In The News

Conferences

2nd International Meeting of Pacific Rim Ceramic Societies

Sponsored by the Australasian Ceramic Society and incorporating Austceram 96, the Second International Meeting of Pacific Rim Ceramic Societies will be held 15-17 July 1996, in Cairns, Australia. The Second International Symposium on Environmental Issues of Ceramics, and The Second International Symposium on Sol-Gel Science and Technology, (ISSST2) will be held concurrently with this meeting.

Technical program topics include, Advanced Structural Ceramics; Advances in Refractories; Applications of New Microstructural and Microanalytical Characterization Techniques; Ceramic Composites; Ceramic Coatings and Films; Ceramic Gas Sensors, Ceramic Joining and FGMs; Clay-Based Ceramic Workshop; Computational Materials Science; Developments in Structural Non-Oxide Ceramics; Electronic, Magnetic and Electro-Optic Ceramics; Emerging Techniques for Forming and Densifying Ceramics; Forum on Ceramic Related National Government and Industrial Perspectives Around the Pacific Rim (by invitation); Glasses and Glass Ceramics; International Symposium on Glass and Ceramic Waste Forms, including Spent Fuel, for Radioactive Waste Management, Reliability Testing, Standardization and Quality Control in Ceramics Manufacture; Solid Oxide Fuel Cells; Surface and Interface Science; Traditional Ceramic Reformulation Using Locally Available Materials and Wear, Corrosion and Erosion Resistant Ceramics.

Contact: PacRim2, PO Box 679, Strawberry Hills, NSW 2012, Australia. Tel: (61-2) 319-7329; Fax: (61-2) 310-3710; E-mail extra@mpx.com.au.

Processing and Design Issues in High Temperature Materials

The Engineering Foundation is sponsoring a symposium entitled Processing and Design Issues in High Temperature Materials to be held 19-24 May, 1996 in Davos, Switzerland. This conference is co-sponsored by the Physical Metallurgy, Mechanical Metallurgy and High Temperature Alloys Committees of the Structural Materials Division of TMS.

Contact: Engineering Foundation Conferences, 345 E. 47th Street, New York, NY 10017, USA. Tel: (212) 705-7836; Fax: (212) 705-7441; E-mail: engfnd@aol.com, World Wide Web: http://www.engfnd.org/engfnd.

High Temperature Coatings II (HTC-II '96)

The TMS Surface Modification and Coatings Technology Committee (SMACT) and Materials Design and Manufacturing Division (MDMD) is sponsoring High Temperature Coatings II (HTC-II '96) at the 1996 TMS Annual Meeting, February 4-8, 1996), in Anaheim, CA, USA.

This symposium will focus on processing and characterization of high temperature coatings with regard to engineering, physical and chemical properties. The synthesis of new and unconventional coating materials will also be included. Various existing methods along with novel and innovative techniques of producing coatings and their applications in a variety of environments will be addressed. This symposium will also cover performance and removal of these coatings in compliance with environmental requirements.

Some of the key areas to be explored include: High Temperature Ceramic Coatings; High Temperature Intermetallic Coatings; High Temperature Composite Coatings; High Temperature Metallic Coatings; Tribological Coatings; Characterization Techniques for Coatings; Repair and Removal of Coatings; and Coatings Formed during High Temperature Corrosion.

For more information contact: Dr. Narendra B. Dahotre, Center for Laser Applications, MS 33 University of Tennessee Space Institute, Tullahoma, TN 37388-8897, Tel: (615) 393-7495, Fax: (615) 454-2271, E-mail: ndahotre@utsi.edu or Dr. Janet Hampikian, School of Materials Science, Georgia Institute of Technology, Atlanta, GA 30332-0245, Tel: (404) 894-2845, Fax: (404) 853-9140, E-mail: janet.hampikian@mse.gatech.edu or Dr. Jacob J. Stiglich, Consultant, PO Box 206, Sierra Madre, CA 91025, Tel: (310) 944-6244, Fax: (310) 944-2485.

Successful Coating and Lining of Concrete

A NACE course on Successful Coating & Lining of Concrete will be held at the following locations in 1996; Toronto (ON) January 15-16; Boston (MA) February 12-13; Philadelphia (PA) April 22-23; Orlando (FL) May 6-7; and Oxnard (CA) June 3-4.

Many millions of square feet of concrete are protected each year with coating and lining systems. Premature failures due to improper selection or installations are extremely costly and can be avoided by understanding the interaction of coatings and linings with concrete. Coating and lining concrete is more complex than coating and lining steel. The porous nature of concrete introduces many variables that affect the ultimate performance of coatings and linings on concrete surfaces.

This seminar will provide participants with an understanding of the methods and processes required to successfully select and apply coatings and linings to concrete. Topics addressed include an overview of the properties and weaknesses of concrete; methods for repairing defects; proper surface preparation steps; coatings for concrete; methods for repairing defects; proper surface preparation steps, coatings for concrete; inspection; testing, and related standards; specifications; and coating failures.

For more information or to request the current Education and Training Guide, contact NACE Headquarters at (713) 492-0535, ext. 80.

Seventh European Conference on Composite Materials

The Seventh European Conference on Composite Materials (ECCM-7), organized by the Institute of Materials, will be held in LONDON on 14-16 May, 1996.

Contact: Ms. Cathy Pearcey, Conference Department (C609), Institute of Materials, 1 Carlton House Terrace London SW1Y 5DB, United Kingdom. Tel: (44) 0171 839 4071, Direct Line: (44) 0171 235 1391, Fax: (44) 0171 823 1638 or Mrs. Christine Madur, EACM, 2 Place de la Bourse, 33076 Bordeaux Cedex, France. Tel: (33) 56 01 50 20, Fax: (33) 56 01 50 05 or (33) 56 90 90 40.

Coatings for Use at High Temperature

The International Conference on Metallurgical Coatings and Thin Films to be held in San Diego on April 22 -26, 1996 will hold sessions in Coatings to Resist High Temperature Corrosion, Coatings to Resist Wear at High Temperatures, Thermal Barrier Coatings, and Coatings for Composites Used at High Temperatures. Contact Robert C. Tucker, Jr., Praxair Surface Technologies, Inc., PO Box 24184, 1500 Polco Street, IN 46224. Tel: (317) 240-2539, Fax: (317) 240-2464 or Martin Thoma, MTU Motoren und Turbinen Union, Munchen GmbH, Dachauer Strasse 665, D-8000 Munchen 50, Germany. Tel: (49-89) 1489-3979, Fax: (49-89) 1489-5941.

Symposium on Joining of Materials

The Welding Research Institute, Bharat Heavy Electricals Limited and the Indian Institute of Welding are organizing the Symposium on Joining of Materials (SOJOM '96) for September 12-14, 1996, in Tifuchirappalli, India.

The symposium will cover novel aspects of materials joining processes, equipment and evaluation aspects; trends in automation and controls; the application of computer technology for welding automation and expert systems development; methods for assessment of remnant life of welded components in exacting service environments; and micro-joining of dissimilar materials.

Contact: Mr. R.S.Babu, Chairman / Organizing Committee - SOJOM '96, Head / WRI / Bharat Heavy Electricals Limited, Tiruchirappalli—620 014, Tamil Nadu, INDIA. Tel: (91-0431) 552770, Grams: BHARATELEC, Telex: 455-372 & 376 (BHTP IN), Fax: (91-0431) 552710, 553250

Literature

Books on Thermal Spray

The following five books are available from Cambridge International Science Publishing, 7 Meadow Walk, Great Abington, Cambridge CB1 6AZ, England. Tel: (44-1223) 893295 or (44-5855) 15357, Fax: (44-1223) 893295; E-mail: 100070.1151@compuserve.com

Thermal Plasma and New Materials Technology, edited by O.P. Solonenko and M.F. Zhukov, Institute of Thermophysics, Russian Academy of Sciences, Novosibirsk. The results of research carried out in the former Soviet Union and now in the CIS in the area of thermal plasma and all its applications are scattered throughout various monographs and journals published in Russian. *Thermal Plasma and New Materials Technology* is a unique up-to-date collection in the English language and provides the reader with a clear and comprehensive picture of numerous achievements by scientists from Russia, Ukraine, and other countries of the former Soviet Union and the CIS. Volume 1 ISBN 1 898326 06 1 (£75), Volume 2 ISBN 1 898326 07X (£79).

Plasma Chemistry, edited by L.S. Polak and Yu.A. Lebedev, Institute of Petrochemical Synthesis, Moscow. The book describes the results of investigations of the electrophysical, chemical, gas-dynamic, and other processes in low-temperature plasma, their diagnostics, modeling and application in various areas of science and technology. Special attention is given to the problems associated with physico-chemical processes and chemical reactions in nonequilibrium and (quasi) equilibrium low-temperature plasma. Kinetic and thermodynamic aspects of plasma chemical reactions and their mechanisms, determined mainly by reactions under electron impacts and reactions of vibrationally excited molecules, are discussed. ISBN 1 898326 22 3 (£65).

Thermal Plasma Diagnostics, A.A. Ovsyannikov, *et al.*, Institute of Thermophysics, Russian Academy of Sciences, Novosibirsk. The book contains the results of investigations of electrophysical, chemical, gas-dynamic, and other processes in low-temperature plasmas and their diagnostics. Both conventional spectral and optical methods of diagnostics and new and laser methods are examined, together with electrostatic probes for investigating rarefied and dense plasmas, especially in the presence of chemical reactions. Problems of probe calorimetry of plasma flows are investigated and approaches to measuring the spatial and time characteristics of plasma are outlined. Procedural problems of processing experimental data and automating diagnostic experiments are discussed. ISBN 1 898326 23 1 (£70).

