In The News

New Literature

World Materials Calendar

The World Materials Calendar contains details of around a thousand materials-related events (conferences, exhibitions, meetings, courses) stretching as far ahead as events organizers plan. The most distant conference currently listed will be held in September 2003. Events are listed chronologically with all new and amended entries clearly indicated. In addition, comprehensive indexes for location, sponsor, and subject are included in each issue.

Recent changes in the journal include "icons," which will enable casual readers to identify at a glance the events they are interested in, and additional information such as abstract submission deadlines, actual venue, prices for attendance and availability of proceedings volumes.

World Materials Calendar is published quarterly, March, June, September, and December. Contact: Debbie Barthelmes, Materials Information, ASM International, Materials Park, OH 44073-0002; tel: 216/338-5151; fax: 216/338-8091; e-mail: dbarthel@po.asm-intl.org or Julie Lee, Materials Information, The Institute of Materials, 1 Carlton House Terrace, London, SW1Y 5DB, UK; tel: 0171-839-4071; fax: 0171-839-2289.

Trends in Welding Research

The proceedings of the 4th International Conference on Trends in Welding Research, covering the four-day conference sponsored by ASM International (Joining Division) and the American Welding Society, is available. Truly international in scope with technical papers from 21 countries, this 950-page resource presents a vast and diversified overview of research activities underway all over the world. Designed to raise welding from an empirical art to a scientifically based technology, this research is taking place at universities plus corporate and government laboratories worldwide.

Subjects covered include: sensing and control, welding processes, heat and fluid flow, solidification, solid state transformations, properties, modeling, consumables, phase transformations, and residual stress.

The proceedings of the 4th International Conference on Trends in Welding Research is available for $130.00 (ASM members $104.00). To order contact ASM International, Member Services Center, Materials Park, OH 44073-0002; tel: 216/338-5151, ext. 900; fax: 216/338-4634; e-mail: mem-serv@po.asm-intl.org. Refer to order #6448NR.

Beam Processing of Advanced Materials

The proceedings of the 2nd International Conference on Beam Processing of Advanced Materials is available from ASM International. This 280-page guide covers the seven-session conference that was a major part of Materials Week '95 sponsored by ASM.

These proceedings covered a vast array of subject matter including: plasma etching, high value materials, low power electronics, nitrogen interaction, diamondlike materials, particle-solid interaction, laser chemical vapor deposition, solar load and reflectivity, energetic particle synthesis, freeform fabrication, NASA's space shuttle, ceramics, solid-liquid interface shape and stability, surface modification technologies, solute segregation-induced instability, temperature calculations, welding, microstructural evolution, ceramic joining, metastable phase formation, film growth, atomic mixing, femtosecond laser, electronic properties, vapor deposition, corrosion resistance, surface treatments, solidification behavior, thin films, thermal effects, iron nitride films, high-energy electron beam, microwaves, powder synthesis, and laser-arc effects.

The proceedings of the 2nd International Conference on Beam Processing of Advanced Materials is available for $104.00 (ASM members $83.20). To order, contact ASM International, Member Services Center, Materials Park, OH 44073-0002; tel: 216/338-5151, ext. 900; fax: 216/338-4634; e-mail: mem-serv@po.asm-intl.org. Refer to order #9201NR.

Hot Isostatic Pressing

The proceedings of HIP'96 International Conference on Hot Isostatic Pressing is available from ASM International. This 510-page book gives valuable information about state-of-the-art HIP including current efforts to improve the technology. Recent developments in process science and advances in the technology of consolidation and shape making are also discussed. Presentations cover the entire spectrum from fundamentals and modeling to equipment and applications. Co-editor Dr. F.H. (Sam) Froes is currently Director of the Institute for Materials and Advanced Processes (IMAP) at the University of Idaho. He holds more than 40 patents and has 500 technical papers and 20 books to his credit.

Contents include: Fundamentals, Modeling, Equipment and Instrumentation, Advanced Ceramics, Composite Materials, Casting Densification, Surface Treatment, Bonding, Competing Technologies.

The proceedings of HIP'96 International Conference on Hot Isostatic Pressing is available for $108.00 (ASM members $86.40). To order contact ASM Member Services Center, Materials Park, OH 44073-0002; tel: 216/338-5151, ext. 900; fax: 216/338-4634; e-mail: mem-serv@po.asm-int.org. Refer to order #6433NR.

Gas Diffusion in Solids and Melts

The *Handbook of Gas Diffusion in Solids and Melts* is available from ASM. Comprehensive and complete, this 300-page book is the first ever written that deals exclusively with the interactions of gases with solid glasses and glass forming melts. It gives information on currently known systems and glasses, descriptions of experimental methods for obtaining data for other materials and gas combinations, and a thorough review of the theories behind the migration, dissolution, and reaction of gases with glasses and melts.

Handbook of Gas Diffusion in Solids and Melts has information covering such topics as: measurements of gas diffusion; solubility; reactions; results of interactions on physical, chemical, and optical properties; applications; the production of sheet, bottle, and insulation fiber glasses; optical fibers; and vacuum devices from light bulbs to high-technology vacuum tubes.

Contents include: Permeation, Diffusion, and Solubility Measurements; Permeation and Diffusion in Inorganic Glasses; Gas Solubility in Inorganic Glasses; Glass-Ceramics and Ceramics; Metals; Organic Glasses and Rubbers; Nanoporous Materials; Gases in Melts; Bubbles and Fining of Melts; Water in Glasses and Melts.

The editor, James E. Shelby, is Professor of Glass Science at New York State College of Ceramics. The author of more than 185 papers in this and related fields, he is currently conducting research with "water" in glasses and melts and the reaction of hydrogen with glasses.

Handbook of Gas Diffusion in Solids and Melts is available for $160.00 (ASM members $128.40). A special prepublication price of $136.00 (ASM members $108.80) is in effect until 15 July 1996. To order, contact ASM Member Services Center, Materials Park, OH 44073-0002; tel: (216/338-5151, ext. 900; fax: 216/338-4634; e-mail: mem-serv@po.asm-intl.org. Refer to order #6462NR.

Specialty Handbook on Cast Irons

The *ASM Specialty Handbook: Cast Irons*, a complete source of one of the most popular engineered materials, is now available from ASM International.

Cast iron offers the design engineer a low-cost, high-strength material that can be easily melted and poured into a wide variety of useful, and sometimes complex, shapes. This latest handbook from ASM covers the entire spectrum of one of the most widely used and versatile of all engineered materials. The reader will find basic, but vital, information on metallurgy, solidification characteristics, and properties. Extensive reviews are presented on the low-alloy gray, ductile, compacted graphite, and malleable irons. New and expanded material has been added covering high-alloy white irons used for abrasion resistance, and high-alloy graphitic irons for heat and corrosion resistance.

Also discussed are melting furnaces and foundry practices such as melting, inoculation, alloying, pouring, gating and risering, and molding. Heat treating including stress relieving, annealing, normalizing, hardening and tempering, austempering (of ductile irons), and surface-hardening treatments are covered, too.

Contents include: Classification and Basic Metallurgy, Solidification Characteristics, Metallurgy and Properties, Melting Furnaces and Foundry Practices, Heat Treating, Welding and Brazing, Machining and Grinding, Surface Engineering, Inspection and Analysis, Fatigue and Fracture Properties, Elevated-Temperature Properties, Physical Properties, Corrosion Behavior, Tribological Behavior, Index.

