose fermentation processes.

Materials Synthesis, Deposition, Growth or Forming

Catalyst Synthesis for Methanol Dissociation and Synthesis - DOE Contact Richard Moorer, 202-252-1878

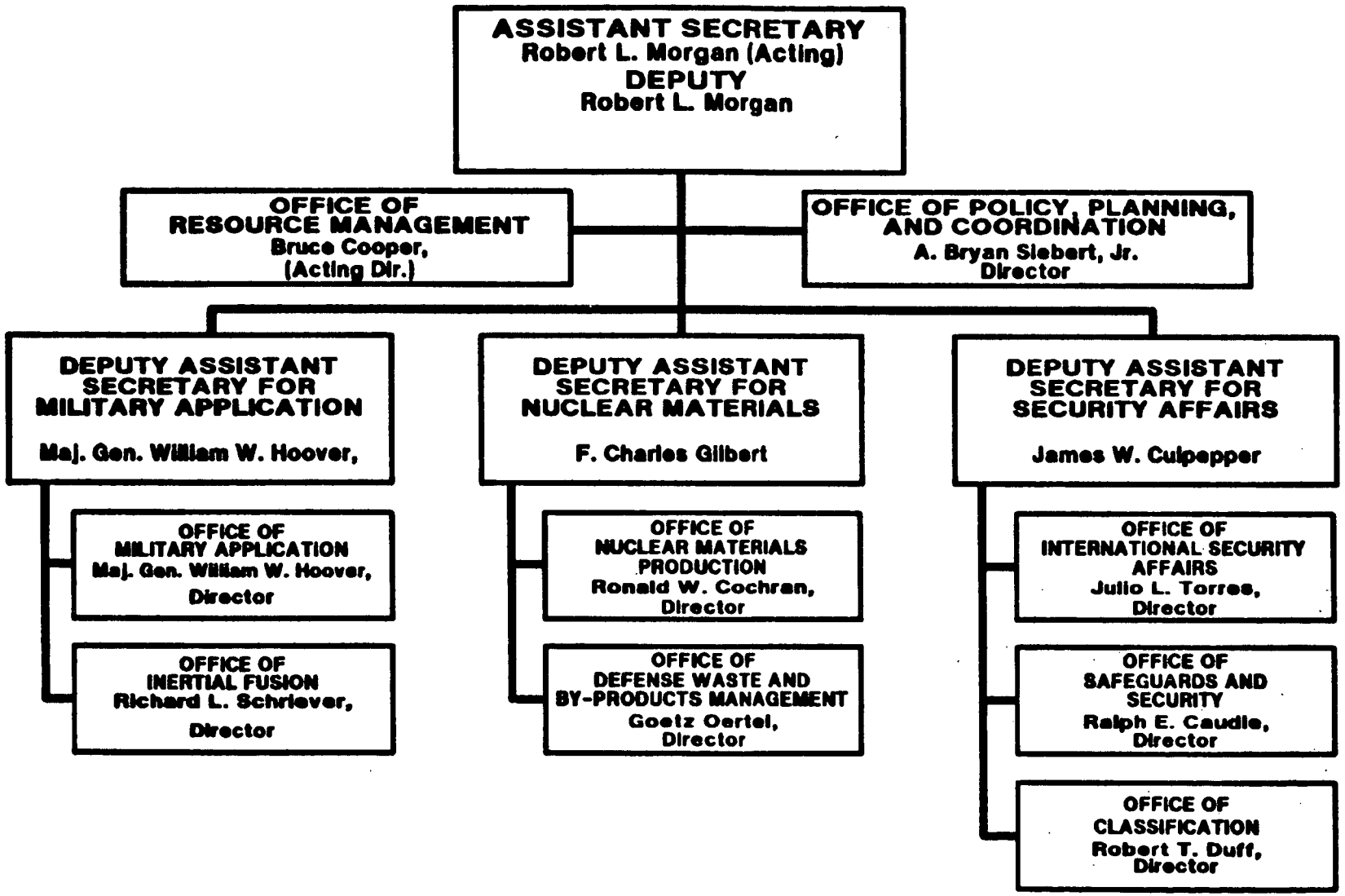
- Developing advanced organometallic compounds to produce CO and H_2 gases from methanol
- Developing heterogenous materials to improve conductive surface of catalytic agent

Materials Properties Characterization or Testing

Membrane Development for Low Energy Separation - DOE Contact Richard Moorer, 202-252-1878

- Engineering performance evaluation on commercial alcohol separating membranes

Office of the Assistant Secretary for Defense Programs



January 1984

OFFICE OF INERTIAL FUSION*

The materials effort consists of applied research and development oriented toward producing controlled thermonuclear fusion reactions in a laboratory environment for military and energy applications. The major areas (and the materials studied therein) are:

- Laser materials and optical components (neodynium glass, metallic optical coatings, and electronic materials);
- Fusion reaction materials (ceramics, glass, carbides, carbon), metals (ferrous and nonferrous), optical materials, thermal materials, construction materials, and electronic materials; and
- Target fabrication (ceramics, glass, carbon), metals (ferrous and nonferrous), polymers (plastics), and composites.

DOE Contact Carl Hilland, 301-353-3687

* Input to the FY 1982 EMaCC Report

OFFICE OF MILITARY APPLICATION

The objective of the materials research sponsored by this office is to develop materials and materials technology for national security uses. This applied research is directed toward material science, the understanding and development of advanced materials and fabrication technology, and the development of materials and processes required to produce nuclear and nonnuclear parts. Major areas are:

- Metals, metallurgy activities and superconducting and magnetic materials;
- Surface science, coating, welding and joining, fabrication, and materials compatibility;
- Ceramics, glasses and amorphous materials;
- Polymers, composite and adhesives; and
- Materials characterization techniques.

DOE Contact Yo T. Song, 301-353-5350

A summary finding table and office and divisional research summaries are presented for the portion of the program that is managed by Sandia National Laboratories. Project summaries for the entire program, which is managed by Sandia, Lawrence Livermore and Los Alamos National Laboratories, are presented in the Appendices.

SANDIA NATIONAL LABORATORIES

ORGANIC AND ELECTRONIC MATERIALS DEPARTMENT, 1810		$1805K	
Chemistry of Organic Materials Division, 1811			$175
Material Synthesis, Deposition, Growth or Forming		$100	
Polysilanes, Photoresists and Non-Charring Dielectrics	100		
Materials Properties, Characterization or Testing		$ 75	
Surface Characterization of Organic Materials	75		
Physical Properties of Polymers Division, 1813			$780
Materials Properties, Characterization or Testing		$780	
Cure Kinetics of Thermosets by DSC	100		
Effects of Crosslink Density of Rubber-Phase on Toughness of Rubber Modified Epoxies	500		
Water Diffusion in Epoxy Encapsulants	180		
Composites and Polymer Mechanics Division			$550
Material Properties, Characterization or Testing		$550	
Surface Chemistry and Bonding of Plasma Aminated Polyaramid Filaments	250		
Creep Rupture of Kevlar Composites	300		
Electronic Property Materials Division, 1815			$300
Materials Properties, Characterization or Testing		$300	
Fundamental Studies of Conductive Polymers	100		
Radiation Hardened Dielectrics	200		

MATERIALS CHARACTERIZATION DEPARTMENT, 1820		$605K	
Analytical Chemistry Division, 1821			$180
Materials Properties, Characterization or Testing		$180	
Development of Automated Methods for Chemical Analysis	80		
Electrochemical Studies of the Li/SO_2 Organic Electrolyte Battery	100		
Electron Optics and X-Ray Analysis Division, 1822			$225
Material Properties, Characterization or Testing		$225	
Development of Advanced Methods of Electron and X-Ray Instrumental Analysis	150		
Thermomechanical Treatment of U Alloys	75		
Surface Chemical and Analysis Division, 1823			$100
Materials Properties, Characterization or Testing		$100	
Advanced Methods for Surface Analysis	100		
Thermophysical Properties Division, 1824			$100
Materials Properties, Characterization or Testing		$100	
Development of New Methods of Thermal Analysis of Films and Nonrigid Materials	100		

METALLURGY DEPARTMENT		$1460K	
Cleaning and Costing Technology Division, 1831			$130
Materials Synthesis, Deposition, Growth or Forming		$ 50	
Erosion Resistant Coatings	50		
Device or Component Fabrication or Testing		$ 30	
Hydrogenation of Silicon Solar Cells	30		
Instrumentation and Facilities		$ 50	
Near Net Shape Processing	50		
Process Metallurgy Division , 1833			$340
Materials Synthesis, Deposition, Growth or Forming		$ 80	
Vacuum Arc Remelting V-6 Wt % Nb	80		
Materials Properties, Characterization or Testing		$ 100	
Mechanical Properties of Inertia Welds	100		
Device or Component Fabrication or Testing		$ 160	
Lazar Welding Component Closures	90		
Plasms Arc Welding	40		
Fusion Welding Dissimilar Alloys	30		
Surface Metallurgy Division, 1984			$990
Materials Synthesis, Deposition, Growth, or Forming		$ 840	
Plasma Spraying	400		
Aluminum Anodization	150		
Silicon Passivation	90		
Ion Implantation	200		
Materials Properties, Characterization, and Testing		$ 150	
Fracture of Brittle Materials	150		

CHEMISTRY AND CERAMICS DEPARTMENT, 1840		$7200K
Materials Synthesis, Deposition, Growth, or Forming		4100
Glass and Glass-Ceramics Development	2500	
Ceramics Processing	1600	
Materials Properties, Characterization or Testing		3100
Fracture of Ceramics	1700	
Corrosion	1400	

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 reliablility of organic and electronic materials pertinent to our unique applications and conducts indepth studies in order to understand and improve these properties. Department 1810 investigates unique and innovative approches 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 coating and molding as well as developing 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 investigation to characterize the reaction chemistry of these materials which influence their formation, processing, or aging.

Materials Synthesis, Deposition, Growth or Forming

- Some alkyl substituted polysilanes undergo a novel photolytic depolymerization-volatilization sequence 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.

Materials Properties, Characterization, or Testing

- The surface chemical structures of a variety of organic materials are being studied by Auger and photoemission spectroscopy, and by electron stimulated desorption of neutrals and ions from organic surfaces (ESD). The emphasis is on understanding the type of chemical bonding which affect polymer-metal and polymer-metal oxide adhesive bond strength and durability.

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 characterizaing 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 Properties, Characterization or Testing

- The capability has been developed to determine the cure kinetics of adhesive and other thermosets by differential scanning calorimetry (DSC). Knowledge of the cure kinetics permits the optimum cure cycle for a system to be determined while minimizing compatibility problems. This kinetic method has been applied to adhesive and encapsulants.

- The relationship between the crosslink density of the dispersed phase and the fracture toughness of rubber-modified epoxies has been investigated. Diethanol amine and polyoxypropyl amine cured rubber-modified epoxies were exposed to gamma radiation which crosslinked the rubber phase.

- Water permeation experiments were carried out on glass microballoon-filled epoxies. These results indicated that the glass filled epoxy is damaged by its exposure to water.

Composites and Polymer Mechanics Division, 1814

The primary mission of Division 1814 is to select, develop, characterize, and certify composite materials and fabrics for use in weapon and energy systems. Responsibilities span exploratory development through design, production, and stockpile life. The Division provides the laboratories with knowledge and engineering data on properties of composite materials and fabrics pertinent to our unique applications and conducts in-depth studies to understand and improve these properties. The Division also provides support to the laboratories on the ultimate properties of structural polymers and adhesives.

Materials Properties, Characterization or Testing

- Thermomechanical performance of polyaramid-reinforced, resin-mixed composites often is limited by poor adhesion in the filament-matrix interphase region. A method to improve adhesion by forming covalent bonds across the interface through amine functional groups has been developed.

- We have found a variation between spools of nominally identical Kevlar 49 fiber. This variation produces major differences in failure life of advanced composite materials and is responsible for much of the scatter previously thought to be inherent in creep rupture data.

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 stockpilings. The Division also performs in-depth studies in order to understand materials properties and associated electronic phenomena. Areas of activity include inhomogeneous materials contacts to electronic materials, dielectrics, and special materials and processes.

Materials Properties, Characterization or Testing

- Polymer dielectrics are being developed that display a minimum radiation-induced conductivity (RIC). These materials would be used in capacitors and cables exposed to high dose-rate radiation so that little charge is lost due to RIC in this environment.

- Conductive polymers are being studied as potential electrode materials for high power density batteries and fuel cells. Basic scientific studies to determine the thermodynamics and kinetics of electrochemical doping processes in polyacetylene are being pursued.

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 meeting 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, glasses, alloys, ceramics, and geologic materials. Analyses are performed by a variety of techniques using absorption and emission spectroscopy, gas chromatography, gas chromatography/ mass spectrometry, ion chromatography, neuton activation analysis, electrochemistry, combustion and classical methods of chemical analysis.

Materials Properties, Characterization or Testing

- New, highly automated methods for chemical analysis of a wide variety of materials are being developed. These include automated inductivity coupled plasma emission spectroscope for trace analysis, a laser source emission spectrometer for microanalysis, and an automated high performance liquid chromatograph. Contact: N. E. Brown, 505-844-2747

- The mechanism of the cathodic half-reaction of the Li/SO_2 organic electrolyte battery has been investigated using advanced automated electrochemical techniques. The reaction involved the reduction of SO_2 and the formation of a dithionite anion which forms a passivating film on the cathode. Studies of the effects of common impurities on the half-reaction showed that water inhibits passivation. Contact: R. V. Whiteley, 505-844-4031

Electron Optics & X-Ray Analysis Division, 1822

The mission of Division 1822 is to perform microstructural characterization in support of Sandia programs throughout the Laboratories. The types of characterization available include: x-ray diffraction, optical metallography, electron microprobe analysis measurement of microscopic concentration gradients, etc, and transmission electron microscopy.

Materials Properties, Characterization or Testing

- Advanced methods of automated electron and x-ray instrumental analysis are being developed to improve resolution, accuracy and efficiency. Improvements in in-situ electron diffraction analysis and image analysis are recent accomplishments. Contact: W. F. Chambers, 505-844-6163

- Thermomechanical treatments of uranium alloys are being investigated as a means to increase strength-ductility properties of these materials. Significant improvements have been found, and a systematic evaluation of the effects of the various processing parameters is presently underway. Contact: K. H. Eckelmeyer, 505-844-7775

Surface Chemistry & 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.

Materials Properties, Characterization or Testing

Contact: J. A. Borders, 505-844-8855

- New facilities and methods are being developed to improve the resolution, accuracy, and efficiency of surface analysis. Recent accomplishments include the development of a system which combines an automated ion scattering spectrometer, a secondary ion mass spectrometer and a scanning Auger spectrometer. A new multivariate least squares software package has been develpped to improve the quantitative analysis of Fourier transform infrared spectroscopic data.

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, and dilatometry.

Materials Properties, Characterization or Testing

Contact: J. N. Sweet, 505-844-3343

- Two new methods for thermal conductivity/diffusivity have been developed and put into operation. The thermal pulse diffusivity apparatus is used to determine the thermal diffusivity of thin films and multilayered materials. The thermal conductivity linear probe provides the capability of measuring conductivities of nonrigid materials like foams and powders.

METALLURGY DEPARTMENT, 1830

Department 1830 supports the laboratories by selecting, developing, and characterizing the nonelectronic 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, this department 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.

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 anodization. In addition, this division provides support for design engineers in specification of processes and transfer of technology involving cleaning and coating.

Materials Synthesis, Deposition, Growth, or Forming Contact: A. Mullendore, 505-844-6833

- Erosion Reistant Coatings - A process is being developed to chemically vapor deposit erosion resistant coatings of TiB_2 on let-down valves. These valves have been tested in a coal liquefaction pilot plant in Baytown, Texas, and are undergoing further testing at Battelle in Columbus, Ohio.

Device or Component Fabrication or Testing Contact: D. Sharp, 505-844-8604

- Solar Cells - A process has been developed to hydrogen ion bombardment silicon solar cells using a Kaufmann ion source. The processing increase the conversion efficiency of the cells to such an extent that it is now being adapted for manufacturing use by Mobil-Tyco.

Instrumentation and Facilities Contact: A. Mullendore, 505-844-6833

- Near Net Shape Processing - A facility is being built to carry out near net shape processing of objects using chemical vapor deposition of nickel from a $Ni(CO)_4$ precursor. Doping with boron should produce high strength, high ductility alloys.

Process Metallurgy Division, 1833

The Process Metallurgy Division supports the laboratories by selecting, characterizing and developing metallurgical processes needed in the manufacturing 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 current processes under study include laser welding, arc welding (GTA and Plasma), soldering, brazing, vacuum induction melting, vacuum arc remelting, and casting techniques for metal-ceramic composites.

Materials Synthesis, Deposition, Growth or Forming Contact: F. J. Zanner, 505-844-7073

- Vacuum Arc Remelting technology is being investigated with the objective of improving the homogeneity of U-6 wt% Nb alloy ingots. Macrosegregation and melt rates depend on interelectrode spacing and current densities.

Materials Properties, Characterization or Testing Contact: G. A. Knorovsky, 505-844-1109

- The mechanical properties of alloy steel inertia welds are being determined as a function of process parameters. Process latitude has been found to depend on minor impurity levels.

Device or Component Fabrication Testing

- Both pulsed and CW laser welding is being developed for application to component closures. The emphasis is on accurate selection and control of power density so as to satisfy both heat transfer and metallurgical requirements. Contact: J. L. Jellison, 505-844-6397

- Plasma ard welding is under development for application to small components. Nozzle design and power supplies are being optimized for low-current, conduction mode welds. Contact: J. L. Jellison, 505-844-6397

- Fusion welding procedure for dissimilar welds are being developed with emphasis on avoidance of hot-cracking. Principal alloys involved are precipitation strengthened stainless steels, Kovar, and precipitation strengthened nickel base alloys. Contact: M. J. Ciselak, (505) 846-7500 and G. A. Knorovsky, 505-844-1109

Surface Metallurgy Division, 1834

The Surface Metallurgy Division is concerned with the influence of surface and near surface regions to the engineering application of materials. Concerns include characterizing, modifying, and coating surfaces in order to optimize engineering properties.

Materials Synthesis, Deposition, Growth or Forming

- Plasma Spraying - Low Pressure Plasma Spraying of metal and ceramic coatings. Contact: M. F. Smith, 505-846-4270

- Aluminum Anodization - Dielectric barrier anodized coatings. Contact: J. K. G. Panitz, 505-844-8604

- Silicon Passivation - Hydrogen ion beam treatment of polycrystalline silicon to enhance electronic properties. Contact: J. K. G. Panitz, 505-844-8604

- Ion Implantation - Ion implantation of species to enhance wear and friction properties of surfaces. Contact: L. E. Pope, 505-844-5041

Materials Properties, Characterization or Testing Contact: R. R. Cuthrell, 505-844-7195

- Fracture of Brittle Materials - Chemomechanical effects of environment on the fracture of brittle materials including environmentally generated surface stresses.

CHEMISTRY AND CERAMICS DEPARTMENT, 1840

Department 1840 supports Sandia weapons and energy programs by selecting, developing and characterizing ceramic materials. Under the general heading of ceramics, glasses, glass ceramics, and refractories are included. Responsibilities span exploratory development through evaluation of performance in weapons and energy applications. The department also supports the Laboratories through the study of reactive processes in inorganic and geologic media. This includes both kinetic and thermodynamic studies. Corrosion and electrochemistry constitute 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 performs research to investigate the corrosion and electrochemical behavior of inorganic materials. Corrosion research is directed toward: (a) development of new and improved materials, (b) defining boundaries for the application of existing materials, and (c) performing failure analyses. Electrochemical studies are undertaken to characterize corrosion behavior and also transport and thermodynamic properties of solid electrolytes. The Division maintains expertise in aqueous and molten salt corrosion, stress corrosion, gaseous and atmospheric corrosion, and solid state electrochemistry.

Materials Synthesis, Deposition, Growth or Forming - Contact R. Glass, 505-844-6638

- New techniques are being developed to electroplate Al. Present Al electroplating techniques require the use of very elaborate facilities including dry boxes. We are developing a simplified process which can be used by industry.

Materials Properties, Characterization or Testing - Contact R. Diegle, 505-846-3450 and N. R. Sorenson, 505-844-1097

- Titanium alloys, particularly Ti-Code 12 (Ti-0.8% Ni-0.3% Mo) are being evaluated in bedded salt and subseabed environments as nuclear waste containers.

- The roles of alloy chemistry and structure in the corrosion of glassy metals is being determined. Ion implantation techniques are being used to help elucidate why low levels of chromium passivate glassy alloys.

Chemical Technology Division, 1843

Division 1843 is responsible for providing chemistry and chemical engineering support to Laboratories' programs in the area of reactive processes. In this regard, the Division will maintain expertise in the following areas: chemical kinetics, thermodynamics, dissolution and precipitation phenomena, colloid and surface chemistry, chemical dynamics of gas/surface interactions emphasizing processes of atomic and molecular energy transfer, and inorganic chemical synthesis. In addition, this Division conducts theoretical and experimental studies of mass transport in reactive media.

Materials Synthesis, Deposition, Growth or Forming - Contact R. Dosch, 505-844-1565

- High purity homogeneous PZT powders have been prepared by sol-gel chemistry techniques. The total mixture has been coprecipitated to insure homogeneity. The most important element is considered to be the ZrO_2 and most of the efforts have focused on this component.

- ZnO variator material has been prepared by sol-gel chemistry techniques. High purity material and doped materials have been prepared and are being evaluated.

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 Synthesis, Deposition, Growth or Forming - Contact J. Wilder, 505-844-1332
R. Loehman, 505-846-2537 and K. Keefer, 505-846-0322

- High expansion phosphate based glasses have been developed for sealing to Al, Cu and stainless steels. The chemical durability has been improved to the point that the glasses compare favorably to many silicate glasses.

- A Li-silicate glass ceramic has been developed which seals to Inconel 718. A high strength, corrosion resistant actuator was required for a weapon application. The use of an appropriate metal system such as Inconel alloys required the development of a new glass ceramic.

- A transformation toughened glass ceramic has been developed wherein a metastable ZrO_2 phase is precipitated in a glass matrix.

Materials Properties, Characterization and Testing - Contact T. Michalske, 505-846-3551

- The effect of the environment on crack propagation in silicates is being determined. A chemical model has been proposed which correlates chemical reactivity and propensity to cause stress corrosion cracking.

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 is specifically concerned with the performance and survivability of materials in severe environments, e.g., chemically reactive, high temperature and/or pressure, irregular configurations. Within this charter, the following areas are specifically covered: preparation, characterization, chemical reactivity and application of inorganic materials of unusual composition or configuration; the chemistry of high temperature systems, e.g., thermodynamics and kinetics of high temperature reactions and the physical and chemical properties and thermal stability of inorganic materials.

Materials Synthesis, Deposition, Growth or Forming - Contact J. Brinker, 505-846-3552 and
R. Quinn, 505-844-1933

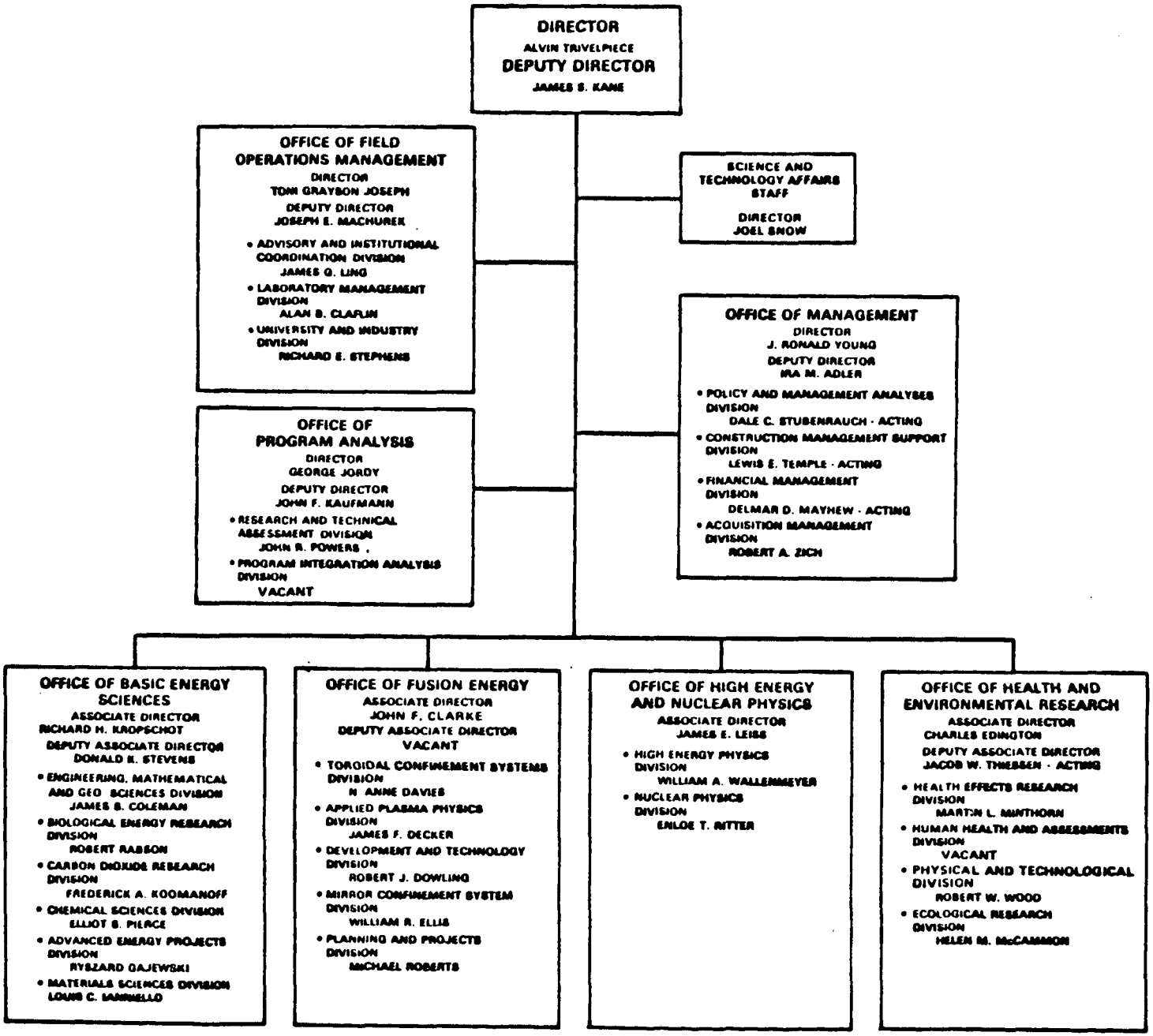
- Novel glasses are being prepared by sol-gel chemistry techniques. This process of preparing glasses for metal organic solutions is ideally suited for the preparation of thin films. The high surface area of the gel prior to densification has allowed nitrogen to be incorporated into the lattice of several types of glasses for the first time.

- A glass has been developed for use in Li/SO_2 batteries. This glass was developed to resist the environment of Li/SO_2 batteries for 5 years. A model of Li under potential deposition was proposed and used to define a glass chemistry resistant to attack.

OFFICE OF DEFENSE WASTE AND BYPRODUCTS MANAGEMENT

The Defense Long-Term Waste Management Technology program is directed toward implementation of long-term management of DOE radioactive waste. It includes materials development and evaluation for high-level and transuranic waste forms and canisters. Applied development programs are being pursued in the preparation of immobile high-level waste forms by vitrification, characterization of these waste forms, and remote welding of containers. DOE Contact Ray D. Walton, Jr., 301-353-3388.

OFFICE OF ENERGY RESEARCH



OFFICE OF HEALTH AND ENVIRONMENTAL RESEARCH			$ 525K
Physical and Technological Research Division			$ 525
Materials Properties, Characterization or Testing		525	
Development of Mercuric Iodide	250		
Radiation Detector Technology	275		

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. The objectives of this research effort are to obtain fundamental biological information on the organization, structure, and function of living organisms and their environment; to determine the health and environmental impacts of energy technology developments on humans and their environment; and to develop new and improved techniques for use of stable and radioactive isotopes for application in research and clinical nuclear medicine practices for diagnosis and treatment of human diseases. The research includes studies of the potential occupational and public health hazards associated with the utilization of toxic materials in energy productions.

Physical and Technological Research Division

The Physical and Technological Research Division conducts physical, chemical and instrumentation research related to health and environmental aspects of energy technology development. Included are support of analytical studies, atmospheric sciences research, measurement and dosimetry, and fundamental physical processes research.

Materials Properties, Characterization or Testing - University of Southern California
Contact A. J. Dabrowski, 213-822-9181
LBL Contact F. S. Goulding, 415-486-6432

- Mercuric iodide and other semiconductor compounds are studied as radiation detectors. Research focuses on the basic physics of the interaction with radiation and detector design.

- Semiconductor materials, primarily germanium and silicon, are studied as radiation detectors. Research includes crystal growth and purification and measurement of materials properties.

OFFICE OF FUSION ENERGY (MAGNETIC)*

The research and development on materials addresses needs of magnetic fusion systems and future fusion reactors. The general objective is to provide the materials property data base and where necessary to develop new materials for the design, construction, and operation of fusion reactor systems.

DOE Contact - G. M. Haas, 301-353-5143

Funding input not received.

* Input to the FY 1982 EMaCC Report

Division of Materials Sciences

The aim of this basic research program is to increase the understanding of materials phenomena, materials properties and behavior of classes of materials important to the Department of Energy's missions. Some of the research is specific to one energy technology (e.g., photovoltaic phenomena for solar energy conversion), some is related to many energy technologies simultaneously (e.g., hydrogen embrittlement) while still other research is aimed at long range advancement of materials science (e.g., neutron scattering). In the pursuit of these objectives, new forefront instruments and facilities are developed as needed. It is recognized that this program carries a major responsibility for many of the nation's premier research facilities including several neutron sources, a synchrotron radiation source and frontier electron microscopes. The 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. The DOE Contact is Louis Ianniello, 301-353-3427. There are three subprograms:

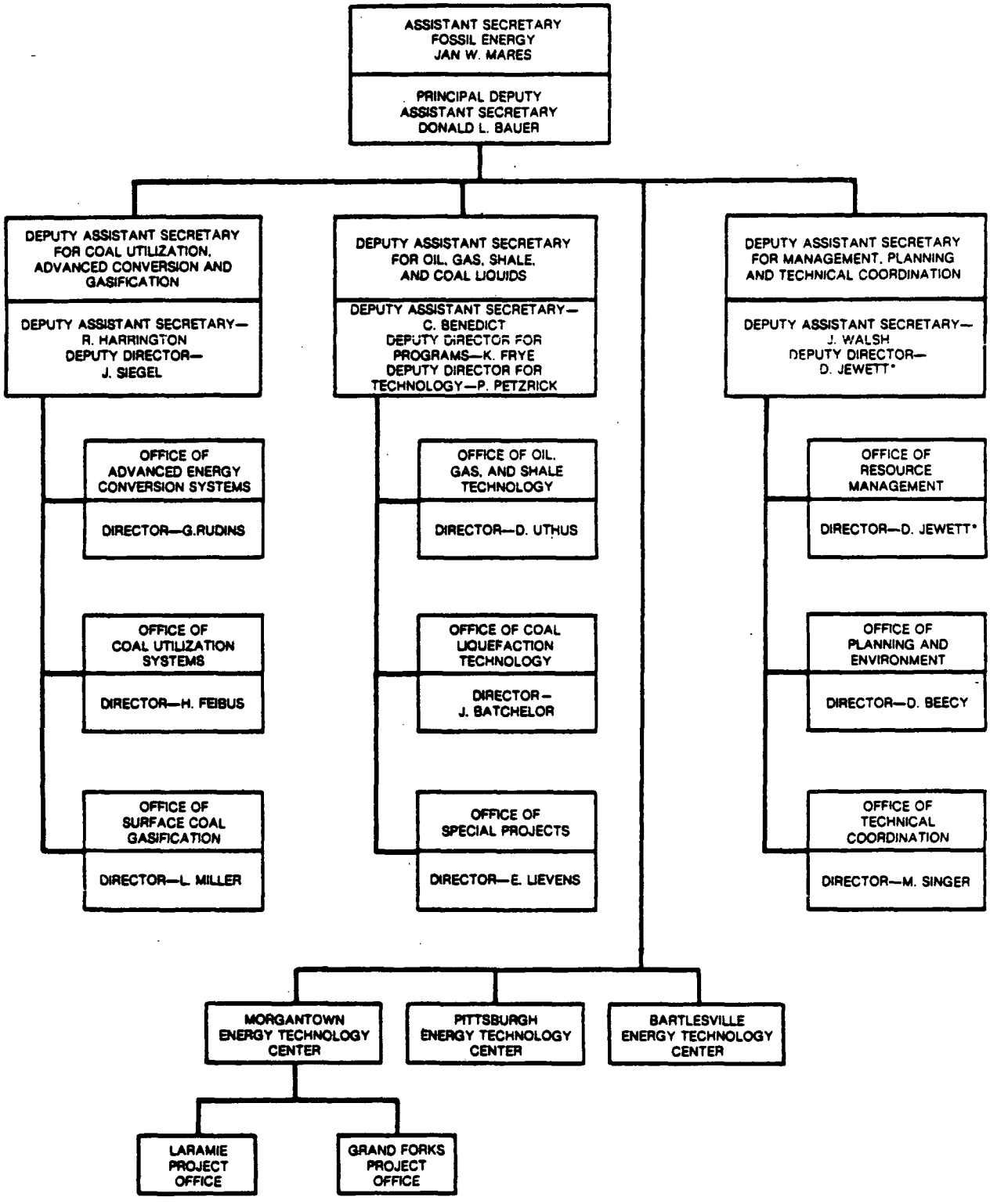
- Metallurgy and Ceramics: To understand better how metallic and ceramic materials behavior/properties are related and controlled by structure and processing conditions.

- Solid State Physics: Directed toward fundamental research on matter in the condensed state, wherein the interactions of electrons, atoms, and defects are tracked with the purpose of determining the critical properties of solids.

- Materials Chemistry: Developing an understanding of the chemical properties of materials as determined by their composition, structure, and environment (pressure, temperature, etc.) and to show how the laws of chemistry may be used to understand physical as well as chemical properties and phenomena.

The reader is referred to DOE publication, Materials Sciences Programs Fiscal Year 1983 (DOE/ER-0143/1 dated September 1983), which gives further details.

OFFICE OF FOSSIL ENERGY



*DUAL POSITION

APPROVED OCTOBER 13, 1982 — MODIFIED JUNE 1983

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.

Funding input not received.

OFFICE OF SURFACE COAL GASIFICATION*

The materials program objectives are to develop and apply appropriate materials to coal gasification plants/components, vessels and piping systems. The overall goal is to improve the operational reliability, system durability and to reduce fabrication as well as operating costs of coal gasification plant constituent elements and/or components operating under high temperature, erosive, corrosive, dirty environment conditions. Materials being evaluated include structural ceramics, coatings and claddings, refractories, high strength metal alloys.

DOE Contact - James Carr, 301-353-5985

Funding input not received.