Thermophysics of Plasma Spraying and Related Technologies, O.P. Solonenko, Institute of Thermophysics, Russian Academy of Sciences, Novosibirsk. The thermophysical fundamentals and experimental data on processes taking place in plasma spraying and related technologies (plasma processing of composite powder materials, including spheroidisation, evaporation, densification, microatomisation of powders, etc.) are presented. Advanced methods of theoretical investigation and diagnostics of these processes are described. The book is compiled to cover the whole range of phenomena associated with plasma generation: (i) high-temperature jet formation, (ii) interphase heat, mass and momentum exchange between disperse materials and high-temperature gas and plasma flows, (iii) collisions of particles with the surface, (iv) formation of a sprayed layer from them and interaction of the gas disperse flow with the substrate, and (v) post treatment of sprayed coatings using high-density energy fluxes. The book also includes a set of Fortran programs for computer calculation of basic phenomena determining the behavior of powder materials during plasma spraying. ISBN 1 898326 24X (£72).

Advanced Surface Coating and Hardness Technologies, edited by O.P. Solonenko and M.F. Zhukov, Institute of Thermophysics, Russian Academy of Science, Novosibirsk. The collection contains selected papers describing the results of extensive research and development studies carried out by Russian scientists in the field of new materials and coating and surface hardening technologies. Each paper describes in detail the experimental results and applications in industry. The book will be of interest to everybody concerned with surface treatment technologies. ISBN 1 898326 35 5 (£70).

Surface Engineering Bulletin

The Surface Engineering Bulletin is a quarterly publication dedicated to the promotion of surface modification technologies. It is neither intended to be as technical as an archival research publication nor as commercial as a trade magazine. Instead, its primary mission is to serve as a link between the various constituencies of the surface engineering industry in an effort to catalyze the advancements in industrial adoption of the surface modification approach. The newsletter will provide an ideal forum for interaction and cross-fertilization between users, jobbers, manufacturers, and researchers. In addition, it will also act as a literature resource and report on various facets of surface engineering.

A number of features have been designed to address the varied interests of a wide spectrum of readers, most of them in response to a survey carried out among the prospective readership. Although not all can be accommodated in every issue of the SE Bulletin, the newsletter will periodically cover the following: (i) *Case Studies* related to surface modification technologies; (ii) *News & Update* on processes, equipment consumables and applications; (iii) *R&D Briefs* concerning exciting news from the laboratories & test beds; (iv) *Technology Watch* featuring recent advances in materials / processes; (v) *Technology Assessment* reports; (vi) *Indian Scenario* of specific technologies, including lists of "Centers of Excellence," jobbers and manufacturers of equipment and feedstock; (vii) *Selected Abstracts* from recent surface engineering patents & literature; (viii) *Conferences Reviews;* (ix) *Problem Page* in a question-answer format; and (x) *Forthcoming Events.*

The annual subscription rates, inclusive of postage and handling, are: Rs. 400 /- (for Indian Subscribers) US$50 (for Foreign Subscribers). Contact: Dr. S.J. Joshi, Surface Engineering Division, Defense Metallurgical Research Laboratory, PO Kanchanbagh, Hyderabad—500 258 India.

Search-in-Print

Bibliographies on Ferrous and Nonferrous Metals and Alloys, Ceramics, Polymers, and Composites. Materials Information (MI) presents the newly updated collection of Search-in-Print titles. Over the years, MI has built up a list of hot topics—those subject areas which generate the most interest among our clients. MI has produced a list of popular bibliographies on these topics, each one containing up to 250 references to journal articles, conference papers, patents, books and reports.

In each Search-in-Print you will find the full details of every item (including the English title, the author(s), bibliographic source and original language) plus, in most cases, an informative abstract (in English) summarizing the contents of the paper. The best feature is that these bibliographies are produced on demand so that you will always be sent the most up-to-date references MI has to offer. Every Search-in-Print comes complete with a subject index and author index. The following 5 Search-in-Print bibliographies would be of interest to the thermal spray community.

Protection of Aerospace Components (Order #Y710) Surface treatments and coatings for wear, thermal, corrosion, erosion and oxidation prevention; commercial, private and military aircraft, space vehicles and/or structures; coating techniques; performance of protected components and coatings; body and structural applications; turbine and engine component protection.

Thermal Spray of Ceramic Coatings (Order #Y715) Spray coating of ceramics onto metals by arc, laser, plasma, and powder methods; equipment, processes and methods.

Plasma Spray Coating of Steels (Order #S703) Spraying of metals, powders, ceramics, and carbides for improved service life and high temperature and corrosion resistance.

Plasma Spray Coating of Nonferrous Alloys (Order #G701) Spraying of metals, powders, ceramics, and carbides for improved service life and high temperature and corrosion resistance. Covers Al, Co, Cu, Ni, and Ti.

Microstructure of Thermal Spray Coatings (Order #Y714) Analysis; effects of substrate characteristics on coating characteristics; alloying effects; and effects on properties including wear and oxidation resistance.

Order from: ASM International, Materials Park, Ohio, 44073-0002, USA. Tel: (216) 338-5151, Fax: (216) 338-4634 or The Institute of Materials, 1 Carlton House Terrace, London SW1Y 5DB, England. Tel: (44-171) 839 4071, Telex: 881-4813, Fax: (44-171) 839 2289. ($95 or £60 per Search-In-Print).

Woldman's Engineering Alloys, 8th Edition

Woldman's Engineering Alloys, 8th Edition, the most comprehensive listing of proprietary alloys in the industry, is now available from ASM International. This 1,400-page volume gives the reader data on the most recently developed alloys as well those that haven't been used in years. It's been completely updated with approximately 1,300 entirely new entries and 10,000 that have been revised. All told, over 55,000 alloys from more than 1,800 companies in 22 countries are detailed. In addition, the full records of 25,000 obsolete alloys from prior editions have been included along with their modern day substitutes and suppliers.

All entries are arranged alphabetically for fast and easy reference. Each includes the manufacturer name so there's no need for cross reference tables. States Bill Scott, Technical Director at ASM, "Ever since this book was published in 1936, almost 50 years ago, it's been recognized as the industry leader. We feel this is our biggest and best edition yet. We haven't changed format; we've just added a lot more information. In fact, this will probably be the last time we'll publish it as just one volume."

Listings for *Woldman's Engineering Alloys*, 8th Edition include: chemical composition, selected properties, main uses, tensile and yield strengths, elongation, reduction in area, and hardness number. Manufacturers are in alphabetical order with new and updated address, phone and fax information thanks to ASM members who helped fill in the missing details. Specification organizations like ANSI, CAD, and the Aluminum Association are also included.

To order *Woldman's Engineering Alloys*, 8th Edition, (ISBN: 0-87170-501-X), contact ASM International, Member Services Center, Materials Park, Ohio 44073-0002. Tel: (216) 338-5151, ext. 900. Fax: (216) 338-4634. Order number 6329NR.

Woldman's—7th Edition Available Electronic Format

Woldman's Engineering Alloys, 7th Edition is now available from ASM International formatted for both Mat.DB and Microsoft Excel. These disks allow the user to make fast and thorough searches of material on the world's principal proprietary alloys. These searches can be done by trade name, manufacturer name, chemical composition, or country of origin.

Although obsolete alloys and their substitutes are not included, the database does cover over 20,000 currently used alloys from 900 manufacturers in 20 countries and includes all the latest updates to the 7th edition. For even further convenience, the manufacturer is listed with each entry. Documentation entails an alphabetical list of manufacturers, their addresses, phone and fax numbers, plus US specification organizations. In some cases the UNS number and material group are provided and may be searchable.

To order *Woldman's Engineering Alloys*, 7th Edition in electronic format, contact ASM International, Member Services Center, Materials Park, Ohio 44073-0002. Tel: (216) 338-5151, ext. 900. Fax: (216) 338-4634.

Five Years of Thermal Spray Information on CD-ROM

Information published on thermal spray applications and developments over the past five years is now available on the SearchMore Thermal Spray CD ROM from Materials Information.

Derived form METADEX and Engineered Materials Abstracts, the CD-ROM is the first in a series of titles covering metals and materials technology. The SearchMore Thermal Spray CD contains over 3,000 abstracts of articles taken from journals, conference proceedings and over 200 patent citations focusing on wire, arc, flame, plasma and other forms of spray coating. Images of full papers are selected from the Journal of Thermal Spray Technology, Advanced Materials and Processes, Metallurgical/Materials Transactions and ASM thermal spray conference proceedings. The CD-ROM serves as an inventory, archive and data-store of thermal spray information from 1989 to 1994.

The CD uses a specially developed MoreCD software, created by Imaginetix, Inc. Three levels of searching are available in the SearchMore Thermal Spray CD. Users can pick from a list of words or key in their own. The software automatically runs an algorithm (Fuzzy Boolean) to rank the retrieved items in the order of their relevancy. This is done by scoring each item based on where the search words occur and how many times they are found. Full images of the articles are available for the users to increase in size for further inspections. The image quality in the SearchMore Thermal Spray CD is comparable to a good photocopy.

A "Quick Search" mode is also available to enter a word, or group of words, which is typical of most on-line and library systems. The CD comes with installation instructions and printed manual and full windows help screens. To use the SearchMore Thermal Spray CD, users must have at least an IBM 486/25 or compatible PC with a double speed CD-ROM drive, 4 MB of RAM and 20 MB of free hard disk space, and preferably with a color monitor.

SearchMore Thermal Spray CD is $495 (North America and other countries), £295 (E.C. countries). To order, contact Ms. Leslie Hayton Chom, ASM International, Materials Information, ASM International, Materials Park, Ohio 44073-0002, USA. Tel: (216) 338-5151, ext. 620. Fax: (216) 338-4634; or Ms. Gill Anderson, The Institute of Materials, 1 Carlton House Terrace, London, SW1Y 5DB, UK. Tel: (44-71) 839-4071. Fax: (44-71) 839-2289.

Internet Journal Service

Internet access to Engineered Materials Abstract and Technology Series, seven titles derived from METADEX, is now available from Materials Information. Subscribers to this service will receive access to the current electronic journal version and the ability to search five years back. Journal titles include Casting, Corrosion Prevention, Heat Processing, Metal Forming, Recycling, Titanium and Welding in the Technology Series. They will be available in the new format, as well as three titles of the Engineered Materials Abstracts database—polymers, ceramics and composites.