ASM Specialty Handbook: Cast Irons is available for $166.00 (ASM members $132.80). A special prepublication price of $133.00 (ASM members $106.40) is in effect until 15 July 1996. To order, contact ASM International, Member Services Center, Materials Park, OH 44073-0002; tel: 216/338-5151, ext. 900; fax: 216/338-4634; e-mail: mem-serv@po.asm-intl.org. Refer to order #6613NR.

Heat Treater's Guide For Nonferrous Alloys

The *Heat Treater's Guide: Practices and Procedures For Nonferrous Alloys*, the first book of its kind on this subject, is available from ASM International. This 500-page reference is easy to use providing quick access to authoritative, how to heat treat information for the most widely used nonferrous alloys. The material is contained in more than 500 data sheet articles, each devoted exclusively to one particular alloy, a proven format first used in the complementary guide for irons and steels.

"For even more convenience, the data sheets are arranged by alloy groups: nickel, aluminum, copper, magnesium, titanium, zinc, and superalloys," relates Bill Scott, Technical Director at ASM. *Heat Treater's Guide: Practices and Procedures for Nonferrous Alloys* provides very worthwhile and practical information in such areas as: compositions, trade names, common names, specifications (both U.S. and foreign), available product forms, typical applications, and properties (mechanical, fabricating, and selected others).

This comprehensive resource also covers the more uncommon alloys by groups in the same data sheet format. Included are: refractory metals and alloys (molybdenum, tungsten, niobium, tantalum), beryllium copper alloys, cast and P/M titanium parts, P/M aluminum parts, lead and lead alloys, tin-rich alloys, and sintering copper-base materials (copper-tin, bronze, brass, nickel silvers).

Heat Treater's Guide: Practices and Procedures for Nonferrous Alloys is available for $196.00 (ASM members $156.80). A special prepublication price of $167.00 (ASM members $133.60) is in effect until 15 July 1996. To order, contact ASM International, Member Services Center, Materials Park, OH 44073-0002; tel: 216/338-5151, ext. 900; fax: 216/338-4634; e-mail: mem-serv@po.asm-intl.org. Refer to order #6325NR.

Steelmaking and Steel Casting CD-ROM

One CD-ROM now covers the last three years of the world's published literature on steelmaking and steel casting, the SearchMore Steelmaking and Steel Casting CD-ROM. From Materials Information, a joint service of ASM International, U.S., and the Institute of Materials, U.K., the CD includes more than 5000 citations of 500 items selected from a variety of journals.

The Steelmaking and Steel Casting CD-ROM covers: raw materials, roasting and reduction, refining and furnace practice, melting technology, iron and steelmaking, strip and slab casting, general casting, steelworking, automation, furnaces and other equipment, modeling and simulation, energy use, environment and recycling, refractories and liners, alloy development, plant foundries and mills, business and economic issues.

The CD has a windows-based search mechanism. The "Quick Search" lets users key in a few terms and quickly look at the results. Using a search matrix, a "Fuzzy Search" allows the use of relevancy rankings to display the best hits first. There are also two browsing modes available on the CD. The "Document Browser" lets the user examine the indexes in the database.

To order (North America/other countries $495; E.U. Countries £295), contact Debbie Barthelmes, Materials Information, ASM International, Materials Park, OH 44073-0002; tel: 216/338-5151; fax: 216/338-8091; e-mail: dbarthel@po.asm-intl.org or Julie Lee, Materials Information, The Institute of Materials, 1 Carlton House Terrace, London, SW1Y 5DB, UK; tel: 0171-839-4071; fax: 0171-839-2289.

Alloy Finder CD-ROM

Alloy Finder CD-ROM, 2nd Edition, the electronic version of popular and respected reference books, is available from ASM International. This CD-ROM compiles information from *Woldman's Engineering Alloys* (8th Edition, 1994), *Worldwide Guide to Equivalent Irons and Steels* (3rd Edition, 1993), and *Worldwide Guide to Equivalent Nonferrous Metals and Alloys* (3rd Edition, 1996). It is an improved and updated version for networked or stand-alone personal computers using Microsoft Windows. Trade names or standard designations for 70,000 chemical compositions of metallic alloys, including trade names in use since 1930, are all included. The Alloy Finder CD-ROM, 2nd Edition can be used to identify an alloy, learn who makes or specifies it, or ascertain similar alloys. Users can also establish an alloy knowing just a chemical composition, discover applicable standards, or simply select and browse.

Alloy Finder CD-ROM, 2nd Edition for multi-user purposes is $1200.00 (ASM members $1130.00) with a special pre-publication price $1050.00 (ASM members $980.00). The single-user application is $560.00 (ASM members $490.00) with a prepublication cost of just $490.00 (ASM members $420.00). Both prepublication prices are in effect until 15 July 1996. To order, contact ASM Member Services Center, Materials Park, OH 44073-0002; tel: 216/338-5151, ext. 900; fax: 216/338-4634; e-mail: mem-serv@po.asm-intl.org. Refer to order #7468NR for multi-user and order #74-69NR for single-user.

Rustbuster Video

In a clear and user-friendly manner, "Rustbuster" host John Apostolos takes the viewer on an educational 1 hour and 45 minute worldwide trip demonstrating the concept of corrosion. Viewers travel from the top of the Golden Gate Bridge to the bowels of a World War II German submarine; from the geysers of Yellowstone Park to a working hot-dip galvanizing plant; from fishing boats in the Mediterranean to an underwater bridge inspection. Viewers are also treated to many full-color computer generated illustrations, microscopic views, and laboratory demonstrations of this natural phenomenon.

"Rustbuster" includes:

- *Fundamentals:* The atom, valences, ions, the corrosion cell and its elements, anodic and cathodic reactions
- *Corrosion rate:* Effects of hydrogen, oxygen, corrosion products, and film formation
- *Corrosive elements:* Atmospheric, water, soil, chemicals and their effects, and special considerations
- *Special corrosive environments:* Oxygen starvation, ion concentration, relative areas of anode and cathode, differing electrolytes, stray current.
- *Corrosion measurements:* Voltage, current, standard electrodes, resistivity measurements, pipe-to-soil surveys
- *Corrosion control:* Insulation drainage, coatings, galvanizing and other metallic coatings, alloys, inhibitors, cathodic protection and combination of methods

To order "Rustbuster": VHS (NTSC std. U.S., Canada) @ $255.00, and VHS (PAL, SECAM std. Europe, Asia) @ $295.00. Contact: John Apostolos, P.O. Box 276881, Sacramento, CA 95827; e-mail: ApostoJ@ns.net.

Thermal Spray Technology Video

This 8-tape video series from ASM International covers:

- *Surface science:* Wear, corrosion, hardening, carburizing, nitriding, electroplating, electroless plating, phosphating, vapor deposition, hardfacing
- *Equipment and theory: combustion and electric arc:* Thermal spray history, basic theory of coating processes, porosity, bonding, application, combustion spray processing and equipment, wire-arc spray processing and equipment, material feed, deposit characteristics, HVOF
- *Equipment and theory: plasma spray:* Theory of 4th state of matter; APS air plasma spray, powder feed, particle distribution trajectory, LPPS plasma spray variations, material feed systems, controls, consoles and power supplies, ancillary equipment, safety and hygiene
- *Processing and design:* Bonding, cleaning, processing, masking, temperature control, spray pattern, process variation, automation, fusing, densification, finishing, stripping
- *Materials:* Material production methods, particle classification

methods, quality control, material specification, standards

- *Applications:* Aerospace, automotive, biomedical, ceramic and glass, marine, nonskid, electronics, printing, processing industries, textiles
- *Testing and characterization: methods and mounting:* Variations in test equipment, metallurgy and materials, grain size, bonding, coating buildup, response generators and variations, metallographic procedures, sectioning, vacuum impregnation
- *Testing and characterization: preparation and procedures:* Specimen preparation, grinding, equipment, abrasive types, material reaction, deformation and smearing, polishing concepts and procedures, etching, lubricants, hardness and tensile testing

The Preview tape: $25 (order # 3319), Lesson modules (order # 5771) or 8-tape series $1575 for non-ASM members (order 3321-28) or $1175 for ASM Members (order # 3320) can be obtained from ASM International, tel: 216/338-5151; fax: 216/338-4634.

