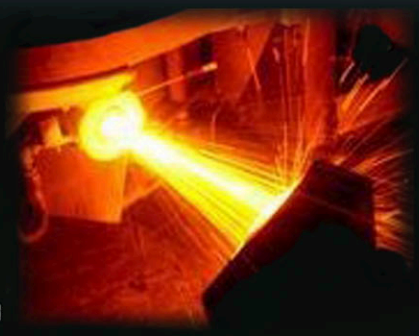
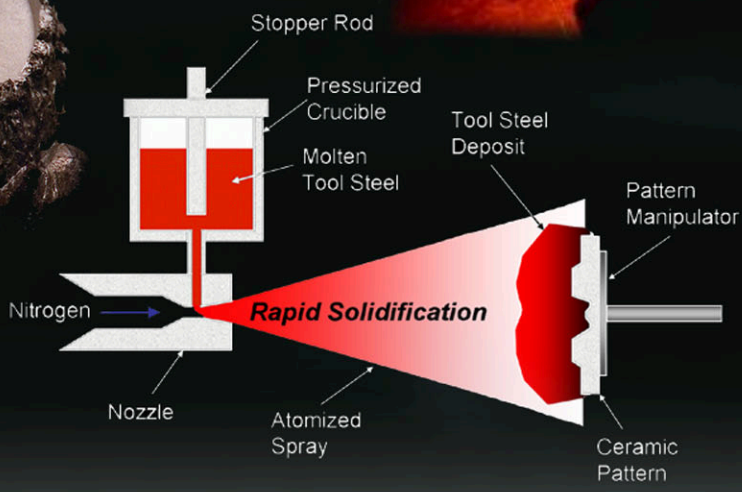
Industrial Materials
for the Future
Fiscal Year 2004 Annual Report





Industrial Technologies Program
Boosting the productivity and competitiveness of U.S. industry through improvements in energy and environmental performance

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Industrial Technologies Program — Boosting the Productivity and Competitiveness of U.S. Industry

Industry consumes 33 percent of all energy used in the United States. By developing and adopting more energy efficiency technologies, U.S. industry can boost its productivity and competitiveness while strengthening national energy security, improving the environment, and reducing emissions linked to global climate change.

The U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) works in partnership with U.S. industry to increase the efficiency of energy and materials use, both now and in the future. EERE's Industrial Technologies Program (ITP) is working to build the Industries of the Future through a coordinated program of research and development (R&D), validation, and dissemination of energy efficiency technologies and operating practices to reduce energy intensity in the industrial sector. ITP develops, manages, and implements a balanced portfolio that addresses industry requirements throughout the technology development cycle. The primary long-term strategy is to invest in high-risk, high-return R&D. Investments are focused on technologies and practices that provide clear public benefit but for which market barriers prevent adequate private sector investment.

ITP focuses its resources on a small number of energy-intensive materials and process industries that account for over 55 percent of industrial energy consumption.

- Aluminum
- Chemicals
- Forest Products
- Glass
- Metal Casting
- Mining
- Steel

ITP uses a leveraging strategy that maximizes the energy and environmental benefits of its process-specific technology investments by coordinating and cooperating with energy-intensive industries. By working closely with the private sector, the ITP is able to effectively plan and implement comprehensive R&D agendas and help disseminate and share best energy management practices throughout the United States. The ITP public-private partnerships also facilitate voluntary efforts, such as the President's Climate VISION initiative, to encourage industry and government to reduce greenhouse gas emissions.

ITP also conducts R&D projects on enabling technologies that are common to many industrial processes such as industrial energy systems, combustion, materials, and sensors and process control systems. In addition, ITP funds technical assistance activities to stimulate near-term adoption of best energy-saving technologies and practices within industry. These activities include plant assessments, tool development and training, information dissemination, and showcase demonstrations.

New technologies that use energy efficiently also lower emissions and improve productivity. By leveraging technical and financial resources of industry and government, the ITP partnerships have generated significant energy and environmental improvements that benefit the nation and America's businesses. Energy-intensive industries face enormous competitive pressures that make it difficult to make the necessary R&D investments in technology to ensure future efficiency gains. Without a sustained commitment by the private and public sectors to invest in new technology R&D and deployment, the ability to close the gap between U.S. energy supply and demand will be severely compromised.

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The images on the cover of this Report are from the project titled "Development and Demonstration of Advanced Tooling Alloys for Molds and Dies". The schematic shows the basic Rapid Solidification Processing technology developed at the Idaho National Engineering and Environmental Laboratory. The spray deposition and metal part photographs are courtesy of RSP Tooling, LLC, the industrial partner created to commercialize the technology.

EXHIBITS

EXECUTIVE SUMMARY

The availability of appropriate materials and processing methods is often critical to the successful realization of a new engineering or process concept. Because harsh industrial environments impose severe demands on materials performance, the success or failure of many industrial energy efficiency concepts depends on the selection of suitable materials and fabrication techniques. As evidence, materials R&D is identified as a high priority in every industry roadmap. The Industrial Materials for the Future (IMF) portfolio focuses on the removal of materials barriers to energy efficiency in the manufacturing sector.

A Successful Strategy with Industry

DOE's Office of Energy Efficiency and Renewable Energy leads federal development of advanced energy-efficient and environmentally friendly industrial technologies. Materials R&D is a component of the overall EERE strategy, contributing to a reduction in energy intensity of industry, a goal outlined in the National Energy Policy.

EERE/ITP is working to build the Industries of the Future through a strategy that is based on multi-year planning, industry involvement and input during the planning process, and careful analysis and data-based decision making. Materials are related to the performance of all industrial equipment and processes. This strategy not only takes into consideration the interests of the industrial sector as described in their R&D Technology Roadmaps, but also consists of an agenda of analytical studies that provide the basis for a more focused decision-making process. For instance, the *Materials for Separation Technologies: Energy and Emission Reduction Opportunities*, to be published in early 2005, will provide the basis for focusing materials R&D on specific applications and material performance criteria by identifying industry needs in the field of separations that can lead to large energy use reductions. Similarly, the *Refractories for Industrial Processing: Energy Reducing Opportunities* report, also to be published in 2005, will provide the basis for focusing materials R&D on refractories by identifying industry research needs in this particular field. By using opportunity studies, the portfolio is able to design a multi-year R&D plan based on the focus area, barrier, and pathway approach. In this approach, a limited number of critical focus areas are identified along with the technical barriers preventing their successful implementation. A multi-year plan (called a "Pathway") is then developed that will guide the R&D activities leading to a successful development of the focus area technology. The "Pathways" are then the basis for solicitations of pre-competitive R&D that addresses both energy efficiency goals outlined in the National Energy Policy and materials industry research priorities. This successful strategy has now evolved to a point where it provides focus on potentially high-impact research to make revolutionary improvements in the industrial sector.

FY 2004 Highlights

Advanced Tooling Alloys for Molds and Dies – Research at the Idaho National Engineering and Environmental Laboratory (INL) has led to the development and commercialization of a rapid tooling technology for manufacturing molds and dies. The technology, termed *Rapid Solidification Process (RSP) Tooling*, allows production-quality tooling for steel, glass, metal casting, forging and heat treating applications to be made in a fraction of the time and at a significantly reduced cost compared to conventional tool-making practices. Energy savings resulting from the elimination of machining, benching and heat treatment operations are estimated to be 5.5 TBtu/year by 2020. A new company, RSP Tooling, LLC was created to further develop, market and commercialize the technology. A third U.S. patent awarded for this technology, U.S. Patent No. 6,746,225, "Rapid Solidification Processing System for Producing Molds, Dies and Related Tooling" was issued in June 2004. A patent for the invention has also been issued in Canada. Patents in Japan, Mexico and the European Patent Office are currently pending. INL has added this new patent to the license agreement portfolio it has with RSP Tooling, LLC. RSP Tooling, LLC has also been awarded an *R&D 100* Award, an *Energy @23 Award*, and a *Federal Laboratory Consortium Award*.