These titles will join 35 other science and technology databases currently on Cambridge's Internet Gopher which recently was awarded the Information Industry Association's "Hot Shot Award" for this innovative service. Each available title or database contains an archive of over 6,000 records highlighting important published literature on the topic. Full abstract summaries, citation details and index terms are searchable and printable.

To use this service, subscribers need full access to the Internet (TCP/IP access) and WAIS client-server software. Free copies of Cambridge Scientific's preconfigured WAIS client-server software will be supplied as part of the "sign-on" process. For subscriber convenience, the Technology Series and Engineered Materials Abstracts (EMA) titles are priced as print plus electronic access and electronic access only. EMA (polymers, ceramics, composites) in print and electronic form is $1340; EMA single title in electronic form is $495; and Technology Series single title in print and electronic form is $155.

For more information about subscribing to this new service contact, Ms. Leslie Hayton Chom at Materials Information, ASM International, Materials Park, Ohio 44073-0002, USA. Tel: (216) 338-5151, ext. 620. Fax: (216) 338-4634.

News from the National Science Foundation[1]

Plasma Progress Presents Possibilities for Pummeling Pollution

Imagine a small magic box which, attached to the bottom of every bus, truck and automobile, could take in toxic gas and convert all that blue and brown smoke to clean air.

Scientists and engineers are advancing toward this goal with studies of how to use plasma physics to eliminate some of the worst sources of sickening smog and corrosive acid rain. Years of basic research have provided progressively more understanding of the physics and chemistry of plasmas, a kind of free-for-all cloud of electrons, ions, neutral atoms and molecules all slamming into each other and interacting with other atomic particles in the environment. Glowing neon lights, bursts of lightning, crackling static electricity and the flash from an engine's spark plugs are all plasmas in action.

Plasma remediation was identified as a promising technology for treating contaminated gas streams and air at the First International Symposium on Advanced Oxidation Techniques in 1993, sponsored by the National Science Foundation (NSF) and the Electric Power Research Institute. This is because plasmas do more than sparkle; they cause a blizzard of chemical reactions. Many university researchers are now investigating whether plasma-powered chemical reactions can help cut belching diesel fumes.

"The challenge is to develop plasma generators that will convert toxic emissions into benign or more treatable products quickly, safely and economically," says NSF-funded engineering professor Mark J. Kushner of the University of Illinois, Urbana, Champaign, who is developing computer models to determine how well plasma generators can do the job. He is collaborating with researchers at Los Alamos National Laboratory and the University of Southern California to validate the models which industry could adopt to design practical manufacturing systems.

"Advances in computer modeling of plasmas have saved some industries such as lighting and microelectronics months and possibly years of trial-and-error manufacturing design," Kushner says. "We hope to transfer that technology to using plasmas for solving environmental problems."

Catalytic converters for automobile gasoline engines process toxic compounds such as nitrous oxides into harmless gases. In diesel engines the conversion isn't complete because particles and unburned hydrocarbons in diesel engine exhaust can dirty the surfaces of conventional catalytic converters. Kushner's work aims to finish the task by processing the toxic gases using a plasma directly in the exhaust.

In a plasma generator, high voltage from a vehicle's generator passes into a metal cylinder by way of an electrode. Kushner is using his computer models to find the right combination of factors—variables such as voltage, electron acceleration and electrode dimensions—to create a burst of free electrons that can lock and unlock chemical bonds and disarm emissions. Plasmas for truck exhaust must be economical, Kushner says, because calculations indicate that if more than 10 percent of a truck's engine power is needed to run a plasma generator, engineers are better off redesigning the engine.

Other industries are already generating plasmas to reduce toxic emissions and recycle captured compounds. In coal burning power plants, for example, nitrogen oxides can be split up and reformed as nitrogen, oxygen and nitric acid. The nitrogen and oxygen can be released safely into the atmosphere while the nitric acid can be combined with ammonia to make fertilizer.

A more difficult challenge is how to safely convert large volumes of fumes emitted by chemicals used by, for example, dry cleaners and auto body shops. Here the chemical conversions within the plasma are more complex and volatile. Improvements in plasma research also are important to the semiconductor chip industry, which use plasma generators in manufacturing. Better computer simulations of plasma technology could lower the cost of producing computers, microwave ovens, cellular phones, fax machines and hundreds of other products that depend on computer chips to operate.

Contact: George Chartier, Tel: (703) 306-1070

New NSF Center to Improve Environmental Decision-Making

The National Science Foundation has announced the award of $5 million to the Joint Institute for Energy and Environment (JIEE) of the University of Tennessee to create a National Center for Environmental Decision-Making Research. The center is intended to improve the environmental decision-making process in both the public and private sectors by making scientific environmental research more relevant and useful to decision makers.

"Public support for protecting the environment continues to be strong, and there is widespread agreement that past environmental legislation and regulation have been effective in correcting and preventing environmental problems," said Bill Butz, NSF's division director for social, behavioral and economic research. "At the same time, both critics and supporters of past policy are struggling to define new directions for environmental policy that will be effective, but less burdensome and more affordable. This center will be an important resource in this ongoing process."

The award to JIEE—a collaboration of the University of Tennessee, Oak Ridge

1 The reports in this section have been adapted from NSF news releases.

National Laboratory, and the Tennessee Valley Authority — is for $1 million per year for up to five years. The center will be directed by environmental analyst Milton Russell, head of the JIEE and a former assistant administrator of the Environmental Protection Agency.

Russell will lead interdisciplinary research teams representing economics, urban planning, policy analysis, sociology, geography, mathematics, ecology, psychology, political science and computer science. The teams will synthesize existing research, perform case studies, assemble a "toolkit" of processes and techniques, and design an information system for decision makers.

The center will increase understanding of how environmental decisions are made. "Public, not-for-profit and private organizations regularly make decisions that affect and are affected by the environment," explained Butz. "We need to understand better the processes that produce these decisions, and thus learn how to encourage the desirable ones. This coordinated, multidisciplinary and long-term research effort can help answer that need."

Advanced Materials and Processing Program (AMPP)

With the changing focus of industrial research, it has become increasingly important that our nation's universities perform the basic research needed for the longer term. To meet that challenge effectively, the interactions between the researchers in our universities and their counterparts in industry need to be strengthened, and approaches need to be developed to ensure that the new knowledge generated is made available to those who can use it in a timely manner.

Several examples of promising areas of materials research in the AMPP of NSF are (i) nanostructures, (ii) electrochemical cells for energy conversion and (iii) high temperature superconductors.

Nanostructures: The first transistors were made of bulky pieces of semiconductor materials and wire, millimeters to centimeters in size. Today's transistors used in integrated circuits are less than one micron in size, or roughly ten thousand times smaller. It is anticipated that transistors in the not too distant future will be ten times smaller still, and then even perhaps one hundred times smaller. This progress in reducing the size of devices allows more of them to be placed on a chip, which increases the functionality of the integrated circuit, allowing at one time the greatly reduced cost of computing and communications. Indeed, the greater than two-fold increase per year of components in a silicon chip, often referred to as "Moore's Law", has provided unparalleled economic impetus that has allowed the development of multi-megabit memories from single transistors in less than fifty years.

At present, commercially produced transistors have minimum feature sizes of less than 1 micron (1000 nanometers). In research laboratories, the production of structures with dimensions between 100 to 500 nanometers is commonplace; devices with even smaller dimensions have been made.

The objective for the next 5-10 years is to establish reliable, reproducible means of fabricating arrays of uniform structures with dimensions of 10 to 100 nanometers. Important fundamental properties of these structures should be established, and the implications of these properties on device performance should be investigated. Development of the fabrication techniques needed will require both new fabrication tools and new strategies, such as the utilization of "self-assembling" structures.

The objective for the next 20 years is to continue to develop fabrication and characterization techniques for structures at yet smaller sizes: dimensions 1 to 10 nanometers in an integrated approach, with the parallel development of circuit architectures that take advantage of the unique properties of these nanostructures, and go beyond the computing strategies currently used.

Scientific understanding of nanostructures, or more broadly, the land where the size of devices approaches atomic dimensions, is essential if past progress in information age technology is to continue. Individual devices must be made smaller and be more closely packed in order to continue the growth in complexity and functionality of microelectronic circuits, at lower cost. The impact of continued scaling down in size and increase in density needs to be understood, and new strategies for reliable fabrication, and ultimately manufacture, must be developed. Moreover, qualitatively different electronic, optical and structural properties will characterize these nanostructures, and these may be utilized in new device schemes and circuit architectures. Research in this area will have impact in every part of the economy, already dominated by the technology of the information age.

Electrochemical Cells for Energy Conversion: Conventional power plants and road vehicles use air-polluting heat engines. Clean, silent, and controlled combustion of fuels to produce electric power may be performed electrochemically. Conversely, electrolysis cells use electric power to obtain value-added chemical products including fuels such as hydrogen from water. A fuel represents stored chemical energy; long-term energy storage is a basic requirement for the emergence of alternate energy technologies.

Electrochemical energy conversion has not been competitive with the heat engine for power plants and road vehicles because materials problems have limited the efficiency of generating high power and the convenience or speed of recharge. However, concerns over air pollution and our growing dependence on foreign oil have stimulated a fresh look at the materials problems, which have been highlighted by unsuccessful attempts to find engineering solutions around them. The relatively inexpensive search by a few individuals for new materials is now beginning to bear good fruit, and a flowering of renewed interest in electrochemical processes has begun. However, a fundamental focused effort in advanced materials and processing is needed to sustain the movement in this field.

