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Advanced Energy Projects FY 1983 Research Summaries

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U.S. Department of Energy
Division of Advanced Energy Projects
Office of Basic Energy Sciences
Office of Energy Research
Washington, D.C. 20545

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OFFICE OF BASIC ENERGY SCIENCES

DIVISION OF ADVANCED ENERGY PROJECTS (AEP)

Program Description

What projects are supported?

This Division supports exploratory research on novel concepts related to energy. The research is usually aimed at establishing the scientific feasibility of a concept and, where appropriate, also at estimating its economic viability. Because projects supported inevitably involve a high degree of risk, an indication of a high potential payoff is required. An immediate, specific application of the concept is not an absolute prerequisite for consideration; thus, for example, proposers of schemes leading to the development of x-ray lasers are not required to justify their proposals by discussing potential applications of such lasers.

The concepts supported are typically at too early a stage of scientific verification to qualify for funding by DOE programs responsible for technology development. Where doubt exists, such programs are consulted, prior to proposal consideration by AEP, in order to establish their possible interest in the project.

Projects not supported

The AEP Division does not support ongoing, evolutionary research. Neither does it support large scale demonstration projects.

Period of support

By design the period of support is finite, generally not exceeding three years. It is expected that, following such a period, the concept will either be at a stage where it can be supported by a technologically appropriate organization or branch of DOE, or else it will be dropped.

Funding levels

The size of a contract in FY '83 varied between $70,000 and $394,000 per annum.

Who can propose?

Unsolicited proposals can be submitted by universities, industrial organizations, nonprofit research institutions or private individuals. Consideration is also given to ideas submitted by scientists working at national laboratories.

Proposal evaluation

Awards are based on the results of an evaluation process which usually involves a review by external reviewers. Regardless of the outcome of the evaluation, proposers receive copies of reviewers' reports.

Questions asked of the reviewers depend on the subject of the proposal. Some typical questions are listed below:

1. Is the proposed concept new? How does it compare with other work in the field?

2. Are there basic flaws in the scientific (technical) arguments underlying the concept?

3. Are the technological requirements of the proposed concept, including material requirements, within the realm of either present or near term future capabilities?

4. Is there anything about the concept which makes its economics manifestly untenable, even under reasonably optimistic assumptions?

5. Is the anticipated benefit to the public high enough to warrant the Government's involvement in the R&D effort?

Preproposals desired

It is suggested that before a formal proposal is prepared, the proposer should submit a brief outline of the proposed work. The outline should provide enough background information to enable a decision as to whether or not the proposed work programmatically fits the mission of AEP.

Proposals

Once a programmatic interest of AEP in the proposed project has been established, a proposal should be submitted along the guidelines specified in DOE/MA-0095, "Guide for the Submission of Unsolicited Proposals." Each proposal must contain:

- A cover page, prepared in a format specified in DOE/MA-0095, Appendix B.

- o A 200-300 word abstract, written in plain English, describing the essence of the project in terms understandable to a layman. The abstract should be in a form suitable for inclusion in DOE program presentations.

- o A technical discussion of the proposed concept and a description of the proposed work. While the discussion should be kept brief, there is no formal limitation on the number of pages allotted to this section of the proposal. Since it is this section that will form the basis for the evaluations by technical reviewers, the proposer is urged to make certain that all aspects of the proposed project which are relevant to forming a judgment of the project's merits are adequately covered.

- o A statement of work specifying all tasks to be performed in the course of the proposed work.

- o Description of available facilities.

- o Resumes of key personnel.

- o Detailed information on any support for the proposed or related work, past, present or anticipated, including proposals submitted, or about to be submitted, to other organizations.

- o A cost estimate for the proposed effort.

Further Information

Inquiries should be addressed to:

Dr. Ryszard Gajewski, Director
Division of Advanced Energy Projects
Office of Basic Energy Sciences
ER-16, GTN
Department of Energy
Washington, D.C. 20545

Phone: 301/353-5995

OFFICE OF BASIC ENERGY SCIENCES

DIVISION OF ADVANCED ENERGY PROJECTS

Summaries of Projects Active in FY 1983

This section contains brief summaries of all projects active in this Division during Fiscal Year 1983 (October 1, 1982-September 30, 1983). The intent of this compilation is to provide a convenient means for quickly acquainting an interested reader with the program in Advanced Energy Projects. More detailed information on research activities in a particular project may be obtained by contacting directly the principal investigator shown below the project title. Some projects will have reached the end of their contract periods by the time this book appears, and will therefore no longer be active. Those cases in which work was completed in FY '83 are indicated by the footnote: *Project completed.

1. THE CONTINUOUS MEMBRANE COLUMN: A LOW ENERGY ALTERNATIVE TO DISTILLATION

BEND RESEARCH, INC.
64550 Research Road
Bend, Oregon 97701-8599

Walter C. Babcock
Membrane Separations Division

Date Started: February 5, 1982

Funding: FY '83 $118,000 for 12 months

Anticipated Duration: 3 years

The objective of this program is to evaluate membrane separation as an energy-efficient alternative to distillation. Three commercially important separations currently performed by distillation are under investigation: isopropanol from water, ethanol from water, and soy bean oil from hexane. Work is under way in the areas of membrane development and assessment of membrane performance in a "continuous column" module configuration. Results thus far have been positive; for example, energy-consumption calculations based on membrane performance in laboratory-scale separations indicate a 44% savings in energy is possible when a hybrid membrane/distillation approach is used in place of distillation alone to to produce a 90 vol % isopropanol-in-water azeotrope.

2. LIQUID MEMBRANES FOR THE PRODUCTION OF OXYGEN-ENRICHED AIR

BEND RESEARCH, INC.
64550 Research Road
Bend, Oregon 8599

Stephen L. Matson

Date Started: April 16, 1979

Funding: FY '83 $302,000 for 12 months

Anticipated Duration: 5 years

The objective of this program is to develop novel liquid membranes for the energy-efficient concentration of oxygen from air. Oxygen-enriched air will find use in a wide range of industrial, chemical, and combustion processes. The liquid membrane consists of a solvent that contains a dissolved oxygen carrier and that is held within the pores of a membrane support. The oxygen carrier selectively transports oxygen across the liquid membrane by the process of facilitated transport, which results in a product gas highly enriched in oxygen. Recent efforts have focused on increasing the flux of oxygen across these membranes by reducing their effective thickness. Work in progress relates to development of membrane modules in regeneration techniques to extend their life.

3. EXTREME ULTRAVIOLET COHERENT RADIATION DEVICE: TRANSVERSE OPTICAL KLYSTRON

BROOKHAVEN NATIONAL LABORATORY*
Upton, New York 11973

C. Pellegrini and A. van Steenbergen
National Synchrotron Light Source

Date Started: September 26, 1983

Funding: FY '83 $115,000

Anticipated Duration: 3 years

This project is for the development of a new radiation source to be incorporated with the VUV storage ring of the National Synchrotron Light Source (NSLS) which will produce coherent, diffraction limited radiation from 500 Å to 2000 Å. Specifically, this radiation source is a Transverse Optical Klystron (TOK) which makes use of a high power laser in the visible region and a broken periodicity undulator structure in conjunction with the circulating electron beam bunches in the VUV storage input ring to produce, with good efficiency, coherent radiation at the harmonics of the input laser.