* Input to the FY 1982 Report

OFFICE OF ADVANCED ENERGY CONVERSION SYSTEMS*

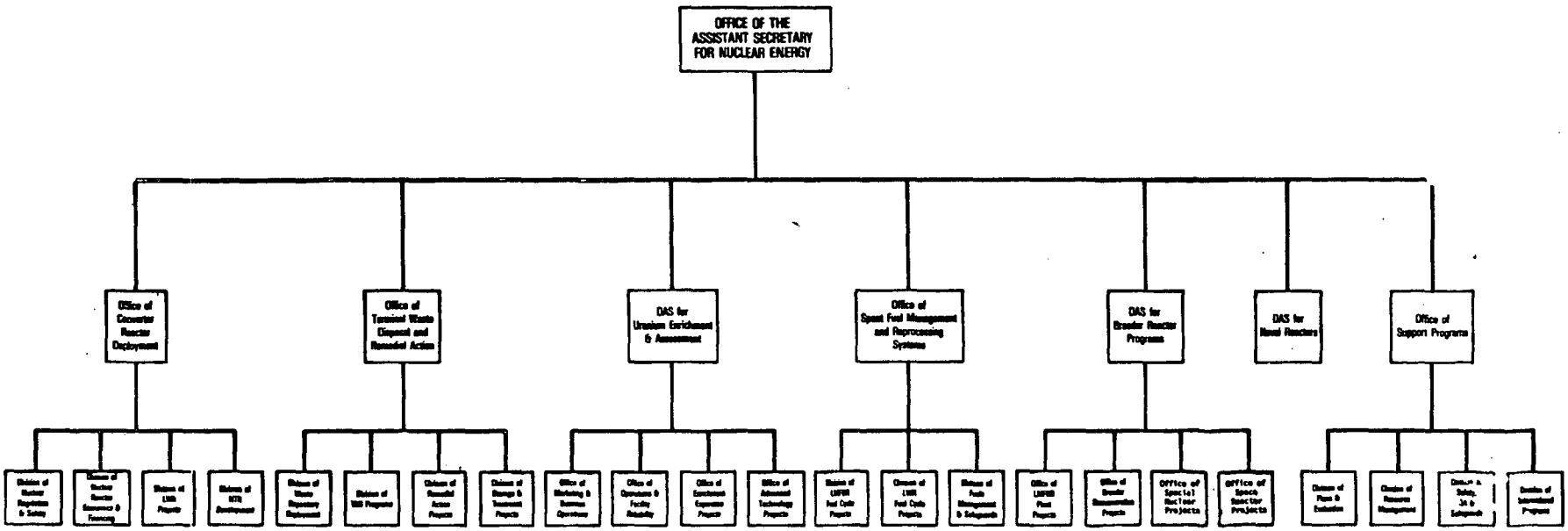
The materials effort emphasizes engineering to improve materials for industrial/utility gas turbine and diesel engine hot-section components to provide efficient, durable, environmentally acceptable operation with coal base fuels. Development of new materials is focused on adherent corrosion resistant oxide ceramic coatings such as zirconia and alumina. Silicon carbide and silicon nitride are also being evaluated. The effect of coating process modifications, such as substantial surface preparation, plasma deposition, and laser heating of the coating, are being examined. Also, to support the water cooled gas turbine engine capability to operate with coal base fuels, materials work on vane and blade materials and fabrication is being conducted to determine the strength of powder metallurgically produced and directionally solidified metallic alloys.

DOE Contact - John W. Fairbanks, 301-353-2822

Funding input not received.

* Input to the FY 1982 EMaCC Report

ASSISTANT SECRETARY FOR NUCLEAR ENERGY



OFFICE OF URANIUM ENRICHMENT AND ASSESSMENT

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 program goal. Uranium enrichment is composed of four major offices: Business and Marketing, Operations and Facility Reliability (Gaseous Diffusion Plants), Expansion Projects (construction of the Gas Centrifuge Enrichment Plant), and Advanced Technology Projects (development/demonstration of the Advanced Gas Centrifuge and the Atomic Vapor Laser Isotope Separation Processes). Total obligated authority for all uranium enrichment activities in FY 1983 was 1.8 billion dollars.

Uranium as found in nature contains about seven-tenths of one percent uranium 235 which is fissionable. The remainder is essentially uranium 238 which is nonfissionable. The fissionable characteristics of uranium 235 make it desirable to enhance its concentration for use as nuclear fuel. Light water reactors typically require uranium 235 concentrations in the two to four percent range. Presently uranium is enriched to the desired uranium 235 product assay levels in gaseous diffusion plants located at Oak Ridge, Tennessee; Portsmouth, Ohio; and Paducah, Kentucky. These plants were built in the 1940's and 1950's and were operated initially to satisfy defense requirements for uranium 235. They are now operated primarily to provide enrichment services to domestic and non-United States utility customers. In these plants, the Department enriches customer-provided natural uranium in the uranium 235 component for a fee which recovers the cost of providing the services. The Department is the sole provider of enrichment services in the United States. The specific statutory authority which established this role is the Atomic Energy Act of 1954, as amended.

Materials activities within the Office of Uranium Enrichment are varied and for the most part, especially the test results, classified Restricted Data. The DOE Contact is Arnold Litman, 301-353-5777.

OFFICE OF CONVERTER REACTOR DEPLOYMENT			$356,990
Division of High Temperature Reactor Development			$6990
Materials Synthesis, Deposition, Growth or Forming		$ 850	
Fuel Process Development	$850		
Materials Properties, Characterization or Testing		$6140	
Fuel Materials Development	940		
Fueled Graphite Development	780		
Graphite Development	530		
Graphite Development and Testing	760		
Metals Technology	1100		
HTR Structural Materials	630		
Advanced Gas Reactor Materials Development	1400		
Division of Light Water Reactor Projects			$350K
Materials Properties, Characterization or Testing		$350K	
Demonstration of LWR Fuels with Improved Pellet-Cladding Interaction Performance	$150K		
Fission Gas Release from High Burnup Fuel	200K		

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 Project, Nuclear Regulation and Safety, and Nuclear Reactor Economics and Financing. The 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, prestressed concrete reactor vessels, thermal barrier pads and insulation, and heat exchanger tubing and tube sheets. DOE Contact J. E. Fox, 301-353-4162.

Materials Synthesis, Deposition, Growth or Forming

Fuel Process Development - GA Technologies Contact D. McEachern, 619-455-4608

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

Materials Properties, Characterization or Testing

Fuel Materials Development - GA Technologies Contact R. Turner, 619-455-2306

Fueled Graphite Development - ORNL Contact F. Homan, 615-574-5169

- 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 - GA Technologies Contact G. Engle, 619-455-2894

Graphite Development and Testing - ORNL Contact W. Eatherly, 615-574-5220

- 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 - GA Technologies Contact D. Roberts, 619-455-2560

HTR Structural Materials - 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 - GE Contact M. Donnelly, 518-385-1086

- 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°C (1400°F).

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 development work is underway within several projects of the Division's Extended Burnup Program. DOE Contact P. M. Lang, 301-353-3313.

Materials, Properties, Characterization or Testing

Demonstration of LWR Fuels with Improved Pellet-Cladding Interaction Performance - Commonwealth Research Corporation Contact D. O'Boyle, 312-294-3836; Consumers Power Company Contact G. Pratt, 517-788-1879

- Improved LWR fuel design being developed
- In-reactor performance data

Fission Gas Release from High Burnup Fuel - PNL Contact M. Freshley, 509-375-2530

- Investigate the effects of burnup, power level, and pellet designs on fission gas release in LWR fuels.

Reactor Materials Division

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 dollars in FY 1983 including over $25 million as the cost for irradiation testing in the Advanced Test Reactor. DOE Contact Robert H. Steele, FTS 557-5565.

OFFICE OF BREEDER TECHNOLOGY PROJECTS		$35,805K
Fuels and Core Materials Division		$35,805K
Materials Properties, Characterization or Testing		$7,962K
Alloy Development	$ 280K	
Alloy Development	3,600	
Fuel Support Technology	2,848	
Improved Oxide Fuel	1,135	
Advanced Alloy Development	99	
Device or Component Fabrication or Testing		$28,588K
Advanced Fuels-Transients	$ 296K	
Advanced Fuels-Transients	148	
Advanced Fuels-Development	2,536	
Reference Fuels	3,013	
Advanced Fuels	3,849	
Absorbers	855	
Program Management	700	
Post-Irradiation Examination, Deactivation and Storage of Carbide Fuel	4,545	
Fuel Blanket Assembly Development	1,829	
Fuel Fabrication	10,817	

OFFICE OF BREEDER TECHNOLOGY*

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, advanced and alternate 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 plutonium bearing fuels, materials and components; sodium technology; standards and quality assurance; assuring a reliable high quality and affordable fuel supply for LMFBR'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 objectives of the materials and structures programs 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.

DOE Contact - D. K. Magnus, 301-353-5004 for the Fuels and Core Materials Division
C. Purdy, 301-353-4486 for the Materials and Structures Program

* Input to the FY 1982 EMaCC Report

OFFICE OF SPACE NUCLEAR PROJECTS*

This office provides reactor and radioisotopic thermoelectric power sources for space flight and terrestrial missions. All applied research and development, fabrication, systems integration and safety requirements for power sources are responsibilities of this office.

DOE Contact - G. Bennett, 301-353-3197

* Input to the FY 1982 EMaCC Report

OFFICE OF WASTE REPOSITORY DEPLOYMENT*

This program evaluates geologic and engineering materials for the isolation of radioactive wastes within deep-mined geologic formations, or within the subsea bed. This includes determination of properties of geologic and engineering materials (on exchange transport of radioactivity through geohydrologic systems, corrosion of metallic containers in geohydrologic environments, teaching), dissolution of radioactive glasses and ceramics, and expanding concretes and clays.

DOE Contact - C. R. Cooley, 301-353-4285

* Input to the FY 1982 EMaCC Report

CONSERVATION

OFFICE OF ENERGY SYSTEMS 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. The Office consists of three divisions: Energy Storage, Energy Conversion and Utilization Technologies (ECUT), and Electric Energy Systems.

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. 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.

Batteries and Electrochemistry

1. Ceramics Research — 1983 $800K

DOE Contact - A. Landgrebe (202) 252-1483
ANL, MIT, Stanford U., Rockwell International, Ceramatec

Sodium/sulfur and lithium/iron sulfide batteries operate at temperatures of several hundred degress Celsius. 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

2. Metals and Alloys — 1983 $1200K

DOE Contact - A. Landgrebe (202) 252-1483
LBL, Eltech, Case-Western Reserve U., LLNL, LANL

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

3. Organometallic Compounds

1983
$500K

DOE Contact - A. Landgrebe (202) 252-1483
Case-Western Reserve U., Eltech Systems, Inc.

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

4. Polymers

1983
$200K

DOE Contact - A. Landgrebe (202) 252-1483
Sandia, U. of Pennsylvania, Castle, U. of Texas

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: Coatings, Films, Polymers

Chemical and Hydrogen Storage

5. High Temperature Electrolysis

1983
$270K

DOE Contact - M. Gurevich (202) 252-1507.
Westinghouse R&D Center Contact - Nick Maskalick (412) 256-2020

Electrochemical cells comprised of yttria-stabilized zirconia (electrolyte), sintered Sr-doped lanthanum manganite (anode) and nickel or cobalt zirconia cermet (cathode) are operated at temperatures in the 1000°C range for the purpose of characterizing voltage vs. current relationships during water vapor electrolysis. Tests are conducted over wide range of H_2/H_2O ratios at inlet and outlet of these cells. The project rationale is to develop base technology as will be applicable to far-term needs for renewable and abundant primary resource conversion to hydrogen which is a storable and transportable chemical and fuels commodity. Water vapor electrolysis promises a cost effective and highly efficient means for attaining dramatic improvements in water-splitting processes which will yield an environmentally benign energy-carrying product. Problems under investigation relate to achieving long-life performance at high reliability by developing stable materials in the oxidation and reduction environments at extreme temperatures. Successful characterization and design improvements will result in the development of modular electrochemical systems which can be interfaced with solar central receivers, fusion/nuclear systems and coal conversion systems in an economically acceptable manner consistent with future energy infrastructure needs.

Keywords: Zirconia Electrolyte, Electrolysis, Redox

6. Hydrogen Embrittlement of Pipeline Steels — 1983 $250K

DOE Contact - M. Gurevich (202) 252-1507
Battelle Columbus Contact - J. Holbrook (614) 424-4357

Pipeline steel materials under investigation include ASTM A516, ASTM A106B, and AP15L-X42 steels. The research includes experiments on both fracture-mechanics specimens and actual pipe sections which have shown that hydrogen gas can dramatically increase fatigue-crack growth rates by as much as a factor of 150. Experiments and analysis also have shown that the magnitude of fatigue-crack growth depends on pressure, hydrogen purity, the stress ratio and cyclic frequency. The rationale for this project derives from far-term projections associated with primary energy resource conversion, storage, and transport options which will utilize hydrogen technology. Hydrogen obtained from advanced water-splitting processes may be transported from remote and dispersed sites via available natural gas transmission and distribution networks; thus eliminating the capital intensiveness which would be associated with new dedicated pipelines for H_2 penetration of the future energy infrastructure. Current R&D thrusts aim toward identifying additives which will inhibit the effects of hydrogen embrittlement. Test procedures are similar to ASTM standard E647-81 except that constant crack-opening displacement amplitude rather than constant load amplitude is imposed on the specimens. The expected output is the preparation of a document which will serve as input to a Design/Operation Manual for pipeline designers concerned with hydrogen transmission.

Keywords: Pipeline Steel, Stress Ratio, Fatigue Crack, Hydrogen Transmission

7. Photovoltaics/Advanced Water Electrolysis Test — 1983 $600K

DOE Contact - M. Gurevich (202) 252-1507
Brookhaven National Laboratory Contact - A. Mezzina (516) 282-3920 and P. Metz (516) 282-4091

The solid polymer electrolyte water electrolysis systems utilize NAFION (a sulfonated Teflon material); molded carbon current collectors (a mixture of carbon and phenolic resin); and several binary and ternary oxygen evolution catalysts. The project will provide a "hands-on" opportunity for illustrating and evaluating the cost-performance benefits as may derive from future primary resource conversion options which will utilize state-of-the-art advances in water electrolysis. Consistent with the far-term thrust of the Chemical/Hydrogen Energy System Program, this test is the first of a series of projects which will examine base technology developments as they approach maturity. A mechanism is provided for cooperative interactions at the national and international level among industrial and academic investigators for the purpose of clearly defining needs for further state-of-the-art advances. Problems under investigation relate to establishing performance, cost and reliability factors as influenced by insolation, electricity costs, and water management requirements for SPE units. Data acquisition systems and controls will be utilized to determine voltage vs current relationships, hydrogen output, downtime (scheduled vs unscheduled, etc.). This project will clearly establish "design-to-cost" features of future resource conversion options and will attract other agencies such as NASA Kennedy Space Center and International Energy Agency in effecting cooperative programs to evaluate prospects for hydrogen production alternatives envisioned in the future.

Keywords: NAFION, Solid Polymer Electrolyte

8. Materials for Advanced High Temperature Molten Salt Storage — 1983 $95K

DOE Contact - M. Gurevich (202) 252-1507
SERI Contact - Werner Luft (303) 231-1202

Identification of materials that can be used as internal thermal insulation for high-temperature molten-salt storage, specifically for single tank thermocline storage at 900°C. Compatibility (corrosion rates and materials strength) of metal alloys and ceramics with high temperature molten salts (molten hydroxide, molten chloride, and molten carbonate) is being investigated. Coupons of each candidate material are immersed in the salts at 900°C for up to 18 days. The weight losses of coupons are measured and their condition assessed after immersion. The expected outputs are ceramic materials that can withstand 20 years of exposure to molten salt at 900°C. Metal alloys that will withstand exposure to molten salt at 850°C for 20 years.

Keywords: Alloys, Ceramics, Corrosion, Alternate Fuels, High-Temperature Service

Thermal Storage

9. Analysis of Zeolite Augmented Ice Storage — 1983 $40K

DOE Contact - Rufus Shivers (202) 252-1476
Pacific Northwest Laboratory 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

10. Geochemical Stability of Sandstones — 1983 $100K

DOE Contact - Rufus Shivers (202) 252-1476
Pacific Northwest Laboratory Contact - Landis Kannberg (509) 375-3919

Laboratory testing is being conducted to determine the effects of flow of 150°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

11. Formation and Dissolution of Gas Clathrates — 1983 $250K

DOE Contact - Imre Gyuk (202) 252-1480
ORNL Contact - Mark Ternes (615) 574-0749

Study of 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 storage of cool at thermodynamically more efficient temperatures 15-20°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

12. Chemically Bonded Ceramic Heat Storage Materials — 1983 $100K

DOE Contact - Imre Gyuk (202) 252-1480
MCA Inc. Contact - Dennis Brosnan (803) 843-6444

Conventional fired ceramic refractories for heat storage constitute 30% of a typical residential storage furnace cost principally because of the expensive energy intensive fabrication process required, i.e., firing temperature $\sim$ 2000°F. A much less expensive fabrication process, chemical bonded castable bricks, will be developed with heat storage characteristics equal to or greater than existing bricks. This will allow a U.S. industry to be developed because local raw materials (North Carolina or Washington Olivine) can be used and low capital investment fabrication equipment can be utilized. Research consists of choice of bonding materials, optimum size distribution of the olivine, addition of iron oxide for increased density, and fabrication techniques for large monolithic segments with cast integral heating elements.

Keywords: Olivine, Materials Characteristics

13. Composite High Temperature Thermal Storage Media — 1983 $445K

DOE Contact - Imre Gyuk (202) 252-1480
IGT Contact - Randy Petri (312) 567-3985

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°C and possibly a 858°C storage media will be developed.

Keywords: Composites, Materials Characteristics

14. Advanced Thermal Energy Storage Technologies Project — 1983 — $240K

DOE Contact - Imre Gyuk (202) 252-1480
Lawrence Berkeley Laboratory Contact - Elton J. Cairns (415) 486-5028

Basic research is being conducted on materials and systems that have the potential for minimal irreversible entropy losses, rapid transformation kinetics, and optimal thermal-material properties for use in thermal energy storage. Specific materials and systems under investigation are listed below under their corresponding subproject areas.

a. Materials with Abnormally High Heat Capacities or Large Entropy Change Reactions (Leo Brewer, Norman Phillips, Robert Connick)

The entropy increase associated with the neutralization of highly charged cations such as Mg^{2+}, VO^{2+}, Fe^{3+}, Sc^{3+}, Te^{3+}, Al^{3+}, Th^{4+} can be very large. The corresponding energy change associated with this process results in an abnormally large heat capacity.

A second project investigates the conversion of non-magnetic face-centered-cubic (f.c.c.) cesium to magnetic f.c.c. cesium as a model compound involving inner shell electron bonding. The approach to study this transition and its associated energy release is to measure the enthalpy of transformation as a function of pressure. The advantages that both of these systems offer for development of advanced energy storage systems is that the systems are homogeneous and do not involve a phase change but still have large potential energy storage capacities.

b. Solid State Radiative Heat Pump (Paul Berdahl)

The objective of this subproject 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.

c. Microparticles as an Advanced Medium for Heat Exchange and Catalysis (Arlon Hunt)

The focus of this subproject area 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: 1. Material Type: Catalyst, Metals, Semiconductors
2. Phenomena: Microstructure, Transformation
3. Techniques: Surface Characterization and Treatment
4. Application: Energy Storage

Mechanical Energy Storage

15. Directory of New Materials — 1983 $280K

DOE Contact - R. Shivers (202) 252-1488
ORNL Contact - J. Martin (615) 576-3977, LLNL

Compilation of the physical properties of newly developed high strength fibers from both manufacturers information and laboratory testing.

Keywords: High Strength Fibers, Materials Characterization

16. Prototype Flywheels — 1983 $80K

DOE Contact - R. Shivers (202) 252-1488
ORNL Contact - J. Martin (615) 576-3977
Garrett, AVCO, G.E., Owens-Corning

Prototype flywheel composites of kevlar, glass and graphite fibers with various matrix materials were fabricated with the purpose of maximizing energy storage density in a flywheel. Both nondestructive ultrasonic testing and radiographic techniques and burst tests were employed to evaluate the flywheels design and the mechanical properties of the materials in a specific flywheel configuration.

Keywords: Composites, Matrix Materials, Fibers, Flywheel

17. Elastomeric Storage — 1983 $140K

DOE Contact - R. Shivers (202) 252-1488
ORNL Contact - J. Martin (615) 576-3977, Eaton

Evaluation of elastomeric materials for energy storage through the fabrication and testing of prototype storage systems. Elastomers included both natural and synthetic rubbers. The emphasis of the testing was in fatigue property measurements.

Keywords: Elastomers, Materials Characterization

18. Superconducting Magnetic Energy Storage — 1983 $600K

DOE Contact - R. Shivers (202) 252-1488
LASL, U. of Wisconsin

The overall objective is to develop technology for small-scale (10 kWh) utility system stabilization devices. The major emphases are the development of a low-cost polyester-glass support structure for cryogenic service and the development of a high-purity aluminum stabilizer conductor. The system has been installed at the Tacoma substation of BPA.

Keywords: Superconductors, Glasses, Alloy Development

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 1983 in two projects, the Materials Project and the Tribology Project. The DOE contact for both projects is Jim Eberhardt (202-252-1484; FTS 252-1484). Both projects are managed for ECUT by the Oak Ridge National Laboratory (ORNL). The ORNL technical manager of both projects is Joe Carpenter (615-574-4571; FTS 624-4571). 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, coatings (metal, ceramic, and plastic), ceramic composites, and materials structures theory. Materials research in the Tribology Project is in the areas of wear of oil lubricated steels and the friction and wear of ceramics at high temperatures.

1. Ordered Metallic Alloys — 1983 $363K

DOE Contact - James Eberhardt (202) 252-1484
ORNL, (Contract W-7405-eng-0026), Contact - Chain Liu (615) 574-4459
Rensselaer, (ORNL Subcontract 19X-22217C), Contact - Norman Stoloff (518) 266-6436
NC State, (ORNL Contract Request 5391), 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

Ductile long-range ordered alloys based on the $(Fe,Ni)_3V$ system and ductile intermetallic alloys based on the Ni_3Al system 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 tensile properties (modulus, yield and ultimate strengths, and elongation) and the creep resistances are measured. Fatigue resistances and crack-growth behavior are measured at RPI; grain boundary diffusion at Lehigh; and wear resistances at Vanderbilt. At NC State, alloys based on mechanical alloying approaches are being prepared and investigated.

Keywords: Alloys, Long-Range Order, Intermetallics

2. Reactive Metallic Brazes for Ceramic-Ceramic and Ceramic-Metal Joints — 1983 $135K

DOE Contact - James Eberhardt (202) 252-1484
ORNL, (Contract W-7405-eng-0026), Contact - Artie Moorhead (615) 574-5153

Reactive brazing filler metals are being developed for joining SiC to SiC, partially stabilized ZrO_2 to ductile iron, and Al_2O_3 to Al_2O_3 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 — 1983 $102K

DOE Contact - James Eberhardt (202) 242-1484
The Norton Company, (ORNL Subcontract RFP 5133-86), Contact - James Hannoosh (617) 853-1000, ext. 3882

Generalized finite element models are being developed to predict the stress states existing in and near solid ceramic-ceramic and ceramic-metal joints of simple geometry. Butt-on-butt joints of two members each of rectangular cross sections and each of cylindrical cross sections are being modeled first. The purpose of the effort is to provide guidance as to what materials should and should not be joined in typical geometries.

Keywords: Ceramics, Metals, Joining, High Temperature Service

4. Assessment of Electromagnetic Joining of Ceramics — 1983 $41K

DOE Contact - James Eberhardt (202) 252-1484
DHR, Incorporated, (ORNL Subcontract 86X-547975V), Contact - Richard Silberglitt (703) 556-8660

The objective of this effort is to assess the technical feasibility of using electromagnetic radiation in the radio frequency (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. The work in fiscal year 1983 is strictly a design study to determine what ceramic-ceramic and ceramic-metal combinations might be joined in this way, in what configurations, and to conduct preliminary designs of the RF equipment needed. It is expected that the product of the fiscal year 1983 assessment effort will be a plan for experiments to be done in fiscal year 1984 and beyond.

Keywords: Ceramics, Metals, Joining, High Temperature Service

5. Recovery and Reuse of Plastic Scrap Via Separation and Bonding — 1983 $193K

DOE Contact - James Eberhardt (202) 252-1484
Plastics Institute of America, (ORNL Subcontract 9100), Contact - Lincoln Hawkins (201) 420-5552

The PIA is coordinating and participating in an effort with four 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 are being developed or acquired, used to produce laboratory test specimens, and the properties of the specimens measured. The use of the auto shred residue as a filler for polymer concretes and techniques for separating it into its constituents are also being investigated. Some binders identified in the laboratory scale tests are being used to produce large specimens from about five 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

6. Recovery and Reuse of Plastic Scrap Via Decomposition — 1983 $166K

DOE Contact - James Eberhardt (202) 252-1484
ORNL, (Contract W-7405-eng-0026), Contact - James Kinstle (615) 574-4571
University of Tennessee, (ORNL Subcontract 37X-73903V), Contact - James Kinstle (615) 974-3390

A technical assessment is being conducted to determine research and development needs 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 such products 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 at the Annual Meeting of the American Chemical Society in Washington, D.C. At ORNL, pertinent literature was reviewed to determine the scopes of further assessments to be done under subcontracts; RFPs for the assessment were being developed at the end of the fiscal year. At the University of Tennessee, literature reviews and limited experiments were conducted in the area of polymer decomposition via hydrolysis and solvolysis.

Keywords: Plastics, Recycle

7. Assessment of the Economic Viability of Recovery and Reuse of Plastic Scrap — 1983 $55K

DOE Contact - James Eberhardt (202) 252-1484
ORNL, (Contract W-7405-eng-0026), Contact - Randall Curlee (615) 576-4864

This is an initial assessment to determine if it appears that the recovery and reuse of plastic scrap in general will be economically viable over the next twenty years. Expected quantities and prices of various types of plastic scrap are predicted, current data on costs of various recycled plastics are compared to prices for similar products made from virgin materials. Initial results indicate that many plastics recovery and reuse techniques are and will be economically viable.

Keywords: Plastics, Recycle

8. Aging of Rigid Urethane Foam Insulation — 1983 $100K

DOE Contact - James Eberhardt (202) 252-1484
Massachusetts Institute of Technology, (ORNL Subcontract 9099), Contact - Leon Glicksman (617) 253-2233

A model to predict the aging of rigid (as opposed to blown-in) urethane foam insulation is being developed. Heat transfer and the diffusion of gases through the insulation are predicted as functions of plastic composition, foam-cell geometry and wall thickness, gas composition, and diffusion barriers. Model predictions are compared against data from accelerated aging tests at elevated temperatures.

Keywords: Insulation, Foam, Urethane

9. Plastic-Coated Low-Temperature Heat Exchangers — 1983 $33K

DOE Contact - James Eberhardt (202) 252-1484
Argonne National Laboratory, (ORNL Subcontract 12X-51959V), Contact - Paul Roach (312) 972-8146

The objective of this task is to identify thin, commercially available coatings for protection of low-cost heat exchanger surfaces used in gaseous effluent streams containing sulfuric acid fumes at temperatures below 400°F where the fumes will condense. Coatings 0.001 to 0.030 inches thick are applied to low carbon steel tubes which are given months of exposure in a laboratory corrosion loop.

Keywords: Plastic, Coatings, Corrosion

10. Materials by Design — 1983 $220K

DOE Contact - James Eberhardt (202) 252-1484
ORNL, (Contract No. W-7405-eng-0026), Contact - Joe Carpenter (615) 574-4571

The ultimate objective of this effort is to establish the technical feasibility of developing, experimentally verifying, and using mathematical models of certan transition interatomic processes and phenomena in order to have the predictive power to design and optimize practical engineering processes and materials. 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 near-term objective 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. An RFP was being issued at the end of the fiscal year for an assessment to address that near-term objective.

Keywords: Alloys, Metals, Ceramics, Coatings and Films, Joining

11. Cubic Boron Nitride and Diamond-Like Carbon Coatings — 1983 $60K

DOE Contact - James Eberhardt (202) 252-1484
ORNL, (Contract W-7405-eng-0026), Contact - Dave Stinton (615) 574-4556

The objective of this work is to explore the feasibility of producing cubic-boron nitride and diamond-like carbon coatings via plasma-assisted chemical vapor deposition (CVD) processes. Diamond is the hardest and cubic-BN is the second hardest substance known; practical low-cost coatings of such materials would have myriad applications in cutting and bearing applications.

Keywords: Coatings, Ceramics, Chemical Vapor Deposition, Engines, High Temperature Service, Refractory Liners

12. SiC-Whisker Reinforced Alumina — 1983 $72K

DOE Contact - James Eberhardt (202) 252-1484
ORNL, (Contract W-7405-eng-0026), Contact - George Wei (615) 574-5129

The objective of this effort is to prepare and evaluate alumina-matrix ceramic composites reinforced with short silicon carbide whiskers. Such composites should have strengths and toughnesses superior to those of unreinforced aluminas. Potential applications include advanced heat engines and cutting tools. This is a joint cooperative effort between ORNL and ARCO; ORNL is preparing and evaluating the specimens while ARCO is supplying the SiC whiskers.

Keywords: Ceramics, Composites, Erosion and Wear, High Temperature Service, Engines, Seals and Bearings

13. Magnetron-Sputtered Adherent Amorphous Metal Wear-Resistant Coatings — 1983 $30K

DOE Contact - James Eberhardt (202) 252-1484
Jet Propulsion Laboratory, (Interagency Agreement OR-21377), Contact - Satish Khanna (213) 354-4489 (FTS 792-4489)

The objective of this effort is to determine if it is possible to deposite an adherent amorphous metal coating onto a substrate. Amorphous metals are known to have "different" tribological characteristics than their crystalline forms, but, as they can usually only be produced in powder or ribbon form, it is difficult (if not impossible) to produce a very adherent amorphous metal coating since techniques involving heating tend to cause crystallization. In this work glassy (amorphous) coatings

of Mo-Ru-B and W-Re-B are deposited onto glass or metal substrates and the corrosion, resistance, friction coefficients, and wear rates are determined. Complementary to related work sponsored by Office of Industrial Programs.

Keywords: Amorphous Materials, Coatings and Films, Corrosion, Erosion and Wear, Physical Vapor Deposition

14. Instruments for Harsh Environments — 1983 $50K

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. FeCrAlY films are deposited onto iron-based substrates. A thin FeCrAlY oxide layer is thermally grown on the FeCrAlY film. A thermocouple junction (e.g., Pt/Pt-Rh) and electrical leads are sputtered onto the oxide. The oxide serves to electrically insulate the thermocouple from the FeCrAlY and the iron substrate while the FeCrAlY film insures adherence of the thermally grown FeCrAlY oxide to the iron substrate. The experimental work in this effort involves the preparation and testing of the sensors.

Keywords: Coatings and Films, Physical Vapor Deposition, Engines, High Temperature Service

15. Supercritical Fluid Equations of State — 1983 $10K

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 is 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 in fiscal year 1983 entails (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 dealing with the supercritical state.

Keywords: Separations

16. Coatings for High Temperature Energy Conversion Systems — 1983 $43K

DOE Contact - James Eberhardt (202) 252-1484
Lawrence Berkeley Laboratory, (ORNL Subcontract 41X-70342V), Contact - A. V. Levy (415) 486-5822

The objective of this effort are 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 include a variety of MCrAlY, 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 are tested to determine the friction and wear rates in a Falex 6 washer-or-disk wear tester modified to achieve 1400°F in air. Coatings are analyzed before and after testing to determine compositions, microstructure, surface finish, hardness, and failure mode.

Keywords: Alloys, Ceramics, Coatings and Films, Corrosion and Wear, Physical Vapor Deposition, Chemical Vapor Deposition, Engines

17. Laser Surface Modifications of Ceramics — 1983 $33K

DOE Contact - James Eberhardt (202) 252-1484
North Carolina State University, (ORNL Subcontract 19X-43377C), Contact - Jagdish Narayan (615) 574-5508

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 α- or β-SiC, Si_3N_4, or Al_2O_3 and then irradiated by pulsed lasers. Fracture strength and toughness, friction and wear behavior, fatigue resistance, microstructure and compositional variations are determined and related to the wavelength of the laser radiation, the pulse duration, and the energy density. The major output expected from this work is an initial determination of the effects of such treatment.

Keywords: Ceramics, Coatings and Films, Diffusion, Erosion and Wear, Surface Characterization and Treatment

18. Assessments of R&D Opportunities for ECUT In Superalloys and Metal Forming — 1983 $40K (FY '82 carry-over)

DOE Contact - James Eberhardt (202) 252-1484
DHR, Incorporated, (ORNL Subcontract 86X-17475V), Contact - Richard Silberglitt (703) 556-8660

This is an assessment to identify possible research and development opportunities appropriate for ECUT support in the areas of superalloys and metal forming. The study concluded that there were few good opportunities for ECUT in the area of superalloys because they are inherently expensive and very specialized materials best suited for military, not civilian, applications and because their development has been, and is being, well supported by DoD and NASA programs. However, the study concluded that the field of metal forming has been generally overlooked in recent years as a field for innovative development and, therefore, may be ripe for support of research sponsored by ECUT. One big need that emerged is the development of lubricants for the "warm-forming" region between about 600 and 1000°C.

Keywords: Metals, Alloys, Forming

19. Lubricant Qualities of the Constituents of Base Stock Oil — 1983 $195K

DOE Contact - James Eberhardt (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 uniquc micro-oxidation test. Chemical species produced during both tests are identified.

Keywords: Metals, Oils, Friction, Wear, Engines

20. Heats of Adhesion of Molecular Constituents of Base Stock Oils — 1983 $83K

DOE Contact - James Eberhardt (202) 252-1484
Martin Marietta, (ORNL Subcontract 86X-47976C), Contact - Frances Lockwood (301) 247-0700, ext. 285

The objective this this task is to measure the heats of adhesion of separated fractions of base stock oils on bearing steel. Heats of adhesion are measures of the tenacity with which a substance adheres to and, therefore, can protect a surface. Droplets of base stock oil fractions, supplied by NBS, are deposited onto a well characterized surface of 52100 or M50 bearing steel immersed in water and the angle of wetting of the droplet on the surface is measured. The heat of adhesion of the droplet is calculated through theory from the measured angle of wetting. The goal is to relate the measured heats of adhesion to friction and wear and oxidative stability tests run at NBS.

Keywords: Metals, Lubricants, Films, Wear, Surface, Characterization, Engines

21. Friction and Wear of Ceramics at Elevated Temperatures — 1983 $211K

DOE Contact - James Eberhardt (202) 252-1484
Advanced Mechanical Technology, Inc., (ORNL Subcontract 86X-17479C), Contact - Forest Carignan (617) 964-2042
ORNL, (Contract No. W-7405-eng-0026), Contact - Charlie Yust (615) 574-4812

Pin-on-disk tests of high technology ceramics of current interest are conducted at AMTI to determine apparent friction coefficients and wear rates. The worn pins and disks are analyzed at ORNL 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°F at speeds of 1 foot per second and nominal pressures above 40 pounds per square inch (2 lb normal load on 1/4-inch diameter pin rounded on end to a 1/4-inch radius).

