In The News

New Literature

CERAC® Catalog for Specialty Materials

The new Specialty Inorganics Catalog from CERAC, Inc. highlights the firm's complete line of specialty inorganic chemicals, metals, alloys, and ceramics. The 30th anniversary, 390-page product reference book also features CERAC's full range of manufacturing capabilities including evaporation materials and sputtering targets.

The catalog includes information on both R&D lots and production quantities. In response to numerous requests for larger quantities, an all new section has been added with special pricing on over 900 items.

Since CERAC is a manufacturer, the new catalog also includes information on the firm's quality control processes including sophisticated analytical testing. Detailed are various operations at CERAC's 100,000 square foot, state-of-the-art manufacturing facility.

Contact CERAC, Inc. to request a free copy of the new Advanced Specialty Inorganics Catalog; P.O. Box 1178, Milwaukee, WI 53201. Tel (414) 289-9800, Fax (414) 289-9805.

Steelmaking and Processing 1993-1994

An international compilation of up-to-date reports for the production of clean and defect-free steels is now available in the *Industry Report, Steelmaking and Processing 1993-1994*. Published by Materials Information, this report provides an organized review of steelmaking research directions, newly-introduced methods and systems and case histories of actual corporate experiences.

Steelmaking and Processing 1993-1994 reviews currently-applied steelmaking processes and plant technology, along with new methods and systems for production analysis, control, and optimization. The report features case histories of actual commercial experiences and production systems designed to produce clean, defect-free steels that meet customer standards and requirements.

Each section of *Steelmaking and Processing 1993-1994* offers easy-to-use tables displaying the corporate sources of the steels that are referred to in the report. These tables serve as a directory to the specific steels cited and to the individual manufacturers, supplier companies, universities, institutes, and associations involved in steelmaking research and commercial enterprise worldwide. The activities of more than 800 corporate organizations are included in *Steelmaking and Processing 1993-1994.*

A PC diskette for the report comes with the print version and includes the entire database of documents in the reference section. The diskette offers expanded search capabilities so the user can search the documents by word or group of words, or to restrict the search to a specific subset of references. This industry report is based on a comprehensive search of the Materials Information Database, METADEX and technical and business-related published literature from January 1993 to September 1994.

To order *Steelmaking and Processing 1993-1994*, $365 ($335 member) US/Canada/Mexico, £200 (£180 member) EC countries, $395 ($345 member) other countries, contact Ms. Debbie Barthelmes, Materials Information, ASM International, Materials Park, Ohio 44073-0002. Tel (216) 338-5151, ext. 532, Fax (216) 338-4634. Or contact Ms. Julie Lee, Materials Information, The Institute of Materials, 1 Carlton House Terrace, London SW1Y 5DB, England. Tel +44(0) 171 839 4071, Fax +44(0) 171 839 2289.

1995 Powder Metallurgy Equipment Directory

The Powder Metallurgy Equipment Association (PMEA) has published a 154-page directory containing catalogs of major suppliers of equipment used to manufacture powder metallurgy (P/M) parts and products and products made from particulate materials.

Technical information is given on P/M compacting presses, tools and dies, sintering furnaces and atmosphere gases, and metal grinding equipment. The directory also includes a 16-page product listing of association members.

For a free copy, contact the Powder Metallurgy Equipment Association, 105 College Road East, Princeton, New Jersey 08540; Tel (609) 452-7700, Fax (609) 987-8523.

Case Histories of Thermal Spray for Infrastructure

The Platt Brothers & Company have published an 8-page brochure on "Thermal Spraying with Zinc and Zinc/Aluminum Alloy Wire" that details 7 case histories of using thermal spray for infrastructure applications. Short descriptions are given of Belleville Lock & Dam (WV), Racine Lock & Dam (WV), Glen Canyon Dam (AZ), Mormon Flat Dam (AZ), Blue Mesa Dam (CO), McClusky Canal (ND) and Morris Shepard Dam (TX).

Contact Platt Brothers & Company, 2670 South Main Street, P.O. Box 1030, Waterbury, CT 06721, Tel (203) 753-4194, (800) 752-8276, Fax (203) 753-9709.

"Surface Engineering Bulletin" from India

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.

Contact Dr. Shrikant V. Joshi (Editor), DMRL/NFTDC, Surface Engineering Division, P.O. Kanchanbagh, Hyderabad - 500 258, India for further information. Subscription rates for 4 issues per year are Rs. 400 for Indian subscribers and US $50 for foreign subscribers.

Rapid Prototyping Report on Fabrication

Rapid prototyping and manufacturing (RPM), a young and fast-growing industry, is based upon newly invented fabrication technologies. Even in the early stages of development, it is apparent that RPM will dramatically reduce the cost and time required to convert a new product design to a practical manufacturing process. Specifically, RPM development can now be used to efficiently and economically produce a prototype part using computer-generated data from a computer file, create molds for metal casting or plastics molding, manufacture small numbers of low volume products, and fabricate custom-fitted orthopedic prostheses and orthoses. In the future, RPM technology will permit the in-one-piece prototyping of larger items and the use of higher-performance prototyping media. In fact, a future generation of RPM machines may be used to manufacture a prototype of an automobile fender or hood made from either a plastic composite or high strength steel. Clearly RPM technology will have profound effects upon global manufacturing over the next 20 years.

According to a recently-released Business Communications Company, Inc. study, "Rapid Prototyping," the global market for RPM apparatus, materials and services was valued at $282 million in 1994. Because RPM is more cost-effective, it is expected to rapidly and permanently displace conventional manufacturing. Overall, the market for RPM is expected to reach $611 million by 1999, reflecting 16.7 percent average annual growth; refer to the table below.

Worldwide Sales of RPM Technology

	Millions of Dollars 1994	1999	AAGR (%) 1994-1999
North American	171	389	17.9
Europe	76	154	15.2
Asia/Australia	35	68	14.2
TOTAL	282	611	16.7

Contact: Randall K. Wakeford, Business Communications Company, Inc., 25 Van Zant Street, Norwalk, CT 06855. Tel (203) 853-4266, Fax (203) 853-0348. The report from which the above information was extracted is titled "RGB-172 Rapid Prototyping and Manufacturing." It was published in October 1994 and costs $2650.00.

Induction Plasma Spraying of Refractory Materials - Thesis Abstract

Projection des Matériaux Réfractaires Plasma Inductif

Thèse de doctorat ès sciences appliquées
Spécialité: génie chimique
Date: June 1994
by Xian-Liang Jiang
Université de Shérbrooke
Faculté des sciences appliquées
Département de génie chimeque
Sherbrooke (Quebec), Canada

Induction plasma technology is proposed for the deposition of dense tungsten and molybdenum coatings and near net shape structural parts. Optical microscopy, scanning electron microscopy, and x-ray diffraction analysis have been used throughout the research program for material characterization. Attention is given to the influences of process parameters on deposit quality.

Fundamental study is presented of the different steps involved in the thermal spray process. These include particle melting and spheroidization, droplet solidification and splat formation, lamellae stacking and porosity distribution, heat flux to the substrate, and substrate temperature measurements. Experimental results indicate that splat deformation, apparent density, and deposition efficiency of tungsten metal are sensitive to the variations in applied plasma power level, chamber pressure, and spraying distance. Radiation heat loss is found to play an important role in the in-flight cooling of tungsten particles. Both RF plasma spraying of coarse powder (45 - 75 μm) and DC plasma spraying of fine powder (5 μm) can produce dense and adhesive tungsten coatings.

