DOE/ER-0102

Energy Materials Coordinating Committee (EMACC)

Fiscal Year 1980

Annual Technical Report

U.S. Department of Energy

Printed in the United States of America

Available from

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

NTIS price codes

Printed Copy: $13.00
Microfiche Copy: $ 3.50

DOE/ER-0102
UC-25

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U.S. Department of Energy
Washington, D.C. 20585

INTRODUCTION

This report contains information on the FY 1980 Department of Energy materials research and development programs and on those programs/projects with a significant materials activity. It was compiled by the Energy Materials Coordinating Committee (EMaCC). The previous report in this series summarized the FY 1979 programs (DOE/US-0002-2).

The Energy Materials Coordinating Committee (EMaCC) is an internal Department of Energy committee set up to exchange information and to sponsor various activities of national interest, such as this compilation. Table I contains the EMaCC membership roster, updated through February 1981. Table II summarizes the funding levels for each of 37 programs in the Department of Energy that had a significant materials component in FY 1980. Total materials related funding for the year was approximately $460M.

The report is separated into sections, each containing programs reporting to one of six Assistant Secretaries of the Department: Conservation and Solar Energy, Defense Programs, Environment, Fossil Energy, Nuclear Energy, and Resource Applications; and one section, Energy Research, responsible to the Director of the Office of Energy Research. For convenience in locating the generic types of materials activities, an Appendix has been added that contains a primary keyword index.

John W. Fairbanks of the Fossil Energy Coal Utilization Systems Office was elected EMaCC Chairman for FY 1981.

EMaCC acknowledges the Nuclear Energy Word Processing Center who carefully prepared the text for this document.

Arnold P. Litman
FY 1980 EMaCC Chairman

TABLE I

MEMBERSHIP LIST
DEPARTMENT OF ENERGY
ENERGY MATERIALS COORDINATING COMMITTEE
FEBRUARY 1981

NAME/ALTERNATE	ROUTE SYMBOL	ORGANIZATION	ROOM/BLDG	PHONE NUMBER
J. William Bennett Arthur S. Mehner	NE-552	Nuclear Reactor Programs/Light Water Reactors/ Fuels and Components	F-424/GTN	353-4471
Beverly J. Berger	CS-321	Solar Energy/Biomass Energy Systems	413/600 E	376-1615
K. D. Cherian	CS-68	Applications for Industry/Solar Thermal Systems	416/600 E	376-9296
Jerome F. Collins Michael B. McNeil	CS-120.1	Conservation/Industrial Programs/Alternate Materials Utilization	6E-034/FOR	252-2366
Jerry Counts	EV-14	Environmental Compliance & Overview/Environmental & Safety Engineering	D-221/GTN	353-5487
Stanley J. Dapkunas	FE-60	Fossil Energy Advanced Research & Technology	C-156/GTN	353-2784
Louis V. Divone	CS-331	Solar Energy/Wind Energy Systems	413/600 E	376-4878
Russell Eaton, III	RA-353	Industrial and Utility Applications & Operations/ Electric Energy Systems/Power Delivery Division	6144/FED	633-8653
James J. Eberhardt	CS-143	Conservation/Advanced Cons. Technologies/Energy Conversion & Utilization	1G-080/FOR	252-1500
Warren K. Eister	NE-331	Nuclear Waste Management/Waste Isolation/R&D	B-212/GTN	353-3188
John W. Fairbanks	FE-22	Coal Technology/Coal Utilization/Heat Engines & Heat Recovery	E-138/GTN	353-2816
J. Edward Fox	NE-541	Nuclear Reactor Programs/Advanced Nuclear Systems & Projects/Gas Cooled Reactor Program	J-417/GTN	353-5634

TABLE I - continued

NAME/ALTERNATE	ROUTE SYMBOL	ORGANIZATION	ROOM/BLDG	PHONE NUMBER
Ernest Freeman	CS-110.1	Conservation/Buildings & Community Systems	GH-068/FOR	252-9187
Gerald Goldstein	EV-35	Health & Environmental Research/Pollution Char. & Safety Research	E-223/GTN	353-5348
Carl B. Hilland	DP-44	Inertial Fusion/Plasmas & Particle Beams	C-421/GTN	353-3687
Joram Hopenfeld	FE-24	Coal Fired Magnetohydrodynamic Systems	F-332/GTN	353-5927
Frank W. Hughes (CDR) Yo T. Song	DP-282	Military Application/RD&T	B-310/GTN	353-5494
James R. Hunter Chester M. Purdy	NE-553	Nuclear Reactor Programs/Light Water Reactors/ Materials & Structures	F-406/GTN	353-3299
Louis C. Ianniello Donald K. Stevens	ER-131	Basic Energy Sciences/Materials Sciences	J-312/GTN	353-3428
Neldon L. Jensen Jeffrey Solash	FE-25	Coal Mining	C-133/GTN	353-2722
Robert A. Jones Harry J. Zimmer	RA-231	Uranium Resources & Enrichment/Gas Centrifuge Enrichment	6528/FED	633-9093
Arnold P. Litman	NE-542	Nuclear Reactor Programs/Advanced Nuclear Systems & Projects/Advanced Isotope Separation	J-424/GTN	353-5777
Michael W. Maybaum	CS-312	Solar Energy/Passive Hybrid	5G-088/FOR	252-8153
Alan Postlethwaite Morton B. Prince	CS-313.1	Solar Energy/Photovoltaics	410/600 E	376-9810
Robert R. Reeber	RA-342.3	Renewable Resources/Geothermal Energy	7109/FED	633-9491

TABLE I - continued

NAME/ALTERNATE	ROUTE SYMBOL	ORGANIZATION	ROOM/BLDG	PHONE NUMBER
Stanley S. Ruby James H. Swisher	CS-141	Conservation/Adv. Cons. Technology/Electrochemical Energy Storage	1G-066/FOR	252-1477
Robert B. Schultz	CS-131	Conservation/Transportation Programs/Automotive Technology Development	5H-039/FOR	252-8064
William E. Richards Eugene K. Kinelski	CS-332	Solar Energy/Ocean Energy Systems	421/600 E	376-5889
Robert H. Steele	NE-40	Naval Reactors/Reactor Materials	4E-38/NC #2	557-5561
Charles O. Tarr	NE-543	Nuclear Reactor Programs/Advanced Nuclear Systems & Projects/Space & Terr. Systems	J-408/GTN	353-2907
Andrew Van Echo	NE-564	Nuclear Reactor Programs/Reactor Research & Technology/Fuels	F-417/GTN	353-3930
Ray D. Walton, Jr.	NE-322	Nuclear Waste Management/Technology	A-171/GTN	353-3381
Benjamin C. Wei	NE-512	Nuclear Reactor Programs/Quality Assurance & Standards	E-423A/GTN	353-3927
Louis R. Willett	DP-73	Nuclear Materials Production/Materials Processing	B-319/GTN	353-4959
Kamel S. Youssef	FE-44	Fossil Energy Engineering and Component Management	E-371/GTN	353-3206
Martin Zlotnick	FE-22	Coal Technology/Coal Utilization/Fuel Cells	E-128/GTN	353-2816
Klaus M. Zwilsky Donald S. Beard	ER-533	Magnetic Fusion Energy/Development & Technology/Materials & Radiation Effects	J-212/GTN	353-4965

TABLE II

SUMMARY OF FY 1980 DOE MATERIALS FUNDING

		($M)
CONSERVATION AND SOLAR ENERGY		47.9
Advanced Conservation Technologies	8.9	
Buildings and Community Systems	1.3	
Industrial Programs	3.1	
Transportation Programs	10.1	
Solar Applications for Buildings	22.5	
Solar Applications for Industry	1.6	
Solar Power Applications	.4	
DEFENSE PROGRAMS		100.2
Inertial Fusion	5.5	
Military Application	64.7	
Nuclear Materials Production	30.0	
ENERGY RESEARCH		91.0
Advanced Technology Projects	.1	
Basic Energy Sciences, Materials Sciences	78.0	
Fusion Energy	12.9	
ENVIRONMENT		.2
Health and Environmental Research	.2	
FOSSIL ENERGY		33.3
Advanced Research and Technology	6.2	
Coal Utilization	21.6	
Magnetohydrodynamics	5.5	
NUCLEAR ENERGY		173.3
Naval Reactors	50.0	
Nuclear Reactor Programs	64.2	
Nuclear Waste Management	59.1	
RESOURCE APPLICATIONS		13.8
Electric Energy Systems	6.9	
Renewable Resources, Geothermal Energy	5.3	
Uranium Resources and Enrichment	1.6	
TOTAL		459.7

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CONSERVATION AND SOLAR ENERGY

The Assistant Secretary for Conservation and Solar Energy is charged with a dual responsibility to urge efficient use of the Nation's energy supplies and to encourage the widespread use of solar energy. The primary objective of this organization is to moderate the Nation's growing demand for petroleum-based energy. Conservation and Solar programs cover a broad spectrum of energy users: from research, development and demonstration of advanced technologies, to financial and technical assistance for conservation-related activities, to support for regulatory programs and technology transfer activities.

A number of materials Research and Development (R&D) projects are being conducted within the Conservation and Solar Program. The breadth of this work is considerable, with projects focusing on coatings and films, elastomers and polymers, materials characterization, materials processing, superconductors and other research areas. Within the Office of Conservation, significant materials R&D is being undertaken in the Office of Advanced Conservation Technologies, the Office of Industrial Programs, the Office of Transportation Programs and the Office of Buildings and Community Systems. Details on these programs immediately follows; information on materials R&D within Solar Energy succeeds the Conservation listings.

Office of Conservation

Office of Advanced Conservation Technologies

This sector of the Office of Conservation incorporates three divisions that focus on longer term research and conservation technology development. These divisions, Electrochemical Energy Systems, Thermal and Mechanical Energy Storage Systems (now Physical and Chemical Energy Storage Systems), and Energy Conversion and Utilization Technologies, are providing the technology base support for the Conservation end use programs.

Electrochemical Energy Systems Division

The principal function of the Division is to develop technology for the storage of electricity as chemical energy in rechargeable batteries to permit more efficient and economical use of intermittent energy sources. The development of new and improved materials is a vital part of the R&D effort.

Activities include materials development, fabrication, characterization, and data base compilation. Because all of these activities are part of component or battery development projects, materials R&D does not appear as a line item in the budget.

The total funding level for materials R&D in FY 1980 was approximately $2.1 million dollars:

1. Batteries and Electrochemistry $2,100K

DOE Contact - S. S. Ruby (202) 252-1477
Argonne National Laboratory, Case-Western Reserve U., Ceramatec, Dow Chemical Co., Diamond-Shamrock, Ford, Gould, MIT, U. of Pennsylvania, Reynolds Metals, Stanford U.

Lithium-iron sulfide and sodium sulfur batteries operate at temperatures of several hundred degrees Celsius. Corrosion of container materials is a concern, as are materials for current collectors, separators, and seals. Of special importance is the development of processing techniques to make beta-alumina parts with reproducible properties for use in sodium sulfur batteries.

Aluminum alloys are being prepared and characterized for use as negative electrodes in aluminum-air batteries. Polymers and glasses are being synthesized and prepared as films for use as electrolytes in storage batteries. Catalysts, which contain no platinum, are being studied for use in the electrochemical reduction and oxidation of oxygen.

Keywords: Alloy Development, Alternate Materials, Coatings and Films, Corrosion, Elastomers and Polymers, Joining Methods

Thermal and Mechanical Energy Storage Systems Division

The principal function of energy storage technology is to permit more efficient and more economic use of intermittent energy sources. The development of new and improved materials is a vital part of the energy storage R&D effort.

The energy storage activities include materials development, fabrication, characterization and data base compilation. Because most of these activities are part of the component development projects, materials R&D does not appear as a line item in the budget.

The total funding level for materials R&D in FY 1980 was approximately $6.85 million.

Described below are the materials R&D efforts of the four subprograms of the Division.

1. Thermal Storage $2,500K

DOE Contact - J. H. Swisher (202) 252-1488
Rocket Research Inc., Trans Energy Inc., I.G.T., North Carolina University, Babcock and Wilcox, Purdue University, Calmac Corp., Sandia Livermore

Material development activities include: developing domestic sources of ceramics for electric resistance charged heat storage units including improved physical (cracking and dusting) characteristics, improved heat transfer performances and reduced costs; development of building materials construction elements which incorporate phase change heat storage material for passive solar buildings; development of high temperature storage materials and compatible containment materials for advanced industrial process heat storage application: research on the means of stabilizing the latent heat performance of salt hydrates which are useful for thermal storage; research to identify and characterize solid-solid transition phase change materials for thermal storage; research on heat exchanger materials and fouling problem activities.

Keywords: Alloy Development, Alternate Materials, Transformations

2. Chemical and Hydrogen Storage $850K

DOE Contact - J. H. Swisher (292) 252-1488
Brookhaven, Univ. of Virginia, Denver Research Inst., Teledyne Energy Systems, International Nickel, Westinghouse Electric Corp., R. J. Teitel Associates, General Atomics, ANL, JPL, Rocket Research Co., Life Systems Inc., I.G.T., Ficher-Foster, Factory Mutual MPD, Ergenics, GE

Work on the behavior of hydrogen in materials includes structural steels for the containment of hydrogen gas, hydrides as storage media, solid polymer electrolytes for producing hydrogen from water, and catalysts for both thermochemical and electrolytic hydrogen production. In other projects in chemical energy storage, chemical heat pumps are being developed for the storage of thermal energy in sulfuric acid/water and salt/water systems.

Keywords: Elastomers and Polymers, Catalysts

3. Mechanical Energy Storage $3,200K

DOE Contact - J. H. Swisher (202) 252-1488
LLNL, MIT, Draper and Lincoln Laboratory, Applied Physics Laboratory, Johns Hopkins University; University of Wisconsin, RPI, Union Carbide Co., Rocketdyne Co., AVCO, Owens Corning Co., Ewald Co.

The primary emphasis is concerned with the development of Mechanical Energy Storage Technology (MEST) suitable for automotive and fixed base applications through in-house and contractual efforts. Of particular interest is the development of materials and placing them in appropriate configurations for flywheels rotors, development of elastomeric materials and configurations for braking energy recovery and development of transmission systems and control techniques for flywheel augmented power systems.

Keywords: Alloy Development, Alternate Materials, Elastomers and Polymers

4. Superconducting Magnetic Energy Storage $300K

DOE Contact - J. H. Swisher (202) 252-1488
LASL, University of Wisconsin

The overall objective is to develop technology for both large scale (1000 Mwh) diurnal energy storage plants and small scale (10 Kwh) utility system stabilization devices. The major emphasis is on developing a low-cost polyester-glass support structure for cryogenic service and developing a high-purity aluminum stabilized conductor.

Keywords: Superconductors, Glasses, Alloy Development

Energy Conversion and Utilization Technologies Division

DOE Contact - J. J. Eberhardt (202) 252-1500

The purpose of the ECUT Program is to support longer-term generic and problem-solving research to develop new technologies for increasing energy productivity. The ECUT program was initiated in FY 1981 and thus conducted no materials activities in FY 1980. Materials R&D efforts that were initiated in FY 1981 include: developing improved catalysis techniques and materials to increase the efficiency of producing industrial chemicals; experimental testing of innovative heat exchanger components in severe industrial environments to improve reliability and effectiveness; and developing temperature-tolerant, low-friction materials for automotive applications.

Office of Buildings and Community Systems (BCS)

The Office of Buildings and Community Systems works to increase energy utilization efficiency, to develop energy substitution options and to provide technologies, methodologies and processes which decrease the amount of energy required to satisfy human needs. Its operations are focused upon: the design and operation of buildings; the design and operation of appliances and other energy consumer products used in buildings; systems that supply energy to buildings and communities; and the energy consuming practices of consumers and the institutional factors affecting these practices. The program conducts research, development, demonstration and implementation activities aimed at increasing energy efficiency in these areas of operation.

Materials R&D is being carried out within three areas of BCS: (1) the Technology and Consumer Products Branch; (2) the Urban Waste and Municipal Systems Branch; and (3) the National Program for Building Thermal Envelope Systems and Insulating Materials, within the Buildings Division. Descriptions of the projects, including FY 1980 funding levels, are provided below.

The Technology and Consumer Products Branch

The objective of this branch is to develop, demonstrate, and encourage the commercialization of more energy-efficient technologies in heating, cooling and ventilating equipment, system lighting and appliances.

1. Advanced Insulation $ 75K

DOE Contact - Ronald Fiskum (202) 252-9130
Arthur D. Little, Inc. (Contract No. 62X-13 800 C)
Dr. Tom Lawrence (617) 864-5770

Research on 14 different materials aimed at producing insulation with an R-value of 20. Investigating best packing factor on materials, type of gases to fill voids and conduction measurements.

Keywords: Material Characterization; Material Processing

2. Condensing Heat Exchanger Systems $100K

DOE Contact - John Cuttica (202) 252-9123
Battelle Labs (Brookhaven Subcontract No. 490885)
Bud Woodworth (516) 345-2123

Investigation of materials feasible for use as heat exchangers for condensing oil and gas-fired burners. Ceramics, stainless steel, plastics and lead-coatings are among the materials being considered.

Keywords: Corrosion; Materials Characterization

The Urban Waste and Municipal Systems Branch

The mission of this branch is to develop systems that deliver energy services to the community more efficiently, to develop processes and systems that use municipal wastes for energy and energy-intensive material recovery and to develop systems, processes and technologies which will conserve energy in key municipal functions such as water and wastewater treatment facilities.

1. Material Corrosion in Municipal Waste-to-Energy Incinerator Systems $150K

DOE Contact - L. Lehr (202) 252-1703
Chemical Thermodynamics Division
National Bureau of Standard (Contract No. 20528)
Joseph Berke (301) 921-2343

Examination of corrosion problems at several municipal waste burning sites to determine the possibility of developing a short-term test to determine the corrosion property of candidate materials in the harsh environment of municipal waste energy recovery systems.

Keywords: Erosion and Wear

National Program for Building Thermal Envelope Systems and Insulating Materials

The objective of this program, part of the Buildings Division, is to provide technical data, test procedures, guidelines and consensus standards in order to produce energy-efficient buildings. Research in the program is contracted through the Oak Ridge National Laboratory.

1. Thermal Insulation $200K

DOE Contact - Ernest Freeman (202) 252-9187
Oak Ridge National Laboratory (Contract No. 3470-0521)
D. L. McElroy - (615) 624-5976

Evaluation of the thermal resistance of thermal insulation. Use of an instrumented Nichrome screen heater is being analyzed and a simple prototoype constructed.

Keywords: Materials Characterization

2. <u>Thermal Resistance of Insulation</u> $ 70K

DOE Contact - Ernest Freeman (202) 252-9187
NBS - Boulder (ORNL Subcontract No. 3470-5261)
F. Powell (202) 921-3275

Developing equipment to measure thermal resistance of insulating materials. Testing a commercial guarded hot plate apparatus to obtain data with an uncertainty of $\pm$ 1% from 80 to 305°K. Data obtained on Standard Reference Material 1450 (a fiberboard) and on glass fiberblanket (0.9 pcf) in an environment of dry nitrogen.

Keywords: Materials Characterization

3. <u>Thermal Resistance of Insulation</u> $210K

DOE Contact - Ernest Freeman (202) 252-9187
NBS - Gaithersburg (ORNL Subcontract No. 3740-5168)
F. Powell (202) 921-3275

Developing equipment to measure thermal resistance of insulating materials at thicknesses up to six inches. Two prototypical line-heated guarded hot plates are being developed and compared to a heat flow meter technique.

Keywords: Materials Characterization

4. <u>Vertical Enclosures of Porous Insulation</u> $ 12K

DOE Contact - Ernest Freeman (202) 252-9187
State University of New York - SB (ORNL Subcontract No. 3470-5267)
A. Berlad - (516) 246-5963

The thermal performance of vertical enclosures of porous insulation was measured and found to include large natural convection effects that reduce R-values.

Keywords: Materials Characterization

5. <u>Corrosion in Insulating Materials</u> $171K

DOE Contact - Ernest Freeman (202) 252-9187
Stevens Institute (ORNL Subcontract No. 3470-5263)
R. Weil - (201) 420-4257

Studies of corrosion testing with urea-formaldehyde foams and also with cellulosic insulation and fiberglass insulation.

Keyword: Corrosion

6. <u>Insulating Materials</u> $ 22K

DOE Contact - Ernest Freeman (202) 252-9187
Tennessee Technological University (ORNL Subcontract No. 3470-5269)
Dale Yarbough - (615) 624-5976

Operating temperatures of convectively-cooled recessed incandescent light fixtures and of insulated fluorescent light fixtures measured. Effect of vibration on density of loose-fill insulation and effects of thickness change due to compressive loading on insulating batts and loose-fill insulation also measured.

Keywords: Materials Characterization

7. <u>Convection Effects, Moisture Transport and Condensation and Scattering</u> $ 62K

DOE Contact - Ernest Freeman (202) 252-9187
University of California - Berkeley (ORNL Subcontract No. 3470-5265)
C. Tein - (415) 642-6000

Analytical and experimental studies on natural convection effects in insulation cavities, on moisture transport and condensation, and on the absorption and scattering characteristics of insulating materials.

Keywords: Materials Characterization

8. <u>Out-gassing Substances</u> $157K

DOE Contact - Ernest Freeman (202) 252-9187
University of Iowa (ORNL Subcontract No. 3470-5264)
K. Long- (319) 353-2121

Identification of out-gassing substances from urea-formaldehyde foams. Attempting to demonstrate multiple stage releases that depend on temperature and humidity.

Keywords: Materials Characterization

9. <u>Shrinkage of U-F Foam</u> $ 30K

DOE Contact - Ernest Freeman (202) 252-9187
Dynatech Co. (ORNL Subcontract No. 3470-0526)
J. Hust, FTS 323-3733

Influence of temperature, humidity and cycling on urea-formaldehyde foams tested, as well as thermal derating of a wall cavity.

Keywords: Materials Characterization

Office of Industrial Programs

The Office of Industrial Programs primarily conducts cost-shared RD&D of selected energy-conservation technologies. The program's efforts are targeted towards processes with wide-ranging industrial applications and processes which are specific to the most energy-intensive industries. A significant effort is placed on the identification and transfer of existing but underutilized technologies, processes and techniques. Activities are selected on the basis of high energy-saving potential, acceleration of implementation, nonredundancy with efforts of private industry and the degree and appropriateness of cost-sharing.

The materials R&D being carried out in Industrial Programs is in the Division of Conservation Research and Development's Alternative Materials Utilization Branch and High Temperature Processes Branch.

Descriptions of materials projects, together with their FY 1980 funding levels, are provided below.

1. Polymers from SO_2 $325K

DOE Contact - Jerome F. Collins (202)252-2366; FTS 252-2366
Brookhaven National Laboratory (Contract No. CS40155)
Meyer Steinberg - 516-345-3036; FTS 666-3036

The goals of the project are to develop useful energy conserving copolymers of ethylene and sulfur dioxide of the polysulfone type and a process for their production for the plastics industry. These polysulfone copolymers offer a major potential for conserving valuable petrochemical feedstock (for ethylene supply) for the plastics industry while at the same time converting SO_2, a waste from the power and metallurgical industry, into a useful product. A high energy radiation process is used to synthesize polysulfone copolymers.

The project is performed by Brookhaven National Laboratory in cooperation with International Nickel Co. Completion of product optimization is scheduled for midway through FY 80, ending the contracted effort. No further plans have been formulated.

Keywords: Elastomers and Polymers; Materials Characterization

2. Alkali-Silica Reaction $138K

DOE Contact - Jerome F. Collins (202)252-2366; FTS 252-2366
Purdue University (Contract No. EM-78-S-02-507CS40222)
Sidney Diamond (317)493-1982

This research project is aimed towards gaining a better understanding of the expansive chemical reaction in cement kiln preheaters between the alkali constituents of the cement and the silica of the aggregates. The work includes laboratory and theoretical analyses. Better understanding of the alkali-silica reaction can allow increased use of preheaters and permit more use of pozzolans to reduce energy consumption in cement making.

This project was taken over by IP after being partially funded by the National Science Foundation in FY 1978. The third quarter of FY 1980 will see delivery of an interim report. The final report, ending the currently planned work, is scheduled for FY 1981. The project is being conducted by Purdue University and is part of the International Energy Agency Cement R&D Program.

Keywords: Cements and Concrete, Materials Characterization; Expansive Reactions

3. Cement Kiln Dust-Flyash Aggregates $150K

DOE Contact - Jerome F. Collins (202)252-2366; FTS 252-2366
DOT-Fed HIghway Admin (Contract No. 01-79CS40293.00)
Donald Fohs (202)557-5216

The objective of this project is to evaluate the effectiveness of substituting kiln dust for hydrated lime in lime-fly ash pavement stabilization systems. Kiln dust is a waste product of lime and cement production. The work is part of Project 4C of the Federal Highway Administration Program for Research and Development in Highway Transportation. DOE is funding Phase I-Laboratory Experiments, and FHWA is funding Phase II-Field Studies.

The contractor for Phase I will be selected with an RFP issued in the first quarter of FY 1980. Contract award is planned for mid-FY 1980. The Phase I final report will be due at the end of FY 1981. The field tests (Phase I), not funded by DOE, will be done by State Highway agencies and are scheduled for completion in early FY 1984.

Keywords: Cements and Concrete; Paving Materials

4. Low Energy Lime & Cement $251K

DOE Contact - Jerome F. Collins (202)252-2366; FTS 252-2366
Southwest Research Institute (Contract No. DE-DE-AC03-79CS40250)
William A. Mallow (512)684-5111 x2341

This project is directed toward the development of a low-energy method for the conversion of limestone to lime for use in the manufacture of hydraulic cements. Laboratory process development and feasibility studies are focused on the catalytic decarboxylation of fine ground limestone to produce a slaked lime slurry. Production of lime in the U.S. uses the energy equivalent of about 17 million barrels of oil annually. In the conventional process, heat energy is used in a rotary kiln to produce quicklime. The new, non-thermal catalytic decarboxylation process would produce hydrated lime at lower rates of energy use. Approximately 3.5 million barrels of oil equivalent are expected to be saved annually if this process is proven effective and reached its commercial potential.

This project was initiated in the last quarter of FY 1979 by the Southwest Research Institute. The major milestone in FY 1980 is selection of the most effective methods for producing the quicklime. Subsequent performance of detailed evaluations on the choice of the optimum method will take place in the second quarter of FY 1981. At present, DOE plans do not extend beyond this time period.

Keywords: Cements and Concrete; Catalysts, Lime

5. <u>Sulfate Effects</u> $146K

DOE Contact - Jerome F. Collins (202)252-2366; FTS 252-2366
Portland Cement Assoc. (Contract No. EM-78-6-02-5011CS40221)
D. L. Kantro (312)966-6200

The effects of high sulfate contents in Portland Cements are being evaluated by studying pure cement compounds and specially designed cements prepared from a variety of commercial Portland cement clinkers.

Results indicate that use of a combination of admixtures can reduce the deleterious expansive effects due to both internal and external sulfate attack. In particular, a combination of alkali sulfates and sucrose can help reduce expansion in over-sulfated cement pastes, while a combination of limestone and gypsum can help reduce the susceptibility of mortars to external sulfate attack.

It is suggested that further work should be carried out on concretes made from commercial Portland cement clinkers interground with the recommended admixtures.

Keywords: Cements and Concrete; Sulfates, Admixtures

6. Comminution $23K

DOE Contact - Jerome F. Collins (202)252-2366; FTS 252-2366
BurMines National Academy of Science
(Contract No. EM-78-I-01-5247CS40280)
Donald Groves (202)389-5626

Conduct a study to include both the short and long term approaches to the improvement of energy efficiencies of comminution operations. Of particular concern in this study will be the conservation of energy in the comminution of mineral ores, cement (including pozzolans and slags) and coal.

Task 1: Development of strategies for the optimization and automatic control of existing comminution devices and the improvement of scale up procedures.

Task 2: For the longer range, improved processes, including "chemical comminution" methods, cryogenic processing, and other new methods for more efficiently applying energy for comminution would be considered. Also to be examined are the possible use of corrosion inhibitors, improved materials of construction and other measures which could lessen the overall use of energy by reducing start/stop time and extending the useful life of equipment.

Keywords: Materials Processing, Cements and Concrete, Ceramics, Glasses, Erosion and Wear

7. High Temperature Heat Pump $400K

DOE Contact - John Eustis (202)252-2084; FTS 252-2084
Westinghouse Electric Corp. (Contract No. EC-77-C-01-5026)

In response to a PON on Industrial High Temperature Heat Pumps, Westinghouse Electric Corporation was competitively selected to develop and to demonstrate a high temperature heat pump for use in an industrial energy conservation application. More specifically, the objective is to develop and demonstrate a reverse Rankine cycle heat pump system that could provide higher delivery temperatures ($\sim$310°F) than commercially available heat pumps. ($\sim$230°F)

The 56 month project began in July, 1977 and consists of the full scale design and development of a system to be constructed and tested at the Westinghouse amplifier facility in Staunton, Virginia. Phase II of the project consists of a proposed industrial team effort, namely Westinghouse and an industrial host partner, to install and demonstrate the heat pump system at a selected plant site.

Keywords: Materials Characterization, Alternate Materials

8. Intermediate and High Temperature Flue Gas Recuperators $250K

DOE Contact - John Eustis (202)252-2084; FTS 252-2084
Institute of Gas Technology (Contract No. EC-77-C002-4235)

The purpose of this program is to field demonstrate the newly developed high-temperature flue gas reradiant stack-type recuperator in an industrial application. More specifically, the objectives are to demonstrate the increased energy savings possible with the reradiant recuperator over the conventional radiant type unit; and to demonstrate the economic advantages of the reduced-size reradiant recuperator versus the conventional radiant recuperator, for any one-unit efficiency and heat recovery capacity. Reynolds Metal Co. furnished three production furnaces on which reradiant recuperators were tested. The furnaces were located at the Alabama Reclamation Plant in Listerhill, Alabama. One furnace is being monitored as a non-recuperated based case. The other two furnaces have reradiant recuperators installed with the reradiant element preheating the combustion air to 1200°F and 1000°F respectively.

Keywords: Alloy Development, Alternate Materials, Corrosion, Joining Methods

9. Coal Fired Gas Turbine $900K

DOE Contact - John Eustis (202)252-2084; FTS 252-2084
Westinghouse Electric Corp.
Paul Berman (215)358-4635

This project will result in the design, construction, and demonstration of a medium sized externally fired gas turbine cogeneration system in a magnesium reduction plant. Although the system is capable of operating virtually on any type of fuel, Texas lignite will be used in the demonstration. Some advantages to this system are that it displaces significant amounts of oil and gas, shows a high rate of return and is environmentally acceptable.

Present new gas turbine technology, using clean (and expensive) scarce fuel utilizes turbine inlet temperature of 1500°F to 2000°F and is viewed by industry as having satisfactory service life. If fuel displacement is attempted by switching to coal or other alternative fuel the turbine inlet air, for acceptable turbine service life, must be kept clean by being kept separated from the combustion gases. The best way to do this is by use of a fluidized bed combustor. A significant body of recently established technical information reveals that with present practicable materials fluidized bed outlet air temperature of 1500°F to 2000°F will not provide adequate service life due to air heater tube deterioration.

The approach is to combine the conservative, mature gas turbine technology using a 1200°F turbine inlet temperature with the innovative fluidized bed combustor to provide a system that displaces natural gas and oil, provides a good economic return of 40% ROI, and presents a credible projected service life to the industry who will adapt it.

Keywords: Alloy Development, Alternate Materials, Erosion and Wear

10. Tool Coatings $31K

DOE Contact - John R. Rossmeissl, (202)252-2378; FTS 252-2378
Alpha Glass/UCLA (Contract No. DE-AC02-80CS40446)
R. Bunshah (UCLA)

Coatings of titanium carbide and titanium nitride were applied to standard (high speed steel) 1/4" drills and tested for cutting wear. TIC coated drills lasted 6-8 times longer than high speed steel and TIN lasted 12-16 times longer. Coatings were applied at UCLA laboratory using the activated reactive evaporation process as developed by Dr. Bunshah.

Keywords: Coatings and Films; Tools

11. Ceramic Heat Recuperators $500K

DOE Contact - John Eustis (202)252-2084
GTE Products Corp. (Contract No. EX-76-C-01-2162)

The objective of this work is to determine the heat transfer performance of the ceramic recuperators; establish the energy savings by recuperation and demonstrate minimum maintenance requirements in typical furnace operations. In addition, the program is working to determine the durability of the ceramic case; to determine the operating requirements of the Lumers and controls when using preheated combustion air; and to establish the overall system costs and payback period.

Keywords: Corrosion, Ceramics, Glasses

Office of Transportation Programs

The Office of Transportation Programs has established a number of broad programs aimed at reducing highway vehicle fuel consumption. One such program, Heat Engine Highway Vehicle Systems, addresses gas turbine and Stirling propulsion systems. These propulsion systems have the potential of achieving significant improvement in fuel consumption over the conventional spark ignition powerplant. A major program is under way to develop advanced gas turbine and Stirling propulsion systems and to demonstrate their potential for future automotive applications. Project management responsibility for the gas turbine and Stirling engine development has been delegated to the NASA Lewis Research Center. Program management is the responsibility of the Office of Transportation Programs.

The success of these advanced propulsion systems is strongly dependent on the development of new or improved materials. Ceramic materials are key to the gas turbine development. Ceramic hot-flow-path components (turbine and heat exchanger) are required to meet both cost and operating temperature requirements. Low cost, iron-base alloys capable of operating at high temperatures in high pressure hydrogen are required for the Stirling system. Materials technology development programs for each of these propulsion systems are under way. Key elements of each materials program are described briefly in the following listings. As indicated, most of the materials activities are being conducted by contract program with industry. Further information can be obtained by contacting R. B. Schulz, Automotive Technology Division, (202) 252-8064.