An electrochemical cell contains two metallic electrodes separated by a "separator" saturated with a liquid electrolyte; a solid electrolyte also acts as the separator. The electrolyte is an electronic insulator, but a good conductor of the "working ion" of the cell. During operation, an ionic current through the electrolyte inside the cell must match the electronic current passing between the electrodes through an external load where useful work is performed. The electrons and working ions are supplied by chemical reactions occurring at the electrode- electrolyte-reactant interface.

High-temperature fuel cells would use oxide-ion electrolytes; unfortunately these solid ceramics require operation temperatures greater than 800 °C, whereas the protonic conductors are restricted to lower temperatures less than

100 °C, where fuel-cell reactions at an interface tend to be slower than desired. There is a clear need to develop electrolytes supporting fast proton or oxide-ion conduction at intermediate temperatures. Nevertheless, the recent design of a superior oxide-ion ceramic electrolyte now makes feasible the development of a high-temperature fuel cell for stationary power generation. The development of a room-temperature fuel cell capable of powering road vehicles with a liquid fuel must await the identification of an anode material capable of catalyzing a sufficiently rapid oxidation of liquid methanol; at the present time, room-temperature fuel cells use pure hydrogen gas as a fuel. Fostering long-term research to develop a catalytic anode for methanol oxidation would prove to be a significant strategic- research objective.

High Temperature Superconductors: The importance of fundamental materials research, in which scientists and engineers are supported to investigate new families of materials, can be demonstrated most easily by pointing to the serendipitous discovery of high temperature superconductors. The two scientists, Bednorz and Muller, had begun research (with little management support!) to determine the ferroelectric properties of oxides. Although their particular interest was in ferroelectricity, their work resulted in the discovery of superconductivity at temperatures most people considered impossible. In fact, the generally agreed "limit" to the range of superconductivity, say less than 25 kelvin, was soon exceeded by a factor of five. This is an example of how "limits" of current knowledge are often overcome by the discovery of new materials.

The impact of this discovery is already being felt 8 years later, which is a short time compared to the time scale of laser development, for example. Products based on high temperature superconductors are already being sold, and a number of small US companies now employ roughly 400 people in an embryonic industry. Some experts have predicted markets of $150 billion by 2020 for this industry world wide.

Recent Conferences

The First Global Symposium on HVOF Coatings—A Conference Report

by Daniel Greving
The University of Tulsa
Mechanical Engineering Department

The First Global Symposium on HVOF Coatings was held May 17, 1995 in Toronto, Canada. Messier-Dowty in Ajax, Canada and Southwest Aeroservice in Tulsa, Oklahoma organized the meeting with the purpose of introducing thermal spray coatings as an alternative to chrome plating for landing gear components. Recent environmental regulations of chrome plating and the need for improved coating performance in the landing gear industry were the major reasons for conducting the meeting. Emphasis was placed on the HVOF application process for thermal spray coatings. HVOF coating performance is expected to meet or surpass chrome plating performance and have less of an impact on the environment.

The meeting was attended by representatives of the major landing gear manufactures, end users, and thermal spray equipment and consumable manufacturers. Invited speakers presented information on the HVOF thermal spray process and coating materials as well as current research trends in the thermal spray industry. Technical presentations were made by representatives of Thermadyne-Stellite, H.C. Starck, Sulzer-Metco, and The University of Tulsa. The meeting was organized as an open forum where participation from all attendees was encouraged. Input from the various attendees provided a unique opportunity to examine relevant industry issues for chrome plating replacement on landing gear components. Areas of discussion included thermal spray coating material and process selection, environmental advantages of using HVOF coatings instead of chrome plating; and possible fatigue and other performance benefits of using HVOF coatings over chrome plating. The general consensus of the meeting was that thermal spray coatings are the likely coating alternative to chrome plating; however, qualification testing must be performed. The meeting concluded with the participants listing the evaluations required to qualify thermal spray coatings for landing gear applications. The qualification evaluations of most importance include: bond strength, high cycle and low cycle fatigue, residual stress, wear, surface finish, corrosion, and maximum coating thickness.

The First Global Symposium on HVOF Coatings was designed to be a forum for open discussion of chrome plating replacement issues in the landing gear industry. Many important issues were examined, and a clearer understanding of common objectives was achieved It was generally agreed that additional dialog on the subject would benefit all concerned by identifying sources of technical information and joint research opportunities. Therefore, plans for a second Global Symposium on HVOF Coatings are being developed. For additional information on the second symposium, please contact Bruce Bodger of Southwest Aeroservice, 1501 E. 4th Place, Tulsa, Oklahoma 74120.

International Conference on Advanced Materials and Technologies

Several papers of the International Conference on Advanced Materials and Technologies held in Plzen, the Czech Republic on June 13-16, 1995 examined thermal spray technology. The Symposium on Thermal Plasma and Coating Technologies contained the following papers: Thermal Plasma CVD Processes" (E. Pfender, USA), "Structural Aspects of Thermal Spray Coatings" (H. Herman and S. Sampath, USA), "New Development in The Thermal Spray Technologies" (A.R. Nicoll, Switzerland), "A Comparison of Thermal Cycling and Oxidation Behavior of Graded and Duplex PSZ TBC Coatings" (R. Oberacker, G. Grathwohl, and M. Alaya, Germany and J. Musil, Czech Republic), "Plasma Spraying of Alumina" (P. Chraska and J. Dubsky, Czech Republic) and "Intelligent Spray Forming and Robotic Spraying" (B.A. Cleveland, USA).

For information concerning the proceedings, contact: J. Musil, Skoda Research, Ltd., Tylova 57, 316 00 Plzen, Czech Republic. Tel: (42-19) 77-32046, Fax: (42-19) 77-33889.

Case History—Spray Coatings Extend Extruder Screws' Life

Extruder screws that inject plastic into molds are subject to various types of wear, but coating the screws with nickel-base alloy powders applied by spraying at high velocity and high temperature can extend their service life considerably. "We coat the root area (of the screws) for enhanced abrasion resistance and we don't have to chrome plate," says Bosko Milankov of Progress Precision Inc., a screw manufacturer that uses the technique.

Thermal spray coatings have provided solutions to some of industry's toughest surface protection problems for more than 70 years. High-velocity, oxygen-fuel (HVOF) spray delivery systems and new nickel-chromium-tungsten-boron powder alloys used today are two key developments in thermal spraying during the past decade.

Extrusion, a widely used technique in plastics manufacturing, entails the melting and compression of plastic granules fed by the rotation of a screw conveyor into a long barrel to which heat and cold can be applied. The screw drives the plastic through a nozzle or die to form the desired shape. Over time, these extruder screws can suffer from galling, abrasion, general corrosion, and delamination. These types of wear are greatly affected by the type of resin and filler used to make the plastic.

Screw materials are typically low alloy steels such as G41300 and G41400. To achieve the hardness and wear characteristics desired by conventional methods, an alloy steel bar is rough machined to the screw profile. The flights or top part of the threads are coated with cobalt or a nickel-composite alloy containing tungsten carbide while the roots or bottom of the threads are often chrome plated. The screw is then ground and polished. Cobalt and tungsten carbide composites are expensive, however, and blended composites can segregate causing a non-uniform overlay. The chrome plating can also delaminate at the overlay interface. Polishing, too, can leave an irregular, dull, mottled surface.

Those problems are overcome using HVOF spraying techniques and specially formulated composite powders allowing the entire screw to be coated or encapsulated. The HVOF process is a variation of the old flame spray technology in which the metal powder is fed into a spray gun that heats the alloy as it sprays it onto the object being coated. HVOF, however, is an internal, closed combustion process. This allows higher combustion temperatures and pressures providing better heat transfer efficiency to the powder and higher particle velocities. The result is a uniform spray pattern and a controlled deposit chemistry.

New alloy powders such as Colmonoy 88 with 64% nickel contain fine, complex bi- and tri-metallic borides and carbides with a variety of hardnesses, which are precipitated during the spraying therefore becoming an inherent part of the microstructure. The results are an enhanced deposit efficiency and a theoretical density that closely approximates that of the matrix.

(By Jon Bryant and reprinted from *Nickel—The magazine devoted to nickel and its applications*, Volume 10, Number 4, June 1995, p.14.)

News from NASA

Predicting Fatigue Lives of Metal-Coated Nickel-Alloy Parts

The LAYER computer program performs thermomechanical-fatigue-life prediction for coated, nickel-based anisotropic materials. Metallic coatings are routinely used in gas turbine engines to protect hot-section airfoils from environmental degradation. With the addition of the coatings, however, turbine-airfoil-life prediction is complicated because the coatings are primary fatigue-crack-initiation sites. LAYER is intended to provide gas-turbine-airfoil designers with means to accurately project service lifetimes.

Given the differences in thermal expansion and creep between the coating and substrate alloys, nonlinear analysis of the cyclic history of a coating/substrate composite is considered necessary for accurate life prediction. Although nonlinear turbine-airfoil analyses have been executed for uncoated airfoils, the highly nonlinear coating behavior essentially eliminates the possibility of conducting coated-airfoil analyses within an acceptable time frame. LAYER, which implements a simplified structural-analysis technique, has been developed to analyze the nonlinear behavior of such a composite at a predetermined critical location.

The base airfoil material considered is the Pratt & Whitney Aircraft single-crystal alloy PWA-1480. Two different generic types of oxidation-resistant metallic coating are considered. The first, PWA-286, is a low-pressure-plasma-sprayed (LPPS) NiCoCrAlY overlay coating. The second coating is a diffusion aluminide, NiAl, designated PWA-273. Although LAYER has been developed for predicting crack initiation in metallic coated PWA-1480, it can be extended to other materials as well.

Input to the LAYER code can come from any available elastic or nonlinear component cyclic analysis—finite element, boundary integral element, or hand calculation. The LAYER code can readily include the influence of multiaxial loading on crack-initiation life; for example, the biaxial effect of coating/substrate thermal-expansion mismatch that occurs during thermal cycling.

