The Department of Energy's Solar Industrial Program 1995 Review

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Produced by SunLab:

Bringing together
solar energy expertise
from the National Renewable
Energy Laboratory and
Sandia National Laboratories

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Overview: Solar Research for American Industry

During 1995, the Department of Energy's Solar Industrial (SI) Program worked to bring the benefits of solar energy to America's industrial sector. Scientists and engineers within the program continued the basic research, applied engineering, and economic analyses that have been at the heart of the Program's success since its inception in 1989. In 1995, all three of the SI Program's primary areas of research and development—solar detoxification, advanced solar processes, and solar process heat—succeeded in increasing the contribution made by renewable and energy-efficient technologies to American industry's sustainable energy future.

Industry is the key to understanding the SI Program. The sharp focus on America's industrial sector differentiates the SI Program from other renewable energy research programs. Today, our industrial sector faces increasingly stringent environmental regulations, heightened competition within the global economy, and a potentially dangerous dependency on imported fossil fuel. The SI Program conducts basic scientific and engineering work that can help alleviate these pressures. The solar technologies being advanced by SI Program researchers are not meant to be the panacea for American industry's environmental and economic challenges; they are meant to offer clean, reliable, cost-effective alternatives for meeting a portion of industry's energy needs.

The SI Program's value to industry is its ability to lay the R&D foundation for promising solar technologies. The research pursued within the SI Program is the seed from which technologies with commercial potential grow. SI Program researchers conduct the investigations that indicate whether a given technology can be cost-effective and reliable for a specific

Warren Gretz, NREL

Laboratory research is the wellspring of tomorrow's solar products and processes

industrial application. At that point, private industry takes the lead in deriving commercially viable products and processes from this basic R&D foundation. Interested companies often work with the SI Program—through Cooperative Research and Development Agreements (CRADAs) and other cost-shared arrangements—to move these technologies from the laboratory to the market place.

The Solar Industrial Program is managed within the Department of Energy's Office of Industrial Technologies, and the work is carried out through SunLab, the research organization that combines the solar expertise of the National Renewable Energy Laboratory in Golden, Colorado, and Sandia National Laboratories in Albuquerque, New Mexico. The SI Program has more than 35 scientists and engineers on staff and dozens of subcontracts with outside research-based organizations including private companies, academic

SunLab

institutions, and other government agencies. The charts to the right break down the SI Program's 1995 budget by research area and show the level of funding the SI Program receives from outside sources—such as industrial partners—participating in the research.

As mentioned previously, the SI Program comprises three discreet subprograms. The Solar Detoxification Program develops solar-based pollution control technologies for destroying hazardous environmental contaminants (see page 3). The Advanced Solar Processes Program investigates industrial uses of highly concentrated solar energy (see page 11). The Solar Process Heat Program conducts the investigations and analyses that help energy planners determine when solar heating technologies—like those that produce industrial-scale quantities of hot water, hot air, and steam—can be applied cost effectively (see page 7). The remainder of this report highlights the research and development conducted within in each of these subprograms during 1995.

1995 Solar Industrial Program Budget

1995 Program Leverage

CD-S25-B098201

Solar Detoxification

Solar detoxification technologies use the energy in sunlight to destroy environmental contaminants. In 1995, these technologies joined the fight against organic and inorganic pollutants—such as spilled solvents and fuels—at a number of test sites throughout the United States. These technologies are being used for environmental remediation and waste management, bringing industrial processes into compliance with Environmental Protection Agency regulations under the Clean Air Act, Clean Water Act, RCRA, and Superfund.

One of the detox techniques—photocatalytic oxidation (PCO)—uses an inert chemical compound, called a photocatalyst, that becomes highly reactive in the presence of ultraviolet sunlight. Titanium dioxide (TiO_2), a common pigment, is the photocatalyst typically used in detoxification systems. When polluted air or water is exposed to this compound, the bonds holding together the polluting molecules are broken, converting the toxins into water, carbon dioxide, and other benign chemicals.

The other detoxification technique—photolytic detoxification—relies solely on concentrated sunlight to destroy contaminants. The technique uses precisely aligned mirrors to concentrate solar energy, similar to the way a magnifying glass concentrates sunlight when held at just the right angle. These detoxification systems concentrate the sun to 1000 times its normal intensity at the surface of the earth. Environmental contaminants exposed to this intense solar energy rapidly oxidize into simple, harmless molecules.