1. <u>Ceramic Applications in Turbine Engines (CATE)</u> $4,550K

DOE Contact - T. J. Miller (216)433-400; x6844
Detroit Diesel Allison (NASA Subcontract DEN 3-17)
J. A. Byrd (317)242-5350

Applies ceramic components to the DDA 404/505 IGT engine. Replacing existing metal parts increased operating temperatures which improves engine efficiency. Ceramic material characterization, ceramic process development, and ceramic design technologies are included.

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

2. Advanced Gas Turbine Powertrain Development (AGT-101) $2,474K

DOE Contact - R. S. Palmer (216)433-4000; x6653
AiResearch/Ford (NASA Subcontract DEN 3-167)
E. E. Strain (602)267-2797

Project objective is to develop an AGT powertrain capable of demonstrating DOE/NASA goals of improved fuel economy, reduced emissions, and alternate fuel capability in vehicle tests by May 1985. Ceramic materials will be required for most, if not all, the hot-section components. Efforts include materials characterization, process development, and component design and test.

Keywords: Ceramics, Glasses, Materials Characterization, Turbine Engines, Silicon Carbide, Silicon Nitride

3. Advanced Gas Turbine Powertrain Development (AGT-100) $884K

DOE Contact - P. T. Kerwin (216)433-4000; x770
Detroit Diesel Allison/Pontiac (NASA Subcontract DEN 3-168)
H. E. Helms (317)242-5335

Project objective is to develop an AGT powertrain capable of demonstrating DOE/NASA goals of improved fuel economy, reduced emissions, and alternate fuel capability by 1985. Ceramic materials will be necessary for most, if not all, the hot-section components. Efforts include materials characterization, process development, and component design and test.

Keywords: Ceramics, Glasses, Materials Characterization; Turbine Engines, Silicon Carbide, Silicon Nitride

4. Ceramic Stator Evaluation $400K

DOE Contact - G. K. Watson (216)433-4000; x6905
Ford Motor Company (NASA Subcontract DEN 3-19)
E. A. Fisher (313)337-5485

Integral stator fabrication development by four ceramic component suppliers and property characterization of silicon nitride and silicon carbide. Durability testing of the stators in a simulated engine environment is being conducted to assess overall potential of the ceramic materials.

Keywords: Ceramics, Glasses, Materials Characterization; Silicon Carbide, Silicon Nitride

5. Ceramic Durability Evaluation $320K

DOE Contact - W. A. Sanders (216)433-4000; x6153
AiResearch Manufacturing Company (NASA Subcontract DEN 3-27)
K. W. Benn (602)267-4373

Commercially available silicon carbide and silicon nitride are being evaluated under extended thermal exposures up to 2500°F for 3500 hours. The program will assess the capability of materials to perform satisfactorily at the temperatures and times required for automotive turbine engine applications.

Keywords: Ceramics, Glasses; Silicon Carbide, Silicon Nitride

6. Sinterable Silicon Nitride Ceramics $220K

DOE Contact - R. N. Katx (617)923-3520
General Electric Co. (AMMRC Subcontract DAAG46-77-C-0030)
C. D. Greskovich (518)385-8691

Program includes evaluation of sintering additives and development of sintering process parameters with the objective of achieving hot pressed material properties in a sinterable product. Both oxide and nonoxide additives are being evaluated.

Keywords: Ceramics, Glasses; Silicon Nitride, Sintering

7. Life Prediction Methodology $200K

DOE Contact - E. M. Lenoe (617)923-3427
Ford Motor Company (AMMRC Subcontract DAAG46-77-C-0028)
R. K. Govila (313)323-1742

A methodology is being developed for life prediction in the use of brittle materials such as ceramics for structural application. Time, temperature, stress dependencies are being statistically treated and comparisons made of silicon nitride behavior in test bar and simple component geometries.

Keywords: Ceramics, Glasses; Structural Mechanics, Fracture Mechanics

8. Ceramic Component Technology $100K

DOE Contact - R. L. Davies (216)433-4000, x6608
NASA Lewis Research Center
G. K. Watson (216)433-4000, x6905

Project includes development and evaluation of advanced techniques for fabrication and evaluation of ceramic components. Ceramic fabrication by hot isostatic pressing (HIP) and Non-Destructive Evaluation (NDE) techniques such as acoustic microscopy will be investigated.

Keywords: Ceramics, Glasses; HIP, NDE

9. Materials Characterization - Stirling Simulation Rig Test $225K

DOE Contact - John A. Misencik (216)433-4000, x6676
NASA Lewis Research Center
J. Stephens (216)433-4000, x6826

Candidate Stirling engine alloys are being subjected to a simulated engine environment to assess the combined effects of high pressure hydrogen, high temperature, and combustion products on material properties. Both commercial alloys and new experimental alloys will be evaluated, with emphasis on relatively low-cost iron-base alloys.

Keywords: Alloy Development, Alternate Materials, Hydrogen Effects, Materials Characterization

10. Materials Characterization - High-Temperature Creep Evaluation $205K

DOE Contact - Robert H. Titran (216)433-4000, x398
IIT Research Institute (NASA Subcontract DEN 3-217)
Otto Ghatta Charyya (312)567-4197

Creep properties of both commercial alloys and new experimental alloys will be characterized over a temperature range spanning the proposed operating temperatures of the Stirling engine. The effects of long-term (350 hours) thermal aging at engine operating temperatures in hydrogen or argon at one atmosphere pressure on subsequent creep-rupture properties will be evaluated to determine mechanical property degradation due to aging, atmosphere and time.

Keywords: Alloy Development, Alternate Materials, Hydrogen Effects, Materials Characterization

11. Materials Characterization - Hydrogen Permeability of Alloys $30K

DOE Contact - S. R. Schuon (216)433-4000, x6826
ITT Research Institute (NASA Subcontract DEN 3-6)
E. J. Vesely (312)567-4228

Hydrogen permeability data are being obtained for both commercial alloys and new experimental alloys in high purity hydrogen and in doped hydrogen at Stirling engine operating temperatures and pressures.

Keywords: Alloy Development, Alternate Materials, Hydrogen Effects, Materials Characterization

12. Materials Development - Improved Cast Cylinder Alloy $491K

DOE Contact - J. R. Stephens (216)433-4000, x6826
AiResearch Casting Company (NASA Subcontract DEN 3-234)
F. Larsen (213) 323-9500, x6905

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

Keywords: Alloy Development, Alternate Materials, Materials Characterization

Office of Solar Energy

Solar Energy programs encompass both solar applications and solar technologies. These programs and related policy initiatives are intended to stimulate accelerated commercialization, market acceptance and demand for solar products for residential, agricultural, and industrial heating and cooling processes in both public and private sectors. Technology programs are oriented toward the development of power generating systems that derive energy directly or indirectly from the sun by means of biomass, wind, the ocean, and solar thermal and photovoltaic effects. Both the applied and the technological areas of Solar Energy programs seek to provide low-cost, renewable solar-related energy source systems.

Solar Energy programs conduct materials R&D aimed at providing a technological base from which solar applications can be generated. This research is especially critical to the success of sectors such as photovoltaics and passive hybrid solar heating and cooling.

The following program areas within the Solar Energy Program contain significant materials R&D:

- o active solar heating and cooling
- o passive and hybrid solar heating and cooling
- o photovoltaic energy systems
- o solar thermal power systems
- o ocean systems

Each of these is discussed below.

Office of Solar Applications For Buildings

Active Solar Heating and Cooling Systems

This program funds projects with industry and academic institutions directed toward the development of cost effective, reliable and publically acceptable active solar heating and cooling systems. A major emphasis of the program is to ensure that the information derived from these projects is made available to all members of the solar community who will benefit from such knowledge.

Detail on materials R&D performed by the Active Solar Heating and Cooling Systems Division is contained below.

1. <u>Solar Fluid Degradation in Solar Energy Systems</u> $ 25K

DOE Contact - Chuck Bankston, (505) 667-6441, ext. 2618
Argonne National Laboratory (Contract No. W-31-109-ENG-38)
Ronald Wolosewicz - (312) 972-7706

Design and fabricate a solar fluid corrosion test loop and perform corrosion studies on aluminum, steel and copper when exposed to heat transfer fluids that are subjected to simulated stagnation conditions.

Keyword: Corrosion

2. <u>Exposure Testing and Evaluation of Solar Collector Materials</u> $ 4K

DOE Contact - Chuck Bankston, (505) 667-6441, ext. 2618
IIT Research Institute (Contract No. EX-76-C-02-0578-034)
K. S. Rajan - (312) 567-4262

Determine by direct exposure to sunlight and ambient weather those collector materials which are most satisfactory and can be expected to provide long, reliable collector life. Material performance monitored by visual appearance and optical and mechanical testing of samples.

Keywords: Materials Characterization

3. <u>Superior Liquid Coolants</u> $ 29K

DOE Contact - Chuck Bankston, (505) 667-6441, ext. 2618
Monsanto Research Corporation (Contract No. DE-AC04-78CS35356)
Leo Parts - (513) 268-3411

Evaluate commercially available, developmental and candidate organic heat transfer fluids for solar heating and cooling applications.

Keywords: Materials Characterization

4. Continuous Deposition of AMA Type Coatings on Strip and Sheet $128K

DOE Contact - Chuck Bankston, (505) 667-6441, ext. 2618
Telic Corporation (Contract No. DE-AC04-80AL13116)
J. Thornton - (213) 828-7449

The goal of this project is to develop materials and technology for producing inexpensive and durable solar selective coatings on metal strip by planar magnetron sputtering. Work includes developing technology for continuous deposition of AMA coatings using reactively sputtered and rf sputtered Al_2O_3.

Keywords: Coatings and Films; Materials Processing

5. Optical Constants of Doped Indium Oxide Films $ 16K

DOE Contact - Chuck Bankston, (505) 667-6441, ext. 2618
Tufts University (Contract No. DE-AC04-78CS5307)
Ronald Goldner - (617) 628-5000, ext. 287

Correlate the wavelength dependence of the optical constants of polycrystalline films of doped indium oxide with structure, composition and thermal history, and, arrive at a useful model of the electromagnetic behavior of doped indium oxide for predictably modifying its optical constants and those of related metal oxides.

Keywords: Coatings and Films; Materials Characterization

6. Collector Sealants and Breathing $182K

DOE Contact - Chuck Bankston, (505) 667-6441, ext. 2618
Westinghouse Electric Corporation (Contract No. DE-AC04-78CS35362)
M. Mendelsohn - (416) 256-3592

Investigate the pertinent properties of a variety of possible sealants for solar collectors and identify the most promising candidates; study the effect of breathing in flatplate, thermal solar collector units; and develop sealants and gasketing material which will exhibit superior long-term retention of physical properties.

Keywords: Seals; Materials Characterization

Passive and Hybrid Solar Heating and Cooling

This program has two principal thrusts: (1) development of new materials products and systems for buildings and community systems, and (2) introduction and dissemination of passive systems design and construction technologies into the building industry. Since passive technology is essentially a design procedure employing passive components, much of this program is primarily concerned with generating design procedures in a form amenable to application by architects, engineers and builders.

The Materials and Subcomponents Program within the Passive and Hybrid Solar Heating and Cooling Division provides financial assistance to passive product companies aimed at increasing the supply of and stimulating the demand for new, cost-competitive materials and components for passive and hybrid heating, lighting and cooling systems. The research covers a wide range of passive solar products, including greenhouse/sunspaces, insulation, improvement of storage walls, and improved glazing and control systems. The program is administered by the Chicago Operations and Regional Office (CORO) and the San Francisco Operations Office (SAN).

1. Southwall Glazing $ 59K

DOE Contact - Carl Alberg, (312) 972-2513
Dow Corning Corporation (Contract No. DE-AC02-80CS30521)
Bernard Van Wert - (517) 496-4000

Develop a single-glazed southwall glazing system, primarily for masonry commercial, institutional and industrial buildings. The silcone southwall glazing system will be suitable for both new construction and retrofit.

Keywords: Coatings and Films

2. Thin-Film Transparent Insulation $176K

DOE Contact - Russ Burke, (202) 252-8119
Suntek Research Associates (Contract No. DE-FC02-80CS30583)
Carl Alberg, (312) 972-2413

Develop a thin-film transparent insulation that could increase the thermal performance of glass.

Keywords: Coatings and Films

3. <u>Multi-Layer Insulation</u> $ 48K

DOE Contact - Russ Burke, (202) 252-8119
Star Technology Corporation (CORO Subcontract No. 02-80CS30532)
Carl Alberg - '312) 972-2513

Develop a multi-layer insulating window shade.

Keywords: Alternate Materials

4. <u>Interior Window Insulation</u> $ 40K

DOE Contact - Russ Burke, (202) 252-8119
Solar Systems Design Inc. (Contract No. DE-FC02-80CS30531)
Carl Alberg - (312) 972-2513

Develop a low cost, lightweight movable, nonburning, interior thermal window shutter. Shutter will include high insulating reduced infiltration.

Keywords: Alternate Materials

5. <u>Collapsing Multi-Layer Insulation</u> $ 55K

DOE Contact - Carl Alberg, (312) 972-2513
Koolview Co., Inc. (Contract No. DE-AC02-80CS30525)
James Boesing, (608) 274-6997)

Develop a collapsing multi-layer interior insulating window shade that will (1) stop convection along the vertical surface of the glazing and (2) form multiple dead air spaces. The product uses a honeycombed structure to create horizontal air spaces paralleling the surface of the glass.

Keywords: Alternate Materials

6. Roll-up Multi-Layer Insulation $82K

DOE Contact - Russ Burke, (202) 252-8119
Thermal Technology Corporation (Contract No. DE-FC02-80CS30585)
Carl Alberg, (312) 972-2513

Develop a system to insulate mass walls in passive systems and reduce thermal losses. The system develops a high insulation valve through use of several layers of metalized reflective fabrics.

Keywords: Coatings and Films

7. Exterior Insulation $22K

DOE Contact - Carl Alberg, (312) 972-2513
Syracuse Research Corporation (Contract No. DE-FC-02-80CS30584)
Clyde Beigh, (315) 425-5100

Develop an insulating shutter and a passive window system that has the thermal performance of an insulating shutter, yet provides daylighting deep within a building and solar thermal gain for conditions of both diffuse and direct sunlight.

Keywords: Alternate Materials

8. Fabric Insulation $122K

DOE Contact - Carl Alberg, (312) 972-2513
ABRI, Inc. (Contract No. DE-AC02-80CS30518)
Susan Gill, (617) 262-2277

Develop a "variable insulation system" which utilizes lightweight translucent material to control thermal lighting and cooling loads.

Keywords: Coatings and Films

9. <u>Movable Insulation Greenhouse</u> $ 92K

DOE Contact - Russ Burke, (202) 252-8119
Solar Central (Contract No. DE-FC02-80CS30528)
Carl Alberg, (312) 972-2513

Develop a greenhouse that uses movable insulation. The insulation is in the form of foam plastic beads fed from a storage bin into an inflated plastic sheet.

Keywords: Elastomers and Polymers

10. <u>Multi-Glazed Greenhouse</u> $ 95K

DOE Contact - Carl Alberg, (312) 972-2513
Four Seasons Solar Products, Inc. (Contract No. DE-AC02-80CS30522)
Joseph Esposito, (516) 654-4400

Develop a greenhouse with multiple glazing and summer shading that incorporates thermal break and other thermal efficiencies.

Keywords: Alternate Materials

11. <u>Inflatable Attached Room Greenhouse</u> $ 93K

DOE Contact - Russ Burke, (202) 252-8119
Solar Resources, Inc. (Contract No. DE-FC02-80CS30530)
Carl Alberg, (312) 972-2513)

Develop a southwall passive/hybrid solar glazing system using thin-film technology for a "solar room" air-inflated tension structure.

Keywords: Coatings and Films

12. <u>Water Wall</u> $ 72K

DOE Contact - Russ Burke, (202) 252-8119
Communico/Crimsico (Contract No. DE-AC02-80CS30520)
Carl Alberg, (312) 972-2513

Develop a vertical, stagnated water-loaded Trombe wall, consisting of metal framing with optional exterior selective coatings, optional interior sealed lined channels and optional sheet rock interior finishing.

Keywords: Materials Processing

13. <u>Water Storage</u> $ 72K

DOE Contact - Carl Alberg, (312) 972-2513
Solar Concept Development Company (Contract No. AC02-80CS30529)
Richard Bourne, (916) 753-1100

Develop a passive collector/water storage system that contains automatically operated insulators that reduce night heat less through the "Sunbin" glazing.

Keywords: Coatings and Films

14. <u>Glazing and Phase Change Storage</u> $ 90K

DOE Contact - Russ Burke, (202) 252-8119
Capital Products (Contract No. DE-AC02-80CS30519)
Carl Alberg, (312) 972-2513

Utilization of Glauber's salt as a phase change material for a thermal storage medium.

Keywords: Transformations

15. <u>Water Wall</u> $251K

DOE Contact - Carl Alberg, (312) 972-2513
One Design, Inc. (Contract No. 02-80CS30527)
Tim Maloney, (703) 877-2172

Develop water walls targeted toward individual building homes, multiple family builders and OEM-manufactured buildings.

Keywords: Materials Processing

16. Phase-Change Storage/Insulation $ 58K

DOE Contact - Carl Alberg, (312) 972-2513
Hiteck, Inc. (Contract No. DE-FC02-80CS30523)
Charles Bliege, (503) 367-6005

Develop a passive thermal battery module which uses phase change materials and whose module size will be optimized for installation, shipping and handling.

Keywords: Transformations

17. Combined Phase Change Material/Concrete Storage $ 49K

DOE Contact - Carl Alberg, (312) 972-2513
University of Delaware (Contract No. DE-FC02-80CS30586)
Maurice Lang, (302) 738-2000

Develop a cement block of approximate heat capacity of 850 Btu/block. The intended final product is a thermal storage material that is packaged in pouches to fit into the cavities of cement blocks. The overall goal is to increase the heat capacity and thermal conductivity of cement blocks in masonry construction.

Keywords: Cements and Concrete

18. Trombe Wall Damper $ 12K

DOE Contact - Carl Alberg, (312) 972-2513
Sunearth Solar Porducts Co. (Contract No. DE-FC02-80CS30581)
Howard Katz, (215) 256-6648

Develop a passive reverse flow damper for Trombe walls.

Keywords: Materials Processing

19. Energy Sensor $ 15K

DOE Contact - Carl Alberg, (312) 972-2513
Intrel Service Company (Contract No. DE-FC02-80CS30524)
James Kuzdsall, (603) 883-4815

Develop an energy sensor to determine the net energy flow through a solar collector window. The sensor compares the incoming radiant energy with that lost to the outside by convection and conduction at the window surface.

Keyword: Materials Characterization; Controls

20. <u>Passive Valving</u> $ 75K

DOE Contact - Carl Alberg, (312) 972-2513
Sunspool Corporation (Contract No. DE-FC02-80CS30533)
H. T. Whitehouse, (415) 324-2022

Develop a passive valving mechanism to drain solar collectors used in thermosyphon water heating systems.

Keyword: Transformations; Controls

21. <u>Radiactive Cooling</u> $ 89K

DOE Contact - Terry Vaeth, (415) 536-7946
Energy Materials Research Company (Contract No. DE-FC03-80SF11504)
John Brookes, (415) 644-2244

Develop an infrared transparent glazing material capable of withstanding ultraviolet radiation and outdoor weather conditions, while transmitting little or no visible solar radiation. The approach consists of coextruding a thin ultraviolet absorbing layer with an infrared transparent plastic substrate sheet.

Keywords: Elastomers and Polymers

22. <u>Regenerative Evaporative Cooling</u> $ 92K

DOE Contact - Terry Vaeth, (415) 536-7946
Energy Alternatives, Inc. (Contract No. DE-FC03-80SF11507)
Jerry Bradley, (702) 293-3030

Develop a compact, unitary, dual-effect regenerative evaporative cooler to replace vapor compression air conditioning in many regions of the U.S.

Keywords: Transformations

23. Vapor Compression Dehumidifer $ 96K

DOE Contact - Terry Vaeth, (415) 536-2946
Trinity University (Contract No. DE-FC03-80SF11505)
Earl Doderer, (512) 736-7011

Develop a high efficiency vapor compression dehumidifer for latent heat removal. The objective is to maximize condensation while minimizing air cooling, through combination with an integrated air-to-air heat exchanger.

Keywords: Transformations

Photovoltaic Energy Systems

The goal of the photovoltaic program is to develop economically competitive, commercially available photovoltaic power systems that provide safe and reliable energy for a wide range of applications. The program strategy calls for the development of the technology and infrastructure needed to yield technically and economically viable energy systems in both grid-connected and stand-alone applications.

Materials R&D work in the photovoltaics programs lies within two program elements: (1) Advanced Research and Development and (2) Technology Development. The principle thrust of AR&D subprogram is to investigate concepts, materials and structures which will lead to low-cost solar cells. The Technology Development subprograms primarily concern themselves with collector development and balance-of-system (BOS) development (i.e., all parts of PV system other than the collector array).

Due to space limitations, general categories of research, rather than individual projects, are presented below. Further detail on the materials R&D of the photovoltaic program can be found in the Photovoltaic Energy Systems Program Summary (January, 1981, DOE/CS Dist. Category UC-63).

1. Cadmium Sulfide Thin Film $1,291K

DOE Contact - Alan Postlethwaite, (202) 252-1723
Solar Energy Research Institute
Richard Burke - (303) 327-1375

The cadmium sulfide thin-film effort achieved cell efficiency above 10% in FY 1980. It has future goals of demonstrating suitable cell activity for large area encapsulated cells and an 8% conversion efficiency for small-scale arrays by the end of FY 1983. In addition, evaluation of feasibility of low-cost production is planned.

Keywords: Coatings and Films; Photovoltaic Materials and Devices

2. <u>Thin-Film Polycrystalline Silicon Cells</u> $1,941K

DOE Contact - Alan Postlethwaite, (202) 252-1723
Solar Energy Research Institute
Jack Stone - (303) 327-1370

Concerned with obtaining large-grain films with array efficiencies of more than 10%, emphasizing the fabrication of these devices on low-cost substrates. Exploratory development activities have been initiated with a goal of demonstrating technical feasibility in FY 1983.

Keywords: Coating and Films; Photovoltaic Materials and Devices

3. <u>Amorphous Materials</u> $2,156K

DOE Contact - Alan Postlethwaite, (202) 252-1723
Solar Energy Research Institute
Jack Stone - (303) 327-1370

Advanced hydrogenated amorphous silicon is being studied to obtain an understanding of the fundamentals of the defect state passivation process which has led to efficiencies greater than 6% for solar cells with areas over $1cm^2$. Amorphous materials other than amorphous silicon: hydrogen, such as amorphous boron and amorphous silicon: hydrogen: fluorine, are also being investigated.

Keywords: Materials Characterization; Photovoltaic Materials and Devices

4. <u>Emerging Materials</u> $1,090K

DOE Contact - Alan Postlethwaite, (202) 252-1723
Solar Energy Research Institute
Richard Burke - (303) 327-1375

Emerging materials are substances that have long-term potential for use in photovoltaic conversion. They include zinc phosphide, cadmium telluride, zinc silicon arsenide, cadmium sulfide/indium phosphide, copper selenide and tungsten diselenide. The goal of this effort is to demonstrate technical feasibility for at least one emerging material by the mid-1980s.

Keywords: Alternate Materials; Photovoltaic Materials and Devices

5. Advanced Concentrator Concepts $549K

DOE Contact - Alan Postlethwaite, (202) 252-1723
Solar Energy Research Institute
Richard Burke - (303) 327-1375

Study of concepts such as multi-junction concentrator cells, which offer projected efficiencies approaching 30%, and luminescent converters.

Keywords: Materials Characterization; Photovoltaic Materials and Devices

6. Electrochemical Photovoltaic Cell $685K

DOE Contact - Alan Postlethwaite, (202) 252-1723
Solar Energy Research Institute
Richard Burke - (303) 327-1375

Centers on fundamental studies of the semiconductor/electrolyte interface and its uses for low-cost, stable high conversion efficiency devices and for in-site storage. The near-term goals of this effort are to develop a stable cell conversion efficiency of 10% in FY 1982 using amorphous or polycrystalline electrodes.

Keywords: Materials Processing; Photovoltaic Materials and Devices

7. Innovative Concepts $558K

DOE Contact - Alan Postlethwaite, (202) 252-1723
Solar Energy Research Institute
Richard Burke - (303) 327-1375

Issues periodic solicitations to explore the feasibility and fundamentals of new photovoltaic concepts. To date, 26 awards have been made.

Keywords: Alternate Materials; Photovoltaic Materials and Devices

8. <u>Low-Cost Solar Array</u> $12,000K

DOE Contact - Alan Postlethwaite, (202) 252-1724
Jet Propulsion Laboratory
Kris Killiwad - (213) 577-5197

Flat-plate silicon arrays are being developed. The project addresses all steps in the array production process, including production of raw polysilicon, growth of silicon sheets, creation of an individual solar cell, encapsulation and high-volume automated array assembly. Emphasis is placed on improving quality while reducing cost during each phase.

Keywords: Materials Processing; Photovoltaic Materials and Devices

Office of Solar Applications for Industry

Solar Thermal Power Systems

The objective of the Solar Thermal Program is to establish the technical feasibility and cost readiness of mid- and high-temperature solar concentrating collector systems. Research is concentrated upon three classes of systems: (1) linear-focusing distributed receivers (parabolic troughs and hemispherical bowls), (2) point-focusing distributed receivers (parabolic dishes), and (3) central receiver systems. The high-temperature heat from solar thermal systems can be used directly in industrial processes, in turbines to produce electricity, in cogeneration applications and ultimately to produce liquid and gaseous fuels.

1. <u>Graded Cermet Selective Absorbers</u> $107K

DOE Contact - Jim Lefferdo, (303) 231-1388
Telic Corporation (SERI Subcontract No. XH-9-8260-A)
John Thornton - (201) 828-7449

Graded composition platinum/alumina cermets have been demonstrated as high performance selective absorbers. By modifying the graded composition, Telic has produced a cermet of equally high performance at a savings of 70% of the precious metal. Current research is attempting to establish commercial process feasibility.

Keywords: Materials Processing, Alloy Development, Alternate Materials

2. Natural Weathering Exposure $153K

DOE Contact - Jim Lefferdo, (303) 231-1388
DSET (SERI Subcontract No. XJ-9-8215)
Tom Anderson - (602) 465-7356

DSET Laboratories conducts natural weathering exposure on reflectors, glazings, and absorbers. Included are commercially produced materials for baseline data, and laboratory materials which are the result of R&D efforts. Exposure includes 45° south facing racks and EMMAQUA (equatorial mounted mirror augmented, water sprayed) 8X concentrators.

Keywords: Erosion and Wear

3. Kinetic Corrosion Mechanisms $ 25K

DOE Contact - Jim Lefferdo, (303) 231-1388
University of Utah (SERI Subcontract No. XP-0-8046-1)
Charles H. Pitts - (801) 581-5157

Determination of a parametric model describing passivation and corrosion kinetics of a typical austenitic, Type 316 stainless steel, and a typical ferritic, Fe-9 Cr-1 Mo, steel is the primary task of this contract. This model includes the effects of cyclic temperatures and variable electrolyte composition, and will allow prediction of corrosion rates.

Keyword: Corrosion

4. Polymer Metallization $ 80K

DOE Contact - Jim Lefferdo, (303) 231-1388
SRI International (SERI Subcontract No. XP-9-8127-1)
Sharon Brauman - (415) 859-2737

Investigation of interactions between polymers and metallized reflective films. Metallization is by electrolysis deposition. Environmental stress includes increased temperature, humidity and cyclic thermal conditions. Testing includes optical and mechanical examination.

Keywords: Elastomers and Polymers, Materials Characterization, Materials Processing

5. Polymer Protective Laminates $185K

DOE Contact - Jim Lefferdo, (303) 231-1388
Springborn Laboratories (DOE Subcontract No. DE-AC01-79)
Eru Einhorn - (203) 749-8371

Polymers typically are deficient in one or more optical/physical properties. By lamination of polymers, a composite material with higher performance can be prepared. This contract is investigating laminated composites for use as reflectors or transmitters.

Keywords: Elastomers and Polymers; Materials Characterization

6. Protective Polymer Coatings $150K

DOE Contact - Jim Lefferdo, (303) 231-1388
Dow Corning Corp. (SERI Subcontract No. XJ-9-8091-1)
John Thornton - (201) 828-7449

Candidate silicon resins are coated on silvered and aluminized float glass and polymer reflectors. Various primers and adhesion promoting schemes are being investigated. Exposure resistance to UV, sea fog and natural weathering as well as abrasives is to be determined.

Keywords: Elastomers and Polymers; Erosion and Wear

7. Soiling of Reflectors $ 70K

DOE Contact - Jim Lefferdo, (303) 231-1388
Battelle Pacific Northwest Labs (SERI Subcontract No. EY-76-C-06-1830)
Mike Lind - (509) 375-3676

The identification of soiling components and their effect on the optical performance of reflectors are the prime efforts of this contract. This initial phase will determine the extent of the soiling problem and possible means of minimizing it.

Keywords: Erosion and Wear

8. <u>Alternate Mirror Development</u> $ 15K

DOE Contact - Jim Lefferdo, (303) 231-1388
SERI, Battelle Pacific Northwest Labs
Pat Call - (303) 231-1931

Alternate mirror materials may be used to reduce the sensitivity of silver reflectors to environmental stresses. Such metal backings as aluminum, tantalum, titanium, nickel and chromium are being investigated as replacements for copper.

Keywords: Alloy Development, Alternate Materials; Coatings and Films

9. <u>Mirror Environmental Stress Matrix</u> $200K

DOE Contact - Jim Lefferdo, (303) 231-1388
SERI, Battelle Pacific Northwest Labs, Sandia National Labs Livermore, Jet Propulsion Labs, Sandia National Labs Albuquerque
Pat Call - (303) 231-1931

A testing matrix has been devised to compare mirrors developed in various laboratories to those commercially available. Detailed characterization will allow insight into the degradation processes. Cooperative efforts between the National Laboratories allows better utilization of expertise and equipment.

Keywords: Materials Characterization; Erosion and Wear

10. <u>Molten Salt Corrosion</u> $520K

DOE Contact - Jim Lefferdo, (303) 231-1388
Sandia National Labs Livermore
Dan Dawson - FTS 532-2953

Molten nitrate salts are a prime candidate for heat transfer and storage media for central receiver systems. Present research is attempting to qualify Incoloy 800 for this purpose. Slow strain rate, isothermal fatigue, and inducing cyclic thermal strains are among the experimental testing techniques.

Keyword: Corrosion

11. Silver/Glass Mirror Degradation $100K

DOE Contact - Jim Lefferdo, (303) 231-1388
Sandia National Labs Livermore
John Vitko FTS 532-2820

This contract is investigating mechanisms of silver/glass reflector degradation. Identification of the aggressive species and modifying the mirror construction are being pursued in order to minimize reflected energy loss from the element.

Keywords: Erosion and Wear

Office of Solar Power Applications

Ocean Systems

The Ocean Systems Branch is investigating several areas of energy production from the oceans, including ocean thermal energy conversion (OTEC), ocean wave energy conversion, ocean current energy conversion, power from salinity gradients and power from electrodialysis. OTEC is regarded as the most important area in terms of energy output potential.

The materials related R&D in the Ocean Systems program is involved with qualification of metals for heat exchanger use with seawater and ammonia, materials useful in biofouling and corrosion countermeasures, and identification of membranes useful in power generation from salinity gradients and electrodialysis. Further detail is presented below.

1. Biofouling and Corrosion Measurements $329K

DOE Contact - E. H. Kinelski, (202) 376-4801
University of Puerto Rico (Contract Nos. ANL-4716 and ANL-5205)
D. Sasscer - (809) 832-1414, ext. 206

Installing on a landing craft apparatus required to measure changes in heat transfer due to microfouling and to study the biology of fouling and the corrosion of candidate OTEC heat exchanger metals. The craft will be moored off Punta Tuna, Puerto Rico, and biofouling and corrosion measurements will be made.

Keyword: Corrosion

2. <u>Marine Crevice Corrosion of Heat Exchanger Alloys</u> $ 68K

DOE Contact - E. H. Kinelski, (202) 376-4801
International Nickel Company (Contract No. ANL-4974)
T. S. Lee - (919) 256-2271

Generating marine corrosion data from materials that are proposed for use in OTEC exchanger design. The critical parameters to be controlled are corrosion by the working fluid and sea water and the minimization of marine biofouling to ensure maximum heat transfer across the metallic interface. The susceptibility of seven candidate alloys to crevice corrosion and of five candidate materials to corrosion resulting from mechanical abrasion of tube materials will be assessed.

Keyword: Corrosion

DEFENSE PROGRAMS

The Assistant Secretary for Defense Programs directs the Nation's nuclear weapons research, development, testing, production, and surveillance programs. In addition, the Assistant Secretary coordinates a safeguards and security program to provide accountability and physical protection of special nuclear materials, including research and development for improvements, testing, evaluation, and implementation of safeguards systems. Additional responsibilities include management of the inertial fusion development and nuclear materials production programs, classification and declassification of sensitive weapons information, and analysis and coordination of international activities related to nuclear technology and materials.

Materials activities in Defense Programs are concentrated in the Offices of Inertial Fusion, Military Application, and Nuclear Materials Production.