LAYER is written in FORTRAN 77 for IBM PC-series and compatible computers running OS/2 2.1 and Sun-series computers running SunOS 4.x. The program requires approximately 10 MB of disk space for installation and 4 MB of random-access memory for execution. Sample executable codes are included on the distribution medium for IBM PC OS/2 platforms. The source code has been optimized for use under OS/2 with the WATCOM F7732 compiler, v9.5, but requires no modification for compilation under SunOS. Sample test problems and their results are also included on the distribution medium to aid in verification of correct operation. The standard distribution medium for LAYER is a 3.5-in. (8.89-cm), 1.44 MB, MS-DOS-format diskette. Alternate distribution media and formats are available upon request. The contents of the diskettes have been compressed by use of the PKWARE archiving software tools. The utility software to unarchive the files, PKUNZIP.EXE v2.04g, is included. This version of LAYER was released to COSMIC in 1994.

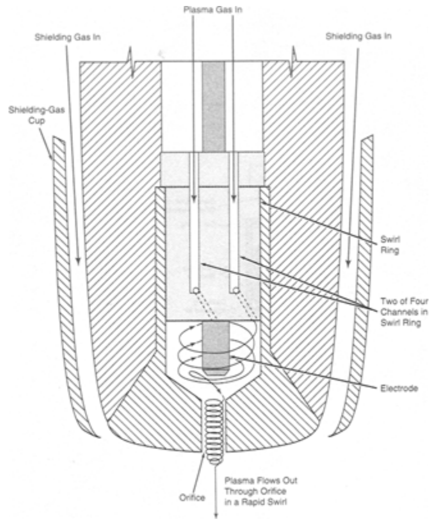
Reprinted from NASA Tech Briefs, 19[6] (June 1995) p. 70. This program was written by Michael A. McGaw of Lewis Research Center and D.M. Nissley of United Technologies Corp. Contact Walter Kim, Tel: (216) 433-3742, e-mail wskim@lims01.lerc.nasa.gov. Reference code LEW-15967.

Swirl Ring Improves Performance of Welding Torch

A plasma-arc welding torch has been modified to create a vortex in the plasma gas to focus the arc into a narrower and denser column. The modified torch can be used in both keyhole and non-keyhole welding modes.

The modification consists in the addition of a swirl ring inside the torch, as shown in the figure. The swirl ring contains four channels, and it surrounds the welding electrode so that gas that flows along the electrode is forced to flow along these channels. Angled holes at the downstream end of the channels cause the gas to flow out with a swirling motion, forming the desired vortex.

The vortex results in a narrower and more nearly symmetrical weld bead and a narrower heat-affected zone than are contained in conventional plasma arc welding without the vortex. Degradation of the electrode and orifice is more uniform with the vortex welding arc, and the need to rotate the torch during operation to compensate for asymmetry in the arc is reduced or eliminated.



The Swirl Ring contains four channels with angled exit holes to force gas to swirl as it flows out of the torch past the tip of the electrode.

Reprinted from NASA Tech Briefs, 19[6] (June 1995) p. 78. This work was performed by William F. McGee and Daniel J. Rybicki of Martin Marietta Corp. for Marshall Space Flight Center. Contact: Harry Craft, Tel: (800) USA-NASA [(800) 872-6272] or E-mail susan.van.ark@msfc.nasa.gov. Reference code MFS-28828.

Improved Growth of Diamond Films from Oxyacetylene Torch

Two modifications have been proposed to improve the nucleation and growth of diamond films on surfaces by use of an oxyacetylene torch. In one modification, carbon monoxide would be added to the fuel gas; in the other modification, carbon monoxide, methane, and oxygen would be added in synchronized pulses. The second modification is intended not only to improve the nucleation and growth of diamond films but also to make those films more nearly homogeneous over areas larger than the spots of such film grown by the oxygen/acetylene-growth technique that has been used until now. The modified technique is expected to enable deposition of diamond films on alternative materials, in particular, copper.

Heretofore, oxygen/acetylene growth of a diamond film has been effected by orienting an oxyacetylene torch above a substrate of silicon or molybdenum, controlling the temperature of the surface of the substrate, and maintaining the ratio of acetylene to oxygen in the general range of 0.85 to 1.02. In the best case, this produces a spot deposit that consists primarily of diamond in the center, but the proportion of carbon in nondiamond forms increases with distance outward from the central region. This radial distribution prevents the use of oxygen/acetylene growth to produce continuous diamond coats because the nondiamond carbon is deposited on the surface prior to the deposition of diamond.

Both modifications are expected to increase the rate of nucleation and the rate of growth of diamond. Preliminary experiments indicate that the first modification (the simple addition of CO) increases the number of nucleation sites of diamond deposits and improves the quality of the deposits. The second modification (pulsed, synchronized additions of CO, CH_4, and O_2) is expected to remove nondiamond carbon and increase the nucleation of diamond, thereby promoting the growth of larger, more nearly homogeneous (and, perhaps continuous) diamond films.

Reprinted from NASA Tech Briefs, 19[7] (July 1995) p. 56. This work was performed by Floyd E. Roberts III of Marshall Space Flight Center. No further documentation is available. Contact: Harry Craft, Tel: (800) USA-NASA [(800) 872-6272] or e-mail susan.van.ark@msfc.nasa.gov. Reference code MFS-28838.

Product Information

Quebec Metal Powders Limited Expansion

Quebec Metal Powders Limited (QMP), a leading producer of iron and steel powders, has announced expansion plans covering three key areas: production, products and technology. QMP's blending capacity will increase with the addition of a 45,000 pound, high-tech blender that was put into operation in September 1995. Also, the powder production capacity will increase by 30% with the addition of an annealing furnace which will be commissioned in April 1996, bringing QMP's total powder producing capability to 151,000 tons per year.

A new line of patented binder-treated mixes will be introduced. Manufactured with the new state-of-the-art blender, these blends will be marketed under the trade name FLOMET. The main attributes of these environmentally-friendly products are improved productivity and quality through better flow rate and superior consistency. Furthermore, QMP is introducing a new composite material that has been designed specifically for use in soft ferromagnetic applications.

Contact: Karen Adams, Box 570, Sorel, Quebec, Canada J3P 5P7. Tel: (514) 746-5050. Fax: (514) 743-0223.

Air Products Facilities Achieve ISO 9002 Certification

Air Products and Chemicals, Inc. epoxy additives manufacturing and blending facilities in Los Angeles and Huntington Beach, California have received ISO 9002 certification under the International Organization for Standardization quality management system. This is the ninth certification Air Products Chemicals Group has received, and the second it has received for its epoxy additives business. The other ISO 9002 epoxy additives certification was received by the company's Clayton, UK facility in 1994. The Los Angeles, Huntington Beach, and Clayton facilities produce epoxy additives and blends that are used in the manufacture of coatings, flooring, adhesives, composites, and electrical laminates.

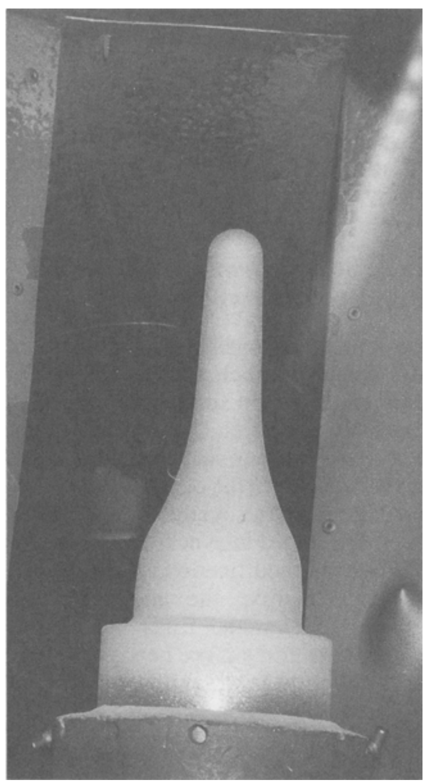
In addition to epoxy additives, Air Products $1.2 billion chemicals business includes polymer emulsions, polyvinyl alcohol, polyurethane chemicals, performance and specialty additives, amines and industrial chemicals. Air Products is also a major international supplier of industrial gases and related equipment, and environmental and energy systems. A Fortune 500 company, Air Products has annual sales of $3.5 billion, operations in 30 countries, and 13,300 employees worldwide.

Contact: Deborah A. Bauer, Air Products and Chemicals, Inc., 7201 Hamilton Boulevard, Allentown PA 18195-1501. Tel: (610) 481-8061.

Glass Plungers Last Longer with Unique HVOF Coating

Glass mold plungers last longer with overlays of Colmonoy 88 applied by the high-velocity oxygen fuel (HVOF) process. Colmonoy 88, manufactured by Wall Colmonoy Corporation (Madison Heights, Michigan), is a patented nickel-based hard-surfacing alloy composed of bi- and tri-metallic borides for maximum abrasion and corrosion resistance. The borides are uniformly distributed throughout the alloy matrix and are much finer than those contained in conventional composite alloys. This prevents particle pull-out and premature erosion, thus achieving and maintaining a superior finish. The smooth, porous-free coating enhances the quality of the glass produced and increases the service life of the plunger.

Contact: Tanya Anandan, Marketing Communications Manager, Wall Colmonoy Corp., 30261 Stephenson Hwy., Madison Hts., MI 48071, Tel: (810) 585-6400, Fax: (810) 585-7960.



WCC-1012: A glass mold plunger receives a HVOF-applied coating of Colmonoy 88 alloy before fusing and machining.

Wall Colmonoy Enhances Multi-Element Analysis Capability

Wall Colmonoy Corporation (Madison Heights, MI) has recently installed a Perkin-Elmer graphite furnace atomic absorption spectrometer (GFAA) to enhance its laboratory testing capabilities. The spectrometer allows Wall Colmonoy to detect exceptionally low limits, down to parts per billion, of nickel, selenium and chromium. GFAA testing services are available on a contract-basis.