*Performed in cooperation with BELL LABORATORIES, 600 Mountain Avenue, Murray Hill, New Jersey 07974, Richard R. Freeman and Brian Kincaid co-principal investigators.

4. FREE ELECTRON LASER TEST,
NATIONAL SYNCHROTRON LIGHT SOURCE

BROOKHAVEN NATIONAL LABORATORY
Upton, New York 11973

C. Pellegrini and A. van Steenbergen
National Synchrotron Light Source

Date Started: May 1, 1980

Funding: FY '82 $298,000 for 12 months

Anticipated Duration: 3 1/2 years

The purpose of this program is to develop a free electron laser test module driven by the circulating beam of a storage ring. The program will explore the effect of the free electron laser on the parameters of the storage ring as well as involve the development of a coherent wiggler to provide the appropriate mechanism for electromagnetic radiation amplification due to repeated interactions of the laser field and the transversely oscillating electrons in the undulator (coherent wiggler). It is anticipated that a basic design for a tunable high average power ultraviolet source with a narrow spectral bandwidth may result from these studies.

5. MEQALAC CLUSTER
ION FUSION

BROOKHAVEN NATIONAL LABORATORY
Upton, New York 11973

Lewis Friedman and Alfred Maschke
Chemistry & Accelerator Departments

Date Started: January 15, 1981

Funding: FY '82 $240,000 for 12 months

Anticipated Duration: 3 years

Proof-of-principle experiments are proposed to demonstrate that isotopic hydrogen molecule cluster ions can be prepared and accelerated. The long range goal of these experiments is the utilization of plasmas produced by accelerated cluster ions for the production of thermonuclear reactions. A cluster ion source has been developed which has produced low intensity beams of narrow mass distribution hydrogen clusters with mass to charge ratios as high as 10^4. Research on fundamental processes in this low temperature ion source designed to improve source intensity is in progress. A high precision "optical bench" beam transport system was developed for use with small aperture MEQALACs. High brightness beams of Argon and Xenon were accelerated in quadrupole focused acceleration columns. Laminar flow was observed in a 10 gap electrostatic quadrupole accelerating column and in a 50 quad transport line.

6. HIGH CURRENT BETATRON
FOR A FREE ELECTRON LASER

UNIVERSITY OF CALIFORNIA
Irvine, California 92717

Norman Rostoker and Amnon Fisher
Department of Physics

Date Started: August 1, 1981

Funding: FY '81 $685,000 for 3 years

Anticipated Duration: 3 years

A modified Betatron is being developed that resembles an Astron. Electrons are injected into an elongated magnetic mirror. The Larmor radius is 6 cm; the distance between mirrors is 80 cm. With a field emission injector (50 kV, 1 amp, 150 nsec) about 20 nC have been trapped for about 10 μ sec. The electron trajectories are helical with an axial period of 40 nsec and an azimuthal period of 3 nsec. Rapid data acquisition is facilitated by a 1 Hz repetition rate. The purpose of the experiment is to study injection, trapping, acceleration and extraction in this new configuration. Multiturn injection has been demonstrated with electrostatic and magnetic inflectors. Acceleration to about 1 MeV has been accomplished with an iron powder ferromagnetic core and increasing the field at the beam from about 100 to 1000 gauss while maintaining the Betatron 2:1 condition. Electrons have been extracted with a gate coil for direct measurement of the trapped charge. The injection is very nearly tangential to the cyclic orbit which should produce a high-current low-emittance beam suitable for a free electron laser. Measurements of the emittance of an extracted beam are the next objective.

7. BIOEXTRACTION OF IRON FROM IRON OXIDES:
REDUCTION OF COKE DEMAND IN STEEL
PRODUCTION BY MICROBIAL BENEFICIATION

CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California 91125

Michael R. Hoffman
Engineering and Applied Science

Date Started: August 15, 1983

Funding: FY '83 $237,000 for 3 years

Anticipated Duration: 3 years

The objective of this project is to investigate the kinetics and mechanisms of the reductive dissolution of iron oxide minerals such as hematite, geothite, lepidocrocite and limonite by various species of iron-reducing bacteria. Kinetic parameters will be obtained from batch and continuous flow reactor studies in which P_O , temperature, P_{CO} , surface area, E_H, pH and carbon source will be primary variables. Mixed-culture systems will be studied to determine the occurrence of bacterial mutualism. In addition to reductive dissolution by iron-reducing bacteria, the kinetics of dissolution of iron (III) from insoluble oxides in the presence of siderophore-producing organisms will be investigated. Finally, the rate of accumulation of hexagonal magnetite by magnetotactic organisms will be determined. Results of this research will indicate the potential of anaerobic, aerobic and microaerophilic iron-metabolizing microorganisms for a variety of industrial and commerical applications.

8. NEW POLYMER ELECTRODES AND CONDUCTORS BASED ON POLY(HYDROQUINONE/QUINONE) OXIDATION/REDUCTION SYSTEMS

CASE WESTERN UNIVERSITY
Cleveland, Ohio 44106

Morton H. Litt
Department of Macromolecular Science

Date Started: September 15, 1983

Funding: FY '83 $277,000 for 14 months

Anticipated Duration: 14 months

This project has the following goals: 1) To synthesize soluble linear fused ring polyaromatic polymers (ladder polymers) which have attached 1,4-hydroxyl groups; 2) To characterize these polymers. The polymer should be a good electrical conductor. It is expected that the hydroxyl groups can be reversibly oxidized and reduced - making this material a good candidate for a very high capacity electrode. High molecular weight polymers will be made into oriented fibers and films and their mechanical properties as well as electrical properties studied. Fiber of these polymers should be like graphite fibers, but should be solution processable.

9. COLLECTIVE ACCELERATION OF IONS USING HIGH CURRENT RELATIVISTIC ELECTRON BEAMS

CORNELL UNIVERSITY
Ithaca, New York 14853

John A. Nation

Date Started: January 1, 1980

Funding: FY '82 $151,000 for 12 months

Anticipated Duration: 3 1/3 years

Experiments have been completed demonstrating the use of slow space charge waves on an electron beam for the collective acceleration of ions. In this demonstration a beat-wave was used to accelerate protons. The wave phase velocity was controlled by slowly varying the period of a rippled magnetic field. Approximately 3×10^{10} protons were accelerated through 1 MeV at an average field strength of about 2 MV/m. Work is continuing on this scheme to optimize and understand the performance of the accelerator in order that its application to ion accelerators can be adequately defined. In addition, extensive measurements have been made showing the non-linear reduction in the phase velocity of space charge waves on an electron beam. This work will continue under different sponsorship and will also be applied to collective ion acceleration.