Keywords: Ceramics, Friction, Wear

22. Observations of "Hot Spots" on Ceramics and Development of Theory — 1983 $25K

DOE Contact - James Eberhardt (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 of 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, which understanding should lead to improvements in the wear resistances of ceramics.

Keywords: Ceramics, Erosion and Wear

23. Assessment of X-ray Methods for Investigations of Ceramic Wear Surfaces — 1983 $10K

DOE Contact - James Eberhardt (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

24. Solid Lubricants Deposited From the Gas Phase — 1983 $25K

DOE Contact - James Eberhardt (202) 252-1484
The Pennsylvania State University, (ORNL RFP in progress), Contact - Larry Duda (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°F.

Keywords: Coatings and Films, Chemical Vapor Deposition

25. Ion Implantation of Zirconia — 1983 $25K

DOE Contact - James Eberhardt (202) 252-1484
Georgia Institute of Technology, (ORNL RFP in progress), Contact - Joe Cochran (404) 894-2851

The object of this work is to determine if it is feasible to toughen the surface of partially stabilized zirconia by implanting excess Zr^+ ions. The surface of cubic-ZrO_2 (stabilized with 9.8 mole % Y_2O_3) is implanted with 200 KeV Zr^+ ions at doses of 1.5, 3, and 6 X 10^{16} ions/cm^2. The implanted specimens are heat treated in air for 4 hours at 1200, 1300, and 1400°C. RHEED, microhardness, fracture toughness, and wear measurements are made before and after heat treatment to determine if tetragonal or monoclinic precipitates have formed from the implanted zirconia and to determine any changes in the properties measured.

Keywords: Ceramics, Ion Implantation

26. Tribological Testing of Ceramics Under Oscillatory Sliding at High Temperatures — 1983 $25K

DOE Contact - James Eberhardt (202) 252-1484
The Pennsylvania State University,
Contact - Norm McMillan (814) 863-0180
DHR, Incorporated Contact - Le Khac Hien (703) 556-8660

A special rig is being built at Penn State to perform friction and wear tests of ceramics at elevated temperatures under conditions of linear oscillatory sliding similar to the conditions expected to be encountered at the interface between the piston ring and cylinder liner of the adiabatic diesel engine. The Carborundum Company is supplying samples of sintered α - SiC, partially stabilized zirconia, an ultra-fine grain Si/SiC composite, a SiC/solid lubricant composite, and a sialons. This work is being jointly funded with the U.S. Army Tank and Automotive Command (TACOM) through a contract with Carborundum.

Keywords: Ceramics, Friction, Wear

27. Identification of Tribological Research and Development Needs for Lubrication of Advanced Heat Engines — 1983 $50K

DOE Contact - James Eberhardt (202) 252-1484
Technology Assessment and Transfer, Inc., (ORNL RFP 5484), Contact - Larry Fehrenbacher (301) 856-1022

This is an assessment to identify research and development needed to provide the base technology for lubrication of advanced heat engines. Both liquid and solid lubricants are considered. Emphasis is on the conditions found in an adiabatic diesel.

Keywords: Lubrication, Heat Engines

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.

1. High-Voltage Breakdown Strengths of Insulating Gas — 1983 $600K

DOE Contact - Russell Eaton (202) 252-4844
ORNL, (Contract No. W-7405-eng-0026), Contact - Lucas Christophorou (615) 574-6199

Analyze, from a fundamental physiochemical point of view, the factors influencing the breakdown strengths of gaseous dielectrics and seek mixtures of gases with superior insulating properties.

Keywords: Insulators (Gaseous), Energy Transmission

2. Aging Process in Solid Dielectrics — 1983 $250K

DOE Contact - Russell Eaton (202) 252-4844
Battelle-Columbus, (Contract No. EC-77-C-01-5100), Contact - Mike Epstein (614) 424-6424

Developing an understanding of insulating aging characteristics of solid dielectrics used for underground transmission cable systems. Develop and verify short-term cable test procedures which will accurately predict insulation life for its rated service.

Keywords: Insulators, Organic Polymers, Energy Transmission

3. Threshold and Maximum Operating Electric Stresses for Selected High Voltage Insulations — 1983 $250K

DOE Contact - Russell Eaton (202)252-4844
Cable Technology Lab, (Contract No. DE-AC02-80RA-50156), Contact - Carlos Katz (201) 846-3220

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

4. AC Superconducting Power Transmission Cable Development — 1983 $1,450K

DOE Contact - Russell Eaton (202) 252-4844
Brookhaven National Laboratory, (Contract No. ET-76-C-02-0016), Contact - E. Forsyth (516) 282-4676

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). Develop optimized polymeric film tapes for superconducting and conventional cable systems.

Keywords: Superconductors, Insulators (Organic Polymers), Energy Transmission

OFFICE OF BUILDING ENERGY RESEARCH AND DEVELOPMENT

The Office of Building Energy Research and Development 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 programs. 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.

1. Unguarded Flat Insulation Nichrome Wire Screen Tester — 1983 $75K

DOE Contact - Bill Gerken (202) 252-9191
ORNL Contact - David McElroy (615) 574-5976

Materials under investigation include mineral fiber board, 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

2. Settled Density Studies of Loose-Fill Insulation — 1983 $75K

COE 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

3. Assessment of Reflective Insulation Material — 1983 $25K

DOE Contact - Bill Gerken (202) 252-9191
ORNL Contact - David McElroy (615) 574-5976

Identification of current issues associated with reflective insulation including technical assessment of reflective properties of multilayered materials fabricated from aluminum sheets. Development of a calculational model for determination of thermal resistance properties for heat flow in various directions.

Keywords: Aluminum, Low Emittance Materials

4. Heat Flow Modeling — 1983 $75K

DOE Contact - Bill Gerken (202) 252-9191
ORNL Contact - David McElroy (615) 574-5976

(a) Mathematical modeling of heat transfer along longitude and radial coordinates. One dimensional heat flow studies in various materials being undertaken and calculation of errors associated with edge heat loss effects also considered.

(b) Physical description of heat transfers in a material with respect to "apparent" thermal conductivity. Detailed study of factors that contribute to heat transfer phenomena.

Keywords: Heat Transfer, Heat Flow Modeling

5. Technical Information Exchange — 1983 $50K

DOE Contact - Bill Gerken (202) 252-9191
ORNL Contact - David McElroy (615) 574-5976

Development and dissemination of an improved and enhanced technical data base on insulation science and technology via extensive interaction with community of scientists and engineers.

Keywords: Technical Data Base, Insulation Science

6. Improved Standard Reference Materials — 1983 $150K

DOE Contact - Bill Gerken (202) 252-9191
National Bureau of Standards Contact - Brian Rennex (301) 921-3501

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

7. Gas Diffusion and Effective Conductivity of Foam Insulation Versus Age — 1983 $90K

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

8. Corrosiveness of Thermal Insulating Materials — 1983 $30K

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

9. Smoldering Combustion Hazards of Thermal Insulation Materials — 1983 $50K

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

10. Environmental Cycling of Cellulosic Insulation — 1983 $25K

DOE Contact - Bill Gerken (202) 252-9191
National Bureau of Standards Contact - Sanford Davis (301) 921-3744

Cellulosic insulation is being investigated to determine the effect of temperature and relative humidity on the smoldering and critical radiant flux performance of manufactured products treated for fire retardancy. Little is known about the effect of climatic conditions on the permanency of retardant chemicals over the period of their useful life in building applications. Tests are conducted in an environmental chamber which exposes test specimens to simulated temperature and humidity conditions considered applicable to attic conditions in eleven U.S. cities. The specimens contain differing fire retardant formulations, in accordance with industry recommendations. Following environmental exposure cycles, specimens are subjected to smoldering combustion and critical radiant flux tests, to determine any changes from their baseline performance. The results of this study will be published in a technical report.

Keywords: Building Insulation, Environmental Testing, Smoldering Combustion

11. Condensing Heat Exchanger Systems — 1983 $450K

DOE Contact - Danny C. Lim (202) 252-9130
Brookhaven National Laboratory, (Subcontract No. 490885), Contact - Bud Woodworth (516) 282-2361

Investigation of materials feasible for use in heat exchangers for condensing oil- and gas-fired heating systems. Ceramics, stainless steel, and plastic materials are being experimentally evaluated for corrosion rates and stress resistance properties in corrosive condensate environments. Low cost materials capable of 20 year service life are being sought.

Keywords: Corrosion, Materials Characterization, Ceramics, Plastics, Coatings, Metallics

12. Advanced Insulation for Appliances — 1983 $128K

DOE Contact - Ronald Fiskum (202) 252-9130
ORNL Contact - Fang Chen, D.L. McElroy (615) 574-0712

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^2BTU in @200F. To evaluate the thermal conductivity of materials or combinations of materials that are potentially suitable for advanced insulation, and to develop the best transfer theory governing novel insulation concepts.

Keywords: Conductivity, Material Characterization

13. Absorption Fluid Pairs Research — 1983 $200K

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. To develop a methodology for screening characterizing and selecting novel fluid pairs and ternary mixtures for advanced absorption cycles. To explore selected materials for corrosion effects and compatibility with existing and novel fluid pairs.

Keywords: Absorption, Fluid Pairs, Corrosion, Heat Pump

14. Non-Azeotropic Refrigerant Mixtures — 1983 $550K

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. To develop computer codes for design and investigative purposes to enhance the understanding of the operational characteristics of non-azeotropic refrigerant mixtures. To identify necessary modifications to the system for enhanced compatability with various mixtures. To test and evaluate novel systems and components. To produce mixture properties data.

Keywords: Refrigerants, Refrigeration Systems

15. Mercury Isotope Separation Process — 1983 $220K

DOE Contact - Robert Boettner (202) 252-9136
GTE Sylvania Contact - Bill Staubitz (617) 777-1900

The material under investigation is Mercury (Hg) and the various isotopes that are used as a fill gas in discharge lamps to maintain the discharge. The applied research effort is aimed at determining the efficiency improvement of fluorescent lamps that have altered isotope compositions and developing an efficient and high capacity isotope separation process that would enable the retrieval of selected isotopes from a natural composition of mercury. The problems under investigation are identification of efficiency improvements, identification of an effective separation process, construction and operation of a laboratory scale reactor and improvement of separation process efficiency. The process used for the isotope separation is a photochemical technique that selectively combines the desired isotope through the use of a highly selective optical filter with an appropriate reactant. The expected output of this project is the identification of efficiency improvements in altered composition fluorescent lamps and the development of an effective separation process.

Keywords: Metals, Isotope Separation

16. Mercury (Hg) Isotope Enrichment — 1983 $140K

DOE Contact - Robert Boettner (202) 252-9136
Lawrence Berkeley Laboratory Contact - Sam Berman (415) 486-5682

The material under investigation is the element mercury (Hg) and the various isotopes of Hg 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 effects 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

17. Zeeman Effect on Lamp Gas Plasma — 1983 $75K

DOE Contact - Robert Boettner (202) 252-9136
Lawrence Berkeley Laboratory Contact - Sam Berman (415) 486-5682

The specific material under investigation is Mercury (Hg) and the isotopes of Hg 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

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.

Division of Waste Energy Reduction

This division conducts research to recover high-temperature waste heat and to upgrade low grade waste heat for industrial applications; combustion research to develop systems for high efficiency conversion of industrial heaters and boilers to solid fuels; research to improve utilization of industrial wastes as fuels, feedstocks, or recovered materials.

1. High Temperature Ceramic Materials Development for Industrial Waste Heat Recovery — 1983 $500K

DOE Contact - James W. Osborne (202) 252-2085
ORNL Contact - A. Shaffhauser (615) 574-4826

Specific Materials Under Investigation: Silicon Carbide, Zirconia, Alumina, Oxide Mixtures, etc.

There is an extremely limited technology base for ceramic materials and material coatings which exhibit required corrosion resistance, good mechanical properties and low cost to enable construction of advanced industrial heat exchanger/heat recuperator designs to operate continuously in corrosive furnace exhaust streams at temperatures exceeding 1500°F and where bulk material temperatures of 2000 to 2600°F may be reached during the equipment operating life. Problems under investigation include: ceramic coatings and improved materials development; low cost, high purity alpha silicon carbide powder synthesis; low cost alpha silicon carbide tube extrusion fabrication development. Techniques being used include: coating CVD, plasma spraying, and sputtering. Develop various structural toughening techniques for high corrosion resistance, high strength and thermal shock resistance. Pursue a continuous rotary kiln calciner design to produce high purity SiC powders. Fabrication techniques include nonthermoplastic bonder extrusion process for large diameter (up to 6 inch diameter) open-end and closed-end sintered alpha SiC tubes. Expected outputs are: identify and select coating materials, develop test and fabrication plans including matrix of coating materials, coating methods, and substrate materials and fabricate coated ceramic specimens. Build and test a rotary kiln furnace, synthesize SiC powders with various reactants, cover gases and sintering aids. Determine effect of variations and analyze sample powders. Produce prototype 1 inch diameter SiC tube samples and assess technical feasibility of nonthermoplastic binder extrusion process.

Keywords: Ceramics, Coatings, Composites, Chemical Vapor Deposition, Sintering, Sputtering, Corrosion, Microstructure, Strength

2. High Temperature Ceramic Data Base — 1983 $900K

DOE Contact - James W. Osborne (202) 252-2085
Idaho Operations Office, Contact - W. H. Thielbahr (208) 526-0682
Idaho National Engineering Laboratory Contact - C. H. Allen (208) 526-9250

High temperature and corrosive constituents in industrial furnace waste exhaust streams (gas) cause durability of the materials and the heat recovery structure and components to be the major limitations to performance reliability and life of ceramic heat exchanger technology. Problems under investigation include: establish an industrial data base of information on lifetime limiting material properties of as fabricated ceramic material heat exchanger components; determine material physical and mechanical properties; microstructure characteristics, flaw sizes, distributions and failure mechanisms, waste streams environmental effects on ceramic materials shapes. Develop a methodology to accurately predict ceramic heat exchanger service lifetimes. Develop material property requirements for advanced heat exchanger components designs, i.e., seals, joints, distributor plates and heat transfer enhancement design techniques. Techniques being used include: heat exchanger proof testing, material testing methods including sophisticated NDE techniques, stress-corrosion testing methods (pre-stressed split-rings) for lifetime and reliability prediction information. Fiber reinforced, glass matrix composite joining designs, silicon carbide fluid bed distributor plates using hole or slot design configurations and advanced seal designs. A heat exchanger technology base will be established for development of new heat recovery equipment and designs. Feasibility of advanced ceramic as fabricated heat exchanger component testing methods will be established through test confirmation of material failure prediction techniques and detailed ceramic heat exchanger geometries/waste stream characterization.

Keywords: Ceramics, Composites, Glasses, Nondestructive Evaluation, Corrosion, Joining, Microstructure, Strength, High Temperature Service, Seals

Division of Improved Energy Productivity

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.

1. Corrosion Resistant Amorphous Metallic Coatings — 1983 $208K

DOE Contact - R. G. Massey (202) 252-2079
Jet Propulsion Laboratory Contact - Satish K. Khanna (213) 354-4489

Magnetron sputtering technique will be used to deposit amorphous metallic alloys; of interest initially are $FeCr_{10}P_{13}C_7$, $FeMoCr_3P_{13}C_7$, and $(Mo_{0.6}Ru_{0.4})_{82}B_{18}$. These alloys have demonstrated high resistance to corrosion but not as coatings, an application that would be of significant benefit in the chemicals processing industries. Problems being investigated include the technique for depositing a hole-free film on flat and on complex shapes of industrial interest, adhesion to the substrate, and crystallization temperatures. Expected output is a report on the laboratory studies. See complementary work on wear resistant coatings under the ECUT program.

Keywords: Alloys, Amorphous Materials Coatings and Films, Metals, Corrosion, Erosion and Wear, Chemical Vapor Deposition, Physical Vapor Deposition, Sputtering, High Temperature Service

OFFICE OF VEHICLE AND ENGINE R&D

The Office of Vehicle and Engine R&D (OVERD) 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 utilitzation.

Another, the Advanced Materials Development Program, is to establish an industrial technology base capable of providing reliable and cost-effective structural ceramics for application to advanced heat engines. Project management responsibliity 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 Program (Advanced Materials Development Program) has been assigned to the Oak Ridge National Laboratory (ORNL). The Army Materials and Mechanics Research Center (AMMRC) support is now part of the Ceramic Technology Program 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 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/processing; data base/life prediction; and design methodology. To support the advanced material work conducted under this and other research programs, a High Temperature Material Laboratory (HTML) is being constructed at ORNL.

Key elements of each program are organized and described briefly in the following. Robert B. Schultz is the DOE contact, (202) 252-8055, for overall coordination of the following OVERD material projects unless otherwise noted.

1. Static Fatigue Behavior of Toughened Ceramics — 1983 — $175K

ORNL Contact - V.J. Tennerey (615) 574-5123

The objective of this ORNL in-house experimental task is to determine the static fatigue life characteristics of partially stabilized zirconia and dispersion toughened alumina as a function of temperature.

Keywords: Ceramics, Microstructure, Strength, Transformation, High Temperature Service

2. Thermal Wear Coatings — 1983 $180K

ORNL Contact - V. J. Tennery (615) 574-5123

The objectives of this ORNL in-house task are to determine the processing requirements and resultant structures of stabilized zirconia coatings on engine alloy substrates using CVD and sol-gel techniques, and to assess coating technology needs for advanced heat engines.

Keywords: Coatings and Films, Chemical Vapor Deposition, Engines

3. Ceramic Composites — 1983 $190K

ORNL Contact - V. J. Tennery (615) 574-5123

An ORNL in-house experimental effort involves processing and mechanical properties of dispersion toughened SiC and transformation toughened alumina/zirconia composites.

Keywords: Composites, Near Net Shape Processing, Transformation, High Temperature Service

4. SiC Powder Synthesis — 1983 $120K

ORNL Contact - V. J. Tennery (615) 574-5123

An ORNL in-house experimental effort has the objective of investigating SiC powder synthesis flow sheets to produce sinterable powder superior to state of the art.

Keywords: Ceramics, Sintering, Near Net Shape Processing

5. Characterization of Chrome Oxide Based Ceramic Coatings for Advanced Heat Engines — 1983 $120K

ORNL Contact - E. L. Long, Jr. (615) 574-5172
Cummins Contact - Gordon L. Starr (812) 378-7244

A subcontract has been placed with Cummins Engine Company, Inc., Columbus, Indiana, to characterize the microstructure and mechanical properties of chrome oxide base ceramic coatings on cast iron cylinder liners for adiabatic diesel engines. The coatings will be characterized as a function of coating conditions before and after engine testing.

Keywords: Coatings and Films, Erosion and Wear, Engines

6. High Temperature Coating Study to Reduce Contact Stress Damage of Ceramics — 1983 $75K

ORNL Contact - D. Ray Johnson (615) 576-6832
Garrett Contact - D. W. Richerson (602) 231-4666

A subcontract is being placed with Garrett Turbine Engine Company, Phoenix, Arizona, to investigate physical vapor deposition (PVD) fully stabilized zirconia coatings on silicon carbide and silicon nitride ceramics for use in advanced heat engines. The purpose of the coatings is to reduce strength degradation due to static contact stresses and sticking.

Keywords: Coatings and Films, Physical Vapor Deposition, Engines, High Temperature Service

7. Studies of Dynamic Contact of Ceramics and Metals for Advanced Heat Engines — 1983 $120K

ORNL Contact - E. L. Long Jr. (615) 574-5172

ORNL is in the process of awarding a competitively bid subcontract to investigate the friction and wear properties of specific ceramics and metals being considered for use in advanced heat engines.

Keywords: Surface Characterization and Treatment, Erosion and Wear, Ceramics, Engines

8. Processing of Sinterable Transformation Toughened Ceramics — 1983 $120K

ORNL Contact - P. F. Becher (615) 574-5157

ORNL is in the process of contracting an experimental effort for the development of synthesis of high-purity, pressureless-sinterable powders of partially stabilized zirconia (PSZ) or of a mixture of PSZ and an appropriate matrix material.

Keywords: Ceramics, Sintering, Microstructure, Transformation

9. Experimental Evaluation of Environmental Effects in Toughened Ceramics — 1983 $100K

ORNL Contact - M. K. Ferber (615) 576-6740

ORNL is in the process of contracting an experimental effort to evaluate the effects of combustion product water vapor on slow crack growth in commercially available PSZ and ceramic matrix/PSZ composites.

Keywords: Ceramics, Microstructure, Transformation, Engines

10. Synthesis of High Purity Sinterable Silicon Carbide (SiC) and Silicon Nitride (Si_3N_4) Powders — 1983 $250K

ORNL Contact - E. L. Long Jr. (615) 574-5172

ORNL is in the process of awarding two competitively bid subcontracts for the development of low cost, high purity sinterable silicon carbide and silicon nitride powders. Contractor selections will be made in early FY 1984.

Keywords: Ceramics, Sintering

11. Development of Ceramic Matrix Composites — 1983 $360K

ORNL Contact - D. Ray Johnson (615) 576-6832

ORNL is in the process of contracting three industrial development efforts to develop ceramic matrix composites toughened with whiskers, short fibers, or particulates. The composites must be fabricable by near-net-shape processes.

Keywords: Composites, Near Net Shape Processing, Microstructure, Engines

12. Sintering of Silicon Nitride — 1983 $135K

ORNL Contact - D. Ray Johnson (615) 576-6832
AMMRC Contact - George Gazzo (617) 923-5410
GE Contact - C. D. Greskovich (518) 345-8691

The Army Materials and Mechanics Research Center, Watertown Arsenal, Massachusetts, has both an in-house and a subcontracted (General Electric Company, Schenectady, New York) effort on developing improved sintering processes for silicon nitride ceramics for high temperature applications.

Keywords: Ceramics, Sintering, High Temperature Service, Strength

13. Advanced Transformation Toughened Ceramics — 1983 $135K

ORNL Contact - D. Ray Johnson (615) 576-6832
AMMRC Contact - L. J. Schider and R. N. Katz (617) 923-5415
U of Michigan Contact - T. Y. Tien (313) 764-9449

The Army Materials and Mechanics Research Center has closely related in-house and subcontracted experimental tasks. The in-house work has the objective of defining the extent and magnitude of overaging and loss of strength at long times at high temperature in transformation toughened zirconia. A subcontract is in place at the University of Michigan to develop toughened ceramic alloy systems which will not be susceptible to overaging at high temperatures.

Keywords: Ceramics, Microstructure, Strength, Transformation, High Temperature Service

14. Component Life Prediction Methodology — 1983 $105K

ORNL Contact - D. Ray Johnson (615) 576-6832
AMMRC Contact - E. M. Lenoe (617) 923-5427

The Army Materials and Mechanics Research Center has an ongoing in-house effort on the development of the DOE/AMMRC code for component life prediction.

Keywords: Microstructure, Strength, High Temperature Service

15. Experimental Life Testing — 1983 $220K

ORNL Contact - D. Ray Johnson (615) 576-6832
AMMRC Contact - E. M. Lenoe (617) 923-5427
Ford Contact - R. K. Govila (313) 323-1742

The Army Materials and Mechanics Research Center has a subcontract with Ford Motor Company that encompasses design and evaluation of ceramic-metal joints, materials properties determination, component testing, analysis, and validation of design methodology.

Keywords: Ceramics, Strength, High Temperature Service

16. Time Dependent Properties of Structural Ceramics — 1983 $90K

ORNL Contact - D. Ray Johnson (615) 576-6832
AMMRC Contact - G. D. Quinn (617) 923-5258

The Army Materials and Mechanics Research Center has an in-house experimental program to characterize the time dependence under load of the strength of new high performance ceramics. The evaluation is done by stepped temperature stress rupture testing over a wide range of stresses and temperatures.

Keywords: Ceramics, Strength, High Temperature Service

17. Transformation Toughened Ceramics — 1983 $183K

DOE Contact - Edgar Gregory (202) 252-8055
NASA Contact - Richard B. Lancashire (216) 422-4000, ext. 489
General Electric Company, (NASA Subcontract DEN 3-323), Contact - Solomon Musikant (215) 962-5825

The objective of this effort is to demonstrate the feasibility of applying transformation toughening (TT) to ceramics for application in advanced heat engines. Three ceramic systems (mullite, aluminum, and SIALON) will be investigated. Alloys of HfO_2-ZrO_2 will be used as the toughening agents. Processing parameters will be optimized, specimens will be fabricated, and the materials will be characterized.

Keywords: Ceramics, Transformation Toughening

18. Joining of Ceramics — 1983 $200K

DOE Contact - Edgar Gregory (202) 252-8055
NASA Contact - Richard B. Lancashire (216) 433-4000, ext. 489
ORNL, (NASA Subcontract C-74148-D), Contact - A. J. Moorhead (615) 574-5153

The objective of this task is to develop and characterize brazing filler metals suitable for making ceramic-to-ceramic and ceramic-to-metal brazements for service at elevated temperatures and at high stress levels in the environments of advanced heat engines. The effort includes the formulation and melting of small quantities of experimental brazing filler metals; evaluation of the wetting and bonding behavior of these filler metals on Al_2O_3, partially-stabilized zirconia, and alpha SiC

in a sessile drop apparatus; and determine the short- and long-term elevated temperature compatibility of the brazements in typical heat-engine environments.

Keywords: Ceramics, Joining

19. Dispersion Toughened Ceramics — 1983 $249K

DOE Contact - Edgar Gregory (202) 252-8055
NASA Contact - Richard B. Lancashire (216) 433-4000, ext. 489
ORNL, (NASA Subcontract C-72801-D), Contact - A. J. Moorhead (615) 574-5153

This effort involves the development and characterization of ceramic matrix composites containing a dispersed metallic phase. Al_2O_3 and ZrO_2 will be used as matrices. Submicron-sized metal particles (Cr, Ni, Pt) will be dispersed in the ceramic matrices. Processing studies (powder preparation, densification, and heat treatment) and detailed measurement of mechanical and physical properties (strength, fracture toughness, thermal shock resistance, thermal expansion, and thermal conductivity) will be made. This effort will also include development of sol-gel powder synthesis techniques for the necessary powders and the densification of the powder without degradation of the dispersed phases.

Keywords: Ceramics, Composites

20. Development of Thermal Barrier Coatings — 1983 $87K

DOE Contact - Edgar Gregory (202) 252-8055
NASA Contact - Murray M. Bailey (216) 433-4000, ext. 5181
Allison Gas Turbine Operations, (NASA Subcontract DEN 3-326), Contact - David L. Clingman (317) 242-4535

The objective of this effort is to develop a thermal barrier coating (TBC) with enhanced durability for application in advanced diesel engines. Test specimens of at least three yttria-stabilized zirconia TBC systems will be prepared using automated plasma spray equipment. The specimens will be screened for thermal shock/fatigue resistance, ranked according to erosion resistance, and evaluated for corrosion/oxidation resistance. The most promising TBC system will be applied to valves, fire deck, and piston dome of a single-cylinder diesel engine for evaluation.

Keywords: Ceramics, Coatings, Thermal Barrier

21. Ceramic Component Technology — 1983 $196K

DOE Contact - Saunders Kramer (202) 252-8000
NASA Contact - T. J. Miller (216) 433-4000, ext. 6153

Development and evaluation of advanced techniques for fabricating and evaluating ceramic components are the targets of this project. Ceramic fabrication by hot isostatic pressing (HIP) and nondestructive evaluation (NDE) by techniques such as acoustic microscopy are being investigated.

Keywords: Ceramics and Glasses, HIP, NDE

22. Cast Iron Alloy Containing Nonstrategic Elements — 1983 $175K (carry-over from FY 82)

DOE Contact - Patrick Sutton (202) 252-8012
NASA Contact - C. M. Scheuermann (216) 433-4000, ext. 398
United Technologies Research Center, (NASA Subcontract DEC 3-282), Contact - F. D. Lemkey (203) 727-7318

The objective of this program is to identify a ferrous alloy, for the automotive Stirling engine cylinder and regenerator housings, which contain only nonstrategic materials. Alloy selection is based on the multi-component Fe-Cr-Mn(Mo)-Al-C(N) system which contains austenitic iron solid solution (8) matrices reinforced by finely dispersed carbide (carbo-nitride) phases.

Keywords: Alloy Development and Alternative Materials, Iron-Based Alloys, Material Properties

23. Improved Cast Cylinder Alloys — 1983 $491K (carry-over from FY 80)

DOE Contact - Patrick Sutton (202) 252-8012
NASA Contact - C. M. Scheuermann (216) 433-4000, ext. 398
AiResearch Casting Company, (NASA Subcontract DEN 3-234), Contact - M. Woulds (213) 323-9500, ext. 6905

The objective of this work is to develop and evaluate castable iron-based alloys for Stirling engine application which will meet performance requirements and reduce both cost and strategic material usage. Modifications to existing commercial or experimental castable alloys will be explored in order to develop materials which will allow heater head operating temperatures as high as 820°C.

Keywords: Alloy Development and Alternative Materials, Iron-Based Alloys, Material Properties

24. Advanced Materials - Intermetallic Components Processing — 1983 $200K

DOE Contact - Patrick Sutton (202) 252-8012
NASA Contact - Joseph R. Stephens (216) 433-4000, ext. 6676

Novel processing techniques will be investigated to produce iron and nickel aluminides in large quantities. These high melting point, low cost compounds offer potential for good high temperature strength and oxidation resistance, but are currently limited by lack of low temperature ductility. Processing variables will be investigated to overcome this deficiency.

Keywords: Alternate Materials, Advanced Materials, Intermetallic Compounds

25. Ceramic Durability Evaluation — 1983 $126K

DOE Contact - Saunders Kramer (202) 252-8000
NASA Contact - Sunil Dutta (216) 433-4000, ext. 6111
Garrett Turbine Engine Company, (NASA Subcontract DEN 3-27), Contact - K. W. Benn (602) 231-4373

The aim of this project is to assess the capability of materials to perform satisfactorily at the temperatures and exposure times required for automotive turbine engines. Commercially available ceramic materials (silicon carbide and silicon nitride) are being evaluated under extended thermal exposures of up to 2500°F for 3500 hours.

Keywords: Ceramics and Glasses, Silicon Carbide, Silicon Nitride

26. Long Term Stability and Properties of Zirconia Ceramics — 1983 $136K

DOE Contact - Edgar Gregory (202) 252-8055
NASA Contact - Richard B. Lancashire (216) 433-4000, ext. 489
IIT Research Institute, (NASA Subcontract DEN 3-305), Contact - David C. Larsen (312) 567-4437

Physical, mechanical, and thermal properties of commercial and developmental zirconia ceramics are being characterized over a temperature range spanning the operating temperatures of diesel engines. Characterization will include measurement of flexure strength, fracture toughness, thermal expansion, thermal diffusivity, thermal shock, creep, elastic modulus, and stress rupture in the as-received condition. Properties will be measured at 25°, 500°, 750°, and 1000°C. Microstructural analysis, thermal expansion, flexure strength, fracture toughness, and creep will also be measured after 2000 hours exposure to air at 1000°C.

Keywords: Ceramics, ZrO_2

27. High Temperature Ceramic Interface Study — 1983 $92K

DOE Contact - Edgar Gregory (202) 252-8055
NASA Contact - Richard B. Lancashire (216) 433-4000, ext. 489
Garrett Turbine Engine Company, (NASA Subcontract DEN 3-324), Contact - David W. Richerson (602) 231-3659

The objective of this study is to evaluate transformation toughened zirconium oxide (TIZ) under realistic contact conditions typical of adiabatic diesel engines. Measurements of coefficient of friction and material strength retention as a function of normal load, contact geometry, and temperature will be accomplished for sliding contact conditions. Material characteristics such as strength, fracture toughness, and surface finish will be correlated with sensitivity to contact damage.

Keywords: Ceramics, ZrO_2

28. Friction and Wear Characteristics of Load Bearing Materials — 1983 $160K

DOE Contact - Edgar Gregory (202) 252-8055
Westinghouse R&D Center, (NASA Subcontract DEN 3-346), Contact - David J. Boes (412) 256-7387

The objective of this program is to determine the friction and wear characteristics of materials considered as candidates for use in high efficiency heavy duty diesel engines. Specific carbide, nitride, and oxide materials will be evaluated under loads and temperatures anticipated for an uncooled diesel engine. Similar and dissimilar

combinations of materials will be compared. Also, friction and wear characteristics of low friction coatings and solid lubricant infiltrated metallic bodies will be evaluated. Candidate materials are silicon nitride, silicon carbide, boron carbide, lithium aluminum silicate, zirconia, Refel, Rene 41, and Clevite 300.

Keywords: Ceramics, Friction and Wear, Coatings and Films

29. High-Temperature Creep Evaluation — 1983 $65K

DOE Contact - Patrick Sutton (202) 252-8012
NASA Contact - R. H. Titran (216) 433-4000, ext. 398

Creep properties of both commercial alloys and new experimental alloys will be characterized over a temperature range spanning the proposed operating temperatures of the Stirling engine. The effects of brazing cycle and alloy composition on creep-rupture properties will be evaluated.

Keywords: Alloy Development and Alternative Materials, Creep Rupture, Material Properties

30. Alloy Properties in High-Pressure Hydrogen — 1983 $110K

DOE Contact - Patrick Sutton (202) 252-8012
NASA Contact - R. H. Titran (216) 433-4000, ext. 398
ITI Research Institute, (NASA Subcontract DEN 3-217), Contact - S. Bhattacharyya (312) 567-4192

Creep properties of candidate Stirling engine alloys will be measured in high-pressure hydrogen at engine operating temperatures using a specially designed creep test apparatus. The results obtained in hydrogen will be compared to results obtained in air to assess the effects of high-pressure hydrogen on material properties.

Keywords: Alloy Development and Alternative Materials, Creep Rupture, Hydrogen Embrittlement, Material Properties

31. Advanced Gas Turbine Engine Technology (AGT-100) — 1983 $4,768K

DOE Contact - Saunders Kramer (202) 252-8000
NASA Contact - P. T. Kerwin (216) 433-4000, ext. 6770
Allison/Pontiac, (NASA Subcontract DEN 3-168), Contact - H. E. Helms (317) 242-5335

The AGT-100 project objective is to develop an advanced gas turbine engine capable of demonstrating, by November 1986, the DOE/NASA goals of improved fuel economy, reduced emissions, and alternative fuel capability. This will require the use of ceramic materials for most or all of the hot-section components. Efforts include material characterizations, process development, and component design and test.

Keywords: Ceramics and Glasses, Turbine Engines, Silicon Carbide, Silicon Nitride

32. Advanced Gas Turbine Technology (AGT-101) — 1983 $5,222K

DOE Contact - Saunders Kramer (202) 252-8000
NASA Contact - R. S. Palmer (216) 433-4000, ext. 6653
Garrett/Ford, (NASA Subcontract DEN 3-167), Contact - E. E. Strain (602) 231-2797

The AGT-101 project objective is to develop an advanced gas turbine engine capable of demonstrating, by November 1986, the DOE/NASA goals of improved fuel economy, reduced emissions, and alternative fuel capability. This will require the use of ceramic materials for most or all of the hot-section components. Efforts include material characterization, process development, and component design and test.

Keywords: Ceramics and Glasses, Turbine Engines, Silicon Carbide, Silicon Nitride

OFFICE OF SOLAR HEAT TECHNOLOGIES

The Office of Solar Heat Technologies conducts R&D aimed at providing a technological base from which low-cost, reliable solar energy source systems can be generated. The Office contains three divisions: Active Heating and Cooling, Passive and Hybrid Solar Energy, and Solar Thermal Technology.