Contact: Tanya Anandan, Marketing Communications Manager, Wall Colmonoy Corp., 30261 Stephenson Hwy., Madison Hts., MI 48071, Tel: (810) 585-6400, Fax: (810) 585-7960.

PSP of India

Plasma Spray Processors (PSP) continues to develop new coating and finishing procedures for tomorrows demand. Contact: Plasma Spray Processors, B-16-18 Noble Chambers, Janmabhoomi Marg, Bombay - 400 001. Tel: 2870192. Telegram: COATPLASMA Telex: 011-93024 PSP IN, Fax: 2870226.

Progressive Technologies

Progressive Technologies, in conjunction with Flow International, has manufactured and installed a Ultra High Pressure Waterjet Cleaning Cell in Europe. The system was designed, manufactured and installed for KLM Royal Dutch Airlines and will provide KLM with the most sophisticated Thermal Spray Coating Removal capability in all of Europe.

This new cleaning cell features: stainless steel lined enclosure, 4 axis gantry robot, CNC control, flow 20XD 55,000 psi intensifier pump, PRIMS process control software, PRIMS automated maintenance software, and closed-loop water filtration.

Sermatech Receives NADCAP Approvals

Two Sermatech facilities have been accredited through the National Aerospace and Defense Contractors Accreditation Program (NADCAP); one for heat treating, the other for non-destructive testing.

Sermatech Klock, in Manchester, CT, is NADCAP accredited for heat treating a range of materials, including aluminum alloys, beryllium copper, cast irons, nickel and cobalt alloys, magnesium alloys, refractory metals, stainless and PH stainless steels, steels, titanium alloys, magnetic irons, and copper alloys. This accreditation covers vacuum and induction heat treating, furnace and induction brazing, and cryogenic (sub zero) treatments. The facility also is accredited for metallography and hardness materials testing to support its heat treating efforts.

The company's plant in Biddeford, ME received accreditation for fluorescent penetrant nondestructive testing.

NADCAP is a quality auditing process that is industry driven. Working together, prime contractors, suppliers, end-users and governmental authorities identify and verify the highest quality standards that are acceptable and desirable for a variety of production disciplines. Prime contractors and suppliers benefit from the cost and time savings inherent in a "one-audit, one-time" accreditation process. Prime contractors also benefit from a predictable quality level from suppliers that are NADCAP accredited.

To achieve NADCAP accreditation, the methods and documentation for each discipline were audited at both facilities. These audits were conducted by the Performance Review Institute (PRI), the independent trade association which administers NADCAP. PRI reported the results of its audits of both facilities to the NADCAP council which is comprised of representatives of the participating prime contractors. The council then approved the Sermatech facilities for the audited disciplines.

For more information about Sermatech Klock's NADCAP accreditation for heat treating, contact Phil Nichols Tel: (203) 646-0700. For more information about Sermatech Maine's NADCAP accreditation for fluorescent penetrant inspection, contact Fred Boorman Tel: (207) 282-3787. (Reprinted from Sermatech Review, Number 52, Summer 1995.)

Associations and Companies

Thermal Spray Technology Center

The Oak Ridge Centers for Manufacturing Technology (ORCMT, Tennessee, USA) has extensive thermal spray and materials characterization capabilities available for materials development, process optimization, and manufacturing development. The Thermal Spray Technology Center objectives are to validate and demonstrate applications for coatings and monolithic parts, to infuse cutting edge technology into domestic industry, to conduct exploratory coating technology research while supporting government projects, and to develop coating materials applicable to industrial needs.

The Thermal Spray Technology Center has a wide range of capabilities, including a robotic closed-loop-controlled plasma/HVOF spray system, a robot controlled HVOF system, a power-turn lathe plasma spray system, glove box plasma spray systems, an oxy-acetylene flame spray system, a wire-arc spray system, a low-pressure/positive pressure plasma spray system, and powder handling and surface preparation capabilities.

The Center offers opportunities to provide solutions for R&D, demonstrate prototypes, train customers, and provide "hands-on" technology transfer. It provides teaming opportunities for sharing resources and technologies; enhancing materials development; allowing cost-effective manufacturing development; integrating and validating enabling technologies; and improving American industry.

Contact: Roland D. Seals, Ph.D., Technical Manager, Thermal Spray Technology Center, Oak Ridge Centers for Manufacturing Technology, PO Box 2009, MS 8039, Oak Ridge, TN 37831. Tel: (615) 574-0936; Fax: (615) 574-9407.

The United States Advanced Ceramics Association

The United States Advanced Ceramics Association (USACA) is a national trade association, formed in 1985, "to advance and commercialize the United States advanced ceramics industry, improve advanced ceramic products and in other ways better serve the interests of the United States advanced ceramics industry."

The USACA mission is to foster the development and to accelerate the commercialization of advanced ceramics technology by advocating government support of industry-led research and development efforts, identifying and cultivating commercial market opportunities, and proactively educating industry at large and the general public regarding technical and societal benefits of advanced ceramics.

To this end, USACA strategic objectives are: represent the United States advanced ceramics industry before federal agencies and Congress; promote industry market expansion initiatives; and act as the industry clearing house and highway for advanced ceramics information.

Led by the Board of Directors, USACA is engaged in promoting the interests of the United States advanced ceramics industry through the work of three standing committees and their working groups. Contact: USACA, 1600 Wilson Boulevard, Suite 1008, Arlington, VA 22209. Tel: (703) 812-8740; Fax: (703) 812-8743.

Project on Thermal NDT Techniques

Thermal sprayed coating quality is normally assessed by carrying out destructive tests, such as micrographic sectioning, or standard pull tests on coupons manufactured prior to the production coating process. There are relatively few organizations that routinely carry out non-destructive testing (NDT) of thermal sprayed coatings as part of their quality chain. The transient thermal NDT technique, also known as pulsed video thermography, is believed to be a practical means of providing a rapid, non-contact primary NDT technique for measuring the quality of thermal sprayed coatings. The principal aim of this project will be to develop it from a high-tech, expensive and laboratory based system, to one which is more simple, relatively inexpensive and PC based for use in the production environment.

Contact: The Welding Institute, Abington, Cambridge CB1 6AL, United Kingdom. Tel: (223) 891162; Telex: 81183 WELDEX G; Fax: (223) 892588.

Awards at ITSC'95—Kobe, Japan

The following Best Paper Awards were presented at the Banquet of the 14th International Thermal Spray Conference on 24 May, 1995, in Kobe, Japan.

- "Development of Brazing Method with Thermal Spray", T. Nakano, R. Uchino and T. Kusano, Aisin Seiki Co. Ltd., Japan.
- "Development of Self-Cleaning Coatings on Hearth Rolls in High Temperature Annealing Line", S. Midorikawa, Y. Sato, S. Matumoto and M. Ito, Kawasaki Steel Co., Japan.
- "Failure Analysis of Some Plasma Spray Coated Superalloy Systems Subjected to the Synergistic High Temperature Damages in Actual Gas Turbine or in Laboratory", M. Yoshiba and T. Aranami, Tokyo Metropolitan University; H. Taira, Nippon Steel Corporation; and Y. Harada, Tocalo Co., Ltd., Japan.
- "Electrochemically Active Thermal Sprayed Coatings for Water Purification Systems", Y. Borisov, A. Murashov, A.Iienko, and V. Balakin, E.O. Paton Electric Welding Institute; and V. Slipchenko, A. Slipchenko and V. Maksimov, Research Institute Kommuneconomika, Ukraine.
- "Hollow Cathode Plasma Spray Stabilized by an Applied Magnetic Field", A. Notomi and Y. Takeda, Mitsubishi Heavy Industries, LTD., Japan.
- "New Performance for HVOF Thermal Spraying Systems with the Use of Natural Gas", Y-M. Yang, H. Liao and C. Coddet, LERMPS—Institut Polytechnique de Sevenans, France.
- "Splat Behavior of Plasma Sprayed Particle on Flat Substrate Surface", M. Fukumoto, S. Katoh and I. Okane, Toyohashi University of Technology, Japan.
- "Calculation of the Limiting Parameters for the Oxide Ceramics Particle during HVOF Spraying", V. Kadyrov, Y. Evdokimenko, and V. Kisel, Institute for Materials Science, Ukraine and E. Kadyrov, University of Wisconsin, USA.
- "Crack Structures in Plasma Sprayed Thermal Barrier Coatings as a Function of Deposition Temperature", P. Bengtsson and J. Wigren, Volvo Aero Corp., T. Johannesson, Lund University, Sweden.
- "Sealing and Strengthening of Plasma-Sprayed ZrO_2 Coating by Liquid Mn Alloy Penetration Treatment", A. Ohmori and Z. Zhou, Advanced Materials Processing Institute Kinki; K.Inoue and K. Murakami, Osaka University and T. Sasaki, Taiyo Engineering Co., Ltd., Japan.
- "Synthesis of Chromium Nitride In Situ Composites by Reactive Plasma Spraying with Transferred Arc", Y. Tsunekawa, M. Okumiya and T. Kobayashi, Toyota Technological Institute, Japan.
- "Adhesion of Thermal Sprayed Coatings: a Model for the Interface Indentation Test", J. Lesage, P. Demarecaux, D. Chicot and G. Mesmacque, University des Sciences et Technologies de Lille, France.
- "Self Propagating High Temperature Synthesis (SHS) of Thermal Spray Powders", R.W. Smith and M. Mohanty, Drexel University; E. Stessel, Exotherm, USA and A.Verstak, P/M Association of Belarus, Belarus.
- "Effect of Nitrogen Atomizing Gas on Coating Properties in Wire Arc Spraying", X. Wang, D. Zhuang, E. Pfender, J. Heberlein and W. Gerberich, University of Minnesota, USA.

AWS Fellowships

The American Welding Society (AWS) and the Welding Research Council (WRC) seek to foster university research in joining and to recognize outstanding faculty and student talent. Each of these two organizations has its own programs to channel funding into graduate research programs at universities. In recent years, AWS and WRC have coordinated their award programs and have made their respective selections based on responses to a joint Request for Proposals. AWS and WRC are again requesting proposals for consideration.