*Project completed

10. DEVELOPMENT OF A BIOCHEMICAL PROCESS FOR PRODUCTION OF ALCOHOL FUEL FROM PEAT

DYNATECH R/D COMPANY
99 Erie Street
Cambridge, Massachusetts 02139

Donald L. Wise

Date Started: June 1, 1981

Funding: FY '83 $199,000 for 12 months

Anticipated Duration: 3 years

Peat reserves in the United States represent a significant untapped energy source (1400 quads). This program is directed toward development of a wet process for utilization of peat as the feedstock in liquid fuel production. The process requires solubilization and partial oxidation of the peat (processed 8% solids) to produce dissolved aromatics which are suitable substrates for adapted anaerobic bacteria. Fermentation parameters are adjusted so that organic acids are the product which can be removed and concentrated by liquid-liquid extraction. The acid salts of the fermentation products can then be electrolytically oxidized to form mixed olefins. A mixed alcohol product, suitable for blending with gasoline can be produced by hydration of the olefins.

11. CATALYSIS OF DIRECT METHANOL ELECTRO-OXIDATION IN BUFFERED ELECTROLYTES

EIC LABORATORIES, INC.
111 Chapel Street
Newton, Massachusetts 02158

S. Barry Brummer
Battery Division

Date Started: July 15, 1983

Funding: FY '83 $134,000 for 12 months

Anticipated Duration: 3 years

The catalysis of CH_3OH oxidation in aqueous, concentrated $K_2CO_3/KHCO_3$ electrolytes for direct CH_3OH/air fuel cells will be explored. A major goal is the elimination of all noble metal catalysts. In the first year of the project, the properties of the $K_2CO_3/KHCO_3$ electrolyte relevant to fuel cells will be determined. These include concentration-conductance-water vapor pressure-CO_2 pressure relationships and the kinetic buffering capacity of the electrolyte. The coulombic efficiency of the CH_3OH-to-CO_2 conversion will be investigated as well as the kinetics of CH_3OH oxidation on Pt electrodes.

12. INVESTIGATION OF THE EXTRACTION OF HYDROCARBONS FROM SHALE ORE USING SUPERCRITICAL CARBON DIOXIDE

ENERGY & ENVIRONMENTAL ENGINEERING, INC.
675 Massachusetts Avenue
Cambridge, Massachusetts 02139

James H. Porter

Date Started: July 15, 1982

Funding: FY '82 $110,000 for 12 months

Anticipated Duration: 16 months**

Carbon dioxide has demonstrated solvent properties for organic materials at temperatures and pressures near its critical point: 31^0C and 72.8 atm. At these conditions, small changes in pressure have large effects on the density and thus the solvent power of CO_2. This project is an experimental investigation of a cycle to extract hydrocarbons from the shale under conditions of high pressure and condense the hydrocarbons out of the CO_2 solvent at conditions of low pressure and temperature. Experiments thus far indicate that it is predominantly the bitumen fraction of the shale which is being extracted. It is anticipated that conditions of higher temperature and CO_2 flow rates will result in higher oil yield from the kerogen fraction of the shale.

**Includes unfunded extension

13.*PHOTOCHEMICAL URANIUM ENRICHMENT IN SOLIDS

GENERAL ATOMIC COMPANY
P. O. Box 81608
San Diego, California 92138

Earl S. Ensberg

Date Started: July 1, 1981

Funding: FY '82 $258,000 for 12 months

Anticipated Duration: 2 years

Experiments at GA Technologies have established the existence of resolvable isotopic shifts in the visible absorption bands of photochemically active uranyl salts at 10 K, established the conditions for achieving two-photon photoreaction at that temperature, and obtained limited but consistent isotope separation. Although the achieved separation was impractically small, this static, high-concentration approach offers many technical advantages as a method of uranium enrichment. The present program is directed to the scientific assessment of the potential process. The ground state absorption spectrum of normal and oxygen isotope labeled materials have been assigned and improved uranium isotope absorption selectivity achieved. Measurement of the excited state absorption spectrum revealed a substantial red shift relative to the ground state absorption. On the basis of this finding a series of two laser, two-color experiments have been carried out leading to characterization of the reaction branching ratio in the higher excited state, revealing the role of an intermediate reaction product, and providing substantially improved uranium isotope separation.

*Project completed

14. FLUID DYNAMIC ENERGY SEPARATION

GEORGE WASHINGTON UNIVERSITY
Washington, D.C. 20052

J.V. Foa
School of Engineering and Applied Science

Date Started: September 15, 1983

Funding: FY '83 $294,000 for 2 years

Anticipated Duration: 2 years

The object of this study, the "energy separator", is a new kind of air conditioning and heating device that promises advantages of energy economy as well as of ruggedness and mechanical simplicity. It has only one moving part, a free-spinning rotor. Air entering it is discharged through slanting orifices on its periphery, causing it to spin. The emerging air separates into hot and cold streams whose difference in temperature can be regulated as desired. The hot output is actually not in the form of heat but rather in the form of recoverable mechanical energy that, if not used for heating, may be utilized to drive a turbine to help the compressor drive, thereby saving energy. Among the energy separator's applications of greatest interest from the standpoint of energy conservation are: (a) those involving the simultaneous heating and cooling of separate spaces; (b) heat pumps; (c) the air conditioning and structural cooling of high-speed vehicles, where the high boundary layer temperature makes it impracticable to dump heat overboard through heat exchangers; (d) industrial processes requiring the "freezing", through extremely rapid cooling, of the high-temperature equilibrium composition of a gas; (e) simultaneous refrigeration, heating, and power generation on board refrigerated ships, and (f) those heating and cooling applications in which mechanical simplicity, low cost, and ruggedness are at a premium.

15. RESEACH AND DEVELOPMENT OF A MASS ACCELERATOR (MAID) AS A DRIVER FOR IMPACT FUSION

GT-DEVICES
5705A General Washington Drive
Alexandria, Virginia 22312

Derek Tidman and Shyke Goldstein

Date Started: May 6, 1981

Funding: FY '83 $297,000 for 12 months

Anticipated Duration: 3 years

The objective of this program is to demonstrate that high pressure plasma jets in the kilobar range can be used to propel solid projectiles to high velocity. The basic concept is to accelerate a solid mass (e.g., 0.5 gram) via a series of momentum kicks provided by sequentially directing the high pressure plasma jets onto the rear projectile surface as it passes through each module. This new approach to mass acceleration has been successfully demonstrated using 10 plasma discharge modules (with projectile sensing and timing circuits) aligned in a manner similar to a linear accelerator. Experiments in which the accelerator has been operated in a sense-and-kick mode have achieved velocities of 4 km/sec and velocities above 6 km/sec are expected in the near future with this small scale demonstration device. The effort is also directed to determining whether a large scale version of such an accelerator could be used as a driver for impact inertial fusion, or other energy related applications such as acquiring a data base for equation-of-state information at high pressures. This system appears to provide a low cost approach to these objectives.

