OE/ER-0107

DIVISION OF ADVANCED ENERGY PROJECTS

PROGRAM DESCRIPTION
AND
SUMMARIES
OF FISCAL YEAR 1981 ACTIVITIES

U.S. DEPARTMENT OF ENERGY
OFFICE OF ENERGY RESEARCH
OFFICE OF BASIC ENERGY SCIENCES

OCTOBER 1981

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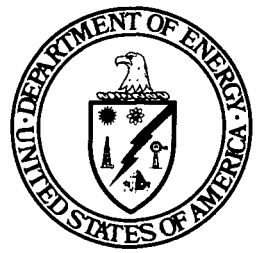

U.S. DEPARTMENT OF ENERGY
OFFICE OF ENERGY RESEARCH
OFFICE OF BASIC ENERGY SCIENCES
WASINGTON, D.C. 20585

OCTOBER 1981

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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 '81 varied between $90,000 and $320,000 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/PR-0010, "Guide for the Submission of Unsolicited Proposals." Each proposal must contain:

- A cover page, prepared in a format specified in DOE/PR-0010, Appendix B.

- 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, DC 20545

Phone: 301/353-5995

Office of Energy Research

Office of Basic Energy Sciences

Division of Advanced Energy Projects

Fiscal Year 1981 Funding

Operating Funds.....$6,300,000

Capital Equipment Funds....$ 300,000

Distribution of FY 1981 Funds by Sector

Universities	33%
Small Business	28%
Other Industry	17%
DOE Laboratories	17%
Federal Laboratories	5%
Total	100%

SUMMARIES OF PROJECTS ACTIVE IN FY 1981

1. DEMONSTRATION OF SCIENTIFIC AND ECONOMIC FEASIBILITY OF A SOLID-STATE HEAT ENGINE

Randall Olsen

POWER CONVERSION TECHNOLOGY, INC.
11588 Sorrento Valley Road
Suite 18
San Diego, California 92121

Date Started: November 7, 1977 Anticipated Duration: 4 1/4 years

Funding: FY '81 $400,000 for 15 1/2 months

The Solid-State Heat Engine rhythmically converts heat to electricity by exposing thin leaves of ferroelectric ceramic to cyclical flows of heat. Electrical charge appears and disappears on the surface of each leaf in rhythm with the heat flow. A device capable of producing significant electrical power is being built and fully characterized.

2.* RADIATION FROM CHANNELED ELECTRONS AND POSITRONS

Richard Pantell
Department of Electrical Engineering

STANFORD UNIVERSITY
Stanford, California 94305

Date Started: February 15, 1978 Duration: 3 1/2 years+

Funding: FY '80 $250,000 for 12 months

When an electron or positron beam passes through a crystal the particles, interacting with the electrostatic potential of the lattice, emit radiation. This project investigates this phenomenon as a photon source for the keV energy range, as a means for studying the behavior of channeled particles, and as a technique for measuring the properties of crystals in which the channeling occurs. According to theoretical analyses, now confirmed by experimental evidence, such a source can have a bandwidth of only 10%, is broadly tunable and has an intensity that is an order of magnitude higher than that obtained from Bremsstrahlung. In addition, the radiation should be linearly polarized, highly collimated, and occur in picosecond bursts.

*Project completed
+Includes unfunded extension

3.* COLLECTIVE FOCUSING ION ACCELERATOR

UNIVERSITY OF CALIFORNIA
Irvine, California 92717

Norman Rostoker & Amnon Fisher

Date Started: April 1, 1978 Duration: 3 years

Funding: FY '80 $200,000 for 12 months

In this device ions are accelerated along a circular track by an externally applied electric field. They are kept on the track by a space charge of electrons confined in a magnetic field of "bumpy torus" configuration. The anticipated high ion energy, high current beams could be of interest for either accelerator breeding or heavy ion fusion.

4.* EFFICIENT ENERGY EXCHANGERS FOR THERMAL AND CHEMICAL CONVERSION

MATHEMATICAL SCIENCES
NORTHWEST, INC.
P. O. Box 1887
Bellevue, Washington 98009

Robert Taussig

Date Started: April 19, 1978 Duration: 3 years

Funding: FY '80 $253,000 for 12 months

In an energy exchanger, an expanding high-temperature gas compresses a lower temperature gas suitable for driving a conventional gas turbine. The suggested application consists of a high-temperature heat source, the energy exchanger, a topping cycle gas turbine and a bottoming cycle (e.g., steam). The objective of the project is to demonstrate experimentally the efficient operation of energy exchangers for use in high Carnot efficiency thermal conversion cycles.

*Project completed

5. STRONG FOCUSING OF COHERENT, TERAHERTZ SOUND

WILLIAMS COLLEGE
Williamstown, Massachusetts 01267

Fielding Brown
Department of Physics

Date Started: June 1, 1978 Anticipated Duration: 3 1/2 years+

Funding: FY '78 $77,000 for 3 years

Acoustic waves in crystals, such as quartz or gallium arsenide, are excited by irradiating the crystal surface with a high power, far infrared D_2O laser ($\lambda vac \approx 385 \mu m$). Focusing is obtained by precision shaping of the crystal surface. The anticipated focal region has a size of the order of 1000 Å^3. The anticipated energy density in the focal region is $10^8 J/cm^3$ for a pulse 100 nsec in duration. The objective of this project is to obtain such high energy concentrations and to explore the ensuing physical phenomena.