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 community who will benefit from it.

1. Research on Advanced Collectors — 1983 $200K

DOE Contact - John Goldsmith (202) 252-8171
ANL Contact - William Schertz (312) 972-6230

ANL is undertaking the construction and testing of an advanced compound parabolic concentrating collector incorporating the latest in state-of-the-art improvements. This includes improved mirror reflectance, improved optical absorptance, and redesigning of the manifold for steam generation. The objective is to improve performance by 50% at 275°F.

Keywords: Coatings and Films, High Temperature Service

2. High Performance Polymer Film Solar Collector — 1983 $317K

DOE Contact - John Goldsmith (202) 252-8171
BNL Contact - William Wilhelm (516) 282-4708

The principal objective is to resolve the delamination problem experienced under testing of polymer thin film collectors in FY 82. Three parallel paths are investigated: (1) further evaluation of adhesive bonded absorber laminates; (2) evaluation of laminates fabricated by both melt bonding and dispersion coating methods; and (3) evaluation of bare metal foil absorbers.

Keywords: Adhesives and Lubricants, Composites, Surface Characterization and Treatment, High Temperature Service, Joining

3. Thickness Insensitive Paint Research — 1983 $75K

DOE Contact - John Goldsmith (202) 252-8171
LANL Contact - Don Neeper (505) 667-6441

The objective is to develop a thickness insensitive paint with absorptivity <0.9 and emissivity >0.1. Various chemical conversion coatings are used with brittle sheet

stock to make flakes. Chemical conversion of standard leafing flake materials are also investigated. These flakes are combined with different binders to develop the desired performance.

Keywords: Coatings and Films, Radiation Effects, Surface Characterization and Treatment

4. Advanced Glazing Materials for Flat Plate Collectors — 1983 $300K

DOE Contact - John Goldsmith (202) 252-8171
SERI Contact - Larry Flowers (303) 327-1081

The objective is to provide the solar industry with a data base on the materials to be investigated and on possible design applications. SERI is conducting collector materials research in the area of improved polymeric materials for low cost collectors, and evacuated glass cover plates for collector performance improvement. There are two subtasks: (1) advanced polymeric materials for collectors and (2) advanced glazings for flat plate collectors. The objective of subtask 1 is to (a) evaluate the surface treatment of polymeric films using F_2 as a means of stabilizing inexpensive materials and/or improving optical performance, and (b) assess the literature on polymers or polymer composites which have both optical and mechanical properties suitable for higher temperature glazing applications. Subtask 2 involves the selection of materials and fabrication methods for possible use in the manufacture of an evacuated glass envelope cover plate for flat plate collectors. The use of tin oxide coated, infrared reflective glass and laser sealing techniques are evaluated.

Keywords: Coatings and Films, Composites, Glasses, Radiation Effects, High Temperature Service, Joining

5. Investigating Specific Material Properties of Solid Desiccants — 1983 $60K

DOE Contact - John Goldsmith (202) 252-8171
SERI Contact - Frank Kreith (303) 231-1109

The purpose is to optimize the performance of a solid desiccant dehumidifier by exploring the sorption hysteresis behavior of desiccants and by quantifying the improvements to be made by changing the desiccant material properties. The absorption/desorption characteristics of commercially available desiccants are measured with the use of a gas chromotograph.

Keywords: Sorption Kinetics, Hysteresis

6. Environmental Degradation of Polymeric Cover Plate Materials — 1983 $250K

DOE Contact - John Goldsmith (202) 252-8171
NBS Contact - Robert Dikkers (301) 921-3285

The objectives are to (1) characterize the moisture degradation mechanisms occurring 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: Microstructure, Strength, Erosion and Wear

7. Phase Change Materials — 1983 $70K

DOE Contact - John Goldsmith (202) 252-8171
NBS Contact - Robert Dikkers (301) 921-3285

In FY 82, NBS identified the specific mechanisms responsible for the loss in performance of phase change storage upon thermal cycling. Thermal cycling devices have been constructed to provide a simulated service environment in which large numbers of materials may be tested. A preliminary mathematical model has been developed to describe the loss in energy storage capacity with thermal cycling. In FY 83, NBS is conducting tests to demonstrate the applicability of this model and its sensitivity to maximum and minimum cycling temperature and heating and cooling rates.

Keywords: Thermal Cycling

8. Development of Improved Desiccant Materials — 1983 $70K

DOE Contact - John Goldsmith (202) 252-8171
ANL Contact - Anthony Fraioli (303) 972-7550

The objective is to determine whether lower adsorption energetics due to MnO_2 would adversely affect the rates of water take-up. Analysis of powder samples for surface area measurements by gas adsorption 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: Diffusion, Adsorption

9. Measurement Techniques for Evaluating Reflector Materials — 1983 $50K

DOE Contact - John Goldsmith (202) 252-8171
NBS Contact - Robert Dikkers (301) 921-3285

Laboratory and field studies are used to evaluate reflector materials according to identified performance requirements. Reflector materials such as mirror, metallic surfaces, and other reflective surfaces, can increase the solar flux received by collectors. Draft measurement techniques, based on new test methods, are developed.

Keywords: Coatings and Films, Glasses, Metals, Surface Characterization and Treatment, Radiation Effects

10. Systems Effectiveness Research — 1983 $100K

DOE Contact - Bob Hassett (202) 252-8163
LANL Contact - Don Neeper (305) 667-6441

There are two objectives to this task. The first is to attain the ability to predict field corrosion and fluid performance and to develop simple techniques for the prevention and/or detection of potential system problems in these areas. The necessary data base is established from laboratory and field tests. By analyzing this data base, techniques are developed for predicting field corrosion and fluid problems. The second objective is to establish a national data base on the degradation exhibited by a wide variety of materials. The high altitude exposure facility is operated with on-line automatic acquisition of insolation, temperature, humidity, and ultraviolet exposure data.

Keywords: Corrosion, Fluid Problems, Degradation

11. PRDA for Thin Film Collectors — 1983 $600K

DOE Contact - John Goldsmith (202) 252-8171
San Francisco Operations Office Contact - C. J. Dankowski (415) 273-7948

The objective is to identify appropriate materials for glazing, laminates for absorbers, adhesives and fabrication techniques to make practical and durable thin film collectors. DOE is negotiating the award with industry to conduct the work in FY 84.

Keywords: Adhesives and Lubricants, Coatings and Films, Erosion and Wear

12. Flame Spread of Combustible Glazing Materials — 1983 $100K (carry-over from FY 82)

DOE Contact - John Goldsmith (202) 252-8171
NBS Contact - Robert Dikkers (301) 921-3285

The objective is to perform a collector representative selection of combustible solar glazing materials subjected to fire tests, including ASTM D635, in order to characterize flame spread in the material. Results are compared with full-scale testing to determine whether a correlation exists between the bench test methods and the full-scale fire performance.

Keywords: Glazing Materials, Flame Spread, Materials Characterization

13. Inhibitors/Buffers for Glycol Based Heat Transfer Fluids — 1983 $100K

DOE Contact - John Goldsmith (202) 252-8171
NBS Contact - Robert Dikkers (301) 921-3285

The objective is to evaluate the effectiveness of buffers/inhibitors in decelerating corrosion attack of metallic containment systems of glycol based heat transfer fluids. The evaluation parameters are a function of solution temperature, solution composition and the presence of metals.

Keywords: Inhibitors/Buffers, Corrosion, Glycol Based Heat Transfer Fluids

14. Development of Thermal Energy Storage Devices Using Cross-Linked High Density Polyethylene and Polypropylene — 1983 $200K (carry-over from FY 82)

DOE Contact - John Goldsmith (202) 252-8171
ANL Contact - William Schertz (312) 972-6230

ANL has built and tested a prototype latent heat storage device using saturated steam as latent heat storage fluid to and from the device. Tests were run and finished. The device has been dissembled so that the properties of the latent heat storage material can be analyzed. Test results are being reported.

Keywords: Latent Heat Storage, High Density Polyethylene, High Density Polypropylene

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 passive solar materials and components that incorporate present technology to meet individual specific building related problems.

In the recent phase of passive materials R&D projects were 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 which 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.

David Pellish is the Program Manager and DOE contact for all of the following projects, (202) 252-8110.

1. Variable Transmittance Electrochromic Windows for Passive Solar Applications — 1983 $146K

SERI Contact - Steve Sargent (303) 231-1366
EIC Laboratories Contact - E. David Rauh (617) 965-2710

The program is aimed at the development of electrochromic windows which can be colored reversibly by the application of an electrical current. These windows will be used to control the amount of sunlight entering passive solar structures as well as for nighttime privacy. The windows are to be comprised of three separate thin film elements,

each a separate topic of investigation in this program. These are: (1) an electrochromic layer, principally WO_3; (2) an H^+ or alkali ion conducting electrolyte in solid or semisolid form (e.g., $LiAF_4$); (3) a counter electrode material to complete the electrochemical cell. The elements will be contained between two transparent conducting oxide electrodes deposited on glass. To date, most of the research has been directed toward development of the electrochromic layer. The main problem under investigation is determining the most suitable application method to achieve desired crystal structures. This research does not deal with critical, strategic or essential materials.

Keywords: Coatings and Films, Microstructure, Physical Vapor Deposition, Sputtering, Surface Characterization and Treatment, Ephoxial Growth, Crystal Growth, Reflective Surfaces, Switchable Glazings

2. Optics and Materials Research for Controlled Radiant Energy Transfer in Buildings — 1983 — $95K

SERI Contact - Steve Sargent (303) 231-1366
Tufts University Contact - Ronald B. Goldner (617) 628-5000, ext. 2492

The overall objective of the Tufts research project is to identify and attempt to solve some of the key materials problems associated with practical approaches for achieving controlled radiant energy transfer (CRET) through building windows and envelopes, so as to decrease heating and cooling loads in buildings. The specific project goals are to: (1) identify the most feasible practical approach for controlled radiant energy transfer through building apertures and envelopes; (2) determine the feasibility of using an electrochromic-based structure for controlled radiant energy transfer; and (3) identify the key materials research problems that need to be solved to achieve a practical design for an electrochromics-based structure, and devise a strategy for solving the problems. This research does not deal with critical, strategic or essential materials.

Keywords: Coatings and Films, Microstructures, Thermal Vapor Deposition, Surface Characterization and Treatment, Crystal Growth, Reflective Surfaces, Switchable Glazings

3. Liquid Desiccant Regenerable by Liquid-Liquid Phase Separation — 1983 — $100K

SERI Contact - Steve Sargent (303) 231-1366
Argonne National Laboratory Contact - William W. Schertz (312) 972-6230

This task determines the liquid/vapor phase diagrams and liquid/liquid phase diagrams of mixtures of water with new organic liquids and liquid mixtures as part of an investigation of a new low-energy concept for dehumidifcation of air and other gases. Dehumidification of gas streams by desiccant liquids is widely practiced in air dehumidification and the natural gas industry. Common to all such practices is regeneration of the hydrated desiccant by distillation or evaporation of the water, an energy costly process. This task explores a new concept: Liquid Desiccants Regenerable by Liquid-Liquid Phase Separation (LIQDES-RELLPS). Experimental work currently in progress includes evaluation of the desiccant properties of N-cyclohexyl-2-pyrollidone (CHP). (CHP is an industrial chemical newly available in bulk, which has vapor pressure and liquid-liquid phase separation properties attractive for the LIQDES-RELLPS concept.) This evaluation involves determination of the vapor pressure vs. composition isotherms for mixtures of CHP and water. Additionally a

thermodynamic cycle analysis on a hypothetical LIQDES-RELLPS system is being carried out to estimate the coefficient of performance (COP). The COP will provide the means for comparing the energy efficiency of LIQDES-RELLPS with other liquid desiccant systems. While the system that is initially being thermodynamically evaluated is not totally passive, due to the requirement of fluid transport in both the absorption and regeneration stages, it is easier to analyze for the first evaluation, and can establish criteria for improved liquids that can be used in passive or hybrid designs. A hybrid system, coupling a LIQDES-RELLPS dehumidification system to a passive solar heat source, may be feasible, and will be evaluated. This research does not deal with critical, strategic, or essential materials.

Keywords: Liquid Desiccants, Liquid Phase Separation, Dehumidification, Solar Dehumidifier

4. Phase-Change Materials for Use in Passive and Hybrid Solar Systems — 1983 — $80K

SERI Contact - Steve Sargent (303) 231-1366
University of Dayton Research Institute Contact - Val Salyer (513) 229-2133 and Don Duvall (513) 229-3618

The University of Dayton Research Institute (UDRI) is conducting a one-year laboratory/exploratory research program to prepare, test, and characterize new solid/solid phase change materials (PCMs) for use in common building materials such as wallboards. UDRI is investigating PCMs having melting points in the 70° to 90°F range with specific attention addressed to congruent melting, supercooling, toxicity, flammability, environmental acceptability, cost, and other potential problems. Major classes of PCMs under evaluation include: crosslinked, crystalline polymers; simple organic compounds; and organic clathrates and semi-clathrates. The objective of the research is to identify PCMs that can serve as their own containers and can be used in conjunction with conventional or solar-assisted heating and/or cooling systems. This project does not involve the use of any critical, strategic or essential materials.

Keywords: Phase Change Materials, Passive Solar Thermal Storage

5. Ceramics Properties Testing for Passive Solar Applications — 1983 — $42K

SERI Contact - Steve Sargent (303) 231-1366
Alfred University Contact - Paul Johnson (607) 871-2473

Alfred University is conducting laboratory and performance tests to determine the optimum properties for ceramics for passive solar applications. Project activities include materials and performance testing, computer modeling, and determination of material properties as a function of fabrication process. The work is being jointly funded by the Masonry Research Foundation. This project does not involve the use of any critical, strategic or essential materials.

Keywords: Ceramics

6. Glazing Materials Development for Radiative Cooling — 1983 $110K

SERI Contact - Steve Sargent (303) 231-1366
Energy Materials Research Company Contact - John Brookes and John Compton (415) 644-2244

Energy Materials Research Company has developed a glazing and selective emitter material to be used for sky radiative cooling. The glazing material is transparent to radiation between 0.25 and 0.4 microns (ultraviolet), reflective to the visible and near infrared portions of the light spectrum, and transparent to infrared radiation. The selective emitter is highly emitting in 8 and 13 microns.

Infrared transparent, solar transparent, reflective, and absorptive glazing samples and IR absorptive emitter samples were produced. These samples were fired polyethylene thin film samples. This film would allow at least some cooling when solar insolation is less than 800 w/m^2. This project does not involve the use of any critical, strategic, or essential materials.

Keywords: Coatings and Films, Passive Solar Glazings

7. Phase-Change Materials for Use in Passive Solar Residential Housing — 1983 $161K

SERI Contact - Steve Sargent (303) 231-1366
National Association of Home Builders/Research Foundation Contact - Paul Kando and Larry Zarker (301) 762-4200

The National Association of Home Builders/Research Foundation (NAHB/RF) has built a passive phase change materials test building. The building consists of two testing rooms with exactly the same south glazing, southwall area and northwall area. One room has a west exterior wall and one has an east exterior wall and they share one wall. The test building is for side-by-side testing of PCMs as to their thermal storage capabilities, reliability and ease of installation with conventional house construction.

Keywords: Phase Change Materials, Passive Solar Thermal Storage

8. Passive Solar Window Module — 1983 $90K

SERI Contact - Steve Sargent (303) 231-1366
Capitol Products Corporation Contact - Gary Dodez and Frank Matunis (717) 766-7661

Capitol Products Corporation has designed, developed, and fabricated a passive solar window module utilizing phase change material (PCM) for storage. The module was designed for compatibility with custom, tract, and manufactured housing. A variety of window options were investigated including double and triple glazing, selective films, aluminized mylar shades, and several phase change materials. This project does not involve the use of any critical, strategic, or essential materials.

Keywords: Phase Change Materials, Energy Storage

9. Water Thermal Storage System — 1983 $53K

SERI Contact - Steve Sargent (303) 231-1366
Communico/Crimsco Contact - Jay Nichols and Jim Nyle (816) 333-2100

Communico/Crimsco has developed a "Solar Heat Wall" thermal storage system of modular dimensions which may be integrated into a variety of construction types. Design development includes some prototype fabrication, performance testing, and detailed component design. The product is directed primarily at the residential market but may be expanded to other markets in the future. This project does not involve the use of any critical, strategic, or essential materials.

Keywords: Passive Solar Water Storage

10. Silicone Southwall Glazing System — 1983 $59K

SERI Contact - Steve Sargent (303) 231-1366
Dow Corning Contact - Chuck Roth (517) 496-4275

Dow Corning has developed a silicone southwall glazing system. Preliminary cost performance goals were established. The Contractor conducted several coating experiments as well as strength, transmission, flammability and durability tests. Market potential was evaluated, including economics, various regional requirements, factors affecting purchase and effective distribution strategies. This project does not involve the use of any critical, strategic, or essential materials.

Keywords: Coatings and Films, Solar Glazing System

11. Dual-Effect Regenerative Evaporative Cooler — 1983 $94K

SERI Contact - Steve Sargent (303) 231-1366
Energy Alternatives Inc. Contact - J. O. Bradley (702) 293-3030

Energy Alternatives Inc. developed a two-stage evaporative cooler that was to be economically competitive with vapor compression air conditioning in certain geographic regions of the United States. Cost analyses and computer simulations of system performance were conducted in the research and development effort. This project does not involve the use of any critical, strategic, or essential materials.

Keywords: Passive Cooling

12. Vapor Compression Dehumidification for Passive and Hybrid Cooling — 1983 $96K

SERI Contact - Steve Sargent (303) 231-1366
Trinity University Contact - Earle Doderer (512) 736-7515

Trinity University developed and tested an improved vapor compression dehumidification system for use in buildings cooled by passive and hybrid means. This project does not involve the use of any critical, strategic, or essential materials.

Keywords: Passive and Hybrid Cooling

13. Insulating Curtain — 1983 $81K

SERI Contact - Steve Sargent (303) 231-1366
Thermal Technology Corporation Contact - Mike Huntly (303) 466-1848

Thermal technology developed an interior movable window insulating curtain. Performance and engineering field tests were conducted. This project does not involve the use of any critical, strategic, or essential materials.

Keywords: Insulators

14. Automatic Control Damper for Trombe Wall — 1983 $25K

SERI Contact - Steve Sargent (303) 231-1366
Sunearth Solar Products Contact - Howard Katz (215) 256-6648 and Don Prowler (215) 546-2314

Sunearth Solar Products adapted a flue draft damper for use in an insulated, unidirectional Trombe wall damper. Prototype testing, development of a user's manual and cost studies were completed. This project does not involve the use of any critical, strategic, or essential materials.

Keywords: Passive Solar Control

15. Rolling Insulating Curtain System — 1983 $125K

SERI Contact - Steve Sargent (303) 231-1366
Star Technology Corporation Contact - Doug Davis (303) 963-1969

Star Technology has designed, fabricated, and tested a multi-layer rolling insulating curtain system with a control system for automatic operation of the curtain. Performance tests have been conducted by both an independent laboratory and the Colorado State University REPEAT facility. Safety tests have been performed by Underwriters Laboratory, and field testing has been conducted at two private sites. A pilot production facility has been constructed, including a computer-controlled fabric cutting and seaming system. This project does not involve the use of critical, strategic, or essential materials.

Keywords: Insulators

16. Insulating Glazing System — 1983 $86K

SERI Contact - Steve Sargent (303) 231-1366
Southwall Corporation Contact - Charles Tilford (415) 962-9111

Southwall Corporation field tested its insulating glazing system, Superglass and developed the production capability for sale to involve manufacturers. Superglass consists of transparent insulation, patented as Heat Mirror, sandwiched between two panes of glass.

Keywords: Coatings and Films

17. Low-Cost Thermal Window Shutter — 1983 $59K

SERI Contact - Steve Sargent (303) 231-1366
Solar Systems Design, Inc. Contact - Robert Mitchell (518) 765-4020

Solar Systems Design has designed, fabricated, tested and patented a low-cost, "do-it-yourself" thermal window shutter. The shutter consists of an extruded plastic frame surrounding an insulating panel and incorporates a draft excluder which eliminates condensation at the glazed surface. Thermal performance, flame, and indurability tests have been conducted. A production facility has been established. This project does not involve the use of any critical, strategic, or essential materials.

Keywords: Insulators

18. Solar Assisted Commercial Greenhouse — 1983 $92K

SERI Contact - Steve Sargent (303) 231-1366
Solar Central Contact - Don Grieder and Wayne Roston (513) 828-1350

Solar Central designed, fabricated, and tested a prototype, solar-assisted commercial greenhouse with an innovative glazing and insulation system. The insulating material is a beadwall which is drawn back during daylight hours and covers the greenhouse solar panels at night. An analysis of the greenhouse's marketability, including cost, durability, ease of installation and/or retrofit opportunities, maintenance, and thermal performance has been performed. This project does not involve the use of any critical, strategic, or essential materials.

Keywords: Passive Solar Greenhouse, Insulating Materials

19. Honeycomb Thermal Insulating Curtain — 1983 $42K

SERI Contact - Steve Sargent (303) 231-1366
Koolview Company, Inc. Contact - Gerry Keodt (608) 238-3966

Koolview has designed, fabricated, and tested a honeycomb thermal insulating curtain that may be drawn across a window by the user. The honeycomb design allows the curtain to fold flat when not in use, minimally controls condensation at the glass surface when in use, and provides insulating qualities by creating air pockets throughout the curtain when open. The primary market for this product is residential construction. This project does not include the use of any critical, strategic, or essential materials.

Keywords: Insulating Curtain

20. Heat Flux Movable Insulation Controller — 1983 $15K

SERI Contact - Steve Sargent (303) 231-1366
Intrel Contact - James Kugdrall (603) 883-4815

Intrel has designed a controller, sensitive to heat, which when connected to movable insulation causes the insulation to move into or out of place depending on heat loss or gain. Technical and economic analysis have been completed to determine the

practicality of production, delivery, and marketing. This project does not involve the use of critical, strategic, or essential materials.

Keywords: Heat Sensitive Insulation Controller

21. Passive Solar Greenhouse Design — 1983 $95K

SERI Contact - Steve Sargent (303) 231-1366
Four Seasons Solar Products Corporation Contact - Joseph Esposito (516) 694-4400

Four Seasons refined an existing greenhouse design to improve its glazing characteristics, ventilation, movable insulation qualities, and improve its overall passive solar collector properties. The greenhouse was designed to be flexible, modular, capable of mass production and marketing. This project does not involve the use of any critical, strategic, or essential materials.

Keywords: Passive Solar Greenhouse

Solar Thermal Technology Division

The objective of this program is to establish the technical feasibility and cost readiness of mid- and high-temperature solar concentrating collector systems. Research is focused upon three classes of systems: (1) linear-focusing distributed receivers (parabolic troughs and hemispherical bowls), (2) point-focusing distributed receivers (parabolic dishes), and (3) central receiver systems.

1. Silver/Glass Mirror Research — 1983 $60K

DOE Contact - Frank Wilkins (202) 252-1684
SERI Contact - Gordon Gross (303) 231-1222

Applied research is being conducted on silvered glass mirrors for solar thermal applications. The problems being investigated are: assessment of the current problems/opportunities of commercially available mirrors; determining the actual composition of a glass surface; nature of the sensitized glass surface onto which a reflective silver coating is to be deposited in solution processes; nature of the bonding of the silver to a sensitized glass surface; effects of solar radiation on bonding at the silver/glass interface. The rationale for the research is to improve the performance and durability of mirrors in order to lower the life cycle costs of solar thermal central receiver systems.

For assessing the current problems/opportunities of commercially available mirrors, a review was made of reports since 1978. It was assembled into a document suitable for publication. For deducing the degradation mechanisms, research is being conducted to understand the basic physical and chemical processes in mirrors. The expected result is the identification of the primary causes of degradation in mirrors so that improved, more controlled processes can be designed and tested - to increase the lives of mirrors in solar thermal applications.

Keywords: Glasses, Metals (Silver), Surface Characterization and Treatment, Erosion and Wear, Radiation Effects (Solar)

2. Silver/Polymer Reflector Research — 1983 $250K

DOE Contact - Frank Wilkins (202) 252-1684
SERI Contact - Gordon Gross (303) 231-1222

Applied research is being conducted on silver/polymer films for use in constructing low-cost, lightweight collectors and concentrators for solar thermal applications.

The problem being investigated is the development of silvered polymer materials that are resistant to ultraviolet and pollutant degradation, cleanable, mar resistant, have reflectances of 90% or more and useful lives of 5-10 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. Also, they provide greater reflectance than the rather durable aluminized polymers currently in use.

This research focuses on studying, testing, characterization and evaluating polyer-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.

The expected result is the identification of at least one silvered polymer that meets the solar thermal requirements - useful life of 5-10 years, reflectance of at least 90% specularity equal to that for silvered glass and resistant to UV and pollutant degradation.

Keywords: Polymers, Sputtering, Surface Characterization and Treatment, Radiation Effects

3. Polymer Synthesis and Characterization — 1983 $350K

DOE Contact - Frank Wilkins (202) 252-1684
SERI Contact - Gordon Gross (303) 231-1222

Applied research is being conducted on polymer materials for solar thermal technology applications. The problems being investigated are: identification, testing and evaluation of chemically bound stabilizers/antioxidants 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 quenches 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. To date, no effective chemically bound antioxidant exists.

The research focuses on the testing, characterization and evaluation of low-cost candidate 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 task is the development of durable, low-cost, lightweight 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

4. Ceramic Materials Research — 1983 — $500K

DOE Contact - Frank Wilkins (202) 252-1684
SERI Contact - Gordon Gross (303) 231-1222
Georgia Institute of Technology Contact - Robert A. Cassonova (404) 894-3589

Applied research is being conducted on ceramic materials for high temperature (i.e., above 600°C) solar thermal technology applications. The problems being investigated are: identification, characterization and testing of ceramic structural materials in high temperatures and high solar fluxes; identifying a method for inhibiting devitrification of silica of the non-transparent forms used for structural ceramic parts; and development of advanced ceramic composite structures for high temperature/high flux solar thermal applications.

The rationale for the project is that for solar thermal applications at high temperatures and for reaction containment as proposed for sunfuels, ceramics provide the best alternative. For high performance applications such as heat engines, fuels/chemicals receivers and heat exchangers, much characterization of ceramics and improvement in joining technology is still required. They are being addressed in this research.

Evaluation of the capabilities of commercially-available refractory materials was performed to identify important candidates. Other materials being evaluated include: (1) alumina, magnesia, silica, and xirconia firebrick and their joining cements, (2) silicon carbide components and welded assemblies, (3) silicon nitride components and welded assemblies (4) large, monolithic assemblies of aggregate-cast fused silica, and (5) refractory metal alloy assemblies.

Based on the continuing test programs at the Advanced Components Test Facility and on microstructure analyses of exposed materials, GIT is identifying the mechanisms responsible for the degradation of ceramic materials exposed to high solar fluxes.

The expected result of this project is the identification of at least one ceramic material that meets solar thermal technical performance requirements and can be used for fabricating solar thermal components that must operate at high temperatures and fluxes.

Keywords: Ceramics, Sintering, Surface Characterization and Treatment, Corrosion, Radiation Effects, High Temperature Service

5. High Temperature Thermal Fluids/Containment — 1983 $230K

DOE Contact - Frank Wilkins (202) 252-1684
SERI Contact - Gordon Gross (303) 231-1222

Applied research is being conducted on heat transfer fluids and storage system materials for high temperatures (i.e., greater than 600°C) solar thermal technology applications. Specific problems being investigated are: identification, characterization and evaluation of heat transfer fluids for use in solar thermal receivers and heav exchangers that operate at temperatures in the range of 600°-1100°C - materials that are low-cost, chemically inert, resistant to corrosion and able to withstand thermal cycling, non-uniform heating and transient solar input; identification, characterization and evaluation of containment materials for high temperature thermal fluids. The rationale for the project is that systems that operate at temperatures in the range of 600°-1100°C will require advanced fluids and compatible containment materials to extract efficiently the high temperature heat. Efficient and reliable high temperature receivers depend on the suitable performance of containment materisl/fluid pairs. Data obtained from research experiments will form the basis for future industrial designs of efficient high temperature receivers.

In FY 83, candidate thermal fluid/containment material pairs were identified. They are being tested with respect to: influence of the mechanical properties of the container materials; corrosion mechanisms; phase relationships in corrosion; high temperature oxidation of fluids; influence of absorption additives and impurities on corrosion in materials.

If the corrosion proves to be a serious problem research will be conducted to identify the mechanisms and develop concepts or additives for alleviating it. In addition, containers will be tested with respect to creep fatigue.

The expected result of this project is the identification or development of at least one thermal fluid/containment material pair that meet the requirements for high temperature/high flux solar thermal technology development programs.

Keywords: Alloys, Nondestructive Evaluation, Corrosion, High Temperature Service

6. High Temperature Windows — 1983 $150K

DOE Contact - Keith Rose (415) 273-4265
Georgia Institute of Technology Contact - Robert A. Cassonova (404) 894-3589

Applied research is being conducted on materials that can be used to fabricate transparent windows for use in high temperature (i.e., above 600°C) central and distributed solar thermal systems. The problems being investigated are: development and selection of transparent refractory windows capable of withstanding the solar, mechanical and chemical environment of the receiver while transmitting a maximum amount of thermal energy into the reactor; development of methods for inhibiting the devitrification of fused quartz and high-silica window materials when they are employed in solar thermal receivers and chemical reactors.

The rationale for the project is that many high temperature applications require transparent windows over the receiver aperture to contain reactants or other absorbing media and to reduce reradiation and convection lossess. The use of a windowed receiver/reactor offers the possibilities for conducting chemical reactions in a unique environment, allowing the direct interaction between the reacting chemical

species, or absorbing media, and a high intensity field of radiant thermal energy. The development and selection of such window materials would allow the fabrication of reactors which exploit the unique nature of solar chemical reactors, using concentrated, direct radiant energy.

Coatings are being developed for inhibiting the devitrification of silica-based windows. Emphasis is on boron-silica oxide polymer coatings. If these coatings give less than satisfactory results, titanica-silica and alumina-silica coatings will be investigated. After the conceptual design and analytical efforts are completed, construction and testing of mosaic window structures will begin. It is anticipated that the first test specimens would consist of two pieces of glass joined by a simple, straight joint. When the concept has proved successful, systems with several panes welded with colloidal silica or silica polymers will be investigated.

The expected results of this project are: identification of at least one coating material for inhibiting the devitrification of silica-based windows for solar thermal receivers; and identification of at least one material for fabricating windows for solar thermal system receivers designed to operate at temperatures above 600°C.

Keywords: Silica, Surface Characterization and Treatment, Corrosion, Radiation Effects, High Temperature Service

7. High Temperature Materials — 1983 — $75K

DOE Contact - Keith Rose (San Francisco Operations Office)(415) 273-4265
University of Houston Contact - Lorin Van Hull (713) 749-1154

Applied research is being conducted on absorptive coatings for materials to be used in high temperature solar thermal systems. The problem is to define, characterize and acquire a basic understanding of photo-induced optical and compositional degradation of absorbers coatings and other materials exposed to high temperature/high flux solar radiation and utilize that knowledge to modify materials or to develop surface treatments to improve performances and durability.

High temperature/high flux solar thermal systems require materials with specilized optical properties (i.e., high solar absorption, low infrared emissivity, solar reflectivity, and long life at high temperatures). For materials with specialized optical (and therefore surface) properties, deterioration of the surface is often found to depend not only on temperature but also on the solar flux incident. Determination of the mechanism of the degradation process provides the possibility of preventing the degradation or of developing a new material where the degradation mechanism has been retarded or stopped.

The approach in this project is to: conduct photocorrosion studies of Fe, Al and Cu (important solar thermal materials); conduct photocorrosion studies of commercial solar absorber coatings; produce high temperature/high flux absorber coatings by ion bombardment of ZrN, ArO_2 and Vn; and acquire an understanding of photo-induced degradation in ceramics.

The expected results of this research are development of an understanding of photo-induced optical degradation and the development of at least one coating material to improve the optical performance of solar thermal receivers operating at high temperatures and fluxes.

Keywords: Coatings and Films, Surface Characterization and Treatment, Radiation Effects, High Temperature Service

Photovoltaic Energy Technology Division

The primary goal of the national photovoltaic program is to reduce the undertainties 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.

1. Amorphous Silicon for Solar Cells

1983
$7,000K

DOE Contact - Anthony Scolaro (202) 252-5548
SERI Contact - Ed Sabisky (303) 231-1483

This project performs applied research upon the deposition of amorphous silicon alloys to modify solar cell properties, primarily the energy gap. Efficient solar energy conversion is hindered by improper impurities 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, Solar Cells

2. Polycrystalline Thin Film Materials for Solar Cells

1983
$3,200K

DOE Contact - Anthony Scolaro (202) 252-5548
SERI Contact - Allen Hermann (303) 231-1311

This project performs applied research upon the deposition of $CuInSe_2$, CdTe and Zn_3P_2 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

3. Deposition of High Purity Polycrystalline Silicon from Silane in a Fluidized Bed Reactor

1983
$1,500K

DOE Contact - Anthony Scolaro (202) 252-5548
JPL Contact - Andrew Morrison (213) 354-7200

This project performs applied research upon the deposition of semiconductor grade silicon from high purity silane in a fluidized bed reactor. Research centers upon studying nucleation and growth of silicon particles and impurities in the deposited silicon. The goal of this research is to prove the feasibility of the fluidized bed reactor as an energy conservative means of forming semiconductor grade silicon from gaseous silicon bearing compounds. Achieving this goal would enable, upon the adoption of this technology, a great reduction in the required price for semiconductor grade silicon, a precursor for crystal silicon photovoltaics and integrated circuits.

Keywords: Semiconductors, Solar Cells

4. Growth of Silicon Ribbons for Solar Cells — 1983 $2,200K

DOE Contact - Anthony Scolaro (202) 252-5548
JPL Contact - Andrew Morrison (213) 354-7200

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 solar cells.

Keywords: Semiconductors, Crystal Growth, Solar Cells

5. Deposition of III-V Semiconductors for High Efficiency Solar Cells — 1983 $3,000K

DOE Contact - Anthony Scolaro (202) 252-5548
SERI Contact - John Benner (303) 231-1396

This project performs applied research upon deposition of III-V semiconductors for high efficiency solar cells, thin film cells 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 cells for flat plate applications. Achieving this goal 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)

6. Materials and Device Characterization — 1983 $2,200K

DOE Contact - Anthony Scolaro (202) 252-5548
SERI Contact - Larry Kazmerski (303) 231-1115
JPL Contact - Ram Kachare (213) 354-4583

iis project measures and characterizes materials and device properties. The roject performs surface and interface analysis, electro-optical characterization nd cell performance and material evaluation to study critical material/cell arameters such as impurities, layer mismatch and other defects that limit erformance 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

7. High Efficiency Crystal Silicon Solar Cells — 1983 $2,500K

DOE Contact - Anthony Scolaro (202) 252-5548
SERI Contact - Joe Milstein (303) 231-7299
JPL Contact - Ram Kachare (213) 354-4538

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

Wind Energy Technology Division

1. Wood Composite Material Fatigue — 1983 $45K

DOE Contact - Peter Goldman (202) 252-1776
NASA Lewis Contact - T. Sullivan (216) 433-6943

The objective of this research is to characterize the static and cyclic fatigue properties of Laminated Douglas Fir veneer wood composite materials with applications to more efficient structure design of rotor blades. Epoxy resin wood laminate test specimens have been fabricated and are being subjected to ultra-high (approaching 4×10^8) cyclic fatigue loads. Data will be collected looking at a number of parameters including wood grade, moisture content, butt joint gap, lamination clamping pressure, and test temperature and humidity levels. Completion of testing is planned in early FY 1984. Test results should be reported in late FY 1984.