16. MEASUREMENT OF THE EFFICIENCY OF MUON-CATALYZED FUSION

IDAHO NATIONAL ENGINEERING LABORATORY
EG&G Idaho, Inc., P.O. Box 1525
Idaho Falls, Idaho 83415

Steven E. Jones
Scientific Information AGM

Date Started: March 8, 1982

Funding: FY '83 $344,000 for 12 months

Anticipated Duration: 3 years

An experimental investigation of muon-catalyzed fusion in deuterium-tritium mixtures has producted a number of new results. We have measured directly for the first time the high-energy neutron yield of the reaction $\mu^- + d + t \rightarrow \mu^- + He + n + 17.6$ MeV. At high deuterium-tritium densities (up to 60% of liquid hydrogen density), copious 14 MeV neutron production has been observed, demonstrating many d-t fusions per muon. Furthermore, the neutron yield has been shown to increase with the temperature of the deuterium-tritium gas in the range 100K - 550K. The fusion yield also depends on the mixture density and deuterium-tritium ratio. Further experiments will explore these effects more fully and, in particular, measure the temperature at which the fusion yield reaches a maximum. The objective of this project is to provide answers to recurring questions regarding the usefulness of muon-catalyzed fusion as a practical energy source.

17. GENERATION OF STIMULATED EMISSION IN THE SOFT X-RAY RANGE BY NONLINEAR PROCESSES WITH EXCIMER LASERS

UNIVERSITY OF ILLINOIS AT CHICAGO
Chicago, Illinois 60680

Charles K. Rhodes
Department of Physics

Date Started: September 15, 1983

Funding: FY '83 $413,000 for 2 years

Anticipated Duration: 2 years

High spectral brightness rare gas halogen (RGH) excimer lasers can be used to generate coherent extreme ultraviolet radiation by either harmonic generation mechanisms or direct multiphoton pumping of appropriate laser media. In order to demonstrate the basic characteristics of these two approaches, recent comparative measurements have been made. Extension of these results to both shorter wavelengths and higher power levels requires an extended study of the basic character of high order nonlinear processes in the ultraviolet. Recent studies of collision-free multiply-charged ion production with irradiation at 193 nm point to an anomalously strong energy coupling to high Z atoms with processes involving as many as 99 photons being observed. These findings strongly suggest that the direct excitation of inversions by appropriate multiquantium processes in the 40-80 eV range in certain atoms can be generated with existing laser instrumentation. This document proposes a two year experimental program to (1) determine the nature of the mechanisms leading to the anomalous ion production, (2) assess the limitations on the quantum state selectivity such processes can provide, and (3) attempt to observe genuine stimulated emission in the 40-80 eV range. Given the scaling characteristics of RGH media, success in this endeavor would imply the feasibility of a laboratory scale coherent source operating in the kilovolt range.

18. FREE ELECTRON LASER AT THE ETA*

LAWRENCE BERKELEY LABORATORY
University of California
Berkeley, California 94720

A.M. Sessler and D. Prosnitz

Date Started: February 8, 1982

Funding: FY '83 $330,000 for 12 months

Anticipated Duration: 32 months

The purpose of this experiment is to develop a tapered-wiggler Free Electron Laser (FEL) as an efficient microwave source between 35 and 40 GHz. One important application of this source is in electron cyclotron resonance heating of thermonuclear plasmas. The Lawrence Livermore National Laboratory's Experimental Test Accelerator provides the high-current, high voltage (1 kA, 4 MeV) low emittance electron beam used to drive the FEL amplifier. The first year was devoted to building beam line components; the electron beam wiggler which is electromagnetic, has no iron, and is pulsed; and microwave input and output diagnostics. Initial operation was developed at 8 mm wavelength, with the capability of studying 2 mm and 4 mm in the future. Experimental runs with the apparatus were initiated in February 1983 and beam has been transported through the wiggler, oscillation (from noise) has been observed, and amplification (with a gain larger than unity) of an input microwave signal has been observed. Further experiments will be done to increase the gain of such a device, as well as to clarify the physics of an FEL amplifier.

*Experimental Test Accelerator at Lawrence Livermore National Laboratory.

19. AN APPROACH TO RECOVER STRATEGIC METALS FROM BRINE

LAWRENCE LIVERMORE NATIONAL LABORATORY
P.O. Box 808
Livermore, California 94550

Ellen Raber
Earth Sciences Department

Date Started: February 1, 1982

Funding: FY '83 $137,000 for 12 months

Anticipated Duration: 20 months

The objective of this project is to evaluate natural brines obtained from salt domes and geothermal sources as possible resources for some strategic metals. Based upon research efforts conducted last year, platinum was detected at near-commercial values of $\approx$ 50 ppb in a brine from the Salton Sea Geothermal Resource, Imperial Valley, California. This brine is also rich in lithium, strontium and manganese. If possible, additional samples will be analyzed from other wells to determine the actual areal extent of platinum in the Salton Sea Geothermal Field. None of the other fluids (from 14 locations sampled elsewhere in the United States) contained interesting concentrations of strategic metals. Bench scale experiments are being conducted to determine the feasibility for recovery of the platinum by activated carbon, commerical reductive resins, iron reduction and electrolytic methods. Any viable method will need to be operational at 90°C in the absence of oxygen. To date, Rohm and Haas Amborane-355 Resin has proven successful under these conditions. The cost-effectiveness of this and other methods will be evaluated. Additionally, a mini-field test is planned in conjunction with a developer to further evaluate the best extraction technique.

20. *DETECTION AND ENRICHMENT OF FRACTIONALLY CHARGED PARTICLES IN MATTER

LAWRENCE LIVERMORE NATIONAL LABORATORY
P.O. Box 808, L-482
Livermore, California 94550

Charles D. Hendricks
Y Division, Laser Program

Date Started: May 1, 1982

Funding: FY '82 $360,000 for 12 months

Anticipated Duration: 3 1/2 years

It is the objective of this experiment to search for fractional charges in matter and if they are found, to concentrate them for further experimental studies. Two vertical column vacuum systems are operational containing 3 meter and 5 meter long deflection plates. One system is reserved for use with very low vapor pressure liquid drops and the other is used with very low vapor pressure liquid drops and the other is used with higher vapor pressure liquids. Streams of equal mass drops have been passed vertically through the deflection system with transverse E fields of 25 kV/cm. Drop deflections have been observed which are consistent with integer electron charge differences between drops. Interactions between drops as a result of polarization by the transverse electric field have also been observed experimentally. To eliminate this source of irregularity in the drop deflections, the drop to drop spacing (which is normally about two drop diameters) is being increased to about 20 drop diameters by removing some of the drops from the stream. Because of the high rate of drop throughput (30 to 50 thousand drops per second) it is necessary to utilize electronic data acquisition. The computer-experiment interface is being designed and will be implemented.

*Projects 20 and 23 are cooperative interlaboratory projects.