6. ELECTROLYTIC DEPOSITION OF LOW COST, HIGH PURITY POLYSILICON SUITABLE FOR USE IN SOLAR CELL DEVICES

STANFORD UNIVERSITY
Stanford, California 94305

Robert Feigelson
Center for Materials Research

Date Started: July 1, 1978 Anticipated Duration: 3 1/2 years+

Funding: FY '80 $220,000 for 12 months

This is an experimental study to establish the viability of electrolytic deposition as a method of producing inexpensive silicon for photovoltaic layers and crystals. The source material is either as-mined silica or K_2SiF_6, which is an inexpensive by-product of fertilizer manufacture. Inclusion-free layers of silicon have been deposited onto silver or graphite using fluoride solvents at 750^0C, the deposits having a purity up to 99.999% and grain size up to 250 μm. The electrodeposition of silicon at temperatures above its melting point has been achieved for the first time, the material being produced as droplets up to 15 mm in size and typically of 0.2 Ωcm resistivity.

+Includes unfunded extension

7. GENERATION OF AN EXTENDED ION SOURCE FOR SHORT-WAVELENGTH LASERS

NAVAL RESEARCH LABORATORY
Washington, D.C. 20375

Raymond Elton
Optical Sciences Division

Date Started: July 27, 1978 Anticipated Duration: 3 3/4 years

Funding: FY '81 $225,000 for 15 months

Experiments at Naval Research Laboratory revealed large population inversions in carbon ions for the 520 Å region. They were also recently confirmed for ions of boron, nitrogen and lithium. These experiments were performed in low density, optically thin regimes where accurate analysis is possible. In taking the next step to a true x-ray laser an elongated medium is required with sufficient ion density that simulated emission and gain occur along the axis, without corresponding losses in transverse direction. It is an objective of the proposed program to demonstrate that highly stripped expanding carbon ions can be channeled from a point source into a rectangular beam and compressed to densities of 10^{17} - 10^{18} cm^{-3} over a length of about 1 cm for use as a medium for laser amplification in the extreme ultraviolet spectral region. With success, the second objective is to tailor the ion expansion velocity to interact in charge-capture reactions to produce population inversions for net gain. For this, various single electron species are compared along with enhanced cooling for increased pumping.

8. DEVELOPMENT OF MATERIALS FOR LUMINESCENT SOLAR COLLECTORS

GTE LABORATORIES
40 Sylvan Road
Waltham, Massachusetts 02154

Alexander Lempicki

Date Started: September 1, 1978 Anticipated Duration: 4 years

Funding: FY '81 $228,000 for 12 months

A luminescent solar collector consists of a panel absorbing light, ideally, across the solar spectrum. The light is then re-emitted, within the panel at wavelengths optimal for photoconversion. It propagates, by internal reflections towards the edges of the panel, where it is coupled to a photovoltaic converter. The aim of this project was to develop materials for luminescent collectors by exploiting properties of metal ions in inorganic glasses. A variety of glasses, particularly those containing high concentrations of Cr^{3+} have been developed. The main conclusions are that Cr^{3+} in glass has a very limited quantum yield (highest observed is 20 per cent) due to non-radiative pathways. Other approaches are the use of glasses codoped with Cr^{3+} and Nd^{3+} and the development of glass ceramics in which the active ion is incorporated into crystalline phase particles of sub-micron dimensions. At present, the ceramics offer the best hope of increased efficiency.

9.* GRADED INDEX ANTIREFLECTIVE COATINGS FOR GLASS

John Haggerty
Energy Laboratory

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, Massachusetts 02139

Date Started: September 1, 1978 Anticipated Duration: 3 years

Funding: FY '79 $328,000 for 2 years

This project's objective is to develop methods of producing graded index antireflective coatings on glass sheet for cover plate applications. These films are created by inducing a two-phase microstructure in the glass by appropriate heat treatment, followed by leaching to leave a porous, graded index surface film. The process is based on results demonstrated with high temperature borosilicate glasses. Unlike that work, the present approach concentrates on glasses with compositions and working characteristics that can be processed at lower temperatures required for the float glass process.

10. APPLICATION OF ARC-PLASMA SPRAYING (APS) FOR SOLAR TECHNOLOGY

Joseph Loferski &
Barton Roessler

SOLAMAT, INC.
885 Waterman Avenue
East Providence,
Rhode Island 02914

Date Started: September 18, 1978 Anticipated Duration: 3 1/4 years

Funding: FY '81 $175,000 for 12 months

The objective of this program is to study applications of APS to: (i) the preparation of low cost silicon solar cells by deposition of silicon powder on metal substrates, (ii) the preparation of selective absorber coatings for solar thermal collectors consisting of thin APS layers of silicon and silicon-germanium alloys, and (iii) the formation of ohmic contacts and barriers for single crystal and polycrystalline thin film solar cells made from silicon, gallium arsenide, etc.

*Project completed

11. LASER EXCITATION OF HIGH LYING ATOMIC AND MOLECULAR STATES BY ULTRAVIOLET MULTIQUANTUM PROCESSES

Charles K. Rhodes
Department of Physics

UNIVERSITY OF ILLINOIS AT CHICAGO CIRCLE
Chicago, Illinois 60680

Date Started: January 1, 1979 Anticipated Duration: 3 years

Funding: FY '81 $120,000 for 10 months

The recently developed ultraviolet excimer laser technology enables both the copious production of electronically highly excited species and the generation of tunable XUV radiation of extremely high spectral brightness. The primary objective of this program is the experimental determination of the feasibility of high-brightness soft x-ray generation by nonlinear optical processes involving both direct excitation and wave mixing.