Keywords: Composites, Materials Characterization

2. Glass Reinforced Concrete for Wind Turbine Structures — 1983 $40K

DOE Contact - Peter Goldman (202) 252-1776
NASA Lewis Contact - J. Faddoul (216) 433-6170

The objective of this research was to determine the effectiveness of using glass fiber reinforced cement in the manufacture of wind turbine structures. A conceptual design

for a wind turbine blade was completed employing internal post-tensioning rods to keep the concrete in compression. Conceptual design weight was not optimized and analysis was discontinued. The final report of this research project is complete and should be published in early FY 1984.

Keywords: Composites, Materials Characterization

OFFICE OF RENEWABLE TECHNOLOGY

The Office of Renewable Technology consists of three divisions: the Geothermal and Hydropower Division; the Energy From Municipal Waste Division; and the Biomass Energy Technology Division.

Geothermal and Hydropower Division

This division supports high-risk, high-payoff R&D aimed at developing the basic technology needed for the private sector to more fully utilize geothermal energy resources for both electric power generation and direct heat applications. Materials R&D is being conducted within four subprograms: (A) Geothermal Materials; (B) Geochemical Engineering; (C) Hot Dry Rock; and (3) Drilling and Completion.

(A) Geothermal Materials

The Geothermal Materials Program is coordinated by the Brookhaven National Laboratory.

DOE Contact - Leon Lehr (202) 252-8076
Brookhaven Contact - Larry Kukacka (516) 282-2123

1. Alternate Materials of Construction — 1983 $250K

Brookhaven (Contract No. DE-AC02-76H00016), Contact - L. Kukacka (516) 282-2123

Evaluating and developing alternate materials of construction. The work includes determination of engineering design requirements, testing of prototype equipment, economic evaluations, and plant demonstrations. Program makes use of subcontracts and industrial participation.

Keywords: Alternate Materials, Elastomers and Polymers

2. Cementing of Geothermal Wells — 1983 $60K (carry-over from FY 82)

Brookhaven (Contract No. DE-AC02-76CH00016), Contact - L. Kukacka (516) 282-2123

Developing improved cements which are specifically designed for geothermal well applications. The task includes preparation of a technical plan, testing and practical demonstration of new cements, and transfer of the technology to the private sector.

Kaywords: Cements and Concrete, Materials Characterization

3. Pitting-Resistant Alloys — 1983 $150K

Brookhaven (Contract No. DE-AC02-76CH00016), Contact - D. Van Rooyen (516) 282-4050

Developing metallic alloys and steels that possess improved properties and are cost-effective. The project makes use of subcontracts with industry, laboratories and universities.

Keywords: Alloy Development

4. New Fluorocarbon Elastomers for Seals — 1983 $155K (carry-over from FY 82)

Exfluor Research (Brookhaven Subcontract No. 486106)
Contact - E. Dumitru (512) 454-3812

Attempting to increase the operating capabilities of elastomers in geothermal environments to 300°C by cross-linking and subsequent fluorination of elastomeric materials.

Keywords: Elastomers and Polymers, Seals and Bearings

5. Pump Bearing Materials Development — 1983 $50K (carry-over from FY 82)

Solar Turbines International (Brookhaven Subcontract No. 490656)
Contact - D. Huey (714) 238-5609

Developing durable materials that will resist wear and deterioration when used as bearings in pumps. The goal is to improve pump lifetimes and to increase the efficiency of heat extraction from geothermal wells.

Keywords: Seals and Bearings, Erosion and Wear

6. Shape Memory Alloy Seals — 1983 $100K (carry-over from FY 81)

Rockwell International (Brookhaven Subcontract No. 509927)
Contact - W. Friske (213) 341-1000

Developing durable high-temperature metallic seals for downhole pump applications. The sealing technique utilizes the unique properties of nickel-titanium (Nitinol) "memory alloy" to provide the seals

Keywords: Alloy Development, Seals and Bearings

7. Geothermal Materials Compatibility and Failure Analysis — 1983 $50K

Radian Corporation Contact - P. Ellis (512) 454-4797

Providing corrosion engineering support services and component failure analysis. Also, preparing geothermal well materials reference book.

Keywords: Corrosion

8. Elastomer Materials Technology Transfer — 1983 $15K

L'Garde, Inc. (Brookhaven Subcontract No. 490316)
Contact - A. Hirasuna (714) 645-4880

Transferring to industry the elastomer technology developed under an earlier contract, and continuing the developing of high-temperature sealing materials.

Keywords: Elastomers and Polymers, Seals and Bearings

9. Cathodic Protection of Well Casing — 1983 $50K (carry-over from FY 82)

San Diego State University, Brookhaven, Contact - Larry Kukacka (516) 282-2123

This project, started in FY 1981, is determining the feasibility of use of cathodic protection for high-temperature applications of well casings and above-ground components. The first phase was to be completed in FY 1982.

Keywords: Corrosion

(B) Geochemical Engineering

The Geochemical Engineering Program is coordinated by the Battelle Pacific Northwest Laboratory; PNL contact - Donald Shannon (509) 376-3139. DOE Contact - Leon Lehr (202) 252-8076.

1. Sampling and Analysis of Geothermal Fluids — 1983 $10K

Pacific Northwest Laboratory Contact - C. H. Kindle (509) 376-5904

Developing standardized, accurate fluid and gas sampling/analysis methods through industry/government/university cooperative efforts. Standardization and acceptance is being accomplished through the American Society for Testing and Materials. Isobutane sampling is being emphasized.

Keywords: Corrosion

2. High-Temperature Chemical Sensors for Geothermal Fluids — 1983 $300K

Leeds and Northrup, University of Pennsylvania, Owens-Illinois, General Electric, Pacific Northwest Laboratory Contact - George Jenson (509) 376-9124

Developing electrical and electrochemical probes that can measure the chemical environment of goethermal water and steam under the high-pressure, high-temperature conditions of a geothermal well and associated piping. Such data will permit the prediction and control of corrosion, scaling, and pollution in geothermal systems. Subprojects are: high-temperature glass pH electrode development, geothermal CO_2 sensor, chemically sensitive semiconductor devices, zirconia-based pH electrode development, redox electrode development, and improved corrosion ratemeter.

Keywords: Corrosion, Semiconductors

3. Binary Cycles Fluid Case Study — 1983 $100K (carry-over from FY 82)

Pacific Northwest Laboratory Contact - Donald Shannon (509) 376-3139

Developing and demonstrating to industry advanced methods for monitoring geothermal power plants. Methods are being tested in the Magma Electric Company's 10 MWe cycle plant. Technical assistance is also being provided for materials and chemical monitoring of the Heber Geothermal Binary 15 MWe Demonstration Plant. In addition, corrosion samples and NDE of heat exchangers are included in this effort.

Keywords: Corrosion, NDE

(C) Hot Dry Rock

The objective of this effort is to determine the technical feasibility of hot dry rock concepts. A major element of the program is the Phase II Energy Extraction System at the Fenton Hill Test Site, which consists of two wellbores drilled to a maximum depth of 15,000 ft and connected by a series of hydraulic-induced fractures.

The Hot Dry Rock (HDR) Energy Extraction Demonstration Program is coordinated by Los Alamos National Laboratory; LANL Contact - Bert Dennis (505) 667-5697. DOE Contact for all the following projects is Allan Jelacic (202) 252-8022.

1. High Temperature Armor Cable — 1983 $100K

LANL Contact - Bert Dennis (505) 667-5697
Rochester Corporation (LANL Subcontract #5-ET2-C2904-1), Contact - George Philpott (703) 825-2111

Results of the LANL testing program for high-temperature well logging armored instrumentation cable for use in geothermal boreholes led to the purchase of a 7-conductor TFE insulated cable from Rochester Corporation. This cable has given excellent service in the geothermal wellbores at Fenton Hill at temperatures above 300°C.

Keywords: Elastomers, Polymers, Materials Characterization

2. High-Temperature Connectors — 1983 $36K

LANL Contact - Bert Dennis (505) 667-5697
Reynolds Corporation (LANL Subcontract #1-KQ3-E2445-1), Contact - Ralph Craig (213) 823-5491

Tested connectors using machineable ceramic inserts to 320°C. Connectors do not deform and are reuseable numerous times after subjection to these temperatures for over 4 hours. Connectors use crimp type pins. Easily assembled in the field.

Keywords: Ceramic Insulation, Materials Characterization

3. Pressure Block Feedthru Insulators — 1983 $10K

LANL Contact - Bert Dennis (505) 667-5697
L'Garde Contact - Allen Hirasuma (714) 645-4880

High-temperature "boots" to electrically insulate wire terminations on high-pressure block feedthrus used in cableheads and downhole instrumentation packages. Uses a special EPDM formulation without graphite strengthener for nonconductive insulation. Operational up to 300°C.

Keywords: Elastomer, Materials Characterization

4. High-Temperature Pressure Transducers — 1983 $ 5K

LANL Contact - Bert Dennis (505) 667-5697
Sparton Southwest, (LANL Contract #7497N), Contact - Lee Butler (505) 892-5300

Potentiometer type pressure transducer rated to 300°C with 5 psi resolution at 10,000 psi.

Keywords: Insulation Materials, Materials Characterization

5. High-Temperature Geophones — 1983 $10K

LANL Contact - Bert Dennis (505) 667-5697
Mark Products, (LANL Contract #J3574), Contact - Bill Haggert (713) 498-0600

High-temperature geophones rated at 250°C with corner frequencies of 30 Hz. The 30 Hz phones are useable at tilt angles up to 80° for use in high-angled geothermal boreholes for acoustic (microseismic) fracture mapping technique.

Keywords: Insulators, Magnetic Materials, Alloys, Materials Characterization

6. High-Temperature Accelerometers — 1983 $2.5K

LANL Contact - Bert Dennis (505) 667-5697
Bolt Beranek Newman, (LANL Contract #3-KG2-C2976-1), Contact - Carl Nicolino (617) 491-0091

Accelerometers rated at 300°C for use in high-angled geothermal wellbores for acoustic (microseismic) frature mapping. No restriction on tilt angle high-frequency operation up to 6 KHz.

Keywords: Materials Characterization

(D) Drilling and Completion

The Drilling and Completion Program is coordinated by Sandia National Laboratory; Sandia Contact - James Kelsey (505) 844-6968. DOE Contact - David Allen (202) 252-5335.

1. Chemical and Elevated Temperature Effects on Clay-Based Drilling Fluids — 1983 $50K

Texas Tech University, (Sandia Contract #13-5104), Contact - M. Guven (806) 742-3110

This project seeks to develop a fundamental understanding of clay particle morphology under the influence of both various chemical species and elevated temperatures similar to the conditions encountered during geothermal drilling activities.

Keywords: Adhesives and Lubricants

2. High-Temperature Particulate Plugging Agents — 1983 $50K

Sandia Contact - J. Kelsey (505) 844-6968

Developing materials to help improve circulation in geothermal wells. Research centered on high-temperature particulate agents for plugging large fractures.

Keywords: Materials Characterization

3. Carbide Development — 1983 $25K

SRI, International, Sandia Contact - J. Finger (505) 844-8089

Developing non-stoichiometric carbides to increase both the toughness and hardness of materials used where abrasions occur. Investigation is focused on the study of tantalum carbides and niobium carbides.

Keywords: Ceramics

4. Aqueous Foams — 1983 $200K

Sandia Contact - Charles Carson (505) 844-6477

Developing aqueous foams for use as a geothermal drilling fluid. Evaluating properties at high temperatures in the presence of geothermal brines.

Keywords: Materials Characterization

Energy From Municipal Waste Division

This division conducts long-range, generic research on processes and systems that use municipal wastes. Its aim is to develop the technological base for enhancing energy recovery, particularly in key municipal applications, such as water and wastewater treatment facilities.

1. Materials Corrosion in Municipal Waste-to-Energy Incinerator Systems — 1983 $50K (carry-over from FY 82)

DOE Contact - Christopher Kouts (202) 252-1697
NBS-Chemical Thermodynamics Division (Contract #20528), Contact - Edward Escalante (301) 921-2556

Examining corrosion problems at several municipal waste burning sites. The aim is to determint the possibility of developing a short-term test for the corrosive property of candidate materials in the harsh environment of municipal waste energy recovery systems.

Keywords: Erosion and Wear

Biomass Energy Technology Division

The division supports long-term, high-risk research on biomass energy production and conversion. Materials research is conducted only to the extent that it will enhance the feasibility of using renewable biomass resources to displace conventional fossil fuels.

1. Hydrogen Containment — 1983 $60K

DOE Contact - Carl J. Wallace (202) 252-1298
SERI Contact - H. Lindsey (303) 327-7285

Hydrogen permeation rates and design stresses are being estimated for polymer films including Tedlar and FEP-Teflon. Rationale for the research includes identification of a cost-effecrive, transparent covering for reactors which have low H_2 and O_2 permeability. Analysis was performed based on a survey of candidate materials for reactors. The projected permeability of Tedlar films is quite low and appears promising as a covering.

Keywords: Coatings and Films, Hydrogen Effects, Radiation Effects, Alternate Fuels

OFFICE OF ALCOHOL FUELS

This office is sponsoring R&D aimed at providing the technology base needed for production of economically-competitive alcohol fuels. The current focus of the program is on long-term improvements in process technologies for the production of alcohol from biomass and for cellulose fermentation processes.

1. Membrane Development for Low Energy Separations — 1983 $125K

DOE Contact - Richard Morrer (202) 252-1878
SERI Contact - H. H. Neidlinger (303) 231-1000

Develop casting techniques for surface modification of commercial polymer membranes enabling them to perform more effectively in separating alcohol and water solutions. Perform engineering performance evaluations on commercial membranes.

Keywords: Elastomers and Polymers

2. Catalyst Development for Methanol Dissociation and Synthesis — 1983 $300K

DOE Contact - Richard Moorer (202) 252-1878
SERI Contact - Jim Smart (303) 231-1000

a. Dissociation - Developing advanced organometallic compounds to produce CO and H_2 gases from methanol with long lasting high activity at operating temperatures around 300°C. Compounds must retain specificity and stability to produce CO and H_2 for higher operation conditions to 500°C.

b. Synthesis - Developing heterogeneous materials to improve the conductive surface area between catalytic agent and methanol and developing homogeneous catalysts through modification of base material with noble metals giving greater specificity to promote more efficient process and lower operating temperatures. It is to be used with a syngas from a biomass gasifier to produce methanol.

Keywords: Dissociation, Synthesis, Methanol, Catalysts

OFFICE OF MILITARY APPLICATION

The objective of the materials research sponsored by this office is to develop materials and materials technology for national security uses. This applied research is directed toward material science, the understandings and development of advanced materials and fabrication technology, and the development of materials and processes required to produce nuclear and nonnuclear parts.

Sandia National Laboratories - Albuquerque

(Contract No. DE-AC04-76DP00789)

1. Surface Chemistry and Bonding of Plasma-Aminated Polyaramid Filaments — 1983 — $ 250K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - F. P. Gerstle (505) 844-3404 and R. E. Allred (505) 846-5538

Thermomechanical performance of polyaramid-reinforced, resin-matrix composites often is limited by poor adhesion in the filament-matrix interphase region. A method to improve adhesion by forming covalent bonds across the interface through amine functional groups has been developed. Amine functionality has been introduced onto poly (p-phenylene terephthalamide), PFTA, filaments by a short exposure to ammonia or monomethyl amine RF glow discharge plasmas. Future work will be directed towards bonding with polymer matrices other than epoxies and development of a continuous filament amination process.

Keywords: Adhesion, Plasma, Composites

2. Cure Kinetics of Thermosets by DSC — 1983 — $ 100K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - J. G. Curro (505) 844-3963 and H. R. Keenan (505) 846-1361

The capability has been developed to determine the cure kinetics of adhesives and other thermosets by differential scanning calorimetry (DSC). Knowledge of the cure kinetics permits the optimum cure cycle for a system to be determined while minimizing compatibility problems. This kinetic method has been applied to adhesives and encapsulants.

Keywords: Diffusion, Encapsulant, Adhesive, Differential Scanning Calorimetry

3. Effect of Crosslink Density of the Rubber-Phase of Toughness of Rubber-Modified Epoxies — 1983 — $ 500K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - J. A. Sayre (505) 844-6631, S. C. Kunz (505) 844-8333 and R. A. Assink (505) 844-6372

The relationship between the crosslink density of the dispersed phase and the fracture toughness of rubber-modified epoxies has been investigated. Diethanol amine and polyoxypropyl amine cured rubber-modified epoxies were exposed to gamma radiation which crosslinked the rubber phase. The fracture toughness of the unmodified epoxy remains essentially unchanged. The diethanol amine cured rubber shows a maximum in tear energy at $\sim$ 20 Mrads and the tear energy of the polyoxypropyl amine cured rubber monotonically decreases as the radiation dose increases.

Keywords: Encapsulants, Fracture Toughness

4. Water Diffusion in Epoxy Encapsulants — 1983 $ 180K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - J. G. Curro (505) 844-3963 and M. R. Keenan (505) 846-1361

Water permeation experiments were carried out on glass microballoon-filed epoxies. These results indicate that the glass filled epoxy is damaged by its exposure to water. The mechanism might include cracking of the epoxy or glass microballoons due to differential swelling stresses, reaction of water with the glass or loss of epoxy-glass adhesion. Further work will be directed toward elucidating the nature of the damage by way of microscopy and scattering techniques. Additional experiments at different temperatures and humidities will also be performed to determine the severity of environmental conditions required for onset of damage.

Keywords: Diffusion, Epoxy, Encapsulant

5. Creep-Rupture of Kevlar Composites — 1983 $ 300K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - F. P. Gerstle (505) 844-4304 and S. C. Kunz (505) 844-8333

We have found a variation between spools of nominally identical Kevlar 49 fiber. This variation produces major differences in failure life of advanced composite materials and is responsible for much of the scatter previously thought to be inherent in creep rupture data. By accounting for it, we can considerably improve the reliability of life predictions for composite pressure vessels. Interest in this discovery has generated a joint program with DuPont (the Kevlar manufacturer) to determine the material cause of the variability.

Keywords: Kevlar, Composites, Pressure Vessels, Long-Term Failure

6. Fundamental Studies of Conductive Polymers — 1983 $ 100K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - W. H. Smyrl (505) 844-6638, S. R. Kurtz (505) 844-5436, J. M. Ziegler (505) 844-0324 and D. S. Ginley (505) 844-8863

Conductive polymers are being studied as potential electrode materials for high power density batteries and fuel cells. Basic scientific studies to determine the thermodynamics and kinetics of electrochemical doping processes in polyacetylene are being pursued. Digital impedance and pulsed electrochemical techniques are being used. Dielectric and photoconductivity measurements are made on these materials to study electronic transport. New electrolytes based on room temperature molten salts are being used to improve cell efficiency and stability. New conductive polymeric materials with improved processibility and environmental stability relative to existing conductive polymers are being synthesized and evaluated for use in electrochemical systems. Materials under investigation include: fluorinated and silylated polyacetylenes, polysilanes, and metalloid substituted polyalkynes. Other applications to be investigated are solar cells, conductive polymer sensors, and corrosion protection with conductive polymer films.

Keywords: Battery, Fuel Cell, Conductive Polymer, Electrochemical Impedance, Molten Salt, Sensor, Solar Cell, Corrosion Protection

7. Radiation Hardened Dielectrics — 1983 $ 200K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - S. R. Kurtz (505) 844-5436, C. Arnold Jr. (505) 844-8728 and R. C. Hughes (505) 844-8172

Polymer dielectrics are being developed that display a minimum radiation-induced conductivity (RIC). These materials would 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. At this time, Mylar doped with an electron acceptor complex (TNF) is being qualified for use in "weak-link" fireset capacitors and techniques for capacitor manufacture explored.

Keywords: Radiation Effects, Dielectrics, Capacitors, Cables

8. Polysilanes, Photoresists and Non-Charring Dielectrics — 1983 — $ 100K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - J. M. Zeigler (505) 844-0324 and L. A. Harrah (505) 844-6847

Some alkyl substituted polysilanes undergo a novel photolytic depolymerization-volatilization sequence 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. Polysilanes with a different structure 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 cross-linkage materials and current efforts are directed toward polysilanes with these properties.

Keywords: Amorphous Materials, High Temperature Materials, Photoresists

9. Surface Characterization of Organic Materials — 1983 — $ 75K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - J. A. Kelber (505) 844-3408

The surface chemical structures of a variety of organic materials are being studied by Auger and photoemission spectroscopy, and by electron stimulated desorption of neutrals and ions from organic surfaces (EED). The emphasis is on understanding the types of chemical bonding which affect polymer-metal and polymer-metal oxide adhesive bond strength and durability. In addition to providing a means of detecting hydrogen at polymer, metal, and metal oxide surfaces, ESD is proving useful in understanding the basic mechanisms by which ionizing radiation breaks chemical bonds in organic materials. These phenomena are being studied using MgKα x-ray sources and cylindrical mirror analyses to provide Auger and photoemission spectra. ESD studies are being carried out using electron guns and quadrupole mass analyses. A tunable dye laser is being used to ionize desorbed neutrals prior to detection by the quadrupole.

Keywords: Surface Characterization and Treatment, Radiation Effects, Adhesives

10. Improved Methods of Materials Characterization

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - R. E. Whan (505) 844-8904, N. E. Brown (505) 844-2747, K. H. Eckelmeyer (505) 844-7775, J. A. Borders (505) 844-8855 and J. B. Sweet (505) 844-3343

New and improved methods of materials characterization are being developed and implemented. Automated data acquisition and instrument control are being added to a variety of facilities to improve accuracy and efficiency. New facilities include: a system which combines an automated ion scattering spectrometer, a secondary ion mass spectrometer, and a scanning Auger spectrometer for rapid surface analysis; laser source emission spectrometer for micro-analysis; and an automated high performance liquid chromatograph. Improved capabilities include the automation of the inductively coupled plasma system and the laser Raman microprobe system, the development of software for image analysis, and the development of new multivariate least squares methods for quantitative analysis of spectroscopic data. New methods to determine thermal conductivity and thermal diffusivity have been developed using a custom laser pulse diffusivity system and a thermal conductivity linear probe.

Keywords: Materials Characterization, Chemical Analysis, Surface Analysis, Microstructural Analysis, Thermophysical Properties

11. High Strength Uranium Alloys — 1983 $ 75K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - K. H. Eckelmeyer (505) 844-7775

Thermomechanical treatments are being investigated in U-3/4%Ti, U-2%Mo, and U-2%Nb. The goals are to increase strength-ductility combinations in quenched material, and to eliminate the need for quenching to obtain moderate strengths with good ductility. Results to date are very promising. Work is continuing to understand the effects of various processing parameters and to optimize mechanical properties.

Keywords: Metals, Uranium Alloys, Strength

12. Lithium/Sulfur Dioxide Battery-Cathode Research — 1983 $100K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - R. V. Whiteley (505) 844-4031

Experiments are in progress to develop a basic understanding of the cathodic half-reaction of sulfur dioxide in a lithium bromide-acetonitrile solution for the Li/SO_2 battery program. Electrochemical experiments using cyclic voltommetry and double potential step chronocoulometry have been completed to show the effects of cation size on the reduction and dimerization reaction to form the dithionite anion. Methods of highly purifying acetonitrile and lithium bromide have been developed. Tests are being conducted to determine the effects of impurities (water, chloride, lithium oxide, etc.) on the cathodic half-cell reactions and to correlate these effects with battery performance.

Keywords: Sulfur Dioxide, Lithium Bromide, Impurities

13. Erosion Resistant Coatings — 1983 $ 50K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - A. K. Hays (505) 844-9996 and A. Mullendore (505) 844-6833

Chemical vapor deposition of TiS_2 is being studied to determine its potential as an erosion resistant coating for let-down valves in coal liquefaction plants. Abrasion testing is being carried out jointly with Battelle Laboratories in Columbis, OH. One valve has been tested in a coal liquefaction pilot plant in Baytown, Texas.

Keywords: Coatings and Films, Erosion and Wear, Chemical Vapor Deposition

14. Near Net Shape Processing — 1983 $ 50K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - A. K. Hays (505) 844-9996 and A. Mullendore (505) 844-6833

Near net shape processing of nickel objects is being pursued using chemical vapor deposition of nickel with a $Ni_9(CO)_4$ precursor. These nickel objects will be doped with boron to produce high strength, high ductility alloys. A facility is now being constructed to carry out this processing.

Keywords: Alloys, Near Net Shape Processing, Chemical Vapor Deposition

15. Hydrogenation of Silicon Solar Cells — 1983 $ 30K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - A. K. Hays (505) 844-9996 and D. Sharp (505) 844-8604

A Kaufmann ion source has been used to bombard silicon solar cells with hydrogen ions. These experiments have produced record conversion efficiencies (14.7%) in polycrystalline silicon solar cells. Since the relatively inexpensive polycrystalline material can be vastly improved using this treatment, Mobil-Tyco is currently adapting this process for manufacturing.

Keywords: Solar Cells, Semiconductors, Ion Implantation, Surface Characterization and Treatment

16. Welding Processes — 1983 $100K

DOE Contact - Yo T. Song (301) 353-5350
Sandia Contact - J. L. Jellison (505) 844-2747, G. A. Knorovsky (505) 844-1109 and M. J. Cieslak (505) 846-7500

Laser and arc processes are being studied for the production of miniature fusion welds for component envelope closure. Plasma arc welding and CW laser welding have recently been added. Weld processes are tailored to provide joints with optimal mechanical properties. The influence of process variables on the mechanical properties of inertia welds is also being evaluated.

Keywords: Laser Welding, Arc Welding, Mechanical Properties, Inertia Welds

17. Chemomechanical Effects on Brittle Fractures — 1983 $150K

DOE Contact - General
Sandia Contact - R. G. Cuthrell (505) 844-7195

It has been demonstrated that the nature of the chemical environment can influence the fracture behavior of brittle material. It is proposed that this effect is due to stresses and stress gradients introduced into surfaces by diffusible species such as hydrogen. The goal of this project is to establish that such stress states are generated in surfaces exposed to chemical environments by determining the surface stresses under very controlled environmental conditions.

Keywords: Brittle Fracture, Chemical Effects

18. Barrier Anodization Studies — 1983 $ 150K

DOE Contact - General
Sandia Contact - J. K. C. Panitz (505) 844-8604 and D. J. Sharp (505) 844-8604

Process variables which influence the electrical properties of barrier anodized films on aluminum are being studied.

Keywords: Anodized Films, Electrical Properties, Aluminum

19. Passivation by Hydrogen Ion Bombardment — 1983 $ 30K

DOE Contact - General
Sandia Contact - J. K. C. Panitz (505) 844-8604

It has been demonstrated that hydrogen ion bombardment of polycrystalline silicon passivates electronic recombination sites thus enhancing carrier lifetime and mobility. This project is directed toward understanding the mechanism of this effect, modeling the effect, and improving the processing. Studies of ion bombardment induced stress, morphological changes, and changes in electronic properties are being conducted.

Keywords: Ion Bombardment, Silicon, Electronic Properties, Passivation

20. Ion Implantation for Erosion and Wear — 1983 $ 200K

DOE Contact - General
Sandia Contact - L. E. Pope (505) 844-5041

Surface and near-surface layers prepared by ion implantation of reactive and non-reactive species are being evaluated for their erosion and wear properties. The mechanics of reduced erosion and wear are being determined and models to allow improved materials to be generated are being developed. Of particular interest in the implantation of Ti + C in surfaces to generate an amorphous surface with good erosion and wear properties.

Keywords: Ion Implantation, Erosion and Wear

21. Low Pressure Plasma Spraying — 1983 $ 400K

DOE Contact - Marvin Cohen
Sandia Contact - Mark Smith, (505) 846-4270

Low pressure plasma spraying is an advanced thermal spraying technique which allows more effective heating of the injected powder and the deposition of higher purity and higher density deposits. Development work is primarily in the fusion reactor materials development program which is supporting the high heat flux component program. Material of primary interest at the present time is a particle-matrix composite consisting of SiC in an aluminum or nickel matrix. An integral part of the program is material testing and characterization. This material is being developed for possible application to the ALT-II pumped limiter module for the TEXTOR program.

Keywords: Plasma Spraying, Fusion Reactor Materials, Composite Coatings

22. Corrosion — 1983 $1,400K

DOE Contact - General
Sandia Contact - R. B. Diegle (505) 846-3450

Glassy metals can have exceptional corrosion resistance. A program is under way to determine why glassy metals can passivate in aggressive solutions with relatively low levels of chromium content. Understanding this phenomena could lead to better utilization of chromium in conventional stainless steels. We are also studying the relative importance of structure and alloy composition on the corrosion of glassy metals. Ion implantation techniques are being utilized in this investigation.

Studies are also under way 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 Hastalloy materials are being studied in molten glass and in high temperature gaseous environments to support our glass header development program; carbon steels are being studied in battery environments.

Keywords: Metals, Amorphous Materials, Corrosion

23. Ceramic Processing — 1983 $1,600K

DOE Contact - General
Sandia Contact - C. J. M. Northrup (505) 844-5650 and 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, ceramic waste forms for nuclear waste disposal and titanate catalyst support for enhanced oil recovery. The first three materials are utilized in ceramic components at Sandia, and more reproducible products or products with enhanced properties have been produced by these new techniques.

Novel glasses are also being prepared by sol-gel techniques. By using a solution approach to preparing glasses, we have been able to make a number of new materials and apply glasses to a number of new applications. At the present time antireflective coatings are being 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

24. Fracture of Ceramics — 1983 $1,700K

DOE Contact - General
Sandia Contact - R. J. Eagan (505) 844-4069

The fracture properties of ceramic materials often limit their application in weapon and energy systems. A program is underway at Sandia to better understand fracture processes in these materials 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. Studies have shown that processing a glass ceramic to obtain a phase separated glass with an optimized ceramic phase can double the toughness of the glass ceramics. Basic studies on the role of the environment in crack propagation of glasses has 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 (both matrix and fibers) is also underway.

Keywords: Ceramics, Glasses, Fracture, Strength, Corrosion

25. Glass and Glass-Ceramics Development — 1983 $2,500K

DOE Contact - General
Sandia Contact - R. J. Eagan (505) 844-4069 and 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 of interest to Sandia. 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 steel. We have also developed a new glass which is very corrosion resistant to Al ambient temperature battery environments. This glass is presently being used in batteries and has an expected life of five years. We are developing a new glass 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

Sandia National Laboratories - Livermore

1. Uranium Corrosion — 1983 $ 100K

DOE Contact - Yo T. Song FTS 233-5350
Sandia Contact - D. A. Nissen (415) 422-2767 and J. E. Farmer (415) 422-3418

The mechanism of corrosion of bare and coated uranium and uranium alloys in moist air is being investigated using electrical impedance techniques. This experimental method provides a simultaneous measurement of film growth kinetics and film structure. The aim of these studies is to identify coating techniques for these materials that will provide improved corrosion protection.

Keywords: Coatings, Metals, Surface Characterization and Treatment

2. Material Compatibility Studies — 1983 $ 200K

DOE Contact - Yo T. Song FTS 233-5350
Sandia Contact - L. A. West (415) 422-2475, D. H. Doughty (415) 422-3346, W. R. Evan (415) 422-3217, M. R. McClellan (415) 422-2598 and L. R. Thorne (415) 422-2636

Understanding the interaction of a material with its environment is a critical factor in predicting how long that material will survive in a given application or use. For example, studies are being conducted to elucidate the effect of water on organics and metals. Tritium tracer techniques have been used to determine the diffusivity and solubility of moisture in polymers (rubbers, polyimides, polyurethanes, etc.). Degradation also affects heat transfer fluids such as high temperature oils. Gas chromatography/mass spectroscopy has been used to investigate changes with time in the hydrocarbon oil employed at Solar 1 in Barstow, CA as part of the energy storage system. This information is important in predicting the long term stability of this unique pilot plant.

Keywords: Encapsulants, Radioactive Materials, Coatings and Films, Corrosion, Diffusion, Metals, Alloys, High Temperature Service

3. Advanced Electrodeposition Studies — 1983 $ 100K

DOE Contact - Yo T. Song FTS 233-5350
Sandia Contact - D. A. Nissen (415) 422-2767, J. E. Farmer (415) 422-3418 and H. R. Johnson (415) 422-2822

Engineering applications, technology development, and basic studies are being pursued in the area of electrodeposition of metal from both aqueous and non-aqueous media. Electrodeposition of Cu, Ni, and Al is being studied with a focus on the relationship between critical process variables and the mechanical properties of the deposit as well as the role surface active agents play in this process. Techniques being used couple spectroscopic and transient electrochemical techniques and include the use of Laser Raman and fourier transform infrared spectroscopy. Process improvements and new and improved analytical techniques for electroplating baths will result.

Keywords: Metals, Electrodeposition, Mechanical Properties, Aqueous and Non-Aqueous Electrolytes, Spectroscopy, Surface Active Agents

4. Powder Metallurgy — 1983 $ 150K

DOE Contact - Yo T. Song FTS 233-5350
Sandia Contact - D. A. Nissen (415) 422-2767 and J. E. Snugeresky (415) 422-2910

The technology for the production of near net shape Ti alloy and high alloy steel components using hot isostatic pressing of blended elemental powders is being developed. This development includes studies of the effect of variations in processing parameters on mechanical properties of consolidated shapes. Techniques for the production of metal powders such as high alloy steels and uranium alloys by both conventional, inert gas atomization as well as rapid solidification processing are being developed. Emphasis is on material preparation and characterization. Dynamic consolidation is being investigated as a technique for the consolidation of metal powders while retaining unique microstructural modification.

Keywords: Alloys, Amorphous Materials, Metals, Hot Isostatic Pressing, Net Shape Processing, Sintering

5. High Strength Martensitic Stainless Steels — 1983 $ 75K

DOE Contact - Yo T. Song FTS 233-5350
Sandia Contact - W. M. Garrison (415) 422-2767 and J. A. Brooks (415) 472-2051

The physical metallurgy and mechanical property microstructure relationships are being studied for three martensitic precipitation-hardened stainless steels (PH13-8, PH15-5 and Custom 450). This work emphasizes the role of microstructure in determining the strength, toughness, response to forging, crack growth in low pressure hydrogen, corrosion resistance, and weldability of these steels.

Keywords: Alloys, Corrosion, Hydrogen Effects, Joining, Microstructure, Strength

6. Complex Thermodynamic Equilibrium Calculations — 1983 $ 75K

DOE Contact - Yo T. Song FTS 233-5350
Sandia Contact - A. S. Nagelberg (415) 422-3361 and R. W. Carling (415) 422-2206

Computer codes are being developed and implemented to determine the chemical equilibrium state of large, complex systems. The long range goal is the development of a user-friendly and versatile code, easily used by any thermochemical researcher.