Office of Inertial Fusion

The major goals of Inertial Fusion are to (1) understand and demonstrate the burning of deuterium-tritium fuel in a small pellet when it is compressed and heated using pulsed laser and particle beam sources, (2) demonstrate near-term weapons technology applications, (3) evaluate and select the most promising driver approach for fusion energy applications, and (4) develop a technology base for the fusion energy engineering phase of the program. Materials research performed as part of the Inertial Fusion program consists of (1) work to develop and characterize advanced optical materials for use in high power lasers, (2) work to develop and characterize high quality microspheres of various compositions for use as fusion fuel pellets, (3) analyses of the irradiation effects in structural materials which might be used in commercial inertial confinement fusion powerplants, and (4) work to develop fabrication and quality control techniques for miscellaneous electronic and optical components required for inertial fusion experiments.

The FY 1980 operating budget for the Inertial Fusion program was $112 million. Most of the projects represent portions of larger programs. The materials related components are generally difficult to separate out. For more details, the principal investigators or the Office of Inertial Fusion (Dr. Carl Hilland, telephone 301-353-3687) should be consulted. The majority of the work is performed under the following contract numbers: W-7405-ENG-48--Lawrence Livermore National Laboratory; DE-AC04-76DP00789--Sandia National Laboratories; and W-7405-ENG-36--Los Alamos National Laboratory.

1. <u>Preparation and Characterization of Thin Metal and Polymer Films</u> $ 30K

Sandia National Laboratories
K. W. Bieg, T. D. Hund

Preparation and characterization of free standing, high strength planar seamless cylindrical thin foils. Metals and polymers of various compositions.

Keywords: Coatings and Films

2. Preparation and Characterization of Polymer Coatings for Particle Beam Fusion Targets $ 60K

Sandia National Laboratories
K. W. Bieg, T. D. Hund

Preparation and characterization of polymer coatings and shells by plasma ploymerization and pyrolysis vapor deposition. Chemical characterization and diffusion properties of polymers.

Keywords: Polymers

3. Particle Beam Fusion Target Fabrication $ 40K

Sandia National Laboratories
K. W. Bieg, T. D. Hund

Fabrication and characterization of particle beam fusion targets using polymers, metals, and ceramics.

Keywords: Polymers, Ceramics

4. CO_2 Laser Absorption and Saturation Studies of Molecular Impurities in Alkali Halide Crystals $ 45K

Cornell University
A. J. Sievers

The objective of this study is to determine the static and dynamic IR properties of tetrahedral molecules embedded in alkali halide lattices.

Keywords: Materials Characterization

5. Research and Development of Fluoride Glasses for Laser Fusion $250K

Corning Glass Works
L. J. Clark

Develop BeF glass to be used for ultraviolet laser windows. Objectives are to demonstrate capability to produce large (30 cm) pieces with good optical quality and to minimize two-photon absorption in the near UV.

Keyword: Glasses

6. Development of Fluorides for High Power Laser Optics $200K

Honeywell
E. Bernal

Study hot forging techniques to increase strength and size of various crystalline material for use as optical windows and lenses for ultraviolet laser systems.

Keyword: Glasses

7. Investigation on the Damage Threshold of Films Coated on Various Compositions of Silicate, Fluorophosphate and Phosphate Laser Glasses $150K

Hoya Optics U.S.A., Inc.
T. Izumitani

Study the relationship between coating materials and substrate materials to improve laser damage thresholds at 1 micron.

Keyword: Glasses

8. Development of Glassy-Optical Coating with Gradient Index $ 60K

National Bureau of Standards
W. Haller

Develop method to deposit glass thin film coatings with a continued gradation in index to improve laser damage thresholds.

Keyword: Glasses

9. Development of Ferromagnetic Spinels for Optical Isolation at 10.6 m $ 41K

University of Rochester
K. J. Teegarden

Fabricate high purity, hot-pressed samples of $CdCr_2S_4$ and $CdCr_2Se_4$ to determine intrinsic absorption level for this material at 10.6 μm. These materials are planned to be used as the active elements in Faraday rotators.

Keywords: Ceramics, Glasses

10. High Power Laser and Materials Investigation $100K

Sanders Associates, Inc.
R. Folweiler

Growth of Faraday rotator materials (KTb_3F_{10} and others) up to 100mm diameter by the Czchralski technique.

Keywords: Ceramics, Glasses

11. Role of Photochemical Defect Production in Optical Breakdown of Halides $ 27K

Washington State University
P. Braunlich

Model various mechanisms which lead to breakdown of optical materials when irradiated by high power laser beams.

Keyword: Glasses

12. Irradiation Effects to Materials in Laser Fusion Reactors $ 70K

University of Wisconsin
G. L. Kulcinski, R. W. Conn

Parametric analysis of various particle debris and photon outputs to determine the effects on reactor cavity first wall materials. The effects of gas and other protective schemes on the modification of first wall response is also investigated.

Keyword: Radiation Effects

13. Formation of Low Density-High Atomic Number Metallic Foams $ 65K

Battelle-Pacific Northwest Laboratories (under contract to LANL)
J. W. Patten

Development of low density (less than 20 percent of theoretical), fine pore size (less than 10 micrometers), metal foams by process of trapping large amount of gas in structure during sputter deposition and subsequent heat treatment. These metal foams to be used in future ICF targets.

Keywords: Coatings, Films

14. Formation of High Quality Organic Coatings for ICF Targets $ 55K

Los Alamos National Laboratory
R. Liepins, M . J. Campbell, J. E. Clements

Development of techniques to coat ICF targets with plastic films to thickness variations of plus or minus one percent and surface smoothness to plus or minus 1000 angstroms. Processes based on vapor phase pyrolysis and low pressure plasma coating technology.

Keywords: Coatings, Films

15. Development of Organometallic Coatings for ICF Targets $ 60K

Los Alamos National Laboratory
R. Leipins, M. J. Campbell, J. S. Clements

Processes for deposition of plastic coatings highly loaded with metal are being developed for possible ICF target applications. Metal contents achieved to date are approximately 30 weight percent lead and 10 weight percent iron.

Keywords: Coatings, Films

16. Metallic Coatings Development for ICF Target Applications $275K

Los Alamos National Laboratory
D. S. Catlett, A. T. Lowe, S. M. Butler

Development of metal coating processes for use in fabrication of ICF targets. Processes used are electroplating, electroless plating, CVD, PVD, and sputter deposition. State of the art in these technologies is applied to forming extremely high quality coating of a wide variety of metals in micro-spherical geometry.

Keywords: Coatings, Films

17. Low Density Metallic Structures $ 50K

Los Alamos National Laboratory
J. V. Milewski

Development of low density, highly uniform metallic foam or felt shells for possible use in ICF targets. Sub-micron fiber technology is basic to development effort.

Keywords: Elastomers, Polymers

18. Neodymium Laser Glass $225K

Lawrence Livermore National Laboratory
R. A. Saroyan, S. E. Stokowski, M. J. Weber

Optical spectroscopy of Nd-doped glasses. Measurements of absorption and fluorescence spectra, fluorescence lifetimes, and quantum efficiencies of Nd^{3+} ions in oxide, fluoride, and oxyfluoride glasses. Evaluation of Nd:glasses for use as amplifying media in lasers for inertial confinement fusion experiments.

Keyword: Glasses

19. Laser-Induced Damage in Optical Materials $500K

Lawrence Livermore National Laboratory
T. Deaton, W. H. Lowdermilk, D. Milam, F. Rainer, W. L. Smith

Determination of thresholds for laser-induced damage in transmitting optical materials and thin film coatings used in high-power lasers.

Effects of surface physics and chemistry on damage thresholds. Gradient index materials for antireflection coatings. Measurements at wavelengths from 1.06 to 0.226 μm and pulse durations from 0.1 to 10 ns.

Keywords: Ceramics, Glasses

20. Hard Coatings $400K

Lawrence Livermore National Laboratory
S. Meyer, R. J. Burt, E. Hseih

Coatings of various metals (Au, Pt, Ta, W, Be, etc.) and various inorganic materials (SiO_2, AlN, BN, etc.) are deposited by evaporation, sputtering, and secondary ion deposition on shells for use as laser fusion targets. Material geometry and physical properties must be controlled to produce layers which are uniform both in bulk and thickness. Surface roughness must be in the 100-300 A range.

Keyword: Coatings

21. Electrodeposition $175K

Lawrence Livermore National Laboratory
J. Illige, C. W. Hatcher, W. Johnson

Techniques are developed to deposit high quality coatings of electrodepositable materials on hollow shells and flat substrates (discs) for use as laser targets. Surface quality and material and thickness uniformity are critical parameters. Layer thicknesses to a hundred micrometers are required.

Keyword: Coatings

22. Lead Glass Spherical Shells $200K

Lawrence Livermore National Laboratory
J. Koo

Development of spherical, hollow, target quality shells of lead glass. The composition is primarily a silicate glass with lead oxide concentration from a few percent to seventy-five percent (by weight). The quality is sufficiently high so that the shells can be used as laser fusion targets. In weight, percents of lead oxide below 50 percent, the shells can be readily filled with DT gas.

Keywords: Ceramics, Glasses, Coatings

23. Polymeric Coatings $500K

Lawrence Livermore National Laboratory
W. Johnson, J. Illige, J. Crane, D. Myers, S. Letts

By using various plasma polymerization techniques, coatings of polymerized fluorocarbons and hydrocarbons are deposited on shells of various materials (e.g., glass, metal) to be used as laser fusion targets. Coating thicknesses may be varied from a few hundred Angstroms to more than one-hundred micrometers. The coating quality is exceptionally good: thickness uniformity is better than 1 percent and surface roughness is less than 300 A.

Keywords: Coatings, Films, Elastomers, Polymers

24. Molecular Beam Levitator - Coater $150K

Lawrence Livermore National Laboratory
J. Crane, W. Johnson

Development of techniques by which spheres can be levitated and coatings applied in the absence or contact with surfaces which may give rise to imperfections in the coatings. The levitation beams are not generally the coating materials. Thus, integration of materials deposition techniques with levitator techniques must be accomplished. Surface finish, layer uniformity, and achievable thickness are critical parameters.

Keywords: Coatings, Films

25. Cryogenic ICF Fuel and Target Development $375K

Lawrence Livermore National Laboratory and University of Illinois
T. Bernat, LLNL; K. Kim, University of Illinois

Cryogenic fuels (DT CD_2T_2, etc.) required for inertial confinement targets pose problems in filling of targets, materials compatibility at cryogenic temperatures (as low as 40K), and materials handling at cryogenic temperatures. In particular, adhesives and polymers which do not fracture spontaneously at such low temperatures are required. Properties of other target materials are also to be determined.

Keywords: Elastomers, Polymers

26. Glass Shells Development $400K

Lawrence Livermore National Laboratory
R. Woerner, V. Draper

Development of glass composition and techniques by which ultra-high quality glass shells may be produced for use as inertial confinement targets. Composition compatible with droplet generator and power techniques are necessary. Shell thicknesses should be uniform to better than 1 percent, sphericity to better than 1 percent surface roughness less than 100 A. Yields are important in the processes and should approach 100 percent as closely as possible. Yields of target quality spheres of 98 percent have been achieved.

Keywords: Ceramics, Glasses

27. Ion Beam Coating Techniques $ 75K

University of Arizona (Tucson)
M. B. Denton

Development of techniques for production of ion beams suitable for high-rate deposition of coatings on target spheres. A wide variety of materials must be available in beam form to provide the required layers on the targets.

Keywords: Coatings, Films

28. Materials and Surface Analysis $350K

Lawrence Livermore National Laboratory
M. Ward

Development techniques, methods, and instrumentation for characterization of the material and surface properties of various ICF target materials. The important parameters include surface composition and geometry, material uniformity and bulk composition. Nonstandard techniques are required because of sample size (50 micrometers in many cases) and the parameter quality required.

Keyword: Materials Characterization

29. Polymer Development for Molding of Hemishells $200K

Lawrence Livermore National Laboratory
L. Lorensen, C. W. Hatcher

Molding of polymers into hemishells which can be assembled into spherical ICF targets requires development of polymers with unusual properties. Shells of a few hundred micrometers diameter and a few tens of micrometers thick are necessary. To achieve uniformity of surfaces and material properties, careful control of polymerization properties, surface characteristics, and stability is necessary.

Keyword: Polymers

30. Microradiography $150K

Lawrence Livermore National Laboratory
R. Singleton, B. Weinstein, J. T. Weir

The requirements for multilayer spherical ICF targets with various material layers necessitates characterization and measurements of opaque structures. To measure thickness and uniformity of the various layers and material properties we are developing microradiographic techniques with very high resolution.

Keywords: Materials Characterization

31. DT Fill of Laser Fusion Targets $225K

Lawrence Livermore National Laboratory
L. D. Christensen, J. T. Weir, I. Moen, B. Weinstein

Development of techniques by which laser fusion targets can be filled with DT fuel. Permeation rates of D_2, T_2, and DT through various glass target spheres are determined as functions of temperature, ultimate pressure, and glass composition.

Keywords: Ceramics, Glasses, Materials Characterization

Office of Military Application

The Office of Military Application, under the Assistant Secretary of Defense Programs, directs the research and development, testing, and production of nuclear weapons. Weapon research and development is conducted primarily at the Department of Energy's three nuclear weapon laboratories: Lawrence Livermore National Laboratory (LLNL), Livermore, California; Los Alamos National Scientific Labortory (LANSL), Los Alamos, New Mexico; and Sandia National Laboratories at Albuquerque, New Mexico (SNLA) and Livermore, California (SNLL). Weapons production is conducted at seven government-owned, contractor-operated plants.

The objectives of the materials research sponsored by the program are to develop materials and materials technology for national security uses. The research is directed toward basic material science, the understanding and development of advanced materials and fabrication technology, and the development of materials and processes required to produce nuclear and nonnuclear parts.

Materials and process development activities emphasize the balance between research and development necessary to provide materials compatible with the extreme environments and performance requirements associated with nuclear ordnance. Detailed knowledge of materials and their behavior often provides the only way to eliminate problems associated with their use and achieves the objectives of functionability, reliability, and longevity. The ability to investigate, characterize, recognize, and develop materials has enabled the weapons program to meet development scheduled for warheads that have remained in the Nation's stockpile with minimum maintenance, maximum safety, and high reliability.

The materials used in nuclear explosives are chosen not only on the usual engineering criteria such as strength, fabricability and cost, but also because of their atomic, nuclear, and bulk hydrodynamic properties. The whole range of materials is spanned, from metals and alloys, through ceramics, salts, plastics, fiber composites, and explosives. Developing, handling, and analyzing these materials has required the building of one of the broadest and most versatile materials science capabilities in the world. The fabrication capability provides state-of-the-art effort for the designer, fabrication of prototype hardware for development programs that are not economically feasible to obtain from production sources, and allows for fabrication of experimental apparatus for research investigation that is not commercially available. Process development includes manufacturing research and development work to improve existing processes for efficiency and safety.

Management of activities within the weapons program is highly decentralized. Responsibility for detailed direction is consistently placed at the lowest level possible. Headquarters activity is primarily one of monitoring field progress and of adjusting field activity based on programmatic requirements. The laboratories are responsible for technical leadership, and the field offices are responsible for production scheduling and coordination, testing coordination and safety, and contract administration. The current decentralization is a continuation of the policy of the past. This approach minimizes staffing requirements at upper levels and puts technical direction in the hands of those responsible for the work.

Requirements for weapon development and production come to DOE from DOD. Formulation of requirements is an iterative process involving continuous interaction between DOD and DOE, the one to present force needs and the other to propose warheads and bomb candidates and estimate the time and cost for their development and production.

The Office of Military Application (MA) translates development requests from DOD and the stockpile quantities approved by the President into an integrated development, testing, and production program. MA issues development guidance directly to the weapons laboratories, guidance on testing to the Nevada Operations Office and the laboratories, and production directives to the Albuquerque Operations Office.

The total MA materials program is estimated at $64.7M in FY 1980 which includes both classified and unclassified research projects.

1. <u>Dynamic Compaction of AlN</u> $200K

DOE Contact - F. W. Hughes (301)353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-eng-48)
- William H. Gourdin (415)422-8093; FTS 532-8093

Investigating methods of producing ceramic objects by explosive compaction of aluminum nitride powders as an alternative to fabrication by conventional sintering. The HE compacted samples are characterized by TEM and SEM. Also using 2-d hydrocode to model HE compaction of powders.

Keywords: Ceramics; Alternate Materials, Materials Processing

2. <u>EB Welding Vanadium</u> $ 25K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-eng-48)
Glenn L. Mara, Donald E. Hoffman (451)422-7067; FTS 532-7067

Short study to determine proper parameters for electron beam welding commercial purity vanadium with reproducible 70 percent penetration.

Keywords: Joining Methods

3. <u>Liquid Pu Corrosion of Refractories</u> $150K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-eng-48)
Robert L. Rose (415)422-9604; FTS 532-9604

A study of the relative corrosion resistance of W, Ta, Nb, V, Mo, and Ti to attack by molten plutonium in the temperature range of 800-1200°C.

Keywords: Corrosion; Materials Characterization

4. <u>Superplasticity of Δ- Pu</u> $200K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-eng-48)
Donald R. Lesuer, William L. Thayer (415)422-9633; FTS 532-9633

This study showed that a delta-Pu 1 wt% Ga alloy exhibited very high ductility under very low flow stresses. These two features represent the principal characteristics of superplasticity and enable polymer processing techniques to be used on metals.

Keywords: Alloy Development; Materials Processing

5. Surface Self-Diffusion $150K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-eng-48)
Daniel M. Makowecki (415)422-8007; FTS 532-8007

A study to investigate the surface self-diffusion on Ge and Si using a laser diffraction technique. It is hoped this study will help elucidate mechanisms of sintering in covalent solids.

Keywords: Materials Characterization

6. Hydrogen Compatibility of Stainless Steel $ 50K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-eng-48)
Philip R. Landon (451)422-7063; FTS 532-7063

An investigation of the influence of yield strength on the fracture mode of stainless steel tubing exposed to high pressure hydrogen, with emphasis on two warm worked high strength stainless steels: 21 CR-6 Ni-9 Mn and Type 316.

Keywords: Hydrogen Effects

7. Structure-Property Relations of Polymers and Composites $250K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-eng-48)
Richard M. Christensen, Roger J. Morgan (415)422-7136; FTS 532-7136

A study to be able to predict durabilities of Kevlar-epoxy and graphite-epoxy composites from a basic understanding of the structure, failure process, and mechanical property relations of the Kelvar fibers and epoxy glasses.

Keywords: Polymers; Materials Processing, Alternate Materials

8. Adhesives Development $ 98K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Lamination-bonding of Kapton/Aluminum to stainless steel grids for electron beam windows. Electron gun accelerator columns in laser amplifiers consisting of alternating aluminum and cast epoxy rings.

Keyword: Adhesives

9. <u>Polymers and Adhesives</u> $350K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
W. A. May, Jr. (505)667-6362; FTS 843-6362

Evaluation and testing of commercial materials for weapons programs. Development of plastic-bonded composites, polyurethane adhesives and silicones.

Keywords: Adhesives, Polymers

10. <u>Plutonium Alloy Development</u> $800K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. R. Harbur (505)667-2556; FTS 843-2556

Development of new alloys of plutonium for weapons applications; includes casting, mechanical working, and stability studies. Measurements of resistivity, thermal expansion, and differential thermal analysis are made to assess fabrication processing and stability.

Keywords: Alloy Development, Plutonium, Phase Stability

11. <u>Mechanical Properties and Alloy Development</u> $200K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
S. S. Hecker (505)667-4563; FTS 843-4563

Thermomechanical processing of plutonium alloys to optimize mechanical properties. Study of complex microstructures, grain refinement, and deformation - induced transformations.

Keywords: Alloy Development, Mechanical Properties, Plutonium

12. Amorphous Actinides $90K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505)667-4665; FTS 843-4563

Intermetallic compounds like U_6Fe and Pu_5Ga_3 have been produced in the amorphous state by fission fragment bombardment from neutron irradiation. Physical properties have been measured using differential scanning calorimetry.

Keywords: Alternate Materials, Amorphous, Irradiation

13. Superhard Materials $56K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Boron carbide in tungsten-nickel-iron alloys for improved hardness and wear. Investigation of stoichiometry, size, size distribution, and purity of boron carbide. Hot pressing and use of binders such as lithium tetraborate or lithium flouride is being examined.

Keywords: Alternate Materials, Boron Carbide, Hot Pressing

14. Surface Studies $400K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
W. P. Ellis (505)667-4043; FTS 843-4043

Studies of surface structures, gas-solid reactions and catalysis. Surface analytical tools used to characterize surface structure, detect and identify impurities, and obtain information about valence band electrons.

Keywords: Catalysts, Surface Science, Gas-Solid Reactions

15. Gas-Solid Reactions in Actinides $ 90K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505)667-4665; FTS 843-4665

Reaction chemistry of actinide metal and alloy surfaces, attack by hydrogen, nature of catalytic processes.

Keywords: Catalysts, Actinides

16. Bulk Glass Fabrication Technology $150K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Casting and hot forming into hemispheres, disks, plates, sheets, and rods. Composition is controlled to yield good strength, hardness, nuclear requirements, or chemical durability.

Keywords: Glass, Hot Forming

17. Slip Casting of Ceramics $100K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Slip casting of many ceramics including alumina and magnesia. Technology uses colloidal chemistry and powder characterization theory along with materials engineering.

Keywords: Ceramics, Slip Casting, Alumina

18. Ceramics Technology $150K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Castable ceramics for molds, crucibles, liners,and electrical insulators. Moldable ceramics of alumina with silica and plastic binder. Ceramic heat pipes. Design and properties of brittle materials.

Keywords: Ceramics, Castable Ceramics, Heat Pipes, Brittle Materials

19. <u>Glass and Ceramic Sealing Technology</u> $ 90K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Ceramic-to-ceramic and ceramic-to-metal seals. Custom alumina combustion tubes, plug closures for alumina and silicon carbide heat pipes, high-voltage feed-throughs, beryllia klystron window.

Keywords: Glass, Ceramics, Seals

20. <u>Plasma-Flame Spraying Technology</u> $ 75K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Metallic and/or ceramic coatings or free-standing shapes. Coatings for radiation hardening, radiochemical detectors, temperature resistance, oxidation and corrosion resistance, light absorbence, and electrical conductance. Microstructure, uniformity, and density of coatings.

Keywords: Coatings, Metals, Ceramics, Plasma-Flame Spraying

21. <u>Physical Vapor Deposition and Surface Analysis</u> $150K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Physical vapor deposition and sputtering to produce materials for structural applications. Doped <u>in situ</u> laminates of aluminum and Al_xO_y and composites of Ta + TaC_x for high strength and smooth surface finish.

Keywords: Coatings, Physical Vapor Deposition, Sputtering, Aluminum, Tantalum

22. Target Coatings $150K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Single and multi-layer metallic coatings, smooth and uniform in thickness. Substrates are hollow or solid small spheres of metal glass, or plastic. Electrolytic and autocatalytic processes being investigated.

Keywords: Coatings, Thin Films

23. Chemical Vapor Deposition Coatings $188K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Low-temperature coatings on hollow, spherical substrates. Low pressure conditions for deposition in fluidized bed. Coatings of tungsten, molybdenum, rhenium, nickel, and Mo_2C.

Keywords: Coatings, Chemical Vapor Deposition, Fluidized Bed

24. Radiochemistry Detector Coatings $150K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Physical vapor deposition of coating for radiochemical detectors. Metallic and non-metallic coatings.

Keywords: Coatings, Radiochemical Detectors, Physical Vapor Deposition

25. Parylene Coating Development $ 75K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Vacuum vaporization of p-xylelene dimer and thermal pyrolysis with *in situ* polymerization on a substrate. Coating produces good physical and chemical resistance and forms strong vapor barrier.

Keywords: Coatings, Parylene, Polymers

26. Structural Polymer Castings $150K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Large complex castings of polymers for a variety of structural applications. Require electrical and structural properties. Polyurethanes with additives for special mechanical and physical properties.

Keywords: Polymers, Polyurethane, Castings

27. Mechanical Properties of Uranium $125K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
S. S. Hecker (505)667-4563; FTS 843-4563

Mechanical properties of U-6%Nb at high strain rates. Hydrogen at ppm levels causes drastic reduction in biaxial ductility with very little effect on uniaxial ductility.

Keywords: Hydrogen, Mechanical Properties, Uranium, Biaxial, Uniaxial, Ductility.

28. Joining Process Development $ 75K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. J. Sandstrom (505)667-4365; FTS 843-4365

Microcomputer technology for process control. Multiaxes programmable control for high-voltage electron beam welder. Fusion welding process include lasers, electron beam, and gas tungsten arc.

Keywords: Joining, Welding, Electron Beam, Lasers, Microcomputers

29. Materials Characterization Studies $100K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. J. Bard (505)667-4691; FTS 843-4691

Optical metallography, scanning electron microscopy, transmission electron microscopy, x-ray diffraction of metals, alloys, ceramics, graphites, and polymers.

Keywords: Materials Charcterization, Electron Microscopy, X-Rays, Metallography

30. Non-destructive Evaluation $500K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. Janney (505)667-7172; FTS 843-7172

Betatron radiography, nuclear fluorescence, acoustic emission and scattering, tomographic techniques for non-destructive evaulation. Image enhancement techniques for better resolution and definition.

Keywords: Non-destructive Evaluation, Radiography, Acoustic Emission

31. Low Temperature Electronic Properties $110K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505)667-4665; FTS 843-4665

Understand electronic properties of materials through their superconducting and magnetic behaviors. Emphasis on actinide elements and their alloys.

Keywords: Superconductivity, Magnetism, Actinides, Electronic Properties

32. Superconducting and Magnetic Materials $ 45K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
T. C. Wallace (505)667-6074; FTS 843-6074

New superconducting materials, high transition temperatures and critical fields, itinerant magnetic materials.

Keywords: Superconductivity, Magnetism

33. Phase Transformations in Pu and Pu Alloys $225K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
S. S. Hecker (505)667-4563; FTS 843-4563

Mechanisms, crystallography, and kinetics of transformations in Pu and alloys. Studies use pressure and temperature dilatometry, optical metallography, and x-ray diffraction.

Keywords: Transformations, Plutonium

34. X-ray Diffraction of Actinides at High Pressure $200K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505)667-4665; FTS 843-4665

X-ray diffraction of plutonium and americium using a diamond anvil cell. Compressibility and transformations in plutonium, alloys, and americium.

Keywords: Transformations, Actinides, X-rays, Diamond Anvil Cell

35. Neutron Diffraction of Pu and Pu Alloys $ 25K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505)667-4665; FTS 843-4665

Neutron diffraction on plutonium and its alloys at the WNR pulsed neutron source. Time-of-flight technique used to do diffraction at elevated temperatures and pressures.

Keywords: Transformations, Plutonium, Neutron Diffraction

36. Coatings and Films $250K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
D. M. Mattox (505)884-7777, D. J. Sharp (505)844-8604,
H. O. Pierson (505)844-6833, E. Randich (505)844-7554,
A. W. Mullendore (505)844-5353, J. K. G. Panitz (505)844-8604

Engineering applications, deposition technology development and basic scientific studies are being pursued in the areas of sputter deposition, ion plating, vacuum deposition, chemical vapor deposition and plasma spraying. Coatings as hydrogen barriers, electrical contacts, insulators, bonding agents, corrosion inhibitions, wear surfaces, and monolytic structures are being developed and studied. Emphasis is on materials preparation and characterization.

Keywords: Coatings and Films, Materials Development, Materials Characterization, Materials Application

37. Erosion and Wear in Mechanical Components $100K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
E. Randich (505)844-7554, R. E. Cuthrell (505)844-7195,
L. E. Pope (505)844-5041, F. G. Yost (505)844-8358

The mechanisms of erosion and wear in mechanical and electromechanical components are being studied. Techniques and materials for reducing erosion and wear are being evaluated. Techniques include coatings, ion implantation, lubrication, and material selection. Studies of chemical and contamination effects on surface deformation and fracture are assisting in defining the mechanisms of erosion and wear.

Keywords: Erosion and Wear, Surface Deformation, Surface Fracture

38. Cleaning Procedures and Residual Contamination $200K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
N. E. Brown (505)844-2747, S. L. Erickson (505)844-2631,
L. K. Jones (505)844-5066

The efficiencies of various types of cleaning procedures are being determined by measuring residual contaminations following use of the procedures. The procedures include detergent cleaning, solvent cleaning, ultrasonic cleaning and vapor degreasing. New methods for the analysis of residual contamination are being developed.

Keywords: Materials Processing, Contamination, Cleaning, Detergent, Solvent, Ultrasonic, Vapor Degreasing

39. Physical and Chemical Aging Mechanisms in Polymers $250K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
J. G. Curro (505)844-3963, R. R. Lagasse (505)844-3305,
K. T. Gillen (505)844-7494, R. L. Clough (505)844-3408

The mechanisms of physical and chemical aging in polymers are being studied to provide a basis for predicting long-term reliability of weapons. The relationship between structure and properties of rubber modified epoxies are being studied to develop process controls. Rubber modified epoxies are used extensively as a tough encapsulant in weapons.

Keywords: Elastomers and Polymers, Encapsulants, Aging, Process Controls, Epoxies, Reliability

40. High Strength Uranium Alloys $ 50K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
K. H. Eckelmeyer (505)844-7775, A. D. Romig (505)844-8940,
R. J. Salzbrenner (505)844-5041, F. G. Yost (505)844-8358

Thermal mechanical treatments are being investigated to provide high strength uranium alloys with good ductility and corrosion resistance. Candidate alloys are U-3/4%Ti, U-2%Mo. Dual-phase steels are being developed with good combinations of corrosion resistance and strength. These alloys are intended to replace, in some applications, moderate strength alloy steels which contain a strategic element, cobalt. Heat treatments which limit stress relaxation of metallic glasses are being pursued in a program directed at using amorphous alloys as high performance springs.

Keywords: Alloy Development, Uranium, Corrosion, Strengthening Mechanisms, Dual-Phase Steels, Metallic Glasses

41. Welding Processes $200K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
J. L. Jellison (505)844-6397, F. J. Zanner (505)844-7073

The pulsed laser and pulsed tungsten inert gas arc processes are being studied for the production of miniature fusion welds for component envelope closure. Weld processes are tailored to provide joints with optimal mechanical properties. Solid phase bonding is being developed for production of joints between dissimilar metals and where fusion welding is unpractical.

Keywords: Joining Methods, Solid Phase Welding, Pulsed Laser Welding, Pulsed Tungsten Inert Gas Welding, Dissimilar Metal Joints, Miniature Welds

42. Improved Methods of Materials Characterization $1500K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
R. E. Whan (505)844-8904, K. E. Eckelmeyer (505)944-7775,
J. A. Borders (505)844-8855

New and improved methods of materials characterization are being developed and implemented. Automated data acquisition and instrument control are being added to existing instrumentation in order to give higher accuracy and reliability and to improve productivity by out-of-hours data acquisition and processing. New facilities include a high resolution transmission electron microscope, scanning Auger microprobe, Fourier transform infrared spectrometer and a laser Raman microprobe. Improved capabilities include automated electron microprobe, x-ray diffraction and emission spectroscopy equipment and development of topographical and compositional electron back-scattering for fracture surface analysis in the scanning electron microscope.

Keywords: Materials Characterization, Analysis, Data Acquisition Electron Microscope, Auger Microprobe, Laser Raman Microprobe, X-Ray Diffraction

43. Ceramics and Glasses $1200K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
R. J. Eagan (505)844-4069, C. J. Brinker (505)844-1322,
J. J. Mecholsky (505)844-0787, J. A. Wilder (505)844-1332

A family of glass ceramics is being developed to match the expansion coefficients of most materials of technical interest. Processing schedules provide hermetic seals to metal. Fracture analyses and structural studies point toward tougher materials for severe environments. The sol-gel processing promises unique applications of glass as a coating in critical electrical components.

Keywords: Ceramics, Glass, Glass Ceramics, Seals, Sol-Gel

44. Uranium Corrosion $250K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
L. J. Weirick (505)844-8940, B. C. Bunker (505)844-1016

The mechanism of uranium corrosion in moist air is being investigated using weight loss measurements and mass spectroscopy. Pyrotechnic compatibility with actuator materials is being assessed using mechanical testing of aged materials. Chemical and electrochemical and surface techniques are used to evaluate and understand corrosion of glasses used in sealing applications to aluminum and battery contact pins. Variables such as glass composition, pH and solution chemistry are under study.

Keywords: Corrosion, Uranium, Actuators, Glass Corrosion

45. Organic Adhesives $200K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
L. A. Harrah (505)844-6847, J. A. Kelber (505)844-3408,
L. E. Pope (505)844-5041

Model polymers are being studied to determine the actual bonding between organic adhesive and metal substrate through the use of detailed analysis of Auger line shapes. Factorial experiments are designed to evaluate the relative importance of several parameters influencing moving friction such as contact force, material hardness, temperature, environment, etc.

Keywords: Adhesives, Bonding, Auger Line Shapes, Friction, Wear

46. E-Beam Fusion Target Characterization $ 30K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
J. W. Guthrie (505)844-5334

Characterization of various metallic/nonmetallic E-beam fusion targets by use of microradiography. Low kV radiographic system developed to operate in vacuum to permit radiography of microspheres with subsequent high magnification and image enhancement.

Keywords: Nondestructive Evaluation (NDE), Materials Processing and Characterization, E-beam Fusion Targets

47. Real-Time Radiography Development $ 60K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
F. A. Hasenkamp (505)844-5334

Real-time video recordings of radiography of various weapons materials/environmental tests are required. A fluoroscopic intensifier system was assembled for use with 10 MeV linear accelerator or 300 to 700 curie cobalt-60 radioisotope. Used on two weapon system burn tests, two thermite/powered metal mixing tests and several molten salts viscosity measurements.