Dense tungsten and titanium carbide deposits have been obtained by induction plasma reactive deposition of tungsten and titanium in the presence of methane as carburizing gas. X-ray diffraction analysis of the powders and deposits obtained indicates that the reaction mechanism includes primary in-flight carburization of the particles followed by the secondary carburization of the deposits on the substrate. Methane injection and reactor pressure are found to be of critical importance for the completion of the reactions and to obtain dense deposits.

Dr. Jiang's present address is Materials Technologies Corp., 205 Research Drive, Milford, CT 06460, Tel (203) 874-3100.

Support for Basic Materials Research?

The Editorial section on page A18 of the January 17, 1995 edition of *The New York Times* addresses the politics of Federal spending on research. The following quotation from an editorial titled "Go After Corporate Welfare" states:

"Some Federal handouts are justified. **Government should underwrite basic research**, for example in biotechnology **or materials science**, that has the **potential to enrich society** even if any one company is unlikely to translate its discovery into large profits."

Many research institutions in the US, including many readers of JTST, breathe a sigh of hope that thermal spray research might be supported well, or even better, in the future. However, this support need not be on the basis of a handout, but on the firm belief that this technology is one linchpin to the needs of a healthy future for our society.

(Note: **bold letters** in the above quotation are from the editor of JTST.)

Wear-Resistant Ceramic Coatings for Diesel Engines[1]

M.H. Haselkorn
Caterpillar Inc.
Peoria, Illinois

Background

The Ceramic Technology sessions of the DOE Automotive Technology Development Contractors' Coordination Meeting, held October 26 and 27, 1994, in Dearborn, Michigan, were chaired by Robert B. Schulz, Debbie Haught, and Joseph Perez (DOE Office of Transportation Technologies) and D. Ray Johnson [Ceramic Technology Project, Oak Ridge National Laboratory (ORNL)]. The brief summary below is of one topic, related to thermal spray, that was presented.

Introduction

Improved fuel economy and a reduction of emissions can be achieved by insulation of the combustion chamber components to reduce heat rejection. However, insulating the combustion chamber components will also increase the operating temperature of the interface of the piston ring and cylinder liner from about 150 to over 300 °C. Existing ring/liner materials cannot withstand these higher operating temperatures and, for this reason, new materials need to be developed for this critical tribological interface.

Program Goal

The overall goal of this program is to develop material pairs for piston rings and cylinder liners that provide the required friction and wear properties at these severe operating conditions.

Tests

Two pairs of piston ring/cylinder liner coatings met the friction and wear goals of this program:

- High-carbon iron-molybdenum against chromia-silica, both plasma-sprayed.
- Plasma-sprayed, high-carbon iron-molybdenum running against a low-temperature arc vapor deposited (LTAVD) chrome nitride cylinder liner coating.

The current overall objective is the scaleup of both the plasma-spray and LTAVD processes for applying wear-resistant coatings to the bores of cylinder liners.

Caterpillar began scaleup of the plasma-spray process by designing and running a statistical experiment to obtain correlations between inner-diameter (ID) plasma-spray process parameters, powder deposition efficiency, coating microstructure, and friction and wear properties for both the high-carbon iron-molybdenum and chromia-silica powders. Once these correlations were obtained, a model was developed to produce a coating with optimum characteristics.

Finally, the parameters identified were used to test the model by applying both the high-carbon iron-molybdenum and the chromia-silica coatings to the ID of simulated cylinder liners.

Two sets of procedures were used to finish machine the ID of the cylinder liners plasma-sprayed with each powder composition. One set had high material-removal rates, while the second set had lower material-removal rates. The higher material-removal rates reduced machining times from 42 to 7.2 min.

Friction and wear properties of the plasma-sprayed and machined surfaces for each powder were obtained by cutting specimens from each of the simulated cylinder liners and running them against plasma-sprayed, high-carbon iron-molybdenum or simulated chromia-silica piston-ring sections. Testing was performed both at Caterpillar, on a Cameron-Plint friction and wear test machine, and at Battelle Columbus Laboratories, using a simulated engine rig.

Test Results

The friction and wear test results showed that material-removal rates did not have a significant effect on the friction and wear properties of the machined surfaces.

Comparing all friction and wear results, Caterpillar determined that the material pair meeting the average wear-factor goals of this contract was piston rings coated with high-carbon iron-molybdenum running against cylinder liners coated with chromia-silica.

Scaleup of the 15 μm thick LTAVD chrome nitride coating system began with optimization of the processing parameters for applying the LTAVD chrome nitride coating system to the ID of a cylinder liner. Proper cleaning of the surface prior to application of the chrome nitride coating system is important in achieving the required coating adherence.

The friction and wear properties of the 15 μm chrome nitride coating system were determined by cutting sections from the LTAVD chrome nitride-coated cylinder liners and running them against plasma-sprayed, high-carbon iron-molybdenum or chromia-silica piston ring sections at both Caterpillar and Battelle. Test results showed that further development of the LTAVD chrome nitride coating system is needed.

[1] Reprinted from "Ceramic Technology Newsletter," No. 45, October-December, 1994, pages 2-4. Article titled "Ceramic Technology Sessions at ATD-CCM Highlight Progress of Research," Editor: Judy M. Wyrick. (Note: Section headings have been added by the editor of JTST to focus the reader.)

Accent on Automobile Engines

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Abstract

Plasma spraying, which is employed to provide the most diverse high-quality surface coatings, has found a permanent place in the automotive industry. The possibility of integrating this automated process into production lines has widened its range of application.

Introduction

Despite significant improvements, the contamination of our environment by pollutants and the consumption of primary energy still leaves the automobile in an unfavorable light. Consequently when motorists purchase their cars, they consider not only the factors of safety and reliability, but also low fuel consumption and minimum emission of pollutants as well as the lowest possible mechanical and corrosive wear.

What are the consequences of this purchaser pattern on the automotive industry which is under pressure from increasing costs? For example, it saves on material and fuel through reductions in weight. Admittedly, this means that the materials are now stressed to their limits, but this disadvantage can be overcome with coated surfaces designed especially for their respective loads. Whereas the substrate provides the mechanical properties, the coating has to inhibit (e.g. wear) or enhance (e.g. lubricate) the surface phenomena (Fig. 1).

Challenging Requirements

Which attributes must a coating process have if it is not to disturb the completely rationalized, automated production process of the automotive industry, if it is to produce homogeneous thick coatings with high quality in an economical manner over a longer period of time, able to combine a multitude of coating materials permanently with the parent material and, finally, does not pollute the environment with emissions. Plasma spraying can meet all these challenging requirements.

A Gem Among the Spraying Processes

In comparison with other thermal spraying processes, plasma spraying offers a series of advantages. With a low consumption of cheap process gas, it facilitates high spraying rates and deposition efficiencies. The workpieces are heated only minimally during spraying, which necessitates only a low level of cooling. Plasma spraying is based on established technology and is an industrially proven and reliable process; in other words teething troubles are not to be expected. A large range of spray guns are available for the numerous application possibilities.

The automated and operator-friendly process can be controlled precisely within a wide range of parameters to produce consistent reproducible coatings of the highest quality. This success is attributable to thoroughly tried and tested components which are characterized by their minimal downtimes, easy maintenance, and their low repair and maintenance costs.

Process Operating Stages

The complex interrelationships of the material treatment for plasma spraying can be depicted in five blocks:

- Surface activation of the components (grit blasting)
- Spray powder (properties)
- Melting of the powder (constant melting process under production conditions)
- Coating deposition (manipulator)
- Coating quality control

All the working parameters found within these segments are interactive. As far as accuracy and reproducibility are concerned, the individual segments are attuned to each other.