Solar Detoxification in 1995

Since its inception in 1989, the solar detoxification research program has progressed steadily each year. Milestones marking the

program's success during the past 6 years include photocatalyst breakthroughs, the design of increasingly efficient reactors, numerous field tests, and growing involvement from potential users and suppliers of the technology. The years of dedicated research began to pay off during 1995 as the first commercial pollution control systems based on detoxification technology were designed, tested, and readied for market introduction.

As in years past, the level of participation from outside researchers and industrial partners continued to grow. In addition to the more than 30 scientists, engineers, and technicians working on detoxification research at SunLab, 9 academic institutions, 11 industrial organizations, and other government agencies participated in various elements of the R&D program.

Many of 1995's research advances were achieved through the program's participation in various cooperative research and development agreements (CRADAs, see box below) that the program participates in with industrial organizations interested in bringing detoxification technology to the pollution control market.

What's a CRADA?

A cooperative research and development agreement—or CRADA—is a research partnership between a federal research institution and a private company. CRADAs are designed to make U.S. industry more competitive and protect our economic security. They bring together complementary expertise, resources, and facilities from government and industry. Private partners benefit from reduced research costs and the retention of intellectual property rights, while the government and society benefit from the wide range of technical advances resulting from these agreements.

The International Technologies CRADA

Since 1993, SI Program researchers have been working with International Technologies (IT) Corporation—a leader in marketing new pollution control technologies—to develop a commercial detoxification system to treat air-borne and gaseous contaminants. IT is interested in the technology for treating waste streams containing chlorinated ethylenes such as Trichloroethylene (TCE), an industrial solvent, and perchloroethylene, or perc, a solvent used extensively in the dry cleaning industry.

During 1995, project researchers built on the dramatic increases in reactor efficiency accomplished in the previous year by redesigning the entire prototype reactor system. The system and reactor redesign takes into account issues associated with manufacturing these systems on a commercial scale. As part of this project, program researchers worked with air-flow specialists from within the National Renewable Energy Laboratory's Building Technologies group to provide uniform air flow in the reactor vessel. By using computational fluid dynamics modeling, the interdisciplinary research team increased the interaction among the catalyst, the contaminant, and the UV light within the reactor vessel, further increasing process efficiency.

The improved performance of the platinum-modified catalyst (reaction rate measured in sec⁻¹)

The process improvements that occurred during 1995 have made gas-phase detoxification technology a viable alternative for treating low-flow-rate waste streams containing common chlorinated-ethylene contaminants. In early 1996, NEPPCO, a subsidiary of IT Corporation, will field-test a prototype system capable of treating 75 to 100 cubic feet of contaminated air per minute at an industrial site in Phoenix, Arizona. NEPPCO anticipates having a similar systems—employing an adaptable modular design—commercially available by the end of the year.

The SEMATECH CRADA

The SI Program and SEMATECH, the R&D consortium of America's leading computer chip manufacturers, have been collaborating since 1994 to develop detoxification technology for treating emissions produced in the semiconductor manufacturing process—primarily alcohols and ketones. During 1995, researchers engineered a number of dramatic breakthroughs that increased by ten times the efficiency with which these target compounds are destroyed.

The destruction rate breakthroughs occurred in a series of attempts to optimize the detoxification process. Researchers experimented with a number of optimization techniques including varying the reactor temperature, adding oxidants to the process, and modifying the TiO₂ photocatalyst with small amounts of metals. The highest destruction rates were obtained using a combination of a platinum-modified catalyst and an elevated reactor temperature. As the graph at left shows, the performance of the platinum-modified catalyst increases substantially above 100°C. Although catalyst performance continues to increase above 150°C, researchers are using 150° as an optimum temperature because steam, which could be used to heat

the reactor, is readily available at this temperature in many industrial operations.

These process improvements make PCO competitive with other treatment options for many of contaminants associated with semiconductor manufacturing. A prototype reactor incorporating these advances will undergo a 2-month field test at Hewlett-Packard's manufacturing plant in Fort Collins, Colorado, in early 1996. During the test the system will be applied to an air stream containing alcohols, esters, ketones, and resins from a semiconductor wafer manufacturing process.

The DuPont CRADA

In 1995, SI Program researchers at Sandia National Laboratories initiated a CRADA with DuPont Central Research to investigate the fundamental mechanisms behind titanium dioxide's photoactivity. The goal of this work is to develop detailed kinetic models of TiO_2 -initiated photochemical reactions.