Keywords: Nondestructive Evaluation (NDE), Materials Processing and Characterization, Weapons Environmental Test Diagnostics

48. Ultrasonic Phased Array Test System $100K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Albuquerque
(Contract No. DE-AC04-76DP00789)
J. H. Gieske (505)844-6346

Development of digital scanning and focusing of ultrasonic wave to enhance testing. Development of acoustic imaging to better define size and shape of flaws.

Keywords: Nondestructive Evaluation (NDE), Materials Characterization

49. Hydrogen Compatibility of Materials $1200K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Livermore
(Contract No. DE-AC04-76DP00789)
David M. Schuster (415)422-2166; FTS 532-2166

This is an interdisciplinary study to: (1) identify and understand the mechanisms of hydrogen embrittlement; (2) characterize the hydrogen compatibility of several austenitic stainless steels; (3) develop and identify new alloys and techniques for hydrogen compatible service; and (4) develop the fabrication technology to produce structures for hydrogen service.

Keywords: Hydrogen Effects on Materials, Hydrogen Embrittlement, Alloy Development

50. Electrochemical Fabrication $150K

DOE Contact - F. W. Hughes (301) 353-5494; FTS 233-5494
Sandia National Laboratories - Livermore
(Contract No. DE-AC04-76DP00789)
David M. Schuster (415)422-2166; FTS 532-2166

Electrodeposition from aqueous solutions of Au, Cu, and Ni is being studied with a focus on the relationship between critical process variables and the mechanical and physical properties of the deposit.

Keywords: Coatings and Films, Materials Procesing, Electrodeposition, Gold, Copper, Nickel

Office of Nuclear Materials Production

The major objectives of the nuclear materials production program are three-fold:

1. to provide nuclear materials for national defense requirements, DOE reactor research and development programs, and the needs of other government agencies and industry;

2. to receive, store, and process fuels from production reactors and from research reactors for the recovery of uranium, plutonium, tritium, and other reactor product materials;

3 to develop improved methods for nuclear materials production, including advanced technology in support of operations.

The principal sites of nuclear materials production activities are the Savannah River plant at Aiken, South Carolina; the Hanford Facilities at Richland, Washington; and the Idaho Operations, Idaho Falls, Idaho. Production reactors are operating at Hanford and Savannah River. Chemical processing facilities are operated at Savannah River and Idaho Falls.

Additional materials processing facilities at Hanford which have previously operated are now in standby. Engineering studies and operational and environmental analyses are being conducted to explore the option of subsequently reactivating these facilities.

Total funding for the nuclear materials production program in FY 1981 is $665 million. Approximately $30 million of this funding is devoted to the assessment and testing of materials used in the processing of the products described above. All of the details are classified information.

ENERGY RESEARCH

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

Five multiprogram and six single-purpose laboratories are administratively assigned to the Office of Energy Research. The single-purpose or specialized laboratories are the Bates Linear Accelerator Facility at the Massachusetts Institute of Technology, the Fermi National Accelerator Laboratory, the Notre Dame Radiation Laboratory, the Princeton University Plasma Physics Laboratory, the Michigan State University Plant Research Laboratory and the Stanford Linear Accelerator Center. The multiprogram laboratories conduct significant research activities for other DOE programs (e.g., Environment) and other Federal agencies, while the six specialized laboratories are funded almost totally by the Office of Energy Research.

Office of Advanced Technology Projects

The Advanced Technology Projects Office reports directly to the Director of the Office of Energy Research. The objective of the Advanced Technology Projects program is to initiate novel and innovative projects which are either not completely within the purview of one of the DOE mission-oriented programs or have too high a risk factor for DOE mission-oriented programs to consider. After a few years' development, if successful, projects are turned over the DOE engineering development programs. Research is conducted in industry, both large and small, in universities, and in DOE laboratories. Some projects are co-funded with other DOE divisions, where appropriate, some projects are co-funded with other government agencies, while still other projects are cost-shared with industry.

The ATP materials project funded for FY 80 follows.

1. Technology Development of Long Ordered Alloys (LRO) $150K

DOE Contact - Ernest F. Blase, (202) 252-2725, FTS 252-2725
Oak Ridge National Laboratory
A. C. Schaffhauser, C. F. Liu, H. Inouye - (615) 483-4826, FTS 624-4826

Improve properties of Fe and Co-based LRO alloys by varying alloy composition. Extend the high-temperature mechanical property data base including tensile, creep, fatigue, and impact properties and study deformation mechanisms by electron microscope. Determine the corrosion behavior of selected alloys in neutral, carburizing, oxidizing, and sulfidizing environments.

Keywords: Alloy Development, Materials Characterization, Corrosion

Office of Basic Energy Sciences

Materials Sciences Division

The Materials Sciences Division reports to the Director of the Office of Energy Research through the Associate Director for Basic Energy Sciences. The objective of the Materials Sciences program is to conduct fundamental research aimed at increasing the understanding of materials and materials related phenomena of interest to the Department of Energy. Reserach is conducted primarily at DOE laboratories, universities and to a lesser extent in industry.

This program is basic or long range in nature and is intended to provide the necessary base of materials knowledge ultimately needed to advance our energy technologies. Emphasis is placed on areas where problems are known to exist or are anticipated and on generic areas of fundamental importance. Another aspect of the program is the development and utilization of unique facilities used not only by DOE contractors but also by other laboratory,university and industry scientists. Among these facilities are several which will begin operation in mid-FY 1981, the Intense Pulsed Neutron Source-I (IPNS-I) at Argonne, the National Synchrotron Light Source (NSLS) at Brookhaven and the nation's highest voltage electron microscope (1.5 MeV) at Lawrence Berkeley Laboratory. These facilities and others are set up as user-type facilities where qualified scientists from outside the Materials Sciences program at that laboratory can take advantage of equipment and expertise developed.

Some of the research is directed at a single energy technology (e.g., photovoltaic materials for direct conversion of solar energy into electricity), whereas other research is applicable to many technologies simultaneously (e.g., the embrittlement of structural materials due to the presence of hydrogen) and still other has more fundamental implications underpinning all materials research (e.g., mechanisms of atomic transport in solids).

At the DOE laboratories, technology and information transfer takes place between the basic and applied programs co-sited there. The Materials Sciences subprogram also supports research at universities and to a lesser extent industrial laboratories, taking advantage of the unique expertise of researchers at each of the different types of institutions. Coordination of DOE's applied materials development efforts with the Materials Sciences program takes place primarily through the DOE Energy Materials Coordinating Committee (EMaCC), but also through Materials Sciences Research Assistance Task Forces and less formal contacts among staff members. The program utilizes workshops and reports of its Council on Materials Science (a non-governmental body with representatives from academia, industry and DOE laboratories) to help focus on critical issues.

For example, in FY 1981, the Council reviewed research needs and opportunities in the areas of amorphous materials and nondestructive evaluation; in FY 1980, corrosion and novel materials were examined. A relatively large portion of program funds (called contact research) is set aside to support unsolicited proposals.

The following program description is separated into three major categories which represent the separation by major disciplines involved and the adminstrative units in the program: A) Metallurgy and Ceramics, B) Solid State Physics and C) Materials Chemistry.

Further information can be obtained by contacting Dr. D. K. Stevens, Director, Division of Materials Sciences (301-353-3427), Dr. M. C. Wittels, Branch Chief, Solid State Physics and Materials Chemistry or Dr. L. C. Ianniello, Branch Chief, Metallurgy and Ceramics. A more complete description of the 392 projects is given in an annual publication of the Materials Sciences Division - the most recent is Materials Sciences Programs, FY 1980, DOE/ER-0064. The FY 1980 operating budget of the Materials Sciences Division was $78.0 million.

TABLE I - Funding by Contractor

	Total Program (%)
Ames Laboratory	7.8
Argonne National Laboratory	21.6
Brookhaven National Laboratory	10.8
Idaho National Engineering Laboratory	0.6
Illinois, University of (Materials Research Laboratory)	2.8
Lawrence Berkeley Laboratory	7.0
Lawrence Livermore Laboratory	1.5
Los Alamos Scientific Laboratory	2.6
Mound Laboratory	0.3
Oak Ridge National Laboratory	20.7
Pacific Northwest Laboratory	2.2
Sandia Laboratory	2.5
Solar Energy Research Institute	0.3
Contract Research	19.3
	100.0

TABLE II - Funding by Selected Areas of Research

	Number of Projects (Total=392) (%)	Total Program $ (%)
(a) Materials		
Polymers	5.6	1.8
Ceramics	31.4	17.2
Semiconductors	12.5	7.9
Hydrides	8.9	5.2
Ferrous Metals	18.1	10.9
(b) Technique		
Neutron Scattering	8.7	16.5
Theory	18.6	9.0
(c) Phenomena		
Catalysis	8.4	4.9
Corrosion	9.4	13.1
Diffusion	16.1	6.6
Superconductivity	11.2	7.4
Strength	21.7	9.9
(d) Environment		
Radiation	14.0	12.5
Sulphur-Containing	5.9	3.0

TABLE III - Funding by Economic Sector

	Percent
Universities (Including those DOE university laboratories where graduate students are involved in a large extent, e.g., LBL and AMES	36.1
DOE Laboratories	63.3
Industry and Other	0.6
	100.0

TABLE IV - Funding by Technology (Estimates Only)

Technology Area	Percent
Conservation and Storage	8.0
Fossil Energy	9.2
Solar Energy	6.8
Geothermal Energy	1.7
Fission	7.2
Fusion	8.3
Environmental and Safety	1.1
Multitechnology	30.7
Long-Term Science	27.0
	100.0

A. Metallurgy and Ceramics

The objective of research conducted under the metallurgy and ceramics category is primarily to better understand how metallic and ceramic materials behavior/properties are related and controlled by structure and processing conditions. By processing is meant the methods and techniques used to prepare, form or fabricate materials. Important properties of materials such as fracture, plastic flow, superconductivity, corrosion resistance, radiation resistance, and transport phenomena all depend on structure. As a consequence of this improved understanding, better materials and a greater ability to predict behavior of materials in energy systems will eventually be possible. Although basic in nature, the program is centered around research areas deemed to be of greatest interest for energy systems. For example, there is within the metallurgy and ceramics category a strong emphasis on hydrogen effects, radiation effects, corrosion, creep and high temperature deformation, high temperature ceramics, and superconductivity.

There are five budget areas under the Metallurgy and Ceramics category: structure of materials, mechanical properties, physical properties, radiation effects and engineering materials.

The structure of materials area supports research designed to enhance our understanding of the atomic, electronic, defect and microstructure of materials, how they are affected by chemical composition and processing, and how they relate to material properties.

The budget area of mechanical properties is concerned with material behavior related structural integrity requirements of all energy systems. Research addresses the understanding of strength at high and low temperatures, creep, fatigue, elastic constants, micro- and macrostrain, fracture, and mechanical-chemical effects in hostile environments.

Research under the physical properties area is directed toward understanding the fundamental phenomena controlling thermal, optical, mass transport, and electrical properties of materials, how they can be altered by various heat treatments or other processing steps, and how they are affected by external variables such as temperature and pressure.

The radiation effects area encompasses research delineating radiation induced changes of materials properties important to fusion and fission energy concepts. The effect of irradiation, both neutron and ion, on mechanical properties, structure and electrical properties is studied in this area.

In the engineering materials area, research is aimed at understanding more fully the complex materials and phenomena generally associated with real world materials problems. Some of the topics under study include: erosion, friction and wear, engineering corrosion and fracture, welding and joining, nondestructive evaluation, and the forming and processing of materials.

B. Solid-State Physics

The solid-state physics category is directed toward fundamental research on matter in the condensed state, wherein the interactions of electrons, atoms, and defects are tracked with the purpose of determining the critical properties of solids. These interactions are the ultimate source of all materials properties. Research under this category includes a broad spectrum of experimental and theoretical efforts, which contribute basic solid-state knowledge important to all energy technologies. Accelerated progress is made in this field through the rapid advancements in unique experimental tools and their coupling with high-speed computer systems. Through these efforts, fundamental understanding of matter in the condensed state contributes broadly to characterizing material properties and processes important for all energy technologies.

There are five budget areas within the solid-state physics category: neutron scattering, experimental research, theoretical research, particle-solid interactions, and engineering physics.

The neutron scattering area supports research of a unique kind, namely the use of the neutron as an analytical probe of the properties of solids and liquids. With this probe, fundamental parameters of superconductors, magnets, hydrides, and solid imperfections are determined in a manner that cannot be accomplished by any other technique. The exploitation of this probe is being advanced by recent development of more efficient monochromators and wider use of longer wavelength probes. The bulk of the Nation's efforts in this important area has historically been supported at DOE laboratories, where the advanced research reactors are in operation.

The experimental research area is very broad and includes all fundamental investigations, experimental in concept, on liquids and solids of metals, alloys, semiconductors, insulators, and compounds. The area of high-temperature materials in both metals and nonmetals, for all high-temperature energy systems is being pursued. Ion implantation and backscattering research is being used to learn how to improve superconductor and photovoltaic performance. Hydrogen and hydrides are under study through ultrahigh-pressure and spectroscopic techniques. Synchrotron radiation is utilized in characterizing surfaces with particular relation to catalytic response.

With nearly all these experimental areas, a highly advanced theoretical research program is closely coupled. A large part of the theoretical effort is directed towards dynamic processes in solids and liquids and requires extensive use of DOE's most advanced computer complexes.

Under particle-solid interactions, a major effort is under way to correlate the complex effects of particles of different mass, energy, and charge, not only on surfaces but in bulk materials as well.

The engineering physics area supports research to fulfill the much needed goal of utilizing solid state physics expertise in engineering research for which it has a unique capability. Typical of the work initiated are research laboratory investigations of novel processing techniques with mass spectrometer-computer control for complex material preparation, such as solar materials and superconducting alloys. Another area is the extension of cryogenic and refrigeration techniques to new fluid systems that hold promise for the utilization of low-grade heat.

C. Materials Chemistry

The materials chemistry category provides support for research directed toward developing our understanding of the chemical properties of materials as determined by their composition, structure, and environment (pressure, temperature, etc.) and to show how the laws of chemistry may be used to understand physical as well as chemical properties and phenomena. Included, for example, are studies of energy changes accompanying transformations, the influence of varying physical conditions on rates of transformations, and the manner in which the structure of atomic groupings influences both properties and reactivity.

Chemical concepts coupled with physical experimental techniques are used to study the kinetics of reactions of solids and liquids, the interaction and/or penetration of species in adjacent media, corrosion, phenomena and the stability of high-temperature materials of interest to fossil and geothermal technologies. The program also includes research on the chemical thermodynamics of fission products and their interactions with fuels and cladding materials. Electrochemistry is an important aspect of research supported under this category. Research involving elastomers and polymers is also beng pursued.

There are three budget areas in the materials chemistry category: structural chemistry, engineering chemistry, and high-temperature and surface chemistry.

Structural chemistry involves studies of a wide variety of problems where a knowledge of the relationship between the atomic structures of materials and their reactivity is required. Important examples of these effects include the influence of different chemical environments on the catalytic properties of metals. Changes in both the crystal and magnetic structures of compounds are correlated with their specific roles in fuel synthesis, for example.

The methods of engineering chemistry are applied to problems that are currently limiting the efficiency of energy conversion systems. Examples of research underway include: structural and morphological changes that arise during the charge-discharge cycles of the high-temperature battery and studies of tritium permeation of oxide films.

The high temperature and surface chemistry area includes programs on fundamental studies of the influence of surface properties on reactivity. The correlation of mass transport and thermodynamic properties of molten salts in high-temperature battery systems and chemical studies of the influence of micro-inclusions such as sulfides on the formation of pits and crevices to determine whether these inclusions play a significant role in the initiation of stress-corrosion cracking are examples of research underway.

Office of Fusion Energy

The primary goal of the Magnetic Fusion Program is to develop the technology for safe, economic and environmentally acceptable use of fusion power for the generation of electricity. A secondary goal is to develop and evaluate other applications of the fusion process including the production of fissile material, synthetic fuels and industrial process heat. To achieve these goals, the program has established several objectives which are:

- To develop, through definitive experimental tests of key physics questions, a strong scientific base necessary for the design of a fusion engineering test facility;

- To complete construction and initiate operation of major physics scaling experiments including the Tokamak Fusion Test Reactor and the Mirror Fusion Test Facility;

- To select; test and provide an assessment of alternate fusion concepts that could potentially lead to more economical and commercially practical fusion reactor systems;

- To provide the base engineering and technology developments needed to support the operation of current and next generation plasma experiments;

- To complete reactor studies of the most promising confinement concepts in order to provide a focus for the physics and technology programs; and

- To establish a strong technology base in materials, reactor components and systems which will permit an evaluation of various approaches to fusion on the basis of technology requirements, economic objectives and environment/safety constraints.

Materials Development for Fusion Reactors

The primary objectives of the Materials Program of the Office of Fusion Energy, are: (a) development of materials and the understanding of materials behavior which will assure plasma integrity and the structural integrity of the first wall of a fusion reactor; (b) development of special purpose materials that are required for magnetic confinement, heat transport, energy conversion and storage, and other functions of specific fusion systems; and (c) materials engineering support for the continuing development program.

Successful economic operation of commercial fusion reactors depends on the development of materials capable of withstanding the severe radiation environment resulting from the deuterium-tritium (D-T) fusion reaction. The first wall of a fusion reactor will be subjected to bombardment by neutrons, charged and neutral particles, electrons, and photons. Although the total neutron flux in fusion reactors may be less than in fission reactors, high energy neutrons produce from 3-4 times the damage of fission neutrons and result in high transmutation rates which lead to helium and hydrogen contents in structural materials 20-180 times as great as those produced in fission reactors; this results in greatly accelerated materials degradation.

The Fusion Materials Program is made up of six key areas:

1. <u>Alloy Development for Irradiation Performance</u> $3,890K

ANL, HEDL, MIT, McDonnell-Douglas, ORNL, and NRL

Alloy Development for Irradiation Performance is the largest element of the Program and includes the development of materials which must operate reliably in the fusion reactor environment. The objective of this is to provide the materials development for those structural materials that will be subject to significant radiation damage, including the first wall and structural elements for the blanket and shield of a commercial fusion power reactor.

Keywords: Alloy Development, Radiation Effects

2. <u>Radiation Facilities Operation</u> $2,370K

ANL, LLL, ORNL

The objectives of this area are to define the radiation environment of fusion reactors and to pursue the development of neutron and plasma sources to simulate this environment for materials testing. Since fusion reactors are not now available for testing, high-energy neutron and plasma sources are needed to develop materials for commercial fusion power. The two principal irradiation facilities utilized are the Oak Ridge Research Reactor (ORR) - a thermal reactor facility - and the Rotating Target Neutron Source (RTNS-II) - a 14 MeV irradiation facility captive to the Fusion Program. Other facilities include the Experimental Breeder Reactor (EBR-II) and the High Flux Isotope Reactor (HFIR). The Fusion Materials Irradiation

Test Facility (FMIT), a high flux, high-energy, broad-spectrum neutron source will be utilized when it becomes available.

Keywords: Materials Characterization, Radiation Effects

3. Damage Analysis and Fundamental Studies $2,170K

ANL, AI, BNL, HEDL, LLL, LASL, ORNL, PNL, Westinghouse, University of California (SB), University of Virginia, University of Wisconsin

Damage Analysis and Fundamental Studies supports the alloy development work. The objectives of this area are to characterize available irradiation test environments and to establish a basis for predicting materials performance under irradiation in a fusion reactor environment. this will be accomplished by materials irradiation data obtained in fission reactors, accelerator-based neutron test environments, and charged particle irradiations.

Keywords: Radiation Effects, Materials Characterization

4. Plasma-Materials Interaction $2,890K

ANL, General Atomic, ORNL, SLA, SLL, Georgia Institute of Technology, University of Wisconsin

Plasma-Materials Interaction relates primarily to processes occurring at the surface of the first wall including interaction with hydrogen, helium, photons, electrons, residual gases, metallic ions, and neutrons. The objectives of the Plasma/Materials area are to minimize the damage to surfaces exposed to plasmas, to minimize the associated release of metallic and gaseous impurities, to control hydrogen recycle between plasma and wall, and to control surface processes occurring in the components and subsystems of fusion experiments and reactors. Included in this work is the development of improved limiter and beam dump materials.

Keywords; Coatings and Films, Erosion and Wear

5. Special Purpose Materials $431K

LLL, LASL, ORNL, PNL

Special Purpose Materials is primarily concerned with materials development outboard of the first wall, including: (i) insulators in structural applications, (ii) insulators for components such as neutral beams and superconducting magnets, (iii) moderator and breeding materials, (iv) materials for heat transfer systems and power-conversion (secondary) systems.

Keywords: Superconductors, Ceramics, Glasses

6. Materials for Magnet Systems $1,200K

NBS, BNL, ORNL

Component materials for magnet systems are being studied for the development of superconducting magnets. Most of the work is intimately tied to magnet development for plasma containment.

Keyword: Superconductors

Information Available on Materials for Magnetic Fusion Energy

Six Materials Program Bulletins have been published and are available on request. The titles are as follows:

Bulletin 1: Overview of Fusion Materials Program
Bulletin 2: First Wall Structural Goal for Economic Fusion Power
Bulletin 3: Alloy Development to Meet First Wall Structural Goals for Economic Fusion Power
Bulletin 4: Plasma-Materials Interactions
Bulletin 5: Neutron Radiation Facilities
Bulletin 6: Special Purpose Materials

Program plans in the areas of Alloy Development for Irradiation Performance, Damage Analysis and Dosimetry, Special Purpose Materials, and Plasma-Materials Interactions are available by calling K. M. Zwilsky (301) 353-4865; FTS 233-4865.

Further information may be obtained by calling the following individuals:

Alloy Development for Irradiation Performance	-T. C. Reuther	353-4963
Damage Analysis and Dosimetry	-M. M. Cohen	353-4253
Plasma-Materials Interaction	-K. M. Zwilsky	353-4965
Special Purpose Materials	-M. M. Cohen	353-4253
Radiation Facilities	-M. M. Cohen	353-4253
Materials for Magnet Systems	-D. S. Beard	353-4958

ENVIRONMENT

The Office of the Assistant Secretary for Environment was established to formulate and manage for the Department of Energy a comprehensive program to assure that the environmental research, assessment, and control issues related to current and developing energy technologies, as well as Departmental operations, are addressed effectively. This program has been designed to meet the specific environmental responsibilities and functions assigned to the Department by the DOE Organization Act (P.L. 95-91) and the generic environmental responsibilities mandated by the National Environmental Policy Act (NEPA) and other environmental legislation.

The Environmental Research and Development program is structured to accomplish two parallel responsibilities: (1) conducting research and development to meet the needs of DOE's programs for the knowledge required to resolve environment, health and safety (EH&S) uncertainties and conflicts and (2) overviewing the energy technology research, development and demonstration activities and operations of DOE to assure the EH&S acceptability of those developments.

Office of Health and Environmental Research

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

In FY 1980 support for materials research and development was limited to studies on the semiconductor materials germanium, silicon, cadmium telluride, and mercury iodide, for application in radiation detectors.

1. Semiconductor Detectors and Materials $196K

DOE Contact - Gerald Goldstein (301) 353-5348; FTS 233-5348
Lawrence Berkeley Laboratory (Contract No. W-7405-eng-48)
F. S. Goulding, E. E. Haller (415)486-5294

Research is conducted on the basic physics and chemistry of the purification of semiconductors, mainly germanium. Zone purification, crystal growing and sophisticated material anlaysis methods are used. Radiation damage of detectors and materials is also studied.

Keywords: Materials Characterization; Materials Processing; Germanium; Semiconductors

FOSSIL ENERGY

The mission of the Fossil Energy Program is to develop technologies that will increase domestic production of oil and gas or that will permit the Nation to shift from oil or gas to more abundant coal. Specifically, the Fossil Energy role is to develop technologies to support the following objectives:

- Provide a capability to convert coal to liquid and gaseous fuels;
- Increase domestic production of coal, oil and gas;
- Ensure that current and new facilities that burn coal can do so in an economically viable and environmentally acceptable manner; and
- Allow more efficient and more economically attractive utilization of fossil energy resources.

The Fossil Energy activity includes fourteen major programs, which are grouped under seven program offices. One of these seven is the Office of Advanced Research and Technology, which is the central point of contact for inquiries from universities concerning the Fossil Energy program.

Project execution and technical monitoring are administered in five energy technology centers and two mining technology centers as well as selected national laboratories.

Office of Advanced Research and Technology

The objectives of the Advanced Research and Technology program are to assess and identify long-range advanced research needs in coal processing, fossil fuels utilization and extraction, materials, components, and instrumentation; to provide oversight of ongoing advanced research in fossil energy so as to ensure balance and proper priorities; to initiate and fund projects involving new, exploratory concepts or goal-oriented basic research; to manage the Materials Research and University Coal Research programs; and to provide policies for, and overview of, Fossil Energy-supported university activities. The Advanced Research and Technology program also is designed to provide an effective communications channel between the Fossil Energy program and academic institutions; to encourage these institutions to become involved in programs related to the DOE Fossil Energy mission; and to manage programs concerned with providing an adequate technical base for development of commercial construction materials and instrumentation for Fossil Energy pilot plants and demonstration plants.

The program supports workshops to identify research needs in all fossil energy technologies, and manages selected training programs for faculty and students at Energy Technology Centers.

It should be noted that a few contracts that were sponsored by this Office and active in FY 1980 were negotiated and funded from prior years' appropriations. In this context, the exact funding level for these activities are not easily determined, and thus are indicated in the text as PYA, prior years' appropriation.

1. Materials Research for the Clean Utilization of Coal Task 2: Materials Performance and Properties Data — $275K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
National Bureau of Standards (Contract No. EA-77-A-01-6010)
S. J. Schneider, H. M. Ondik, R. C. Dobbyn - (301)921-2892

To assist the coal conversion industry in extending the useful life and reliability of plant components by maintaining a central source of information on the performance, especially failures, of materials and components used in coal conversion environments.

To provide an integrated materials properties data base for materials of construction to aid the coal conversion industry in the design, construction, and operation of plants converting coal to alternate energy forms, including MHD power generation.

To collect and evaluate the appropriate information, maintain suitable computer files for ready retrieval, and disseminate the data in convenient form to the users.

Keywords: Materials Characterization

2. Development and Application of Nondestructive Test Methods for Coal Conversion and Utilization Systems $217K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
W. A. Ellingson, C. A. Youngdahl, M. J. Caines, R. R. Roberts - (312)972-5068

The objectives of this research program are to: (1) Identify those areas in coal conversion and utilization processes where development and application of advanced nondestructive evaluation (NDE) methods and procedures would have identifiable payoff in terms of improved reliability and safety, (2) develop those necessary NDE methods and procedures through comprehensive analytical, laboratory, and field programs, and (3) provide NDE support not available on a conventional commercial basis to DOE-funded test facilities. Through employment of a comprehensive reliability program employing appropriate NDE techniques, long-term, safe and reliable operation of coal conversion and utilization systems can expect to be enhanced.

Keywords: Non-Destructive Evaluation (NDE)

3. Failure Prevention and Analysis in Coal Liquefaction Systems $100K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26).
V. B. Baylor, J. R. Keiser, R. W. Swindeman - (615)574-4457; FTS 624-4457

This task is aimed at improving materials performance and operating lives in large coal liquefaction plants through a careful metallurgical examination of components and surveillance coupons taken from pilot plants and process demonstration units.

Pilot plant and process demonstration unit materials experience for liquefaction and other fossil energy systems can provide some of the most important and practical guidance for needed research and development for later plants. Under this program, Oak Ridge National

Laboratory staff members examine failed or used components and surveillance coupons from operating plants. The objectives are to:

1. obtain materials-related data and experience that can assist in the selection of materials for and in the design, construction, and operation of later plants;

2. provide assistance to plant operators by providing failure analyses;

3. provide permanent records of significant results for incorporation in the Central Failure Analysis Data Bank operated at the National Bureau of Standards.

Keywords: Materials Characterization

4. Component Performance and Failure Analysis $114K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
D. R. Diercks - (312)972-5032

The objectives of this program are: (1) to provide failure analysis services and evaluate the performance of coal conversion plant components that have failed or have otherwise been removed from service, (2) to make recommendations concerning materials selection, component design, or process conditions so that similar failures can be avoided, and (3) to disseminate this information for subsequent use in the design and operation of related pilot and demonstration plants.

Keywords: Materials Characterization

5. Program on Materials for the Gasification of Coal $452K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
The Metal Properties Council, Inc. (Contract No. DE-AC05-760R10670).
H. L. Black - (212)644-7693

The objective of this program is to test materials of construction, both metals and ceramics, to evaluate their usefulness under anticipated service conditions in plants for the gasification of coal. Testing includes screening, followed by determination of those properties essential to engineering design. These include corrosion and erosion resistance as well as mechanical and physical properties under service conditions.

Keywords: Corrosion, Materials Characterization

6. Evaluation of Advanced Materials for Use in Letdown Valves for Coal Liquefaction Service — $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Battelle's Columbus Laboratories (Contract No. 13537)
A. H. Clauer, I. G. Wright - (614)424-4377

The objective of the program is to conduct laboratory slurry erosion experiments with limited supporting pilot plant trials to:

- o Generate data on candidate valve materials under varied wear designers in materials selection and valve design.
- o Determine a suitable substitute erodant and liquid carrier combination for use in standardizing laboratory materials evaluation and screening tests.
- o Confirm the utility of a laboratory wear test in evaluating materials for actual valve service.
- o Develop an improved understanding of materials behavior in slurry erosion.

Keywords: Corrosion, Materials Characterization

7. Correlation of the High-Temperature Corrosion Behavior of Structural Alloys with the Components of Coal Conversion Environments — $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Battelle's Columbus Laboratories
(Contract No. EY-76-C-02-0092-092.A001)
I. G. Wright - (614)424-4377

This program was designed to characterize and describe the corrosion behavior of four structural alloys in several coal conversion environments in a manner that would allow statistical correlations to be developed between corrosion behavior, process variables, such as gas temperature, total pressure, composition, and alloy variables.

It was anticipated that the results would allow the prediction of trends in corrosion behavior with changes in process conditions for alloys of the general Fe-Ni-Cr type. The analysis should also establish the relative importance of variables such as total pressure, and so provide information on the basic requirements for accelerated corrosion testing in these complex environments.

Keyword: Corrosion

8. Corrosion and Mechanical Properties of Materials for Application in Coal Conversion and Utilization — $ 53K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. 85991)
K. Natesan, (312)972-5103

The objectives of this program are: (1) experimentally evaluate the high-temperature corrosion behavior of iron- and nickel-base alloys in gas environments with a wide range of oxygen, sulfur, and carbon potentials, (2) evaluate deposit-induced hot corrosion behavior of heat-exchanger and gas turbine materials with and without coatings after exposure to multicomponent gas environments, (3) develop uniaxial tensile data on four selected Fe-Cr-Ni alloys after exposure to complex gas mixtures typical of coal-gasification process environments, and (4) develop an approach that is based upon available thermodynamic and kinetic information for evaluating possible corrosion problems in different coal-conversion systems.

Keywords: Corrosion; Materials Characterization

9. Mechanism of Corrosion of Structural Materials in Contact with Coal Chars in Coal Gasifier Atmospheres — $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
University of California Materials Department
(Contract No. EY-76-S03-00341T254)
D. L. Douglass - (213)825-1622

The primary objectives of this program are: A. To measure the reaction rates between coal chars, one containing low sulfur and the other containing high sulfur, and six alloys over the range of 1600 to 1800°F. To determine the mechanism(s) of reaction and the principal mode by which degradation of the metals occurs. B. To determine the effect of preoxidation treatments on the behavior of some alloys in contact with coal chars.

Keyword: Corrosion

10. Thermal Stability of Ferritic Alloys for Fossil Fuel Processing Systems $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Metallurgical Engineering Division, FB-10 University of Washington
(Grant No. ET-78-G-01-3319)
Douglas H. Polonis - (206)543-2600

This program is examining the influence of ternary alloy element additions on the metallurgical stability of low chromium ferritic steels for application in fossil fuel processing systems. Other workers have shown that small additions of aluminum to Fe-Cr steels have beneficial effects on the resistance to high temperature oxidation and sulfidation. The susceptibility of Fe-Cr binary alloys to 475°C embrittlement has been well documented in the literature, and this reaction imposes serious limitations in using ferritic stainless steels at temperatures in the range of 400 to 600°C for prolonged periods of time.

The present research project is investigating the effect of aluminum content on the kinetics of phase instability and the constitutional changes occurring during prolonged exposure to elevated temperatures up to 1000°C. The major long range objective is to develop quantitative mathematical models for the decomposition reactions as a basis for designing improved ferritic alloys having reduced chromium contents and stable metallurgical structures at elevated temperatures for prolonged periods of time.

Keywords: Materials Characterization

11. Erosion Studies in Coal Conversion Systems $ 62K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. UCC-19X-31546V)
J. Y. Park, (312)972-5030

The objective of the erosion program at ANL is to develop an engineering data base for rational design of components subject to erosive wear in coal conversion plants.

Keyword: Corrosion

12. Weld Overlaying for Corrosion Resistance in Coal Gasification Atmospheres $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
INCO Research and Development Center, Inc. (Contract No. EF-77-C-01-2621)
E. P. Sadowski - (914)753-2761

The primary objective of this program was the development and evaluation of weld deposited overlays to provide corrosion resistance in coal gasification atmospheres. This work was aimed at providing corrosion resistance in areas where corrosion conditions are expected to be most severe such as gasifier internals.

A secondary objective was to establish the effects of exposure to a coal gasification atmosphere on the mechanical properties of weldments as a measure of metallurgical stability.