12. RESEARCH AND DEVELOPMENT PROGRAM ON A SODIUM HEAT ENGINE

Thomas Hunt & Neil Weber

FORD MOTOR COMPANY
P. O. Box 2053
Dearborn, Michigan 48121

Date Started: January 2, 1979 Anticipated Duration: 3 years

Funding: FY '81 $329,000 for 15 months

The sodium heat engine (SHE) is a new device for direct thermal to electrical energy conversion. It uses the ionically conducting ceramic β"-alumina, to form a high temperature concentration cell for elemental sodium. The vapor pressure (activity) gradient across the cell is maintained by a high temperature heat source on one side of a beta-alumina membrane and a low temperature condenser on the other side. The high temperature region operates in the range of 600-1000^{o}C with the low temperature region at 100-200^{o}C. Theoretical analysis of the SHE shows that under quasi-reversible conditions the efficiency should be more than 90% of Carnot efficiency. Specific output powers in the range of 0.5-1.0 W/cm^{2} have been achieved. The SHE has achieved an efficiency of 19% and is projected to reach overall thermal efficiencies of 20-40%. The goal of this project is a quantitative understanding of the SHE electrodes and the electrical and mass transport at the electrode-beta-alumina interface.

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

Harold K. Lonsdale

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

Date Started: April 16, 1979 Anticipated Duration: 2 1/2 years

Funding: FY '81 $22,000 for 7 months

This program is directed toward the development of novel membranes for the production of oxygen-enriched air. With membranes of suitable performance, the cost and energy-efficiency of an oxygen-enrichment process would justify the use of such upgraded air supplies in standard combustion processes, thus extending and conserving available fossil fuel supplies. The approach involves the use of liquid membranes held by capillary forces in the pores of a microporous support membrane. Oxygen is preferentially transported across these membranes by facilitated transport. The liquid membrane will be incorporated into microporous hollow fibers for scaleup studies.

14. THERMOELECTRIC ENERGY CONVERSION FOR SOLAR AND OTHER APPLICATIONS

David Benson

SOLAR ENERGY RESEARCH INSTITUTE
1536 Cole Blvd.
Golden, Colorado 80401

Date Started: June 1, 1979 Anticipated Duration: 3 years

Funding: FY '81 $220,000 for 12 months

The objective of this project is to examine the option of using either traditional or new thermoelectric materials to produce economical electric power from low grade, thermal resources. Detailed parametric analyses have been used to identify promising thermoelectric generator design options. Research is currently directed at the development of proof-of-concept generators.

15.*COLLECTIVE ACCELERATION OF HEAVY IONS FROM A LASER-PRODUCED PLASMA

UNIVERSITY OF MARYLAND
College Park, Maryland 20742

Martin Reiser & William Destler
Electrical Engineering Department

Date Started: July 1, 1979 Duration: 2 years

Funding: FY '79 $30,000 (major funding provided by the National Science Foundation)

In this program, the collective acceleration of heavy ions produced by laser-target interaction is investigated. An intense, relativistic electron beam (1.5 MeV, 30 kA, 30 ns) is injected through a laser produced plasma into an evacuated drift tube, and ions are extracted from the plasma and accelerated to high energies by virtual cathode formed by the beam electrons immediately downstream of the plasma cloud. The goal of this program is to accelerate heavy ions (e.g., C, A, Fe, etc.) to energies of several MeV per nucleon.

16. NEW MATERIALS FOR ORGANIC PHOTOVOLTAIC CELLS

RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
New Brunswick, New Jersey 08903

George Bird
Department of Chemistry

Date Started: July 1,1979 Anticipated Duration: 3 years

Funding: FY '79 $223,000 for 3 years

Experimental photovoltaic cells with organic absorber layers have already given quantum efficiencies of 30% and total solar energy conversion on the order of 1%. Low exciton mobility and limited radiation stability have prevented improvements in performance. Under this project, new high stability chromophores are being prepared and studied in terms of structure, solid-state packing, electrochemistry and exciton mobility. Promising materials will be fabricated into Al/Al_2O_3/dye/Ag cells for direct measurements.

*Project completed

17. A NOVEL APPROACH TO THE EXPLOITATION OF TIDAL ENERGY

NORTHEASTERN UNIVERSITY
Boston, Massachusetts 02115
Alexander M. Gorlov
Department of Mechanical Engineering

Date Started: July 1, 1979 Anticipated Duration: 2 1/2 years

Funding: FY '79 $131,000 for 2 1/2 years

The objective of this program is to develop theoretically, and analyze, a new approach to harnessing tidal energy. The approach is based on replacing conventional rigid dams with light, flexible plastic barriers, and on converting tidal energy into the energy of compressed air.

18. EJECTOR-TURBINE HEAT ENGINE

J. E. Minardi
UNIVERSITY OF DAYTON RESEARCH INSTITUTE
300 College Park Avenue
Dayton, Ohio 45469

Date Started: August 1,1979 Anticipated Duration: 3 years

Funding: FY '80 $373,000 for 21 months

The objective of this project is to test the feasibility of a novel low-power Rankine turbine concept which promises low cost, significant reduction in rpm over similarly rated turbines, and low maintenance, long-life operation at competitive efficiencies. This is accomplished through the use of an efficient two-fluid ejector which lowers the pressure and temperature operating conditions seen by the turbine. Potential applications for this type of turbine would include the generation of electricity and air conditioning of homes. The concept permits engine cycles that cover a broad range of peak temperatures, including those corresponding to stoichiometric combustion of hydro-carbon fuels, waste heat sources, and solar.