Manufacturing Protocol Developed for Nickel Aluminide Rolls and In-Process Testing Continues – Steel reheat furnaces are used to heat treat steel slabs and plates prior to further processing. Currently, the rollers that transfer steel slabs through a furnace have severe problems with blistering and bending, which result in increased slab rejection rates and energy use. ISG (formerly Bethlehem Steel) and Oak Ridge National

Laboratory (ORNL) are evaluating the use of a new intermetallic nickel aluminide alloy for furnace rolls in the heat treating of steel plates. A manufacturing protocol has been developed and used in the specification for producing nickel aluminide rolls at Duraloy and UltraCast. A full complement of 101 IC221M nickel aluminide rolls, fabricated by Duraloy Technologies and Ultracast, has been installed and has been undergoing testing at the ISG Burns Harbor facility. The new nickel aluminide intermetallic alloy has superior properties to current alloys, including increased oxidation resistance, high-temperature strength and resistance to blistering. Their enhanced properties are leading to vastly improved furnace system operations, eliminating over 50 furnace shutdowns (~150 days; over 30 percent increase in up-time) over the last 18 months; creating higher yield and increasing product quality of steel; increasing energy efficiency by 35 percent; and lowering operating and maintenance costs. When fully deployed, this application is expected to save 10.8 TBtu/year and greatly increase the reliability of rolling operations. This effort was funded by three areas of ITP: the Steel portfolio, Technology Delivery and Industrial Materials for the Future.

Novel Superhard Materials and Nanostructured Diamond Composites – Researchers at Los Alamos National Laboratory, the Carnegie Institution's Geophysical Laboratory, and the Phoenix Crystal Corporation have produced synthetic single crystal diamonds, which are harder than natural diamonds. The gem-sized crystals were produced at a rate up to 100 times faster than other methods used to date. Diamond single crystals were grown using high-growth rate microwave plasma chemical vapor deposition (CVD), in which hydrogen gas and methane are bombarded with charged particles or plasma in a chamber. The crystals were then processed at high-pressure, high-temperature conditions for further hardening. The crystals are anticipated to have a variety of industrial applications, including high-pressure anvils electronics devices and cutting tools. Results have been reported in the February 20th online *Physica Status Solidi*. IMF estimates that this project will save approximately 0.7 TBtu/year by 2020.

Partnership Highlights

Portfolio Review Meeting – The Industrial Materials for the Future (IMF) Annual Project and Portfolio Review meeting was held June 21-24, 2004, in Arlington, VA in conjunction with the Glass and Sensors portfolios. More than 170 participants from universities, industry and the national laboratories, as well as representatives from DOE's ITP Office and the Golden Field Office attended the sessions. During the event, the principal investigators for the 36 IMF-sponsored projects reported on their progress for the past year and outlined their direction for future activities. A group of industry and subject matter experts, tasked by IMF to evaluate the projects, provided technical feedback and comments on the status and direction of the projects to the IMF staff and the project teams.

THE CHALLENGE

DOE sponsors materials R&D to lead a national effort to research, design, develop, engineer and test materials needed for energy efficiency improvements in ITP portfolios. Through coordinated research and development, validation, and dissemination of innovative materials and materials applications, IMF partners with ITP portfolios and other stakeholders to achieve the goals of ITP (Exhibit 1). As a priority, DOE fosters high-risk, high-return R&D with the potential to significantly improve energy efficiency, environmental performance and product yield. The IMF portfolio seeks to identify, support and nurture promising efforts in materials and processing technologies so they can be demonstrated in industrial applications. Funded activities cover proof of concept, applied research and development, and applications engineering (Exhibit 2). The Materials portfolio is crosscutting, emphasizing longer-range materials needs common to multiple industries and encouraging multi-industry partnerships.

Exhibit 1
ITP Goals to Meet the Challenge

- Increase energy efficiency
- Reduce reliance on foreign oil
- Reduce environmental impacts
- Increase use of renewable energy
- Improve competitiveness
- Improve process yield
- Conserve resources
- Improve worker health and safety
- Improve quality of life

Materials Energy Challenges

Advanced materials represent one of the most important and urgent technical needs of U.S. industry. The eight ITP portfolios – aluminum, chemicals, forest products, glass, metal casting, mining, petroleum refining and steel – all cite materials as high-priority R&D in their technology roadmaps, and all industry technology roadmaps collectively cite at least 10 specific materials-related priorities (Industrial Materials for the Future R&D Priorities, RAND 2001).

Exhibit 2
FY 2004 IMF R&D Addressed

- New corrosion resistant steels, refractories, and composites
- Nanocrystalline materials and coatings for industrial applications
- Databases and modeling for alloy design
- Materials for energy-efficient separations
- Tubes, tools and components for industrial processes

Material properties play a central role in determining the operating parameters and efficiencies of almost all industrial processes. However, materials also cause many planned and unplanned process interruptions in which productivity and energy are lost, and safety is compromised. Operating efficiency is also lost as materials corrode, wear, foul or otherwise degrade. Improved materials that perform better under corrosive, high-temperature and high-pressure conditions will enable new technologies to save more energy. In addition, longer lifetime saves the energy and raw materials needed to produce and install replacement materials.

Specific examples of opportunities for improved process technologies can be observed in almost all manufacturing processes. Separation processes are among the most energy-intensive operations in industry, accounting for more than a third of the energy used in manufacturing. Distillation and evaporation account for a vast majority of the separations energy consumed. These operations utilize the "heat of vaporization" as the separating phenomena and typically have high operating and capital costs. By far the most important area for materials research in separations is the development of low-temperature technologies that utilize "heats of solution" as the separating phenomena. Development of new mass-separating materials such as adsorbents, absorbents, ion-exchange resins, ionic liquids and membranes, and new process equipment designs to incorporate these materials will be required. New separation materials with improved selectivity, stability, morphology and the ability to regenerate will move these low-temperature technologies from niche applications into broader use. Successful development could lower separations energy consumption by 40 to 80 percent while reducing capital costs. (*Materials for Separations Technologies: Energy and Emission Reduction Opportunities*, ORNL, in preparation)

Refractories are used in most manufacturing industries as insulation and/or containment vessel linings for high-temperature and corrosive environments. In addition, refractory components often also have load-bearing or heat-transfer functions which contribute further to their performance requirements. Reduction of

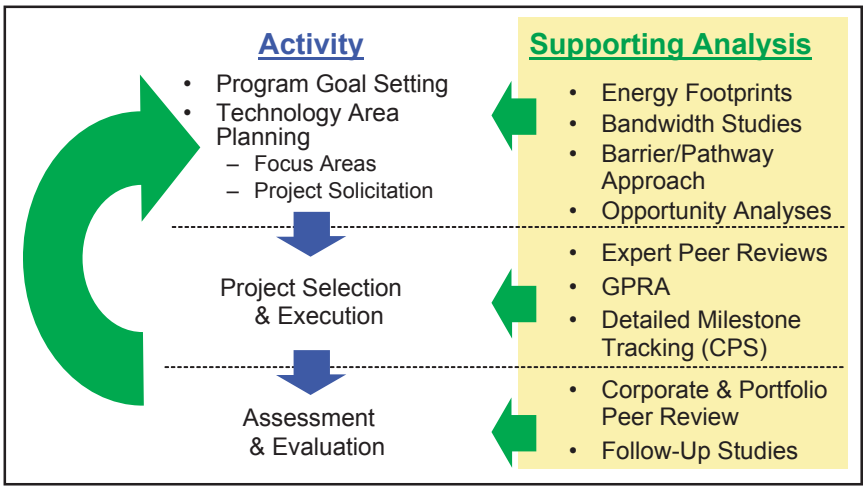
energy losses and increased productivity in processing could be realized by developing higher-strength refractories capable of operating at higher temperatures; developing refractories with lower thermal conductivity to reduce wall losses at higher service temperatures; improving the thermal expansion capabilities of current refractories; and developing refractories with greater resistance to degradation (*Refractories for Industrial Processing: Energy Reduction Opportunities*, ORNL, in preparation).