21. PUMPING OF GAMMA-RAY LASERS: EXPERIMENTAL AND THEORETICAL INVESTIGATIONS

LOS ALAMOS NATIONAL LABORATORY
Los Alamos, New Mexico 87545

G. C. Baldwin
Physics Division

Date Started: September 27, 1983

Funding: FY '83 $360,000 for 12 months

Anticipated Duration: 2 years

The power required to pump gamma-ray lasers could be significantly reduced, thereby enhancing the prospects for their early development, if a) a long-lived nuclear isomer, prepared in advance, could be rapidly converted to a short-lived state that emits recoilless gamma radiation; and/or b) internal conversion could be controlled. This research will investigate the preparation of nuclear isomers by selective laser photoionization, will study the possibility of their de-excitation by laser-induced Raman processes, and will attempt, by optical excitation of its electronic structure, to modify the internal conversion rate in the 73-eV isomer of ^{235}U.

22. LIQUID METAL THERMO-
ACOUSTIC ENGINE

LOS ALAMOS NATIONAL LABORATORY
Los Alamos, New Mexico 87545

J. C. Wheatley
Physics Division

Date Started: September 27, 1983

Funding: FY '83 $240,000 for 12 months

Anticipated Duration: 3 years

This project is concerned with studying a new type of thermoacoustic heat engine using a liquid metal as the working substance. The thermophysical properties of liquid metals make them far superior to ideal gases as working substances in such an engine. Although the study is of fundamental interest it is also expected that this engine will be of technological importance, because it will produce electricity from heat with no moving parts and with an efficiency that is a substantial fraction of the Carnot efficiency. Currently efforts are under way to extend previous work on thermoacoustics in ideal gases to liquids, and efforts will soon begin on detailed computer design of an experimental engine with an electrical power output of about 1 kW.

23.*DETECTION AND ENRICHMENT
OF FRACTIONALLY CHARGED
PARTICLES IN MATTER

LOS ALAMOS NATIONAL LABORATORY
P.O. Box 1663
Los Alamos, New Mexico 87545

George Zweig
Theoretical Division

Date Started: May 1, 1982

Funding: FY '83 $100,000 for 12 months

Anticipated Duration: 3 1/2 years

The basic unit of electric charge is one third that of the electron. It is therefore natural to ask if isolated particles of fractional charges $\pm$ 1/3e, $\pm$ 2/3e, $\pm$ 4/3e. . . . exist freely as elements of the earth. William Fairbanks' group at Stanford University has concluded that they do. Negative fractionally charged particles are interesting because they could replace electrons in atoms, molecules and solids, leading to super-dense states of matter. Under certain circumstances they would even catalyze fusion reactions. This project is a combined theoretical and experimental effort to search for fractionally charged particles in a wide variety of materials, to determine which materials are most abundant in fractionally charged particles, and to enrich the fractional charge content of sample materials. The crystal chemistry of fractionally charged particles will be theoretically developed and those materials most likely to contain enhanced concentrations of fractionally charged atoms will be identified. These materials will then be obtained, analyzed and used as samples for the experimental studies.

*Projects 20 and 23 are cooperative interlaboratory projects.

24. MAGNETIC REFRIGERATION FOR EFFICIENT CRYOGEN LIQUEFACTION

LOS ALAMOS NATIONAL LABORATORY
P.O. Box 1663, MS M764
Los Alamos, New Mexico 87545

John A. Barclay
Group P-10

Date Started: February 1, 1982

Funding: FY '83 $340,000 for 12 months

Anticipated Duration: 3 1/2 years

The objective of this work is to consider conceptual designs, test models of those designs, and develop a data base for compact, reliable, high-efficiency magnetic refrigeration, with special emphasis on applying this technology to liquefaction of cryogens. Experiments are conducted to determine the magneto-caloric effect and the heat capacity of suitable solid magnetic working materials over the temperature range 1 to 300 K and at magnetic fields up to 9 T as well as the heat and fluid flow through beds of these materials. Three bed geometries are considered: porous beds made of small particles; many parallel sheets separated by small gaps; and a block with many circular channels. Additional efforts are directed toward: determination of parasitic heat losses; optimization of magnetic field configuration; design of heat exchangers, cryogenic pumps, and fluid entrainment suppressors; and development of new concepts (other than rotating and reciprocating devices) for magnetization/demagnetization. Samples of several gadolinium compounds with Curie temperatures from 300 to 4 K were fabricated. The density, Curie temperature, magnetization, magnetic susceptibility, heat capacity, and adiabatic magnetization/demagnetization temperature change for one of the samples, GdNi, have been measured. Similar measurements on the other samples are in progress.

25. ZONE-MELTING RECRYSTALLIZATION FOR SOLAR CELLS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

Henry I. Smith
Electrical Engineering & Computer Science

Date Started: September 1, 1982

Funding: FY '82 $200,000 for 24 months

Anticipated Duration: 2 years

The objective of this project is to develop a process for producing oriented silicon films suitable for low-cost solar cells. A new technique, zone-melting recrystallization, has been developed which produces crystalline silicon films having mobilities close to bulk values. Using a vertical-constriction technique, (100) texture has been obtained in films 60 μm thick. Single-grain films are produced by passing the molten zone through a lithographically-defined planar constriction. Lithographically-defined patterns have also been used to confine grain boundaries, dislocations and impurities to a set of narrow, parallel rejection channels spaced ∿100 μm apart. An orientation-filtering technique has been developed to control azimuthal orientation. Electrical measurements have indicated that the films are free of deep-level-producing impurities and have acceptable minority carrier diffusion lengths. Our strategy is to produce high-quality crystalline silicon films on low-cost glass substrates. The glass substrate would serve as the cover of the final module.

26.*COGENERATION OF ELECTRIC ENERGY AND USEFUL CHEMICALS IN A FUEL CELL

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

J. Wei
Department of Chemical Engineering

Date Started: September 1, 1980

Funding: FY '82 $100,000 for 12 months

Anticipated Duration: 4 1/3 years**

The conversion of the heat released by exothermic chemical reactions into electrical energy is becoming increasingly important in chemicals manufacture. Unfortunately, the conversion efficiency of traditional thermal cogeneration systems is thermodynamically limited and practical efficiencies may be quite small. Electrochemical cogeneration, in which a useful chemical product and electricity are produced simultaneously in a fuel cell, is not subject to this limitation. The present project investigates the concurrent electrochemical production of electricity with the oxidative dehydrogenation of ethylbenzene to styrene and butane to butadiene in zirconia fuel cells with appropriate catalytic electrodes.

*Project completed.
**Includes unfunded extension.

27. DEVELOPMENT OF DIRECT-CONTACT, HIGH EFFECTIVENESS DROPLET HEAT EXCHANGERS

MATHEMATICAL SCIENCES NORTHWEST, INC.
2755 Northup Way
Bellevue, Washington 98004

William J. Thayer III
Flow Technology Group

Date Started: July 1, 1981

Funding: FY '83 $257,000 for 12 months

Anticipated Duration: 3 years

A reliable technique for transferring heat between gas and liquid streams in the 1500-2000 K temperature range could greatly improve the efficiency of current power generation systems. Heat transfer between media in direct contact may eliminate many limitations of conventional heat exchangers which require intervening solid walls. The objective of this program is to characterize and evaluate techniques for providing high effectiveness heat transfer between high temperature droplets and counterflowing gas streams. A computer code has been developed for evaluating two-dimensional flow aspects of droplet and gas injection, column flow, and collection, convective and radiative heat transfer, and wall losses for direct-contact heat exchanger configurations. Tests have been conducted to characterize and evaluate processes which control the formation of uniform droplets of very viscous fluids which simulate molten refractories. Analysis and experiments are continuing to evaluate heat transfer and flow processes, materials issues, design constraints, and the economic impact of the direct-contact heat exchanger for several high temperature applications.