19. EVAPORATED LITHIUM-DOPED AMORPHOUS SILICON SOLAR CELLS

P. H. Fang
Department of Physics
BOSTON COLLEGE
Chestnut Hill,
Massachusetts 02167

Date Started: August 1, 1979 Anticipated Duration: 2 1/2 years+

Funding: FY '80 $140,000 for 12 months

The objective of this program is to test the feasibility of fabricating amorphous silicon solar cells by electron beam evaporation in vacuum. The role of lithium as an n-dopant and as a compensator for the broken bound of silicon in amorphous structure is being investigated.

+Includes unfunded extension

20.*SEMICONDUCTING POLYACETYLENE MATERIALS FOR ENERGY CONVERSION APPLICATIONS

Zoltan J. Kiss

CHRONAR CORPORATION
P. O. Box 177
Princeton, New Jersey 08540

Date Started: August 1, 1979 Duration: 2 years

Funding: FY '80 $124,000 for 12 months

Polyacetylene is emerging as a new class of potentially low cost semiconducting materials. This program aims to optimize different preparation methods, to study doping and polymeric modification techniques, and to evaluate the polyacetylene materials so obtained for photovoltaic energy conversion devices, particularly, for photoelectrochemical solar cells.

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

Szymon Suckewer

PRINCETON UNIVERSITY
PLASMA PHYSICS LABORATORY
Princeton, New Jersey 08544

Date Started: September 13, 1979 Anticipated Duration: 3 years

Funding: FY '81 $266,000 for 12 months

The objective of this project is an experimental investigation of lasing action in the soft x-ray spectrum region at wavelengths 182 Å and 135 Å corresponding to the 3→2 and 4→2 transition in the C(VI) ion. The basic idea is to use a multi-Z (e.g., carbon, oxygen) thin plasma column confined by a strong longitudinal magnetic field (100-200 kG), first heated by a CO_2 laser and then cooled rapidly by radiation losses. Calculations indicate total gains in excess of 100 for the 3→2 transition, and in excess of 10 for the 4→2 transition, for a 10 cm long plasma column heated by a 10-20 gigawatt CO_2 laser beam.

*Project completed

22* EFFICIENT ULTRASONIC GRINDING: A NEW TECHNOLOGY FOR MICRON-SIZED COAL

William B. Tarpley, Jr.

ENERGY & MINERALS RESEARCH COMPANY
P. O. Box 389
964 E. Swedesford Road
Exton, Pennsylvania 19341

Date Started: September 15, 1979 Duration: 15 months

Funding: FY '79 $174,000 for 15 months

The objective of this project is to develop on a laboratory scale an efficient ultrasonic grinding system which can produce 1-10 micron coal with an anticipated energy input in the range of 25-100 kWh/ton. Additionally, the mechanisms of ultrasonic comminution should permit selective grinding, tensile fracture at pyrite and ash inclusions, and easy separation. Experimental work will include consideration of ultrasonic power levels, frequencies, and modes of application as well as throughput rates, evidence of selective fracture, and repeatability of ultrasonic effects. Such a process would expedite conversion of oil fired burners to the use of coal-oil mixtures. The

23.*TOPICS OF INTERFACE MECHANICS

Benjamin Levich

CITY UNIVERSITY OF NEW YORK
THE CITY COLLEGE

Date Started: November 1, 1979 Duration: 1 year

Funding: FY '80 $75,000 (plus $75,000 from the Division of Mathematical, Engineering and Geo-Sciences)

This project will develop a systematic investigation of the field of Interface Mechanics. Of special practical interest is the influence of surface active substances on the motion of fluid-fluid interface. Following one year of joint funding, the project is now supported fully by the Division of Engineering, Mathematical and Geo-Sciences.

*Project completed

24. INTEGRATED FUNCTION NONIMAGING CONCENTRATING COLLECTOR TUBE FOR SOLAR THERMAL ENERGY
Roland Winston

UNIVERSITY OF CHICAGO
Chicago, Illinois 60637

Date Started: December 1, 1979 Anticipated Duration: 2 years

Funding: FY '81 $199,000 for 12 months

An evacuated tube solar collector which can deliver thermal energy at temperatures up to 600°F without tracking or seasonal adjustment is undergoing proof-of-concept testing. The combination of a) nonimaging, thermodynamically "ideal" optics to permit an intermediate level of non-tracking solar concentration, (b) selective absorber surfaces to suppress radiation losses and c) hard vacuum ($<10^{-5}$ torr) to eliminate conduction losses reduces total heat losses to values comparable to those achieved by line focus tracking parabolic troughs.

25. COLLECTIVE ACCELERATION OF IONS USING HIGH CURRENT RELATIVISTIC ELECTRON BEAMS
John A. Nation

CORNELL UNIVERSITY
Ithaca, New York 14853

Date Started: January 1, 1980 Anticipated Duration: 2 years

Funding: FY '81 $213,000 for 12 months

This project studies a collective acceleration system which uses an adiabatic increase in the phase velocity of a large amplitude slow space charge wave as a means of accelerating protons trapped in the wave. The objective is to accelerate protons from about 15-20 MeV to between 25 and 30 MeV and hence to demonstrate the feasibility of the proposed approach to the acceleration of high fluxes of protons to high energy.