Industrial energy systems provide significant opportunity for materials to facilitate improved energy efficiency. New and advanced materials are key crosscutting technologies necessary for efficiency improvements in processes using furnaces, boilers, gasifiers, steam systems, recuperators and heat exchangers. Efficiency gains in these systems will result not only from the development of higher-temperature and more thermodynamically efficient processes, but also from the development of robust new materials. In addition to advanced refractories and insulation, affordable metals, ceramics, composites or coating systems with improved high-temperature properties are needed to improve productivity and lower energy use per unit of production.

Portfolio Strategy/Key Pathways

Focus Area/Barrier/Pathway Strategy– Over the past two years, ITP initiated a new approach to portfolio planning. This approach, illustrated in Exhibit 3, relies on a continuous analysis and review process to identify, fund and manage R&D opportunities with high energy-savings potential. A Focus Area – Barrier – Pathway strategy is used in the planning of both ITP portfolios and individual projects. Based on a technical analysis of the industry Roadmaps, four priority technical focus areas have been identified for the IMF, which now form the framework for materials research and development work (Exhibit 4).

Exhibit 3
Analysis-Guided Planning



Studies – Analytical studies are being conducted in order to understand and identify the most promising materials-related opportunities and barriers within the four focus areas. These studies include:

- Refractories for Industrial Processing: Energy Reduction Opportunities
- Materials for Separations Technologies: Energy and Emission-Reduction Opportunities
- Thermophysical Databases and Modeling Needs for Industrial Energy Efficiency
- Energy Costs of Corrosion
- Opportunity Analysis for Recovering Energy from Industrial Waste Heat and Emissions

Exhibit 4
IMF Priority Focus Areas

- Degradation-resistant materials
  - Materials development and processing
  - Coatings and surface modifications
  - Refractories
- Thermophysical databases and modeling
- Materials for Separations
- Materials for Engineering Applications

These reports will specifically attempt to identify the largest energy-savings opportunities across all manufacturing and allow the IMF to focus future solicitations on materials that provide significant improvements in energy efficiency. Two of the studies, *Refractories for Industrial Processing* and *Materials for Separations Technologies* have been completed and are now being reviewed. They will be available on the ITP Web site in early FY 2005. Future analyses will be initiated in response to pressing industry needs, opportunities or gaps identified in the IMF portfolio.

Project Portfolio – A near-term goal for the IMF is to concentrate portfolio resources on a smaller number of projects. The FY 2003 portfolio supported 27 projects. This level of funding often requires extended work periods to obtain meaningful results, and it is anticipated that an earlier application of greater resources to a more select group of projects will expedite bringing the energy savings to market. FY 2004 brought the addition of 13 new projects to the IMF portfolio, raising the total number of active projects in 2004 to 36 – moving in a direction that prima facie appears to work against the goal. However, the new projects are funded at twice the level, on average, than were the older projects. In addition, approximately 20 of the older projects are ending in FY 2004 or FY 2005, bringing the portfolio down to a more easily manageable size.

2004 Peer Review – The Industrial Materials of the Future participated in the ITP Corporate Peer Reviews held March 9-10 and May 19-20, 2004. These meetings represent the Assessment and Evaluation stage of ITP Analysis-Guided Planning (Exhibit 3). The March Peer Review brought industry stakeholders and government partners together to review the mission, strategies and future direction of the Industrial Technologies Program, including a strategic overview of the various ITP portfolios. Feedback from the Materials portfolio review in March is summarized in Exhibit 5. Verbal and written feedback at the Peer Review meetings reinforced the importance of crosscutting R&D, especially in the Thermodynamic Databases and Modeling area.

Exhibit 5
Feedback from March Peer Review

Strengths of the Portfolio	Recommendations for Improvement
TECHNICAL	
• Current material database development provides researchers and industry easy access to material characteristics, reducing dissemination and commercialization times.	• Thermochemical databases for materials at room temperature and higher; databases for structural materials. • Simulation software that can predict materials performance. • Improved sensor materials for hostile environments. • Quality issues in recycling ferrous, copper, steel, and other co-metal materials.
PROGRAMMATIC	
• Materials for degradation is a broad, crosscutting need. Results are more broadly applicable, ultimately saving more energy per dollar invested.	• Expand the crosscutting approach to include even more end users. • Promote the economic benefits, as well as the energy savings of the portfolio.

FY 2004 HIGHLIGHTS AND ACCOMPLISHMENTS

Project Portfolio

The IMF portfolio received $12.7 million in funding in FY 2004 for materials projects that address focus area needs in multiple industries. Thirteen new projects were started in FY 2004, increasing the total number of active projects in the IMF portfolio to 36. The portfolio consists of multi-partner projects led by industry, universities and laboratories. Exhibit 6 lists the projects and shows the crosscutting areas where the technologies are applicable. Fact sheets for each project can be found at: http://www.eere.energy.gov/industry/imf/portfolio.html.

Exhibit 6
FY 2004 IMF Project Portfolio and Crosscutting Applications

	Aluminum	Chemicals	Forest Products	Glass	Heat Treating	Metal Casting	Mining	Petroleum	Process Heating	Steel
DEGRADATION RESISTANT MATERIALS										
Materials Development and Processing										
Development of a New Class of Fe-3Cr-W(V) Ferritic Steels for Industrial Process Applications		X	X		X			X	X	X
Development of Stronger and More Reliable Cast Austenitic Stainless Steels		X	X		X			X		X
Fracture Toughness and Strength in a New Class of Bainitic Chromium Tungsten Steels		X	X		X			X	X	X
Ultrasonic Processing of Materials	X					X				X
New Class of Ultra Hard Borides			X			X	X			
Ultrahigh Magnetic Field Processing of Materials	X	X			X	X				X
Novel Superhard Materials and Nanostructured Diamond Composites							X	X		
Advanced Nanoporous Composite Materials for Industrial Heat Applications	X	X		X	X	X		X	X	X
High Strength/High Alkaline Resistant, Fe Phosphate Glass Fibers as Concrete Reinforcement				X						
Development of Materials Resistant to Metal Dusting Degradation		X								X
Coating and Surface Modifications										
High Density, Infrared, Transient Liquid Coatings for Improved Wear and Corrosion Resistance	X	X	X	X		X	X	X		X
Advanced Composite Coatings		X			X			X		X
Ultrananocrystalline Diamond Coatings for Pump Seals	X	X	X	X		X	X	X		X
Low Temperature Surface Carburizing of Stainless Steels		X	X							
Advanced Wear and Corrosion Resistant Systems Through Laser Surface Alloying Materials Simulation	X	X	X		X	X	X		X	X
Structurally Integrated Coatings for Wear and Corrosion	X		X				X			X
Refractories										
Development of Cost Effective Ceramic and Refractory Components for Aluminum Melting and Casting	X	X		X		X		X		
Materials for High Temperature Black Liquor Gasification			X							
Multifunctional Metallic and Refractory Materials for Energy Efficient Handling of Molten Metals	X					X				X
THERMOPHYSICAL DATABASES AND MODELING										
Inverse Process Analysis for the Acquisition of Thermophysical Data	X			X		X				X
Thermochemical Models and Databases for High Temperature Materials	X	X	X	X	X	X	X	X	X	X
Combinatorial Methods for Alloy Design and Optimization		X	X		X	X	X	X		X
Prediction of Corrosion of Advanced Materials and Fabricated Components		X								
MATERIALS FOR SEPARATIONS										
Advanced Chlor-Alkali Technology		X						X		
Novel Modified Zeolites for Energy Efficient Hydrocarbon Separations		X						X		