Contact: Dr. Martin Prager, Executive Director, The Welding Research Council, Inc., 345 E. 47th Street, New York, NY 10017.

People in the News

Malik Receives US-EPA Award

Dr. Mohinder P. Malik of the Material and Process Technology Division of Deutsche Lufthansa AG has received an award from the United States Environmental Protection Agency. He was one of 50 individuals and organizations from 10 countries to receive this honor in recognition of exemplary efforts to protect the ozone layer.

Kratochvil of TAFA Promoted to Vice-President

William R. Kratochvil, formerly the Director of Research and Development at TAFA Incorporated, has been promoted to the position of Vice President and General Manager. Just ask Bill why he's smiling: "We have the best of all worlds here. Products that have been under development are being introduced, and received, like wildfire. We have a synchronicity with perfected products and the introduction of new developments. The results will double our product line and sales," says Bill. The numbers speak for themselves: TAFA had a 40% increase in personnel and a 30% annual sustained growth in sales over recent years.

"We're in the middle of a dynamic growth phase," says Bill, "With our newly formed partnership with E+C (Switzerland), worldwide markets have opened in over 100 countries." With the international market now being visited, a bright future of international growth awaits TAFA. Bill, who holds degrees in physics and mathematics from the University of Wisconsin and an MBA from Indiana University, signed on with TAFA in February of 1987 as the Marketing Manager of the Plasma Division. Responsible for the delivery of numerous high tech systems, he was quickly promoted to the position of Technical Services Manager. In his most recent position as the Director of Research and Development, Bill's projects, including much of the original work on the environmentally sound Waterjet Coating Removal System, are primarily responsible for TAFA's dynamic growth. "TAFA wouldn't be the company it is without team work and fresh ideas at all levels," says Bill, pointing out excellence at all levels in the growing organization.

A wholly owned subsidiary of the Swiss based Eutectic + Castolin Group, TAFA is the high technology thermal spray company, providing thermal spray coating equipment and materials for a variety of industrial applications. Originated in the mind of inventor and visionary Merle Thorpe nearly 30 years ago, TAFA has grown to two buildings in Concord, NH with late 1995 expansion plans. Their product line has expanded to coating removal systems, high power plasma systems, RF plasmas, HVOF thermal spray, twin wire arc and complete automation capabilities.

Contact: Joan Rich, TAFA Incorporated, Concord, New Hampshire 03301. Tel: (603) 224-9585, Fax: (603) 225-4342.

Lech Pawlowski Joins Universite D'Artois


Dr. L. Pawlowski

Dr. Lech Pawlowski was recently appointed a professor of physics at the University D'Artois in Bethune in northern France. This tenured position will enable him to conduct the research on thermal spraying and laser treatment of ceramics. Lech holds a Masters degree in Electronic Technology and a Ph.D. in Chemistry from the Technical University of Wroclaw (Poland). He pursued his research in the University of Limoges, where he gained a D.Sc. degree in Physics and in the University of Stuttgart in Germany and in the Monash University in Melbourne (Australia). His research activity was closely associated with the application of the coatings in the industry. In fact, Pawlowski developed the ceramic coatings for anilox and corona rolls while at the company W. Haldenwanger (Berlin, German). He also participated in a development of thermal barrier zirconia coating at Centro Sviluppo Materiali in Trento (Italy). Pawlowski has recently published a book *The Science and Engineering of Thermal Spray Coatings* for John Wiley & Sons.

James Walker Named Chairman ITSA

At the annual International Thermal Spray Association (ITSA) Spring meeting, James P. Walker of the F.W. Gartner Thermal Spraying Company (Houston, Texas) was sworn in as the 1995-1996 chairman of the ITSA, replacing past chairman Robert D. Dowell of Plasma Technology (Torrance, California). At the same session, Joseph Stricker of St. Louis Metallizing (St. Louis. Missouri) was sworn in as vice-chairman. ITSA executive board members also include Scott Goodspeed of Miller Thermal (Appleton, Wisconsin), Albert Kay of ASB Industries (Barberton, Ohio), Andrew Muller of Plasma Coating Corporation (Gardena, California), Daniel Parker of Engelhard Surface Technologies & Specialty Products Group (East Windsor, Connecticut) and Gary Ritchie of Bender Machine (Vernon, California).

Mr. Walker has targeted international membership development as a key objective of his term in office. A major membership drive was launched at the Fall 1995 National Thermal Spray Conference in Houston, Texas, where the ITSA staged a series of informative "get acquainted sessions for potential new members. "The goal," says Mr. Walker, is to give non-ITSA companies an opportunity to discuss, in depth, some of the programs and benefits of membership in the ITSA.

Established in 1948, ITSA comprises a select group of coating contractors, suppliers and research organizations. Many members are world-recognized leaders in thermal spray products and technology development. As an organization, ITSA promotes continuing excellence in thermal spray technology through its scholarship programs, by co-sponsorship of thermal spray and other industry events, by contributions to the world body of technical worldwide and by supporting environmental, training and standards programs which raise the level of thermal spray technology worldwide. For information: ITSA Member Services, PO Box 693, Glastonbury, CT 06033 USA. Tel: (203) 657-3440; Fax: (203) 657-2252.

Testing and Characterization—The First Best Practice Challenge

John Sauer
Metcut Research Associates, Inc.
3980 Rosslyn Drive
Cincinnati, Ohio 45209-1196

The thermal spray community is facing the challenge of developing standards and best practices for discipline within the community. Testing and characterization is one of the initial topics which must be addressed in this arena.

This report summarizes the variation in results which can exist in the metallography and tensile test methods for three coatings. The data highlights the substantial need for formulation of best practices and standards in testing and evaluation to provide a true picture of coating characteristics. A call to participate in the ASM TSS sub-committee is made.

Table 1 Preparation schedule for WC-Co (Fig. 1 and 2)

SiC paper	psi/mount(a)	Speed, rpm	Time(b), s
180	5	150	30
240	5	150	30
320	5	150	30
400	5	150	30
600	5	150	30
800	5	150	30
1200	5	150	30

Figures 1 and 2 are epoxy (cold mount) with Al_2O_3 filler. Fig. 1 is polished with napless cloth, 1 μm diamond, extender or water, 5 psi/mount, 2 minutes, 300 rpm. (Apply diamond spray every 20 to 30 seconds.) Fig. 2 is polished with high nap cloth, 0.3 μm Al_2O_3, water, 13 psi/mount, 2 minutes, 150 rpm. (a) This run was loaded with 3 mounts or 15 psi total (70 N) pressure. Head is always rotating at 150 rpm. Rotation of head and table is complimentary. Mounts are loaded into a rack to achieve compression during grinding/polishing. (b) Two (2) papers each.

Table 2 Preparation schedule for TBC-8% yttria-zirconia (Fig. 3 to 6)

SiC paper	psi/mount(a)	Speed, rpm	Time(b), s
180	5	150	30
240	5	150	30
320	5	150	30
400	5	150	30
600	5	150	30
800	5	150	30
1200	5	150	30

Figures 3 and 4 are mounted in epoxy with vacuum impregnation. Figures 5 and 6 are mounted in epoxy using a combination of vacuum impregnation and pressure curing at 1200 psi (air) Figures 3 and 5 are polished with a napless cloth, 0 3 μm Al_2O_3, water, 10 psi/mount, 1 to 3 minutes, 300 rpm. For Fig. 4 and 6, after the Al_2O_3 step, the mounts illustrated in Fig. 3 and 5 were given the additional step of napless cloth, 1 μm diamond, 5 psi/mount, 2 minutes, extender or water, 150 rpm (a) This run was loaded with 3 mounts or 15 psi total (70 N) pressure. Head is always rotating at 150 rpm. Rotation of head and table is complimentary. Mounts are loaded into rack to achieve compression during grinding/polishing. (b) Two (2) papers each.

Introduction

The thermal spray industry faces a number of challenges as we move forward to the year 2000 and beyond. The most formidable issue is that of developing industry-wide best practices or standards. As we move to expand our presence into markets such as the automotive, aerospace, and chemical processing fields, there must be standards for equipment and processing. However, the critical first step is to understand the quality and characteristics of what is transferred to the products. Testing and characterization should be our first best practice challenge with everyone's active participation.

Where Are We Now?

Characterization of thermal spray coatings is performed with many standard metallurgical testing methods; metallography, tensile/bond testing, hardness, erosion, thermal cycling, etc. There are ASTM, aerospace and automotive standards which govern these tests. Why then can we not achieve the same results from different laboratories on a set of thermal spray coupons? This occurs because thermal spray products are not homogeneous materials like metals for which the ASTM standards were written. We are not the only industry battling this dilemma. Our ceramics and composite counterparts have the same prob-

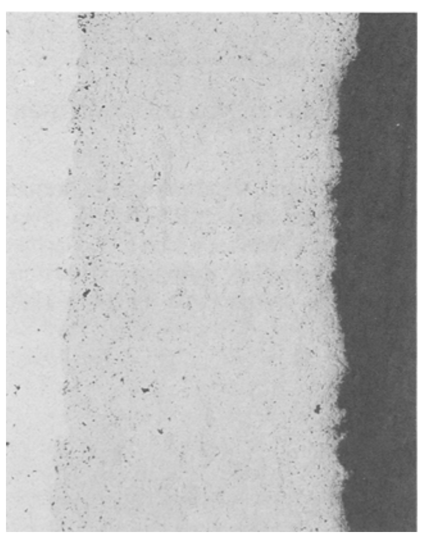


Fig. 1 Tungsten carbide-cobalt (WC-Co) grinding with parameters of Table 1 and 1 μm diamond final polish. (200×, no etch)