26. FREE ELECTRON LASER TEST, NATIONAL SYNCHROTRON LIGHT SOURCE
A. van Steenbergen

BROOKHAVEN NATIONAL LABORATORY
Upton, New York 11973

Date Started: May 1, 1980 Anticipated Duration: 3 1/2 years

Funding: FY '81 $312,000 for 12 months

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 by repeated interaction between the emitted synchrotron radiation and the electrons passing through the 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.

27. AN H-ATOM INITIATED RAPID COAL GASIFICATION STUDY
Alan Snelson

IIT RESEARCH INSTITUTE
Chicago, Illinois 60616

Date Started: May 12, 1980 Anticipated Duration: 1 1/2 years

Funding: FY '80 $84,000 for 12 months

The purpose of this study is to investigate a scheme for coal gasification involving direct interaction of atomic hydrogen with finely ground coal in the presence of iodine as a catalyst. Initial experiments at IITRI indicate that a practical, flow through system might be feasible in which a steady state concentration of atomic hydrogen is maintained in the coal reduction reactor at temperatures of 600° C. In such a system, at hydrogen pressure of 100-200 atm., complete reduction of coal to CH_4 and C_2H_6 appears possible at contact times of 1 sec. The economic impact of a potential gasification process based on the above approach will also be evaluated.

28. EXTREMELY HIGH TEMPERATURE PLASMA RESEARCH

COLUMBIA UNIVERSITY
New York, New York 10027

Robert A. Gross

Date Started: June 1, 1980 Anticipated Duration: 2 years

Funding: FY '81 $97,000 for 12 months

Basic research will be performed on the laboratory production of extremely hot ($T > 50$ keV), dense ($n \sim 10^{16}$ cm^{-3}) plasmas created in a superfast z pinch, and confined for the order of several nanoseconds. Processes to be investigated include: plasma energy loss rates through the ends, electron-ion equilibration rates, radiation emission, possible nuclear fusion events (nucleosynthesis), and potential relativistic gas effects.

29.*SMALL SCALE DEMONSTRATION OF HYDRAULIC CAPSULE PIPELINE

UNIVERSITY OF MISSOURI
Columbia, Missouri 65211

Henry Liu

Date Started: June 1, 1980 Duration: 1 year

Funding: FY '80 $45,000 for 12 months

Hydraulic Capsule Pipeline is a proposed alternative way of transporting cargos such as coal, but also grain, through hydraulic, water filled pipelines. The cargo is contained in a capsule, which floats in the water and is moved along the pipeline by one of a number of proposed schemes. The concept was first proposed some ten years ago in Canada, where an active R&D effort is being pursued. Its energy relevance rests with the potential of significantly decreasing the cost of transporting coal over distances of 50-200 miles. Under the present program, several improvements over the existing state of the art are explored, one being the application of the Linear Induction Motor principle to capsule propulsion, another a new method for capsule injection into, and ejection out of the pipeline. A small, laboratory scale model of the system has been constructed.

*Project completed

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

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, Massachusetts 02139

Costas G. Vayenas & J. Wei

Date Started: September 1, 1980 Anticipated Duration: 2 years

Funding: FY '80 $150,000 for 24 months

All conventional fuel cells suffer from one obvious disadvantage: an expensive fuel is converted into useless oxidation products such as CO_2 and H_2O. It would be extremely desirable to use fuels which would make the fuel cell products more valuable than the fuel itself, i.e. to use a fuel cell in order to cogenerate electrical energy and useful industrial products. Recently nitric oxide and electricity have been produced simultaneously in a fuel cell using ammonia as fuel. The present project examines the oxidative dehydrogenation of ethylbenzene and butane into styrene and butadiene using zirconia cells with appropriate catalytic electrodes.

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

STATE UNIVERSITY OF NEW YORK
Albany, New York 12222

Petr Chylek and Bernard Vonnegut

Date Started: September 1, 1980 Anticipated Duration: 3 years

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

Some regions of the earth's atmosphere are often in the state of supersaturation with respect to ice crystal formation while still in the state of subsaturation with respect to water droplets formation. If such regions are seeded with an appropriate seeding agent an artificial cirrus cloud can be formed. Under otherwise clear sky conditions the effect of cirrus cloud is to decrease the average and maximum daytime temperature and to increase the average and minimum nighttime temperature. Consequently an artificially formed cirrus during summer days over densly populated areas can save energy required for air conditioning and reduce the maximum power usage on a given day. During winter nights the surface temperature increase would reduce the consumption of energy required for heating. The objective of the project is to explore, in a preliminary fashion, the practicality of the above concept by theoretical modelling of the effects of cirrus clouds, assessing the technology involved, studying the economics of cloud seeding operations, performing actual seeding experiments and analyzing the achievable energy savings.

32.*EXPLORATION OF THERMAL SELF-FOCUSING IN A PLASMA
James Drummond

POWER CONVERSION TECHNOLOGY, INC.
11588 Sorrento Valley Road
Suite 18
San Diego, California 92121

Date Started: September 1, 1980 Duration: 1 year

Funding: FY '80 $100,000 for 12 months

Thermal self-focusing is an instability which occurs when a microwave beam of sufficiently high intensity penetrates an electron-ion plasma. This phenomenon is likely to play an important role in the technical evaluation of the Satellite Power System (SPS) concept. This project will examine the phenomenon of thermal self-focusing quantitatively in a laboratory experiment.