Keywords: Materials Processing; Corrosion

13. Liquefaction Corrosion $250K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
J. R. Keiser, V. B. Baylor, J. H. Devan - (615)574-4453; FTS - 624-4453

Our objective is to provide data on the general corrosion and stress corrosion susceptibility of commercial alloys (welded and unwelded) that are candidate materials for construction of large coal liquefaction plants. Specimens are exposed under a range of service conditions in operating liquefaction pilot plants and under controlled laboratory conditions to establish acceptable conditions of stress, temperature, time, and environment. Chemical analyses are carried out to identify the corrosion-causing constituents of the liquids.

Keyword: Corrosion

14. Materials for in situ Processing Systems $ 50K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
EG&G IDAHO, INC. (Contract No. UCC-19X-31450V)
R. B. Loop - (208)526-0509; FTS - 583-0509

The purpose of this work is to examine environmental effects on materials which are intended for use in in situ processing systems.

Keyword: Corrosion

15. Alloy Evaluation for Fossil Fuel Process Plants (Liquefaction) $120K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Ames Laboratory (Contract No. AA-05-15)
T. E. Scott - (515) 294-4446; FTS - 865-4446

Since petroleum refinery pressure vessels are constructed of 2-1/4 Cr-1Mo steel (A387-74A-Gr.22-C1.2) with a stainless steel weld overlay liner, it is anticipated that coal liquefaction "dissolver" vessels will be fabricated similarly. In the event the stainless steel liner is breached, the feritic 2-1/4 Cr-1Mo steel shell will be exposed to the coal liquefaction environment. Consequently, the objective of this investigation is to evaluate the mechanical property integrity of dissolver vessel materials.

Keywords: Corrosion, Materials Characterization

16. Development of Coatings for Corrosion/Erosion Protection of Internal Components for Coal Gasification Vessels $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Solar Turbines International (Contract No. EF-77-C-01-2775)
W. G. Stevens - (714)238-6875

The group of coal gasification processes (including HYGAS, COGAS, Agglomeratic Ash Gasifier, etc.) require the use of particulate solid handling equipment and instrument probes wholly within the hot, high-pressure enclosure (gasifier). This environment is quite aggressive and corrosion of the alloys (304 and 310 stainless steels and Incoloy 800) from which these internal components will be fabricated has been predicted to proceed at rates up to 0.5 mm/year.

Keywords: Coatings and films

17. <u>Microstructural Effects in Abrasive Wear</u> $ 50K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Department of Metallurgical Engineering and Materials Science,
University of Notre Dame (Contract No. DE-AS02-77ET10460, A004)
N. F. Fiore, T. H. Kosel - (219)283-4516

This research is aimed at establishing quantitative relations between microstructure and wear resistance for highly alloyed white irons and Co-base powder metallurgy alloys commonly used in coal mining, handling and conversion processes. The objective has both basic and applied aspects. On the applied side, a better understanding of the physical and mechanical metallurgy of wear is leading to the semi-empirical development of abrasion-resistant alloys of minimal alloy content and heat treatment requirements. Further, gaining an understanding of the micro-flow and micro-fraction processes in abrasion is providing the means of alloy design from first principles.

Keywords: Elastomers and Polymers; Materials Characterization

18. <u>Wear-Resistant Materials for Coal Conversion Components</u> $150K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Albany Research Center Bureau of Mines U.S. Department of the
Interior (Contract No. DE-A105-80OR206987)
J. E. Kelley, H. W. Leavenworth, Jr. - (503)967-5896; FTS - 420-5896

To improve the performance of coal conversion systems by developing and identifying improved wear-resistant materials for valves, nozzles, and other wear-prone components. The need for these improved materials has been amply demonstrated by frequent failures in gasification and liquefaction plants.

Keywords: Elastomers and Polymers

19. <u>Fossil Energy Welding and Cladding Program</u> $100K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
G. M. Goodwin, D. P. Edmonds - (615)574-4809; FTS - 624-4809

The objective of this task is to develop economical and reliable techniques for cladding and welding critical components of coal conversion and coal utilization systems and to help evaluate and characterize heavy-section weldments.

Keywords: Materials Processing; Coatings and Films

20. Evaluation of the Fracture Toughness of Candidate Steels for Pressure Vessels for Coal Conversion Systems $175K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
D. A. Canonico - (615)574-4465; FTS - 624-4465

This program is directed toward the characterization of the fracture toughness of the steels that are candidates for the construction of the extremely large pressure vessels that have been proposed for second generation of coal conversion systems. Our goal is to determine the effect of operating environments, particularly hydrogen, on their properties.

Keywords: Materials Characterization

21. Development of Automated Welding Processes for Field Fabrication of Thick-Walled Pressure Vessels - Electron Beam Method $ 9K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Babcock & Wilcox Co. Alliance Research Center (Contract No. DE-AC05-77OR10244)
Charles N. Weber - (216)821-9110

Field fabrication of coal gasification vessels will be required due to shop and transportation limitations for these large vessels. Electron beam welding is a welding process that potentially could reduce the field fabrication costs. In comparison to existing field welding processes (shielded metal-arc welding), the rate of welding 8" thick 2-1/4 Cr-1 Mo material in the horizontal position is about 200 times faster.

The objective of this project was to develop and demonstrate an electron beam welding procedure for welding 8" thick SA387 Grade 2 (2-1/4 Cr-1 Mo) materials in the horizontal position acceptable to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 2. In addition to the work necessary to accomplish the objective, work was performed to acquire information relative to the feasibility of electron beam welding coal gasification units.

Keywords: Materials Processing

21. Biaxial Testing of Candidate Coal Gasifier Alloys $ 75K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
EG&G Idaho, Inc. (Contract No. UCC-19X-31450W)
R. M. Horton - (208)526-8271; FTS 583-8271)

The goal of this program is to measure the biaxial stress rupture strength and ductility of four selected candidate coal gasifier alloys in four atmospheres intended to simulate a coal gasifier atmosphere (CGA). Baseline tests in air will show whether exposure to these simulated gasifier atmospheres has an adverse effect on these mechanical properties.

Keywords: Materials Characterization

23. Fatigue Crack Growth in Low Alloy Pressure Vessel Steels $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Massachusetts Institute of Technology (Contract No. DE-AC02-79ER10389)
R. O. Ritchie - (617)253-2311

Energy requirements in this country have prompted major efforts in developing additional energy sources to oil and natural gas. One such system involves gasification of coal by reacting pulverized coal with steam at high pressures and temperatures. Processes designed to produce 250 million cubic feet of high or low BTU gas per day are being considered. Such processes will require welded steel pressure vessels, as large as 60 m long, 6 m diameter, with 250-350 mm thick walls, to operate at high pressures and temperatures in the presence of erosion-producing solid particles and chemically-aggressive atmospheres containing H_2O, H_2, H_2S, CH_4 etc. Design of such vessels must allow for the fact that sub-critical growth of crack-like defects, which invariably are present in large-scale structures, may be vastly accelerated by the presence of such environments, particularly those containing (or producing) hydrogen.

Keywords: Materials Characterization

24. Analysis of Hydrogen Attack on Coal Conversion Vessels $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
University of California (Contract No. ET-78-S-01-3133)
R. Odette, S. Vagarali, W. Oldfield - (850)961-3525

Steels used for fabrication of coal conversion vessels are exposed to hydrogen at high temperatures and pressure (T ∿ 450°C and PH_2 15MPa). Under these conditions hydrogen readily diffuses into the metal matrix and reacts with carbon at internal surfaces to form methane. This phenomenon, known as hydrogen attack (HA), results in internal decarburization and the nucleation, growth and eventual coalescence of grain boundary cavities; these microstructural changes, in turn, result in severe degradation of mechanical properties. Hence, HA may be a serious failure mechanism for thick-walled pressure vessels.

The purpose of this research is to develop physical models of the HA process describing important mechanisms and containing pertinent environmental and metallurgical parameters. These models are then used to correlate statistically engineering and laboratory data, and to extrapolate the data to predict HA behavior under actual vessel service conditions.

Keywords: Hydrogen Effects

25. Hydrogen Attack in Cr-Mo Steels at Elevated Temperatures $137K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Cornell University Department of Materials Science and Engineering - Bard Hall (Contract No. DE-AS05-78OR12298)
Che-Yu Li - (607)256-4349

The objective of this program is to determine the kinetics of nucleation and growth of methane bubbles or cavities in 2 1/4 Cr-1 Mo steels (primarily ASTM 387) at elevated temperatures under the influence of high pressure hydrogen and applied stress and to develop kinetic equations for estimating the number density and size distribution of grain boundary cavities as a function of time under conditions of interest to coal conversion plant operations.

Keywords: Hydrogen Effects

26. Program to Optimize Cr-Mo Steels to Resist Hydrogen and Temper Embrittlement $ 97K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Westinghouse Electric Corporation Research and Development Center
(Contract No. DE-AC05-78ORB513)
Bevil J. Shaw - (412)256-3255

This program is a three-year investigation to evaluate and optimize the resistance to hydrogen and temper embrittlement susceptibility of chromium-molybdenum steels for use as structural materials in coal-conversion pressure vessels. Phase I concentrates on the degradation of properties of commercial 2-1/4 Cr-1 Mo steel, supplied by the American Petroleum Institute, due to the effects and interactions of hydrogen and temper embrittlement. Phase II is an investigation of the effect of composition and strength level with the intention of establishing compositions with a maximum resistance to both embrittlement effects. The embrittlement susceptibility of weld heat affected zones is of particular interest to the study.

Keywords: Hydrogen Effects

27. Characterization of the Toughness of Thick-Sectioned Electroslag Weldments $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Department of Metallurgical Engineering Colorado School of Mines
(Contract No. DE-AS05-78OR12313)
G. R. Edwards, R. H. Frost - (303)279-0300

Electroslag welding, wherein large singlepass welds are made by consuming a wire electrode in an ohmically heated flux pool, has been a particularly appealing process for thick-section welding because of the high deposition rate. Application of the process is currently hindered, however, by lack of a fundamental understanding of the critical process variables. Careful control of the potential, the electrode composition and velocity, and the flux composition are all critical to fabrication. The post-weld heat treatment strongly affects the final mechanical properties of the weldment, especially in 2 1/4 Cr-1 Mo steel. The objective of this program is to characterize the effects of the process variables stated above, and to apply that knowledge in optimizing the properties of 4-in.-thick 2 1/4 Cr-1 Mo electroslag weldments.

Keywords: Materials Processing; Joining Methods, Materials Characterization

28. <u>Manufacturing Technology for Improved Low-Cost Electroslag Cast Materials and Components for Application in Coal Conversion</u> $111K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Mellon Institute Carnegie-Mellon University (Contract No. PR-79ET 13532)
G. K. Bhat - (412)578-3277

Program objectives are to determine: (a) the economics, (b) the technical factors which define the value of using electroslag casting as a means of fabricating components of coal conversion equipment. The components evaluated include valve bodies and compressor castings which will be simulated by a cast thick-walled carbon steel shape containing integral nozzles, plugs and flange mounting openings.

Keywords: Materials Processing

29. <u>Program on Corrosion of Metals in Coal Liquefaction Processes</u> $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
The Metal Properties Council, Inc. (Contract No. DE-AC05-79-OR13546)
Martin Prager, F. F. Lyle, Jr., R. Arey, L. M. Adams - (212)644-7693

The objectives of this program are to (1) determine the general susceptability of carbon steels, stainless steels, and nickel-base alloys to corrosion in coal liquids; (2) identify and measure concentrations of suspected corrosive species in coal liquids before and after corrosion tests; (3) determine the effect of temperature on corrosion of metals and on the stability of corosive species in coal liquids; (4) relate extent, type of corrosion, and corrosion mechanism(s) to corrosive species present in coal liquids; and (5) provide background data for the interpretation of results of in-situ corrosion tests and failures in liquefaction plants.

Keyword: Corrosion

30. Coal Liquefaction Alloy Test Program $120K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Lawrence Berkeley Laboratory (Contract No. W-7405-eng-26)
A. V. Levy - (415)486-5822

The object of this program is to determine the erosion/corrosion behavior of materials used in the flow passages of liquid slurries under conditions representive of those in coal liquefaction systems. From the understanding gained from testing a number of different materials over a range of controlled operating conditions within and beyond those of currently acceptable practice, slurry flow operating parameter guidelines and improved performance, materials selection and design criteria will be developed. The information that will be gained from this program will be structured in a manner that will make it directly usable by coal liquefaction system designers.

Keywords: Corrosion; Erosion and Wear

31. Design of Low alloy Steels for Thick Walled Pressure Vessels $200K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Department of Materials Science and Mineral Engineering, University of California (Contract No. W-7405-eng-26, Union Carbide Subcontract 7843) E. R. Parker, V. F. Zackay, (J. A. Todd - Project Leader) - (415)642-3811

The objective of this program is to modify existing commercial low alloy steels or to develop new alloys which can be fabricated into large diameter, thick walled pressure vessels for coal gasification and liquefaction systems.

Keywords: Alloy Development, Alternate Materials

32. Testing and Development of Materials for Catalytic Coal Gasification Process Equipment $150K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
U.S. Department of the Interior Bureau of Mines (Contract No. DE-A105-80OR20686)
H. Heystek, N. S. Raymon - (205)758-0491

The objectives of this research are to: (1) determine the effect of catalytic coal gasification (CCG) environments on metal and refractory materials of construction by exposure to CCG reactor conditions in a laboratory simulator and (2) identify the attack mechanisms of CCG environments on metals and refractories so that materials offering improved performance at lower cost can be identified.

Keyword: Corrosion

33. Chemical and Physical Stability of Refractories for Use in Coal Gasification — $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
University of Missouri-Rolla (Contract No. DE-AC02-76ET-10544)
D. E. Day, G. L. Lewis - (314)341-4354

This investigation had the following objectives:

a. To achieve an understanding of the types of chemical reactions that occur in refractory ceramics exposed to conditions representative of those at the cold face of the refractory linings in coal gasifiers.

b. To assess the relative importance of these reactions to those physical/chemical properties required for long-service life.

c. To identify those refractories providing optimum service performance particularly in regard to bond phases.

Keywords: Corrosion; Ceramics, Glasses

34. Selection of Refractories for Slagging Coal-Conversion Systems — $104K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. 85991)
C. R. Kennedy - (312)972-5120

The primary objectives are (1) determine which commercial refractories are most likely to withstand the environment expected in coal-conversion plants where slagging conditions exist, (2) identify grain-bond systems that have potential for improved refractory performance, and (3) provide technical support for the IITRI and PSU programs.

Keywords: Corrosion; Ceramics, Glasses

35. Investigation of CO Disintegration of Refractories in Coal Gasifiers $ 68K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Department of Materials Engineering Virginia Polytechnic Institute and State University (Contract No. DE AS01-77ET 10682)
J. J. Brown, Jr. - (703)961-6777

The objectives of this investigation are to determine 1) whether or not CO disintegration is likely to occur in the refractories used in coal gasifers, and 2) to identify the conditions under which CO disintegration of the refractories can be expected to be a serious problem. It is also a goal of this investigation to develop information that will assist in the identification of refractory deterioration or failure that is caused by CO disintegration.

Keywords: Corrosion; Ceramics, Glasses

36. Improvement of the Mechanical Reliability of Monolithic Refractory Linings for Coal Gasification Process Vessels $ 80K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Babcock & Wilcox Company Research and Development Division (Contract No. DE-AC05-76OR10434)
Ralph Potter - (804)384-5111 x5194; FTS - 671-1060

Monolithic refractory designs based on practices in the petrochemical industry have been used in many of the non-slagging coal gasifiers processes being developed or partially sponsored by the Department of Energy. These linings are easy to install and relatively inexpensive and generally insulate vessel shells more effectively than brick linings. They are very prone to cracking, however, and it is this characteristic that concerns those involved with the operation and overall performance of coal conversion process. It is generally thought that the cracking and associated thermomechanical degradation of monolithic refractory linings is most significantly affected by their performance during the initial dry-out and heat-up. It was the objective of this work to improve the thermomechanical reliability, i.e., reduce or eliminate the cracking, of monolithic refractory linings of coal gasification process vessels operating to 2000°F during the initial dry-out and heat-up.

Keywords: Corrosion, Ceramics, Glasses; Materials Characterization

37. Fracture of Refractory Concretes $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Department of Materials Science and Engineering, The Pennsylvania State University (Contract No. EF-77-S-01-2678)
R. C. Bradt - (814)865-0497

A number of refractory concretes are being utilized or considered for utilization as the linings in coal gasification vessels. These concretes are subjected to a variety of transient thermal and mechanical stresses that usually result in extensive cracking and may cause eventual spalling. Data concerning strength and fracture characteristics are needed to establish design criteria and operational parameters when these refractory materials are employed.

Keywords: Ceramics, Glasses

38. Stability of SiC, Si_3N_4, Si_2N_2O, Sialon and Chromium Oxide-Containing Refractories in Coal Gasification Environments $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Pennsylvania State University (Contract No. DE-AS05-77OR10476)
Arnulf Muan - (814)865-7042

Coal gasifiers operated at sufficiently high temperatures (1400°C) to reject the coal ash in the form of a liquid phase (slag) have potential operating advantages as well as higher efficiencies than gasifiers operated at lower temperatures (1000°C). However, increasing the temperature of a process places heavier demands on the refractory materials used for lining the reaction vessels. The objectives of the present research are to determine the chemical constraints affecting the performance of refractory materials under experimental conditions corresponding to those prevailing in slagging gasifiers, and to provide guidelines for selecting optimum compositions of such refractories.

Keywords: Ceramics, Glasses; Corrosion

39. Creep Behavior of Monolithic Refractory Materials $ 91K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Engineering Research Institute Department of Materials Science and Engineering, Iowa State University (Contract No. W-7405-eng-26 Sub-contract No. 7949)
T. D. McGee, J. R. Smyth - (515)294-1214; FTS - 865-1214

Refractory concretes appear to be prime candidate materials for the linings of dry ash coal gasification pressure vessels. Due to extreme conditions in the gasification process (temperatures to 1200°C, stresses to 2000 psi, corrosive atmosphere) it is important to have available high-temperature high stress creep data for these materials. Not only is data important but also information on the mechanisms of creep is desirable. This information is needed for ongoing research at other institutions into elimination of cracking in the refractory linings which causes failure.

Keywords: Ceramics, Glasses; Materials Characterization

40. Hot Corrosivity of Coal Gasification Products on Gas Turbine Alloys $ 75K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
University of Pittsburgh (Contract No. DE AC01 79ET 13547)
G. H. Meier, R. A. Stoehr, E. A. Gulbransen - (412)624-5316

The object of this program is to develop information about the hot corrosion of gas turbine alloys in the environment likely to be found when a gas turbine is operated on low Btu gas produced from coal in a fluidized bed gasifier. The program is designed to determine the mechanisms of attack and the major factors which influence the kinetics of hot corrosion in these environments.

Keyword: Corrosion

41. Potential Use of Modified 9 Cr-1 Mo Steel for Fossil Utility Boiler Applications $ PYA

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
V. K. Sikka - (615)574-5112; FTS - 624-5112

Steels used in fossil energy applications operate under various temperatures, stresses and environmental conditions. A modified

9 Cr-1 Mo alloy under development at ORNL in conjunction with Combustion Engineering is extremely useful as material for heat exchangers, superheater tubing, transfer lines, and reheater tubing. The usefulness of modified 9 Cr-1 Mo comes from its high tensile and creep strength, low ductile-brittle transition temperature, high upper shelf energy, excellent hardenability, good thermophysical properties, and significantly better stress corrosion resistance compared with currently used stainless steels. The use of this alloy will help eliminate the need for transition joints, a frequent failure problem in conventional power plants.

Keywords: Alloy Development, Alternate Materials; Materials Characterization

42. Heat Exchanger Materials for Fluidized-Bed Coal Combustors $100K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
J. H. Devan, T. G. Godfrey - (615)574-4451; FTS 624-4451

Our objective is to determine the corrosion performance of heat exchanger and uncolled internal structural materials in atmospheric fluidized-bed combustors (AFBCs). Although crushed limestone is used in the fluidized bed as a sulfur absorber, the potential exists for both oxidation and sulfidation of in-bed components that operate at temperatures from 500 to 870°C. Accordingly, these studies are conducted to estimate the service lifetimes of AFBC candidate alloys under prototypic AFBC conditions.

Keywords: Alloy Development, Alternate Materials; Erosion and Wear

43. Technology for Ceramic Tube Heat Exchangers $ 80K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Solar Turbines International (Contract No. AC01-77-ET10571)
M. E. Ward - (714)238-5575

Present gas turbines must operate with high grade fuels to avoid damage when the combustion gases are expanded through the turbine. Low grade fuels when the combustion gases are expanded through the turbine. Low grade fuels including coal can be used if the turbine is fired indirectly by the transfer of heat from the combustion gases to the compressor air by means of a heat exchanger. The new, silicon-base ceramics appear to be the only materials able to provide the strength at temperature, erosion and corrosion resistance, and thermal shock resistance required in the tubes of this heat exchanger. The objectives of the program were to develop and identify technology enabling the construction of a full size pressurized, high temperature ceramic heat exchanger module.

Keywords: Ceramics, Glasses; Corrosion

44. Materials Research for the Clean Utilization of Coal Task I: Creep and Other Properties of Refractories $130K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
National Bureau of Standards (Contract No. EA-77-A-01-6010)
S. J. Schneider - (301)921-2892

The objectives of the task are 1) to obtain data on the high temperature compressive creep of the refractories being considered for use in MHD air preheaters and 2) to rank the proposed refractories in terms of their creep resistance at the proposed service temperatures of 1400 - 1600°C.

Keywords: Ceramics, Glasses; Materials Characterization

45. High Temperature Applications of Structural Ceramics $245K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
National Bureau of Standards Center for Material Science
(Contract No. DE-A105-800 R20679)
S. J. Schneider - (301)921-2892

The objective of this study is to characterize the high temperature failure mechanisms and factors that influence their operation with an aim toward improving the properties of structural ceramics, especially silicon carbide and silicon nitride based materials, for use in coal conversion applications.

Keywords: Ceramics, Glasses; Materials Characterization

46. X-Ray Analysis of Residual Stress $100K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Pennsylvania State University (Contract No. DE-AC05-790R13591)
Clay Rudd - (814)863-2843

X-ray diffraction techniques will be used to measure residual stresses adjacent to welds of various types. Narrow-groove and conventional gas tungsten-arc welds will be studied first, followed by a third process to be determined.

Keyword: Materials Processing

47. Field Welding of Pressure Vessels, GTAW - Narrow Groove $395K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Westinghouse Electric Corporation, Tampa Division
(Contract No. DE-AC05-780R13511)
U. A. Schneider - (813)837-7441

A variation of the gas tungsten-arc welding process will be investigated. This process uses AC-heated filler wire and a narrow joint preparation to increase the rate at which filler metal is deposited and reduce the amount of filler necessary for a given application. Welding characteristics of the system and properties of the weld will be investigated.

Keyword: Materials Processing

48. Thermomechanical Modeling of Refractory Liners $128K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Massachusetts Institute of Technology (Contract No. UCC-7862)
Oral Buyukozturk - (617)253-7186

A thermomechanical model for refractory concrete liner - anchor interaction is being developed.

Keywords: Cements and Concrete, Materials Characterization

49. Engineering Scale Testing of Refractories of Slagging Gasifiers $1,274K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
IIT Research Institute (Contract No. DE-AC05-780R-13410)
S. A. Bortz - (312)567-4400

Program to develop and test refractory lining systems and provide a handbook of design parameters and specifications.

Keywords: Corrosion, Ceramics

50. Project Engineering for IITRE Refractory Test Facility $ 33K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
R. A. Bradley - (615)574-6094; FTS - 624-6094

Engineering evaluations and reviews of the IITRE refractory test facility.

Keywords: Corrosion, Ceramics

51. Evaluation of Structural Ceramics for Coal Combustion $ 75K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
R. A. Bradley - (615)574-6094; FTS - 624-6094

Candidate structural ceramics for heat exchangers are being exposed to the products of combustion of fossil fuels. The effects of this exposure on the microstructure and mechanical properties of the ceramics are being evaluated.

Keyword: Ceramics

52. Corrosion of Iron and Nickel-Base Alloys $ 50K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
R. A. Bradley - (615)574-6094; FTS - 624-6094

Evaluation of the high-temperature corrosion behavior of iron- and nickel-base alloys.

Keyword: Corrosion

53. A New Class of Pressure Vessel Steel $125K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Department of Materials Science and Mineral Engineering, University of California (Contract No. W-7405-eng-26, Union Carbide Subcontract 7843)
E. R. Parker, V. F. Zackay, (J. A. Todd - Project Leader) - (415)642-3811

To develop a new class of pressure vessel steels. Precipitation-hardened alloys should in principle have properties much less sensitive to section thickness than conventional bainitic or martensitic steels. Ni-V-C steels appear capable of giving good mechanical properties with very slow cooling rates. The program will optimize compositions with respect to toughness, weldability, and other operationally important characteristics.

Keywords: Alloy Development, Coatings and Films

Office of Coal Utilization

The Office of Coal Utilization (OCU) reporting to the Assistant Secretary for Fossil Energy is comprised of four divisions: Fuel Cells, Combustion Systems, Cleanup Technology, and Heat Engines and Heat Recovery. The DOE coal strategy is to develop technology to allow expanded use of coal and coal-derived fuels in an environmentally acceptable and an economically viable manner. The majority of the materials development work in this office is incorporated in major programs and directed by the commercial contractors at specific problems related to accomplishment of program objectives. Thus, the costs identified for materials developments represents an estimate by the DOE Program Manager of the fraction of the development work that could reasonably be classified as materials development. Materials work in OCU is strongly applications oriented. The candidate materials have modest compositional changes or element additions. However, the major work involves microstructural optimization engineered to or forming a specific component. Much of the work involves coatings which includes substrate preparation, process control for coverage, uniformity and adherence. Post-deposition peening and/or heat treatment of the coated component are sometimes critical. The operational environment involves these coating factors as well as possible component redesign to achieve economic operation. These data are particularly relevant in this stage of alternative fuel development wherein decisions involving improvements to the fuel quality or enhancement of the engines ability to operate efficiently, durably and in an environmentally acceptable manner on minimally processed alternative fuels must be made.

An increasingly important aspect of advanced coatings is their role in critical metals use. Coatings may make it possible to use alloys with lower critical element composition than currently used alloys. Advanced coatings will extend the component life. Ceramic coatings are being emphasized as they are the key to the adiabatic diesel engine and gas turbine durability. If erosion significantly effects the ability of current metallic coatings to form and regenerate a very thin protective oxide scale to combat hot-corrosion attack, gas turbine operating costs could be dramatically affected. Hot-corrosion protection of many ceramic coatings is provided by the bulk material which suggests it should provide significant advantages under erosion/corrosion conditions.

The Division of Heat Engines and Heat Recovery has a Combustion Zone Durability Program which is managed by Battelle-Pacific Northwest Laboratories (PNL). This program supports the gas turbine and diesel engine programs primarily with development, test and evaluation of coatings. The gas turbine coating development capability is being spun-off to the diesel engine community to provide compatibility with alternative fuels. Also, many of the combustion techniques to reduce NO_x formation in the gas turbine and diesel strongly need viable ceramic coatings.

The total funding level for the materials development related work for the Office of Coal Utilization is approximately $21.5M. The following programs comprise the principal materials related work supported by the Office of Coal Utilization.

Heat Engines and Heat Recovery Division

1. Combustion Zone Durability Program $800K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Battelle Pacific Northwest, Richland, Washington
(Contract No. BR AA 550510)
James Patten (509) 942-2603; FTS 443-2603

OBJECTIVES: Ensure that the combustion sections of current and future gas turbine and diesel engines are capable of efficient, durable, and environmentally acceptable operation on alternative fuels.

APPROACH: Management Combustion Zone Durability Program with industrial and academic subcontractors. Conduct test and evaluation of promising candidate materials or coatings. Program definition priority assignment and program reviews are supported by a Steering Committee composed of individuals with proven expertise in coating development from inception through the engine use who are now working in National Labs or other agencies. Develop coatings in-house using high rate triode sputter deposition techniques. Triode sputtering provides much greater flexibility for variation in coating composition. Independent test facilities to support DOE and EPRI are being constructed.

Keywords: Coatings and Films, Ceramics

2. <u>Hot-Corrosion Mechanisms in Ceramic Coating for Use in Industrial/Utiity Gas Turbines</u> $ 70K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
UTC-Pratt & Whitney, East Hartford, Conneticut
(Contract No. DE-AC03-78ET13330)
Richard Barkalow (203) 344-5080

OBJECTIVES: Evaluate and compare hot corrosion resistances of selected candidate ceramic coatings and current art metallic coatings and account for the observed differences.

STATUS: Hot-corrosion attack of Na_2SO_4, V_2O_5, NaCl and SO_3 in furnace tests was investigated at 700° and 982°C. The effects of sulfates of CO and FE mixed with Na_2SO_4 are negligible unless they reduce the melting point of the molten salt. $ZrSiO_4$ showed no signs of chemical attack but is difficult to apply. A potentially promising coating candidate, calcium silicate ($CaSiO_3$) was found to undergo almost complete conversion ot $CaSO_4$ on exposure for 100 hours at 900°C with SO_3 containing salt deposits with the SO_3 being derived from the gaseous environment. Further, the rate of these corrosion reactions was shown to be systematically and reproducibly dependent on temperature, salt chemistry and SO_3 pressure.

Keywords: Ceramics, Coatings and Films

3. <u>Investigate Vanadium and Hot-Corrosion Resistance of Cr-Si Base Coating System</u> $ 85K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Pratt & Whitney - West Palm Beach, Florida
(Contract No. DE-AC06-79ET15322)
Ralph Hecht (305) 840-5681

OBJECTIVES: Develop an improved metallic coating using the silicon base system for use in industrial/utility gas turbine hot-sections operating on high vanadium, sulfur and sodium base petroleum fuels, minimally processed coal-derived fuels and petroleum/shale oil fuels. This program will also provide a reduced use of strategic materials.

STATUS: This program has demonstrated the following:

a. Si former coating systems are more V_2O_5 induced hot-corrosion resistant than Cr_2O_3 or Al_2O_3 formers.

b. ZrO_2 additions to the NiCrSi coating system improved its resistance to V_2O_5 attack.

c. SiCrTa intermetallics offer best resistance to V_2O_5 attack.

Keywords: Coatings and Films

4. <u>Investigation of Influence on Diesel Engine Emissions of Ceramic Combustion Zone Components</u> $130K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Cummins Engine Company, Columbia, Indiana
(Contract No. DOE/PNL B-A0763-AP)
Roy Kamo (812) 379-5591

OBJECTIVES: Determine effect on emissions of insulated diesel engine combustion zone components operating on a coal-derived liquid fuel.

STATUS: Insulating a diesel engine combustion chamber will raise internal wall temperatures. Piston temperatures will rise from 700° in a conventional engine to about 1500°F. Testing will determine if these higher temperatures in the combustion zone enhance combustion, reduce hydrocarbon formation, reduce NO_x either directly or with NH_3 hot-gas cleanup, improve efficiency and ease of starting. Five engines builds of a 5 1/2 x 6 (bore x stroke) single cylinder test engine are being made and tested. There are cooled and uncooled metallic engines, hot-pressed silicon nitride engine, plasma sprayed $ZrO_2 + Y_2O_3$ and a build with Norwegian coatings. All builds will be tested on conventional No. 2 diesel fuel and with SRC-II middle distillate cola-derived liquid fuel. Testing is beginning.

Keywords: Ceramics, Coatings and Films

5. <u>Mechanical Properties Characterization of Candidate Thermal Barrier Coatings for Diesels and Gas Turbine Engines</u> $ 40K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Naval Research Lab., Washington, D.C.
(Contract No. DE-AC05-79ET15328)
Roy Rice (202) 767-2131

OBJECTIVES: NRL is characterizing and conducting fracture analysis of Norwegian and U.S. plasma sprayed ceramic coatings.

STATUS: The Norwegian coatings, which have been successful in diesel engines, are of several variations of Y_2O_3 and MgO stabilized ZrO_2 over NiCoCrAlY type bond coats. The Norwegian ZrO_2 + Y_2O_3 had a fully cubic ZrO_2. The surface was prepared by extensive roughening the surface which enhanced interlocking of the bond coat-substrate and bond coat - ceramic interfaces. the microstructure was different than that of the NASA supplied ZrO_2+Y_2O_3 coating but the adherence of both coatings was similar. The Norwegian MgO stabilized ZrO_2 had roughly twice the adherence as the ZrO_2+Y_2O_3. The ZrO_2+MgO were 2 phase coatings with a non-cubic ZrO_2 plus a MgO phase. The MgO phase provides stress relief during cooldown.

Keywords: Ceramics, Materials Characterization, Coatings and Films

6. Investigation of Modified Zirconia Thermal Barrier Coatings for Gas Turbine Applications — $ 40K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
General Electric R&D Center, Schenectady, New York
(Contract No. DE-AC05-79ET11289)
Doug McKee (518) 346-8771

OBJECTIVES: Determine the effects of Y_2O_3 content and open porosity on the hot-corrosion behavior of Y_2O_3 stabilized ZrO_2.

STATUS: Specimens were prepared for cyclic oxidation test using 8, 12, 20, and 30 weight percent ZrO_2 + Y_2O_3 deposited over NiCrAlY bond coat. The ceramic thickness of all specimens was 0.25 mm. Cyclic furnace testing from 140° to 1100°C was conducted in air. Test data indicated that the durability of these plasma sprayed ZrO_2 + Y_2O_3 coatings under hot oxidation conditions improves with decreasing Y_2O_3 content with the composition range investigated.

Keywords: Coatings and Films, Ceramics, Corrosion

7. Development and Engine Test of Ceramic Coatings on Diesel Engine Components — $ 50K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Central Institute for Industrial Research, Oslo, Norway
(Contract No. ET-78-X-01-4288)
Dr. Ingard Kvernes (011) 472-6955880

OBJECTIVES: (1) Test and evaluate ceramic or thermal barrier coatings developed and tested in Norwegian diesel propelled ships operated on residual petroleum fuels, and (2) provide some U.S. coatings for Norwegian lab test and evaluation.