Keywords: Thermochemistry, Equilibrium Calculations, Computer Codes, Solid Solutions, Liquid Solutions

7. Hydrogen - Induced Crack Growth — 1983 $ 500K

DOE Contact - Yo T. Song FTS 233-5350
Sandia Contact - M. W. Perra (415) 422-2093, N. R. Moody (415) 422-2522, J. M. Hyzak (415) 422-2098 and S. L. Robinson (415) 422-2209

Quantitative data on the hydrogen-produced crack growth susceptibility of austenitic stainless steels and their weldments are being obtained in high pressure hydrogen gas. The observed effects of hydrogen pressure on crack growth kinetics and thresholds are being used to identify mechanisms and evaluate models by hydrogen embrittlement.

Keywords: Alloys, Hydrogen Effects, Microstructure, Strength

8. Welding Science and Technology

DOE Contact Yo T. Song FTS 233-5350
Sandia Contact - J. C. Swearengen (415) 422-3022, H. W. Perra (415) 422-2093, J. C. Kippold (415) 422-2686, J. A. Brooks (415) 422-2051, J. R. Spingarn (415) 422-3307 and J. E. Snugeresky (415) 422-2910

We are directing considerable effort toward developing a science-based methodology for designing, analyzing, and optimizing welding processes, in order to control microstructure and thereby improve the performance of weld joints. Present activities include microanalytical analyses of solidification processes (in fusion welds), computer modeling of heat flow and deformation (in upset welds), measurements of the characteristics of joining processes, and evaluation of the weldability of specific alloys. Microstructural variables of interest in fusion welds include kinetics of microsegregation and phase transformations during solidification and cooling, hot cracking, the effects of heat flow, and residual stress development. In solid state welds, the primary variables under investigation include metal flow and flow formation, bond development, and residual stresses. Alloy systems of current interest include austenitic and martensitic stainless steels (single phase and precipitation-hardenable), powder-processed alloys (especially U-6Nb), and copper alloys.

Keywords: Joining, Microstructure, Alloys, Transformation

9. Improved Methods for Materials Characterization

DOE Contact - Yo T. Song FTS 233-5350
Sandia Contact - R. W. Rohde (415) 422-2166, D. A. Hissen (415) 422-2767, D. K. Ottesan (415) 422-2787, J. C. Swearengen (415) 422-3022 and L. A. West (415) 422-2475

Improved facilities and methods are being developed to provide more rapid and/or more accurate analyses of material microstructure and microchemistry. These capabilities are required for evaluation of process variables, prediction of material performances, and diagnostics of degradation or failure. New automated data acquisition and control systems have been added which significantly enhance the capabilities of existing laboratory instruments, including a Scanning Auger Microscope, the Fourier Transform Infrared and Laser Raman Spectrometers, an Electron Microprobe, and X-ray Diffractometer and Coupled Plasma Emission Spectroscopy systems. State-of-the-art instruments recently acquired to upgrade our capabilities include a high resolution Scanning Electron Microscope and a Scanning Transmission Electron Microscope.

Keywords: Surface Characterization and Treatment

Lawrence Livermore National Laboratory

(Contract No. W-7405-Eng-48)

1. Dynamic Compaction of Powders — 1983 $ 455K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - William H. Gourdin (415) 422-8093

We are investigating the consolidation of metal and aluminum nitride ceramic powders as an alternative to conventional metallurgical processing. Because of the short time over which consolidation occurs, the technique is of particular interest in the processing of metastable and rapidly solidified powders. We have measured the Hugoniot curves of 4330V steel, aluminum - 6 wt.% silicon, and copper powders and have examined their microstructures following compaction at different stresses. We have developed a simple model for energy deposition behind the shock that adequately describes the local microstructural changes which occur. In conjunction with existing hydrocodes, this model makes possible realistic simulations of the dynamic compaction process.

Keywords: Metals, Ceramics, Amorphous Materials, Near Net Shape Processing

2. Weld Modeling — 1983 $ 350K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - M. Kassner and K. W. Mahin (415) 423-2329

This is a study to improve the understanding and prediction of residual stresses in welds. The approach is to predict the temperature of elements as a function of time during welding and cooling. Constitutive equations that would relate temperature, structure, stress and strain-rate of the base and weld metal would be incorporated into existing mechanical codes. These codes and the thermal analysis would predict residual stresses.

Keywords: Joining Development, Modeling

3. Liquid Pu Corrosion of Refractories — 1983 $ 100K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - Lawrence J. Hrubesh (415) 423-1691

We are studying the relative corrosion resistance of W, Ta, Nb, V, Mo, and Ti to attack by molten plutonium in the temperature range of 800°C to 1200°C. This work is needed to determine the best materials to contain molten plutonium; refractory metals are good candidates. Problems involve rapid dissolution of some refractories in the temperature range 1000°C to 1200°C. We are using immersion tests of refractory metal coupons into molten plutonium and measuring weight loss after post immersion leaching, to determine dissolution rate. We expect to fully characterize the corrosion resistance for all the refractories listed.

Keywords: Corrosion, Materials Characterization, Radioactive Materials

4. Structure-Property Relations of Polymers and Composites — 1983 $ 400K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - John R. Kolb (415) 422-6424

This is a study to be able to predict durabilities of Kevlar and graphite reinforced composites from a basic understanding of the structure, failure processes, and mechanical property relations of Kevlar and graphite fibers and epoxy glasses. The critical structure-property relations of Kevlar have been reported and the chemical degradation and aging of the structures are being addressed.

Keywords: Polymers, Materials Processing, Alternate Materials, Composites, Kevlar, Graphite, Epoxy

5. Directed Energy Surface Modification — 1983 $ 400K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - Elton N. Kaufmann and R. G. Musket (415) 423-2640

The use of energetically implanted ions of solute element and the use of laser or electron beam irradiation for rapid controllable melting and cladding are being investigated for applications to surface property enhancement. Resistance of nuclear and structural metals to reaction in hydrogen, high temperature-oxygen bearing gases, liquid metals, etc. is being tested and results are being related to the parameters of the directed energy processing and the underlying operative mechanisms of surface protection.

Keywords: Ion Implantation, Laser Surface Treatment, e-Beam Surface Treatment

6. Uranium Metallurgy — 1983 $ 100K

DOE Contact - Dr. Yo. T. Song (301) 353-5350
Lawrence Livermore Contact - Dave H. Wood (415) 422-7169

This is a general study in two areas: (1) to understand the synergistic effects of texture and fracture direction on the fracture transition curves of U and (2) to elucidate the mechanism(s) of elevated temperature creep behavior of U as influenced by chemical impurities and thermomechanical processing.

Keywords: Metals, Alloys, Microstructure, Strength

7. Pu Sputtering — 1983 $ 370K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - Harry F. Rizzo (415) 422-6369

This is a study to explore the glass forming ability of various elements with Pu by sputtering. Composite targets of Fe, Co, Os, and Si with Pu are being sputtered and the resulting binary coating compositions will be examined by X-ray and metallographic techniques.

Keywords: Amorphous Materials, Alloys, Sputtering, Corrosion

8. Pu Laser Welding — 1983 $ 100K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - Haskell Weiss (415) 422-6268

This study is to develop a technique for the joining of plutonium by using a laser heat source. This task is being initiated to develop a technique for joining Pu-base materials with a minimum of heat input. Microstructural changes will be characterized as a function of laser welding parameters.

Keywords: Joining, Microstructure

9. Actinide Oxidation/Hydriding — 1983 $ 130K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - Donald L. Seaton (415) 422-6391

The kinetics and detailed mechanism of the reaction or uranium with dry oxygen, oxygen-free water vapor and oxygen-water vapor mixtures are being studied using thermogravimetric and surface sensitive analysis techniques. In addition, the kinetics of the reactions of uranium, plutonium, and plutonium alloys will be studied using manometric and surface sensitive analysis techniques. A detailed understanding of these reactions will make possible more accurate predictions of the service life of uranium and hazards associated with plutonium.

Keywords: Metals, Corrosion, Surface Characterization

10. Water Vapor Permeation Through Elastomer Films — 1983 $ 200K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - Donald L. Seaton (415) 422-6391

The moisture permeation through polymer films will be determined as a function of water vapor partial pressure and temperature. The materials of interest are two adhesives, Halthanes 73-18 and 88-2 (polyurethanes) and the fluorocarbon Kel-F 800. The measurements will be made using the thermogravimetry and ASTM procedures. With this information we will be able to predict the time to interface separation when the materials are used on reactive metal, e.g., uranium.

Keywords: Adhesives, Diffusion

11. Particle Characterization — 1983 $ 200K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - Sam P. Perone (415) 422-6322

The purpose is to develop measurement techniques addressing unique problems related to characterization of non-ideal particulates and novel microstructures. In particular we are exploring mercury intrusion porosimetry as a tool to provide pore size distributions for silicone polymer cushions, low density foams, and high explosive materials, which may correlate with performance characteristics and/or changes in microstructure with aging or treatment.

Keywords: Microstructure, Surface Characterization

12. Microstructure Research — 1983 $ 200K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - Tomas Hirschfeld (415) 422-6364

Structures and devices in the size range of 100 Å - 100 μ 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.

Our 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 doman. 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. Two of our first engineered microdevices are a microdryer and an integrated temperature microsensor.

Keywords: Semiconductors, Coatings and Films, Metals, Catalysts, Diffusion, Surface Characterization

13. Pu Transformations

1983
$ 220K

DOE Contact - Dr. Yo T. Song (301) 353-5350
Lawrence Livermore Contact - Paul Adler (415) 423-4417

We are exploring the relationships between the mechanical properties of plutonium and its phase transformation. This study is looking at transformation-induced plasticity in the $\alpha \longrightarrow \beta$ and $\alpha \longrightarrow \delta$ transformations in the plutonium gallium alloy system. Emphasis is being placed on both the mechanisms and kinetics of these transformations. We are investigating the role that interfacial energy minimization may play in the resulting crystallography of the alpha plutonium materials formed from either the beta or delta phases.

Keywords: Metals, Alloys, Microstructure, Transformation

Los Alamos National Laboratory

(Contract No. W-7405-eng-36)

1. Fluidized Bed Coatings — 1983 $ 150K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - D. W. Carroll (505) 667-2145

Techniques have been developed for low temperature deposition of tungsten, molybdenum, rhenium, and nickel on hollow substrates of spherical and cylindrical shapes. Ultrathin, freestanding shapes have been fabricated.

Keywords: Coatings, Metals, Chemical Vapor Deposition

2. Materials Synthesis by Solid-State Combustion — 1983 $ 50K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - R. G. Behrens (505) 667-8327

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

3. Powder Preparation by Plasma Chemical Synthesis — 1983 $ 100K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - G. J. Vogt (505) 667-5813

Plasma assisted chemical vapor deposition is being developed as a technique for the production of ultrafine, ultrapure ceramic powders. Development work is expected to extend this technology to ultrafine metal and metal alloy powders.

Keywords: Alloys, Ceramics, Metals, Chemical Vapor Deposition

4. Precision Tungsten Tubes — 1983 $ 150K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - D. W. Carroll (505) 667-2145

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

5. Preparation of Filamentary Composite Materials — 1983 $ 160K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - L. R. Newkirk (505) 667-6074

The chemical vapor deposition technology has been developed for the uniform infiltration of carbon and other yarns and fabrics with a variety of elements and compounds. These include but are not limited to tantalum, niobium, TaC, TaB_2, SiC, NbC, B_4C, and TiB_2.

Keywords: Coatings, Composites, Metals, Chemical Vapor Deposition

6. Superhard Materials — 1983 $ 30K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

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.

Keywords: Alloys, Composites, Erosion and Wear, Strength, Hot Pressing, Cutting Tools and Bearings

7. Bulk Glass Fabrication Technology — 1983 $ 15K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Casting and hot forming into hemispheres, disks, plates, sheets, and rods. Composition is controlled to yield good strength, hardness, nuclear requirements, or chemical durability. 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.

Keywords: Amorphous Materials, Glasses, Near-Net-Shape Processing Hot Forming

8. Slip Casting of Ceramics — 1983 $ 160K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Slip casting of many ceramics including aluminum, magnesia, and thoria. 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

9. Whisker Growth Technology — 1983 $ 250K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

SiC and Si_3N_4 are grown as fine, ultra-high-strength single-crystal fibers called whiskers. Research involves investigation of the relationship of process conditions to whisker yield. These materials are used for development of metal, polymer, and ceramic-matrix composites which in turn are candidates for applications requiring high specific strength, such as engines and air frames. Work is expected to lead to development of technology for large-scale production.

Keywords: Ceramics, Composites, Metals, Polymers, Strength, Engines, High Temperature Service, Whiskers

10. Development of Ceramic Matrix Whisker-Reinforced Composites — 1983 $ 51K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Borosilicate glass 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 and resulting in high fracture toughness. Ceramic whisker-reinforced ceramic-matrix composites are potentially applicable to replacement of metals in high temperature applications.

Keywords: Ceramics, Whiskers, Composites, Metals, Fracture Toughness, High Temperature Service Microstructure

11. New Hot Pressing Technology — 1983 $ 200K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

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 laboratory programs and other National Laboratories, 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

12. Glass and Ceramic Coatings — 1983 $ 50K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Develop vitreous enamels and general ceramic coatings to provide radiation-hardened electrical-insulating components for accelerator technology. Research involves synthesizing formulations to bond to various metals, matching of thermal expansion, and preserving electrical insulating qualities.

Keywords: Enamels, Ceramic Coatings, Metals, Radiation Effects, High Temperature Service

13. Cold Pressing and Cold Isostatic Pressing and Sintering — 1983 $ 160K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

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 crucibles and fluxes, fuel pellets, high temperature resistant ceramics for nuclear reactors, and metal filters.

Keywords: Metals, Ceramics, Nuclear Reactors, High Temperature Service, Thoria

14. Single Crystal Growth and Processing — 1983 $ 60K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Single crystal growth is carried out by techniques such as Czochralski, Bridgman-Stockharger, Flux, Sublimation, and the various traveling heater or traveling solvent methods. Materials under investigation include WO_3, LiF with various dopants, and CdTe. Crystals are supplied to programs involving end uses in laser technology, radiation damage studies, and detector fabrication.

Keywords: Semiconductors, Ceramics, Single Crystals, Radiation Effects

15. Plasma-Flame Spraying Technology — 1983 $ 200K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Free-standing shapes, 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, the object being 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

16. Super-Hard Parylene Coating Development — 1983 $ 80K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Use of a unique plasma crosslinking technique during the deposition of thermally pyrolyzed pxylylene monomer in an inert atmosphere yield a highly crosslinked, hard polymer product. New polymer has a thermal stability in an inert atmosphere greater than 500°C.

Keywords: Polymer Coating, Parylene, Encapsulant

17. Three New Conducting Polymers — 1983 $ 140K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

One polyphenylguinoxaline and two polypyrrones, heretofore unknown materials, have been synthesized and all shown unique electrical conductive properties when treated with appropriate doping agents. These new polymers all show better thermal stability than polyacetylene.

Keywords: Polyphenylguinoxaline, Polypyrrone, Conducting Polymers

18. New Highly Conductive Doped Polyacetylene — 1983 $ 140K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

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

19. Surface Property Modified Plastic Components — 1983 $ 70K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

The surface properties of plastic components can be modified by a solvent infusion process. Process may be used to improve biocapability properties of such plastics as acrylics and silicones.

Keywords: Acrylics, Silicones, Polymers, Surface Properties

20. High-Z Loaded Parylene Polymer Coatings — 1983 $ 50K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

High-Z metals such as gold can be infused into parylene coatings using organometallic-solvent systems. Both uniformly loaded and graded Z loaded coatings can be prepared by this method.

Keywords: Parylene, Metal Doped Polymers

21. Low-Density, Microcellular Polyolefin Foams — 1983 $ 150K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Microstructural polyolefin foams with densities between 0.01 g/cc to 0.2 g/cc are manufactured by a nonconventional foaming process. Foams are open-celled and have large surface areas.

Keywords: Foams, Polyolefins

22. Radiochemistry Detector Coatings — 1983 $ 150K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Physical vapor deposition of coatings for radiochemical detectors. Metallic and non-metallic coatings.

Keywords: Coatings and Films, Physical Vapor Deposition, Radiochemical Detectors

23. Target Coatings — 1983 $ 700K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

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

24. Physical Vapor Deposition and Surface Analysis — 1983 $ 450K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

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 of gases and liquid plutonium. Deposition of oriented AlN onto various substrates to enable nondestructive evaluation of materials. Reflective and antireflective coatings for infrared, visible, ultraviolet and x-ray wavelengths.

Keywords: Coatings and Films, Physical Vapor Deposition, Sputtering, Ion Plating, Corrosion, Nondestructive Evaluation

25. Explosion Welding — 1983 $ 35K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Dissimilar metal clads between 5000 series aluminum alloys and 300 series stainless steel have been produced with bond strengths in excess of 33 Kai (225 MPa). Explosion bonds between tantalum and A36 steel have been produced for evaluation and process modeling.

Keywords: Joining, Welding, Explosion Welding

26. High Energy Density, Joining Process Development — 1983 $ 60K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Microcomputer technology and signal analysis for process control and multiaxis programmable component manipulation for high voltage electron beam welder. High voltage electron beam welded modified and spectrometer obtained for beam/target interaction studies. High voltage electron beam welder operational for fabrication of products in fissile material area.

Plasma effects upon laser welding efficiency are studied. Photodiode, accoustic, light spectral and electron current measurements have been made and are being correlated with high speed cinematography and resultant weld geometry. Real time diagnostics of laser welding efficiency are thus under investigation.

Keywords: Welding, Laser, Electron Beam, Diagnostics

27. Arc Welding Process Development — 1983 $ 30K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Video monitoring and varistraint testing established as technique to investigate cracks susceptibility of gas tungsten arc welds. Emphasis directed toward dissimilar metal welds between 304L stainless steel and Inconel 625.

Keywords: Welding, Hot Cracks, Stainless Steel, Inconel, Varistraint, Video

28. Superplastic Forming — 1983 $ 60K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

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 ($\sim$2 μm grain size) has been shown to exhibit superplasticity and will be evaluated in biaxial forming.

Keywords: Superplastic Forming, Near-Net-Shape, Titanium, Utanium Alloys

29. Plutonium Alloy Development — 1983 $1380K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - D. R. Harbur (505) 667-2556

Development of new alloys of plutonium, including casting, thermomechanical working, and stability studies. Measurements of resistivity thermal expansion and bend ductility are made to evaluate fabrication processes and alloy stability.

30. Metallic Glasses — 1983 $ 166K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - R. N. R. Mulford (505) 667-4665

Surface modification of uranium alloys by laser and electron-beam treatments. Also experi mental and calculational modeling studies of atomic-mobility phenomena and irradiation effects in metallic glasses (Fe_{40} Ni_{40} P_{14} B_6 and Pd_{80} Ge_{20}).

Keywords: Alloys, Amorphous Materials, Coatings and Films, Surface Characterization and Treatment, Radiation Effects

31. Structural Ceramics — 1983 $ 310K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - R. N. R. Mulford (505) 667-4665

Development of ceramic materials based on SiC or Si_3N_4 to improve fracture toughness and strength through controlled processing.

Keywords: Ceramics, Composites, Chemical Vapor Deposition, Strength, High Temperature Service

32. Surface Studies — 1983 $ 270K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - W. P. Ellis (505) 667-4043

Studies of surface structures and atomic and electronic properties of uranium alloys and intermetallics, NO_2 and ThO_2 single crystals, semimetallics and UF_4. 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, ThO_2 surface structure, valence bands of UO_2, residues on electro-polished/oxidized uranium, D_2-tungsten interactions, and use of MeV ion beams to probe surface structure.

Techniques used are: Low Energy Election Diffraction (LEED), Auger and Loss Spectroscopies, Ion-Scattering Spectroscopy (ISS), Ultraviolet Photoelectron Spectroscopy (UPS), Synchrotron Radiation, and Van de Graff MeV ion beam diffraction. All items have been addressed in FY 1983 and papers published on most.

Keywords: Alloys, Radioactive Materials, Microstructure, Surface Characterization and Treatment

33. Tritiated Materials — 1983 $ 359K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - D. H. W. Carstens (505) 667-5849

Advanced R&D on low-Z tritiated materials with the emphasis in Li(D,T) (salt). Studies of new methods for preparing, fabricating, and containing such compounds.

Keywords: Tritium, Li(D,T), Tritiated Materials, Radioactive Materials

34. Actinide Surface Properties — 1983 $ 532K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - D. R. Harbur (505) 667-2556

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 on surface reactions, chemisorpton, attack by hydrogen, nature of associated catalytic processes.

Keywords: Actinides, Hydrides, Surface Characterization, Hydrogen Effects, Radioactive Materials

35. Mechanical Properties and Alloy Development — 1983 $ 300K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - R. N. R. Mulford (505) 667-4665

Thermomechanical processing of plutonium alloys to optimize mechanical properties. Study of complex microstructures, grain refinement and deformation-induced transformations.

Keywords: Alloys, Radioactive Materials, Microstructure, Strength, Transformation

36. Mechanical Properties of Uranium — 1983 $ 200K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - R. N. R. Mulford (505) 667-4665

Mechanical properties of U-6 wt% Nb at high strain rates. Hydrogen at ppm levels causes drastic reduction in biaxial ductility with very little effect on uniaxial ductility.

Keywords: Alloys, Hydrides, Radioactive Materials, Microstructures, Strength

37. Low Temperature Electronic Properties — 1983 $ 779K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - R. N. R. Mulford (505) 667-4665

Understand electronic properties of materials through their superconducting and magnetic behavior. Emphasis on actinide elements and their alloys.

Keywords: Alloys, Magnetic Materials, Radioactive Materials, Superconductor

38. Phase Transformations in Pu and Pu Alloys — 1983 $ 375K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - R. N. R. Mulford (505) 667-4665

Mechanisms, crystallography, and kinetics of transformations in plutonium and alloys. Studies use pressure and temperature dilatometry, optical metallography, and x-ray diffraction.

Keywords: Alloys, Radioactive Materials, Microstructure, Transformation

39. X-Ray Diffraction of Actinides at High Pressure — 1983 $ 152K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - R. N. R. Mulford (505) 667-4665

X-ray diffraction status of Actinide metals at pressure using a diamond anvil cell. Compressibility and phase transformations in plutonium and americium are determined. Data relates to f-electron bonding in actinides.

Keywords: Radioactive Materials, Metals, Transformation

40. Neutron Diffraction of Pu and Pu Alloys — 1983 $ 150K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - R. N. R. Mulford (505) 667-4665

Neutron diffraction studies on plutonium and its alloys conducted at the Los Alamos WNR pulsed neutron source. Time-of-flight technique used to do diffraction at elevated temperatures and pressures.

Keywords: Alloys, Radioactive Materials, Transformation, Microstructure

41. Powder Characterization — 1983 $ 125K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Processing of metal or ceramic powders critically depends upon the characterization of the powder being used. This project characterizes the starting powders, for example, RF plasma SiC, and commercial powders of ThO_2, tungsten, copper, and Al_2O_3, among others.

Properties determined include particle size, distribution, morphology, state of agglomeration, and zeta potential.

Keywords: Metal Powder, Ceramic Powder, Particle Size, Zeta Potential

42. Polymers and Adhesives — 1983 $1050K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - W. A. May, Jr. (505) 667-6362

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 for fabrication techniques to specific weapons related materials and components for the purpose of improving efficiency and economy of weapons design.

Keywords: Adhesives, Composites, Polymers Strength, Near-Net-Shape Processing, Surface Characterization, Treatment

43. Salt Fabrication — 1983 $ 400K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. E. Nasise (505) 667-1459

Development and evaluation of fabrication processes of lithium tritide. Techniques involve hot pressing and hot isostatic pressing to near-net-shape to improve part shape versatility, density, and surface quality. Also component integrity studies involving radiation induced growth and outgassing.

Keywords: Tritium, Hydrides, Radioactive Materials, Near-Net-Shape Processing

44. Ceramics Technology — 1983 $ 50K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

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

45. Glass and Ceramic Sealing Technology — 1983 $ 25K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Seals are formed to join ceramic components and ceramic and metal components, which are used in experimental devices for energy technologies. Such components are frequently large assemblies of Al_2O_3 ceramic bodies joined to metals such as kovar or copper by means of brazing to a metallized coating, or glass brazing using a frit. Experimental problems include design of joints and selection of materials to control thermal expansion mismatch stresses.

Keywords: Ceramics, Coatings and Films, Glasses, Metals, Joining

46. Brittle Material Design Methodology — 1983 $ 35K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

This work focuses an analysis of the importance of materials properties in the design of components using brittle materials. The principal case under consideration is a ceramic heat exchanger fabricated from SiC. Other materials considered include MgO and Al_2O_3. The program uses experimental work to generate uniaxial and multiaxial strength data as well as computer analysis. Results will extend the state-of-the-art in brittle materials design.

Keywords: Ceramics, Strength, High Temperature Service, Brittle Materials Design, Computer Analysis

47. Microwave Sintering/Processing — 1983 $ 40K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

In this program, techniques of bonding and sintering of ceramics are being investigated. Materials under study include Al_2O_3 and glass. The method involves the use of very high frequency microwave 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

48. Injection Mold Process for Making Snap-On Fittings — 1983 $ 30K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

High-strength snap-on tube fittings are made from carbon-fiber reinforced nylon by an injection molding process. Fittings are functionally equivalent to brass counterparts.

Keywords: Snap-On Tube Fittings, Nylon Composites, Injection Molding

49. Composite Spring Support Structures — 1983 $ 100K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

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

50. Solid State Bonding — 1983 $ 65K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - J. M. Dickinson (505) 667-4365

Initial experimentation has been conducted on aluminum solid state bonding for seamless ICP 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 fusion experiments.

Keywords: Joining, Solid State Bonding, Sputtering

51. Nondestructive Evaluation

1983
$ 990K

DOE Contact - Dr. Yo Song (301) 353-5350
Los Alamos Contact - R. Morris (505) 667-6216

Develop nondestructive evaluation techniques that produce quantitative estimates of material properties. Apply multivariate analysis to welding processes. Use tomographic techniques to extend radiographic inspections.

Keywords: Nondestructive Evaluation, Radiography, Acoustic Emission

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. The objectives of this research effort are to obtain fundamental biological information on the organization, structure, and function of living organisms and their environment; to determine the health and environmental impacts of energy technology developments on humans and their environment; and to develop new and improved techniques for use of stable and radioactive isotopes for application in research and clinical nuclear medicine practices for diagnosis and treatment of human diseases. The research includes studies of the potential occupational and public health hazards associated with the utilization of toxic materials in energy productions.

1. Development of Mercuric Iodide and Other Compound Semiconductors for X-Ray, Gamma Ray and Optical Detection Applications — 1983 $ 250K

DOE Contact - Gerald Goldstein (301) 353-5348
Institute for Physics and Imaging Science, University of Southern California Contact - Andrzej J. Dabrowski (213) 822-9181

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. Technology transfer to commercial instrument manufacturers has been initiated.

Keywords: Semiconductors, Radiation Effects

2. Radiation Detector Technology — 1983 $ 275K

DOE Contact - Gerald Goldstein (301) 353-5348
Lawrence Berkeley Laboratory Contact - F. S. Goulding (415) 486-6432

Research is conducted on the basic technology of semiconductor radiation detectors, primarily germanium and silicon. Work includes crystal growth and purification, advanced diagnostic methods for measuring material parameters, special device fabrication and testing procedures, and development of optimized electronic signal processing methods. Improved detector systems are developed for physics research, environmental studies and biomedical applications.

Keywords: Semiconductors, Radiation Effects

Materials Sciences Division

The Materials Sciences Division reports to the Director of the Office of Energy Research through the Associate Director for Basic Energy Sciences. The objective of the Materials Sciences program is to conduct fundamental research aimed at increasing the understanding of materials and materials related phenomena of interest to the Department of Energy. Research is conducted primarily at DOE laboratories, universities, and to a lesser extent in industry.

This program is basic or long range in nature and is intended to provide the necessary base of materials knowledge ultimately needed to advance our energy technologies. Emphasis is placed on areas where problems are known to exist or are anticipated and on generic areas of fundamental importance. Another aspect of the program is the development and utilization of unique facilities used not only by DOE contractors but also by other laboratory, university, and industry scientists. These special facilities are available within the 14 Collaborative Research Centers and are described in detail in the Materials Sciences Programs annual listing of projects report (see Section D of the FY 1983 Report).

Some of the research is directed at a single energy technology (e.g., photovoltaic materials for direct conversion of solar energy into electricity), whereas other research is applicable to many technologies simultaneously (e.g., the embrittlement of structural materials due to the presence of hydrogen) and still other has more fundamental implications underpinning all materials research (e.g., mechanisms of atomic transport in solids).

At the DOE laboratories, technology and information transfer occurs quickly between the basic and applied programs when they are co-sited at the same laboratory. The Materials Sciences subprogram also supports research at universities and to a lesser extent industrial laboratories, taking advantage of the unique expertise of researchers at each of the different types of institutions. Coordination of DOE's applied materials development efforts with the Materials Sciences program takes place primarily through the DOE Energy Materials Coordinating Committee (EMaCC), but also through Materials Sciences Research Assistance Task Forces, technology meetings, and less formal contacts among staff members. The program utilizes workshops and reports of its Council on Materials Science (a non-governmental body with representatives from academia, industry, and DOE laboratories) to help focus on critical issues. In FY 1981, the Council reviewed research needs and opportunities in the areas of radiation effects and theory of condensed matter/role of computation. For FY 1982, two areas: nuclear waste and materials research at high pressure were reviewed. During FY 1983, two additional Panel meetings were held, surface modification and organic conductors. Reports of these Panel meetings are available from the Materials Sciences office. Many of the past reports have been published in the open literature.

The Materials Sciences Division has three major categories which represent the disciplines involved and the administrative units in the program: (a) Metallurgy and Ceramics, (b) Solid State Physics, and (c) Materials Chemistry. The following description of the program is separated into those three categories. Further information can be obtained by contacting Dr. L. C. Ianniello, Director, Division of Materials Sciences (301-353-3427) or other staff members:

Dr. M. C. Wittels, Branch Chief for Solid State Physics and Materials Chemistry

Dr. T. A. Kitchens, Solid State Physicist

Dr. S. M. Wolf, Metallurgist

Dr. R. J. Gottschall, Ceramist

A description of all the Division's projects is given in an annual summary report--the most recent is Materials Sciences Programs FY 1983, DOE/ER-0143/1.

1. Metallurgy and Ceramics

	1983
	$43.85M

The objective of research conducted under the metallurgy and ceramics category is primarily to better understand how metallic and ceramic materials behavior/properties are related and controlled by structure and processing conditions. By processing is meant the methods and techniques used to prepare, form, or fabricate materials. Important properties of materials such as fracture, plastic flow, superconductivity, corrosion resistance, radiation resistance, and transport phenomena all depend on structure. As a consequence of this improved understanding, better materials and a greater ability to predict behavior of materials in energy systems will eventually be possible. Although basic in nature, the program is centered around research areas deemed to be of greatest interest for energy systems. For example, there is within the metallurgy and ceramics category a strong emphasis on hydrogen effects, radiation effects, corrosion, creep and high temperature deformation, high temperature ceramics, and superconductivity. Research is carried out at INEL, Ames, ANL, LANL, LBL, LLNL, ORNL, PNL, Sandia, SERI, and universities.

The structure of materials area supports research designed to enhance our understanding of the atomic, electronic, defect, and microstructure of materials, how they are affected by chemical composition and processing, and how they related to material properties.

The budget area of mechanical properties is concerned with material behavior related structural integrity requirements of all energy systems. Research addresses the understanding of strength at high and low temperatures creep, fatigue, elastic constants, micro- and macro-strain, fracture, and mechanical-chemical effects in hostile environments.

Research under the physical properties area is directed toward understanding the fundamental phenomena controlling thermal, optical, mass transport, and electrical properties of materials, how they can be altered by various heat treatments or other processing steps, and how they are affected by external variables such as temperature and pressure.

The radiation effects area encompasses research delineating radiation induced changes of materials properties important to fusion and fission energy concepts. The effect of irradiation, both neutron and ion, on mechanical properties, structure and electrical properties is studied in this area.

In the engineering materials area, research is aimed at understanding more fully the complex materials and phenomena generally associated with real world materials problems. Some of the topics under study include: erosion, friction and wear, engineering corrosion and fracture, welding and joining, non-destructive evaluation, and the forming and processing of materials.

2. Solid State Physics

1983
$53.5M

The solid state physics category is directed toward fundamental research on matter in the condensed state, wherein the interactions of electrons, atoms, and defects are tracked with the purpose of determining the critical properties of solids. These interactions are the ultimate source of all materials properties. Research under this category includes a broad spectrum of experimental and theoretical efforts, which contribute basic solid state knowledge important to all energy technologies. Accelerated progress is made in this field through the rapid advancements in unique experimental tools and their coupling with high-speed computer systems. Through these efforts, fundamental understanding of matter in the condensed state contributes broadly to characterizing material properties and processes important for all energy technologies. Research is carried out at Ames, ANL, BNL, LANL, LBL, LLNL, ORNL, PNL, Sandia, and universities.

There are five budget areas within the solid state physics category: neutron scattering, experimental research, theoretical research, particle-solid interactions, and engineering physics.

The neutron scattering area supports research of a unique kind, namely the use of the neutron as an analytical probe of the properties of solids and liquids. With this probe, fundamental parameters of superconductors, magnets, hydrides, and solid imperfections are determined in a manner that cannot be accomplished by any other technique. The exploitation of this probe is being advanced by recent development of more efficient monochromators and wider use of longer wavelength probes. Increased efforts are conducted with neutrons from pulsed spallation sources at ANL and LANL. The bulk of the Nation's efforts in this important area has historically been supported at DOE laboratories, where the advanced research reactors are in operation.

The experimental research area is very broad and includes all fundamental investigations, experimental in concept, on liquids and solids of metals, alloys, semiconductors, insulators, and compounds. The area of high-temperature energy systems is being pursued. Ion implantation and backscattering research is being used to learn how to improve superconductor and photovoltaic performance. Hydrogen and hydrides are under study through ultra-high-pressure and spectroscopic techniques. Synchrotron radiation is utilized in characterizing surfaces with particular relation to catalytic response.

With nearly all these experimental areas, a highly advanced theoretical research program is closely coupled. A large part of the theoretical effort is directed towards dynamic processes in solids and liquids and requires extensive use of DOE's most advanced computer complexes.

Under particle-solid interactions, a major effort is underway to correlate the complex effects of particles of different mass, energy, and charge not only on surfaces but in bulk materials as well.

The engineering physics area supports research to fulfill the much needed goal of utilizing solid state physics expertise in engineering research for which it has a unique capability. Typical of the work initiated are research laboratory investigations of novel processing techniques with mass spectrometer-computer control for complex material preparation, such as solar materials and superconducting alloys. Another area is the extension of cryogenic and refrigeration techniques to new fluid systems that hold promise for the utilization of low-grade heat.

3. Materials Chemistry

1983
$11.3M

The materials chemistry category provides support for research directed toward developing our understanding of the chemical properties of materials as determined by their composition, structure, and environment (pressure, temperature, etc.) and to show how the laws of chemistry may be used to understand physical as well as chemical properties and phenomena. Included, for example, are studies of energy changes accompanying transformations, the influence of varying physical conditions on rates of transformations, and the manner in which the structure of atomic groupings influences both properties and reactivity.