33.*IMMOBILIZED EXTRACTION AGENTS FOR URANIUM RECOVERY
Kelly L. Smith

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

Date Started: September 8, 1980 Duration: 1 year

Funding: FY '80 $89,000 for 12 months

This project explores a new uranium extraction technique applicable to low grade resources available in mine waters, copper dump leach solutions and natural waters, including seawater. The technique employs microporous fibers containing immobilized ion-exchange polymers. The fibers would be spun by conventional fiber-spinning techniques, with their high surface area allowing rapid extraction of uranium even from very dilute feed solutions. The selectivity and high capacity for uranium ions of the immobilized ion-exchange polymers could be utilized without the problems of entrainment and solubility loss, which prohibit the application of conventional solvent-extraction techniques to very-low-concentration feeds.

*Project completed

34. TWO-PHASE TURBINES FOR EFFICIENT WASTE-HEAT RECOVERY

David G. Elliott

CALIFORNIA INSTITUTE OF TECHNOLOGY JET PROPULSION LABORATORY
Pasadena, California 91103

Date Started: September 15, 1980 Anticipated Duration: 2 years

Funding: FY '81 $100,000 for 12 months

The concept of two-phase engines is aimed at increasing the efficiencies attainable in low grade heat recovery. It is based on a novel thermal cycle, the efficiency of which compares favorably with that of a Rankine cycle. This is so because in a two-phase engine the working fluid is heated entirely in the liquid phase, thus permitting the heat exchanger to operate with a constant small temperature difference between the working fluid and the source fluid. In addition to improved efficiencies, the proposed cycle results in reduced turbine speeds -- an advantage from the point of view of material requirements. Contemplated applications include heat recovery from distributed solar energy systems, geothermal wells and diesel exhausts. Under the present program, a 50 kW two-phase turbine will be designed, built and tested.

35. THERMOCHEMICAL CONVERSION OF BIOMASS TO ETHANOL

William J. Huffman

BATTELLE COLUMBUS LABORATORIES
Columbus, Ohio 43201

Date Started: September 30, 1980 Anticipated Duration: 17 months

Funding: FY '80 $128,000 for 14 months

The objective of this project is to test a new, proprietary process for converting sugars to ethanol. In the program, the basic chemistry and kinetics of the non-fermentation process will be investigated. The ultimate goal is to develop a process which is capable of using wood or other sources of cellulose.

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

Ronald E. Sager

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

Date Started: September 30, 1980 Anticipated Duration: 2 years

Funding: FY '80 $275,000 for 18 months

A major obstacle to the widespread use of superconducting devices and instrumentation is the lack of reliable, inexpensive, and convenient refrigerators capable of reaching a temperature of 4 to 5 Kelvin. This project will explore the technical viability of a novel cryocooler employing a Stirling cycle. Potential applications include the full spectrum of cryogenic technologies with special emphasis on applications characterized by low power consumption and dissipation.

37. URANIUM FROM SEAWATER

David W. Gregg

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

Date Started: October 1, 1980 Anticipated Duration: 2 years

Funding: FY '81 $50,000 for 1 year

This project explores both engineering technologies and chemical extraction technologies for achieving economic uranium recovery from seawater. The concept is to use activated carbon as the absorbant material and utilize ocean currents for circulation of sufficient fresh ocean water. After an appropriate time period the carbon is collected, dried and burned to concentrate the recovered uranium. Preliminary experiments indicate that addition of minute amounts of titanium hydroxide to the water results in formation of an insoluble uranyl compound which is more strongly absorbed on the activated carbon.

38. MEQALAC CLUSTER ION FUSION

BROOKHAVEN NATIONAL LABORATORY
Upton, New York 11973

Lewis Friedman & Alfred Maschke

Dated Started: January 15, 1981 Anticipated Duration: 3 years

Funding: FY '81 $260,000 for 12 months

A new method of producing thermonuclear reactions is suggested. The basic scheme involves the acceleration of deuterium-tritium clusters (singly charged with atomic weight of 1000-10,000) in a multiple aperture accelerator (MEQALAC). A short pulse is formed, and the beams are focussed to a central collision point where the density and temperature reach values necessary for net fusion gain. The research program involves the development of the cluster ion source, and a demonstration that the clusters can be electrostatically focussed, and accelerated in a pulsed drift tube accelerator. A second beam, pulsed drift tube accelerator will be built to accelerate the cluster to a few million volts, and demonstrate the bunching and space charge neutralization necessary for the final focussing conditions. In addition, parametric studies will be undertaken to determine what the best values should be for a "break-even" fusion experiment.

39. CUPROUS OXIDE PHOTOVOLTAIC CELLS FOR SOLAR ENERGY CONVERSION

WAYNE STATE UNIVERSITY
Detroit, Michigan 48202

Dan Trivich

Date Stated: February 1, 1981 Anticipated Duration: 1 1/4 years

Funding: FY '81 $157,000 for 15 months

Cuprous oxide is a potentially important material for photovoltaic cells for solar energy conversion because of its low cost, high availability, easy processing, and low toxicity. The objective of the research is to raise the energy conversion efficiency from ~1% to 4-6%. Recently the open circuit potential of the cells has been improved from 0.35 V to 0.7 V by better surface preparation and junction formation. The main objective now is to improve the short circuit current by improving the quality of the cuprous oxide through purification of the starting copper by electro-refining and zone refining, by zone refining of the cuprous oxide and by suitable annealing. It is also planned to use ion implantation and laser annealing to prepare junctions that cannot be made by conventional methods.