STATUS: Norwegian ships encountered significant hot corrosion after the 1973 Yom Kippur war due to changes in world refinery practices. The Central Institute was tasked to investigate this problem and develop solutions. They have developed a series of plasma sprayed stabilized ZrO_2 coating systems which have demonstrated 2 to 3X extension of diesel engine exhaust value and piston crown life. These coatings are being evaluated in diesel engine testing at Delaval and Cummins, and in lab testing at NRL, Eaton, LBL, NASA, and David Taylor Naval Ship R&D Center.

Keywords: Materials Characterization, Corrosion, Coatings and Films

8. Advanced Vapor Deposited Ceramic Coatings for Industrial Gas Turbines — $ 30K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Pratt & Whitney, East Hartford, Connecticut
(Contract No. DOE/PNL B-A0762-A2)
Bill Goward (203) 565-7363

OBJECTIVES: Establish the capability to produce electron beam physical vapor deposited (EB PVD) ceramic coatings with extremely high reproducible resistance to spalling for industrial/utility gas turbine airfoils.

STATUS: The approach is to determine the factors influencing reproducibility of cyclic thermal resistance. Attention is focused on phenomena affecting the metallic/ceramic interface region which control ceramic bonding and establishment of the initial ceramic segmentation structure. Coatings of this type have shown 20X improvements in life to thermal spalling at very high temperatures (2100°F) compared to the best current plasma sprayed coatings.

Keywords: Coatings and Films

9. <u>Advanced Plasma Sprayed Ceramic Coatings for Industrial Gas Turbines</u> $ 85K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
UTC, East Hartford, Connecticut (Contract No. DE-AC05-79ET15326)
Scott Duvall (203) 565-7775

OBJECTIVES: Develop durable ceramic coatings for near term turbine hot-section components, primarily airfoils, to substantially improve hot-corrosion/erosion resistance and achieve advantages of thermal insulation.

STATUS: The approach to achieve thermal stress resistance with the plasma spray deposited ceramic coatings by reducing the coatings susceptibility to thermal strain induced spallating during engine operation. The increased spalling resistance is achieved by use of ceramic compositions and process techniques which produce microcrack "toughening" and/or segmentation of the ceramic layer. Early coatings of this type on uncooled metal bars have gone 10,000 cycles in 1850°F clean-fuel burner rig tests before incipient spallation.

Keywords: Ceramics, Coatings and Films, Corrosion

10. <u>Controlled Nucleation Thermochemical Deposition of SiC Overcoat to Thermal Barrier Coatings</u> $ 42K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
San Fernando Labs, Dart Industries, Pacoima, California
(Contract No. DOE/PNL BA-0759-A2)
Bob Holzl (213) 899-7484

OBJECTIVE: (1) Produce an impervious outer layer on ceramic coatings to prevent corrosive condenstate migration on otherwise porous coatings which can accommodate engine thermal stresses, and (2) characterize fine grain size SiC coatings for improved erosion/corrosion resistance on diesel and gas turbine hot-section components.

STATUS: Specimens to be tested in mid-1981.

Keywords: Coatings and Films, Ceramics

11. <u>Improved Erosion/Corrosion Resistant Coatings for Gas Turbine Airfoils</u> $223K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Airco-Temescal, Berkeley, California (Contract No. DE-AC05-79ET15007)
Steven Shen (415) 841-5720

OBJECTIVES: (1) Improve corrosion/erosion resistance of coatings for gas turbine hot sections, and (2) systematically develop electron beam physical vapor deposited (PVD) ceramic coatings.

STATUS: A dedicated full scale PVD coating system has been developed to deposit controlled structures with Y_2O_3 stabilized ZrO_2 coatings. Systematic variations in structure achieved by variations in deposition parameters are being produced. This approach reduces contamination, down time and enhances response to iterative ceramic coating development. Stoichiometry of the deposited compound can not be precisely controlled at this stage. Efforts are being directed towards the use of controlled partial pressures of O_2 to control stoichiometry and evaporation rates. Deposit structure is being controlled by substrate temperature and specimen rotation.

Keywords: Coatings and Films

12. <u>Development of Metallic/Ceramic Layered Thermal Barrier Coatings by Triode Sputtering</u> $100K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Battelle Pacific Northwest, Richland, Washington
(Contract No. BRAA 550510)
James Patten (509) 942-2603; FTS 444-2603

OBJECTIVE: Investigate the practicality of an alternate metallic-ceramic multi-layered coating for heat engine applications to increase heat engine hot-section durability. The goal is to provide improved hot-corrosion resistance, erosion resistance and obtain a large thermal gradient between the combustion gas and the component metal substrate.

STATUS: Coatings consisting of alternate metal (Ni, Ni-Cr, CoCrAlY or Pt) and ceramic (Al_2O_3 or ZrO_2 + Y) layers are being developed. The ceramic layers should provide most of the corrosion resistance and the thermal insulation. The metal layers provide the mechanical properties. Also, coatings are being developed with dense, impermeable outer layers and more open columnar inner ceramic layers. A third approach involves filling in the intestices of an open columnar ceramic coating.

Keywords: Coatings and Films, Ceramics, Corrosion

13. Investigation of Sputtered Metallic Coating Composition Profile vs. Combustion Zone Durability $ 62K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Battelle Pacific Northwest, Richland, Washington
(Contract No. BRAA 550510)
James Patten (509) 942-2603; FTS 444-2603

OBJECTIVE: Develop metallic coatings which significantly enhance the life of gas turbine engine components operating on residual petroleum, coal-derived fuels and shale oil/petroleum fuel blends. High-rate triode sputtering is used to develop CoCrAlY coating systems modified by including high Cr near surface compositions, gradients in Cr and Al composition, underlayers and graded Pt additions and Hf substitutions for Y.

STATUS: These coatings significantly outperformed currently used coatings in 1000 hour burner rig testing conducted at the David Taylor Naval Ship R&D Center - Annapolis, Maryland. Additional testing is being planned with coal-derived fuels.

Keywords: Coatings and Films

14. Advanced Conversion Technology - Ceramic/Thermal Barrier Coatings $1,200K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
NASA Lewis Research Center, Cleveland, Ohio (Contract No. DOE/NASA IAA DE-A101-TIET-1311)
Stan Levine (216) 433-6000 x6150

OBJECTIVE: Develop the capability for industrial/utility gas turbine engines to operate on a wide range of fuels with emphasis on minimally processed coal-derived fuels by use of ceramic or thermal barrier coatings on hot-section components.

STATUS: Phase I has been completed and a competitive Phase II designed to address the problems identified in the early work is scheduled for late '81. The results obtained are discussed in the two following sections.

Keywords: Coatings and Films

15. Advanced Ceramic Coating Development for Industrial/ Utility Gas Turbines $798K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Westinghouse Electric, Concordiville, Pennsylvania
(Contract No. NASA/DOE DCN3-110)
C. A. Anderson (412) 256-7335

OBJECTIVES: (1) Develop ceramic coatings which increase industrial/utility gas turbine hot-section durability with heavy emphasis on operation with lower grade petroleum based fuels and coal-derived fuels, and (2) take advantage of the insulative properties of ceramic coatings on turbine airfoils and combustors.

STATUS: Fifty-eight types of coatings were evaluated. Initial testing on clean fuels indicated the NASA supplied $ZrO_2 8Y_2O_3$ coatings were the best. However, testing with doped fuel to simulate hot-corrosion conditions indicated that the porosity which helps the NASA coating accommodate thermal stresses also permits migration of corrosion condensates resulting in coating spallation. Three approaches were pursued; various dense sputtered outerlayers, a fine mesh screen installed at the ceramic coating - bond coat interface and a combination of the two, these coatings are about 5X more resistant than the NASA coating in burner rig tests with doped fuels.

Keywords: Coatings and Films

16. Advanced Ceramic Coating Development for Industrial/ Utility Gas Turbines $239K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Solar Turbines International, San Diego, California
(Contract No. NASA/DOE D-N3-109)
J. W. Vogan (714) 238-5500

OBJECTIVE: Development of fuel flexible, corrosion-resistant coatings for the hot-section components of industrial/utility gas turbine engines.

STATUS: Four types of ceramic coatings, all over CoCrAlY base coats, are being developed. These are $ZrO_2 + Y_2O_3$, spinel structure coatings ($MgAl_2O_4$), perovskite structure coatings ($CaTiO_3$) and two-phase ($ZrO_2 + MgO$). Three burner rig test were conducted and four coating systems were engine tested. Solar also coated the transition duct with a ceramic coating as this component has been a problem. The engine test is comprised of 50 hours calibration run followed by 500 hours of cyclic endurance test. No failures were noted at 250 hours and the engine test is continuing.

Keywords: Coatings and Films

17. High Temperature Turbine Technology (HTTT) $5,000K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
General Electric, Schenectady, New York
(Contract No. De-AC01-76ET10340)
M. W. Horner (518) 374-2211

OBJECTIVES: To bring to technology readiness a high-temperature (2600°F - 3000°F firing temperature) turbine for use in an Integrated Gasification Combined Cycle (IGCC) powerplant using coal-derived fuels. Also, evaluate the corrosion and ash deposition characteristics of the water-cooled composite turbine nozzle in simulated IGCC operation.

STATUS: Current efforts in Phase II are directed at design, fabrication and test of a large water-cooled composite nozzle in an IGCC pilot plant. The first stage nozzle composite structure consists of Nitronic 50 cooling water tubes imbedded in magnesium zirconium chromium (MZC) Copper. The copper is reinforced by Nitronic 50 spar rods and endplates and bonded to IN 617 skin cladding. The composite nozzle is hot isostatically pressed (HIP) and inspected by ultrasonic and eddy current NDE techniques. This nozzle has been successful in early rig testing. The first, second, and third stage blades are forged IN-718 with airfoil heights of up to 12". Techniques were developed to accurately drill 0.060" diameter cooling passages at the leading and trailing edge and 0.080" diameter passages elsewhere in the airfoil. The large nozzles were cast. Advanced segmented mold techniques were developed to eliminate shrinkage related problems.

Keyword: Alloy Development

18. <u>High Temperature Turbine Technology (HTTT)</u> $3,500K

DOE Contact - G. Manning (202) 353-2817; FTS - 233-2817
Curtiss-Wright, Wood-Ridge, New Jersey
(Contract No. DE-AC01-76ET10348)
John Wolf (201) 891-4097

OBJECTIVES: To develop to technology readiness, a turbine system capable of turbine inlet temperatures exceeding 2600°F, while limiting cooling requirements, operating on coal-derived fuels. Specifically, develop transpiration-air cooled turbine airfoils capable of durable operation in the corrosion-erosion and deposition environment of coal-derived fuels.

STATUS: Phase II efforts primarily involved initial testing of the LP rig engine test with clean distillate fuel and then with Al_2O_3 particles, alkali-metal salts and fly ash particulates injected into the hot-gas stream. The transpirational cooled airfoils are of either a wound or a woven configuration. The orientations used were circumferential and diagonal with four wire diameters from 0.0045 to 0.023". Nichrome V-Cb was used for the airfoil forming mesh. The permeability of these essentially screen meshes installed on an airfoil spar was 3.6×10^{-11} in^2. The rig engine test included a full set of transpirational cooled airfoils in the rotor and stator assemblies. After 644 hours operation, of which 500 hours was with contaminants, no sulfidation was noted, oxidation depth was <.001" and the maximum fly ash deposites were 0.010" but the fly ash did not penetrate beyond the surface wires. Testing is continuing. Plans are being implemented to test the engine rig on SRC-II middle distillate in FY '81.

Keywords: Alternate Materials, Corrosion

19. <u>High Temperature Evaluation of Ceramic Materials for Corrosion/Erosion Exposure</u> $ 50K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
IIT Research Institute, Chicago, Illinois
(Contract No. AF-F33615-79-C-5100)
D. C. Larsen (312) 567-4400

OBJECTIVES: Evaluation of the high temperature mechanical properties of various ceramic materials that will be exposed to corrosion/erosion tests at METC.

STATUS: This work is an add-on to an Air Force Wright Aeronautical Laboratory contract. This approach helps standardize analysis of these ceramic materials in a cost-effective manner. Approximately 760 samples, nominally 50 samples each of 14 materials will be tested prior to static soak test in coal-derived low-Btu gas product of combustion environment.

Keywords: Materials Characterization

20. Applications of Composite Gas Turbine Components $300K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
G.E., Schenectady, New York (Contract No. DE-AC01-80ET17005)
Gene Kunkel (518) 385-7206

OBJECTIVE: Obtain the advantages of 150°F increased turbine inlet temperature, with attendant increased efficiency, as well as significantly enhanced turbine airfoil life under coal-derived fuel combustion environments. Turbine airfoils are the current engine life-limiting component.

STATUS: This program involves developing bonding techniques to mate a turbine airfoil section made by directional solidification (DS) techniques with alloys designed for high temperature erosion/corrosion resistance, improved tensile strength and ductility to a powder metallurgy root section optimized for low cycle fatigue resistance. Contract work is in initial stages.

Keywords: Materials Processing, Materials Characterization

21. Ceramic Corrosion/Erosion Project Description $800K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
Morgantown Energy Technology Center, Morgantown, West Virginia (Contract No. IR-442 (1979))
C. V. Nakaishi (304) 599-7722

OBJECTIVE: Create a technology base for candidate materials to be used in stationary gas turbine engines operating on coal-derived, low-Btu gas products of combustion.

STATUS: The major effort has been involved in facility development.

Keywords: Alternate Materials, Ceramics

22. Application of Proof Testing to Brittle Materials at High Temperature — $100K

DOE Contact - J. W. Fairbanks (301) 353-2816; FTS - 233-2816
National Bureau of Standards, Gaithersburg, Maryland
(Contract No. EA-77-A-01-6010/T.O. A086CPS)
Dr. Nancy Tighe (301) 921-2901

OBJECTIVE: Test and evaluate candidate ceramic materials for stationary turbine applications. Specifically, determine physical and chemical limitations that limit proof testing for reliability projections.

STATUS: This work is divided into four tasks as follows:

1. Effect of high temperature exposure on strength distribution of ceramic materials with natural and artificial flows.

2. Microstructural analysis to characterize the mechanisms of strength degradation.

3. Proof testing of ceramic specimens to validate the concept.

4. Effect of simulated turbine environment on strength of silicon-based ceramics.

Proof testing is a method of assuring the reliability of structural ceramics. Proof tests truncate a distribution to eliminate component infant mortality. Previous work has shown significant effects of life of silicon nitride from billet characteristics through machining, heat treatment and exposure. Strength distributions with various ceramic specimens exposed at 1200°C for times up to 1000 hours have been obtained to evaluate long-term reliability. Creep-rupture experiments are also being tested. Proof testing is beginning.

Keywords: Ceramics, Materials Characterization

Fuels Cell Division

1. Fuel Cells $7,500K

DOE Contact - M. Zlotnick (301) 353-2816; FTS - 233-2816
Phosphoric Acid - L. D. Nichols, NASA Lewis Research Center (216) 433-6135; FTS 294-6135
DOE Contact - G. L. Hagey (301) 353-2820; FTS - 233-2820
Molten Carbonate and Solid-Oxide Electrolyte - John Ackerman, ANL (312) 972-4545; FTS 972-4545

Develop technology required to make fuel cells commercially viable. This involves reducing costs while increasing lifetime and performance. The materials-related effort is completely integrated within the R&D so it cannot be broken out separately in a meaningful way. As a rough estimate, on the order of 25% might considered to be related to materials R&D. Typical materials issues include corrosion, both as it affects the cells under their operating potentials and as it affects contiguous ducts or manifolds; sintering of catalysts; development of low-cost manufacturing processes; achieving requisite porosity distribution while maintaining structural integrity.

Status:

- Successfully tested new integrated phosphoric acid fuel cell stacks. This is considered significant because the integrated stack concept has the potential of significantly reducing cell manufacturing costs while increasing stack life because of its compatibility with mass production techniques.

- Initiated an on-site/integrated energy system power technology advancement program, with cost-sharing from GRI.

- Initiated an electric utility powerplant technology development program with cost-sharing from EPRI, TVA and some electric utilities.

- Verified feasibility of thermally cycling molten carbonate fuel cells, previously believed to be a limiting problem.

- Identified and established feasibility of a potentially cost effective internally-manifolded molten carbonate stack design, and successfully tested cells for this design of approximately 1 square foot area.

- o Established feasibility of a simple, externally-manifolded molten carbonate stack design with cell components manufactured by methods suitable for mass production, and successfully tested such components.

- o Demonstrated feasibility of mass production of full-scale molten carbonate fuel cell electrolyte structures by two methods: tape casting and hot pressing. 10,000 hour tests without electrolyte addition were completed.

- o Over 1,500 hours of stable performance in a 7-cell solid oxide stack at 400 mA/cm^2 with 0.7 volts/cell was demonstrated, exceeding target specification; also demonstrated 10 watts in a 20-cell stack.

<u>Heat Exchanger Research Program</u>

Several material R&D projects that are in the process of being relocated into the Conservation and Solar ECUT Program received funding in FY 1980 from the Division of Fossil Fuel Utilization. These projects were managed by the Office of Coal Utilization, as part of Fossil Energy's Advanced Research and Technology Development (AR&TD) Program. Details on these projects, part of the Heat Exchanger Technology Program, are contained below.

1. <u>Flow-Induced Tube Vibration of Shell-and-Tube Heat Exchangers</u> $165K

DOE Contact - Bill Thielbahr, (208) 526-0682
Argonne National Laboratory (Contract No. ANL-189-Nos. 499909, 49913)
Marty Wambsganss - (312) 972-2000, ext. 6144

Attempting to evaluate and improve current tube vibration prediction methods and design criteria. Work divided into two tasks: (a) Heat Exchanger Tube Vibration Tests, and (b) Heat Exchanger Tube Vibration Data Bank. The tube vibration test activity involves water flow testing of segmentally-baffled shell-and-tube heat exchangers. The vibration data bank task involves collecting and cataloging field experience data pertaining to heat exchanger tube vibration.

Keywords: Non-Destructive Evaluation

2. <u>Low Cost Fabrication of Spirally Fluted Tubes</u> $ 40K

DOE Contact - Bill Thielbahr, (208) 526-0682
General Atomic Company (Contract No. ET-78-C-05-5761)
Jack Yampolsky - (714) 455-3645

The objective of this program is to evaluate the manufacturing cost and thermal performance of spiral fluted tubes (internal and external) for augmenting heat transfer in waste heat recovery/conversion applications. Spirally fluted tubes made from 6061 aluminum, steel (Type 410, Type 409) and titanium will be analyzed.

Keywords: Materials Processing

3. <u>Fouling and Acid Corrosion of Heat Exchangers in Diesel Exhaust Streams</u> $ 80K

DOE Contact - Bill Thielbahr, (208) 526-0682
Garrett Airesearch Mfg. Company (Contract No. EC-77-C-03-1447)
Max Greeven - (213) 323-9500, ext. 3521

Program to experimentally determine rates of fouling and acid corrosion of candidate heat exchanger materials/surfaces immersed in the exhaust of large, stationary diesel engines. The program addresses the characterization of diesel exhaust streams and the collection of heat transfer, pressure drop, fouling and acid corrosion data from heat exchanger segments inserted into actual diesel engine exhaust streams.

Keyword: Corrosion

4. <u>Evaluation of High Efficiency Heat Transfer Techniques</u> $ 58K

DOE Contact - Bill Thielbahr, (208) 526-0682
Heat Transfer Research, Inc. (Contract No. ET-78-C-03-2167)
John Clegg - (213) 570-3980

Project designed to provide the capability to evaluate the degree of heat transfer enhancement associated with realistic fluids and heat exchanger surfaces including the possible effects of fouling; to provide an assessment of the importance and usefulness of this information and to disseminate it to all major manufacturers and users of heat exchanger equipment; and to incorporate this information into a form that can be effectively used by heat exchanger designers.

Keywords: Materials Characterization

successful economic operation of commercial MHD power systems will depend to a large measure on the availability of reliable materials of construction, capable of extended service at MHD operating conditions. The primary objective of the Materials Program of the Office of MHD is the development of materials applicable to the unique operating environment of coal-fired MHD systems. Program effort is divided into two general categories: 1) research effort to provide a fundamental understanding of materials behavior and a basis for the development of particular materials properties for MHD systems, and 2) applied engineering development of MHD component materials. Materials development effort within the Office of MHD is coordinated by the Program Manager for Materials Development through the Office of the Director. Development effort in the first category is managed by the Division of Research and Advanced System Development, and effort in the second category by the Division of Engineering Development.

The MHD Materials Development Program is made up of three key areas:

Development of MHD Generator Electrode and Insulator Materials

The objectives of this area are to define the thermal, electrical, chemical and fluidynamic environment of electrode materials and to develop electrode and insulator materials applicable to this environment. Service conditions include: temperatures up to 2000°C, heat fluxes up to 300 w/cm^2, exposure to magnetic fields of 50,000-60,000 Gauss, exposure to strongly alkali chemical species and reducing gases, current densities up to 1 amp/cm^2, and sonic velocities.

Program effort is currently directed toward the development of alternative electrode concepts; the development of cold (externally cooled) metallic electrodes, hot (1200-1900°K) refractory electrodes, and superhot (>1900°K) ceramic electrodes. Among the metals, Ni, Co, Cr, Fe, W, Ti, Ta, Nb and their alloys have been evaluated. Among the refractories a number of spinels based on Al, Fe, La, Cr and Mn have been evaluated. Among the high temperature ceramics a number of materials based on rare earth doped ZrO_2 and HfO_2 have been evaluated. Key materials development contractors for this area are: Avco-Everett Research Laboratory, Westinghouse Electric Corporation, Battelle Northwest Laboratory, Massachusetts Institute of Technology, and Stanford University.

Heat Recovery/Seed Recovery (HRSR) System Materials

The HRSR System consists of the MHD radiant boiler, superheater, air heater, economizer and various downstream components. Materials applications include radiant and convective heat transfer surfaces exposed to MHD flue gases under both reducing and oxidizing conditions at temperature varying from 300-3800°F. In addition, these gases contain appreciable quantities of slag and alkali salts (added to enhance conductivity in the MHD process) that are condensed to form liquid and solid deposits on downstream heat transfer surfaces. Current materials development effort is focused on evaluation of candidate materials for two critical components: the radiant boiler, where the concerns are high temperature corrosion/erosion under reducing gas conditions and loss of seed to the slag, and; the intermediate temperature air heater, where the concern is corrosion in the seed condensation zone. Major materials development efforts are thus directed toward the characterization of environmental conditions (temperatures, velocities, chemical species) on a component-by-component basis and corrosion endurance testing of candidate heat transfer surface materials. Key materials development contractors for this area are: Babcock and Wilcox Company, Argonne National Laboratory, Mississippi State University, and National Bureau of Standards.

Development of High Temperature Ceramic Air Heater Materials

The thermodynamic efficiency of an MHD system is enhanced significantly by increase in combustion air temperature, therefore, the development of heaters capable of preheating air to temperatures of 2800°F or higher is being actively pursued by the Office of MHD. Ceramic materials have been chosen for development over metals because they offer potentially greater advantages in higher service temperatures, heat loss, chemical stability, fabrication, and cost. Development of both the direct-fired and indirect-fired air heater concepts are in progress. Direct-fired air heater materials, including chrome magnesia and magnesia bonded magnesia-alumina spinels, have been evaluated under MHD flue gas conditions with promising results. Indirect-fired air heater materials, including Al_2O_3, MgO, and SiO_2, have performed well in the relatively clean environment of indirectly-fired systems. Key materials development contractors for this area are: FluiDyne Engineering Company, General Electric Company, Montana Energy MHD Research and Development Institute, Montana State University, Montana College of Mineral Science and Technology, and National Bureau of Standards.

Budget Level Summaries

In FY 1981, approximately $5.5 million will be expended on materials development related efforts for MHD systems and components. Included below are summaries of major contracts related to the MHD Materials Program development effort.

1. <u>Materials for MHD Balance-of-Plant Systems</u> $1,400K

DOE Contact - Dr. J. Hopenfeld - (301) 353-5927; FTS 233-5927
Argonne National Laboratory (Contract No. 49745)
T. R. Johnson - (312) 972-5970; FTS 972-5979

Development of materials corrosion information for MHD Heat Recovery/Seed Recovery (HRSR) components (e.g., air heater, superheater). Investigate seed/slag corrosion of materials. Conduct laboratory materials screening studies and provide long term (<2000 hr.) corrosion data on selected alloys (Incoloy 800, Type 304 and Type 310 stainless steel, Fe-2.25Cr-1Mo.).

Keywords: Corrosion, Materials Characterization

2. <u>MHD Channel Development</u> $10,000K

DOE Contact - J. Klepeis - (301) 353-5915; FTS 233-5915
Avco-Everett Research Laboratory, Inc. (Contract No. DE-AC01-80ET15614)
R. W. Detra - (617) 389-3000

MHD Channel Development in support of the engineering data base necessary for the design and construction of MHD generators. Test existing channel hardware and fabricate and test new channel hardware. Conduct performance tests on channel loading of control, lifetime, and durability at the Component Development and Integration Test Facility (CDIF), Butte, Montana. Development of hardware for CDIF generators.

Keywords: Alloy Development, Corrosion, Erosion and Wear

3. <u>Heat Recovery and Seed Recovery Development Project</u> $2,100K

DOE Contact - Dr. V. K. Der - (301) 353-5935; FTS 233-5935
Babcock & Wilcox Company (Contract No. DE-AC02-79CH10018)
A. H. Arkett - (216) 753-4511

Engineering design and construction of a 20 MW_t scale HRSR System at the Coal Fired Flow Facility (CFFF) of the University of Tennessee Space Institute. Screening tests for the selection of candidate materials for the 20 MW_t HRSR System are in progress. The 20 MW_t HRSR System to be utilized to evaluate long-term performance characteristics of materials (corrosion, erosion, useful service life).

Keywords: Alloy Development, Corrosion, Erosion and Wear

4. MHD Electrode Development $400K

DOE Contact - Dr. J. Hopenfeld - (301) 353-5927; FTS 233-5927
Battelle Memorial Institute, Pacific Northwest Laboratory
(Contract No. EX-76-C-06-1830)
J. Lambert Bates - (509) 946-2579

Development, testing, characterization, and evaluation of materials for open-cycle, coal-fired MHD power generators. Test and evaluation of the effects of alkali seed on ceramic and metal electrode materials and insulator materials in a dc electric field. Fabrication and testing of improved electrodes and insulators with controlled electrical, chemical, and physical properties. Characterization and evaluation of materials tested under the USSR and US MHD Program.

Keywords: Ceramics, Materials Characterization

5. MHD Air Heater Development $1000K

DOE Contact - Dr. J. Hopenfeld - (301) 353-5927; FTS 233-5927
FluiDyne Engineering Corporation (Contract No. DE-AC01-80ET15602)
David G. DeCoursin - (612) 544-2721

Development of a directly-fired high temperature air heater (HTAH) for MHD powerplants. Development of ceramic materials technology for the directly-fired HTAH. Demonstration of HTAH operability and acquisition of information on life and corrosion resistance of HTAH materials. Identification of control requirements and design needs for full-scale HTAH development.

Keywords: Ceramics, Materials Characterization, Corrosion

6. Testing and Evaluation of Heat Recovery/Seed Recovery $2100K

DOE Contact - L. D. Sullivan - (301) 353-5914; FTS 233-5914
Mississippi State University (Contract No. DE-AC02-80ET15601
Dr. D. L. Murphree - (601) 325-2105

Simulate MHD environmental conditions for Heat Recovery/Seed Recovery (HRSR) components using the Dynamic Flow Test Sand constructed at MSU and obtain corrosion/erosion data for component materials. Conduct preliminary screening tests to select candidate materials for MHD radiant boiler and superheater components. Conduct post-test materials analysis to determine corrosion/erosion mechanisms.

Keywords: Corrosion, Erosion and Wear, Materials Characterization

7. Materials Evaluation $1420K

DOE Contact - J. Hopenfeld - (301) 353-5927; FTS 233-5927
The Montana Energy and MHD Research and Development Institute, Inc. (MERDI), Contract No. EF-77-C-01-2524
Subcontracts: Montana State University; Montana College of Mineral Science and Technology
Dr. G. E. Youngblood - (406) 494-6100

Materials support for MHD High Temperature Air Heater (HTAH) Program. Evaluation of fusion cast refractory bed material for direct-fired HTAH. Establishment of a Materials Properties Data Base for HTAH Refractory Materials. Materials Performance Evaluation (Erosion, Cracking, Slag Deposition and Penetration) and Bench Scale Characterization (Slag Wettability, Thermal Cycling and Clean-Out Additives).

Keywords: Materials Characterization, Ceramics, Erosion and Wear

8. MHD Electrode Development $1400K

DOE Contact - Dr. J. Hopenfeld - (301) 353-5927; FTS 233-5927
Massachusetts Institute of Technology, Energy Laboratory (Contract No. DE-AC01-79ET15518)
Prof. J. F. Louis - (617) 253-1760

Investigation of thermal and electrical phenomena for the design of MHD electrode and insulating walls. Determine performance degradation from electrical arcing and the extent of damage to the channel walls. Investigate critical performance issues in the development of combustion disk generators with particular emphasis on the determination of the effective plasma properties. Design, construction of dielectric breakdown of insulator materials and coal slag. Examine coal combustion kinetics relevant to the two-stage MHD combustors focusing on coal oxidation kinetics and ash behavior.

Keywords: Erosion and Wear

9. MHD Air Heater Development $150K

DOE Contact - Dr. J. Hopenfeld - (301) 353-5927; FTS 233-5927
National Bureau of Standards (Contract No. EA-77-A-01-6010)
Samuel J. Schneider, Jr. - (301) 921-2893

Determination of seed/slag interactions and associated effects. Determination of alkali seed retention of slags produced by coal combustion in an MHD seeded environment. Phase equilibrium studies to determine the flow of slag and condensed seed and its effect on the operation of downstream MHD components. Electrical conductivity measurements on slag (containing large amounts of iron or calcium) from a coal burning steam plant. Determine corrosion of downstream MHD components by testing type 316 stainless steel exposed to oxygen-rich and fuel-rich environments with K_2SO_4 and K_2CO_3 seeding. Examine feasibility of using metal and ceramic coatings on mild steels.

Keywords: Ceramics, Corrosion

10. High Magentic Field MHD Generator Program $1600K

DOE Contact - L. D. Sullivan - (301) 353-5914; FTS 233-5914
Stanford University (Contract No. DE-AC01-80ET15611)
Prof. C. Kruger - (415) 497-1745

Investigate electrode degradation mechanisms (e.g., erosion and arc discharge phenomena under transient operating conditions). Construct and evaluate experimental MHD generator electrode configurations utilizing the MHD facilities of the Stanford High Temperature Gas Dynamics Laboratory.

Keywords: Erosion and Wear

11. MHD Coal Fired Flow Facility (CFFF) $7616K

DOE Contact - Dr. R. G. Lightner - (301) 353-5920; FTS 233-5920
University of Tennessee Space Institute (Contract No. DE-AC02-79ET10815)
Dr. J. B. Dicks - (615) 455-0631

Engineering development and evaluation of MHD components and materials in CFFF. The CFFF Low Mass Flow Facility is an operational 8 lb/sec mass flow facility capable of MHD test operation for periods of up to 100 hr. Performance testing of electrode materials, radiant furnace materials, and downstream system materials.

Keywords: Materials Characterization

12. MHD Electrode Development $1200K

DOE Contact - Dr. J. Hopenfeld - (301) 353-5927; FTS 233-5927
Westinghouse Electric Corporation (Contract No. DE-AC01-79ET15529)
John W. Sadler - (412) 892-5600

Development, evaluation, and fabrication of MHD electrode and insulator materials. Alloy selection for Cold Metallic Anodes, (Pt, Cu, TiB_2). Evaluation of candidate insulator materials (Al_2O_3, Al_2O_3-Cr_2O_3, $MgAl_2O_4$-Cr_2O_3, $MgAl_2O$, MgO). Evaluation of hot (1200-1900°K) refractory electrodes and superhot (>1900°K) ceramic electrodes. Investigation of anode arc erosion phenomena.

Keywords: Alloy Development, Ceramics, Corrosion

13. Closed Cycle Plasma MHD $1000K

DOE Contact - Dr. Stephen Sacks - (301) 353-5940; FTS 233-5940
General Electric Company (Contract No. ET-78-C-01-3106)
Dr. C. S. Cook - (215) 962-4610

Analytical investigation of the fluid dynamic, electromagnetic, and kinetic phenomena in Closed Cycle MHD Systems. Detail design, construction, and experimental testing of a direct coal fired ceramic regenerative heat exchanger/combustor system. Evaluation of ceramic degradation and resulting particulate formation. Evalution of combustion gas absorption by ceramics, ceramic temperature gradients, and gas stream contamination.

Keywords: Ceramics, Corrosion, Erosion and Wear, Materials Characterization

NUCLEAR ENERGY

The Assistant Secretary for Nuclear Energy is in charge of Nuclear Reactor Programs, Naval Reactors, and Nuclear Waste Management; and all the activities associated with these offices. The Office of Nuclear Reactor Programs is responsible for the research and development programs associated with fission energy, including converter reactors, breeder reactors; the evaluation of alternative reactor fuel cycle concepts, including nonproliferation considerations; development of advanced isotope separation processes and space nuclear and special terrestrial generator systems. Naval Reactors is responsible for the development of naval nuclear propulsion plants and reactor cores. The Office of Nuclear Waste Management provides direction for the planning, development and execution of DOE programs for civilian and defense nuclear waste processing and disposal, spent fuel storage and transfer, transportation of nuclear waste materials, and decommissioning and decontamination of DOE nuclear facilities. Much of the effort in Nuclear Energy, especially the nuclear reactor programs, is directed toward technology and engineering development and as such have significant materials efforts spanning the range of research through demonstration of major components and systems.