Industrial and Products Information

Tough Cathodes

Vacuum deposition is widely used to improve the surfaces of metals, nonmetals, optical lenses, and a host of other materials and products. One method is to use electron guns, which discharge electrons to heat the cathode. In the past, some of these cathodes have been made of high melting point metals such as tungsten, but life expectancy of the cathode was less than 100 operating hours.

Ishikawa Harima Heavy Industries Company, Ltd., Tokyo, has developed a new electron gun and a new plasma gun that both feature a three-fold increase in life expectancy. The new gun uses a ceramic cathode composed of lanthanum tetraborate, which allows a large electrical discharge at low temperatures. The lanthanum borate cathode has an operating lifetime of up to 300 h of continuous operation. This new development will make it commercially feasible to use electron guns for film formation on optical lenses.

[Extracted from p 5 of *Rare-Earth Information Center News*, Dec 1995, Ames Laboratory, Institute for Physical Research and Technology, Iowa State University, Ames, IA 50011-3020; tel: 515/294-2272; fax: 515/294-3709; e-mail: ric@ameslab.gov].

New Company Extends Life of Machinery

Perspective Technical Services, Inc., specializes in thermal spray coatings that can economically extend the life of new and used machinery and improve product durability. Essentially, the company uses the arc spray method to create coatings that protect new or worn parts from corrosion and wear as well as extend the life of parts that have worn out and would otherwise need replacement.

While the thermal spray process isn't new, the company's approach to extending the life of existing equipment is. "We view our customers' problems as opportunities to excel. If we can help reduce a customer's material and/or maintenance costs by just a few percentage points, we can make significant improvements to their profitability" says company president, Burt Crapo.

Contact: Perspective Technical Services Inc., Burt Crapo, President, 332 Beacon Hill Road, Pembroke, NH 03275; tel/fax: 603/225-7875.

Impregnation Technology to Seal Pores

General Magnaplate Corporation has announced that its new vacuum impregnation facility, which meets all the environmental requirements and sodium silicate limitations of MIL-Std-276A, is now in operation at its Arlington, Texas, facility.

Magnaplate's state-of-the-art technology uses organic sealants to impregnate inherently porous castings or powdered metal parts of iron, aluminum, copper, magnesium, and zinc alloys. The process enhances corrosion resistance and permanently seals or reseals components, assuring critical pressure tightness and the elimination of fluid and air leaks. Impregnation is a small fraction of the high cost of scrapping or reworking parts that are leaking due to porosity.

The expanded facility can handle bulk lots, thus producing a high-quality product with lower individual pressure-testing costs for the product/part. The new vacuum impregnation technology is ideal for: (1) sealing brazed assemblies whose high levels of porosity prevent conventional brazing and (2) parts that can be sealed prior to plating, painting, or chemical finishing.

Applications for Magnaplate's vacuum impregnation include valves, meters, and housings; automotive components such as fuel systems, ABS brake systems, automotive windshield wiper parts and bumper components; electronic components; and aerospace hardware and components. It is also recommended for a wide variety of parts used in pipeline operations.

Contact: Candida Aversenti, General Magnaplate Corporation, 1331 Route 1, Linden, NJ 07036; tel: 800/852-3301; fax: 908/862-6110; Web Site: http://www.magnaplate.com or e-mail: info@magnaplate.com.

Nickel Aluminum Bonding Wire

Plasma Powders & Systems, Inc., manufacturers of Bondrite nickel aluminum bonding wire have improved their process of manufacturing by incorporating a diamond die to size the wire. They have also incorporated a two-axis Laser Micrometer in their line to monitor the size of the wire every 200 ms and sound an alarm if there is excessive variation in the diameter from the specified tolerances. The wire is also cleaned by using an ultrasonic process before packing and shipping.

For further information contact: V.T. Mayor, Plasma Powers & Systems Inc., Boundary Road, P.O. Box 132, Marlboro, NJ 07746; tel: 800/358-4287; fax: 908/308-1075.

Near-Net-Shape Processing

Near-net-shape processing of ceramics greatly reduces the need for expensive machining processes. According to a study from Business Communications

Co., Inc., Norwalk, CT, the United States market for ceramic near-net-shape processed products for 1995 was $1.4 billion and is expected to grow to $2.1 billion by 2000, reaching an average annual growth rate of 9.7%. In the area of structural ceramics, the U.S. market for components using the near-net-shaping process is expected to grow at an average annual growth rate of 10.2%. For a copy of the report ($2750), contact Business Communications Co. Inc., 25 Van Zant St., Norwalk, CT 06855; tel: 203/853-4266; fax: 203/853-0348. [Extracted from p 7,*Ceram. Ind.*, Vol 145 (No. 1), 1996.]

Access to the World Wide Web

General Magnaplate: http://www.magnaplate.com

Engineers and designers seeking to enhance the performance characteristics of a wide variety of metal parts now have instant access to data on high-performance, surface-enhancement coatings by visiting General Magnaplate's new "home page" on the World Wide Web. This web site, which can be accessed at http://www.magnaplate.com, also contains corporate and new product information.

The design of this web site permits users to access the information in a variety of convenient ways. For example, by clicking on the name of the type of base metal to be enhanced (e.g., aluminum), the program will automatically list all of the various proprietary Magnaplate coatings that can be used on that metal. Or, if the user already knows which of the various Magnaplate coatings is of interest, complete information on that coating (e.g., Nedox) may be accessed. Operational data available includes such information as temperature range, hardness, coating thickness, FDA and/or USDA acceptability, and many other characteristics. Typical application case histories for all coatings are also included.

An important feature of the Magnaplate web site is that it permits the user to establish a direct computer link to an expert at General Magnaplate headquarters or at the nearest Magnaplate facility. Thus, the user can initiate a dialogue with Magnaplate to answer any questions not answered at the web site.

To further enhance its communications capability, General Magnaplate has also established an e-mail address—info@magnaplate.com. Contact: Candida Aversenti; tel: 908/862-6200; fax: 908/862-6110.

CERAC: http://www.cerac.com

CERAC, Inc., a leading manufacturer of advanced specialty inorganics, has posted a new site on the World Wide Web located at http://www.cerac.com. This site offers a corporate summary and complete description of CERAC's' products and services featuring inorganic chemicals, evaporation materials, sputtering targets, and custom manufacturing. An on-line feedback form is available for people to request one of several technical publications or product catalogs, subscribe to quarterly newsletters, or request quotations on specific materials.

In addition to the web site, an e-mail address—marketing@cerac.com—has also been established for correspondence related to literature requests and product inquiries. Contact: Nora Bauer, Marketing Administrator; tel: 414/289-9800; fax: 414/289-9805.