	Aluminum	Chemicals	Forest Products	Glass	Heat Treating	Metal Casting	Mining	Petroleum	Process Heating	Steel
MATERIALS FOR ENGINEERING APPLICATIONS										
Corrosion-Resistant Materials										
Physical and Numerical Analysis of Extrusion Process for BiMetallic Tubes		X	X			X				X
Stress Assisted Corrosion in Boiler Tubes	X	X	X	X	X	X	X	X	X	X
Wear-Resistant Materials/Improved Lifetime										
Novel Carbon Film for Next Generation Rotating Equipment Applications	X	X	X	X		X	X	X		X
High Performance, Oxide Dispersion Strengthened Tubes for Production of Industrial Chemicals		X			X			X		
Development and Demonstration of Advanced Tooling Alloys for Molds and Dies				X	X	X				X
Development of Functionally Graded Materials for Manufacturing Tools				X		X				
Development of Bulk Nanocrystalline Cemented Tungsten Carbide for Industrial Applications	X	X					X			X
Heat Recovery										
Materials for Industrial Heat Recovery Systems	X		X							
Advanced Thermoelectric Materials for Efficient Waste Heat Recovery in Process Industries	X	X		X						X
Welding/Joining										
Virtual Welded Joint Design Integrating Advanced Materials and Processing Technologies			X		X		X	X		X
Advanced Integration of Multi-Scale Mechanics and Welding Process Simulation in Weld Integrity Assessment			X	X		X	X			X
Red: Projects scheduled to conclude in FY 2004 or 2005										
Blue: FY 2004 new projects										

Broad Industry Partnership

One of the strengths of the IMF portfolio is the significant participation of industry partners who aid research and provide cash and in-kind cost-share. Currently, the portfolio engages 174 partners – 134 industrial, 27 university, 10 laboratory and 3 industry association – in 32 states. The geographic reach of the IMF portfolio is illustrated in Exhibit 7a. (Exhibit 7b lists the IMF industrial partners.)

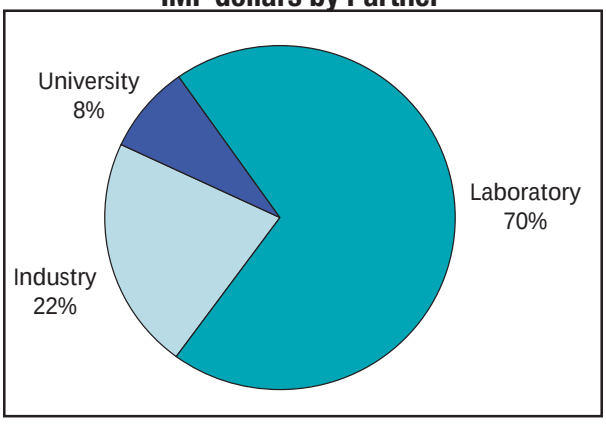
Exhibit 7a
Geographic Reach of IMF Activities

Partnerships spread both cost and risk of R&D, enabling projects too complex, costly or time-consuming for individual companies to undertake alone. Industry involvement during the early stages of R&D accelerates technology transfer and dissemination of

Exhibit 7b
List of IMF Industrial Partners

Advanced Diamond Technologies
Advanced Glassfiber Yarns LLC
Air Products and Chemicals, Inc.
AK Steel
Alcoa
Allied Minerals, Inc.
Alon Surface Technologies
ALSTOM Power, Inc.
Altair Engineering
Alvord-Polk Corporation
Ametek
Anderson, Burns and McDonnell
Applied Sciences Laboratory, Inc.
Atofina Chemicals, Inc.
Babcock & Wilcox
Battelle Memorial Institute
Bethlehem Steel Corp.
Blasch
Boise Cascade Corporation
BP Amoco
Brunner & Lay Inc.
California Steel Corp.
Carpenter Technology Corporation
Caterpillar, Inc.
Chevron Texaco
Conoco Philips
Crucible Research Division
Cummins Engine Company, Inc.
Deere and Co.
Deloro Stellite
Domtar
DuPont
Duraloy Technologies, Inc.
Dynamet Technology
E3M Inc.
Eclipse
Ellwood Materials Technologies
Emhart Glass Co.
Energy Industries of Ohio
Engineering Mechanics Corporation of Columbus (EMC2)
ExxonMobil Chemical Co.
Flow Science, Inc.
Ford Motor Co.
General Aluminum Manufacturing Co.
Georgia Pacific
GKN Sinter Metals
Goodyear Chemical
Grenada Industries Inc
Haldor Topsoe
Harbison-Walker Refractory Co.
Harper International
Haynes International
Hercules Inc.
Howmet Research Corp.
ILZRO (International Lead Zinc Research Organization)
International Paper
IPLAS Innovative Plasma Systems
IPSCO
ISG Plate
John Crane, Inc.
Kennametal Inc.
Kyanite Mining
Kvaerner Power
Leadbetter and Sons, Inc.
Longview Inspections
Lund International Corp.
Magneco-Metrel, Inc.
Materials Resources International
Materials Technology Institute
MeadWestvaco
Metaldyne Group Operations
Metaullics Systems
Mitsubishi Chemical
MonofraxRefractories Inc.
MORCO Refractory
Morgan Advanced Ceramics
MO-SCI Corporation
NETZSCH Instruments, Inc.
Nooter-Eriksen
Nooter Corporation
NUCOR Steel Corporation
Nuvonyx Corp.
OLI Systems, Inc.
Ondeo-Nalco
OPTOMEC
Owens-Illinois
Pechiney Rolled Products
Pilkington - LOF
Plymouth Tube Co.
PPG Industries, Inc.
Praxair Surface Technologies, Inc.
ProCAST, Inc.
Process Simulations Limited
Pyrotek, Inc.
QuesTek Innovations
Reaction Design
RHI Refractories
Rock Bit International, Gearhart Industries Inc.
RPM and Associates Inc.
RSP Tooling, LLC
Sandvik Material Tech.
Secat, Inc.
Shell Global Solutions
Shell Oil Products Co.
Simulent, Inc.
Smith International, Inc.
Solar Turbines
Southern California Gas Co.
Southwest Research Institute
Special Metals Corporation
Spirax Sarco Inc
Spirex Corporation
SRI International
St. Louis Metallizing
Stoody Company
Sturm Rapid Response Center
Swagelok Company
Synergis Technologies Group
Techneglas Corporation
Teckcominco
The Techs
The Timken Company
Thermal Ceramics
THT Presses Inc.
ThyssenKrupp VDM
Toyo Engineering Corp.
Unifrax
Vesuvius McDanel
Visteon Automotive Systems
Weirton Steel
Welding Services Inc.
West Virginia Steel Futures, Inc.
Weyerhaeuser Company
Wheatland Tube Co.

Exhibit 8
IMF dollars by Partner



research results. Partnerships bring together technical expertise, practical experience, and state-of-the-art resources and facilities to dramatically accelerate advances in critical challenge areas. Exhibit 8 illustrates the distribution of IMF funding by organization type.

In FY 2004, the IMF had 134 industry R&D partners, providing the portfolio with approximately 42 percent cost-share funding. Partnerships established around cost-shared projects ensure that the R&D activities undertaken are of real and commercial value to the industry. This approach accelerates the rate of new product diffusion, and garners energy efficiency benefits earlier in the product life cycle. This successful government-industry partnership continues to focus on developing high-impact research projects to make revolutionary improvements in energy efficiency.

Exhibit 9 illustrates IMF funding by general R&D activity for FY 2004. The portfolio addressed the diversity of ITP, with research in degradation-resistant materials, databases and modeling, materials for separations, and materials for engineering components. Exhibit 10 breaks up the spending percentage of the separate areas within degradation-resistant materials – materials development and processing, coatings and surface modifications, and refractories.