Chemical concepts coupled with physical experimental techniques are used to study the kinetics of reactions of solids and liquids, the interaction and/or penetration of species in adjacent media, corrosion phenomena and the stability of high-temperature materials of interest to fossil and geothermal technologies. The program also includes research on the chemical thermodynamics of fission produces and their interactions with fuels and cladding materials. Electrochemistry is an important aspect of research supported under this category. Research involving elastomers and polymers is also being pursued. Research is carried out at Ames, ANL, LANL, LBL, LLNL, ORNL, and universities.

There are three budget areas in the materials chemistry category: structural chemistry, engineering chemistry, and high-temperature and surface chemistry.

Structural chemistry involves studies of a wide variety of problems where a knowledge of the relationship between the atomic structures of materials and their reactivity is required. Important examples of these effects include the influence of different chemical environments on the catalytic properties of metals. Changes in both the crystal and magnetic structures of compounds are correlated with their specific roles in fuel synthesis, for example.

The methods of engineering chemistry are applied to problems that are currently limiting the efficiency of energy conversion systems. Examples of research underway include: structural and morphological changes that arise during the charge-discharge cycles of the high-temperature battery and studies of thermodynamics of advanced nuclear fuels.

The high temperature and surface chemistry area includes programs on fundamental studies of the influence of surface properties on reactivity. The correlation of mass transport and thermodynamic properties of molten salts in high-temperature battery systems and chemical studies of the influence of micro-inclusions such as sulfides on the formation of pits and crevices to determine whether these inclusions play a significant role in the initiation of stress-corrosion cracking are examples of research underway.

Advanced Research and Technology Development

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.

1. Management of the AR&TD Fossil Energy Materials Program — 1983 $ 350K

DOE Contact - S. J. Dapkunas (301) 353-2784
Oak Ridge National Laboratory (ORNL), (Contract No. W-7405-eng-26) Contact - R. A. Bradley and P. T. Carlson (615) 574-6094

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 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

2. Technical Monitoring of Coal Gasification Subcontracted Materials Projects for the AR&TD Fossil Energy Materials Program — 1983 $ 45

DOE Contact - S. J. Dapkunas (301) 353-2784
Argonne National Laboratory (ANL), (Contract No. W-31-109-eng-38) Contact - W. A. Ellingson (312) 972-5068

The purpose of this technical management activity is to provide DOE Oak Ridge Operations and ORNL 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

3. Assessment of Materials Needs for Advanced Steam Cycle Pulverized Coal Plants — 1983 $ 75K

DOE Contact - S. J. Dapkunas (301) 353-2784
ORNL, (Contract No. W-7405-eng-26) Contact - P. L. Rittenhouse (615) 574-5103

The purpose of this task is to assess the status of materials technology for advanced steam cycle pulverized coal plants and to identify materials research and development which would permit the design, construction, and reliable operation of more efficient power plants.

A pulverized coal power plant employing an advanced steam cycle to improve the overall plant efficiency will be defined by a consultant knowledgeable about pulverized coal power plants. The proposed system(s) will be analyzed using existing computer codes to determine the net efficiencies achievable with various steam conditions, e.g., at temperatures between 1100 and 1200°F and pressures between 4000 and 5000 psi. Through consultation with boiler and turbine-generator manufacturers, the ability of existing materials to meet the requirements for advanced steam cycles will be determined. Materials research and development needs and areas of research which will provide the greatest payback in terms of improved efficiency and/or plant availability will be identified. An assessment report documenting the findings and recommendations resulting from the study will be prepared. A draft of the report will be sent to boiler manufacturers, turbine-generator manufacturers, and EPRI (and their contractors) for their review and comment. The final report will address the comments received in the review by industry.

Keywords: Combustion, Pulverized-Coal, Materials, Assessment

4. Materials and Components in Fossil Energy Applications Newsletter — 1983 $ 135K

DOE Contact - S. J. Dapkunas (301) 353-2784
Battelle-Columbus Laboratories, (Contract No. DE-AC05-80ET10609) Contact - E. E. Hoffman (DOE/ORO) (615) 576-0735 and I. G. Wright (BCL) (614) 424-4377

The purpose of this task is to publish a newsletter to address recent developments in materials and components in fossil energy applications.

Keywords: Materials, Components

5. Investigation of the Weldability of Iron and Nickel Aluminides — 1983 $ 20K

DOE Contact - S. J. Dapkunas (301) 353-2784
Auburn University, Mechanical Engineering Department, (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 19X-43335V) Contact - W. A. Jemian (205) 826-4820

The purpose of this project is to investigate the weldability of iron and nickel aluminides using gas tungsten arc and electron beam processes. The fusion zone grain structure and microscopic segregation within the weld metal will be characterized. The cracking tendency of the weld and heat affected zones will be related to various welding parameters, weldment microstructural characteristics, and segregation behavior. The microstructure and cracking behavior will be analyzed in terms of phase relationships and thermodynamics.

Keywords: Intermetallics, Welding, Strength

6. Microstructural Control to Improve Properties of Weldments in Chromium-Molybdenum Steels — 1983 $ 50K

DOE Contact - S. J. Dapkunas (301) 353-2784
Combustion Engineering, Inc., Metallurgical and Materials Laboratory, (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 11X-64760V) Contact - E. W. Pickering, Jr. (615) 752-7196

This project is concerned with the production and evaluation of shielded metal arc (SMA) and submerged arc (SA) welds to determine the effects of composition of welding consumables and welding parameters on the microstructure and properties of the weldments. Welding parameters to be studied will include heat input, preheat and interpass temperature, welding techniques, and postweld heat treatments. The study of welding consumable composition will include the effect of important elements as well as deoxidation and basicity of electrodes and fluxes. Materials will include microalloyed versions of 3 Cr-1.5 Mo and 9 Cr-1 Mo steels.

Keywords: Steels, Weldments

7. Characterizing and Improving the Toughness of Thick-Sectioned Electroslag Weldments — 1983 $ 101K

DOE Contact - S. J. Dapkunas (301) 353-2784
Colorado School of Mines, Department of Metallurgical Engineering, (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 19X-07219C) Contact - R. H. Frost and G. R. Edwards (303) 273-3777

The objective of this program is to characterize the effects of process variables, including potential, electrode composition and velocity, and flux composition, that are important to the optimization of the electroslag welding process. Early work focused on electroslag weldments in 100 mm plates of 2¼ Cr-1 Mo steel. Emphasis was placed on process control and flux development rather than microstructural and mechanical properties characterization. Welding of thicker plates is not envisioned since to some extent commercially produced electroslag weldments in 2¼ Cr-1 Mo steel are currently available. In contrast, this project is aimed at a more fundamental understanding of the electroslag welding process.

Keywords: Materials Processing, Joining Methods, Materials Characterization

8. Development of Iron and Nickel Aluminides — 1983 $ 140K

DOE Contact - S. J. Dapkunas (301) 353-2784
ORNL, (Contract No. W-7405-eng-26) Contact - C. T. Liu (615) 574-4459

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 development of iron and nickel aluminides for critical components in coal conversion systems would rely on understanding the structure-property relationships that determine

the oxidation/sulfidation behavior and the mechanical properties. This will require a knowledge of the physical metallurgy of the alloy systems involved as well as the source of the grain boundary embrittlement and the oxide/sulfide formation. Compositional control by macro- and micro-alloying and microstructural control by processing techniques will be used to optimize the desirable properties.

Initial 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 be extended to the FeAl-NiAl system which contains 50 at. % Al for better oxidation and corrosion resistance.

Keywords: Strength, Intermetallics, Alloys

9. An X-Ray Study of Residual Stresses in Narrow Groove TIG Weldments — 1983 — $ 45K

DOE Contact - S. J. Dapkunas (301) 353-2784
Pennsylvania State University, Materials Research Laboratory, (Contract No. DE-AC05-790R13591) Contact - C. O. Ruud (814) 863-2843

X-ray diffraction techniques are being used to measure residual stresses adjacent to welds of various types. The first activity is an X-ray stress analysis of the NG-GTA weld produced by Westinghouse-Tampa. This will be followed by a detailed analysis of a SAW weld and a NG-GTA weld in the 300 mm plate of 2¼ Cr-1 Mo steel obtained by ORNL. Efforts will be made to procure and analyze an electron beam (EB) weldment in the same plate. An examination of residual stress distribution in cladding will be made. Experimental data obtained on weldments will be correlated with predictions based on a finite element model and on experimental mechanical properties data produced elsewhere in the AR&TD Program.

Keywords: Materials Processing, Materials Characterization

10. Design of Low Alloy Steels for Thick-Walled Pressure Vessels — 1983 — $ 135K

DOE Contact - S. J. Dapkunas (301) 353-2784
University of California, Department of Materials Science, (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 7843) Contact - E. R. Parker, R. O. Ritchie and D. S. Sarma (415) 642-0863

The objectives of this project are primarily aimed at producing a modification of 2¼ Cr-1 Mo steel (Ni, Cr, Si, and Mn additions) to improve hardenability, toughness, and resistance to temper embrittlement. Good progress has been made in this direction but there has not been a great deal of industrial interest in the compositions currently being examined. Rather, concerns with respect to reaction vessel materials have produced interest in higher chromium materials that have good strength. Nevertheless, a 2¼ Cr-1 Mo steel could continue to be of interest providing that stable microstructures can be developed that are strong, tough, and resistant to hydrogen attack. This project will lead the AR&TD effort to produce a modified alloy that can be used in reaction pressure vessels at temperatures as high as 540°C. Alloys that have been produced and characterized through this task on design of low alloy steels will be examined in some detail to evaluate their adequacy with respect to strength, toughness, and resistance to hydrogen attack under dynamic loading.

Keywords: Alloy Development, Alternative Materials

11. Microstructure and Micro-mechanical Response in Austenitic Stainless Steel Overlays on Low Alloy Steel Plate — 1983 $ 50K

DOE Contact - S. J. Dapkunas (301) 353-2784
University of Cincinnati, Department of Materials Science and Metallurgical Engineering, (Contract No. W-7405-eng-26, Union Carbide Corporation 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, micro-mechanical response and macroscopic mechanical behavior. Microhardness is being used to establish the material micro-mechanical 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

12. The Fatigue Behavior of Chromium-Containing Ferritic Steels at Elevated Temperatures — 1983 $ 70K

DOE Contact - S. J. Dapkunas (301) 353-2784
University of Connecticut, Metallurgy Department, (Contract No. W-7405-eng-26, Union Carbide Corporation 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

13. Transformation, Metallurgical Response and Behavior of the Weld Fusion and Heat Affected Zone in Cr-Mo Steels for Fossil Energy Applications — 1983 $ 80K

DOE Contact - S. J. Dapkunas (301) 353-2784
University of Tennessee, Department of Chemical, Metallurgical and Polymer Engineering, (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 7685X77) 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

14. Development of Narrow Groove-Gas Tungsten Arc (NG-GTA) Welding Procedures for Thick Sections of 2¼ Cr-1 Mo Steel — 1983 $ 30K

DOE Contact - S. J. Dapkunas (301) 353-2784
Westinghouse Electric Corporation, Tampa Division, (Contract No. DE-AC05-78OR13511) Contact - U. A. Schneider (904) 474-4395

A variation of the gas tungsten arc welding process was investigated. This process uses AC-heated filler wire and a narrow joint preparation to increase the rate at which filler metal is deposited and reduce the amount of filler necessary for a given application. Welding characteristics of the system and properties of the weld were investigated. A field demonstration of the process, including all necessary fixturing and positioning equipment, was made after laboratory research was completed.

Keywords: Materials Processing

15. Developing New Materials by Rapid Decompression (Pressure Quenching) — 1983 $ 125K

DOE Contact - S. J. Dapkunas (301) 353-2784
R&D Associates, (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 22X-72819C) Contact - Richard Latter (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 μsec 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

16. Hydrogen Attack in Cr-Mo Steels at Elevated Temperatures — 1983 $ 150K

DOE Contact - S. J. Dapkunas (301) 353-2784
Cornell University, Materials Science and Engineering Department, (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 7963) 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 2¼ Cr-1 Mo steels (primarily ASTM 387) 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 plant operations. 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 some sort of evaluation. The work on the effect of constant stress and pressure on the nucleation and growth of methane bubbles in low alloy steels will be continued. Models will be developed, based on experimental observations, to describe hydrogen attack in 2¼ Cr-1 Mo steel and the important metallurgical parameters will be identified.

Keywords: Hydrogen Effects

17. Analysis of Hydrogen Attack on Pressure Vessel Steels — 1983 — $ 40K

DOE Contact - S. J. Dapkunas (301) 353-2784
University of California at Santa Barbara, Department of Chemical and Nuclear Engineering, (Contract No. W-7405-eng-26, Union Carbide Corporation 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 and 2¼ Cr-1 Mo steel. 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 fracture 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

18. Deformation and Fracture of Low Alloy Steels at High Temperatures — 1983 — $ 106K

DOE Contact - S. J. Dapkunas (301) 353-2784
University of Illinois, Department of Mechanical and Industrial Engineering, (Contract No. W-7405-eng-26, Union Carbode Corporation 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 2¼ 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

19. Study to Optimize Cr-Mo Steels to Resist Hydrogen and Temper Embrittlement — 1983 — $ 91K

DOE Contact - S. J. Dapkunas (301) 353-2784
Westinghouse Electric Corporation Research and Development Center, (Contract No. DE-AC05-780R13513) Contact - B. J. Shaw (412) 256-3255

This program developed from earlier work sponsored by the American Petroleum Institute and has as its objective the establishment of the effects of composition and strength level on the tendency of Fe-Cr-Mo steels to undergo temper or hydrogen embrittlement (K_{ISCC}). Although these correlations will be developed from knowledge of the composition and heat treatment, the resulting model is expected to be largely empirical and lack a sound metallurgical basis. To rectify this situation Westinghouse initiated a

new program to fully characterize the microstructures and constituents in the alloys prepared for the embrittlement work. The characterization data will be of considerable value to the hydrogen attack studies.

Keywords: Hydrogen Effects

20. Creep Rupture of High-Chromium Alloys in Mixed Gas Environments — 1983 $ 95K

DOE Contact - S. J. Dapkunas (301) 353-2784
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - W. A. Ellingson and K. Natesan (312) 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

21. Biaxial Stress-Rupture of Alloys in Coal Gasification Atmospheres — 1983 $ 160K

DOE Contact - S. J. Dapkunas (301) 353-2784
EG&G Idaho, Inc., Idaho National Engineering Laboratory, (Contract No. DE-AC07-76ID01570) Contact - G. R. Smolik (208) 526-8317

The purpose of this program is to measure the biaxial stress-rupture strength and ductility of type 310 stainless steel, alloy 800H, Haynes alloy 188, and Inconel 657. Test temperatures range from 649 to 982°C, and times of the tests are up to 500 h. Data from this continuing program will be used to supplement existing data on these alloys for coal gasification environments since little information exists on the structure of these alloys after exposure to coal gasification environments.

Keywords: Creep, Gasification

22. Corrosion in Coal Liquefaction Processes — 1983 $ 0K (Prefunded in FY 1982)

DOE Contact - S. J. Dapkunas (301) 353-2784
The Metal Properties Council, Inc., (Contract No. DE-AC05-790R13546) Contact - Martin Prager, F. F. Lyle, Jr. and L. M. Adams (212) 644-7693

The objectives of this program are to (1) determine the general susceptibility of carbon steels, stainless steels, and nickel-base alloys to corrosion in coal liquids; (2) identify and measure concentrations of suspected corrosive species in coal liquids before and after corrosion tests; (3) determine the effect of temperature on corrosion of metals and on the stability of corrosive species in coal liquids; (4) relate extent, type of corrosion, and corrosion mechanism(s) to corrosive species present in coal liquids; and (5) provide background data for the interpretation of results and in-situ corrosion tests and failures in liquefaction plants.

Keywords: Corrosion

23. Corrosion in Coal Derived Liquids — 1983 — $ 65K

DOE Contact - S. J. Dapkunas (301) 353-2784
ORNL, (Contract No. W-7405-eng-26) Contact J. R. Keiser and R. R. Judkins (615) 574-4453

The purpose of this research is to study the modes of corrosive attack occurring in coal liquefaction processes. Such corrosion modes include general attack by organic and inorganic acids and stress corrosion cracking. Basic corrosion studies are conducted to understand the reaction between the oxidants and engineering materials. In addition, this task includes pilot plant testing of alloys for resistance to corrosion and stress corrosion cracking in various coal liquefaction process stream environments. The results of this work should provide an understanding of the various corrosion modes observed as well as alloy screening data to permit selection of alloys for use in future plants.

Keywords: Corrosion

24. Corrosion of Alloys for Internals and Heat Exchangers in Gasification Environments — 1983 — $ 120K

DOE Contact - S. J. Dapkunas (301) 353-2784
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - W. A. Ellingson and K. Natesan (312) 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

25. Screening and Study of Behavior of Materials Subjected to Combined Erosion and Corrosion — 1983 — $300K

DOE Contact - S. J. Dapkunas (301) 353-2784
The Metal Properties Council, Inc., (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 19X-40455C) Contact - A. O. Schaefer and E. J. Vesely (212) 705-7693

The purpose of this program is to obtain experimental information on the synergistic effects of corrosion and erosion. Complex laboratory experiments are carried out to evaluate the effects of corrosive environments on erosion behavior. These tests are carried out at high temperature (to 900°C) and high pressure (to 0.7 MPa). Particle velocities of 60 m/s in a corrosive environment are studied. The results from this work will establish the critical erosion parameters for increased materials degradation in an erosion-corrosion environment at elevated temperatures.

Keywords: Erosion, Corrosion, Materials Characterization

26. Corrosion of Alloys in FBC Systems — 1983 — $ 120K

DOE Contact - S. J. Dapkunas (301) 353-2784
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - W. A. Ellingson and K. Natesan (312) 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

27. Investigation of Gas-Metal Reactions in Cyclic Oxidizing and Reducing Atmospheres and the Effect of Sulfate Deposits on Corrosion — 1983 — $ 150K

DOE Contact - S. J. Dapkunas (301) 353-2784
ORNL, (Contract No. W-7405-eng-26) Contact - J. H. DeVan and P. J. Ficalora (615) 574-4451

The purpose of this task is to determine the corrosion properties of heat exchanger and uncooled internal structural materials under normal and off-normal heating conditions in coal-fired fluidized-bed combustors (FBCs).

The materials are exposed to simulated FBC environments under a variety of well-defined operating conditions in order to systematically evaluate corrosion-erosion mechanisms as they apply to heat exchanger surfaces in coal-fired, limestone-scavenged fluidized beds. This task is intended to guide the selection of materials of construction for utility and industrial AFBCs intended for the mid-1980s.

Keywords: Gas-Metal Reactions, Fluidized-Bed Combustors

28. Hot Corrosivity of Coal Conversion Products on High-Temperature Alloys — 1983 — $ 85K

DOE Contact - S. J. Dapkunas (301) 353-2784
University of Pittsburgh, (Contract No. DE-AC01-79ET13547, Union Carbode Corporation Subcontract No. 19X-43346C) Contact - G. H. Meier, R. A. Stoehr and E. A. Gulbransen (412) 624-5316

The object of this program is to develop information about the hot corrosion of high-temperature alloys in the environment likely to be found when a gas turbine is operated on low Btu gas produced from coal in a fluidized bed gasifier. The program is designed to determine the mechanisms of attack and the major factors which influence the kinetics of hot corrosion in these environments.

Keywords: Corrosion

29. Cathode Material Development for Carbonate Fuel Cells — 1983 $ 97K

DOE Contact - S. J. Dapkunas (301) 353-2784
General Electric Company, (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 11X-43123C) Contact - K. W. Browall and C. E. Baumgartner (518) 385-8678

The purpose of this work is to identify and characterize materials that will be candidates for use as cathodes in molten carbonate fuel cells. A critical problem in molten carbonate fuel cells is the loss of nickel from the cathode material. This work focuses on the selection of alternate cathode materials on the basis of the chemical stabilities and solubilities of candidate materials in the molten electrolyte and their electronic conductivities.

Keywords: Fuel Cell, Cathode, Corrosion

30. Investigation of the Mechanisms of Molten Salt Corrosion of Candidate Materials for Molten Carbonate Fuel Cells — 1983 $ 125K

DOE Contact - S. J. Dapkunas (301) 353-2784
ORNL, (Contract No. W-7405-eng-26) Contact J. H. DeVan (615) 574-4451

This program focuses on the corrosion mechanisms associated with the anode and cathode current collectors in molten carbonate fuel cells. DTA/TGA studies of structural metals in Li_2CO_3-K_2CO_3 salts will be conducted to establish the sequence of oxidation reactions that occur between the elements Fe, Ni, Cr, and Co and the salt in an oxidizing gas typical of the cathode region. The resistance of Ni_3Al to a thin coating of Li_2CO_3-K_2CO_3 will be evaluated under reducing (anodic) and oxidizing (cathodic) conditions. Lastly, 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 Al_2O_3) in molten carbonate salt under anodic and cathodic conditions.

Keywords: Fuel Cells, Current Collectors

31. Oxide Electrodes for High Temperature Fuel Cells — 1983 $ 225K

DOE Contact - S. J. Dapkunas (301) 353-2784
Pacific Northwest Laboratory, (Contract No. DE-AC06-76RL01830) Contact - J. L. Bates and D. D. Marchant (509) 375-2579

This project is a research effort to find and develop highly electronically conducting oxides with resistance to corrosion in molten alkali metal carbonates. The oxides are to be used as cathodes in molten carbonate fuel cells. Specifically, the work will determine the effects of rare earth (RE) and indium oxide additions on the electrical transport properties and on the corrosion resistance of $HfO_2(ArO_2)$-RE_xO_y-In_2O_3. In addition, the study will develop an understanding of the crystallographic, microstructural, and phase equilibrium factors which influence the above properties. Materials will be fabricated for testing under molten carbonate fuel cell conditions.

Keywords: Fuel Cells

32. Effects of Alkali- and Sulfur-Enhanced Corrosion of Advanced Energy Systems — 1983 $ 150K

DOE Contact - S. J. Dapkunas (301) 353-2784
Aerodyne Research, Inc., (Contract No. W-7405-eng-26), Union Carbide Corporation Subcontract No. 86X-47953C) Contact - G. W. Stewart and C. E. Kolb (617) 663-9500

This research effort is to investigate and characterize the phenomena associated with magnetohydrodynamics (MHD) channel electrodes and, in particular, the anode degradation mechanisms. Equilibrium thermochemistry and diffusion-controlled mass transport principles will be used to extend an existing theoretical model to develop a detailed description of the corrosion processes in terms of the diffusive transport of sulfur. A one-dimensional diffusion layer model which describes the turbulent transfer of species from the core of the MHD channel flow to the condensed layer will be developed. Experiments will be performed to measure the corrosion rate as a function of temperature, sulfur concentration and current. Four anode materials will be exposed to a simulated MHD plasma to investigate the dependence of the structure and composition of the passive and corrosion product layers as well as the dependence of the corrosion rate on surface temperature, sulfur concentration, and arc current. The materials to be investigated are Inconel 600, E-Brite 26-1, platinum-clad Cu, and pure Cu. Based on the experimental results, the theoretical models will be refined to reflect the specific aspects of the corrosion process. In particular, the effects of diffusion-controlled mass transfer on the degree of corrosion will be incorporated into the model. The understanding of extreme corrosion problems, such as the MHD anode degradation problem in high-sulfur atmospheres, will enhance the understanding of such phenomena in other advanced coal combustion and conversion systems.

Keywords: MHD, Corrosion, Anode

33. Erosion in Dual-Phase Microstructures — 1983 — $ 170K

DOE Contact - S. J. Dapkunas (301) 353-2784
University of Notre Dame, Department of Metallurgical Engineering and Materials Science, (Contract No. W-7405-eng-26, Union Carbide Corporation 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 containing 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 (SPP) 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

34. Evaluation of Advanced Materials for Slurry Erosion Service — 1983 — $ 225K

DOE Contact - S. J. Dapkunas (301) 353-2784
Battelle-Columbus Laboratories, (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 85X-69611C) Contact - I. G. Wright and 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 tungsten 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

35. Studies of Materials Erosion in Coal Conversion Systems — 1983 $ 300K

DOE Contact - S. J. Dapkunas (301) 353-2784
Lawrence Berkeley Laboratory, (Contract No. DE-AC03-76SF00098) Contact - A. V. Levy (415) 486-5822

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

36. Mechanisms of Galling and Abrasive Wear — 1983 $ 145K

DOE Contact - S. J. Dapkunas (301) 353-2784
National Bureau of Standards, Center for Materials Science, (Contract No. DE-AI05-830R21322) Contact - K. J. Bhansali (301) 921-2982

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

37. Mechanisms of Erosion-Corrosion in Coal Liquefaction Environments — 1983 $ 150K

DOE Contact - S. J. Dapkunas (301) 353-2784
ORNL, (Contract No. W-7405-eng-26) Contact - J. R. Keiser and P. J. Ficalora (615) 574-4453

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

38. Nondestructive Testing: Erosive Wear Detection — 1983 $ 90K

DOE Contact - S. J. Dapkunas (301) 353-2784
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - W. A. Ellingson and K. J. Reimann (312) 972-5068

The purpose of this continuing program is to develop reliable real-time, on-line, high-temperature systems that will measure erosive wear. An active program involving laboratory and field tests over the past six years has developed a first-generation, field-implementable system for real-time monitoring of erosive wear. The program involves development of nondestructive testing methods and evaluation of the reliability of the test methods for the measurement of erosive wear.

Keywords: Nondestructive Testing, Erosion

39. Development of Nondestructive Evaluation Techniques for Structural Ceramics — 1983 $ 75K

DOE Contact - S. J. Dapkunas (301) 353-2784
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - W. A. Ellingson and D. S. Kupperman (312) 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

40. Development of Thermal Shock Resistant Refractories — 1983 $ 135K

DOE Contact - S. J. Dapkunas (301) 353-2784
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - W. A. Ellingson and D. R. Diercks (312) 972-5068

The purpose of this program is to develop thermal-shock resistant refractories for use in slagging gasifiers. The proposed improvements will be accomplished by the addition of selected secondary phases in the refractory compositions so that the thermal and microstructural characteristics of the refractories are suitably modified. The basic principles of thermal shock improvement through such secondary phase additions will be established in the laboratory- and engineering-scale experiments.

Keywords: Refractories

41. Creep Properties of Monolithic and Brick Linings — 1983 — $ 170K

DOE Contact - S. J. Dapkunas (301) 353-2784
Iowa State University, Engineering Research Institute, Department of Materials Science and Engineering, (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 7940) Contact - T. D. McGee (515) 294-9619

Refractory concretes appear to be prime candidate materials for the linings for dry ash coal gasification pressure vessels. Due to extreme conditions in the gasification process (temperatures to 1200°C, stresses to 2000 psi, and corrosive atmospheres) it is important to have available high-temperature, high stress creep data for these materials. Not only is data important but also information on the mechanisms of creep is desirable. This information is needed for ongoing research at other institutions which is concerned with the elimination of cracking in the refractory linings.

Keywords: Refractories, Materials Characterization

42. Development of Thermomechanical Model to Predict Thermal Stress and Strain in Refractory Brick Linings — 1983 — $ 176K

DOE Contact - S. J. Dapkunas (301) 353-2784
Masaachusetts Institute of Technology, (Contract No. W-7405-eng-26, Union Carbode Corporation Subcontract No. 7862) Contact - Oral Buyukozturk (617) 253-7186

The objective of this continuing program is to modify the existing model for prediction of thermal stress and strain in monolithic linings so that it can be used to predict (and improve) the performance of brick linings.

Keywords: Refractory Liners

43. Investigation of Carbon Monoxide Disintegration of Refractories in Coal Gasifiers — 1983 — $ 85K

DOE Contact - S. J. Dapkunas (301) 353-2784
Virginia Polytechnic Institute and State University, Department of Materials Engineering, (Contract No. DE-AC01-80ET13702) Contact - J. J. Brown, Jr. (703) 961-6777

The objectives of this investigation are (1) to determine whether CO disintegration is likely to occur in the refractories used in coal gasifiers, and (2) to identify the conditions under which CO disintegration of the refractories can be expected to be a serious problem. It is also a goal of this investigation to develop information that will assist in the identification of refractory deterioration or failure that is caused by CO disintegration.

Keywords: Corrosion, Refractories

44. Corrosion of Refractories in Slagging Gasifiers — 1983 — $ 175K

DOE Contact - S. J. Dapkunas (301) 353-2784
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - W. A. Ellingson and S. Greenberg (312) 872-5068

The purpose of this program is to investigate the parameters that affect the corrosion of refractories in slagging gasifiers so that lining lifetimes can be optimized through proper choice of refractory materials, coal selection or modification, and/or changes in process variables.

Keywords: Gasifiers, Corrosion, Refractories

45. Testing and Development of Materials for Coal Gasification Process Equipment — 1983 $ 80K

DOE Contact - S. J. Dapkunas (301) 353-2784
U.S. Department of the Interior, Bureau of Mines, Tuscaloosa Research Center, (Contract No. DE-AI05-820R20992) Contact - H. Heystek (205) 758-0491

The objectives of this research are to (1) determine the effect of catalytic coal gasification (CCG) environments on metal and refractory materials of construction by exposure to CCG reactor conditions in a laboratory simulator and (2) identify the attack mechanisms of CCG environments on metals and refractories so that materials offering improved performance at lower cost can be identified.

Keywords: Corrosion

46. Investigation of Corrosion of Refractories by Slag Penetration — 1983 $ 210K

DOE Contact - S. J. Dapkunas (301) 353-2784
National Bureau of Standards, Center for Materials Science, (Contract No. DE-AI05-830R21349) Contact - S. M. Weiderhorn (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

47. Determination of Phase Diagrams Relevant to Coal Slag-Refractory Systems — 1983 $ 135K

DOE Contact - S. J. Dapkunas (301) 353-2784
Pennsylvania State University, (Contract No. 7405-eng-26, Union Carbide Corporation Subcontract No. 9006) 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.

In particular, this program concentrates on systems containing chromic oxide since refractories containing significant amounts of this component have demonstrated excellent resistance to corrosion. This program interfaces with programs at Argonne National Laboratory to provide information on chemical stability of reaction products.

Keywords: Corrosion, Ceramics

48. Short Fiber Reinforced Structural Ceramics — 1983 $ 200K

DOE Contact - S. J. Dapkunas (301) 353-2784
Los Alamos National Laboratory, (Contract No. W-7504-eng-36) Contact - F. D. Gac (505) 667-5126

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 (α-Si_3N_4) whiskers and beta-phase silicon carbide (β-SiC) 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, Components

49. Silicon Carbide Powder Synthesis — 1983 $ 50K

DOE Contact - S. J. Dapkunas (301) 353-2784
ORNL, (Contract No. W-7405-eng-26) Contact - M. Janney (615) 574-5129

The purpose of this work is to develop processes for synthesis of improved, highly pure, uniformly sinterable powders. The developmental and some selected commercial SiC powders will be characterized and evaluated.

Keywords: Powder Synthesis, Silicon Carbide

50. Ceramic Fabrication and Microstructure Development — 1983 $ 200K

DOE Contact - S. J. Dapkunas (301) 353-2784
ORNL, (Contract No. W-7405-eng-26) Contact - M. Janney (615) 574-5129

The purpose of this work is to develop improved structural ceramics by developing techniques for fabricating powders into dense monolithic ceramics and ceramic-matrix composites with controlled microstructure. The task includes correlation of the properties of structural ceramics with their microstructure, crystal structure, microchemistry, and fabrication history.

Keywords: Fabrication, Microstructure, Ceramics

51. Fabrication of Fiber-Reinforced Composites by CVD Infiltration — 1983 $ 170K

DOE Contact - S. J. Dapkunas (301) 353-2784
ORNL, (Contract No. W-7405-eng-26) Contact - W. J. Lackey and A. J. Caputo (615) 574-4551

The purpose of this task is to develop a ceramic composite having higher than normal strength and toughness yet retain the normal ceramic attributes of refractoriness and high resistance to abrasion and corrosion. Further, a practical process capable of fabricating simple or complex shapes is desired. The ceramic fiber-ceramic matrix composites will be fabricated by infiltrating felted or woven fiber structures with vapors, which deposit on and between the fibers to form the matrix of the composite.

Keywords: Composites, Fiber-Reinforced, Ceramics

52. Development of Advanced Fiber Reinforced Ceramics — 1983 — $ 170K

DOE Contact - S. J. Dapkunas (301) 353-2784
Georgia Institute of Technology, Georgia Tech Research Institute, (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 19X-43369C) Contact - T. L. Starr and J. D. Walton, Jr. (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

53. High Temperature Applications of Structural Ceramics — 1983 — $ 195K

DOE Contact - S. J. Dapkunas (301) 353-2784
National Bureau of Standards, Center for Materials Science, (Contract No. DE-AI05-80OR20679) Contact - S. J. Schneider and E. R. Fuller (301) 921-2845

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, Materials Characterization

54. Mechanical Behavior and Strength of Structural Ceramics — 1983 — $ 140K

DOE Contact - S. J. Dapkunas (301) 353-2784
ORNL, (Contract No. W-7405-eng026) Contact - P. F. Becher (615) 574-5157

The purpose of this work is to develop improved structural ceramics by correlating the mechanical properties of structural ceramics with their microstructure, crystal structure, microchemistry, and fabrication history. Changes in such key properties as flexural strength, fracture toughness, and subcritical crack growth as a function of exposure time to combustion products of fossil fuels at high temperatures are also determined. This correlation is accomplished by determining changes in mechanical properties of the structural ceramics after long-term exposures and comparing with properties of as-manufactured specimens. Another purpose is to identify the degradation mechanisms for these materials and to determine the fundamental role of intrinsic and extrinsic defects, impurities, and second phases in limiting the high-temperature performance of structural ceramics in order to aid in the development of new materials or improvements in existing materials for fossil energy components such as heat exchangers and high-temperature gas turbines.

Keywords: Structural Ceramics

OFFICE OF SURFACE COAL GASIFICATION

1. Advanced Pressure Vessel Materials Technology — 1983 $ 500K

DOE Contact - J. P. Carr (HQ) (301) 353-5985 and J. M. Hobday (METC) (304) 291-4347
ORNL, (Contract No. W-7405-eng-26) Contact - R. W. Swindeman (615) 574-5108

The purpose of this project is to advance pressure vessel materials technology to permit more economical design and fabrication of large coal conversion vessels that will operate reliably and safely through their design lifetimes. This project will provide verification of the practicability of utilizing a 3 Cr-1.5 Mo-0.1 V steel heat treated to a strength level greater than that presently permitted in the ASME Boiler and Pressure Vessel Code (ASME Code). The approach will include the mechanical testing of commercially supplied base plate and ORNL produced weldments to provide material property data needed for approval of this alloy in appropriate sections of the ASME Code.