Universal Application

The high temperatures (about 10,000 K) and the specific energy densities achieved in the thermal gas plasma facilitate the melting of any material which exhibits a stable molten phase and is available in powder form. The plasma spraying of materials such as ceramics, carbides, alloys, and refractory metals has therefore become well established as a commercial process. Such coatings produce specific surface properties; e.g., corrosion resistance, thermal insulation, wear resistance, and electrical insulation. These coatings are applied to a variety of materials such as steel, copper, aluminum, cast iron, nickel and cobalt-based superalloys and more recently to composite structures.

The powder is introduced into the source of thermal energy, i.e. a gas plasma stream, in an air or low-pressure/vacuum atmosphere. The plasma is based on the ionization of gases such as argon, hydrogen, nitrogen, and helium using an electric arc. The particles then

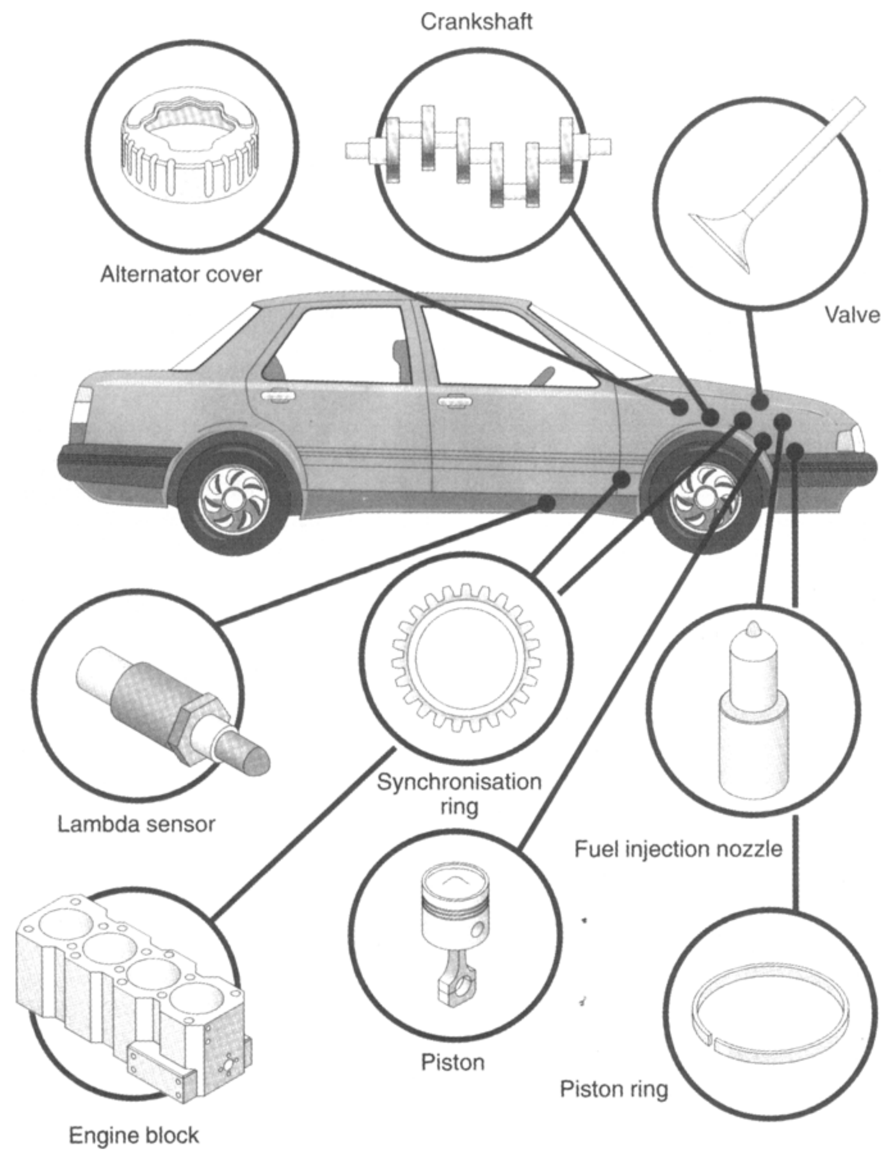


Fig. 1 Examples of parts provided with plasma-sprayed functional surfaces.

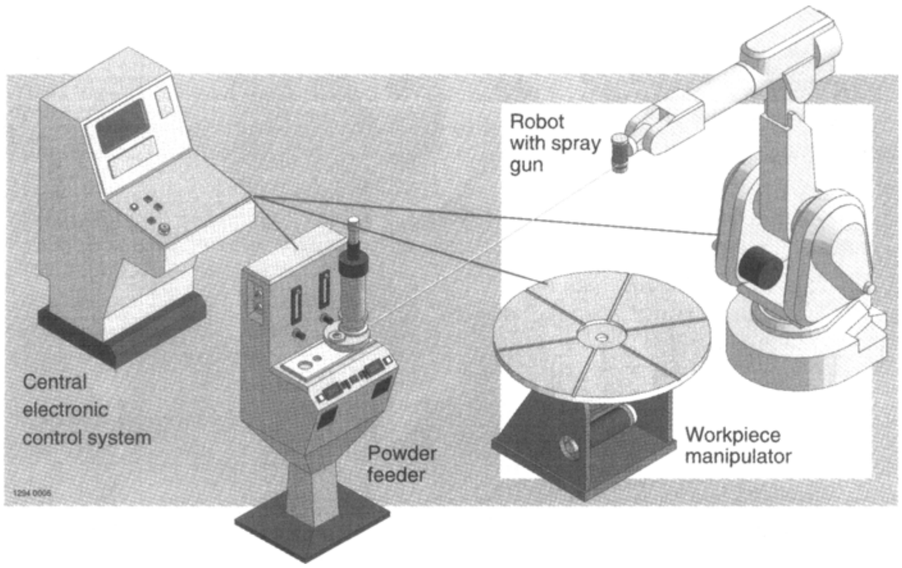


Fig. 2 The plasma spraying equipment. The powder feeder and the electronic control system are located outside the cabin where they are accessible for the operator. The robot with spray gun and the manipulator with the workpiece are accommodated in the spray cabin.

Fig. 3 The plasma gun rotating device — RotaPlasma® 500 — enables the cylinders of engine blocks to be sprayed without having to rotate the part. With this device, for example, it is possible to coat the cylinder walls of aluminum engine blocks in an existing production line.

Table 1 Plasma spray coating materials used in automobile applications (focus on European markets and applications)

Production coatings	Coating
Piston rings	Mol+lNiCrSiB, ceramics, others
Lambda sensors	Spinel
Fuel-injection nozzles	Molybdenum
Experimental coatings	
Piston crowns	Thermal barrier coatings
Engine bores	Anti-sliding wear
Alternator covers	Alumina
Synchornization rings	Mo, Mo blends
Valves	Thermal barrier coatings
Exhaust valves	Anti-adherence coatings

become semi-molten, molten, or remain as solid particles.

Reproducible melting requires careful gas and arc regulation, as well as a constant water temperature and flow rate of the cooling water circulating through the gun. This ensures constant gas ionization and therefore constant energy density at the point of powder injection. These parameters are calibrated at a single source. As a consequence, all the systems are the same and the working parameters can be transferred to the factory production line without difficulty.

The substrate is provided beforehand with a sufficient surface roughness by means of grit blasting or in a vacuum using a reverse transfer arc. The accelerated, fused powder particles impinge, solidify and interlock on the substrate surface.