DuPont and Sandia are interested in gaining this fundamental understanding for different reasons. DuPont, which plays an important role in the paint and pigment industry, wants to suppress titanium dioxide's photoactivity. TiO_2 is a commonly used pigment, but its photoactivity reduces the life of the medium in which it is embedded. Sandia, as a primary member of the detoxification research team, is interested in enhancing the compound's photoactive qualities. A clearer understanding of the kinetics involved will help both partners attain their respective goals.

Solar-Driven Reactors

The development of commercially viable, solar-driven PCO treatment systems has been the fundamental goal of the

Craig Turchi, NREL

Researcher monitors detoxification system being tested at Hewlett-Packard's Fort Collins plant.

detoxification research since the program's inception. Market forces within the pollution control industry, though, dictate that the PCO process be proven initially with a more consistent source of photons—namely, electric lamps. Given the advances, discussed in the preceding sections, that have brought lamp-driven systems to commercial readiness, SI Program researchers began designing experimental solar-driven treatment systems.

The gas-phase solar photocatalytic (GSP) reactor, shown on page 6, is the first in a series of solar reactors tested by SI Program researchers. This unit, originally designed and built by Industrial Solar Technologies for aqueous streams, has been modified by SI researchers to treat gas-phase waste streams. Built in the fall of 1995, the system has gone through a series of tests using varying concentrations of trichloroethylene, a common organic solvent. Early results indicate the system is achieving

The gas-phase solar photoreactor

destruction efficiencies equal to the lamp-driven systems that will soon be commercially available. Researchers will experiment with other solar designs in the coming year.

Industries of the Future

The photochemical research ongoing at NREL and Sandia dovetails well with the U.S. Department of Energy's Industries of the Future Program, which was initiated in 1995. The Industries of the Future program promises to be an avenue by which PCO and other photochemical processes will penetrate the market. Industries of the Future brings together the DOE and key materials and process industries to strengthen the position

of these industries—economically and environmentally—in the global market in the coming decades. The following list presents the role PCO could possibly play in this program.

- **Petroleum refineries.** PCO can destroy the benzene, toluene, ethylbenzene, and xylene (BTEX) contamination associated with petroleum operations such as pipelines, underground storage tanks, tank vents, refineries, and gas stations.
- **Chemicals.** PCO will be tested on volatile organic compounds (VOC) emissions from curing operations on adhesives and polymers.
- **Forest products.** PCO can be applied to emissions from green wood and particle board drying, pulp mill odors, plywood and pressboard manufacturing, and unit operations in pulp and bleach mills.
- **Foundries.** Recent legislation requires this industry to reduce aromatic compound emissions, such as toluene and xylene, and the organic binders vaporized in the molding process; PCO may be an effective treatment for these emissions.
- **Aluminum.** PCO may be effective in eliminating toxic components of the off-gas from dry scrubbing systems.
- **Steel.** PCO could reduce lubricant contamination from cooling and wash water and may control VOC emissions from painting and melting processes.

Solar Process Heat

American industry uses a tremendous amount of energy to heat water, create steam, and generate warm air. A variety of solar technologies are available to meet some of industry's specific heating needs, and the SI Program helps bring together suppliers and potential users of this technology. In addition to increasing the number of solar heating systems in use, the SI Program's participation in these projects helps expand the volume of performance data available on solar heating systems, improving economic and engineering analyses and establishing better estimates of the lifetime of the various solar heating technologies.

The "process" in solar process heat refers to industrial and business-scale heating loads. For example, schools, hospitals, and hotels have a great demand for hot water for cooking, cleaning, and bathing. Factories and warehouses often contain vast volumes of space that must be heated and ventilated. Industries use large quantities of thermal energy in their manufacturing processes. Depending on the geographic location and the specific application, solar energy can supply 30% to 70% of the heat required for these processes. In fact, several hundred solar heating systems are operating in business and government settings today, saving their users money and reducing the amount of fossil fuel consumed.

The Solar Industrial Program works with potential users of solar heating systems to determine if solar is a feasible option given their operational needs, matching potential users with solar heat companies to conduct feasibility studies. In addition to funding studies, the SI Program funds a portion of the solar heating systems at strategically selected sites. Researchers within the SI Program monitor many of these systems after installation, collecting a range of performance and economic data that

ultimately improves the information available to system designers and potential users.

Solar Process Heat in 1995

In 1995, the solar process heat program expanded fundamental engineering studies and increased the number of solar heating systems in use in the industrial sector. Both of these elements of the program—basic engineering and technical assistance to potential users—are vital contributions to the continued advancement of this practical and cost-effective technology.