PFS: http://www.marshill.com/pfs/

PFS is now on the Internet. The Internet address for Plastic Flamecoat Systems is: http://www.marshill.com/pfs/. The e-mail address is pfs@marshill.com.

ASM International: http://www.asm-intl.org/

ASM International, the Materials Information Society, has just redesigned and added several new features to its home page on the World Wide Web. The site can be found at the Uniform Resource Locator (URL) http://www.asm-intl.org/.

"The new design to the home page better reflects ASM' s long history as an information-sharing network and a publisher," said Leslie Chom, ASM Manager of Online Services. "We have designed our site to be a key resource for the metallurgical and materials science communities because of the useful information that can be found."

On the ASM site, visitors can find a Directory of Materials Producers, with mail addresses and telephone numbers of more than 1000 companies that produce raw materials. There is also a world-wide calendar of upcoming conferences, seminars, and meetings in materials science. On the home page, ASM maintains a hot-linked list of other materials-science-related sites that can be used as a starting point to further explore the Web.

Visitors will also find information covering ASM's electronic products, conferences and expositions, education and training, magazines and journals, reference publications, ASM's affiliate societies, membership, chapters, student activities, and awards. For more information, contact Leslie Chom, ASM International, Materials Park, OH 44073-0002; tel: 216/338-5151, ext. 510; fax: 216/338-4634; e-mail: lhchom@po.asm-intl.org.

The Thermal Spray Laboratory at Stony Brook: http://doL1.eng.sunysb.edu

The Thermal Spray Laboratory at Stony Brook can be found on the home page of The Department of Materials Science and Engineering (http://doL1.eng.sunysb.edu). Many interaction options allow "exploration" of the faculty, students, and educational and research programs.

Mathematical Model of Variable Polarity Plasma Arc Welding

A mathematical model of the variable polarity plasma arc (VPPA) welding processes has been developed for use in predicting the characteristics of welds and thus serving as a guide for the selection of process parameters. These parameters include the welding electric currents in, and the durations of, straight and reverse polarities; the rates of flow of plasma and shielding gases; and the sizes and relative positions of the welding electrode, the welding orifice, and the workpiece. The model includes submodels that approximate the time-dependent major electrical, thermal, radiative, and mechanical phenomena involved in the transfer of energy through the electrode and gases to the workpiece and environment. The model predicts (1) electric potentials (in both straight and reversed polarities) at key locations; (2) electric powder input at the electrode, within the orifice, in the free plasma jet column, and in the weld keyhole in the workpiece; (3) powder loss at the electrode, within the orifice but outside the electrode, in the standoff column, and in the workpiece; (4) enthalpy of the plasma arc; and (5) widths and heights of the crown and root of the weld bead. In a study, predictions by this model were found to agree fairly well with data on both normal and abnormal experimental welds.

This work was done by R.J. Hung of the University of Alabama in Huntsville for Marshall Space Flight Center. Contact Harry Craft; tel: (800) USA-NASA; e-mail: susan.van.ark@msfc.nansa.gov. [Reprinted from p 92 of *NASA Tech Briefs,* Vol 20 (No. 3), 1966.]

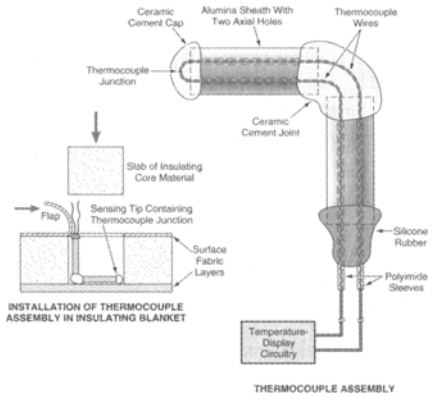
Measuring High Temperatures in Ceramic-Fiber Blankets

Thermocouple assemblies have been devised specifically for measuring temperatures at fixed locations within insulating blankets made of such ceramic fibers as alumina, silicon carbide, and/or aluminoborosilicate. The thermocouples in these assemblies can measure temperatures from 100 to 3200 °F (38 to 1769 °C) in oxidizing atmospheres.

A thermocouple assembly of this type is L-shaped. It includes a type-R thermocouple—a platinum wire welded at the sensing tip to a wire of platinum alloyed with 13% Rh. The wires are enclosed in an alumina sheath for protection against hot oxidation and mechanical damage.

Typically, the thermocouple assembly is installed in an insulating blanket to measure the temperature just inside one of the surface fabric layers. First, a flap is cut to make a hole in the opposite fabric surface layer, then a slab of insulating core material is removed to make room for the thermocouple assembly. The assembly is inserted in the hole with the thermocouple wire leads trailing, and the sensing tip is placed in contact with the inner face of the desired surface layer. The assembly is bonded in place by use of ceramic cement. The slab of insulating core material is then reinserted, the flap is closed, and the edges of the flap are fastened in place by use of room-temperature vulcanizing silicone-rubber cement. The thermocouple wires extending from the flap are then connected to the external circuitry that generates a temperature display from the thermocouple reading.

This work was done by Demetrius A. Kourtides of Ames Research Center. This invention has been patented by NASA (U.S. patent 5,399,019). Contact the Patent Consul, Ames Research Center; tel: 415/604-5104. Refer to ARC-11984. [Reprinted from p 46 of *NASA Tech Briefs,* Vol 20 (No. 2), 1996.]



Refractory materials protect and support the thermocouple wires in the hot measurement region

Coating Silicon-Base Ceramics with Durable Mullite

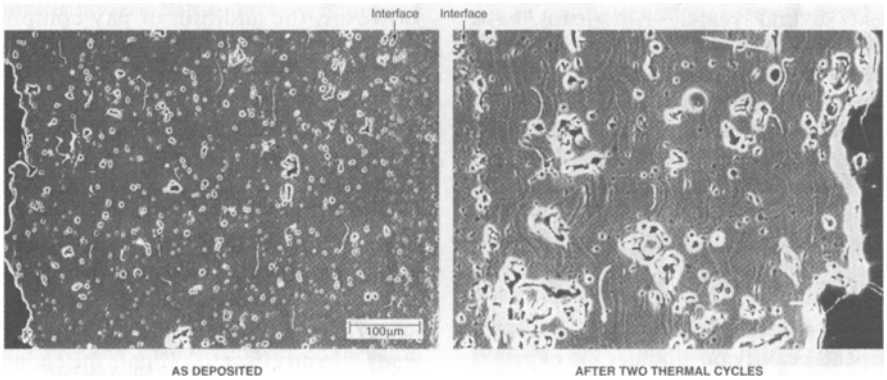
An improved plasma-spraying process deposits mullite (aluminum silicate) on silicon carbide substrates. The process is also expected to be useful in depositing mullite on substrates made of other silicon-base ceramics (e.g., Si_3N_4 and SiC/Si_3N_4 composites) and other ceramic substrates (e.g., AlN) that have coefficients of thermal expansion similar to those of mullite.

Mullite coats are highly desirable for silicon-base ceramic structural components of heat exchangers, gas turbine engines, and advanced internal combustion engines. Mullite exhibits high chemical stability, low thermal conductivity, and a coefficient of thermal expansion approximately equal to those of silicon-based ceramics. Therefore, an adherent coat of mullite could serve as both a chemical and a thermal barrier that would protect the underlying ceramic against high-temperature chemical attack. In addition, overlayers of such other refractory oxides as alumina, yttria-based zirconia, or yttria could be applied to the base coats of mullite.