The coordinated movement between the activated surface to be sprayed and the stream of molten particles ensures the correct deposition of the coating in the required form and in the right place.

The complete range of system equipment permits the spray system to be installed in a production line without disturbing the existing tooling or other operators.

Spray Cell Management

The plasma gun is placed on a robot and the component on a manipulator. The gun and manipulator are located in a cabin, which has accurate feedback control and protects the environment against dust, noise, and UV radiation. The powder feeder and the electronic control system are mounted outside the cabin where they can be easily supervised by the operator (Fig. 2). The design of the work cell depends, above all, on the type of parts to be coated and the lot sizes. The object is to automate the changing of workpieces whenever possible, so that the operator does not have to concern himself with the start-up and shut-down of the plasma process and the workpiece changeover. This enables him to concentrate on his control duties and quality assurance.

Vacuum plasma spraying is employed if the spray powder contains elements which are sensitive to oxygen and oxidize in air. In this case, the spray gun, robot, and manipulator are accommodated in a vacuum chamber. Thermal stress can be avoided by preheating the workpieces.

Examples of Application

The quoted examples are associated with the European automotive industry and are not coincident with applications in the USA. Table 1 further indicates some of the plasma spray coating materials used in automobile applications.

It is estimated that between 30 and 40% (approximately 220 million) of all piston rings that are manufactured and fitted in Europe each year are coated by means of wire arc and plasma spraying. The major advantage of using plasma is the ability to select a specific powder composition according to the application that can be based on metals, carbides, or ceramics. The optimum coating can be found by analyzing the wear on the top ring or on the liner.

Lambda sensors, which control the gas emissions from the engine, are protected against corrosive engine emissions by a spinel coating. One advantage of the plasma process is the ability to spray various porous coatings to ensure exact measurement by means of the sensor electrode for a particular type of engine. Systems with continuously operated multiple guns have been developed to enable the large number of sensors to be coated economically — at present more than 50 million.

Experimental Coatings

It has to be possible to apply coatings not only to external but to internal surfaces as well. For example, a rotating plasma gun sprays the cylinders of stationary engine blocks (Fig. 3). The potential of this coating is found in the appreciable saving of costs. Requirements of a particular nature call for the development of special layers. Investigations have shown that the exhaust emissions of automobiles can be reduced by thermal barrier coatings. These coatings are applied to piston crowns, heads, and valves. Expensive regrinding of the components can be avoided by depositing the coating material accurately, in the required thickness and without creating excessive thermal strains.

Computer-Integrated Manufacturing Capability

In the future, the integration of the grit blasting operation and the plasma spraying will be effected in a single processing area. These two operations will be controlled by a host computer which, parallel to other host computers, communicates with the main frame computer. This will enable plasma spraying to be anchored in computer-integrated manufacturing (CIM).

Reprinted from "Sulzer Technical Review," Volume 76, Number 3, 1994, Pages 28 - 31. Note that the original article contained 5 figures. These were reduced to 3 figures (and the text changed accordingly) for the present article since the color figures would not reproduce well in the JTST black and white format.

News from NASA

Plasma-Spray Metal Coating on Foam

Molds, forms, and other substrates made of foams would be coated with metals by plasma spraying, according to a proposal. In a given application, the foam might be ceramic, carbon, metallic, organic, or inorganic. After the coat has been applied by plasma spraying, the foam could be left intact (e.g., to serve as thermal and/or electrical insulation or as an acoustic damper) or could be removed by acid leaching, conventional machining, water-jet cutting, or another suitable technique.

Cores or vessels made of various foam materials plasma-coated with metals according to this method might be useful, for example, as thermally insulating containers for foods, liquids, or gases, or as mandrels for making composite-material (matrix/fiber) parts. A foam-filled core or vessel could be used, with the foam intact or removed depending on the specific application, as a substrate for the deposition of an additional layer or layers of the same or different metal(s).

One potential application might be in making thermally insulating firewalls in automobiles. A metal firewall provides structural integrity, but it also conducts heat from the engine compartment to the passenger space. To obtain a more desirable combination of strength and thermal insulation, the main body of the firewall could be made of graphite phenolic or other high-temperature composite material. A thin layer of insulating foam could be sprayed onto the composite, and a thin coat of aluminum could be applied to the foam by plasma spraying. The aluminum coat could be machined and polished to a heat-reflective finish.

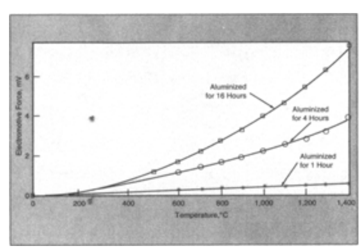
Reprinted from "NASA Tech Briefs," Volume 18, Number 11, November 1994, Page 26. This work was done by J. Cranston of Martin Marietta for Marshall Space Flight Center (MSFC). Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Robert L. Broad, Jr., Mail Code CC01, MSFC, AL 35812, Phone: (205) 544-0021. Refer to MFS-28904.

High-Temperature, Oxidation Resistance Thermocouples

An alternate Pt-type of thermocouple gives reproducible readings in an oxidizing atmosphere or in a vacuum. The two legs of a thermocouple of this type are made of platinum and a platinum/aluminum alloy, respectively. Heretofore, the thermocouples used most commonly at temperatures above 1000 °C have been made with legs of platinum and 87 weight percent platinum/13 weight percent rhodium: these thermocouples are denoted "type R" and they perform well in hot, oxidizing atmospheres. However, rhodium is scarce and expensive at about \$4,000/ounce (about \$1.4 x 10^5/kg) (1992 prices). The ability of a thermocouple of platinum and platinum/aluminum to resist hot oxidation derives from a protective scale of aluminum oxide on the surface of the platinum/aluminum alloy leg. (The platinum leg is inherently resistant to oxidation.)

Platinum/aluminum legs for use in demonstrating the present thermocouple concept were made from platinum wires 0.045 in. (1.1 mm) in diameter. The wires were aluminized by heating them for various times (1, 4, and 16 h) at a temperature of 1000 °C in a bed of aluminum oxide sand containing 2 percent aluminum powder and 2 percent ammonium chloride as an activator. During the heating, the platinum wires became enriched with aluminum to various degrees and depths that depended on the heating times. The Pt/Al wires were spot welded to Pt wires to form thermocouples.

The electromotive force produced by the thermocouples was found to depend on the heating times. The thermocouple that contained the Pt/Al wire aluminized for 16 h generated 7 mV at 1400 °C. (A thermocouple of type R generates 16 mV at the same temperature.) The thermocouple that contained the Pt/Al wire aluminized for 4 h produced only 4 mV, but in practice it would be preferable to the thermocouple containing the 16 hour wire because it would be more ductile. The thermocouple that contained the wire aluminized for 1 h produced only 0.5 mV — too low to be practical. The measured electromotive forces of these



The electromotive force increases with aluminum content in the Pt/Al leg of a Pt/(Pt/Al) thermocouple. Therefore, wires baked longer in an aluminizing bed produce larger voltages.

three thermocouples are shown in the figure.