The SI Program's process heat engineering studies help manufacturers better understand the complex interactions among system components, allowing them to design better-performing, more economical systems. By helping users of solar heating technology evaluate their heating needs and procure heating systems, the SI Program is increasing the number of systems in the field, which increases the amount of real-world performance data available to the research and manufacturing community. The program's major activities in 1995, described in the following sections, exemplify how these program elements collectively improve the technology and increase solar's contribution to our industrial sector.

The Solar Process Heat Data Network

1995 witnessed the maturation of the Solar Process Heat Data Network. Created at the end of 1994, the Data Network expanded in 1995 and began producing in-depth information on how process heat systems perform in actual industrial applications.

The data network uses standardized monitoring equipment and procedures to measure the performance of selected solar heating systems located in widely varying climatic regions. The systems in the network are monitored by an automated

Daily Delivered Solar Energy

Date of Performance Data: July 1995 Site Name: Adams County Jail
Total Delivered Energy (MBtu): 114.76 Site Location: Adams County Jail, Brighton, CO

Example of data network output

The Adams County Detention Facility north of Denver, Colorado, is one of the process heat systems monitored by the data network.

data collection system, and collected data, such as total energy delivered by the system and the ambient atmospheric conditions, are downloaded daily to a central computer at the National Renewable

Energy Laboratory (NREL) in Golden, Colorado. Researchers at NREL analyze the data to determine the total system availability, system efficiency, cost of energy delivered, and other performance parameters. The data network represents a dedicated effort by the research community to collect and analyze solar heating performance data in a consistent and unbiased manner.

The data network is a valuable resource to the solar research community, solar manufacturers, and potential users of solar heating systems. The network helps researchers and manufacturers pinpoint heating system components and designs that need further development, and it can be used to correlate computer models with actual performance data. Potential users of solar heating systems can turn to the network for detailed performance data on various heat technologies, such as solar troughs or flat-plate systems, in user-friendly formats (see report formats, at left). The network will ultimately improve the credibility of solar technology among the vast number of potential industrial users.

The data network is currently monitoring three systems: a moderate-sized trough system at the Adams County Correctional Facility near Denver, Colorado; a large trough system at the federal prison at Tehachapi, California; and a large flat-plate system, which was added to the network in 1995, at the Packerland Packing Company in Green Bay, Wisconsin. Program researchers are currently adding a fourth site—at the Jefferson County Detention Center in Golden, Colorado—to the network. In 1996 researchers will diversify the network by monitoring other heating technologies, such as compound parabolic collectors and evacuated tube collectors, and systems used in other applications, such as absorption chillers.

The California Department of Corrections Multisystem Competitive Solicitation

SI Program engineers helped the California Department of Corrections (CDC) and the California Energy Commission (CEC) lay the groundwork for one of the largest solar heating purchases in history. Based on the success of the solar hot water system at the federal prison in Tehachapi, California, the CDC issued a letter-of-interest solicitation as the first step toward purchasing solar heating systems for up to six additional correctional facilities under a single competitive solicitation. The heating systems will be constructed and operated under an arrangement whereby a group of third-party investors owns and operates the systems and sells the energy produced to the CDC under a long-term energy purchase agreement.

The SI Program has worked with the CDC and the CEC since the inception of this project, contributing technical and logistical support. Program engineers conducted the initial feasibility studies at the candidate facilities to determine their specific thermal energy requirements. Program staff members also helped write the request for proposals (RFP), which will be issued in early 1996, and they will help the CEC evaluate the submitted proposals.

As a method of reducing the perceived risk of this landmark project, the SI Program will contribute a portion of the total project cost. The first systems purchased through this solicitation are scheduled to be operational in late 1996.

This "big buy" project is of considerable interest to the SI Program and solar equipment manufacturers. Project participants are optimistic that purchasing systems on a large scale will reduce the manufacturing and installation costs, thereby reducing the

cost of energy delivered by these systems. Such cost reductions could make solar process heat technology more attractive to other large-scale users. Program researchers will monitor the construction and operational phases, identifying where and how much savings were realized. Ultimately, the "big buy" strategy could dramatically increase the use of solar process heat in industrial settings.

State-of-the-Art Technology Used at Colorado Prison

The SI Program collaborated with Industrial Solar Technology, Inc. (IST) to begin construction of a state-of-the-art solar-trough water heating system at the Jefferson County Detention Center in Golden, Colorado. Numerous engineering improvements, developed by SI Program researchers and IST under a joint research project, were incorporated into the system. These improvements include the use of a durable, high-performance silvered-polymer reflector material in the troughs, a black nickel selective coating inside the receiver tubes, and an anti-reflective coating on the outside of the receiver tubes. Researchers expect these improvements to deliver 30% more energy than a system without these advances.