28. PERVAPORATION: A LOW-ENERGY ALTERNATIVE TO DISTILLATION

MEMBRANE TECHNOLOGY AND RESEARCH, INC.
719 Colorado Avenue
Palo Alto, California 94303

Richard Baker

Date Started: April 15, 1983

Funding: FY '83 $84,000 for 12 months

Anticipated Duration: 20 months

The object of this project is to develop selective pervaporation membranes. Pervaporation is a membrane separation process that could offer substantial energy savings compared to distillation. The principal problem inhibiting the development of pervaporation is the lack of suitably selective membranes. A series of provisional criteria for the selection of high-performance membranes has been developed. These criteria are being evaluated using model organic mixtures chosen to simplify the interpretation of the results. Thin film composite membranes made by the free-radical polymerization of single monomers will be used. Based on the experience obtained with these model mixtures we propose to determine the applicability of pervaporation to more economically significant organic mixtures. This data will be used to perform a technical and economic analysis of the process.

29. EXPERIMENTAL RESEARCH IN HIGH TEMPERATURE SOLAR THERMOCHEMICAL PROCESSING. HYDROGEN AND SULFUR FROM HYDROGEN SULFIDE

UNIVERSITY OF MINNESOTA
111 Church Street, S.E.
Minneapolis, Minnesota 55455

Edward A. Fletcher
Department of Mechanical Engineering

Date Started: July 16, 1982

Funding: FY '82 $229,000 for 24 months

Anticipated Duration: 2 years

Highly concentrated sunlight is uniquely suited for supplying process heat at very high temperatures. The efficiency with which process heat is used to effect endothermic processes increases as the temperature at which the heat is added increases. This project makes use of a highly-concentrating solar furnace to study the production of hydrogen and sulfur from hydrogen sulfide in a high-temperature effusional process. We have studied the effect of hydrogen sulfide and its decomposition and oxidation products, as well as admixed hydrocarbons, on material for reactor construction, constructed the major components of a reactor-separator and its appurtenances, and are evaluating various techniques for the construction of effusion membranes. We shall conduct experiments to test the efficacy of the process and evaluate the cost benefits which may be achievable by these kinds of processes vis-a-vis more conventional methods.

30. HOLOGRAPHIC TECHNOLOGY FOR SOLAR ENERGY CONCENTRATION

NATIONAL TECHNICAL SYSTEMS
12511 Beatrice Street
Los Angeles, California 90066

Tomasz Jannson
Research Division

Date Started: June 1, 1981

Funding: FY '83 $204,000 for 12 months

Anticipated Duration: 3 years

Research in this project is aimed at establishing the practical feasibility of using holographic technology (diffractive optics) for solar energy concentration. Very high reflection concentrators were fabricated in the first phase of the program and extinction rations of over 90% were achieved for on-axis holograms for the visible range. The objective during the second year is to build a bench scale photovoltaic solar energy conversion device using a holographic solar concentrator. Holographic solar concentrators with high concentration ratios will be fabricated with dichromated gelatin films. Measurements will be made on this system for system efficiency. Theoretical analysis is being conducted for nontracking type holoconcentrators and they will be fabricated in the third phase of this program.

31. HIGH-FLUX, EXTENDED-PULSE ION ACCELERATOR

UNIVERSITY OF NEW MEXICO
Albuquerque, New Mexico 87131

S. Humphries, Jr.
Department of Chemical and Nuclear Engineering

Date Started: September 27, 1983

Funding: FY '83 $267,000 for 3 years

Anticipated Duration: 3 years

A novel plasma source and ion injector gap geometry which may allow intense ion beam generation for pulselengths exceeding 1 ms will be studied. The pulselength is a factor of 1000 improvement over the present state-of-the-art. The source and injector utilize a radial magnetic field to confine a high density of trapped electrons. This allows transport of ion flux well above conventional space charge limits. The source operates as a cold-cathode discharge with good ionization probability because of the high electron density. A system to produce a 1 ms, 1 kA beam of He+ or heavier ions will be built. The 10 A/cm^2 beam will be extracted at 5 to 20 kV and a divergence less than 20 mrad.

32. MODIFICATION OF THE SURFACE TEMPERATURE BY AN ARTIFICIAL CIRRUS CLOUD

STATE UNIVERSITY OF NEW YORK
Albany, New York 12222

Bernard Vonnegut and Peter Chylek
Atmospheric Sciences Research Center

Date Started: September 1, 1980

Funding: FY '80 $244,000 for 36 months

Anticipated Duration: 3 1/3 years*

The objective of this project is to explore the practicality of using artificially formed cirrus clouds to achieve significant energy savings in densely populated areas. Meteorological data for about 10 years in the Albany area have been analyzed to determine how often the situation favorable for formation of an artificial cirrus cloud occurs. Preliminary results indicate that a suitable situation in the middle and upper troposphere occurs about 10 times per cold season. The combined effect of clearing clouds during the daytime and making cirrus clouds during nighttime gives a benefit-to-cost ratio of about 4/1 for the Albany area. For large metropolitan areas the benefit-to-cost ratio may be up to 40/1. Experimental work carried out at the University of Alaska's site at Fairbanks was concerned with observing the details of how light is scattered by clouds of water droplets and ice crystals. Analysis has also been carried out on about 10 years of data showing the effect of cirrus clouds over Mauna Loa on hourly average diffuse and direct solar radiation. This analysis can be used to suggest what effects artificial cirrus clouds would have on solar radiation reaching the surface. A radiative-convective climate model has been used to estimate the effect of increased cloudiness on the surface temperature, and radiative properties of ice clouds have been studied.

*Includes unfunded extension.