Office of Naval Reactors

The Materials Research and Development Program is in the Division of Naval Reactors under the Deputy Assistant Secretary for Naval Reactors. The program supports the development and operation of improved and longer life reactors and pressurized water reactor plants for naval nuclear propulsion. In addition, this program supports the Light Water Breeder Reactor (LWBR) currently operating in the Shippingport Atomic Power Station and the Advanced Water Breeder Activity to develop technical information that will assist U.S. industry in evaluating the LWBR for commercial scale applications.

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

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

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

The materials program effort applied to the Water Breeder Reactor program includes irradiation testing of fuel rods utilizing the thorium-uranium-233 fuel cycle, which has the potential for providing appreciably more energy than the current design of water reactors. This testing provides the basis for the development of analytical models for use in calculating the performance of fuel rods in pressurized water reactors.

Funding for this materials program is incorporated in naval projects jointly funded by the Department of Defense and the Department of Energy and the Water Breeder Reactor program funded by the Department of Energy. This funding amounts to approximately $50 million dollars in FY 1980, including about $19 million as the cost for irradiation testing in the Advanced Test Reactor.

Office of Nuclear Reactor Programs

Office of Advanced Nuclear Systems and Projects

The Office of Advanced Nuclear Systems and Projects is composed of three Divisions: (1) Space and Terrestrial Systems, responsible for developing radioisotope thermoelectric generators, heat and radiation sources for use in space and terrestrial applications, and advanced space power reactors, (2) Advanced Isotope Separation, responsible for developing new and lower cost methods for obtaining uranium enrichment, and evaluating advanced concepts for isotopic separation for nuclear power applications, and (3) Gas Cooled Reactor Programs Division, responsible for developing the technology to format the commercialization of High Temperature Gas Reactors. Further information can be obtained from Dr. F. E. Coffman, Director, ANSP (301) 353-5006; FTS 233-5006.

Advanced Isotope Separation Division

The major objectives of the Advanced Isotope Separation (AIS) Program are to:

- o conserve uranium resources by developing technologies which will permit the economic lowering of the tails assay for the U.S. enrichment complex,
- o develop a separation technology which will reduce the cost of primary enrichment to less than one half that for the current production process,
- o evaluate the technical feasibility and proliferation implications of new and alternate enrichment technologies, and
- o apply advanced isotope separation technologies to the solution of other energy problems.

Three processes are under development for applying advanced isotope technology. They are the molecular laser process, the atomic vapor laser process and the plasma separation process. Most of the details of the research and development are classified 'restricted data' as defined in the Atomic Energy Act of 1954, as amended.

One dedicated materials effort is supported by the AIS Program and is summarized below. However, as is the case for any evolving technology, development of components and subsystems requires a continuous decisionmaking process on materials selection, applications, property evaluation, analysis and testing. These efforts amount to approximately $2.7 million dollars, making the overall AIS materials component approximately $5.8 million dollars. Of this, approximately one half is devoted to metals and alloys and the balance to ceramics and glasses. For more details the Director of the Advanced Isotope Separation Division, Dr. N. Haberman (301) 353-5017, FTS 233-5017, should be contacted.

1. Materials Handling and Compatibility $3,100K

DOE Contact - A. P. Litman (301) 353-5777; FTS 233-5777
Y-12 Plant, Union Carbide Corporation-Nuclear Division
(Contract No. W-7405-eng-26)
W. J. Hulsey (615) 574-1749; FTS 624-1749

Develop coatings for deposition on various substrates to contain uranium. Development and demonstration of engineering components for source and collector regions of AIS enrichment systems.

Keywords: Coatings and Films, Corrosion; Uranium

Gas Cooled Reactor Programs Division

The objective of this program is to develop the technology required to permit the commercialization of gas cooled thermal reactors which will satisfy some of the future energy needs of the country. The FY 1980 budget outlay for this Division was $35.9 million and as indicated below, approximately one-third of this budget was devoted to fuels and materials development work.

1. Fuel Development $2,700K

DOE Contact - J. E. Fox, (301) 353-5634; FTS 233-5634
General Atomic Company (Contract No. DE-AM03-76SF00167)
O. M. Stansfield - (714) 455-2895

Development of high-temperature coated-particle fuels and fuel rods. Ceramic fuel kernel preparation and coating process development. Irradiation testing, performance demonstration and specific preparation.

Keywords: Fuel Development; Coated Particles, Radiation Effects, Thermal Stability

2. <u>Fuel Development</u> $1,600K

DOE Contact - J. E. Fox, (301) 353-5634; FTS 233-5634
Oak Ridge National Laboratory (Contract No. W-7405-ENG-26)
F. J. Homan - (615) 574-5169; FTS 624-5169

Development, preparation and demonstration testing of coated-particle fuels and fuel rods in ORNL test reactors. Preparation of fissile and fertile fuel kernels, applications of multi-layer ceramic coatings, preparation of fuel rods, fabrication and testing of irradiation capsules, and analysis of results.

Keywords: Fuel Development; Coated Particles, Radiation Effects, Thermal Stability

3. <u>Graphite Development</u> $1,200K

DOE Contact - J. E. Fox, (301) 353-5634; FTS 233-5634
General Atomic Company (Contract No. DE-AM03-76SF00167)
G. B. Engle - (714) 455-2894

Evaluation and development of graphites for use as fuel and reflector blocks and core support blocks and posts. Determination of oxidation rates and effects on strength, and effects of irradiation on dimensional changes and mechanical and physical properties.

Keywords: Ceramics; Graphite, Radiation Effects, Oxidation, Materials Characterization

4. <u>Graphite Development</u> $700K

DOE Contact - J. E. Fox, (301) 353-5634; FTS 233-5634
Oak Ridge National Laboratory (Contract No. W-7405-ENG-26)
W. P. Eatherly - (615) 574-5220; FTS 624-5220

Determination of effects of irradiation on creep properties and dimensional changes of HTGR candidate graphites. Determination of oxidation rates and the effects on strength of candidate materials. Characterization of samples and effects on mechanical properties.

Keywords: Ceramics; Graphite, Radiation Effects, Oxidation, Materials Characterization

5. <u>Alloy Evaluation</u> $4,200K

DOE Contact - J. E. Fox, (301) 353-5634; FTS 233-5634
General Atomic Company (Contract No. DE-AM03-76ET34202)
D. I. Roberts - (714) 455-2560
General Electric Company (Contract No. DE-AC02-76ET34202)
R. G. Frank - (518) 385-2224
Oak Ridge National Laboratory (Contract No. W-7405-ENG-26)
R. L. Rittenhouse - (615) 574-5103; FTS 624-5103

Evaluation and development of high-temperature alloys for primary circuit applications (heat exchangers, ducts, thermal barriers) in HTGR's. Mechanical property and corrosion evaluations after extended exposures in simulated HTGR environments.

Keywords: Alloy Development, Corrosion, Thermal Stability, Materials Characterization; Mechanical Properties

Space and Terrestrial Systems Division

This division is responsible for radioisotope thermoelectric generator heat and radiation sources for use in space and terrestrial applications and advanced space power reactors.

1. <u>Iridium Alloy Processing and Fabrication</u> $800K

DOE Contact - C. O. Tarr (301) 353-2907; FTS 233-2907
Oak Ridge National Laboratory
R. H. Cooper (615) 574-4470; FTS 624-4470 - Contract W-7405-eng-26

Iridium alloys are prepared from purchased powders and processed to sheet from electron beam plus arc-cast melted ingots. The alloys must meet nuclear/aerospace quality and processing control specifications.

Keywords: Alloy Development, Materials Processing

2. <u>Materials Technology Support</u> $400K

DOE Contact - C. O. Tarr (301) 353-2907; FTS 233-2907
Oak Ridge National Laboratory
R. H. Cooper (615) 574-4470; FTS 624-4470 - Contract W-704-eng-26

Iridium alloy properties were characterized in support of the General Purpose Heat Source system requirements. Mechanical properties, physical properties and stability of the iridium base alloy DOP 26 in space flight system environments were measured in support of system design.

Keywords: Materials Characterization

3. Carbon Bonded Carbon Fiber Insulation Development (CBCF-3) $300K

DOE Contact - C. O. Tarr (301) 353-2907; FTS 233-2907
Oak Ridge National Laboratory
R. H. Cooper (615) 574-4470; FTS 624-4470 - Contract W-7405-eng-26

Processing procedures and the physical/mechanical properties of CBCF-3 were developed in FY 1980 aimed at the 0.20 - .24 gram/cm^3 density range. CBCF-3 in FY 1981 will be produced for General Purpose Heat Source space missions.

Keywords: Ceramics, Materials Processing, Materials Characterization

4. Cesium-137 Terrestrial Isotope Development $125K

DOE Contact - W. C. Remini (301) 353-2962; FTS 233-2962
Oak Ridge National Laboratory
E. Lamb, F. N. Case; FTS 624-7095 - Contract W-7405-eng-26

Development of $^{137}CsAlSi_2O_6$ as an insoluble ceramic gamma emitter fuel. Physical properties of the hot pressed material and source design for highest source efficiency.

Keywords: Ceramics, Materials Characterization

5. Strontium-90 Heat Source Development $150K

DOE Contact - W. C. Remini (301) 353-2962; FTS 233-2962
Pacific Northwest Laboratory
H. H. Van Tuyl, H. T. Fullam; FTS 444-3577 - Contract RL01830

Qualification testing to IAEA Series 33 requirements for both Hastelloy-S and Hastelloy-C4 clad strength members for double walled capsules.

Keywords: Ceramics, Materials Characterization

6. General Purpose Heat Source $2,000K

DOE Contact - G. Bennett (301) 353-3197; FTS 233-3197
Los Alamos National Scientific Laboratory
S. Bronisz (505) 667-4782; FTS 843-4782 - Contract AL-7405-eng-36

Assembly and testing of $^{238}PuO_2$ fuel bodies encapsulated in iridium alloy clad vent sets and inserted into fine weave pierced fabric graphites was conducted using developmental heat source components. Testing included system compatibility, high temperature - high strain rate impact studies. Launch incident evaluations have included and will include launch pad abort fire, reentry impact, blast overpressure, sequential testing and component qualification tests.

Keywords: Ceramics, Materials Characterization

7. Space Power Advanced Reactor (SPAR) $2,000K

DOE Contact - Major R. E. Smith, Jr. (USAF) (301) 353-4021; FTS 233-4021
Los Alamos National Scientific Laboratory
D. Buden (505) 667-5540; FTS 843-5540 - Contract AL-7405-eng-36

Titanium-potassium and molybdenum-sodium heat pipes containing wire wicks are under development for the SPAR radiator and reactor core, respectively. These heat pipes are essential components of the SPAR design targeted for future Space Shuttle launch. The wire mesh artery wicks will be evaluated during the heat pipe engineering tests.

Keywords: Materials Characterization

Office of Light Water Reactors

Fuels and Components Division

The Fuels and Components Division, is responsible for fostering the design development, demonstration, and commercial utilization of a wide range of technologies associated with Light Water Reactors (LWR's) in accord with National energy policies and goals. Principal objectives of the Division's efforts are to increase fuel utilization, improve plant availabilities, and reduce occupational radiation exposures to powerplant personnel. The Division also contributes to broader objectives of the Office of Light Water Reactors associated with speeding up project times for plants under construction, increasing safety and reliability, and fostering a favorable policy climate for continued use of LWR's. No separately identified materials program exists within the projects being sponsored by the Division. However, materials testing and development work is underway within several of the projects. This R&D work for FY 1980 in the materials area is described below.

Further information can be obtained by contacting J. W. Bennett, Acting Director, Fuels and Components Division, Office of Light Water Reactors (301-353-3692) (FTS 233-3692).

1. Materials Support for Steam Generator Chemical Cleaning $235K

DOE Contact - Jeffrey Hangst (301) 353-3692; FTS 233-3692
Commonwealth Edison, Commonwealth Research Corp. and Dow Chemical Corp.

Perform tasks to qualify PWR steam generator materials for application of chemical cleaning processes to secondary side of generators. Studies include corrosion tests of coupons in autoclave and in model steam generators at PWR operating temperatures and pressures.

Keyword: Corrosion

2. Materials Support for Oxygen Suppression Program $140K

DOE Contact - Jeffrey Hangst (301) 353-3692; FTS 233-3692
Commonwealth Edison, Commonwealth Research Corporation, General Electric Company

Materials tests to qualify BWR piping materials for use with low-oxygen coolant water. The program which is designed to support a one-month demonstration of oxygen suppression at the Dresden 2 reactor, includes corrosion tests, constant extension rate tests, and straining electrode tests of BWR piping materials in test loops and in-reactor loops.

Keyword: Corrosion

3. Demonstration of LWR Fuels with Improved Pellet-Cladding Interaction Performance $300K

DOE Contact - Peter M. Lang, (301) 353-3313; FTS 233-3313
Commonwealth Research Corp., General Electric Co., Consumers Power Co., Exxon Nuclear Co., Battelle-Pacific Northwest Laboratories

Develop and demonstrate improved fuel concepts designed to eliminate pellet-cladding interaction (PCI) caused fuel failures. Designs being developed are annular fuel pellets with graphite coated cladding, sphere pac fuel, and metal liners of either zirconium or copper. The projects include in-reactor parameter testing, laboratory testing, and test-reactor ramp testing to examine power ramp performance and stress corrosion cracking in both unirradiated and irradiated specimens. Out-of-reactor tests provide mechanical and corrosion properties required for continuing evaluations and/or to support fabrication and licensing. Large scale commercial reactor demonstrations of the prototype fuels will be conducted to show improved fuel performance.

Keywords: Materials Characterization, Radiation Effects

4. Fission Gas Release From High Burnup Fuel $300K

DOE Contact - Peter M. Lang 353-3313; FTS 233-3313
Battelle-Pacific Northwest Laboratories, Riso National Laboratory (Denmark)

Obtain fission gas data from UO_2 fuel irradiated to high burnups, i.e., >33,000 MWd/MT. Multi-sponsored projects with several countries participating. The projects include an updated evaluation of the current state-of-the-technology on this subject. The experimental phase includes burnup testing well-characterized fuel types to high power levels with subsequent examination, fission gas sampling, and continued irradiation. Selected samples will be destructively examined to provide data on burnup, fuel structure and other characteristics.

Keywords: Materials Characterization, Radiation Effects

Materials and Structures Division

The Materials and Structures Division, under the Office of Light Water Reactors, is responsible for overall program management of the Materials and Structures Program. Funding for the Program is provided through the Office of Reactor Reserch and Technology. The objectives of the Program*are to 1) provide technologies to assure LMFBR components and systems will be safe and reliable during their design lifetime; 2) provide LMFBR designers and manufacturers with materials, methods, procedures, tools and criteria that are consistent with good economics, are not overly conservative, and provide for broad component design flexibility; and 3) provide an improved technological basis for licensing. R&D programs for FY 1980 in the material area are described below. Further information can be obtained by contacting J. R. Hunter, Acting Director, Materials and Structures Division, Office of Light Water Reactors (301-353-3299) (FTS 233-3299).

1. Mechanical Properties Design Data $2,883K

ANL, GE-ARSD, HEDL, INEL, NRL, ORNL, W-ARD

Generate materials properties data to support the development and implementation of high temperature structural design methods and criteria. Characterize the deformation and failure characteristics of reference structural materials. Environments considered include irradiation, steam, sodium and elevated temperature.

Keywords: Materials Characterization, Radiation Effects, Mechanical Properties

2. Fabrication Technology $910K

GE-ARSD, INEL, ORNL

Develop improved methods and procedures for fabricating LMFBR piping systems. Develop designs and fabricating methods for transition joints between piping sections of ferritic and austenitic materials. Develop materials for welding austenitic stainless steels which have improved properties at LMFBR operating temperatures.

Keywords: Joining Methods; Fabrication, Welding

3. Nondestructive Testing Technology $1,032K

ANL, HEDL, ORNL

Develop methods, techniques and equipment for inspection of LMFBR components during manufacture and for periodic inservice inspection after plant construction. Emphasis is on radiographic, eddy-current and ultrasonic methods.

Keywords: Nondestructive Evaluation, Inspection

4. Corrosion/Tribology Technology $466K

GE-ARSD, HEDL, W-ARD

In the corrosion area, 1) develop appropriate water chemistry specifications, analytical instrumentation, and operating procedures to ensure the integrity and reliability of LMFBR steam generators; and 2) determine carbon transport behavior in bimetallic LMFBR systems and effects of decarburization on 2-1/4 Cr-1Mo steel steam generator material. In the tribology area, qualify wear-resistant materials and processes for LMFBR applications.

Keywords: Corrosion, Erosion and Wear, Tribology

5. Advanced Alloy Technology $850K

ORNL, W-ARD

Develop a modified 9 Cr - 1 Mo alloy steel as a structural material for LMFBR plant systems, and as an alternative to the current reference materials, i.e., austenitic stainless steels and 2-1/4 Cr - 1 Mo alloy steel.

Keywords: Alloy Development, Alternate Materials, Materials Characterization

6. Documentation $192K

HEDL

Coordinates and maintains a system for documenting materials data to provide an authoritative data source for use in the design and construction of nuclear powerplant systems.

Keywords: Materials Characterization; Materials Data Documentation

Office of Reactor Research and Technology

Reactor Research and Technology materials programs described in the following FY 1980 Budget Summary are directed at providing technical support on materials required for the design of reliable, safe and economical fast breeder reactor plants and their operation. The funding for core component materials, such as reactor fuels, absorbers, cladding and ducts, at various contractors, national laboratories and government laboratories is as follows.

Fuels Division

1. Advanced Fuels - Transients $600K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Argonne National Laboratory (Contract No. W-31-109-ENG-38)
L. Neimark, S. M. Gehl - (312) 972-5199; FTS 972-5199

Design, irradiate and evaluate advanced fuels transient tests. Develop fuel and blanket pin performance codes. Validate codes with pin irradiation data.

Keywords: Ceramics, Glasses; Radiation Effects

2. Advanced Fuels Development $600K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Atomics International (Contract No. DE-AT03-76SF76026)
W. Wolfe, E. Specht, B. Ostermeir - (213) 341-1120; FTS 791-1120

Fabricate advanced fuel blanket pellets for carbide blanket fuel assembly testing. Perform pin evaluation and pin code development.

Keywords: Ceramics, Glasses; Fuel Development, Uranium Carbide, Pin Evaluation, Code Development

FY - 1980

BUDGET SUMMARY

Contractor	Core Components	Fuels Fabrication	Materials Development	TOTAL
ANL	600	-	-	600
AI	540	60	-	600
B&W	-	60	-	60
CE	451	49	-	500
EXXON	-	60	-	60
GE	1,458	372	500	2,330
HEDL	9,818	5,596	4,425	19,839
LASL	5,680	574	-	6,254
NRL	-	-	75	75
ORNL	-	-	585	585
PNL	290	15	-	305
WARD	2,610	60	960	3,630
	21,447	6,846	6,545	34,838

3. <u>Fuel Fabrication Development</u> $ 60K

DOE Contact - W. M. Hartman, (301) 353-5196; FTS 233-5196
Babcock and Wilcox (Contract No. DE-AT03-76SF71031)
E. M. Benson - (804) 384-5111

Fuel fabrication development of low gamma pellets for process automation.

Keywords: Materials Processing; Fuel Fabrication

4. <u>Advanced Fuels - Steady State</u> $500K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Combustion Engineering Company (Contract No. DE-AT02-76-CH91001)
S. A. Caspersson - (203) 688-1191

Design, irradiate and evaluate advanced blanket fuel test. Steady state performance evaluation and pin code development.

Keywords: Ceramics, Materials Characterization

5. <u>Fuel Fabrication Development</u> $ 60K

DOE Contact - W. M. Hartman, (301) 353-5196; FTS 233-5196
Exxon Corporation (Contract No. DE-AT03-76SF71031)
L. G. Merker - (509)

Fuel fabrication development of low gamma pellets for process automation.

Keywords: Materials Processing, Fuel Fabrication

6. <u>Alloy Development</u> $500K

DOE Contact - R. J. Neuhold (391) 353-4471; FTS 233-4471
General Electric Company (Contract No. DE-AT03-76SF1031)
E. A. Aitken - (408) 738-4238; FTS 738-7238

Perform examinations and analysis of creep-in-bending test, and assess post-irradiation ductility of advanced alloys for core components.

Keywords: Radiation Effects, Materials Characterization

7. <u>Advanced Fuels Development</u> $1,830K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
General Electric Company (Contract No. DE-AT03-76SF71031)
E. A. Aitken - (408) 738-7238; FTS 738-7238

Design, irradiate and evaluate advanced oxide fuels, and blankets under specific conditions of neutron irradiation. Tests are focused on providing data for design and licensing in the areas of thermal performance, mechanical performance, chemical effects and run-beyond-cladding breach.

Keywords: Ceramics, Fuel Development, Radiation Effects

8. <u>Alloy Development</u> $4,425K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
J. L. Straalsund - (509) 376-3306; FTS 444-3306

Characterize the in-reactor deformation behavior of breeder reactor cladding and duct materials. Work emphasizes measurement of in-reactor swelling, creep, and post-irradiation mechanical properties such as tensile behavior and fracture toughness. Irradiation resistance of tailored commercial and developmental alloys is investigated.

Keywords: Radiation Effects, Materials Characterization

9. Reference Fuels $4,439K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Hanford Engineering Development Laboratory (Contract NO. DE-AC14-76FF02170)
C. M. Cox - (509) 376-0384; FTS 444-0384

Design, fabricate, irradiate, examine and evaluate standard FFTF driver fuel. Conduct special tests such as high power, power-to-melt and Fuel Open Test Assembly experiments. These experiments cover both steady-state and transient conditions.

Keywords: Ceramics, Materials Characterization

10. Advanced Fuels $3,325K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170
C. M. Cox - (509) 376-0384; FTS 444-0384

Design, fabricate, irradiate and examine advanced driver fuel. Perform post-irradiation examination of advanced breached fuel pins.

Keywords: Ceramics, Radiation Effects

11. Absorbers $972K

DOE Contact - A. VanEcho, (301) 353-3930; FTS 444-3930
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
M. Parker - (509) 376-3238; FTS 444-3238

Design, fabricate, irradiate absorber pellets, pins and assembly experiments for reference and advanced breeder reactor control rod concepts. This experimental work includes physical and mechanical property evaluation of boron carbide and related materials.

Keywords: Ceramics, Radiation Effects, Materials Characterization

12. Fuel Support Technology $1,082K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
C. M. Cox - (509) 376-0384; FTS 444-0384

Obtain by laboratory measurements, properties data required for design, performance analysis and fabrication of fuel and blanket materials. Develop analytical relationships to describe experimental data compatible with performance codes and models. Review, evaluate and recommend properties data for non-metallic fuel/blanket materials.

Keywords: Materials Characterization

13. Fuel Fabrication $5,596K

DOE Contact - W. M. Hartman, (301) 353-5196; FTS 233-5196
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
L. Rice - (509) 376-1911; FTS 444-1911

Design, develop and build an automated fuel pin fabrication facility. The facility will incorporate advanced equipment and techniques designed to reduce personnel exposure and maximize special nuclear materials safeguards.

Keywords: Materials Processing

14. Advanced Fuels Fabrication, Post Irradiation Examination $6,254K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Los Alamos Scientific Laboratory (Contract No. W-7405-ENG 36)
J. L. Green, W. T. Wood - (505) 667-2610; FTS 843-2610

Fabricate uranium carbide post irradiation examinations of reference and advanced fuel test experiments. Develop advanced low gamma fuel fabrication processes and analytical QA standards.

Keywords: Ceramics, Materials Processing, Materials Fabrication

15. Alloy Characterization $ 75K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Naval Research Laboratory (Contract #IA-E/49-5/-2110)
F. Smidt - (202) 547-2566; FTS 767-2566

Conduct microstructural examination of ferritic alloy specimens and perform fracture toughness evaluation of ferritic alloy samples.

Keywords: Materials Characterization

16. Advanced Alloy Development $585K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Oak Ridge National Laboratory (Contract No. W-7405-ENG-26)
A. Rowcliffe - (615) 574-5057; FTS 624-5057

Conduct examinations and analysis of selected advanced alloy specimens for swelling and phase stability. Perform post irradiation tensile tests and microstructural exams of advanced alloys.

Keywords: Radiation Effects, Materials Characterization

17. Assembly Performance Evaluation $305K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Battelle Pacific Northwest Laboratory (Contract No. EY-76-C-06-1830)
E. Khan - (509) 375-2529; FTS 444-2529

Conduct data analysis and evaluations of verification experiments for assembly code developments for COBRA Code and CORTRAN Code.

Keywords: Materials Characterization; Code Development

18. <u>Advanced Alloy Development</u> $960K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Westinghouse Advanced Reactors Division (Contract No. EY-76-C-02-3045-M)
M. Bleiberg, A. Boltax - (412) 722-5363; FTS 726-5363

Characterize the swelling behavior and phase stability of selected advanced alloy specimens. Conduct tensile tests and examinations of alloys to determine the mechanisms of ductility loss. Conduct analysis and post irradiation examinations of creep/swelling opposition test for CRBR core restraint applications.

Keywords: Materials Characterization, Transformations

19. <u>Fuel/Blanket Assembly Development</u> $2,610K

DOE Contact - R. J. Neuhold, (301) 353-4471; FTS 233-4471
Westinghouse Advanced Reactors Division (Contract No. EY-76-C-02-3045-M)
A. Boltax - (412) 722-5363; FTS 726-5363

Design, fabricate and test performance of oxide and carbide fuel subassemblies in support of the national effort on advanced fuels development. Perform design, thermal-hydraulic analysis, and fabrication of blanket fuel assemblies. Develop and verify pin life codes.

Keywords: Ceramics, Materials Processing, Materials Characterization

Office of Safety, Quality Assurance and Safeguards

The Office of Safety, Quality Assurance and Safeguards (OSQ) reports to the Deputy Assistant Secretary for Nuclear Reactor Programs (NE). One of the responsibilities of the Office is the development and implementation of improved quality assurance and standards program for civilian nuclear plants and facilities.

The major involvement in materials program in this office is in the management of RDT (NE) Standards Program. The goals of this program are to: (1) ensure that the materials and equipment obtained would be of a quality consistent with the application needs; (2) establish the important features of the equipment, systems and structures to be properly evaluated during design, procurement, fabrication, installation, and operation; (3) establish practices that would be understood and used by industry.

Out of a total of 416 RDT (NE) standards listed on the Nuclear Standards Master Index dated October 1980, 130 standards deal with materials. The materials standards cover the following categories:

1. Welding Rods, Electrodes
2. Fittings, Flanges, Forgings
3. Pipe, Tubing
4. Castings
5. Plate, Sheet, Strip
6. Bolting, Bolting Materials
7. Bar, Rod, Wire, Extruded Shapes
8. Springs
9. Metallic Seals
10. Ingots
11. Seals, Gaskets, Packings
12. Thermal Insulations
13. Liquids
14. Gases
15. Paints, Protective Coatings
16. Absorbents, Adsorbent Filter Materials
17. Miscellaneous

Although program standards for specific project needs are being developed and funded by line organizations, the present approach is to adopt standards via a Limited Consensus Standards (LCS) or a National Consensus Standards (NCS). Since voluntary contributions from industries, standards writer organizations, etc., in addition to government funds, are involved, the total funds attributed to these activities are not available. Further information can be obtained from Mr. A. J. Pressesky, Acting Director, OSQ (301) 353-4567, FTS 233-4567.

Office of Nuclear Waste Management

The Nuclear Waste Mangement Program provides the technology and facilities necessary to meet all applicable safety and environmental requirements for the long-term management of nuclear waste. The wastes include these from both the commercial and the defense nuclear activities of the nation. In broad scope the materials activities support: waste packaging, interim storage, and disposal; and evaluates existing structural and materials geologic formations.

The major objectives for waste disposal are: 1) to select suitable geohydrologic regions to minimize the release of radioactivity in the event of failure of the containment systems 2) to select suitable geologic formations within satisfactory geohydrologic regions to contain the waste, 3) to design the repository to minimize the effect of mining and waste emplacement on the integrity of the geologic formation, and 4) to provide an engineered system as a backup to the geologic formation to contain the waste within the package for sufficient time to allow for decay of major radioactive nuclides.

1. Waste Isolation

DOE Contact - C. R. Cooley (301) 353-3013; FTS 233-3013
Office of Waste Isolation

The materials activities related to Waste Isolation include:

- o migration of radioactive waste through geohydrologic systems
- o thermomechanical response of geologic formations
- o engineered barriers for waste containment within the repository
- o waste packaging materials and fabrication processes for spent nuclear fuel and for the containerized high-level and transuranic wastes for emplacement in geologic environment

Details, Contracts and Funding for the Elements in Waste Isolation Follow:

1A. Waste Migration Rates

Geohydrologic Testing	$17,400K
Waste Transport	$ 5,500K

DOE Contact - T. Longo (301) 353-3791; FTS 233-3791
Geohydrologic Testing: Law Engineering Testing Co. Woodward-Clyde, Schlumberger, Dresser Industries, Sigma Exploration, ANA-LOG Inc., Texas Bureau of Economic Geology, USGS, Louisiana State University, University of Utah, University of Southern Mississippi

Waste Migration: PNL, SL, LLL, LASL, RHO, ORNL, University of New Mexico, Battelle Memorial Institute

The materials characteristics of the geohydrology and geologic formation are evaluated using geophysical measurments and drilling operations. A major cost is the extraction of rock cores for additional physical and chemical analysis. The measurement of the ion exchange capability of the geologic media delays the rate of migration of radioactivity sufficiently that all but the very long lived radioactivity would decay below natural levels before release to the biosphere. The rock formations of interest include basalt, granite, salt, and tuff.

Keywords: Ceramics, Materials Characterization, Radiation Effects, Corrosion

1B. Thermomechanic Response of Rocks $4,700K

DOE Contact - W. Eister (301) 353-3188; FTS 233-3188
RE//SPEC, LLL, RHO, LBL, USGS, Colorado School of Mines

The effect of mining and waste emplacement is of concern as it relates: 1) to the stability of the mined openings in the rock, and 2) to the stability of the rock and its associated hydraulic conductivity. Since there is considerable experience as related to mining effects, the primary attention is directed to the thermomechanics response of the rocks. The heat will result from the decay of radioactive waste. The thermomechanic property and the effect on the related hydraulic conductivity are being studied in the laboratory and in deep geologic formations.

Keywords: Materials Characterization, Ceramics

1C. Waste Package $3,100K
Engineered Barriers $5,500K

DOE Contact - W. Eister (301) 353-3188; FTS 233-3188
HEDL, SL, PNL, RHO, Penn State University, Westinghouse, ANL

The objective of this activity is to seal the spent fuel in an overpack container compatible with the geologic environment. The property of principal interest is corrosion resistance of the overpack container, however, there are also significant efforts on the other components of the package and the engineered barriers. Titanium, copper, and nickel alloys are the principal candidates at this time. These studies include:

- o leach rate of the UO_2 in the spent fuel,
- o the characteristics of the zirconium clad,
- o the selection of fillers to provide internal stability to the overpack; lead alloys, sand and helium are typical candidates,
- o sleeves outside the overpack to implement retrieval particularly in salt type media; mild steel is a candidate, and
- o backfill materials between the overpack, sleeve and rock to limit the access of ground water to the overpack and/or retard the transport of radioactivity from a failed package; a bentonite-sand mixture is a typical candidate.

In addition, materials are being evaluated to seal the repository. Concrete is the principal material being used in these studies.

Keywords: Cements and Concrete, Corrosion, Hydrogen Effects, Joining Methods, Materials Characterization, Materials Processing, Non-Destructive Evaluation, Radiation Effects

2. Waste Forms and Containers for High Level and Transuranic Wastes

DOE Contact - G. H. Daly (301) 353-4001; FTS 233-4001
Office of Waste Operations and Technology

Alternative waste forms, containers, and related processes are being developed for high-level and transuranic wastes.

Details, Contracts and Funding for the Elements in This Activity Follow:

2A. High-Level Waste Forms $7,000K

DOE Contact - R. D. Walton (301) 353-3388; FTS 233-3388
DuPont, Exxon, PNL, RHO, LLL

Alternative waste forms and compositions are being developed and characterized. This is primarily done with simulated, nonradioactive waste on a laboratory scale. Characterization tests include chemical durability, radiation stability, thermal stability and mechanical properties.

Keywords: Cements and Concretes, Ceramics, Glasses, Materials Characterization, Radiation Effects

2B. High-Level Waste Process $15,000K

DOE Contact - R. D. Walton (301) 353-3388; FTS 233-3388
DuPont, Exxon, PNL, LLL, ANL, ORNL, National Patent Development Corp./Catholic University of America, Rockwell Energy Systems, RHO

Processes are being developed to produce alternative waste forms incorporating high-level radioactive waste. Both lab scale radioactive and nonradioactive engineering scale studies are included. Waste forms include glasses, ceramics, concretes, polycrystalline ceramics, and multibarrier forms.

Keywords: Cements and Concretes, Ceramics, Glasses, Joining Methods, Materials Characterization, Non-Destructive Evaluation

2C. Transuranic Waste Form and Process Development $900K

DOE Contact - A. Camacho (301) 353-5343; FTS 233-3388
Mound, Pacific Northwest Laboratories, Rocky Flats Plant

Alternative waste forms and processes are being developed for the packaging of transuranic wastes. The processes are converting sludges and incinerator ash into pelletized concrete and glass forms. The alternative waste forms are being tested to evaluate their chemical and physical stability.