The system will provide approximately 45% of the energy required to heat the 17,000 gallons of hot water used at the 500-inmate facility. The project is a model of cooperation between government agencies and private industry; in addition to the SI Program and IST, participants include the Colorado Office of Energy Conservation, the Jefferson County Board of Commissioners, and the Jefferson County Sheriff's Department. The system is scheduled to go on line in the spring of 1996.

Sandia Engineers Lend a Helping Hand

SI Program researchers at Sandia National Laboratories put their solar engineering expertise to use in 1995 helping two small New Mexico companies save energy and reduce operating costs. The companies received help through Sandia's design-assistance program.

The San Juan Agricultural Cooperative, founded in 1992, is an association of native American farmers at the San Juan Pueblo in northern New Mexico that is working to bring the pueblo's lands back into production. The cooperative is marketing a line of dried fruits and vegetables grown at the pueblo. Traditionally, these products were sun-dried on wooden racks, but large production requirements made the sun-drying technique economically impractical. Operating on a very limited budget, the cooperative asked Sandia for assistance. SI Program engineers immediately set to work designing a solar dehydration system that fit the pueblo's budget.

Produce dried in the San Juan Pueblo's new solar dehydrating facility

The engineers devised a solution that is simple and uses many of the pueblo's existing resources. They advised the cooperative to move the pueblo's existing greenhouse next to the drying and processing facility. They added a black plastic floor to the greenhouse, which raises the internal temperature to between 120° and 140° Fahrenheit. A large exhaust fan transports the heat to drying units in the processing facility, and excess heat is used to warm an occupied warehouse during the winter. The dramatic increases in the volume of produce that can be efficiently dehydrated will enable the cooperative to plant and process more crops, moving them toward their goal of doubling the amount of acreage now being farmed for commercial use.

A small solar manufacturer in Florida also contacted SI Program engineers at Sandia seeking ideas to improve the automated welding processes they use to manufacture solar collectors. After three days of on-site assessments and experiments, the Sandia team proposed a number of modifications that not only optimized the welding machine, but also increased productivity in other areas. The team developed a new welding procedure that decreased handling and manpower, and they proposed a modification to the welding machine that more than doubled throughput. They also suggested a high-speed operational method that reduced the energy required to produce a weld by 50%.

Sandia's assistance had a dramatic effect on the company's production capacity, increasing it from 175 to 250 collectors per month. The company believes Sandia's help will increase revenues by about \$1 million during the next two years and create a dozen new jobs at the plant.

Advanced Solar Processes

Modern industry relies increasingly on high-value, high-technology materials—such as ceramic/metal composites and surfaced-hardened metals—that resist wear, operate under high temperatures, and meet exacting performance specifications in harsh operating environments. Researchers in the SI Program are exploring manufacturing such materials using sunlight concentrated to laser-like intensities.

Highly concentrated sunlight—referred to as high solar flux—has properties that are well suited to manufacturing advanced materials. Researchers create high solar flux by reflecting sunlight from precisely designed curved mirrors, similar to the way a satellite dish reflects radio waves to a point. Solar energy can be concentrated from a few hundred to 50,000 times the normal intensity of the sun at the earth's surface. This intense energy creates and sustains extremely high, but very localized, temperatures; modest concentrations of 2500 suns can easily burn through 1/4-inch steel. Also, the surface of a material exposed to high solar flux heats rapidly while the base or substrate remains relatively unaffected. Such rapid surface heating allows advanced surface processes such as ceramic metallization, chemical vapor deposition, and cladding to be performed.

Most of the SI Program's work in advanced processes takes place at the National Renewable Energy Laboratory's High-Flux Solar Furnace (HFSF) in Golden, Colorado (see figure at right). The DOE designated the furnace a National User Facility in 1993, giving qualified outside researchers easy access to this cutting-edge solar laboratory.

NREL's HFSF is a research tool in the vanguard of both advanced materials and solar energy research. As discussed in the previous paragraphs, the HFSF offers

*The High-Flux Solar Furnace in Golden, Colorado.
Top: artist's rendering.
Bottom: the actual laboratory
on South Table Mountain.*

researchers laboratory conditions unavailable elsewhere. Creating such conditions in the laboratory would be prohibitively expensive and time consuming. By taking advantage of the HFSF's user status, researchers from industry and academia can save considerably on R&D costs.