33. ENERGY SYSTEMS BASED ON POLYACETYLENE: RECHARGEABLE STORAGE BATTERIES AND SCHOTTKY BARRIER SOLAR CELLS

UNIVERSITY OF PENNSYLVANIA
3451 Walnut Street
Philadelphia, Pennsylvania 19104

A. G. MacDiarmid
Department of Chemistry

Date Started: March 1, 1981

Funding: FY '82 $101,000

Anticipated Duration: 3 years

The objective of this project is to investigate the chemical, electrochemical, electrical and optical properties of the novel conducting polymer $(CH)_x$, polyacetylene, with a view toward applications in two areas: rechargeable storage batteries made with $(CH)_x$ electrodes, and Schottky barrier solar cells made with $(CH)_x$. Work during FY 1983 continued to focus on the rapid progress in the area of $(CH)_x$ batteries. Coulombic efficiency, constant current discharge characteristics, energy density, maximum power density and the relationship of cell potential to degree of reduction of a partly reduced polyacetylene, $[Li_y(CH]_x (y \leq 0.1)$ cathode in a cell of the type $[Li_y(CH)_x/LiClO_4/Li$ were determined. The $[Li_y(CH)]_x$ $(y \leq 0.1)$ electrode appears to be stable indefinitely in an electrolyte of 1M $LiClO_4$ in tetrahydrofuran in a sealed cell. The stability and reversibility of the reduced polyacetylene electrode holds promise for its use as an anode active material. Current investigations include the construction of rechargeable battery cells using $[Li_y(CH)]_x$ or $[Na_y(CH)]_x$ anodes together with titanium disulfide (TiS_2) cathodes.

34. IMPLODING PLASMA
X-RAY LASER

PHYSICS INTERNATIONAL
2700 Merced Street
San Leandro, CA 94577

Raymond Dukart

Date Started: September 1, 1981

Funding: FY '83 $375,000 for 12 months

Anticipated Duration: 2 1/2 years

A collisionally pumped Ne-like krypton x-ray laser scheme is being investigated using an imploded plasma source ($\sim$4 cm x 0.5 mm). The implosion is driven by the 5 TW Defense Nuclear Agency PITHON electrical pulse generator. According to theories developed at Lawrence Livermore National Laboratory, the measured plasma temperature ($T_e \sim 1$ keV) and density ($N_e \sim 10^{21}$ electrons/cm^3) are nearly ideal for producing population inversions in XUV ($\sim$83-100 eV) 3-3 Ne-like krypton transitions. Analysis of the time integrated XUV spectra show the presence of Al-like through O-like krypton states. Time-resolved XUV spectra have been obtained, completing identification of the 3-3 Ne-like spectra and provide data on the Ne-like krypton line widths for input into the theoretical laser model. Work is also continuing on further improving the plasma implosion simultaneity and instantaneous high temperature plasma length (>2.4 cm during a 2 ns frame has previously been obtained).

35. SOFT X-RAY LASING ACTION IN
A CONFINED PLASMA COLUMN

PRINCETON UNIVERSITY
Princeton, New Jersey 08544

Szymon Suckewer
Plasma Physics Laboratory

Date Started: September 13, 1979

Funding: FY '83 $305,000 for 12 months

Anticipated Duration: 4 years

The objective of this project is an experimental investigation of lasing action in the soft x-ray spectrum region at wavelengths 182 A, 135 A and 520 A corresponding to the 3→2, 4→2, and 4→3 transitions in the CVI ion. The basic idea is to use a multi-Z (e.g., carbon, oxygen) thin plasma column confined by a strong longitudinal magnetic field (100 kG), first heated by a CO_2 laser and then cooled rapidly by radiation losses. Calculations indicate a total gain in excess of 100 for the 3→2 transition, in excess of 10 for the 4→2 transition, and in excess of 300 for the 4→3 transition for a 10 cm long plasma column heated by a 10-20 GW CO_2 laser beam. Experiments showed good plasma confinement in magnetic fields 50-100 kG and effective radiation cooling of such a plasma, especially with additional small amounts of higher-Z elements such as Ar or Xe. Measurements of gain for CVI 4 3 (520 A) and 3→2 (182 A) transitions indicate the possibility of obtaining a high gain for 4 3 transitions, and also for the 3→2 transitions with improved CO_2 laser optics.

36. DEPOSITION OF HIGH QUALITY $CuInSe_2$ BY SPRAY PYROLYSIS

RADIATION MONITORING DEVICES, INC.
44 Hunt Street
Watertown, Massachusetts 02172

Gerald Entine

Date Started: September 15, 1982

Funding: FY '83 $116,000 for 12 months

Anticipated Duration: 2 years

The ultimate success of any terrestrial photovoltaic energy conversion approach requires that the following factors be satisfied: 1) high individual solar cell conversion efficiency, 2) low cost per unit area to produce the cells, 3) adequate availability of the constituent materials to produce the cells, 4) long term stability. This project is a proof-of-concept effort to show that spray pyrolyzed $CuInSe_2$ can meet all of the requirements. $CuInSe_2$ is a promising solar cell material and spray pyrolysis is a technique well-suited for use in a manufacturing process.

37. IONIZATION FRONT ACCELERATOR

SANDIA NATIONAL LABORATORIES
Albuquerque, New Mexico 87185

Craig L. Olson
Plasma Theory Division - 1241

Date Started: June 1, 1981

Funding: FY '83 $110,000 for 6 months

Anticipated Duration: 3 years

The objective of this project is to accelerate ions to high energies using the large space charge field ($\sim$100 MV/m) from the potential well at the head of an intense relativistic electron beam (IREB). The Ionization Front Accelerator (IFA) accomplishes this by using laser photoionization of a special working gas to control the motion of the potential well. A second generation system (IFA-2) is being brought into operation. This system includes an IREB machine (1.0 MV, 30 kA, 30 nsec) with laser-triggered switches, and a beam conditioning cell to steepen the current rise time; an experimental cell with Cs as the working gas; and a dye laser (852.1 nm) to pre-excite the Cs, an XeCl laser (308 nm) to photoionize the excited Cs, and a Pockels deflector to provide a continuous sweep for the XeCl laser beam. The IREB is operational with a command firing jitter of 1 nsec and a conditioning cell current rise time of < 3 nsec. The experimental cell and Cs ovens are complete, the dye laser and XeCl laser are operational, and testing of a high voltage driver for the deflector is in progress. After system check out, IFA-2 experiments with a 30 cm sweep length will commence, complete with ion diagnostics.

38.*RELIABLE, LOW-COST, LOW POWER CRYOCOOLER TO REACH 4.0 KELVIN

S.H.E. CORPORATION
4174 Sorrento Valley Blvd.
San Diego, California 92121

Ronald E. Sager

Date Started: September 30, 1980

Funding: FY '82 $121,000

Anticipated Duration: 2 1/2 years

The goal of this project is to develop a cryocooler suitable for operating superconducting instrumentation below 5 Kelvin without the requirement for liquid helium cooling. Potential applications include geophysical prospecting using magnetotelluric measurements, magnetic borehole mapping, and interborehole electromagnetic propagation measurements. In the past year the physics of nonmagnetic cryocoolers was investigated, starting from room temperature, and a cooler is now operating at 7 Kelvin. Experiments are underway on innovations which should substantially improve the low temperature performance of the cryocooler and permit mounting a superconducting magnetic sensor on the cryocooler for demonstration purposes. Work has also started on the design of an experimental model cooler which is expected to evolve eventually into a very reliable instrument capable of operating continuously for years without maintenance or failure.

*Project completed.