Keywords: Cements and Concretes, Ceramics, Corrosion, Glasses, Materials Processing, Materials Characterization, Non-Destructive Evaluation

RESOURCE APPLICATIONS

The Assistant Secretary for Resource Applications is responsible for managing and coordinating an array of programs that affect the production or the supply of national energy sources, such as uranium, oil shale and geothermal.

This organization is the DOE focal point for introducing into the marketplace proven technologies that are environmentally acceptable and economically viable. The industrialization effort is conducted through the activities of several resource managers responsible for specific technologies which the Department has determined to have reached commercial readiness, e.g., atmospheric fluidized bed combustion.

The major elements of this sector having significant materials activities are Electric Energy Systems, Geothermal Energy and Uranium Enrichment.

Office of Electric Energy Systems (EES)

The overall goal of the Electric Energy Systems Program is to ensure that the Nation will have a strategy for developing and improving systems for generation, transmission and distribution of electricity. EES conducts RD&D designed to expedite the development of higher risk, long-term payback technologies which have a significant potential for improving the efficiency of the electrical energy system (increased capacity utilization, loss reduction, etc.); shifting fuel from oil and gas to move abundant resources; successfully integrating new energy sources (dispersed generation and storage) in meeting utility customer needs; and enhancing environmental protection.

1. Development of a Low Magnetic Composite Material $417K

DOE Contact - Russell Eaton, (202) 633-8250
General Electric Company (Contract No. AC01-78ETZ-9313)
Harley Lake - (518) 385-8606

Development and optimize the process necessary to produce a magnetic material made of amorphous metal flakes. The resultant technology when applied to magnetic circuits of electric power equipment should provide potential benefits of increased efficiency.

Keywords: Materials Processing

2. Development of Future Insulating Systems $320K

DOE Contact - Russell Eaton, (202) 633-8250; FTS 633-8250
National Bureau of Standards (Contract No. EX-77-A-01-6010/A053)
Richard VanBrunt - (301) 921-3121

Develop advanced diagnostic techniques, test procedures and statistically valid models for monitoring and identifying aging or degradation processes in compressed gas electrical insulating systems under normal or near normal operating conditions.

Keywords: Erosion and Wear

3. <u>High Voltage Breakdown Strengths of Insulating Gas</u> $677K

DOE Contact - Russell Eaton, (202) 633-8250
Oak Ridge National Laboratory (Contract No. W-7405-ENG-0026)
Lucas Christophorou - (615) 574-6199

Analyze, from a physiochemical point of view, the factors influencing the breakdown strength of gaseous dielectrics and seek gases with superior performance.

Keywords: Materials Characterization

4. <u>Study of Gas Dielectrics as Cable Insulators</u> $150K

DOE Contact - Russell Eaton, (202) 633-8250
Massachusetts Institute of Technology (Contract No. ET-76-C-01-2295-T019)
Chad Cooke - (617) 253-2591

Fundamental study of gas dielectrics for insulation purposes to cover four areas of applied research: basic gases and mixture studies, particle trap studies, large system performance, and insulating surface studies.

Keywords: Materials Characterization

5. <u>Non-Cellulosic Insulation for Transformers</u> $199K

DOE Contact - Russell Eaton, (202) 633-8250
General Electric Company (Contract No. AC01-79ET2-9343)
J. W. Fessler - (413) 494-1110

Determine the potential for economic utilization of non-cellulosic solid insulation to reduce size, weight and electrical losses in transformers.

Keywords: Materials Characterization

6. Aging Process in Solid Dielectrics $801K

DOE Contact - Russell Eaton, (202) 633-8250
Battelle - Columbus Laboratories (Contract No. EC-77-C-01-5010)
Mike Epstein - (614) 424-6424

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

Keywords: Erosion and Wear

7. Synthetic Tape Development $510K

DOE Contact - Russell Eaton, (202) 633-8250; FTS 633-8250
Brookhaven National Laboratory (Contract No. ET-77-C-02-0016)
Bill Harrison - (516) 345-2124, ext. 4774

Develop optimized polymeric film tapes for ambient temperature taped cable use.

Keywords: Elastomers and Polymers; Coatings and Films

8. Mechanisms of Water Tree Growth in Extruded Cables $ 58K

DOE Contact - Russell Eaton, (202) 633-8250; FTS 633-8250
Phelps Dodge Cable and Wire Corporation (Contract No. ET-78-C-01-3034)
Tony Dopkin - (914) 963-8200

Analysis and comparison of observed laboratory and field data with the various theories regarding water tree growth mechanisms in polymeric insulations. A novel theory involving electro-osmotic pressure effects will be investigated. Experimental verification of the new theory will be attempted.

Keywords: Elastomers and Polymers

9. <u>Transient Breakdown Voltages in Solid Dielectric Cables</u> $250K

DOE Contact - Russell Eaton, (202) 633-8250; FTS 633-8250
Cable Technology Laboratories (Contract No. ET-78-C-01-3062)
Carlos Catz - (201) 846-3220

Develop a physical model of voltage aging of solid dielectrics used for high voltage underground transmission cable systems. Develop a procedure for a short-term voltage test on solid dielectric full real cables.

Keywords: Erosion and Wear

10. <u>Investigation of Intercalated Graphite Fibers</u> $142K

DOE Contact - Russell Eaton, (202) 633-8250; FTS 633-8250
Naval Research Laboratory (Contract No. ET-78-I-01-2897)
Lynn Jarvis - (202) 767-3550

Determine the feasibility of developing a practical, lightweight, high strength, highly conductive cable material from intercalated graphite fibers suitable for use in future power transmission and distribution systems.

Keywords: Materials Processing

11. <u>Develop an Intercalated Graphite Composite Wire</u> $165K

DOE Contact - Russell Eaton, (202) 633-8250; FTS 633-8250
Westinghouse Electric Corporation (Contract No. AC01-79ET2-9044)
S. Singhal (412) 256-3129

Demonstrate feasibility of fabricating lightweight, highly conductive, intercalated graphite composite wires suitable for use in future transmission and distribution systems.

Keywords: Materials Processing

12. AC Superconducting Power Transmission Cable Development $3064K

DOE Contact - Russell Eaton, (202) 633-8250; FTS 633-8250
Brookhaven National Laboratory (Contract No. ET-76-C-02-0016)
E. Forsyth (516) 345-2123

Develop a flexible AC superconducting cable system based on Nb_3Sn conductor and a tape dielectric. The project includes management on all supporting research on materials and refrigeration.

Keyword: Superconductors

13. Hydrogen-Cooled Superconducting Power Transmission Lines $165K

DOE Contact - Russell Eaton, (202) 633-8250; FTS 633-8250
Westinghouse Electric Corporation (Contract No. DE-AC02-79ET29354.A000)
Andy Slettin - (412) 256-7000, ext. 3687

Investigate materials which can be used in future superconducting power transmission lines with performance characteristics superior to Brookhaven National Laboratory's liquid helium cooled superconducting line. The investigation consists of two parts: (1) dielectric studies of liquid hydrogen, and (2) investigation of superconducting materials with transition temperatures in the liquid hydrogen range.

Keyword: Superconductors

Office of Renewable Resources

Geothermal Energy

The Division of Geothermal Energy (DGE) reports to the Assistant Secretary for Resource Applications through the Program Director for the Office of Renewable Energy Resources. The majority of the materials work in this program is combined under geochemical engineering and materials. R. R. Reeber, DOE/Washington, (telephone 202-633-9491); FTS 633-9491, coordinates this subprogram. Field implementation is carried out through the San Francisco Operations Office, (A. Adduci, (telephone 415-273-7943). Technical support for major subdivisions are provided by the following DOE National Laboratories:

(A) Geothermal Materials, Brookhaven National Laboratory
L. Kukacka (516-282-3065), FTS 666-3065

(B) Geochemical Engineering, Battelle Pacific Northwest Laboratory
D. Shannon (509-376-3139), FTS 444-3139

(C) Materials Activity In Other DGE Projects

Hot Dry Rock
Drilling and Completion
Logging Instrumentation
Raft River 5 MWe Binary Plant

The objective of this work is to provide materials support for major demonstrations, advanced energy conversion projects and other major programs within the Division of Geothermal Energy. Generic/high payoff applied research projects in each major area is reviewed by industrial/university task groups such as the American Petroleum Institute or the American Society for Testing and Materials. The goal of these projects is to accelerate the acceptability of geothermal energy by lowering life cycle costs. At the same time the program provides necessary failure analysis; materials selection/design reviews of major demonstrations, advanced energy conversion projects, and other DGE initiatives; as well as documents all materials-related developments and experience. Coordination with National technical societies provides the necessary interfaces for industry/university/government interactions and cooperation.

Major reports published to date include:

1. Geothermal Materials Program Strategy DOE/RA/12183-01, October 1980.

2. Materials Selection Guidelines for Geothermal Power Systems Radian Corporation Report No. ALO-3904-1, September 1978, Second Edition Spring 1981. DOE/RA/27026-1.

3. Cementing of Geothermal Wells Quarterly Progress Reports for Contract EY-76-C-02-0016, Brookhaven National Laboratory and Subcontracts.

4. Alternate Materials of Construction Quarterly Progress Reports for Contract EY-76-C-02-0016, Brookhaven National Laboratory and Subcontracts.

5. Proceedings of a Workshop/Symposium on Materials in Geothermal Energy Systems, Radian Corporation, Contract No. EG-77-C-04-3904, Report No. COO-3904-1.

6. Geothermal Materials Review, Radian Corporation, P.O. Box 9948, Austin, Texas 78766.

7. Geothermal Elastomeric Materials (GEM) Program, L'Garde Corporation Final Report, October 1976, June 30, 1979, Contract No. DE-AC03-77ET28309, Report No. SAN-1308-2.

8. Economic Assessment of Using Non-Metallic Materials in the Direct Utilization of Geothermal Energy, Burns & Roe Industrial Services Corporation (Brookhaven National Laboratory Contract No. 442252-5), February 1979.

9. An Assessment of Non-Destructive Testing of Well Casing, Cement and Cement Bond in High Temperature Wells, GeoEnergy Corporation

(A) Geothermal Materials

1. Development of Geothermal Well Completion Systems $183K

B. Simpson, (918) 560-2848
Dowell Division of Dow Chemical (Contract No. DE-AC02-77ET283324)

Develop and evaluate a suitable geothermal well cementing material through stability measurements, placement measurements, and chemical measurements.

Keywords: Cements and Concrete, Elastomers and Polymers

2. Geothermal Cement Screening $ 60K

D. Roy, (814) 865-1196
Pennsylvania State University (Brookhaven Subcontract No. 422272)

Develop new cements suitable for geothermal well completions up to 400°C. Major points are the determination of the hydrothermal stability of new cementing compositions and the determination of the mechanical and physical properties of the new materials.

Keywords: Cements and Concrete, Materials Characterization

3. Geothermal Materials Handbook and Failure Analysis $150K

P. Ellis, (512) 454-4797
Radian Corporation

Analysis of failed plant components and compilation of world-wide materials information on geothermal systems.

Keywords: Materials Characterization

4. Alternate Materials of Construction $300K

L. Kukacka, (516) 282-3065
Brookhaven National Laboratory (Contract No. DE-AC02-76CH00016)

Performance of a program involving subcontract and industrial participation. BNL will evaluate and develop alternate materials. The work includes determination of engineering design requirements, testing of prototype equipment, economic evaluations, and plant demonstrations.

Keywords: Alternate Materials, Elastomers and Polymers

5. Cementing of Geothermal Wells $150K

L. Kukacka, (516) 282-3065
Brookhaven National Laboratory (Contract No. DE-AC02-76CH00016)

Development of improved cements specifically designs for geothermal-well applications. The task includes preparation of a technical plan, testing and practical demonstration of new cements, and transfer of the technology to the private sector.

Keywords: Cements and Concrete, Materials Characterization

6. Downhole Heat Exchangers in Direct Utilization No cost extension

V. Baldwin, (919) 541-5824
Research Triangle Institute (Brookhaven Subcontract No. 483982)

A definition study to examine the feasibility of eliminating waterline corrosion by using HIP Ti-clad steel as a means of ensuring the durability and availability of non-electric heat exchangers immersed in geothermal fluid.

Keywords: Corrosion

7. Cementing of Geothermal Wells No cost extension

R. Kalyoncu, (614) 424-5821
Battelle's Columbus Laboratories (Brookhaven Subcontract No. 420825)

Develop high-temperature cementing materials for use in the completion of geothermal wells that will meet the requirements of durability, thickening time, minimum strength loss, and minimum permeability. Program was completed in FY 1980.

Keywords: Cements and Concrete, Materials Characterization

8. Pitting Resistant Alloys $150K

D. Van Rooyen, (516) 282-4050
Brookhaven National Laboratory (Contract No. DE-AC02-76CH00016)

Development of metallic alloys and steels that possess improved properties and are cost-effective. Management of metallic subcontracts in industry, laboratories and universities.

Keywords: Alloy Development

9. Materials Needs for the Utilization of Geothermal Energy $44.1K

D. Groves, (202) 389-6526
National Materials Advisory Board, National Academy of Sciences
(Brookhaven Sucontract No. 494818)

Identification of the materials problems that limit the design and operation of cost-effective geothermal energy systems, and recommendations of action to take in a NAS-approved report.

Keywords: Materials Characterization

10. Economic Impact of Using Non-Metallic Materials $6.2K

T. Gass, (614) 846-9355
National Water Well Association (Brookhaven Subcontract No. 485874)

Evaluate the potential economic impact of using non-metallic materials in low-temperature (150C) geothermal well construction.

Keywords: Elastomers and Polymers

11. Elastomer Materials Technology Transfer $88.8K

A. Hirasuna, (714) 645-4880
L'Garde, Inc. (Brookhaven Subcontract No. 490316)

Transfer to industry the elastomer technology developed under an earlier DGE contract and continue the development of high temperature sealing materials.

Keywords: Elastomers and Polymers

12. New Fluorocarbon Elastomers for Seals $ 95K

E. Dumitru, (512) 454-3812 or 471-5679
Exfluor Research Corporation (Brookhaven Subcontract No. 486106)

Increase the operating capabilities of elastomers in geothermal environments to 300C by the cross-linking and subsequent fluorination of elastomeric materials.

Keywords: Elastomers and Polymers, Seals and Bearings

13. Design and Fabrication of Polymer Concrete Pipe $102.7K

J. Schroeder, (213) 969-3471
Lindsey Industries, Inc. (Brookhaven Subcontract No. 486337

Design and fabricate full-scale section of polymer concrete pipe and appropriate joining methods for use in direct utilization geothermal processes.

Keywords: Cements and Concrete

14. Improved Drill Bit Material $73.3K

R. Hendrikson, (801) 582-2220
Terra Tek, Inc. (Brookhaven Subcontract No. 492267)

Optimized alloys and the heat treatment of candidate alloys to ensure longer life of drill bits and reamers; also, liaison will be maintained with interested bit manufacturers.

Keywords: Alloy Development, Materials Characterization

15. Pump Bearing Materials Development $52.1K

D. Huey, (714) 238-5609
Solar Turbines International (Brookhaven Subcontract No. 490656)

Develop durable materials that will resist wear and deterioration when used as bearings in pumps. The goal is to improve pump lifetimes and increase the efficiency of heat extraction from geothermal wells.

Keywords: Seals and Bearings, Erosion and Wear

16. Elastomer Life Prediction $ 50K

B. Franconi, (301) 921-3344
National Bureau of Standards

Long term elastomer life performance predictions from short term screening test data.

Keywords: Elastomers and Polymers, Materials Characterization

17. Well Casing Materials $124K

R. D. McCright, W. P. Frey, E. A. Snell, F. E. Locke, (415) 422-7051
Lawrence Livermore National Laboratory (Contract No. W-7405-Eng-48)

Evaluation of the corrosion performance of carbon and alloy steel (up to 9 Cr - 1 Mo) tubing string materials exposed for 6 months in a producing well at the Salton Sea Geothermal field. Some API steels were heat treated. All materials were exposed to brine at 3 depths in the well.

Keywords: Alloy Development, Alternate Materials, Corrosion, Materials Processing

18. Localized Corrosion - Plant Materials $ 70K

R. D. McCright, W. P. Frey, F. E. Locke, (415) 422-7051
Lawrence Livermore National Laboratory (Contract No. W-7405-Eng-48)

Evaluation of the general and localized corrosion rate, including time dependence, of several grades of API steels and AISI-ASTM steels in two-phase Salton Sea Geothermal Field Brine.

Keywords: Alloy Development, Alternate Materials, Corrosion, Materials Processing

19. <u>Metal Sheath Logging Cable Development</u> $252K

A. Halpenny, (716) 856-3185
Halpen Engineering Inc. (Sandia Subcontract No. 13-5163)

Commercial development of a metal sheath, mineral insulated single conductor electromechemical logging cable for continuous operation in geothermal wells at temperatures up to 350C.

Keywords: Materials Processing; Logging Cables

20. <u>Cable Component Materials</u> $284K

A. F. Veneruso, B. H. Major, (505) 844-9162; FTS 844-9162
Sandia In-house project

Commercially available, elastomeric insulated wire geothermal logging cables, cableheads and their associated materials and components design configurations are being laboratory tested to determine their suitability for geothermal service. Component problems are being identified and deficiencies are being corrected by appropriate materials and design changes.

Keywords: Elastomers and Polymers; Logging Cables

21. <u>Shape Memory Alloy Seals</u> $49.7K

W. Friske, (213) 341-1000
Rockwell International (Brookhaven Subcontract No. 509927)

Develop durable high temperature metallic seals for downhole pump applications. The sealing technique utilizes the unique properties of nickel-titanium (Nitinol) "memory alloy" to provide the seals.

Keywords: Alloy Development, Seals and Bearings

22. <u>Hydrogen Embrittlement and Localized Corrosion of Steels</u> $150K

A. Troiano, (216) 368-4234
Case Western Reserve University (Brookhaven Subcontract No. 510034)

Use the NACE tensile test to extend the sour environment test to a series of new alloys now being developed and prepared for service for geothermal downhole applications.

Keywords: Alloy Development, Corrosion

23. <u>Non-destructive Testing of Drill Pipe</u> $100K

L. Yaeger, (202) 924-4800
Daedalen Associates, Inc. (DOE Contract No. EC-77-C-01-4045)

Application of an acoustical damping non-destructive testing technique for detecting the incipient failure of drill pipes used in geothermal drilling. Field data is being obtained for a population of 10,000 drill pipes.

Keywords: Non-Destructive Evaluation (NDE), Materials Characterization

(B) <u>Geochemical Engineering</u>

1. <u>Sampling and Analysis of Geothermal Fluids</u> $130K

C. H. Kindle, (509) 376-5904
Pacific Northwest Laboratory

Standardized, accurate fluid and gas sampling/analysis methods are being developed through industry/government/university cooperative efforts. Standardization and acceptance is being accomplished through the American Society for Testing and Materials.

Keywords: Corrosion

2.. <u>High Temperature Chemical Sensors for Geothermal Fluids</u> $563.5K

George Jensen, (509) 376-9124
Pacific Northwest Laboratory Subcontracts and Management

1. High temperature glass pH electrode development 70.5K
   Leeds and Northrup Company

2. Geothermal CO2 sensor 39K
   Leeds and Northrup Company

3. Chemically sensitive semiconductor devices 155K
   University of Pennsylvania

4. High temperature pH electrode development 28K
   Owens Illinois

5. Zirconia-based pH electrode (new) 1.0K
   General Electric Corporation

6. Sulfide ion electrode 140K
   Beckman Instruments

7. Redox electrode development 45K
   Pacific Northwest Laboratory

8. Improved Corrosion Ratemeter 85K
   Pacific Northwest Laboratory

The development of electrical and electrochemical probes that can measure the chemical environment of geothermal water and steam under the high pressure, high temperature conditons of a geothermal well and associated piping. These data will permit the prediction and control of corrosion, scaling and pollution in geothermal systems.

Keyword: Corrosion

3. <u>Binary Cycles Fluid Case Study</u> $79.5K

Donald W. Shannon, (509) 376-3139; FTS 444-3139
Pacific Northwest Laboratory

To develop and demonstrate to the industry advanced methods of monitoring geothermal power plants. Methods are being tested on the

Magma Electric Company's 10 MWe cycle plant. Corrosion samples and NDE of heat exchangers are included in the test plan. Total funding for this study is $530K.

Keyword: Corrosion

(C) Materials Activity and Other Projects

Hot Dry Rock

DOE Contact - Allan Jelacic, (202) 667-1378; FTS 843-1278

The Hot Dry Rock (HDR) Energy Extraction Demonstration Program has a total budget of $14,000K. The program objective is to determine technical and economic feasibility of hot dry rock concepts. A major element of the program is the Phase II Energy Extraction System at the Fenton Hill Test Site which will consist essentially of two wellbores drilled to maximum depth of 15,000 ft. connected by a series of hydraulic-induced fractures.

The materials development support of the HDR Program covers all aspects of geothermal energy extraction including drilling, hydraulic fracturing and wellbore logging and is funded at $792K. It is coordinated with other DGE programs to produce hardware of greatest mutual utility and prevent duplication. Materials developed in other DGE program are field tested where HDR applications exist. The major areas of materials development of HDR involve field and limited laboratory testing of packer hardware, electrical insulation for logging cables, and cementing hardware.

Keywords: Materials Characterization, Elastomers and Polymers, Cements and Concrete

1. Straddle Packers, Compression - Type $212K

LASL Contact - Roland A. Pettitt, (505) 667-1113; FTS 843-1113
Guiberson/Dresser (LASL Subcontract 2-LGg-0326K-1)
Dennis Spriggs - (214) 421-4101

Manufacture of straddle packer assemblies for use in deep, hot wells for HDR program, asbestos fiber core and wire reinforced fabric sheath packers are rated at 350C (660F) with p=5,000 psi and for 15,000 ft. depth.

Keywords: Seals and Bearings, Ceramics, Materials Characterization

2. Cement Hardware - Geothermal $ 50K

LASL Contact - Roland A. Pettitt, (505) 667-1113; FTS 843-1113
Halliburton Services
David Szarka - (405) 251-3271

LASL field test support of Halliburton seals and valves developed for 275C (520F) geothermal cementing service.

Keywords: Cements and Concretes, Corrosion

3. Float Valve Seals $ 10K

DOE Contact - John C. Rowley, (505) 667-1378; FTS 843-1278
Barkerline/Baker Int. (LASL Subcontract 2-KVO-9765N-1)
Clyde Wainwright - (512) 845-7030

Manufacture of geothermal, 600F float valve seal replacement kits for use in drilling operations; inhibits back flow to prevent plugging of pipes and motors.

Keywords: Seals and Bearings, Elastomers and Polymers; Drilling

4. High-Temperature DC Motors $ 80K

LASL Contact - Conrad Fink, (505) 667-7619; FTS 843-7619
American Electronics, Inc. (LASL Subcontract #KE8-4774E-1)
Leo Leinz - (714) 871-3020

Manufacture of high-temperature DC motors for use in downhole instrument logging tools. Motors were tested for operation at 275C. Motors will develop 150 in./lbs. forces, 10 rpm with 110 VDC excitation (AEI Model #17DG2).

Keywords: Materials Characterization, Elastomers and Polymers

5. Cablehead $ 23K

LASL Contact - Billy Todd, Conrad Fink, (505) 667-7619; FTS 843-7619
Los Alamos National Laboratory In-House Development

Cablehead developed for borehole logging and fracture mapping for the Phase II System at the Hot Dry Rock Fenton Hill site. Bottom-hole temperature in EE-2 wellbore is 317C. Cablehead is designed for field assembly and durability in the geothermal environment. It has been deployed in the borehead for temperature and caliper logs with no failures to date. L'Garde and Bal-Seal O-rings and high-temperature potting compounds, grease are used.

Keywords: Elastomers and Polymers, Adhesive and Lubricants

6. Straddle Packers, Inflation Type $ 42K

LASL Contact - John C. Rowley, (505) 667-1378; FTS 843-1278
Lynes, Inc. (LASL Subcontract LG91290L)
Gene Craig - (713) 943-0170, ext. 231

Manufacture of EPDM Elastomeric Sheath over Metal Rib Reinforced inflatable straddle packer assemblies for 14,000 ft. 290C (550F), psi service in HDR applications.

Keywords: Seals and Bearings, Elastomers and Polymers, Joining Methods

7. Drilling Jars and Shock Absorbers $150K

LASL Contact - John C. Rowley, (505) 667-1378; FTS 843-1378
Houston Engineers, Inc.
Derrel D. Webb - (713) 237-3097

Upgrading of seals and shock absorbers for drilling and fishing in high-temperature geothermal wells to 300C (600F). Additional funding for development cost-shared by Houston Engineers.

Keywords: Seals and Bearings, Elastomers and Polymers, Materials Characterization

8. Elastomer Seal Components $ 50K

LASL Contact - Conrad Fink, (505) 667-7619; FTS 843-7619
L'Garde, Inc. (LASL Subcontract 4-L40-7470N-1)
Alan R. Hirasuna - (714) 546-4671

Manufacture of high-temperature elastomer for use in geothermal well logging construction. Material was used in making O-rings and a cable-head bend protector tested at temperatures up to 300C.

Materials now used in cableheads and instrument packages to log the EE-2 wellbore (bottom-hole temperature 317C).

Keywords: Elastomers and Polymers, Seals and Bearings

9. High-Temperature Armor Cable $ 55K

LASL Contact - Bert Dennis, Billy Todd, (505) 667-5697; FTS 843-5697
Southwest Research Institute (LASL Subcontract #4-L40-4069M-1)
Roy S. Marlow - (512) 684-5111

Cable test program to test samples of high-temperature well logging armored instrument cable for use in geothermal boreholes. Test electrical integrity of insulation materials and cable performance at 275C temperature and 8,000 psi fluid pressure. Electrical insulation materials primarily PFA and TFE teflon.

Keywords: Elastomers and Polymers, Materials Characterization

10. Downhole Cable Test Facility $120K

LASL Contact - Bert Dennis, (505) 667-5697; FTS 843-5697
Los Alamos National Laboratory; DOE/Los Alamos National Laboratory

Hot dry rock support program to test downhole cable performance and electrical integrity at 300C in water.

Keywords: Elastomers and Polymers, Materials Characterization

Drilling and Completion

1. Diamond Compact Wear Mechanisms $150K

Sandia Contact - C. Huff, (505) 844-8796; FTS 844-8796
General Electric Company (Sandia Contract No. 13-9406)
L. E. Hibbs, Jr. - (518) 385-8330

Objective: To provide technical support concerning the effects of drilling fluids on the required cutting force, wear mechanisms and wear rates of polycrystalline diamond compacts.

Keywords: Erosion and Wear, Ceramics, Materials Characterization

2. Geothermal Drill Bit Seals and Lubricant Development $ 80K

Sandia Contact - J. H. Barnette, (505) 844-0129; FTS 844-0129
Terra Tek, Inc. (Sandia Contract No. 46-3053)
J. Finger - (505) 844-8089

Objective: The development of a 200-hour-life bearing and seal package adaptable to most types of downhole motors that operate at a 121C (250F) circulation temperature.

Keywords: Seals and Bearings, Adhesives and Lubricants

3. Chemical and Elevated Temperature Effects on Clay-Based Drilling Fluids $100K

Sandia Contact - B. T. Kenna, (505) 844-1565; FTS 844-1565
N. Giiven - (806) 742-3110

Objective: Fundamental understanding of clay particle morphology under the influence both of various chemical species and elevated temperatures similar to the conditions encountered during geothermal drilling activities.

Keywords: Adhesive and Lubricants

4. High Temperature Elastomers $ 80K

Sandia Contact - Morris Skalka, (202) 633-8754; FTS 633-8754
Sandia National Laboratories
C. Arnold - (505) 844-8728; FTS 844-8728

Investigate and recommend appropriate elastomeric materials and material design considerations for high temperature elastomers needed in geothermal drilling system bearings and seals and in downhole tools used in geothermal drilling and completions and borehole logging.

Keywords: Elastomers and Polymers

5. Investigation of Inert Geothermal Drilling Fluids/Gases $ 90K

DOE Contact - Morris Skalka, (202) 633-8754; FTS 633-8754
B. C. Caskey - (505) 844-8835; FTS 844-8835

Experimentally evaluate the field performance of alternate drilling fluids and gases such as nitrogen to inhibit the chemical corrosion of geothermal drill pipe while minimizing erosion and wear on the drilling components.

Keywords: Corrosion; Erosion and Wear

6. Drillstem Corrosion Testing $200K

DOE Contact - Morris Skalka, (202) 633-8754; FTS 633-8754
Sandia National Laboratories
R. J. Salzbrenner - (505) 844-5041; FTS 844-5041

Investigate the effects of corrosion fatigue and stress corrosion cracking on candidate geothermal drillstem materials.

Keywords: Corrosion; Erosion and Wear, Materials Characterization

Geothermal Logging Instrumentation Materials Support

Sandia Contact: A. F. Veneruso, (505) 844-9162; FTS 844-9162

1. High Temperature Thick Film Development $ 70K

DOE Contact - Raymond J. LaSala, (202) 633-8110; FTS 633-8110
Purdue University (Sandia Subcontract No. 42-5815)
R. W. West - (317) 749-6244

Develop a family of ceramic thick film materials (conductive, resistive, dielectric, and semiconductive) which retain useful electrical and mechanical characteristics for both extended periods (10^5 h) at 300C and short periods (1,000 h) at 500C.

Keywords: Coatings and Films; Ceramics, Glasses

2. Gallium Phosphide Semiconductor Fabrication $110K

DOE Contact - Raymond J. LaSala, (202) 633-8110; FTS 633-8110
Sandia National Laboratory
A. F. Veneruso - (505) 844-9162; FTS 844-9162

Develop electric contacts and materials processing technique for gallium phosphide semiconductors that must operate at 275C for at least 1,000 hours.

Keywords: Materials Processing; Coatings and Films

3. High Temperature Gallium Phosphide and Gallium Arsenide Semi-Conductors $ 62K

DOE Contact - Raymond J. LaSala, (202) 633-8110; FTS 633-8110
Texas A&M University (Sandia Subcontract No. 42-7271)
O. Eknoyan - (713) 845-7030

Investigate metallization, passivation and doping techniques to establish a technological basis for the fabrication of high temperature (GaP, GaAs) diodes, controlled rectifiers, and the eventual design of transistors.

Keywords: Coatings and Films; Materials Processing

4. High Temperature Magnetic Materials Research $ 50K

DOE Contact - Raymond J. LaSala, (202) 633-8110; FTS 633-8110
Texas A&M University (Sandia Subcontract No. 42-5820)
R. K. Pandey - (713) 845-7030

Measure magnetic properties of commercially available soft and hard materials from 20 to 400C. Complete a literature search for promising developmental high temperature magnetic materials.

Keywords: Materials Characterization

5. Amorphous Metallization for Semiconductor Circuits $ 40K

DOE Contact - Raymond J. LaSala, (202) 633-8110; FTS 633-8110
University of Wisconsin (Sandia Subcontract No. 49-1664)
J. D. Wiley - (608) 262-3736

To investigate the related phenomena of diffusion and electromigration in amorphous metals and to obtain experimental data needed to assess the feasibility of amorphous metal films as metallization on high temperature semiconductor intergrated circuits to improve reliability.

Keywords: Coatings and Films, Semiconductors, Materials Characterization

Raft River 5 MW Binary Plant $200K

DOE Contact - M. Scheve , (202) 633-8755; FTS 633-8755
J. Whitbeck, D. F. Suciu - (208) 526-0259; FTS 583-0259

Corrosion and scale inhibitor support for Raft River project.

Keyword: Corrosion

Office of Uranium Resources and Enrichment

The goal of the U.S. uranium enrichment program is to meet the requirements of domestic and foreign customers for uranium enrichment services in an economical, reliable, safe, and environmentally acceptable manner. The Office of Uranium Resources and Enrichment, reporting through the Deputy Assistant Secretary for Utility and Energy Applications to the Assistant Secretary for Resource Applications, is responsible for the management of DOE resources to attain the program goal.

One of the specific objectives of the enrichment program is to develop gas centrifuge technology for installation in the Gas Centrifuge Enrichment Plant (GCEP) being built at Portsmouth, Ohio. Materials development is one aspect of the overall gas centrifuge development. The R&D in this area was funded at $1.6 million in FY 1980. The work is carried out at Union Carbide Corporation-Nuclear Division, Oak Ridge, Tennessee and includes:

1. Development of improved rotor materials.
2. Identification and categorization of centrifuge machine failure mechanisms.
3. Evaluation of UF_6 compatibility with proposed centrifuge materials (gas attack); descriptions of chemical attack mechanisms; and outlining the mechanical mechanism of rotor failure resulting from UF_6 corrosion.
4. Development of an accelerated test that will provide rapid evaluation of UF_6 corrosion resistance of various centrifuge configurations.
5. Characterization of the stress life of centrifuge rotor materials and evaluation of the mechanisms of this failure mode.
6. Development of test methods to better measure transverse shear strength of rotor material.

The materials testing program is concerned with both the baseline materials selected for the Portsmouth GCEP and with potential alternate materials which could be qualified for use in the GCEP. The baseline material will be tested to assure the performance adequacy of material produced from prototypical volume production equipment.

While there is no strong technical or performance motivation for pursuit of alternate materials for near-term use in the GCEP, there are a number of business reasons which point toward pursuit of alternate materials. The existence of multiple qualified materials would promote price competition and avoid the procurement/contracting disadvantages associated with a sole-source position. Multiple qualified materials would also increase the assurance of supply by reducing the potential adverse effects of strikes, fires, acts of God, and currently unforeseen health-safety regulations.

Further information can be obtained by contacting R. G. Wolf, Chief, Technical Support Branch, GCEP, (202) 633-8614; FTS 633-8614.

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