40. ENERGY SYSTEMS BASED ON POLYACETYLENE: RECHARGEABLE BATTERIES AND SHOTTKY BARRIER SOLAR CELLS

UNIVERSITY OF PENNSYLVANIA
Philadelphia, Pennsylvania 19104

A.J. Heeger and A.G. MacDiarmid

Date Started: March 1, 1981 Anticipated Duration: 3 years

Funding: 'FY 81 $505,000 for 36 months

Aspects of the chemical, electrochemical, electrical and optical properties of the novel conducting polymer $(CH)_x$, polyacetylene, are being investigated. The effort will focus on two areas; rechargeable batteries made with $(CH)_x$ electrodes and Schottky barrier solar cells made with $(CH)_x$. Initial emphasis is on the battery systems; including studies of the $(CH)_x/(CH)_x^{+y}$ electrode, the $(CH)_x/(CH)_x^{-y}$ electrode, and a variety of specific model configurations.

41. LOW HEAT LOSS, LONG LIFETIME, LOW COST, HERMETICALLY SEALED THERMAL PANE WINDOW CONSTRUCTION

SPIRE CORPORATION
Patriots Park
Bedford, Massachusetts 01730

Wallace S. Kreisman

Date Started: April 15, 1981 Anticipated Duration: 6 months

Funding: FY '81 $46,000 for 6 months

The objective of this project is to use electrostatic (anodic) glass-to-metal bonding to provide hermetically sealed spaces between glass panes. Electrostatic bonds are made by passing an electric current through a heated glass-metal interface. Mobile ions within the glass, such as oxygen, combine chemically with the metal. The sealed spaces between the glass panes will be filled with a gas that reduces the conductive/convective heat flow. The hermeticity of the glass-metal seal will insure long term retention of the fill gas and prevent the intrusion of water vapor. It is expected that these thermal pane units will be cost effective and energy conserving compared with present plastic sealed units.

42. RESEARCH AND DEVELOPMENT OF A MASS ACCELERATOR (MAID) AS A DRIVER FOR IMPACT FUSION

GT-DEVICES
205 S. Whiting Street
Alexandria, Virginia 22304

Derek Tidman and Shyke Goldstein

Date Started: May 6, 1981 Anticipated Duration: 3 years

Funding: FY '81 $274,000 for 12 months

The objective of this project is to construct a small scale mass accelerator capable of propelling projectiles to extremely high velocity by sequentially imploding a series of z-pinches behind the projectile. A ten module system will be constructed to investigate the physical properties and scaling laws for this device. The effort is directed to determining whether a large scale version of such a mass accelerator could be used as an ignitor for inertial fusion.

43. HOLOGRAPHIC TECHNOLOGY FOR SOLAR ENERGY CONCENTRATION

NATIONAL TECHNICAL SYSTEMS
RESEARCH DIVISION
26525 Golden Valley Road
Saugus, California 91350

Hla N. Tin

Date Started: June 1, 1981 Anticipated Duration: 3 years

Funding: FY '81 $219,000 for 12 months

This program will explore the feasibility of using holographic technology (Diffractive Optics) for solar energy concentration. This new optical technology will allow the recording of all the optical information of current solar energy concentrators in a thin fiber hologram. As a result, the structural requirements for solar concentrators will be greatly reduced and the cost to manufacture (photographic process) will be extremely low. The project will result in the fabrication and testing of a solar energy concentration device for photovoltaic conversion. In addition, one may be able to track the sun by optical means as opposed to current methods of mechanical tracking for conventional solar concentrators.

44. IONIZATION FRONT ACCELERATOR

Craig L. Olson

SANDIA NATIONAL LABORATORIES
Albuquerque, New Mexico 87185

Date Started: June 1, 1981 Anticipated Duration: 3 years

Funding: FY '81 $118,000 for 4 months

The Ionization Front Accelerator (IFA) uses laser photoionization of a special working gas to control the motion of the potential well at the head of an intense relativistic electron beam for the purpose of accelerating ions to high energies. Initial experiments (supported by AFOSR and DOE-Nuclear Physics) on a small system (IFA-1) demonstrated accurate control of the potential well motion, and ion data sets indicated accelerating fields of 50 MV/m, controlled over 10 cm. A new system (IFA-2) is now being constructed to thoroughly test and characterize the IFA concept; this system is designed to produce accelerating fields of 100 MV/m over 1 meter. The IFA is a compact, high-gradient, high-power collective ion accelerator with several potential DOE applications.

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

Donald L. Wise

DYNATECH R/D COMPANY
Cambridge, Massachusetts 02139

Date Started: June 1, 1981 Anticipated Duration: 2 years

Funding: FY '81 $216,000 for 12 months

Peat reserves in the United States represent a significant untapped energy source (1400 quads). The program is directed toward development of a process for production of an alcohol fuel from peat. The process requires solubilization and partial oxidation of the peat (processed in a slurry) to produce fermentable dissolved aromatics which can then be fermented by anaerobic, mixed-culture bacteria. Conditions of the fermentation will be manipulated so that ring-cleavage, acidic compounds are the product which can be removed and concentrated by liquid-liquid extraction. The acid salts of the fermentation products can then be oxidized to form alcohols. The product will be a mixture of alcohols with a higher molecular weight and energy density than ethanol or methanol and will be suitable for mixing with gasoline.