39. PLANAR FLOW CASTING OF SHEET SILICON FOR PHOTOVOLTAIC CELLS

SOURCE TECHNOLOGY APPLIED METALLURGICALS, INC.
SOLAMAT DIVISION
885 Waterman Avenue
East Providence, Rhode Island 02914

Mandayam C. Narasimhan

Date Started: August 1, 1982

Funding: FY '83 $208,000 for 12 months

Anticipated Duration: 2 years

The object of this research program is to evaluate the castability of silicon sheets for photovoltaic application by the planar flow casting process and a newly developed roller quench casting process. The planar flow casting process was found to be inoperative in ambient. This is due to the oxidation of the surface of the melt which results in poor thermal contact between the chill wheel and the silicon melt. Ribbons produced in inert atmosphere by this process show columnar grain structure with the grain dimensions in the range of 1 - 10 microns. The newly developed roller quench casting process casts wide polycrystalline silicon sheets (approximately 2" in width) with thicknesses of 15 - 25 mils at casting speeds of 50 - 100 feet per minute. The initial results of the sheet characterization show that the grain structure in these sheets in columnar, the grain dimensions are in the millimeter range, the sheets are p-type and their electrical resistivity is in the range of 0.1 - 10 ohm-cm. The resistivity of these sheets is maintained within the same order of magnitude as that of the starting material. Solar cells are being fabricated and characterized to assess the photovoltaic quality of these silicon sheets.

40. SYNTHESIS AND PHOTOELECTROCHEMICAL CHARACTERIZATION OF SEMICONDUCTING GROUP VIII TRANSITION METAL CHALCOGENIDES AND PNICTIDES

SOLAR ENERGY RESEARCH INSTITUTE
1617 Cole Boulevard
Golden, Colorado 80401

Bruce Parkinson
Photoconversion Research Branch

Date Started: September 26, 1983

Funding: FY '83 $143,000 for 12 months

Anticipated Duration: 2 years

Semiconducting electrodes, which are illuminated in an electrolyte solution, are capable of harvesting solar energy and converting it directly to electrical power or storable chemical fuels. Previous efforts in this area have concentrated on semiconducting materials which have been available because of their use in solid state devices, but these materials are not necessarily the best materials for photoelectrochemical applications. We are synthesizing and characterizing new semiconducting materials specifically for photoelectrochemical applications. The semiconductors are made from a Group VIII metal (Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Pt), combined with a chalcogen (S, Se, Te) or a pnicogen (P, As). The metals are chosen because they have catalytic activity for many of the important photoelectrosynthetic reactions, such as water photolysis and carbon dioxide reduction. The pnictides and chalcogenides of these metals should have favorable bandgaps and have stability against photocorrosion.

41. MULTIFUNCTION WALL SYSTEM FOR APPLICATION WITH SOLAR HEATING AND GROUND COOLING

VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY
Blacksburg, Virginia 24061

James F. Riley and Gary E. Day
College of Architecture and Urban Studies

Date Started: September 1, 1981

Funding: FY '81 $105,000 for 18 months

Anticipated Duration: 3 1/4 years*

The purpose of this project is to establish the scientific feasibility of the concept of a multifunction wall system (for application with solar heating and ground cooling) as applied to contemporary design and construction methods. The concept of the system is to expand the use of structure and enclosure elements of a building to function additionally as: the ductwork for the solar heated or earth cooled air, the heat transfer membrane between the heated or cooled air and the living environment of the building, the heat storage medium (in winter), and the temperature leveling and control medium. During FY '83 activity has focused on monitoring and evaluating a small test building at Virginia Tech. The data derived from this testing is being used to generate system performance models relative to the heating and cooling functions.

*Includes unfunded extension.

42. A METHOD OF ACHIEVING SUPER-PRESSURES BY ADVANCED GASDYNAMIC TECHNIQUES

UNIVERSITY OF WASHINGTON
Seattle, Washington 98195

A. Hertzberg, A.P. Bruckner and Y.K. Rao
Aerospace and Energetics Research Program

Date Started: September 27, 1982

Funding: FY '83 $131,000 for 12 months

Anticipated Duration: 1 1/2 years

A new gasdynamic concept for the generation of isentropic pressure pulses in the range of tens of kilobars to several megabars, with durations of the order of microseconds, will be investigated. The technique involves the generation of an isentropic wave system at relatively low pressures (i.e., less than 5-10 kbar) in a medium of low acoustic impedance (e.g., gaseous hydrogen) and the propagation of this wave system through media of increasing impedance, thereby generating very high pressures in the final, maximum impedance medium. The succession of media may include gases, liquids and solids. This method could be used to measure equation of state data along isentropes at very high pressures. The technique also has the potential for creating heretofore inaccessible states of matter which may have important industrial or energy applications, as well as for applications in controlled thermonuclear fusion.

43.*ANALYSIS OF IMPACT FUSION TARGET DYNAMICS

UNIVERSITY OF WASHINGTON
Seattle, Washington 98195

F.L. Ribe
Aerospace and Energetics Research Program

Date Started: April 15, 1983

Funding: FY '83 $84,000 for 12 months

Anticipated Duration: 3 years

In conjunction with rail-gun experiments on macroparticle acceleration we study the conversion of rectilinear projectile motion to a spherical or quasi-spherical implosion. Initial work involves one-dimensional numerical solutions of the hydrodynamic and transport equations, matched at the interface of a compressible metallic shell and an internal fusile gas for planar and spherical geometry. Later work will involve the two-dimensional problem of rectilinear and quasi-spherical motion.

*Projects 43 and 44 are cooperative interlaboratory projects.

44.*INVESTIGATION OF HIGH-VELOCITY ELECTROMAGNETIC LAUNCHER BEHAVIOR FOR USE IN IMPACT FUSION

WESTINGHOUSE R & D CENTER
1310 Beulah Road
Pittsburgh, Pennsylvania 15235

Ian R. McNab
Electrotechnology Department

Date Started: July 18, 1983

Funding: FY '83 $394,000 for 12 months

Anticipated Duration: 4 years

It has been proposed that thermonuclear fusion can be ignited by impact of a deuterium-tritium pellet by a one-half gram heavy-metal projectile at velocity of about 200 km/s. The objective of this program is to investigate the scientific and technological problems associated with the electromagnetic acceleration of a 1 g projectile to 30 km/s using a multi-stage railgun, and to obtain scaling relationships for attaining higher velocity. A companion program to explore theoretically impact physics at high velocities and target design concepts to achieve thermonuclear burn is undertaken at the University of Washington. The velocity of 30 km/s is considered to be the minimum velocity at which impact will yield detectable quantity of neutrons.

*Projects 43 and 44 are cooperative interlaboratory projects.

OFFICE OF BASIC ENERGY SCIENCES

DIVISION OF ADVANCED ENERGY PROJECTS

Fiscal Year 1983 Program Data

FY '83 Budget

Operating Funds.....$8,310,000

Capital Equipment Funds.....$ 300,000

Distribution of Projects by Institutional Sector

Universities	37%
Small Business	26
Other Industry	9
DOE Laboratories	28
	100%

INVESTIGATOR INDEX
(Project Numbers)

INSTITUTIONAL INDEX
(Project Numbers)

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