Until now, plasma-sprayed mullite coats have cracked and flaked away from substrates during thermal cycling, thereby losing their protective qualities. This cracking and debonding was found to be a consequence of the large proportion of amorphous (noncrystalline) mullite that formed during plasma deposition on cold substrates: during subsequent thermal cycling, the amorphous material crystallized when it was heated to temperatures above 1000 °C. The newly crystallized material shrank, giving rise to cracks.

The improved process prevents the formation of amorphous mullite by maintaining high temperature of the sprayed deposit to allow crystallization to occur. For this purpose, the plasma spraying of mullite is done in a furnace that heats the substrate to about 1000 °C. Once the substrate has reached the desired temperature, mullite powder is introduced into an argon-40% helium plasma in a stream of argon gas. The deposited mullite adheres to the substrate and exhibits little or no cracking during thermal cycling. Tests have shown that mullite coats deposited by the improved process adhere and have substantially greater resistance to oxidation in dry air and corrosion by molten salt.

This work was done by Robert A. Miller and Nathan S. Jacobson of Lewis Re-



The specimen of mullite coat on a silicon carbide substrate contained no interconnected cracks and could thus protect the substrate against chemical attack, even after two thermal cycles In each cycle, the specimen was suddenly heated to 1000 °C, kept at that temperature for 24 h, and quenched to room temperature.

search Center and Kang N. Lee of Cleveland State University. This invention has been patented by NASA (U.S. Patent 5,391,404). Contact: the Patent Counsel, Lewis Research Center; tel: 216/433-2320. Refer to LEW-15561. [Reprinted from p 54 of *NASA Tech Briefs,* Vol 20 (No. 3), 1996.]

Laser-Based Ultrasonic Coating Thickness Sensor System

A laser ultrasonic sensor system, linked to the coating equipment to maintain precision deposition rates, provides precision thickness control of high-temperature coatings during their application. Coatings down to 2 mils in thickness can be accurately measured with thickness control to ±5% at application temperatures as high as 1400 °C (2550 °F). In operation, a pulsed laser ultrasonic generator directs a ring-shaped pulse at the surface being coated. Ultrasonic waves travel through the coating to a central laser sensor point and are picked up and reflected back to an interferometer sensor, so the coating thickness can be detected and read out directly. On-line, real-time measuring offers precision control over the coating process, especially when the interferometer sensor is linked to the coating equipment.

Innovative materials are answering the need to meet stringent performance demands for advanced Air Force systems. For example, crystalline silicon nitride coating has been developed to provide thermal protection for carbon-carbon components in high-temperature applications. This coating, applied by chemical vapor deposition, has protected carbon-carbon components in environments up to 1760 °C (3200 °F) for as long as five hours, successfully proving the feasibility of the control and the process. The thermal expansion rate of crystalline silicon nitride is very close to that of carbon, so the coating will not work loose and break off through hot and cold cycling.

Achieving the crystalline form of silicon nitride in coating deposition depends on intelligent control of the deposition rate and maintenance of application temperatures above 1400 °C (2550 °F). At lower deposition rates and temperatures the material structure remains uncrystallized, resulting in a coating with reduced oxidation resistance and lessened structural stability at elevated temperatures.

Besides nondestructive measurement of coatings for precision high-temperature barrier applications for Air Force turbine engines, the laser ultrasonic sensor can be used to measure ceramic and polymeric coatings on the skins of advanced aircraft and as an end-process sensor to measure thickness of virtually any kind of coating. Both crystalline and amorphous coatings can be measured with the same degree of accuracy. The coating process and intelligent control are being transferred to a manufacturing-scale reactor at the Amercom Corporation (Santa Ana, CA).

This work was performed under Wright Laboratory Materials Directorate contract with United Technologies Research Center, East Hartford, CT. Kristen Kearns of the Materials Directorate is responsible for monitoring the contract. Contact: Materials Directorate Technology Transfer Center, WL/MLI-TTC, 2977 P St., Suite 13, Wright-Patterson AFB, OH 45433-7746; tel: 513/255-4689. [Reprinted from p 5a of Laser Tech Briefs, *NASA Tech Briefs,* Vol 20 (No. 3), 1996.]

News from the National Science Foundation

Shutdown Causes Crunch at National Science Foundation

The NSF is digging out from its own blizzard of paperwork left by the unprecedented government shutdown in 1995. The NSF supports nonmedical science and engineering research and education through competitive grants to about 2000 institutions nationwide. The furlough postponed dozens of panel meetings to review hundreds of proposals for research. Researchers nationwide could not consult with NSF staff regarding their proposal submissions. Technical support to state, urban, and rural education reform projects funded by NSF was suspended, which may adversely impact these multimillion-dollar efforts. Hundreds of science projects have been delayed or canceled, the budgets of researchers at universities nationwide have been disrupted—affecting funding for graduate students and innovative pilot undergraduate courses across the country—and the pace of science exploration has slowed at a time when the United States faces more overseas technology competition than ever before.

NSF Tackles Shutdown Backlog as More Uncertainty Looms

As mailroom employees work overtime on a backlog of at least 2500 research proposals and more than 40,000 pieces of mail, the National Science Foundation is preparing for more uncertainty. The current continuing resolution allows NSF to continue to operate at roughly its fiscal year 1995 funding level, but it expires on January 26.

"I am very concerned about the serious long-term and short-term impact that this unprecedented shutdown could

have on the nation's research and education community," said NSF Director Neal Lane. "It has already been very disruptive, and the impact will likely reverberate throughout the year." Lane added that he is "hopeful that an agreement will be reached for our appropriation that will enable us to recover from the backlog and to continue the business of investing in the nation's future."

The agency receives about 60,000 proposals each year—an average of 240 a day—and makes awards to about one-third of them. Typically, a grant is awarded or declined within six months of its receipt. However, NSF officials are warning proposers to expect delays, while promising to do all it can to avoid them.

"Mail clerks and proposal processing technicians will work 12-h shifts until the proposals are properly accounted for and distributed," said NSF's director for information and resource management, Connie McLindon. She estimated the process to take a few weeks.

In attacking the proposal backlog, NSF's six research directorates will struggle to reschedule dozens of canceled meetings of top researchers—called review panels—who advise the agency on whether or not to fund new proposals. Dr. Lane worried that "although science will go forward, it will limp painfully."

Many of the institutions that NSF supports have already felt the impact.

"The shutdown was beginning to fray nerves when our researchers missed grant deadlines and couldn't get answers to their questions," said University of Alaska (Fairbanks) Provost John Keating.

Steve Kahl, Director of the University of Maine Water Research Institute, worried that "some proposals may not be submitted because of lack of information from NSF during the shutdown." He added that even funded research may be severely impacted if the money arrives late. "If your field season is three months long, and a month-long shutdown means that the funding will be a month late, you have a real problem," said Kahl.

Dr. Lane remains "cautiously optimistic" that the recognition of the obvious value of scientific research will lead to stable funding, but continues to worry about the potential impact of the shutdown and projected budget cuts over the next several years. "Americans have been justly proud of our scientific achievements and assume that we will retain our world leadership. But that assumption has been rocked by the shutdown and by continuing budget uncertainties," he said.