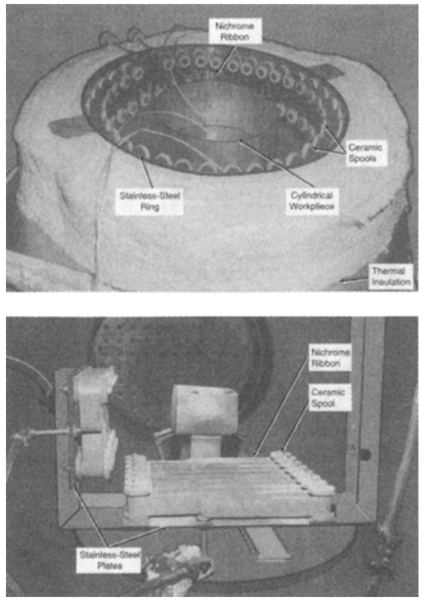
Thermocouples containing platinum/aluminum legs can be used instead of thermocouples of type R in furnaces, heat engines, and chemical reactors. They are especially suited to high-velocity oxidizing environments. They could be constructed as thin-film sensors on turbine blades and vanes, where preoxidation could provide the insulating film needed between the thermocouple legs. Because the aluminum content is slowly depleted by oxidation, long-term use is recommended only where the maximum temperature is 1200 °C or less.

Reprinted from "NASA Tech Briefs," Volume 18, Number 9, September 1994, Page 86-87. This work was performed by James L. Smialek and Michael A. Gedwill of Lewis Research Center. This work has been patented by NASA (US Patent No. 5,275,670). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the NASA - Lewis Research Center, Patent Counsel, Gene E. Shook, Mail Code LE-LAW, 21000 Brookpark Road, Cleveland, OH 44135. Phone : (216) 433-5753. Refer to LEW-15515.

Rugged Preheaters for Vacuum Plasma Spraying

Electric preheater units have been built to ensure that large workpieces to be coated with metals by vacuum plasma spraying are heated uniformly to the requisite high temperatures by the time the plasma torch arrives. For small workpieces, heating by quartz lamps or by the plasma torch itself suffices to ensure the proper temperatures. However, for large workpieces, a more dependable source of heat is needed.

Typically, a workpiece to be vacuum plasma-sprayed should be at a temperature between 800 and 2000 °F (430 and 1100 °C). On a large workpiece, the torch passes any given spot too infrequently to maintain the needed constant high temperature. As a result, there can be large temperature gradients in the workpiece, and the quality of the coating is adversely affected. Quartz lamps are often used to maintain the proper temperatures, but they do not last long in the hot, low-pressure, metal-powder-laden environment.



Nichrome resistance-heating ribbons are wrapped around ceramic insulating spools on rings and plates. A round workpiece is placed in the middle of the ring preheater. Plate preheaters are needed near a workpiece.

The present electric preheater units are similar to (but much larger than) the electrical-resistance ribbon heaters in toasters and in some small portable electric "space" heaters. Each unit includes an 80/20 nickel/chromium resistance heater ribbon 1.5 in. (3.81 cm) wide by 0.1 in. (0.254 cm) thick, supported and electrically insulated by ceramic spools (see figure). Each heater is designed to use power from a high current (600 A), low-voltage power supply, the low voltage being advantageous in that it minimizes arcing in the process vacuum. These heater units outgas hardly at all and are relatively unaffected by the buildup of metal powder from the process. Each unit is connected to the power supply by a thick, thermally and electrically insulated wire via vacuum feedthroughs.

The ring preheater shown in the figure was used to heat cylindrical stainless steel barrels 12 in. (about 30.5 cm) in diameter in a 40 Torr (5.3 kPa) vacuum to a required temperature of 1650 °F (about 900 °C). For this purpose, it was necessary to supply the heater with a current of 350 A at a potential of 53 V. The panel preheater shown in the figure was supplied at 180 A, 25 V to heat a valve housing to 815 °F (435 °C), also in a 40 Torr vacuum. Thereafter, the power was decreased to 130 A at 18 V to maintain a temperature of 925 °F (496 °C) during plasma spraying. Both the ring and the panel preheaters have proved durable.

Reprinted from "NASA Tech Briefs," Volume 18, Number 12, December 1994, Page 76. This work was done by William H. Woodford, Timothy N. McKechnie, Lewis D. Sander, Christopher A. Power, Heather L. Sander, and Dalton D. Nguyen of Rockwell International Corp. for Marshall Space Flight Center. Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Robert L. Broad, Jr., Mail Code CC01, MSFC, AL 35812, Phone: (205) 544-0021. Refer to MFS-29983.

Waterjet Cuts Space-Age Materials

Abstract

To regain the competitive edge in a global aerospace market, Pratt & Whitney Government Engines and Space Propulsion (P&W/GESP), best known for their aircraft engines, has fundamentally changed the way they operate by redesigning their manufacturing processes and establishing partnerships with key suppliers.

Introduction

The transition from a military to a peacetime industry, as well as a change to the new generation of lightweight composites and exotic materials, were factors that made a streamlined approach to manufacturing necessary.

Part of Pratt & Whitney' s solution was the establishment of Integrated Product Development (IPD). This involved simultaneous engineering that enabled manufacturing and engineering to work together at every stage of development, with suppliers contributing technical input at the appropriate points. A key element of IPD in meeting speed, quality, and cost requirements was a state-of-the-art waterjet facility. Pratt & Whitney created a versatile waterjet cutting center designed to cut complex shapes and designs from space-age materials, as well as to remove coatings and to clean parts. Creating this facility was the joint responsibility of Ingersoll Rand (I-R) Waterjet Cutting Systems and S.E. Huffman Corporation.

Advantages of the IPD

The advanced water jet processing center emphasized the effectiveness of IPD by involving everyone in the learning process, and by exploring potential new applications and maintenance. "Because of the types of exotic materials processed, waterjet cutting more often than not tends to be the method of choice," says Michael Thomason, Senior Materials Engineer, Pratt & Whitney, GESP. One example of this is a titanium flange over 40 in. long and 0.5 in. thick. Conventional milling of this flange would have taken about 20 hours. Using the waterjet system, the part was completed in this configuration to final dimension and tolerance in less than 1.5 hours.

Coating removal of plasma-sprayed jet engine components used to be done by lathes and/or chemical processes. By using waterjet the processing time is reduced by 90% without altering the base metal. Thomason notes the increased life of parts, speed, and lack of weakened, heat-affected zones make waterjet an ideal process for aerospace applications. "In addition, we can now perform multiple processes on the part with the same setup and minimal tooling, whereas before, the job might have required multiple setups, or even multiple machine types with elaborate tooling."

State-of-the-Art Facility

The waterjet center has both I-R's abrasive cutting and non-abrasive cleaning capabilities, linear accuracy of ± 0.0035" without electrical compensation (± 0.0010" with electrostatic compensation), and a rotary table used for cleaning. S.E. Huffman manufactured the 5-axis, all-steel gantry system. Concrete walls, double-paned glass, and a separate room for I-R's intensifier, which pressurizes soft water to 55,000 psi, provide an environmentally clean workcell. The facility was designed by P&W / GESP specifically for the waterjet, utilizing their IPD philosophy. The system runs two shifts per day, five days each week, and maintains a 2-week work backlog.

As a beta site for all three companies involved, the waterjet processing center was designed to be environmentally clean and safe. To reduce noise, the intensifiers and the wastewater treatment system were located in a separate mechanical room. In addition, the center is one of the few air-conditioned operations of its kind. Abrasive waterjet cutting and coating removal processes generate airborne particulates that can be detrimental to machine controls and motion systems. All air inside the workcell is processed through a 3-stage filtration system to ensure operator and system health. Air in the workcell is filtered completely every two minutes. Pratt & Whitney, like its parent company, United Technologies, has a long history of being environmentally responsible. Thomason believes the waterjet center is a major contributor to making products and processes more environmentally sound and energy efficient.