Exhibit 9
IMF Funding by R&D Focus Area

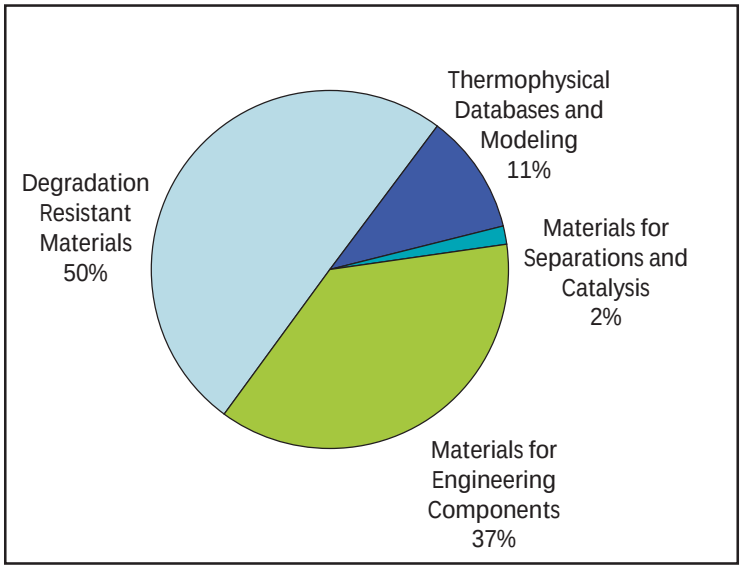
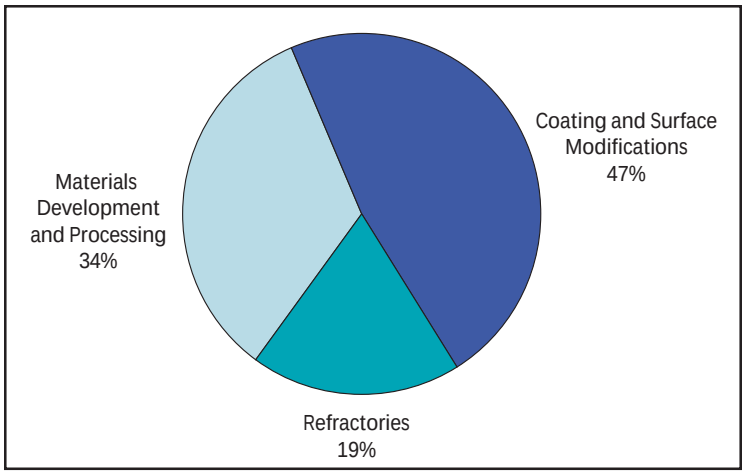


Exhibit 10
Degradation Resistant Materials



Extended Research Portfolio

The extended ITP Materials portfolio (Exhibit 11, following page) addresses shorter-term materials needs for a specific industry or application, while the IMF portfolio (Exhibit 6) consists of projects boasting broad crosscutting applications in multiple ITP portfolios. In addition to the IMF portfolio, materials R&D is conducted through many of the other ITP portfolios.

R&D Highlights

The following examples of current projects display promising results including some that are now emerging in commercial settings. Fact sheets for these projects are located on the IMF Web site at: http://www.eere.energy.gov/industry/imf/portfolio.html.

Development of a New Class of Fe-3Cr-W(V) Ferritic Steels for Industrial Process Applications - Nooter Corporation, Oak Ridge National Laboratory and several industrial partners are developing a new class of Fe-3Cr-W(V) steels. These steel compositions are targeted to have 50 percent higher strength at temperatures up to 650ºC than current alloys and require no postweld heat treatment. U.S. and foreign patent applications were submitted for the optimized alloy compositions. 50 ton heats have been commercially melted and processed into forgings and plates. Documentation of the new alloy for ASTM is being prepared and a preliminary ASME Code package, including material property data and design stress values, has been assembled. The developed alloys are expected to be used in the fabrication of hydrocrackers, chemical reaction vessels, heat recovery systems and boilers.

High Density Infrared (HDI) Fusion of Wear- and Corrosion-Resistant Cermet and Hardfacing Coatings - Materials Resources International and Oak Ridge National Laboratory are developing a High Density Infrared (HDI) Fusion process to deposit wear- and corrosion-resistant claddings. The research revealed that the thermal and chemical properties lead to a distinct difference in the structure due to wetting, adherence and densification behaviors of the cladding compositions. A model was developed to predict thermal processing parameters for wear- and corrosion-resistant coating-substrate systems. One of the project partners, Lund International Corporation, is preparing agricultural cutting blade samples for the application of thermal spray and suspension precursor layers. These blades will be HDI-processed and installed into agricultural equipment and evaluated via industrial trials selected by Lund. IMF estimates that this project will save approximately 0.2 TBtu/year by 2020.

Alloys for Ethylene Production Successfully Extruded at Pilot Scale – Ethylene, both in number of kilograms and chemical use, is the world's most important chemical building block. ITP's project with the Materials Technology Institute (MTI) and the Oak Ridge National Laboratory (ORNL) has led to the development of three alloys for ethylene production reaction vessel tubing that can provide energy benefits and also improve operations by nearly a factor of ten. The pilot-scale extrusions of the tubing were performed at Special Metals Corporation using a 5,000 ton press. Ten 10.7-inch OD by 30-inch long billets were successfully extruded to a new size of 5.25-inch OD by 0.75-inch wall thickness by ~20 feet long tubes. Additional metallurgical operations will now be performed on the tubes prior to the upcoming in-plant test planned at an ExxonMobil ethylene production plant.

Advanced Composite Coatings – Research at Pacific Northwest National Laboratory, the University of Washington, Stanford Research Institute, and the Materials Characterization Facility at the University of Central Florida has resulted in new protective coatings on steels for the chemical process industry. Several new coatings have been developed based on polymer-filled ceramic systems that are inexpensive and can be applied as a paint-like product. In one coating formulation, SiC is formed in situ during a displacement reaction between Al and an Si-O-C polymer system at 800°C. The ramifications of these findings are that less expensive metals, such as 316 or 310 stainless steels, can potentially be used for process conditions that would otherwise require more expensive alloys. A recent project review meeting was held in Indianapolis, Indiana

Exhibit 11
Extended ITP Materials Portfolio

Forest Products
Development of Corrosion-Resistant Chromium-Rich Alloys for Gasifier and Kraft Recovery Boiler Applications (CPS #1701)
Evolution of Ceramic Coating for Protection of HTHP BL Gasifiers (CPS #1702)
Aluminum
Inert Metal Anode Life in Low-Temperature Aluminum Reduction Process (CPS #929)
Chemicals
Alloys for Ethylene Production (CPS #1222)
Metal Dusting Phenomena (CPS #1223)
Alloy Selection System (CPS #1243)
Advanced Membrane Materials for Reducing Energy Consumption in P-Xylene Separation (CPS #885)
Metal Casting
Grain Refinement of Permanent Mold Cast Copper-Base Alloys (CPS #1500)
Creep Resistant Zinc Alloy Development (CPS #1190)
Innovative Semi-Solid Metal (SSM) Processing (E-SMARRT) (CPS #17328)
The Development of Surface Engineered Coating Systems for Aluminum Pressure Die Casting Dies: Towards a "Smart" Die Coating (E-SMARRT) (CPS #17328)
Improvement in Die Design to Improve Die Life as Affected by Thermal Fatigue Cracking, Erosion and Soldering (E-SMARRT) (CPS #17328)
Casting Porosity-Free, Grain Refined Magnesium Alloys (E-SMARRT) (CPS #17328)
Development of Elevated Temperature Aluminum MMC Alloy and Process Technology (E-SMARRT) (CPS #17238)
Mining
Fibrous Monolithic Composites as Wear-Resistant Components for Mining (CPS #1620)
Castcon Process for Mining Applications (CPS #1619)
Metal-Matrix Composites and Thermal Spray Coatings for Mining Machines (CPS #1618)
Inventions and Innovations
Chemically-Inert Membranes (CPS #17827)
Oxide Dispersion Strengthened Iron Aluminide by CVD (CPS #17811)
Development of New Stainless Steel (CPS #5416)

with Air Products and Chemicals, and resulted in a renewed emphasis on coating testing and evaluation under industrial process conditions. The new coatings, which can survive multiple thermal cycles in air, will be tested on steels for use at 900°C in steam-methane reformers. IMF estimates that this project will save approximately 2.7 TBtu/year by 2020.