The SI Program is working with a number of scientists from academia and industry interested in various materials and processes that use solar flux as the source of energy.

Advanced Solar Processes in 1995

During 1995, the SI Program's work in advanced solar processes was characterized by exciting advances in ongoing research projects and the initiation of research in a number of new areas. The novel research environment at NREL's HFSF continued to attract growing interest from the academic research community and from industrial organizations that see near-term potential for a number of high-flux processes.

The year was also characterized by increasing information exchange between SI Program researchers and their colleagues around the globe involved in high-flux studies. Researchers helped organize a number of international conferences and played an active role in the International Energy Agency's SolarPACES Task II—Solar Chemistry group.

One of the year's crucial accomplishments—which benefited all the research projects at the HFSF—was an upgrade to the heliostat control system. The heliostat is the large, flat mirror that tracks the sun as it travels across the sky. The previous control system allowed the heliostat to drift slightly, causing flux intensities to vary up to 5%, which at times was enough to invalidate experimental results. Wind had also been a problem, causing unacceptable

oscillations in the heliostat. Technicians installed new motors, encoders, gear reducers, electronics, and control software that collectively resulted in a four-fold improvement in the heliostat's tracking resolution. With these upgrades, researchers can now aim the heliostat precisely and maintain peak flux intensities at the target area—even in high-wind conditions.

Producing Fullerenes Using Solar Energy

In 1993, SI Program scientists discovered that high solar flux could be used to create fullerenes, the recently discovered large carbon molecules that have potential uses in dozens of industries ranging from pharmaceuticals to petroleum refining. Conventional fullerene production techniques are energy intensive and produce small quantities. The solar production process caught the attention of academia and industry as a possible way to reduce costs and increase production volume.

The highlight of the program's fullerene research in 1995 was the design and construction of a new fullerene reaction chamber for use at NREL's HFSF (see page 13). The new reactor's ability to accommodate a continuous feed of graphite—the starting material for fullerene production—is an important step toward a commercially viable solar-based system.

New Advances in Manufacturing Electronic Components

The SI Program has been working with Brush Wellman, a leading electronics manufacturer, since 1993 to investigate using high solar flux to bond thin layers of metal to ceramic substrates. These metallized ceramic components are vital to today's electronics industry: the metal layer is a conductor, and the ceramic base acts as an insulator. Because of its ability to rapidly

heat an illuminated surface, high solar flux holds promise as a technique for creating a strong, uniform bond between the metal and the ceramic substrate.

This research took new directions in 1995 as researchers discovered that the high flux manufacturing technique creates metal layers that are free from the small pinholes caused by conventional manufacturing techniques. Such pore-free coatings could have a substantial effect on the electronics industry by allowing components to operate at low voltages, extending the service lifetimes, and minimizing component weight. SI Program researchers and Brush Wellman are pursuing this research and are currently experimenting with combinations of ceramic substrates and metal conducting layers.

In work directly related to the ceramic metallization studies, program researchers worked with Science Applications International Corporation to design unique secondary concentrators that deliver uniform solar flux to a ceramic target. Secondary concentrators are placed at the focal point of the furnace's primary concentrator, further intensifying the incoming solar beam. The secondary concentrators used previously in the metallization work delivered flux that varied substantially across the target, affecting the overall quality of the metal-ceramic bond. SAIC used a proprietary computer code to develop the new secondary concentrators, called Irradiance Redistribution Guides (IRGs). Analyses show that these designs increase flux uniformity by a factor of two. The IRGs greatly improve the quality of the metallized ceramic samples and will likely improve researchers' ability to precisely control the flux in future experiments at the furnace.

Coors Ceramics Adopts New Manufacturing Process

In 1995, researchers at the National Renewable Energy Laboratory completed a 3-year cooperative research and development agreement with Coors Ceramics Company that successfully developed a new method of producing silicon carbide powder. Although the process—in its final form—did not use solar energy, it was initially conceived as a solar-furnace-based technology, and much of the early developmental work was conducted at the HFSF.

The new process produces silicon carbide powder for about half the price of traditional manufacturing techniques. The powder is the starting material for highly durable industrial ceramic components—such as water pump seals and paper mill machinery—that can withstand high temperatures and corrosive environments. The dramatic reduction in production costs should give rise to a variety of new ceramic products. Coors Ceramics is currently evaluating ceramic component markets to determine the best way to integrate this new process into their manufacturing operations.

For More Information

The Solar Industrial Program

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