NSF Study Yields Insights into Impact of Expert Testimony

Jurors' perceptions of expert testimony depend heavily on whether the expert is paid or highly credentialed, or both, according to NSF-funded research on the effects of science and technology testimony in the legal system. The effect of these factors is magnified when the testimony is complex.

"The U.S. legal system in this age of technology increasingly depends on testimony by science and technology experts, particularly in civil litigation," said legal scholar Joan Hall, a member of the research team. "That raises some important questions, such as whether peripheral factors influence jurors more than facts and testimony."

Princeton University psychologist Joel Cooper led the research project, which combined focus groups and experiments to determine the effects of expert science and technology testimony in the legal system. The research specifically targeted product liability cases.

Among the studies' most interesting findings are:

- When testimony was given in complex language, jurors were more likely to form judgments based on the credentials of the expert rather than the validity of the testimony.
- Experts who are paid highly, and who jurors assumed testified frequently, were considered hired guns and were regarded less favorably, regardless of their testimony.
- In medical liability cases, jurors' decisions were affected by their own or others' past medical experiences and by whether the defendant was an individual or a corporation.
- A court-appointed expert did not automatically convince or influence jurors more than experts called by the defense or prosecution.

According to Hall, the most effective expert witness was one with strong credentials who used simple language. However, the addition of pay complicated the findings. An expert who was paid very highly and had strong credentials was not always an effective witness, from the jurors' point of view. "Perhaps jurors feel that the highly paid and high-credentialed expert is using his position to make money," said Hall.

Expert witnesses are used in 86% of civil cases, with an average of four experts in every trial, according to the study. "In an effort to validate the claims that are in dispute, a rising number of expert witnesses are being used in any given case, and sometimes they contradict each other," Hall pointed out. "How is a juror to determine which expert is correct, when each claims to have the answer and the juror is unfamiliar with the issue?" Based on this research at least, jurors use peripheral factors, in addition to the testimony itself, to make their judgments. According to William P. Butz, NSF's division director for social, behavioral, and economic research, the findings have implications for new technologies in this country. "U.S. industry may be less likely to develop or market major innovations, because of the risk that they will not be able to convince juries with expert testimony," he said.

Traffic Jams on the Internet

While the Internet grows in popularity, a related problem is growing: traffic jams. The increased demand of more people on-line using increasingly sophisticated tools has caused delays in transmission unacceptable for some scientific uses.

The National Science Foundation has introduced a new twist to its connections program: emphasizing innovative solutions that may have broad implications for all Internet users. The program will look for meritorious applications that require high-performance networking and will then fund development by university and college campus network service providers. Technology developed for this program will likely affect future operation of the Internet.

The technology will introduce the idea of prioritization to Internet traffic. For example, if planning to use the U.S. Postal Service to send a package, you have options: overnight mail, first-class service, or third-class service. The rate of the package delivery is contingent on

how it is designated. Freeways around major cities often have either express toll roads or high-occupancy-vehicle lanes to bypass congested areas. Similarly, NSF's connections program is expected to spur the development of switches and routers to help alleviate bottlenecks of information.

"There is no single solution. We hope this grant program will stimulate the development of a technological option for the Internet, to introduce prioritization and provide a new style of connection that gives a guaranteed level of service at a national level," said Mark Luker, manager of NSF's connections program.

Currently on the Internet, all packets of information are treated alike. While this worked fine before the popularization of the Internet, it now interferes with some uses that require high-performance service. One example is to use high-performance connections of multiple small computers to create a large workstation cluster distributed across the nation. The Internet is currently too congested for such a system. Teleconferencing or video conferencing also places too great a need on the current capacity. In addition, some scientific instrumentation requires specific fast connections, though not necessarily high bandwidth. Interruptions or delays caused by Internet congestion could be fatal to experiments.

One solution might include prioritization of traffic on the Internet. Another solution might involve diverting specially coded traffic to high-performance, special-use networks, such as NSF's vBNS (very high speed Backbone Network Service).

People Who Drive on Glass Bridges...

Very soon, bridges will be made of glass. And plastic. And carbon. Scientists and engineers around the world are working on a new generation of construction materials for bridges that will resist corrosion and last longer with less need for repair. Canada, China, Japan, and Scotland are among nations that have built or are about to build bridges using polymer composites. In the near future, the suspension cables, support girders, and main deck of many bridges will be made of millions of braided, woven, and fused strands of composite materials cooked up in laboratories by engineers.

There's an international race to develop these materials because bridges everywhere are crumbling from the effects of weather, pollution, and age, says John Scalzi, a structural engineer who directs the National Science Foundation (NSF)'s Large Structural and Building Systems Program. Scalzi says the United States, which has lagged dangerously behind, urgently needs to catch up with advances in construction materials achieved in other countries for several reasons. Most important is that the civil infrastructure in the United States is in bad shape. The Federal Highway Commission reports that 42% of bridges need repair and are obsolete; the cumulative repair bill by the year 2010 is estimated to reach $50 billion. New, low-maintenance materials are needed immediately to repair a long list of existing bridges in every state of the union.

Academic R&D Expenditures Outpaced Inflation in 1994

The good news is that despite pressures of ever-tightening budgets, colleges and universities outpaced inflation in their investment in research and development (R&D) in 1994. The bad news is that the expenditures reflect a nearly flat-line increase in contrast to the booming 1980s.

According to the newest data compiled and released by the NSF, academic expenditures for R&D in the sciences and engineering in the United States reached $21 billion in 1994—an increase of nearly 6% from 1993 levels or, when adjusted for inflation, almost a 4% rise. The spending increase matches the average annual rate of real growth during the last five years.

The latest figures show that while campus investment in R&D spending has more than doubled from $8.6 billion a decade ago, most of that growth occurred during the 1980s. The rate of increase in the 1990s has dramatically slowed.

Academic institutions historically have devoted about two-thirds of their R&D efforts to the performance of basic research, a trend that was uninterrupted in 1994. The federal share—$8.9 billion—accounted for 63% of the basic research total.

Overall academic R&D spending shows federal funds in 1994 totaled $12.6 billion, compared to $3.8 billion from industry. Among research areas, the greatest rate of spending growth was in computer sciences—9%.

Foreign Students in Japan—American Students Decreasing

The Ministry of Education, Science, and Culture (Monbusho) recently made public the numbers of foreign students studying in higher educational institutions in Japan, as of 1 May 1994. Numbers were based on data from the Japanese Immigration Office, covering all individuals who entered Japan on student visas for enrollment in higher educational institutions including graduate schools, universities, junior colleges, technical colleges, and special

Table 1 Total number of foreign students yearly

Year	Total Number	Increase
1985	15,009	20.9%
1986	18,631	24.1%
1987	22,154	18.9%
1988	25,643	15.7%
1989	31,251	21.9%
1990	41,347	32.3%
1991	45,066	9.0%
1992	48,561	7.8%
1993	52,405	7.9%
1994	53,787	2.6%

Table 2 Breakdown of foreign students by country of origin

Country	No. of students		No. of students as a percentage	
	1994	1993	1994	1993
China	23,256	21,801	43.2%	41.6%
South Korea	12,965	12,947	24 1%	24 7%
Taiwan	5,648	6,107	10 5%	11 8%
Malaysia	2,276	2,,105	4 2%	4 0%
Indonesia	1,178	1,206	2 2%	2 3%
United States	1,146	1,192	2 1%	2 3%
Thailand	1,014	992	1 9%	1 9%
Bangladesh	637	581	1 2%	1 1%
Philippines	487	528	0 9%	1.0%
Hong Kong	479	520	0 9%	1 0%
Others	4,701	4,326	8 8%	8 3%
Total:	53,787	52,405	100.0%	

Table 3 Japanese government science and technology—related budget

JFY	Billion yen	Yearly increase
1977	870.6	12 8%
1978	990 5	13.8%
1979	1,150 8	16 2%
1980	1,292.1	11 8%
1981	1,398 2	8.2%
1982	1,448 0	3 6%
1983	1,450 1	0.1%
1984	1,483 8	1 5%
1985	1,532 9	3.3%
1986	1,606 4	4 8%
1987	1,662 3	3.5%
1988	1,715 7	3.2%
1989	1,815.6	5.8%
1990	1,920.9	5.7%
1991	2,022.6	5 4%
1992	2,134 7	5.5%
1993	2,266.3	6 2%
1994	2,358.5	4 1%
1995	2,499.5	6 0%
1996 (Proposed)	2,672 1	6 9%

training colleges. (Note that individuals entering Japan for the sole purpose of learning the Japanese language were not included in these statistics.)