Ultrahigh Magnetic Field Processing of Materials – Recent magnetic field processing research at the Oak Ridge National Laboratory (ORNL) and the National High Magnetic Field Laboratory at Florida State University (FSU) has shown significant enhancement of the properties of several iron-based alloys. The importance of these findings is that alloys with enhanced performance can be made with shorter heat-treating cycles, higher production rates, increased tooling life, reduced fabrication costs and significant energy benefits. Meetings have been held at ORNL with various industries interested in this new magnetic field-processing breakthrough technology, including the cast iron, heat treating and steel industries. This research and development has resulted in a U.S. patent submission, "Magnetic Field Processing for Customizing Microstructures and Properties in Materials," which covers several major intellectual property concepts developed in this project.

Novel Superhard Materials and Nanostructured Diamond Composites – Researchers at Los Alamos National Laboratory, the Carnegie Institution's Geophysical Laboratory, and the Phoenix Crystal Corporation have produced synthetic single crystal diamonds which are harder than natural diamond. The gem-sized crystals were produced at a rate up to 100 times faster than other methods used to date. Diamond single crystals were grown using high-growth rate microwave plasma chemical vapor deposition (CVD), in which hydrogen gas and methane are bombarded with charged particles or plasma in a chamber. The crystals were then processed at high-pressure, high-temperature conditions to harden them further. The crystals are anticipated to have a variety of industrial applications including high-pressure anvils, electronic devices and cutting tools. Results have been reported in the February 20th online *Physica Status Solidi*. IMF estimates that this project will save approximately 0.7 TBtu/year by 2020.

Materials for High Temperature Black Liquor Gasification – In mid-January 2004, the Weyerhaeuser black liquor gasifier at New Bern, NC, was taken out of service for repairs and inspection of the refractory lining. Representatives from Weyerhaeuser, Oak Ridge National Laboratory (ORNL), several refractory companies, and the gasifier designer were present. Eight core-drilled samples from a previously installed test panel of new refractories were removed and then examined at ORNL. The results of the examinations have shown that one of the new test refractories defined by ORNL performed very well. Consequently, Weyerhaeuser has made a major IMF project go-no-go decision to install a much larger test panel of the new type of refractory when the gasifier is scheduled for a shut-down in September 2004. As a result of the R&D, one patent titled "Alkali Resistant Refractories" has been submitted and a second patent disclosure is in the final stages of preparation. IMF estimates that this project will save approximately 17.1 TBtu/year by 2020.

Applying R&D Results

Industry is adopting IMF research into their operations. The following examples demonstrate technologies that are moving beyond the bench and into the plant. Fact sheets for these projects are located on the IMF Web site at: http://www.eere.energy.gov/industry/imf/portfolio.html.

Manufacturing Protocol Developed for Nickel Aluminide Rolls and In-Process Testing Continues - Steel reheat furnaces are used to heat treat steel slabs and plates prior to further processing. Currently, the rollers that transfer steel slabs through a furnace have severe problems with blistering and bending, which result in increased slab rejection rates and energy use. ISG (formerly Bethlehem Steel) and Oak Ridge National Laboratory (ORNL) are evaluating the use of a new intermetallic nickel aluminide alloy for furnace rolls in the heat treating of steel plates. A manufacturing protocol has been developed and used in the specification for producing nickel aluminide rolls at Duraloy and UltraCast. A full complement of 101 IC221M nickel aluminide rolls, fabricated by Duraloy Technologies and Ultracast, was installed and has been under test at the ISG Burns Harbor facility. The new nickel aluminide intermetallic alloy has properties superior to current alloys, including increased oxidation resistance, high-temperature strength and resistance to blistering. These enhanced properties are leading to vastly improved furnace system operations, eliminating over 50 furnace shutdowns (~150 days; over 30 percent increase in up-time) over the last 18 months; creating higher yield and increasing product quality of steel; 35 percent increase in energy efficiency; and lowering operating and

maintenance costs. When fully deployed, this application is expected to save 10.8 TBtu/year and greatly increase the reliability of rolling operations. This effort was funded by three areas of ITP: the Steel portfolio, Technology Delivery and Industrial Materials for the Future.

Thermochemical Models and Databases for High Temperature Materials – Sandia National Laboratory and Oak Ridge National Laboratory are working with nine industrial partners on a project to improve the availability, accuracy and accessibility of thermochemical property data that is required to understand, simulate and optimize industrial processes. Project accomplishments and milestones center on developing thermodynamic models of condensed-phase systems, prediction of high-temperature thermochemistry of gas-phase species, and the development of a Web-based database/model site that will provide the necessary input for commercial operation. The database is now available at: http://www.ca.sandia.gov/HiTempThermo/index.html. Presently, the database contains information for gas-phase compounds and a wide range of metal oxides used in refractories. Data on this site enable the modeling of materials and refractories in high-temperature industrial environments, so that both optimal selection of compatible materials, as well as interpretation of failure mechanisms can occur. Project activities are directed toward predicting thermodynamic data for compounds of relevance to the glass, pulp/paper, chemicals and metals refining industries, all of which use refractories extensively. Currently, the database has more than 70 industrial and academic subscribers and the site has received over 3,300 hits since its inception more than a year ago. IMF estimates that this project will save approximately 1.4 TBtu/year by 2020.

Novel Carbon Films for Next Generation Rotating Equipment Applications –The University of Illinois at Chicago, Drexel University and Argonne National Laboratory have developed tribological coatings on SiC seal rings to improve frictional and wear properties for rotating equipment applications. The coatings are based on Carbon Derived Carbon (CDC), which is a carbon conversion film produced by a high-temperature chlorination process. This process results in a structure and properties ranging from graphite to diamond, modified by Near Frictionless Carbon (NFC), which is deposited by a plasma CVD process. Processing conditions for optimal CDC synthesis have been identified and the friction and wear properties of coated surfaces were characterized. U.S. Patent No. 6,579,833, "Process for Converting a Metal Carbide to Carbon by Etching in Halogens," was issued to the University of Illinois on June 17, 2003. Carbide Derived Technologies, a start-up company that incorporated last year, has licensed the technology from the University of Illinois and is working with the project team to transition the technology from the laboratory to a commercial-scale process. Components whose lifetime and reliability are increased when coated with this novel carbon film will be marketable in the chemical, transportation and other industries that use rotating equipment containing mechanical seals, sliding bearings or shafts.

Crosscutting Applications for a New Class of Ultra-Hard Materials Based on $AlMgB_{14}$ – Researchers at Iowa State University's Ames Laboratory have developed a new class of ultra-hard materials based on $AlMgB_{14}$ for wear-intensive applications, such as cutting, grinding, milling and drilling operations in the mining, forest products, metal casting and agricultural industries. U.S. Patent No. 6,099,605, "Superabrasive Boride and a Method of Preparing the Same by Mechanical Alloying and Hot Pressing," was issued on August 8, 2000, and a divisional Patent, No. 6,432,855, "Superabrasive Boride and a Method of Preparing the Same by Mechanical Alloying and Hot Pressing," was issued on August 13, 2002. Continued research, based on these patents, resulted in recent project accomplishments that included, 1) the establishment of a powder processing scale-up technology, 2) the development of a new high-strength, high-ductility binder composition, 3) the preparation and characterization of high-hardness, low-friction thin film coatings, and 4) the evaluation of high-speed cutting potential of boride tools with various metal alloys. The Iowa State Research Foundation, which is responsible for the commercialization of technologies developed at Iowa State University, created a commercialization roadmap for the ultra-hard boride materials. An option agreement for an exclusive license to manufacture ultra-hard $AlMgB_{14}$-based materials was executed with Viable Technologies, LLC in May 2004. Viable Technologies, LLC has assumed responsibility for providing sample materials to industrial partners to be evaluated for commercial applications.