Pratt & Whitney's new working relationship with their suppliers, such as Ingersoll-Rand and S.E. Huffman, is also a cost-cutting move. They are reducing their manufacturing supplier base from over 500 to under 250 companies. This is another aspect of P & W's efforts to reduce product costs. "We now have true working relationships with the remaining suppliers," says Thomason, "that constantly update and redesign manufacturing processes."

Looking to the Future

Robert Bescher, of P&W / GESP, sees non-air breathing engines as the next major market segment for the rapidly changing aerospace industry. "To compete internationally in the large-engine segment of the market, we need to think globally but act locally," claims Bescher. "The largest aerospace markets today are Europe and Asia where there are already 17 commercial partnerships. Simultaneous engineering is crucial to us as the only partnership and process that will enable us to meet the speed, quality, and low-cost requirements of today's marketplace."

Currently, work is underway for the Korean Air Force; Japan Airlines, for their new Boeing 777s; and for the PW 4000, the wide-body aircraft that is the flagship of Pratt & Whitney's commercial airline business. Despite military cutbacks, work on the F119 engine for the US Air Force's Advanced Tactical Fighter Aircraft (F22) will take their defense business well into the 21st century.

Pratt & Whitney is also expanding its overhaul and repair capabilities in the US and overseas. Coatings removal via waterjet has evolved as a major aspect of this business. Northwest Airlines has already converted to the waterjet method, with P & W's approval. Now, NASA is using this faster and less invasive method to remove coatings from its solid rocket boosters.

The competition in commercial and military aerospace markets for thrust and efficiency requires increasing precision in the manufacturing process, and consistent metallurgical properties even after the material has been cut. Pratt & Whitney believes that waterjet provides the competitive edge for all these requirements.

Reprinted from "Modern Applications News," Vol. 28, Number 10, October 1994, Pages 10-11.

Plasma Pyrolysis System for Medical Waste Planned for San Diego

The country's first commercial plasma pyrolysis system for processing medical waste is planned for a Kaiser Permanente medical center in the San Diego area and could be operating as early as next year (1995). EPRI is helping to offset a portion of the system's capital cost as part of its support of several new electro-technologies for waste disposal in the health care industry.

Hospitals traditionally have incinerated their medical waste on-site. But tightening air quality regulations are forcing the closure of many on-site incinerators. Most hospitals that have lost the use of their incinerators must rely on contractors for off-site disposal, which not only is more costly but also raises concerns about liability should problems occur after the waste leaves the hospital.

In the plasma pyrolysis process, an electric arc is created that heats gases to 12,000 °F — to an ionized, or plasma, state. The plasma, in turn, heats the waste-processing chamber to about 3000 °F. During pyrolysis, or heating in a low-oxygen environment, the organic waste is converted into stable gases like hydrogen, carbon monoxide, and nitrogen. What's left is a molten mass that cools to become a slag of glass beads. The slag is disinfected and can be recycled for use as an aggregate substitute in roadbed material or concrete.

Plasma pyrolysis reduces the volume of infectious waste (so-called red bag waste) by more than 90%, and its weight by 80%. In principle, the process is capable of handling all types of medical wastes except those that are radioactive. Hot gases released in the pyrolysis process can be used for other purposes, such as generating hot water for use in the hospital. The resulting stack emissions are like those from combustion processes and include particulates, nitrogen oxides, and trace metals. However, the quantities of these emissions are significantly lower than in incineration; trace organic emissions, such as dioxins and furans, are near zero.

Disadvantages of the plasma pyrolysis process include its currently high capital cost and the significant throughput rates required for economical operation. These factors make the technology appropriate only for large hospitals and regional treatment facilities. In supporting the Kaiser Permanente project, EPRI (The Electric Power Research Institute) hopes to help make other health care facilities familiar with the technology, the capital cost of which should come down as use grows. The system planned at Kaiser, to be supplied by Plasma Energy Applied Technology, Inc., could be under construction this year and operating by 1995.

This article has been reprinted from "EPRI Journal," Vol. 19, Number 6, September 1994, Page 33. For more information, contact Myron Jones, Electric Power Research Institute, PO Box 10412, Palo Alto, CA 94303. Phone (415) 855-2993, Fax (415) 855-8574.

Thermal Spray at NACE Meeting

The 50th Annual Conference and Exposition of the National Association of Corrosion Engineers was held at the Orange County Convention Center, Orlando from March 26 to 31, 1995. Technical papers and one meeting were held that are of special interest to the thermal spray community. These have been extracted from the program and are listed below.

1. Committee Meeting of T-6H-45 on "Thermal Spray Coatings," Howard L. Novak, USBI.
2. "Production and Evaluation of Nonequilibrium Aluminum Alloy Plasma Spray Coatings for Enhanced Corrosion Resistance," A.S. Iyengar (The Pennsylvania State University). 1995 Student Poster Paper.
3. "E.I.S. Measurements and Current Distribution Calculations to Evaluate Sprayed Zinc Sacrificial Anodes for Reinforced Concrete," W. Morris (University of South Florida). 1995 Student Poster Paper.
4. "Optimization of Thermal Spray Parameters for Cathodic Protection of Reinforcement in Concrete," C.C. Berndt and S. Reddy (University of New York at Stony Brook) and M.L. Allan (Brookhaven National Laboratory). Paper 95012.
5. "Atmospheric Corrosion in Coastal Environments," S.D. Cramer, B.S. Covino, Jr., S.J. Bullard, and G.R. Holcomb (US Bureau of Mines) and G. McGill and C. Cryer (Oregon Department of Transportation). Paper 95005.
6. "High Temperature Corrosion of Silicon Based Thermally Sprayed Coatings for Utility Boiler Components," J. Porcayo-Calderon and S.D. Granda (Ins. de Investigaciones Elec.) and E. Martines (Univ. de Campeche). Paper 95466.
7. "Corrosion Factors of Water Wall Tube and Protection by Field Metal Spraying in Municipal Refuse Incineration Plant," Y. Kawahara and M. Kira (Mitsubishi Heavy Industries, Ltd.). Paper 95563.
8. "Application of Thermal Spray Coatings Using High Deposition Rate Equipment," H.L. Novak (USBI Co.). Paper 95586.
9. "Mitigation of Stress Corrosion Cracking by Underwater Thermal Spray Coatings of Noble Metals," P.L. Andresen (General Electric Corp. R&D). Paper 95412.
10. "Galvanic Corrosion Evaluation of Wear Resistant Thermal Spray Coatings," B.A. Shaw and K.M. Cetin (The Pennsylvania State University) and L. Moskowitz (NAWC). Paper 95270.
11. "A Thermal Sprayed Titanium Anode for Cathodic Protection of Reinforced Concrete Structure," J.E. Bennett and T.J. Schue (Eltech Research Corp.) and G. McGill (Oregon Department of Transportation). Paper 95504.
12. "Sprayed-Zinc Sacrificial Anodes for Reinforced Concrete in Marine Service," A.A. Sagues (University of South Florida) and R. Powers (Florida Department of Transportation). Paper 95515.
13. "Update on Sacrificial Anode Cathodic Protection on Steel Reinforced Concrete Structures in Seawater," R.J. Kessler and R. Powers (Florida Department of Transportation) and I.R. Lasa (University of South Florida). Paper 95516.

Further details about the purchase of technical papers are available from NACE International, PO Box 218340, Houston, TX 77218-8340. Tel (713) 492-0535, Fax (713) 579-6694.

Update on ITSC-95 in Kobe from the Chairman

Following is an open letter, dated February 24, 1995, from Prof. Dr. Y. Arata, Chairman of the ITSC'95 Organizing Committee.