Keywords: Alloys, Strength, Joining, Alternative Fuels

2. Electroslag Component Casting — 1983 $ 400K

DOE Contact - J. P. Carr (HQ) (301) 353-5985 and J. M. Hobday (METC) (304) 291-4347
ORNL, (Contract No. W-7405-eng-26) Contact - V. K. Sikka (615) 574-5112

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

3. Plant Materials Surveillance Tests — 1983 $ 140K

DOE Contact - J. P. Carr (HQ) (301) 353-5985 and J. M. Hobday (METC) (304) 291-4347
The Metal Properties Council, Inc., (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 19X-22241C) Contact - A. O. Schaefer and E. J. Vesely, Jr. (212) 705-7693

The purpose of this project is to evaluate construction materials for resistance to coal gasification environments by testing in current gasification pilot plants. This task is being performed for DOE by The Metal Properties Council, Inc. (MPC). This MPC testing program is testing materials in the Bi-Gas, Westinghouse, General Electric (Gegas), and Mountain Fuel Resources plants. To aid the correlation of the different phases of the corrosion program and help identify the effects of plant variables, detailed metallurgical examinations of test specimens will be performed.

Keywords: Alloys, Corrosion, Alternative Fuels

4. Slagging Gasifier Refractories: Application Evaluation — 1983 $ 400K

DOE Contact - J. P. Carr (HQ) (301) 353-5985 and J. M. Hobday (METC) (304) 291-4347
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - S. Greenberg (312) 972-5084

This effort will establish base technology on refractories which have been systematically selected for slagging gasifiers relative to corrosion resistance. In addition, the total program (of which this effort is a part) will develop an analytical predictive model which will be capable of predicting refractory lifetime as a function of the chemical composition of coal, chemical composition of refractory, temperature, and slag viscosity. This effort will emphasize slag corrosion of medium-chromia and high-chromia refractories in acidic and basic slags with the tests to be in a laboratory rotating drum test facility. There will be six to eight refractories included. The data from this effort will contribute to the specification of refractory linings of reasonable lifetimes for slagging gasifiers.

Keywords: Refractories, Corrosion, Alternative Fuels

5. Ceramic Fabrication/Application Technology — 1983 $ 275K

DOE Contact - J. P. Carr (HQ) (301) 353-5985 and J. M. Hobday (METC) (304) 291-4347
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - T. E. Easler (312) 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 α-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

6. Protective Coatings and Claddings: Application/Evaluation — 1983 $ 500K

DOE Contact - J. P. Carr (HQ) (301) 353-5985 and J. M. Hobday (METC) (304) 291-4347
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - D. R. Diercks (312) 972-5032

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 (900 to 1000°F) required for good plant efficiency.

Keywords: Coatings and Films, Nondestructive Evaluation, Corrosion, Alternative Fuels

7. Materials Review and Component Failure Analysis — 1983 $ 100K

DOE Contact - J. P. Carr (HQ) (301) 353-5985 and J. M. Hobday (METC) (304) 291-4347
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - D. R. Diercks (312) 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 ongoing 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

8. Ceramic Application Technology, Brittle Material Design — 1983 $ 200K

DOE Contact - J. P. Carr (HQ) (301) 353-5985 and J. M. Hobday (METC) (304) 291-4347
Los Alamos National Laboratory, (Contract No. W-7405-eng-36) Contact - F. D. Gac (505) 667-5126

The principal objective of this program is to develop brittle materials (ceramic) design methodology that can be used for the employment of structural ceramics in high performance coal gasification applications. A secondary objective is to adapt this methodology for use by the conventional designer, who is generally unfamiliar in designing with ceramics. The program approach will consist of three simultaneous tasks. First, a Brittle Materials Design Handbook (BMDH) will be prepared, targeted at the conventional designer, and containing an extensive materials data base and sample problems. Second, the Los Alamos computational capabilities will be upgraded to include crack modeling, stress relief modeling, and improved statistical methods. Finally, work will focus on extending brittle material design techniques to include predictive modeling of materials under multiaxial stress states.

Keywords: Ceramics, Alternative Fuels

1. Assessment of Materials Selection and Performance for Coal Liquefaction Plants — 1983 $ 250K

DOE Contact - J. A. Reafsnyder (ORO) (615) 576-1051
ORNL, (Contract No. W-7405-eng-26) Contact - A. R. Olsen (615) 574-4832

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

2. Materials Review and Support for the SRC-I Liquefaction Project — 1983 $ 120K

DOE Contact - J. A. Reafsnyder (ORO) (615) 576-1051
ORNL, (Contract No. W-7405-eng-26) Contact - A. R. Olsen (615) 574-4832

The objectives of this work element 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 design documents. Reviews conducted include materials selection, welding practices, heat treatment methods, inspection techniques, corrosion-erosion allowances, corrosion surveillance coupons and specimen and other materials-related topics in critical areas of the SRC-I demonstration plant project.

Keywords: Alloys, Corrosion, Erosion and Wear, Alternative Fuels

3. Materials Support for Improved Slurry Letdown Valves in Direct Coal Liquefaction Plants — 1983 $ 65K

DOE Contact - J. A. Reafsnyder (ORO) (615) 576-1051
ORNL, (Contract No. W-7405-eng-26) Contact - E. L. Long, Jr. (615) 574-5172

The objectives of this work element are to characterize trim materials used in service at coal liquefaction pilot plants and to develop alternative trim materials.

This includes the characterization and testing of letdown valve trim used in the various coal liquefaction pilot plants. The intent of this work is to characterize the various trim materials used in service; prepare erosion test samples from used trim; and compare the characterization and test results with in-service performance.

Keywords: Ceramics, Erosion and Wear, Alternative Fuels

4. Mechanical Properties Data for Pressure Vessels — 1983 $ 95K

DOE Contact - J. A. Reafsnyder (ORO) (615) 576-1051
ORNL, (Contract No. W-7405-eng-26) Contact - R. W. Swindeman (615) 574-5108

The objective of this project is to provide materials data needed to develop and implement a design methodology for the design and safety analyses of the pressure vessels in the hydrogenation section of the SRC-I demonstration plant. Fatigue and creep-fatigue testing were completed on heavy section SA-387 grade 22 plate, SA-336 F22 forging and their weldments for temperatures to 482°C. These data were combined with data available from other sources to construct fatigue curves of the type contained in the ASME Boiler and Pressure Vessel Code Case N-47. Base metal samples were heat-treated to produce heat-affected zone properties typical of weldments and subsequently tested under creep and fatigue conditions. These data plus information on base metal, weld metal, and weldment behavior were used to determine stress or strain concentration factors for weldments under fatigue loadings.

Keywords: Alloys, Strength, Alternative Fuels

5. Materials Performance Evaluation for the Exxon Coal Liquefaction Plant — 1983 $ 110K

DOE Contact - J. A. Reafsnyder (ORO) (615) 576-1051
ORNL, (Contract No. W-7405-eng-26) Contact - J. R. Keiser (615) 574-4453

The objectives of this work element are to examine various components from the Exxon Coal Liquefaction Plant (ECLP) and to assess materials performance in the various process areas of the plant. The determination of the extent of materials degradation (or failures) and the causes related thereto should be invaluable in consideration of materials selections for future plants. The ORNL Fossil Energy Materials Program staff worked with Exxon staff members to identify and select various components for examination and analysis. Selections were made on the basis of experience (problems) during pilot plant operation and on potential failure modes such as erosion and corrosion.

Keywords: Alloys, Corrosion, Erosion and Wear, Alternative Fuels

6. Materials Surveillance for the H-Coal Pilot Plant — 1983 $ 70K

DOE Contact - J. A. Reafsnyder (ORO) (615) 576-1051
ORNL, (Contract No. W-7405-eng-26) Contact - J. R. Keiser (615) 574-4453

The objectives of this project are to test, in the pilot plant environment, alloys for resistance to corrosion and stress corrosion cracking, perform on-site metallography and nondestructive examinations of components, and examine failed components to determine failure modes. This work includes in-plant surveillance and testing of materials by exposing corrosion and stress-corrosion coupons in the process streams. Exposure sites include reactor (dissolver) vessels, separator vessels, and fractionation columns. Trips were made to the H-Coal Pilot Plant to perform on-site metallography of various vessels as well as nondestructive examinations of vessels and transfer lines. Analyses of failed components were performed to establish causes and modes of failure. Such analyses are useful not only in providing solutions to current problems but also the results of these analyses may be incorporated into future designs to preclude materials related failures.

Keywords: Alloys, Corrosion, Erosion and Wear, Alternative Fuels

7. Coal Liquefaction Pilot Plant Materials Testing and Failure Analysis — 1983 $ 24K

DOE Contact - T. B. Simpson (HQ) (301) 353-3913 and S. R. Lee (PETC) (412) 675-6137
ORNL, (Contract No. W-7405-eng-26) 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

8. Coating Studies for Coal Conversion — 1983 $ 50K

DOE Contact - T. B. Simpson (HQ) (301) 353-3913 and S. R. Lee (PETC) (412) 675-6137
ORNL, (Contract No. W-7405-eng-26) Contact - W. J. Lackey and A. J. Caputo (615) 574-4551

This task is developing chemically vapor deposited coatings which offer the hope of extending the life of valve trim materials in coal conversion applications. The scope of the task consists of using available equipment to deposit coatings onto cemented tungsten carbide and other substrate disks. The erosion rate of such coatings is being determined using an established test in order to evaluate whether these coatings appear promising for valve trim and other severe erosion environment fossil applications. A systematic study of the role of coating and substrate variables is being made to determine the optimum conditions for producing coatings that offer the greatest potential for letdown valve trim applications.

Keywords: Ceramics, Erosion and Wear, Chemical Vapor Deposition, Alternative Fuels

9. Centrifugal Slurry Pump Wear and Hydraulic Studies — 1983 $ 250K

DOE Contact - T. B. Simpson (HQ) (301) 353-3913 and S. R. Lee (PETC) (412) 675-6137
Ingersoll-Rand Research, Inc., (Contract No. DE-AC22-82PC50035) Contact - P. Cooper (609) 921-9103

The objectives of this work are to develop a hydraulic and materials data base and methods for the design and scale-up of slurry pumps for coal liquefaction service with optimum wear resistance. The project will provide a data base that will guide slurry pump vendors and users in improving centrifugal slurry pump design and life. The project will also provide an improved synthetic fuels slurry pump design. Small- and medium-scale pump erosion investigations of various hydraulic designs and design features are being conducted. Erosion and corrosion behavior of materials are being investigated. Finally, this project will lead to the design and building of optimized slurry pumps that will be subjected to endurance tests in a synthetic fuels facility.

Keywords: Alloys, Ceramics, Erosion, Corrosion, Alternative Fuels

10. Material Coatings for Valves — 1983 $ 25K

DOE Contact - T. B. Simpson (HQ) (301) 353-3913 and S. R. Lee (PETC) (412) 675-6137
Sandia National Laboratory, (Contract No. 73A 22-82PC50029) Contact - B. Granoff (505) 844-8145

The objectives of this project are to evaluate erosion-resistant coatings for coal conversion process equipment and to compare state-of-the-art material performance with TiB_2. The work includes process development and materials testing and evaluation of TiB_2; fabrication, coating, preservice evaluation and documentation of prototype trim for testing in a pilot plant; and development, fabrication and evaluation of novel coatings and substrate materials.

Keywords: Ceramics, Chemical Vapor Deposition, Erosion, Alternative Fuels

Fuel Cells Program

1. Electrode Surface Chemistry — 1983 $ 150K

DOE Contact - W. J. Huber (304) 291-4663
Lawrence Berkeley Laboratory, (Contract No. DE-AC03-76SF00098) Contact - P. N. Ross (415) 486-4000

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

2. Development of Ternary Alloy Cathode Catalysts for Phosphoric Acid Fuel Cells — 1983 $ 200K

DOE Contact - W. J. Huber (304) 291-4663
Giner, (Contract No. DEN3-294) Contact - V. Jalan (617) 899-7270

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 catalyst have been supplied to the National Aeronautics and Space Administration (NASA) for evaluation.

Keywords: Catalysts, Performance/Endurance, Sintering/Surface Characterization and Treatment, Fuel Cells

3. Organometallic Catalysts for Primary Phosphoric Acid Fuel Cells — 1983 $ 150K

DOE Contact - W. J. Huber (304) 291-4663
ECO, (Contract No. DEN3-206) Contact - F. Walsh (617) 964-7010

This work involves the synthesis of several metal-cobalt-organic ligand type catalysts. These catalysts have shown increased catalytic activity compared to platinum catalysts. Development quantities of these catalysts are being prepared and will be supplied to NASA for further evaluation.

Keywords: Catalysts, Performance/Endurance, Sintering/Surface Characterization and Treatment, Fuel Cells

4. High-Temperature Solid Oxide Electrolyte Fuel Cell Power Generation System — 1983 $ NBA*

DOE Contact - F. D. Gmeindl (304) 291-4751
Westinghouse Electric Corporation R&D Center, (Contract No. DE-AC02-80ET17089) Contact - W. Feduska (412) 256-7726

* The acronym NBA indicates that this project is a subtask of a singly funded, larger statement of work and that no information on specific funding breakdown is available for this task.

The goal for this project for FY 1983 has been to qualify cell performance and life as a precursor to submodule and module development. This goal is 1500 h operation with no more than 13 mV/1000 h voltage degradation with starting performance of 640 mV at 160 mA/cm^2 and 85 percent utilization of 66 percent H_2, 22 percent CO, and 11 percent H_2O fuel. Efforts have focused on strengthening the electrode-electrolyte bonds. The principal problem has been interface microcracking. Sintering temperatures of the fuel electrode were modified. The composition of the fuel electrode was graded from all ZrO_2 at the electrolyte to a ratio of 95/5 for Co/ZrO_2. The electrochemical vapor deposition (EVD) process is used to apply the yttria-stabilized zirconia electrolyte; a large EVD reactor will be used to produce multiple, long (30 cm active area) cells. The calcia-stabilized zirconia support tube was strengthened by adding zirconia fibers. Various techniques of improving the stability and compatibility of the lanthanum manganite air electrode with the support tube are being investigated.

Keywords: Ceramics, Metals, Semiconductors, Chemical Vapor Deposition, Sintering, Fuel Cells

5. Advanced Fuel Cell Research — 1983 $ 200K

DOE Contact - F. D. Gmeindl (304) 291-4751
Argonne National Laboratory, (Contract No. W-31-109-eng-38) 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. The effort is centered on fabricating 1- to 5-mil layers of cell components chiefly by tape casting. The results show that close attention must be given to preparation of starting materials and ceramic processing procedures to obtain derived porosity and microstructure in the sintered ceramic. The materials under investigation are similar chemical compounds to those in the fuel cell being developed by Westinghouse Electric Corporation.

Keywords: Ceramic, Sintering, Fuel Cells

6. Molten Carbonate Fuel Cell and Stack Technology Development — 1983 $ NBA

DOE Contact - F. D. Gmeindl (304) 291-4751
United Technologies Corporation, (Contract No. DE-AC01-79ET15440) Contact - A. Meyer (203) 727-2214

Materials which maintain springiness under molten carbonate fuel cells (MCFC) operating conditions with temperatures up to about 700°C are being evaluated for use in the construction of flexible flanges which maintain sealing pressures against electrolyte-filled ceramic matrices. Examples of materials studied include 316 SS Fe-Cr alloys, and MA956. No material has been identified that has both satisfactory performance and cost. The typical study evaluates the room temperature spring constant and the extent of load relaxation at operating temperatures. The desired material must permit flange sealing with room temperature pressures of less than about 100 psi and not relax at operating temperature pressures greater than about 10 psi.

Modified oxides, e.g., perovskites, are being evaluated as possible substitutes for NiO cathodes in MCFCs. The need for this work arises from the fact that the NiO has a small but finite solubility in the molten carbonate electrolyte, and the soluble nickel species is reduced when it enters a reducing region of the cell as it diffuses away from the cathode. The suitable alternative must have either a lower solubility or else not precipitate out of the electrolyte other than at the cathode. As a cathode, it must have good electrochemical activity, electrical conductivity, and stability under all conditions

that can arise at the cathode of a MCFC. Once it is found that the solubility is satisfactory and the material is stable under open circuit conditions, MCFCs are constructed and operated over a range of conditions. This type of evaluation provides all of the above information in direct and indirect ways. The ideal alternate cathode material will have the electrochemical characteristics of NiO without the negative effects of its solubility.

The corrosion of 316 SS and other alloys are being studied in a MCFC cathode gas/molten carbonate film environment. These materials have been proposed as the component making up the separator plate in MCFCs. The particular concerns are 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. The primary technique being used at this time is retort screening under various conditions expected to occur under normal MCFC operation.

ZrO_2 materials in various forms, such as felts and cloths, are being evaluated as gasket materials between gas manifolds and the MCFC stack. The gasket is required to prevent gas leakage and to accommodate differences in expansion coefficients between the manifold and stack. The material selected must also show a minimal capability of wicking the electrolyte. Electromigration of molten carbonate is being used to develop specifications for the gasket material.

Tape casting studies are being carried out for the purpose of producing thin porous nickel sheets from metal powder. The porous nickel sheets are a required component of MCFCs. The work is being directed to the formation of high-strength sheets with controlled porosities. Bending and tensile tests are used to evaluate the strength, and porosities are determined by density and porosimetry measurements.

Keywords: Alloys, Ceramics, Metals, Corrosion, Strength, Fuel Cells

7. Molten Carbonate Fuel Cell and Stack Technology Development — 1983 $ NBA

DOE Contact - F. D. Gmeindl (304) 291-4751
General Electric Company, (Contract No. DE-AC02-80ET17019) Contact - R. W. Barta (518) 899-4506

Porous bodies consisting of strontium titanate particles coated with nickel and then sintered to about 50 percent porosity are being developed as a lower cost alternative to porous nickel for use in molten carbonate fuel cells. Mechanical deformation under load is being evaluated. A higher mechanical stability than homogeneous porous nickel is expected.

Thermoplastic films loaded with up to 55 percent of a ceramic powder, platelet, or fiber have been made. The film can be mass produced by calendering, despite the high ceramic content.

Coatings for stainless steels that are resistant to either (1) air or (2) hydrogen/carbon monoxide at 650°C are being developed. The coatings must also be stable in molten carbonate and be electronically conductive.

Keywords: Coatings, Corrosion, Fuel Cells, Sintering, Strength, Ceramics

8. Molten Carbonate Fuel Cell Component Technology Development — 1983 $ NBA

DOE Contact - F. D. Gmeindl (304) 291-4751
Energy Research Corporation, (Contract No. DE-AC03-76ET11304) Contact - H. Maru (203) 792-1460

A porous composite body consisting of nickel and up to 20% ceramic powder is being made by film casting the mixture and then burning out the organic binder and sintering the nickel. This composite material has greater mechanical strength than similar nickel bodies under load.

Keywords: Composites, Sintering, Strength, Fuel Cells

9. Alternative Molten Carbonate Fuel Cell Cathodes — 1983 $ NBA

DOE Contact - F. D. Gmeindl (304) 291-4751
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - R. D. Pierce (312) 972-4450

This project is involved in the 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. The thermodynamically stable oxide phases under a range of cathode conditions for many metals (principally transition elements) have been determined. Experiments are underway to promote conductivity in these stable phases by doping and to assess the suitability of these materials as MCFC cathodes. This assessment involves conductivity measurements, dopant and morphological stability testing, solubility determinations, fabrication studies, in-cell migration testing, and cell-performance determinations.

Keywords: Ceramics, Semiconductors, Microstructure, Fuel Cells

Magnetohydrodynamics Program

1. MHD Materials Development, Testing and Evaluation — 1983 $ 100K

DOE Contact - T. W. Arrigoni (412) 675-5981
Pacific Northwest Laboratories, (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

2. UTSI MHD Development Testing — 1983 $ 560K

DOE Contact - C. A. Thomas (412) 675-5731
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. Measurement 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

3. MHD Heat and Seed Recovery Technology 1983
$ 100K

DOE Contact - R. F. Sperlein (412) 675-5985
Argonne National Laboratory, (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 deposits 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

OFFICE OF URANIUM ENRICHMENT AND ASSESSMENT

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 program goal. Uranium enrichment is composed of four major offices: Business and Marketing, Operations and Facility Reliability (Gaseous Diffusion Plants), Expansion Projects (construction of the Gas Centrifuge Enrichment Plant), and Advanced Technology Projects (development/demonstration of the Advanced Gas Centrifuge and the Atomic Vapor Laser Isotope Separation Processes). Total obligational authority for all uranium enrichment activities in FY 1983 was 1.8 billion dollars.

Uranium as found in nature contains about seven-tenths of one percent uranium 235 which is fissionable. The remainder is essentially uranium 238 which is nonfissionable. The fissionable characteristics of uranium 235 make it desirable to enhance its concentration for use as nuclear fuel. Light water reactors typically require uranium 235 concentrations in the two to four percent range. Presently uranium is enriched to the desired uranium 235 product assay levels in gaseous diffusion plants located at Oak Ridge, Tennessee; Portsmouth, Ohio; and Paducah, Kentucky. These plants were built in the 1940's and 1950's and were operated initially to satisfy defense requirements for uranium 235. They are now operated primarily to provide enrichment services to domestic and non-United States utility customers. In these plants, the Department enriches customer-provided natural uranium in the uranium 235 component for a fee which recovers the cost of providing the services. The Department is the sole provider of enrichment services in the United States. The specific statutory authority which established this role is the Atomic Energy Act of 1954, as amended.

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.

DOE Contact - Arnold Litman (301) 353-5777

1. Gaseous Diffusion

a. Barrier Quality

1983
$1,605K

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 production facilities. This activity is a long-term undertaking and will be maintained at the appropriate levels of effort in the future.

b. Barrier Science

1983
$1,040K

Fundamental aspects of the diffusion barrier. Work on barrier theory is performed and assistance is given to the barrier quality activities.

c. Materials and Chemistry Support

1983
$3,175K

Routine materials and chemistry support of the diffusion plants. Characterization of containment-process gas cascade reactions, physical/chemical properties of UF_x materials, corrosion of materials, failure analyses, trapping technology, and alternative materials replacement.

2. Gas Centrifuge

DOE is currently constructing a gas centrifuge enrichment facility to enhance the economics of the U.S. enrichment complex. The Gas Centrifuge Enrichment Plant (GCEP) is under construction within the perimeter of the gaseous diffusion complex at Portsmouth, Ohio. The baseline gas centrifuges to be employed initially in CGEP are designated as Set III. They are fully qualified for use in GCEP and the infrastructure has been established for manufacturing gas centrifuges by selected U.S. companies. DOE is currently developing an advanced gas centrifuge (AGC) which will ultimately replace the Set III machines. AGC is also designated as Set V and is expected to be available for GCEP beginning in 1989. The goal of the AGC is to design and qualify a machine capable of producing 600 separative work units (SWU) of enriched uranium per machine-year, as compared with the nominal 200 SWU's/machine-year obtained from the Set III centrifuge.

The increase in separative performance for Set V is based primarily on the use of improved materials for the rotor. These permit the rotor to operate at substantially higher speeds of rotation to take advantage of the marked improvement in separative performance with speed increase. The rotor materials being assessed for potential use are commercially available. Hence, the emphasis is not on materials development but on the utilization of existing materials for higher performance gas centrifuge rotors. The funding identified below is for the development of Set V rotors and associated hardware.

	FY 1983
Rotor Tubes	10,091K
Caps and Baffles	4,582K
Advanced Materials	6,961K
Assembly Integration	950K
Characterization of Test Specimens	12,000K
Total	$34,584K

3. Atomic Vapor Laser Isotope Separation (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 U-235 ions can then be removed from the vapor using electromagnetic methods.

On April 30, 1982, the Department announced the selection of AVLIS as the process, over two other candidates, to proceed to engineering development as part of the uranium enrichment program. The primary emphasis for AVLIS in FY 1983 was to determine the most economical design approach for the uranium collector subsystem. Available resources were focused on the operation of existing testbeds to conduct and evaluate key experiments. The goal is to develop an AVLIS plant module point design, fully supported by experimental results.

a. Materials Handling and Compatibility

1983
$8,000K

Coating development for various substrates to contain uranium. Development/demonstration of engineering components for source and collector systems including materials selection, property evaluation, analysis and testing.

Keywords: Enrichment, Gaseous Diffusion, Uranium, Gas Centrifuge, Laser Isotope Separation

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 development work is underway within several projects of the Division's Extended Burnup Program.

1. Demonstration of LWR Fuels with Improved Pellet-Cladding Interaction Performance — 1983 $ 150K

DOE Contact - P. M. Lang (301) 353-3313
Commonwealth Research Corporation Contact - D. O'Boyle (312) 294-3836
Consumers Power Company Contact - G. Pratt (517) 788-1879

Designs being developed are annular fuel pellets with graphite coated cladding, sphere pac fuel, and metal liners of either zirconium or copper. The projects include in-reactor parameter testing, laboratory testing, and test-reactor ramp testing to examine power ramp performance and stress corrosion cracking in both unirradiated and irradiated specimens. Out-of-reactor tests provide mechanical and corrosion properties required for continuing evaluations and/or to support fabrication and licensing. Large-scale commercial reactor demonstrations of the prototype fuels will be conducted to show improved fuel performance.

Keywords: Materials Characterization, Radiation Effects

2. Fission Gas Release from High Burnup Fuel — 1983 $ 200K

DOE Contact - P. M. Lang (301) 353-3313
PNL Contact - M. Freshley (509) 375-2530

Multi-sponsored project with several countries participating. The project includes an updated evaluation of the current state-of-the-technology on this subject. The experimental phase includes burnup testing well-characterized fuel types to high power levels with subsequent examination, fission gas sampling, and continued irradiation. Selected samples will be destructively examined to provide data on burnup, fuel structure, and other characteristics.

Keywords: Materials Characterization, Radiation Effects

High Temperature Reactor Development Division

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.

1. Fuel Process Development

1983
$ 850K

DOE Contact - J. E. Fox (301) 353-4162
GA Technologies Contact - D. W. McEachern (619) 455-4608

This work includes establishing, characterizing, and qualifying fabrication processes and equipment for the preparation of microsphere fuel particles of uranium-oxicarbide (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°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

2. Fuel Materials Development

1983
$ 940K

DOE Contact - J. E. Fox (301) 353-4162
GA Technologies, Inc. Contact - R. F. Turner (619) 455-2306

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 and high enriched 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

3. Fueled Graphite Development

1983
$ 780K

DOE Contact - J. E. Fox (301) 353-4162
ORNL Contact - F. J. Homan (615) 574-5169

This work supports 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 and high enriched 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

4. Graphite Development

1983
$ 530K

DOE Contact - J. E. Fox (301) 353-4162
GA Technologies, Inc. Contact - G. B. Engle (619) 455-2894

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 fuel element blocks, and with sufficient oxidation resistance to be qualified for reflector blocks and core support 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

5. Graphite Development and Testing — 1983 $ 760K

DOE Contact - J. E. Fox (301) 353-4162
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 fuel element blocks, and with sufficient oxidation resistance to be qualified for reflector blocks and core support 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

6. Metals Technology — 1983 $1100K

DOE Contact - J. E. Fox (301) 353-4162
GA Technologies, Inc. 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 establish the air data base required for code qualifications, develop fabrication plans for Alloy 800H heat exchanger tubesheet, 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 2¼ 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

7. Advanced Gas Reactor Materials Development

1983
$1400K

DOE Contact - J. E. Fox (301) 353-4162
General Electric Company Contact - M. E. Donnelly (518) 385-1086

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 800°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 data base for development of high temperature design criteria and code qualification rules.

Keywords: Alloys, Strength, Corrosion, Joining, Microstructure, High Temperature Service

8. HTR Structural Materials

1983
$630K

DOE Contact - J. E. Fox (301) 353-4162
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-to-tubesheet welding procedures, investigation of control rod compact/cladding compatibility, and determination of the fracture toughness of concrete reactor vessel penetration steels.

Keywords: Alloys, Strength, Corrosion, Joining, Microstructure, High Temperature Service

Fuels and Core Materials Division

The Fuels and Core Materials Division materials program described in the following are directed at providing technical support on materials required for the design of reliable, safe and economical fast breeder reactor plants and their operation. The funding for core component materials, such as reactor fuels, absorbers, cladding and ducts, at various contractors, national laboratories and government laboratories is as follows:

1. Advanced Fuels - Transients — 1983 $ 296K

DOE Contact - D. K. Magnus (301) 353-5004
Argonne National Laboratory, (Contract No. W-31-109-eng-38) Contact - L. Neimark and S. M. Gehl (312) 972-5199

Keywords: Ceramics, Glasses, Radiation Effects

2. Advanced Fuels - Transients — 1983 $ 148K

DOE Contact - D. K. Magnus (301) 353-5004
Atomics International, (Contract No. DE-AT03-76SF76026) Contact - W. Wolfe, E. Specht and B. Ostermeir (213) 341-1120

Fabricate advanced fuel blanket pellets for carbide blanket fuel assembly testing. Perform pin evaluation and pin code development.

Keywords: Ceramics, Glasses, Fuel Development, Uranium Carbide, Pin Evaluation, Code Development

3. Advanced Fuels - Steady State — 1983 $ 0

DOE Contact - D. K. Magnus (301) 353-5004
Combustion Engineering Company, (Contract No. DE-AC02-76CH91001) Contact - S. A. Caspersson (203) 688-1911

Assess an extended lifetime advanced oxide fuel system.

Keywords: Ceramics, Materials Characterization

4. Alloy Development — 1983 $ 280K

DOE Contact - D. K. Magnus (301) 353-5004
General Electric Company, (Contract No. DE-AC03-76SF1031) Contact - E. A. Aitken (408) 738-4238

Perform examinations and analysis of creep-in-bending test, and assess post-irradiation ductility of advanced alloys for core components.

Keywords: Radiation Effects, Materials Characterization

5. Advanced Fuels Development — 1983 $2536K

DOE Contact - D. K. Magnus (301) 353-5004
General Electric Company, (Contract No. DE-AT03-76SF1031) Contact - E. A. Aitken (408) 738-4238

Design, irradiate and evaluate advanced oxide fuels, and blankets under specific conditions of neutron irradiation. Tests are focused on providing data for design and licensing in the areas of thermal performance, mechanical performance, chemical effects and run-beyond-cladding breach.

Keywords: Ceramics, Fuel Development, Radiation Effects

6. Alloy Development — 1983 $3600K

DOE Contact - D. K. Magnus (301) 353-5004
Hanford Engineering Development Laboratory, (Contract No. DE-AC14-76FF02170) Contact - J. S. Straalsund (509) 376-3482

Characterize the in-reactor deformation behavior of breeder reactor cladding and duct materials. Work emphasizes measurement of in-reactor swelling, creep, and post-irradiation mechanical properties such as tensile behavior and fracture toughness. Irradiation resistance of tailored commercial and development alloys is investigated.

Keywords: Radiation Effects, Materials Characterization

7. Reference Fuels — 1983 $3013K

DOE Contact - D. K. Magnus (301) 353-5004
Hanford Engineering Development Laboratory, (Contract No. DE-AC14-76FF02170) Contact - C. M. Cox (509) 376-0059

Design, fabricate, irradiate, examine and evaluate standard FFTF driver fuel. Conduct special tests such as high power, power-to-melt and fuel open test assembly experiments. These experiments cover both steady-state and transient conditions.

Keywords: Ceramics, Materials Characterization

8. Advanced Fuels — 1983 $3849K

DOE Contact - D. K. Magnus (301) 353-5004
Hanford Engineering Development Laboratory, (Contract No. DE-AC14-76FF02170) Contact - C. M. Cox (509) 376-0059

Design, fabricate, irradiate, and examine advanced driver fuel. Perform post-irradiation examination of advanced breached fuel pins.

Keywords: Ceramics, Radiation Effects

9. Absorbers — 1983 $ 855K

DOE Contact - A. Van Echo (301) 353-3930
Hanford Engineering Development Laboratory, (Contract No. DE-AC14-77FF02170) Contact - L. Pember (509) 376-3104

Design, fabricate, irradiate absorber pellets, pins and assembly experiments for reference and advanced breeder reactor control rod concepts. This experimental work includes physical and mechanical property evaluations of boron carbide and related materials.

Keywords: Ceramics, Radiation Effects, Materials Characterization

10. Fuel Support Technology — 1983 $2848K

DOE Contact - D. K. Magnus (301) 353-5004
Hanford Engineering Development Laboratory, (Contract No. DE-AC14-77FF02170) Contact - C. M. Cox (509) 376-0059

Obtain by laboratory measurements, properties data required for design, performance analysis and fabrication of fuel and blanket materials. Develop analytical relationships to describe experimental data compatible with performance codes and models. Review, evaluate and recommend properties data for non-metallic fuel/blanket materials.

Keywords: Materials Characterization

11. Fuel Fabrication — 1983 $10817K

DOE Contact - J. D. Nulton (301) 353-5198
Hanford Engineering Development Laboratory, (Contract No. DE-AC14-76FF02170) Contact - L. Rice (509) 376-5761

Design, develop and build an automated fuel pin fabrication facility. The facility will incorporate advanced equipment and techniques designed to reduce personnel exposure and maximize special nuclear materials safe-guards.

Keywords: Materials Processing

12. Program Management — 1983 $ 700K

DOE Contact - D. K. Magnus (301) 353-5004
Hanford Engineering Development Laboratory, (Contract No. DE-AC14-76FF02170) Contact - D. E. Mahagin (509) 376-5288

Draft and implement multi-year program and test plan.

Keywords: Program Plan

13. Post-Irradiation Examination, Deactivation and Storage of Carbide Fuel — 1983 $4545K

DOE Contact - D. K. Magnus (301) 353-5004
Los Alamos National Laboratory, (Contract No. W-7405-eng-36) Contact - J. L. Green and W. T. Wood (505) 667-2610

Conduct hot cell operations. Deactivate carbide fuel/blanket fabrication facilities.

Keywords: Ceramics, Materials Processing, Materials Fabrication

14. Improved Oxide Fuel — 1983 $1135K

DOE Contact - D. K. Magnus (301) 353-5004
Hanford Engineering Development Laboratory, (Contract No. DE-AC14-76FF02170) Contact - C. M. Cox (509) 376-0059

Obtain by laboratory measurements, properties data required for design, performance analysis and fabrication of fuel and blanket materials. Develop analytical relationships to describe experimental data compatible with performance codes and models. Review, evaluate and recommend priorities data for non-metallic fuel/blanket materials.

Keywords: Materials Characterization

15. Fuel/Blanket Assembly Development — 1983 $1829K

DOE Contact - D. K. Magnus (301) 353-5004
Westinghouse Advanced Energy Systems Division, (Contract No. EY-76-C-02-3045-M) Contact - A. Boltax (412) 722-5363

Design, fabricate and test performance of oxide fuel subassemblies in support of the national effort on advanced fuels development. Perform design, thermal-hydraulic analysis, and fabrication of blanket fuel assemblies. Develop and verify pin life codes.

Keywords: Ceramics, Materials Processing, Materials Characterization

16. Advanced Alloy Development — 1983 $ 99K

DOE Contact - D. K. Magnus (301) 353-5004
ORNL, (Contract No. W-7405-eng-26) Contact - A. Rowcliffe (615) 574-5057

Conduct examinations and analysis of selected advanced alloy specimens for swelling and phase stability. Perform post-irradiation tensile tests and microstructural exams of advanced alloys.

Keywords: Radiation Effects, Materials Characterization

UNITED STATES
DEPARTMENT OF ENERGY
WASHINGTON, D.C. 20585

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF ENERGY
DOE 350

THIRD CLASS MAIL