Advanced Tooling Alloys for Molds and Dies – Research at the Idaho National Engineering and Environmental Laboratory (INL) has led to the development and commercialization of a rapid tooling technology for manufacturing molds and dies. The technology, termed *Rapid Solidification Process (RSP) Tooling*, allows production-quality tooling for steel, glass, metal casting, forging and heat treating applications to be made in a fraction of the time and at significantly reduced cost compared to conventional

tool-making practices. Energy savings resulting from the elimination of machining, benching and heat treatment operations are estimated to be approximately 5.5 TBtu/year by 2020. A new company, RSP Tooling, LLC was created to further develop, market and commercialize the technology. A third U.S. Patent awarded for this technology, U.S. Patent No. 6,746,225, "Rapid Solidification Processing System for Producing Molds, Dies, and Related Tooling," was issued in June 2004. A patent for the invention has also been issued in Canada. Patents in Japan, Mexico and the European Patent Office are currently pending. INL has added this new patent to the license agreement portfolio it has with RSP Tooling, LLC. RSP Tooling, LLC has also been awarded an *R&D 100* Award, an *Energy @23* Award, and a *Federal Laboratory Consortium* Award.

Partnership Highlights

In addition to partnering in R&D projects, the IMF works with other organizations to accomplish the goals of the ITP.

Portfolio Review Meeting – The Industrial Materials for the Future (IMF) Annual Project and Portfolio Review meeting was held June 21-24, 2004, in Arlington, VA in conjunction with the Glass and Sensors portfolios. More than 170 participants representing universities, industry and the national laboratories, as well as representatives from DOE's ITP Office and the Golden Field Office attended the sessions. During the event, the principal investigators for the 36 IMF-sponsored projects reported their progress over the past year and outlined their direction for future activities. A group of industry and subject matter experts, tasked by IMF to evaluate the projects, provided technical feedback and comments on the status and direction of the projects to IMF staff and the project teams.

MPLUS – The Metals Processing Laboratory Users Facility (MPLUS) at Oak Ridge National Laboratory is an Industrial Technologies Program user facility designated to assist in research to improve energy efficiency, environmental performance and competitiveness in industry. MPLUS receives a portion of its funding directly from the IMF to support research and development efforts of concern to ITP. The goal of MPLUS is to provide access to specialized technical expertise and equipment needed to solve metals processing issues currently limiting the development and implementation of emerging metals processing technologies. The scope of work can also extend to other types of materials; MPLUS also offers industry and academia access to unique DOE laboratory capabilities to address key industrial materials issues.

Annual reporting of MPLUS activities has recently been initiated, beginning with the complete FY 2001 report. MPLUS objectives for FY 2004 are to continue to publish and distribute annual reports on MPLUS research activities, increase participation of ITP partners, and quantify energy benefits on existing projects and future work in order to focus its efforts on those projects that provide the highest impact on energy savings.

Forging Industry Association – Oak Ridge National Laboratory hosted the Forging Industry Association's (FIA) Plant Engineering Committee Meeting on June 9-10. Participants from 25 companies and 6 states representing both commercial metal forging producers and their suppliers addressed specific plant operation issues. Topics such as shop floor procedures, energy benefits, safety and environmental concerns were discussed. Tours of the laboratory included the Metals Processing Laboratory Users (MPLUS) facility. FIA is a trade association headquartered in Cleveland, Ohio that promotes the advancement of technology in the North American forging industry.

American Foundry Society - A panel of ORNL Laboratory's MPLUS users discussed the applications of infrared cameras in foundries during the AFS Conference on June 13. The MPLUS infrared camera technology, sponsored by ITP, has been particularly useful in studying the lost foam casting process – an environmentally friendly, energy-efficient metal casting process that can provide a competitive advantage to North American companies in the making of complex parts.

Intra-EERE/Government Activities
In addition to close work with industrial and academic partners, IMF seeks opportunities to coordinate with other government groups to maximize resources and research. Some of these include:

SBIR Topic – In 2004, the IMF developed and managed a Small Business Innovation Research (SBIR) topic solicitation and proposal review on *Materials for Industrial Energy Systems*. Five projects addressing refractories for molten metal, novel heat exchangers, coatings for pipe protection, and shape memory alloys for waste heat recovery systems were selected for negotiation. These projects will leverage the IMF portfolio efforts in the Materials for Engineering Applications focus area.

EMaCC Report – The IMF contributed to and helped fund the annual Energy Materials Coordinating Committee (EMaCC) report. EMaCC serves primarily to enhance coordination among DOE materials programs and to further effective use of materials expertise within DOE. These functions are accomplished through the exchange of budgetary and planning information among technical managers and through technical meetings/workshops on selected topics involving both DOE and major contractors. In addition, EMaCC assists in obtaining materials-related inputs for both intra-agency and interagency compilations. For more information, please visit: http://www.eere.energy.gov/industry/imf/pdfs/EMACC_Annual_Technical_Report_FY2003.pdf.

Annual Interagency Metals Meeting – The IMF organizes, coordinates and participates in an annual Interagency Metals Meeting and distributes the proceedings to participants.

Climate VISION Activities

On February 14, 2002, President Bush announced a new strategy to address the long-term challenge of global climate change. The President committed to reducing America's greenhouse gas intensity – the ratio of emissions to economic output – by 18 percent in the next decade, and challenged American businesses and industries to undertake broader efforts to help meet the goal. The President's strategy, known as Climate VISION (Voluntary Innovative Sector Initiative: Opportunities Now), is focused on voluntary partnerships between the government and entire industry sectors. These partnerships aim to reduce the projected growth in America's greenhouse gas emissions through research, development and deployment of energy-saving technologies and processes.

The U.S. Department of Energy, along with other key federal agencies, recognizes that major energy-intensive sectors of the American economy are undertaking significant initiatives to meet the President's challenge. These initiatives build upon the progress made by the industrial sector in the past decade. From 1990-2001, the economy grew by almost 40 percent, while greenhouse gas emissions in the industrial sector remained constant. The Industrial Technologies Program (ITP) is working in partnership with the U.S. cement industry through the Portland Cement Association (PCA) to implement activities in support of the PCA achieving its Climate VISION commitment. PCA's Climate VISION goal is to reduce CO_2 emissions/per ton of product by 10 percent from 1990 levels. In 2004, PCA worked with ITP and the U.S. Environmental Protection Agency to develop a Climate VISION workplan and timeline. (See Climate VISION Web site: http://www.climatevision.gov).

The strategy described in the cement industry workplan is a three-part program that not only sets out to achieve its goal—this strategy also fosters additional reductions by users of its product. The reduction goal will be achieved by changes in the cement manufacturing process and in product formulation. In addition, applications of cement and concrete can result in energy-savings that will further reduce overall global greenhouse gas emissions. The elements of the workplan strategy are:

Process: Reduce emissions through increased energy efficiency and decreased fuel use. PCA anticipates that approximately half of the projected reductions will come from these activities.

Product Formulation: Develop cement production techniques that require a lower proportion of calcined materials, thereby reducing CO_2 emissions per unit of product. PCA anticipates that approximately half of the projected reductions will come from these activities.

Product Application: Promote the use of concrete as a climate change solution. This is the area that provides the greatest promise for reductions, yet is largely beyond the industry's control and therefore, may not contribute much toward implementation of the 2020 CO_2-reduction goal.