The total number of foreign students enrolled in Japanese higher educational institutions as of 1 May 1994 was 53,787; an increase of 1382 (2.6%) over the previous year. Table 1 gives numbers for the past 10 years, indicating a recent slow-down in the rate of yearly increases.

Of the 53,787 students in 1994, more than three-fourths were from China, South Korea, and Taiwan, as show in Table 2.

Inquiries or requests for additional information may be addressed to: Student Exchange Division, Bureau of Science and International Affairs, Ministry of Education, Science and Culture, 3-2-2 Kasumigaseki, Chiyoda-ku, Tokyo, Japan 100; tel: +81-3-3581-4211, ext. 2620; fax: +81-3-3581-2164.

Japan's Fiscal Year 1996 Government Budget Proposed for Science and Technology

On 1 February 1996, Japan's Science and Technology (S&T) Agency made public a summary of the S&T-related government budget recommended by the Cabinet for JFY 1996 (1 April 1996 to 31 March 1997). The gross total of the proposed S&T-related budget amounts to 2672.1 billion yen (about U.S. $25 billion at the current exchange rate of Yen 107 per dollar), an increase of 172.6 billion yen (U.S. $1.6 billion) or 6.9% over the previous year's initial budget level of 2499.5 billion yen. This will be the highest rate of yearly increase since JFY 1981, as noticed in Table 3. Note that while the budget is still subject to approval by the National Diet, it is expected to be approved without major changes.

For reference, the total general account government budget proposed for JFY 1996 is 75,104.9 billion yen (about $701.9 billion), an increase of 5.8% over the previous year's initial budget level of 70,987.1 billion yen. The Ministry of Education, Science, Sports, and Culture accounts for nearly one-half (46%) of the government's total S&T budget. Following Monbusho are the Science and Technology Agency with about one-fourth (26%) of the total, and the Ministry of International Trade and Industry accounting for approximately one-eighth (12%) of the total S&T budget.

NSF Fiscal Year 1997 Budget Request Totals $3.3 Billion

The President's budget request for the National Science Foundation for Fiscal Year 1997 is $3.3 billion, representing a 4.6% increase over the total FY 1996 estimate. (NSF does not yet have a final budget for FY 1996.)

NSF Director Neal Lane said the increase is critical if NSF is to maintain its role as a catalyst for national progress. "NSF supports exploration, innovation, and imagination, and history shows that the return on these investments will help propel America into a future of growth, prosperity, and health," he said.

Requested funding for research activities is up 8.7% over the previous year's estimated funding level. The major disciplinary fields—represented roughly by NSF's six research directorates—would receive comparable increases. Funding for education and human resources is up 3.3%.

Of the total NSF budget request, roughly 56% supports science and engineering, research; 20% supports education reform in science, engineering and math; 20% supports research facilities; and 4% supports administration and management. NSF's FY 1997 request emphasizes three principles:

- Developing a balanced portfolio that spans the frontiers of knowledge. NSF is the only federal agency that extends support to research and education in all science and engineering fields and intends to continue this balanced support across major fields while also retaining flexibility to move quickly into new and emerging areas.

- Linking discovery and learning. Fundamental science and engineering research is enriched by the educational environment in which much of it is conducted. Likewise, experimentation, inquiry, and discovery enhance and reinforce the learning process.

- Working in partnership. NSF directly supports at least 200,000 researchers, teachers, and students and 2000 colleges, universities, and research institutions (including nearly 600 businesses); and indirectly engages millions more.

The FY 1997 request enhances NSF's ability to mobilize and guide these vast resources. The budget request eliminates NSF support for modernizing facilities under the Academic Research Infrastructure program. This change is consistent with recommendations of the September 1995 National Performance Review report that this function of upgrading and renovating university laboratories be supported by state, local, and institutional sources.

"This allows NSF to focus on its unique facilities role, which is to fund large, national research platforms that support broad segments of the research community—for example, Supercomputer Centers, the Laser Interferometer Gravitational Wave Observatory (LIGO), and oceanographic research vessels," said Lane. NSF typically devotes from one-fifth to one-fourth of its annual budget to such complex facilities. In the FY 1997 request, they account for $661 million (roughly equal to the 1996 level).

The request also includes $25 million for safety improvements to facilities at the South Pole. Dr. Lane emphasized that over the past 45 years, NSF has proven its ability to deliver the benefits. "There are so many examples where investment in basic research led to recognizable payoffs later on, and the rate of discovery is accelerating. This is an exciting time, even a revolutionary time, in science and engineering—and NSF is at the center of it."

Jiayin GUO

Jiayin Guo has successfully submitted and defended his Ph.D. thesis on **Plasma Synthesis and Sintering of Ultrafine SiC Powder (UFP) directly from Solid Silicon and Methane.** He was awarded his Ph.D. in October 1995 at the Sherbrooke University Graduation ceremony.

Dr. Guo's research investigations involved the vaporization of silicon powder, followed by carburization of the vapor and condensation of SiC UFP. At first, DC plasma synthesis was undertaken using a rotary reactor, but though the resultant UFP was very fine, it was unsatisfactory, due to high content of free silicon and carbon. Induction RF plasma was then employed; optimization of processing conditions gave essentially pure SiC powder, with minimal free silicon and carbon and high specific surface, 30 to 50 m2/g. A parametric study of the vapor phase reaction made explored the influence of plasma gas composition, injection position, feed rates of reactants, stoichiometry, and plasma reactor wall temperature on the mechanism of powder formation and properties of the UFP produced. Pressureless sintering of the synthesized SiC powder was then carried out with various solid sintering aids. The results indicated that the plasma produced UFP powder had superior sinterability over that of commercial powders with Al_2O_3 and Y_2O_3 as dopants. Further, in flight boron doping during plasma synthesis significantly improved the sinterability of the SiC powder compared to the incorporation of solid sintering aids into plasma powders.

Mohamed RAHMANE

Mohamed Rahmane has been awarded his Ph.D. degree for his research thesis entitled: **Mass Transfer under Thermal Plasma Conditions.**

The research work presented in his thesis is devoted to the study of the transfer of heat, mass, and momentum, resulting from the injection of a cold gas flow into a thermal plasma flow (jet). Particular attention is given to mass transfers and to the evaluation of the effective transport properties for the plasma conditions, that is, the mass diffusivity, the thermal conductivity, and the viscosity. The methods employed consisted of measuring the plasma temperature, velocity, and concentration fields, utilizing the enthalpy probe technique, then calculating the fields for these same variables with the aid of a two-dimensional, mathematical model, assuming local thermodynamic equilibrium conditions and taking the turbulence into account by means of a κ-ε model.