46. PHOTOCHEMICAL URANIUM ENRICHMENT IN SOLIDS

Earl S. Ensberg

GENERAL ATOMIC COMPANY
San Diego, California 92138

Date Started: July 1, 1981 Anticipated Duration: 2 years

Funding: FY '81 $275,000 for 12 months

Experiments at General Atomic Company have established the existence of resolvable isotopic shifts in the visible absorption bands of photochemically active uranium salts at 10 K, established the conditions for achieving two-photon photoreaction at that temperature, and obtained limited but consistent isotope separation. Although the presently achieved separation is 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 mechanism(s) that reduce the selectivity observed in the product from that expected on the basis of the absorption spectrum will be determined and plausible approaches to maintaining selectivity tested. The quantum yield and energy utilization for the process will be measured and the investigations extended to alternative uranium salts and materials.

47. DIRECT CONTACT HIGH EFFECTIVENESS DROPLET HEAT EXCHANGERS

William J. Thayer, III

MATHEMATICAL SCIENCES NORTHWEST, INC.
Bellevue, Washington 98004

Date Started: July 1, 1981 Anticipated Duration: 3 years

Funding: FY '81 $255,000 for 12 months

The objective of this program is to study the feasibility of direct contact droplet gas heat exchangers for high effectiveness operation up to the 1500 to 2000 K range. Direct heat transfer between media can eliminate many materials and temperature limitations of conventional heat exchangers. Heat transfer, droplet formation, flow, and materials aspects of heat exchangers using counterflowing molten refractory droplets and gases are being investigated through tests and analysis.

48. HIGH CURRENT BETATRON FOR A FREE ELECTRON LASER

UNIVERSITY OF CALIFORNIA
Irvine, California 92717

Norman Rostoker & Amnon Fisher

Date Started: August 1, 1981 Anticipated Duration: 3 years

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

A modified Betatron with a toroidal magnetic field and inductive charging can be designed to accelerate a very large current of electrons -- of the order of 10^5 amperes. In principle it can meet most of the requirements of a free electron laser. A notable exception is the beam quality. A normalized emittance of about 10^{-1} rad cm is required and the present estimates based on inductive charging are at least a factor of 10 larger. Therefore in this program the emphasis will be on alternate methods of injecting and trapping electrons in the presence of a strong toroidal magnetic field. In addition, a series of compact high current Betatron/free electron laser experiments will be constructed to bring the state of the art into the visible region.

49. ULTRASONIC COALESCENCE FOR SCRUBBING OF FLUE GAS POLLUTANTS

ENERGY & MINERALS RESEARCH CO.
Exton, Pennsylvania 19341

William B. Tarpley, Jr.

Date Started: September 1, 1981 Anticipated Duration: 1 year

Funding: FY '81 $111,000 for 12 months

Sub-micron particulates may be effectively trapped at room temperature by using standing waves to differentially move larger aerosol droplets and pollutants particulates, so that the aerosol serves as a collective surface. In the flue-gas application, this technology can simultaneously be used to collect gaseous pollutants such as SO_x and NO_x using reactive collector aerosols. Both particulate and gaseous pollutants will tend to impact on the additive collectors at the standing wave peaks and coalesce at the nodes. They will then pass along as agglomerates in the flue-gas stream and enter a conventional cyclone at a sufficient size to be easily removed. Preliminary energy extrapolations for this ultrasonic technique appear beneficial. Evaluation of ultrasonic coalescence of typical gaseous and particulate flue-gas pollutants, at the ranges of temperature and gas stream flow rates encountered in an operating utility or industrial boiler flue will be undertaken.

50. IMPLODING PLASMA X-RAY LASER

PHYSICS INTERNATIONAL
San Leandro, California 94577

Raymond Dukart

Date Started: September 1, 1981 Anticipated Duration: 2 years

Funding: FY '81 $126,000 for 12 months

VUV laser transitions have been observed for collisionally pumped neon-like transitions. This scheme will be extended to the soft x-ray region for krypton (83 eV) and molybdenum (128 eV) utilizing an imploded plasma source ($\sim$ 4 cm x 1 mm) driven by the 5-Tw Defense Nuclear Agency PITHON generator. Neon-like krypton ($\bar{z}$ = 36) and molybdenum ($\bar{z}$ = 42) lines have been observed previously, indicating the existence of the necessary pump conditions for times of 20 ns. The research will be conducted in collaboration with Lawrence Livermore National Laboratory (LLNL) scientists who will provide a high resolution spectrometer for diagnosing the laser. Detailed numerical simulations of krypton plasmas, which included opacity effects, have been carried out at LLNL and indicate significant gains in ideal systems.

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

COLLEGE OF ARCHITECTURE AND URBAN STUDIES
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Blacksburg, Virginia 24061

James F. Riley &
William C. Schillig

Date Started: September 15, 1981 Anticipated Duration: 17 1/2 months

Funding: FY '81 $105,000 for 17 1/2 months

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. In addition to establishing the scientific feasibility of the concept, the project will generate mathematical performance models relative to the heating and cooling functions, and will analyze this system relative to other heating and cooling methods (conventional and unconventional).

INDEX OF INVESTIGATORS

(Project Numbers)

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