Improving Energy Efficiency Today

BestPractices – BestPractices, part of DOE's ITP, works with industry to identify plant-wide opportunities for energy savings and process efficiency. Through the implementation of new technologies and systems improvements, companies across the United States are achieving immediate savings results. Involvement in BestPractices allows companies to join the ranks of forward-thinking U.S. industrial manufacturers who are saving energy and money, reducing pollution and emissions, and increasing productivity today.

Disseminating Research Results to Industry – The IMF performs various outreach activities to disseminate R&D results and enable industry to implement energy saving practices and technologies. These include participating in trade shows and maintaining an up-to-date Web site that highlights IMF activities. In addition, IMF conducts an annual portfolio review with industry and provides bi-annual highlights of research activities.

Energy Analysis

The IMF is targeting annual energy savings of over 247 TBtu per year in 2020. Exhibit 12 shows the projected savings by IMF focus area.

Exhibit 12
IMF Energy Savings

IMF Focus Area	TBtu Per Year Savings	
	2010	2020
Degradation-Resistant Materials	5.3	135.2
Thermophysical Databases & Modeling	0.4	11.0
Materials for Separations	1.3	38.1
Materials for Engineering Components	3.3	62.9
TOTAL	**10.3**	**247.2**

TOOLS, PUBLICATIONS, AND RESOURCES AVAILABLE

Many of the publications available from IMF are listed below. To view these documents and applications, please visit: http://www.eere.energy.gov/industry/imf/analysis.html.

Industrial Materials for the Future Review Meeting – Presentations and project summaries from the June 21-24, 2004 Industrial Materials for the Future Annual Portfolio Review Meeting.

Highlights of the IMF Portfolio – Brief descriptions of significant project accomplishments.

EMaCC Report –The Annual Technical Report for the Energy Materials Coordinating Committee (EMaCC)

Fact Sheets – The IMF disseminates information on current and past projects through project fact sheets. The information provided in each fact sheet includes the objectives, accomplishments, benefits, principal investigator and project partners. All IMF fact sheets are available online at: http://www.eere.energy.gov/industry/imf/portfolio.html.

HOW TO GET INVOLVED AND CONTACT INFORMATION

Partnership Information

Public-private partnerships are the foundation of ITP's technology delivery strategy. ITP includes its partners in every phase of the technology development process to focus scarce resources where they can have the greatest impact on industrial energy efficiency. To learn more, please visit our Web site at http://www.eere.energy.gov/industry.

- Collaborative, cost-shared research and development projects are a central part of ITP's strategy. Annual solicitations provide technology development opportunities in a variety of energy-intensive industries.

- Industries of the Future Partnerships increase energy efficiency in the most energy-intensive industries. In addition to cost-shared research and development projects, industry partners participate in the development of vision and roadmap documents that define long-term goals, technology challenges, and research priorities.

- Allied Partnerships provide an opportunity for ITP to reach a broad audience of potential customers by allying with corporations, trade associations, equipment manufacturers, utilities, and other stakeholders to distribute industrial energy efficiency products and services. By becoming an Allied Partner, an organization can increase its value to clients by helping them achieve plant efficiencies.

- State energy organizations work with ITP in applying technology to assist their local industries. ITP assists states in developing partnerships to mobilize local industries and other stakeholders to improve energy efficiency through best practices, energy assessments, and collaborative research and development.

- EERE's technical programs (of which ITP is one of 11) give manufacturers access to a diverse portfolio of energy efficiency and renewable energy technologies and bring advanced manufacturing technology to the renewable energy community. For more information, access the EERE home page at http://www.eere.energy.gov.

- The President's Climate VISION (Voluntary Innovative Sector Initiatives: Opportunities Now) effort also offers opportunities for manufacturers to pursue cost-effective actions that will reduce greenhouse gas emissions. See http://www.climatevision.gov for details.

Access to Resources and Expertise

The Industrial Technologies Program provides manufacturers with a wide variety of industrial energy efficiency resources to help your company cut energy use right away. Visit our site at http://www.eere.energy.gov/industry or call the EERE Information Center at 877-337-3463 to access these resources and for more information.

- ITP offers energy management best practices to improve energy efficiency throughout plant operations. Improvements to industrial systems such as compressed air, motors, process heat, and steam can yield enormous savings with little or no capital investment.

- Our suite of powerful system optimization software tools can help plants identify and analyze energy-saving opportunities in a variety of systems.

- Training sessions are held several times per year at sites across the country for companies interested in implementing energy-saving projects in their facilities. DOE software tools are used as part of the training sessions.

- ITP's qualified industrial energy specialists will work with your plant personnel to identify savings opportunities and train staff in the use of ITP software tools.

- Our extensive library of publications gives companies the resources they need to achieve immediate energy savings.

- Plant-wide energy assessments are available to manufacturers of all sizes interested in cutting their energy use. Cost-shared solicitations are available each year for plant-wide energy assessments. In addition, no-cost, targeted assessments are provided to eligible facilities by teams of engineering faculty and students from 26 university-based Industrial Assessment Centers around the country.

- The DOE Regional Offices provide a nation-wide network of capabilities for implementing ITP's technology delivery strategy. Regional Offices are located in the Southeast, Northeast, Midwest, Central, Mid-Atlantic, and Western regions. Visit http://www.eere.energy.gov/regions/ for more information.

Where to Get More Information

Visit our Web site: http://www.eere.energy.gov/industry/imf

Learn about all EERE programs: http://www.eere.energy.gov

EERE Information Center answers questions on EERE's products, services and 11 technology programs, refers callers to the most appropriate EERE resources, and refers qualified callers to the appropriate expert networks. You may contact the EERE Information Center by calling 1-877-EERE-INF (1-877-337-3463) or by completing the form at this site: http://www.eere.energy.gov/informationcenter. A customer service specialist or energy expert at the EERE Information Center will respond to your inquiry.

For print copies of DOE, EERE and ITP Publications, contact the
Energy Efficiency and Renewable Energy Information Center
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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and great energy independence for America. By investing in technology breakthroughs today, our nation can look forward to a more resilient economy and secure future.

Far-reaching technology changes will be essential to America's energy future. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a portfolio of energy technologies that will:

- Conserve energy in the residential, commercial, industrial, government, and transportation sectors
- Increase and diversify energy supply, with a focus on renewable domestic sources
- Upgrade our national energy infrastructure
- Facilitate the emergence of hydrogen technologies as a vital new "energy carrier"

The Opportunities

Biomass Program
Using domestic, plant-derived resources to meet our fuel, power, and chemical needs

Building Technologies Program
Homes, schools, and businesses that use less energy, cost less to operate, and ultimately, generate as much power as they use

Distributed Energy & Electric Reliability Program
A more reliable energy infrastructure and reduced need for new power plants

Federal Energy Management Program
Leading by example, saving energy and taxpayer dollars in federal facilities

FreedomCAR & Vehicle Technologies Program
Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle

Geothermal Technologies Program
Tapping the Earth's energy to meet our heat and power needs

Hydrogen, Fuel Cells & Infrastructure Technologies Program
Paving the way toward a hydrogen economy and net-zero carbon energy future

Industrial Technologies Program
Boosting the productivity and competitiveness of U.S. industry through improvements in energy and environmental performance

Solar Energy Technology Program
Utilizing the sun's natural energy to generate electricity and provide water and space heating

Weatherization & Intergovernmental Program
Accelerating the use of today's best energy-efficient and renewable technologies in homes, communities, and business

Wind & Hydropower Technologies Program
Harnessing America's abundant natural resources for clean power generation

To learn more, visit www.eere.energy.gov

Industrial Materials for the Future

Industrial Technologies Program
Boosting the productivity and competitiveness of U.S. industry

U.S. Department of Energy
Energy Efficiency and Renewable Energy

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