We heartily appreciate the expressions of sympathy from ITSC'95 participants all over the world for the devastation caused by the Great Hanshin Earthquake which occurred in the Kobe area on January 17, 1995.

According to the official report of the President of the Kobe International Association dated January 24, 1995: the Kobe International Conference Center, the venue of ITSC'95, was damaged only a little and is expected to be reopened in early April. Most of the large hotels are also expected to be reopened during March. Jet Foil services between Kansai International Airport and Kobe City Terminal on Port Island where the conference center is located have been operating on normal schedule. Under the circumstances **we have decided to hold ITSC'95 on schedule**, that is: 22-26 May, 1995; International Conference Center Kobe, Kobe, Japan.

Kobe will Receive International Conventions

The following press release, dated February 28, 1995, was issued by Kazutoshi Sasayama: the Mayor of the City of Kobe.

The Great Kobe Earthquake was reported to people around the world through the mass media. The quake hit Kobe's central area on January 17, 1995, bringing about severe damage including the loss of many lives.

However, after a short-while turmoil from the disasters, Kobe city and its citizens immediately stood up to rebuild their city. The city has already begun the movement of "We Love Kobe" to recover the business activities, led by the Kobe Chamber of Commerce and Industry.

Kobe, one of Japan's leading convention cities, has been inviting numerous international conventions to its excellent facilities and surroundings. Fortunately there was no damage to Kobe Convention Center, and it is going to begin its business in April 1995. City hotels will also resume their business along with restored services of water and gas.

Convention Facilities

Kobe International Conference Hall is scheduled to resume their business in April 1995 and Kobe International Exhibition Hall in June.

Accommodations

City hotels, including Portopia Hotel, Hotel, Okura Kobe, Shinkobe Oriental Hotel, and Kobe Bay Sheraton Hotel & Towers suffered very little. They are going to resume business in the course of February-March 1995.

Access

The Kansai International Airport did not suffer any damage. The jet foil shuttle service is in service to connect Kobe and the airport in 30 minutes. The "Shinkansen" bullet line is going to resume its service by May 1995.

We would like to report that the restoration work of Kobe is now under rapid progress, and that Kobe will receive international conventions very soon.

Exhibit at ITSC'95 in Kobe, Japan

The International Thermal Spray Conference is a tri-annual event and the leading world event in the thermal spray industry. For the first time this big event will be held in Asia from 22-26 May, 1995 when the High Temperature Society of Japan will be hosting the 14th International Thermal Spray Conference in the city of Kobe, Japan.

As the 1993 World Bank report titled "The East Asian Miracle" states: economically, the East Asian countries are the brightest spots in the world. In 1993 when the net growth rate of the GDP of the advanced countries of the world was only around 2%, those of the east Asian countries were approximately as follows: China, 14%; Singapore, 11%; Malaysia, 10%; Thailand, 9%; and Indonesia, 7%.

Another interesting report is titled "After the Cold War, Part 2: The US Aerospace Industry in the International Market Place" prepared by the Aerospace Research Center and released by the Aerospace Industries Association of America (AIA). According to AIA report "The only bright spot for the aerospace industry's near-term prospects is in the Asia-Pacific Rim area. From 1991 through 1993, US deliveries to the region totaled $24 billion, or more than double the deliveries in the previous three years. Boeing expects that over 30 percent of aircraft deliveries through the year 2010, accounting for $245 billion in sales, will be to Asia-Pacific carriers."

In Asian countries there are so many ambitious entrepreneurs always looking for new fields of business and accustomed to commuting to Japan. We would like to offer you the opportunity to display your products at ITSC'95 Exhibition. There, you will be interfacing with the top decision makers as well as design, mechanical, project, and materials engineers: representatives of growing industries looking for companies like yours to fulfill their needs. This is where you will be able to talk to individuals with buying influence in your industry.

The Exhibition will be held on the 4th and 5th floors of the International Conference Center Kobe, the same building where the 14th ITSC is held, occupying 1,200 sq. meters. The Exhibition organizer is Sampo Publications, Inc., Namba Bldg., 2-8-9 Motomachi, Naniwa-ku, Osaka, Japan 556, Tel 81-6-633-0720, Fax 81-6-633-0840.

NSF Budget Request for 1996 Totals $3.36 Billion

The Administration continues to see NSF as an "Investment." National Science Foundation (NSF) Director Neal Lane today [February 6] announced that the Clinton Administration has proposed a fiscal year 1996 budget of $3.36 billion for NSF, a $96 million increase over fiscal year 1995. Characterizing the three percent increase as "good news in tight times," Lane said that he believes the NSF budget is viewed at both ends of Pennsylvania Avenue as an essential part of the US investment in research and education, an investment which "strengthens and secures our Nation's capability to excel in science and engineering." According to Lane, the overall increase for NSF reflects goals outlined by the Administration in its August 1994 report, "Science in the National Interest." That report stated that "America's future demands investment in our people, institutions, and ideas. Science is an essential part of this investment, an endless and sustainable resource with extraordinary dividends."

Lane said that although the NSF budget accounts for only three percent of the $70 billion federal investment in research and development, it amounts to nearly 50 percent of all Federal support for non-medical basic research at academic institutions, and about 30 percent of all Federal support for science, mathematics, engineering, and technology education. In addition, in several key areas — physics, chemistry, mathematics, and others — NSF provides the majority of Federal funding.

Prior Investments Bring Present Dividends

Lane cited several examples of how the past investments in NSF have reaped substantial dividends. For example: the Nation's automakers use micromechanical systems (MEMS), mixtures of sensors, motors, and computers small enough to fit on a pinhead, in airbags and electronic ignition systems. MEMS have emerged as a valuable commercial technology thanks in-part to NSF's timely support of fundamental engineering research.

Future Investment Goals

Lane explained that the budget proposal is consistent with the agency's strategic plan, which was endorsed by the National Science Board in October 1994. That plan identified three broad goals for the Foundation: help the US uphold world leadership in science, mathematics, and engineering; promote the discovery, integration, dissemination, and employment of new knowledge in service to society; and help achieve excellence in US science, mathematics, engineering, and technology education at all levels.

World Leadership in Science, Mathematics, and Engineering

To help uphold world leadership in science, mathematics, and engineering, the President proposed that funding for research increase by 7.6 percent to $2.45 billion. NSF's contribution is often referred to as the "seed corn" of scientific enterprise, i.e., basic research conducted at academic institutions and education in science and engineering. This produces both the new knowledge and talented people that enable the US to pursue current and emerging opportunities, Lane said. **The budget increase for engineering is up 7.7 percent to $344.2 million.**

Scientific Knowledge Serves Society

Turning to science's role in advancing knowledge as a service to society, Lane said that nearly two-thirds of the agency's support for research and education is invested in seven defined "strategic" areas. These initiatives span disciplinary boundaries, government agencies, industrial sectors, and international borders.

In fiscal year 1996, NSF expects to increase by $85 million its investment in these interdisciplinary areas, an integral part of the Nation's efforts in fundamental research and education in science and engineering. For example, **funding for advanced materials and processing will increase 6 percent to $226.1 million; civil infrastructure systems, up 5.1 percent to $57.3 million**; environment and global change, up 7.9 percent to $355.6 million; high performance computing and communications increases 5.6 percent to $313.6 million; **manufacturing, up 6.2 percent to $136.4 million; and science, mathematics, engineering, and technology education, up 1.4 percent to $656 million.**

US R&D Expenditures Continue Slow Growth in 1994

Total expenditures for R&D performed in the US reached an estimated $177 billion in 1994, about 1 percent more than the estimated $174 billion spent in 1993. In inflation-adjusted terms, however, 1994 expenditures declined by approximately 1 percent. Of the nation's 1994 R&D total, 18 percent was expended for basic research activities, 23 percent for applied research, and 59 percent for development. Overall, R&D was 2.6 percent of the gross domestic product (GDP).