These activities were undertaken with the goal of developing and improving the enthalpy probe technique in its application to the diagnostics of DC or RF plasmas. An experimental assessment of calibration, sensitivity, and precision of the technique is presented. At the same time, the emission spectroscopy (absolute intensity) technique was used for analysis of transfer phenomena in the case of compressible DC plasma jets. The comparison of experimental and theoretical results for velocity temperature and composition fields in an inductive coupled plasma, has provided validation of the model (mathematical) employed and has permitted estimation of effective transport properties. In making the comparison of the molecular and turbulence components of these plasma properties, it has been possible to evaluate the separate contributions of each of the two flow modes, that is, the laminar and turbulent modes, to the mass transfer phenomena for the plasma reactor configuration studied.

Karlis Agris GROSS

Karlis Agris Gross graduated with a Ph.D. from the Department of Materials Science and Engineering of the State University of New York at Stony Brook in December 1995. His thesis topic was **The Amorphous Phases in Hydroxyapatite Coatings.**

The formation and location of the amorphous phases in hydroxyapatite coatings used in dental and orthopedic implants were investigated. This was conducted by characterizing the amorphous phase, studying crystallization and investigating the effects of plasma spray parameter settings on the amorphous phase content. Finally, the amorphous phase was tested *in vitro* to examine the durability of the coating.

Hydroxyapatite $[Ca_{10}(PO_4)_6(OH)_2]$ powder was thermally sprayed using air plasma spraying to produce an amorphous phase. Thermal analysis revealed that hydroxyl rich regions crystallized at 500 °C and hydroxyl-deficient areas at 700 °C. The activation energies of these processes were found to be 274 and 440 kJ/mole, respectively. Crystallization was accompanied by cracking and, therefore, heat treatment is not advised as a means of increasing the crystalline phase content of coatings.

Two conditions led to the formation of the amorphous phase; high cooling conditions or a depleted hydroxide concentration within the molten particle. High cooling rates adjacent to the substrate commonly produced an amorphous phase. As the cooling rate decreases with coating buildup, the lower thermal conduction of the amorphous phase causes crystallization. If the cooling rate is sufficiently low in the dehydroxylated regions, but fast enough to avoid decomposition to tricalcium and tetracalcium phosphates, oxyapatite will form that will transform to hydroxyapatite upon exposure to air. A model for the amorphous phase formation is proposed, and the use of thermal spraying hydroxyapatite discussed.

Dental coatings consisted of a range in amorphous phase content with features comparable to the coatings produced in the parameter study. A higher crystalline content was found on the tip of the threads and the apical end on some implants.

Degradation studies revealed preferential dissolution of the amorphous phase. Crystalline areas remain as a scaffolding in the coating or leave the coating when totally surrounded by the amorphous phase. The amorphous phase, thus, leads to coating failure if positioned uniformly within the coating and is very important to control in the design of hydroxyapatite coatings for biomedical applications.

Chung-Kwei LIN

Chung-Kwei Lin graduated with a Ph.D. from the Department of Materials Science and Engineering of the State University of New York at Stony Brook in December 1995. His thesis topic was **Statistical Approaches to Study Variations in Thermal Spray Coatings.**

Thermal spray materials have a layered structure consisting of lamellae, pores,

oxides, cracks, and unmelted particles. The present work encompasses several experimental and theoretical experts to assess the variability in materials properties of thermal spray materials.

Microhardness tests with different loads were used to assess how variability was related to the "test volume" of the material. A general trend was that the larger the load, the smaller the average microhardness and the larger the Weibull modulus after heat treatments. High variability was found at high temperature.

The reliability of test results was assessed by a Monte Carlo method, where subsets of data were randomly selected from the parent data sets and analyzed statistically. The coefficient of variation for the mean is ~5%, if 20, 15, and 5 measurements were made for ceramic coating, bond coat and $MoSi_2$ composite, respectively.

Four-point bend tests with in situ acoustic emission monitoring were performed on as-sprayed and heat-treated specimens in both cross section and inplane orientations. The AE responses were analyzed with respect to time and displacement. For as-sprayed samples tested in the cross section orientation, microcracking before failure was observed. However, catastrophic failure was commonly observed after heat treatment.

The energy and amplitude distributions change after heat treatment, but no significant difference can be noticed in different orientations. Macrocracks, characterized by their high energy and high amplitude, tend to occur when the event activity is low, dominate the cracking mechanism, and induce final failure. For as-sprayed and heat-treated samples, the AE responses differ not only in the percentage of macrocracks (these increase after heat treatment), but where the macrocracks occur during the tests (macrocracks can only be observed after a normalized displacement of 0.82).

Sang-Ha LEIGH

Sang-Ha Leigh graduated with a Ph.D. from the Department of Materials Science and Engineering of the State University of New York at Stony Brook in March 1996. His thesis topic was **Stereological Investigation on Structure/Property Relationships of Plasma Spray Deposits.**

The mechanical properties of plasma sprayed alumina-13wt% titania deposits were studied employing indentation and four-point bend tests. Extensive quantitative microstructural information is required to better understand and explain the mechanical properties of thermal spray deposits. Stereology, which describes 3-D information using 2-D sections, has been applied to quantitatively investigate the microstructural features of thermal spray deposits. Stereology enables the generation of strict microstructural information that is not available directly from the analysis of metallographic cross sections.

The relationship between mechanical properties and microstructure of plasma spray-formed alumina-13wt% titania (AT13) has been studied. Indentation and four-point bend tests were employed to determine elastic modulus, microhardness, and strength of the deposit. The anisotropic behavior of these materials was also investigated. The anisotropy is attributed to the unique microstructure of thermal spray deposits, that is, the spheroidal shape of pores and splats. The mechanical behavior of thermal spray deposits can be better understood by reliable and unbiased microstructural information. Stereological analysis has been applied to acquire quantitative microstructural indices of thermal spray deposits. The splat and void size-shape distributions were measured assuming the splats and voids were spheroidal in shape. The surface area of voids and splats were measured by using cycloid-shape test lines. The degree of anisotropy of the surface area of splats and voids were also determined.

The five independent elastic constants were calculated from constitutive equations and the microstructural information (void aspect ratio and porosity) gained from stereological analysis. The calculated elastic constants were comparable to the experimentally determined values.

People in the News

Dr. Rangaswamy Joins Wall Colmonoy

Dr. Subramaniam Rangaswamy has joined Wall Colmonoy Corporation (Madison Heights, MI) as Brazing Products Manager. Rangaswamy will have overall responsibility for marketing and sales of the Nicrobraz product line. He will provide technical service to the brazing industry and assume the positions of course co-leader for the company's brazing school, and Editor-In-Chief of *Nicrobraz News*, a technical newsletter.

Rangaswamy received his Ph.D. in Materials Science and Engineering from the State University of New York at Stony Brook. During his 20 years in the field, he has published many technical articles and holds several patents.

Wall Colmonoy Corporation manufactures high-temperature brazing filler metals, brazing aids, and paste and spray application systems for the aerospace, automotive, and power generation industries. Wall Colmonoy also manufactures nickel-base hard-surfacing alloys for the plastics, glass and petrochemical industries.

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