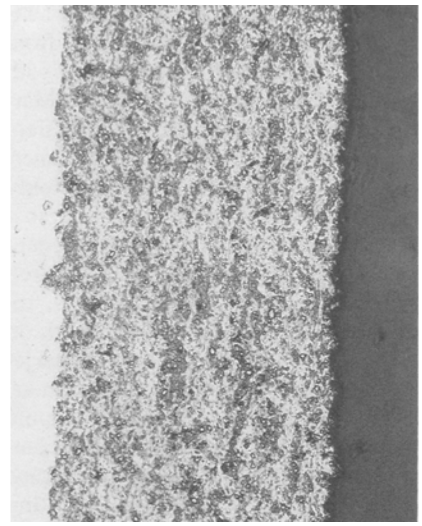


Fig. 2 Tungsten carbide-cobalt (WC-Co), same sample as Fig. 1. Grinding indicated in Table 1 with Al_2O_3 final polish. (200×, no etch)

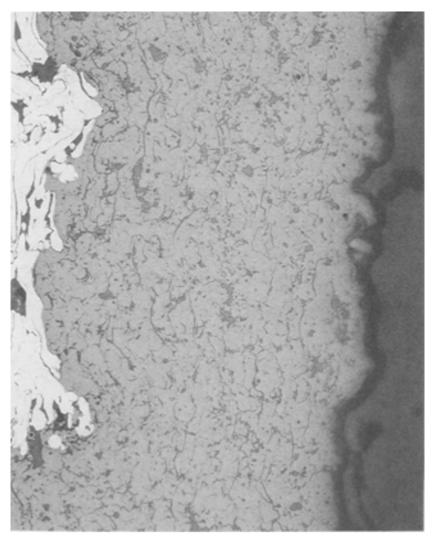


Fig. 3 TBC of 8 % yttria (ZrO_2) mounted in epoxy with no pressure curing. Grinding with parameters of Table 2 and Al_2O_3 final polish. (200×, no etch)

lem. This is not a startling revelation to industry veterans who have wrestled with this situation for many years. There have been very few studies and research on the best methods for evaluation.

Both companies and individuals, spanning the spectrum from powder/equipment suppliers to end users have developed special methods and processes to evaluate their coatings. So who is right or wrong ? Let's review some current coatings and practices used at varied locations/or companies. Tungsten carbide—cobalt (WC-Co) is a common coating used for wear applications in both aerospace and petrochemical industries. Figures 1 and 2 represent the same sample prepared using two different polishing methods. Thermal spray processing history indicated marginal parameter settings for this particular run. Table 1 summarizes the grinding and polishing methods. Which structure is correct?

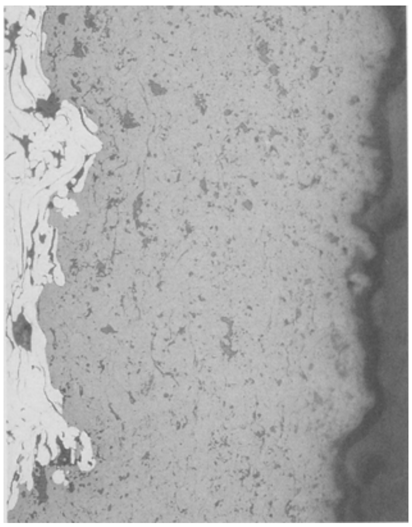


Fig. 4 TBC of 8 % yttria (ZrO_2), same mount as in Fig. 3 but another polishing step of 1 μm diamond after initial Al_2O_3 polish was added. (200×, no etch)

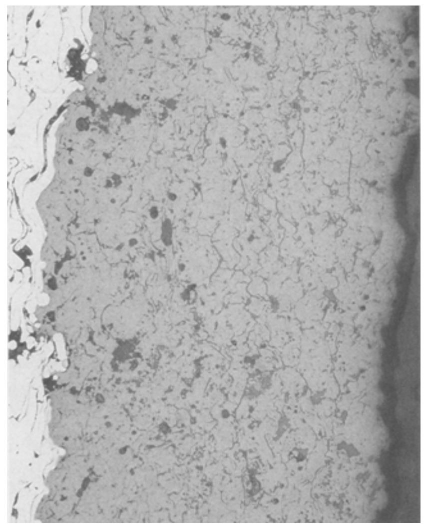


Fig. 5 TBC of 8 % yttria (ZrO_2), mounted in epoxy-pressure curing. Grinding with parameters of Table 2 and Al_2O_3 final polish. This is the same as Fig. 3 with mounting procedure as the only difference. (200×, no etch)

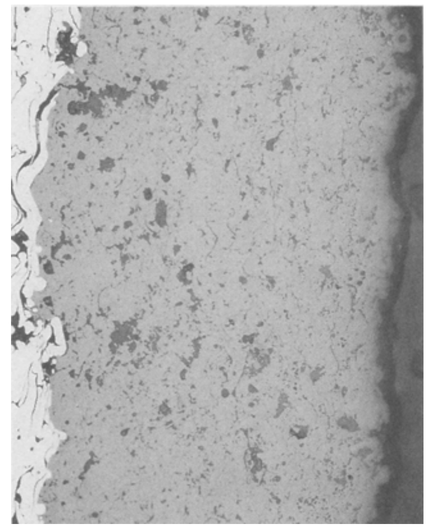


Fig. 6 TBC of 8 % yttria (ZrO_2), same mount as Fig. 5 but another step of 1 μm diamond after initial Al_2O_3 polish was added. (200×, no etch)

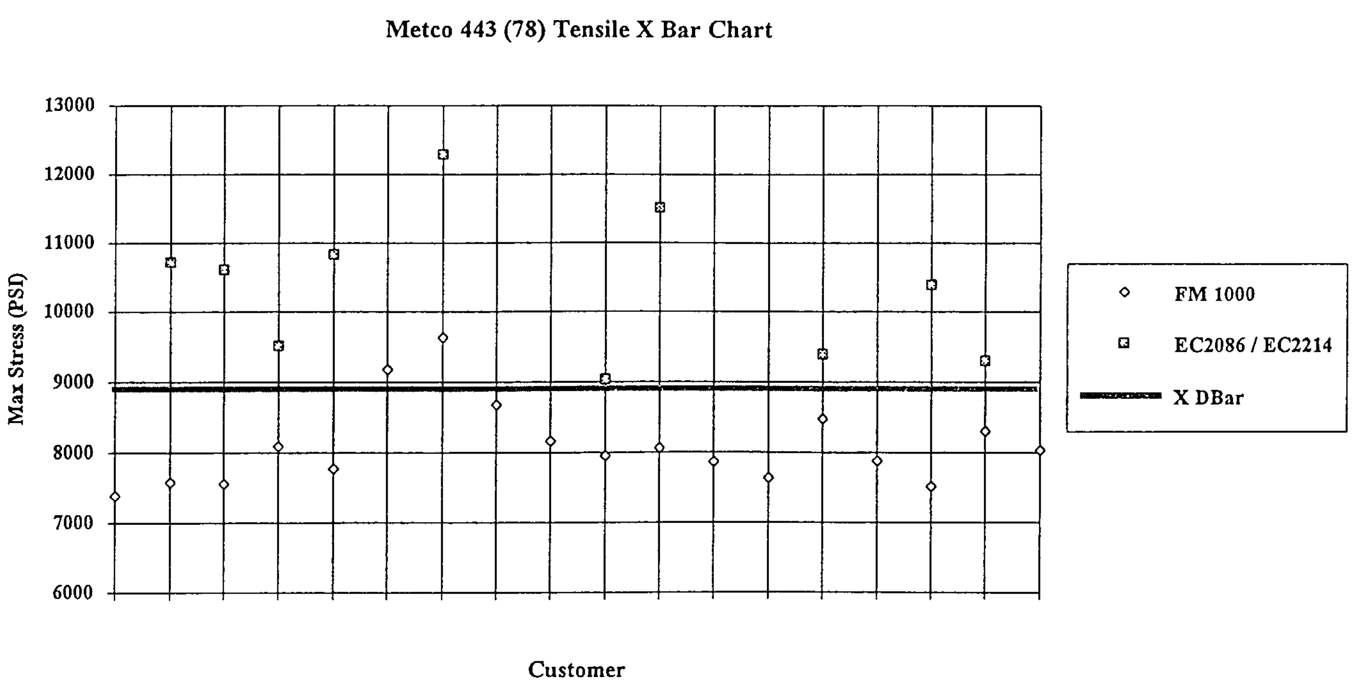


Fig. 7 Metco 443 (78) tensile bar chart.

Figures 3 to 6 represent a combination of mounting and polishing techniques on an 8% yttria-zirconia TBC (see Table 2). Again, thermal spray processing indicated marginal parameter settings for this particular run. Is the coating unacceptable as depicted in Fig. 4 or very dense as shown in Fig. 6? There are newer metallographic methods which rely on the use of coarser diamond and fine grinding steps. How will these changes affect the results of Fig. 1 to 6?

Figure 7 shows tensile testing on a set of buttons for a Metco 443 (NiCrAl) build up coating. Each point on the graph represents an average of 15 buttons cured and pulled at a vendor using film (FM1000) and liquid (EC-2086 or EC-2214) epoxy. What number is correct?

The Testing and Characterization Committee of TSS

To move forward, it cannot be an issue of right or wrong or who is correct. The current situation must be addressed with an attitude that only differences exist in current evaluation techniques. We are all working towards the true structure or the real strength of the coating in question. There can be many variations of a method to achieve the same result.

However, there must be a basic set of principles and methods to achieve the true representation of the coatings. Towards this purpose, we may want to produce *standard* coatings that illicit a known response via RR evaluation similar to Rockwell standard hardness blocks. We could then gather data on "true" test method variation. Whatever the course of action, our efforts must be focused on understanding the differences in the techniques and how various parameters affect the final result.

The testing and characterization subcommittee of the Best Practices, Standards and Specification Main Committee is formulating a plan to address the Best Practice Issue. Your active participation on the committee is welcomed. Please contact the writer if you have an interest in participation.

Acknowledgments

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