In 1994, industry provided 59 percent ($104 billion) and the Federal Government, 36 percent ($64 billion) of the nation's total expenditures for R&D. State governments, universities and colleges, and other nonprofit organizations account for the remaining 5 percent ($9 billion). Industry support increased an estimated 2 percent in 1994, and Federal support declined by 1 percent. In constant-dollar terms, both industrial and Federal support declined by 1 percent and 3 percent, respectively.

NSF Supports Agile Manufacturing Research Centers

Three agile manufacturing research institutes and an industry forum have been created with an $18 million, five-year commitment by the National Science Foundation (NSF) and the Advanced Research Projects Agency (ARPA) of the Department of Defense. Agile manufacturing, a key in making United States industries more competitive, is the ability to alter any aspect of the manufacturing enterprise — from business arrangements with subcontractors to the machine tooling in the factory — rapidly in response to changing market demands.

The Agile Manufacturing Enterprise Forum, associated with Lehigh University

[2]Extracted from NSF Press Releases on September 17, 1994; January 12 & 20, 1995; and February 8, 1995. The full article has been edited to cover only information pertinent to readers of JTST. Bold lettering has been inserted by the editor of JTST.

in Bethlehem, Pennsylvania, is an industry-led forum to develop a vision of agile manufacturing, create educational training materials, access small businesses, and publish results of agile manufacturing studies. The forum collaborates with the research institutes, government, and a broad spectrum of industry groups to support training and awareness needs. More than 100 companies are cooperating in the forum activities. The forum has received $5 million from ARPA, as well as industry support. "We're helping American industries be more competitive in the future and the future starts today," said Terry Schmoyer of the Agile Manufacturing Enterprise Forum. "To be more competitive, American industry must be able to respond efficiently to unanticipated change to meet the needs of customers in a global marketplace."

The three research institutes are the Agile Aerospace Manufacturing Research Institute at the University of Texas at Arlington; the Electronics Agile Manufacturing Research Institute at Rensselaer Polytechnic Institute; and the Machine Tool Agile Manufacturing Research Institute at the University of Illinois. Each of the research institutes will investigate the principles of agile manufacturing as it applies to specific industries. Each institute collaborates with many companies with industry leaders helping to direct the research agenda. Industry also provides funding for all three of the institutes. "The agile vision assumes that high quality and productivity — the near term result of being lean — are a prerequisite for 21st century manufacturers," said Michael McGrath, ARPA executive director of manufacturing. "Future agile competition will be based on the ability to react quickly and effectively to changes in markets, production teams and product/process technology." "This is a great chance to make a difference," said F. Stan Settles, program director for design and integration engineering with the National Science Foundation. "America is waking up to the need to do something about manufacturing. This is part of the wake up call."

For more information about any aspect of the Agile Manufacturing Program, contact: Terry Schmoyer, Agile Manufacturing Enterprise Forum: (610) 758-5510; Bob Graves, Electronics Agile Manufacturing Research Institute: (518) 276-6955; John Mills, Aerospace Agile Manufacturing Research Institute: (817) 794-5900; Dick DeVor, Machine Tool Agile Manufacturing Research Institute: (217) 333-3543; or Bruce Kramer, National Science Foundation: (703) 306-1330

NSF Establishes New Engineering Research Centers

The National Science Foundation will establish six new Engineering Research Centers (ERCs) and renew four which recently passed their sixth-year renewal reviews. These cross-disciplinary centers couple engineering and scientific disciplines to focus on next-generation technological advances in engineering systems. The centers address technologies that form the foundation for innovation in US industry.

ERCs are partnerships among academe, industry, the National Science Foundation, and the state and federal governments. The centers advance fundamental knowledge of new engineering systems, processes, and devices, while examining the barriers to engineering advancements. Centers explore such areas as: design and manufacturing; materials processing; optoelectronics, microelectronics, and telecommunications; biotechnology and bioengineering; energy and resource recovery; and civil infrastructure.

"These ERCs help catalyze a new culture in academe through their integration of cross-disciplinary research and education, and industrial and academic perspectives," said Joseph Bordogna, who leads the NSF's Directorate for Engineering. Eighteen established ERCs work with more than 1,000 partners from 727 firms. Of these companies, 40 percent are small businesses and 28 percent are medium-sized firms. Total annual funding from all sources for each center ranges from $2.5 to $12 million; the NSF's contribution ranges from $1.4 to $3 million annually. Centers are initially funded for five years. During the third year, centers are reviewed and, if successful, another five year award can be added to the end of the third year. A similar process is undertaken at the end of the sixth year. Thus, an ERC has a potential initial life-span under NSF support of 11 years. At the end of the ninth year, existing centers may recompete for a new life cycle. If a center fails to pass a renewal review, scale-down funding for a final two years is provided.

Supersonic Abrasive Ice-Blasting

The feasibility of a new method for the removal of paint or grease from surfaces with minimum impact on the environment has been demonstrated by National Science Foundation-funded researchers at Pennsylvania State University. Called "supersonic abrasive ice-blasting," this new method projects a cold stream of compressed gas and tiny ice microparticles at high speed against the surface being cleaned. The ice microparticles impact upon and wear away soft coatings such as paint, grease, dirt, or radioactive "crud" without damaging the surface underneath. This approach has commercial potential for such applications as aircraft depainting and metal-part degreasing. It is also simpler than previous iceblasting methods, said Gary Settles, the principle investigator.

"This is a wonderful example of modifying existing technology for new uses," said Mihail Roco, director of NSF's Fluid, Particulate and Hydraulic Systems Program. "With just a small amount of money, the researchers have developed a use for the technology that is not only immediately applicable for a variety of industrial uses, but also is kind to the environment."

Previous iceblasting techniques manufactured relatively large chunks of ice or dry ice which were then transported through a hose and out a blasting nozzle. The approach used by the Penn State Gas Dynamics Lab produces microparticles of ice just before the blasting nozzle itself, eliminating much of the previous complexity of icemaking equipment. This is accomplished by a water atomizing nozzle mounted upstream of the blasting nozzle. Freezing the atomized water droplets is insured by the fact that they are conveyed by compressed air which has been chilled by a small amount of injected liquid nitrogen. The feedwater for the iceblaster is augmented by adding a commercial substance (SNOMAX) used in snow-making machines to encourage rapid freezing. The resulting ice microparticles, which average about 70 micrometers (3 thousandths of an inch) in diameter, are then accelerated through a supersonic nozzle in order to bring them to a high velocity before impact. Average particle velocities of 230 meters/sec (515 miles/hour) have been measured.

The kinetic energy of the particles, which does the work in wearing away coatings on surfaces, comes mainly from particle velocity rather than particle mass in this approach. As a result, coatings can be removed without fear of damage to the underlying surfaces, since the job is done by millions of small particle impacts rather than fewer but more energetic impacts by larger chunks of ice. Tests have shown, for example, that polished aluminum panels can be stripped of paint by the new technique without marring the polish of the surface, even though the individual ice particles have a hardness similar to that of the metal itself. Further, coating removal by iceblasting carries important environmental benefits. In traditional abrasive blasting using mineral abrasives such as sand, the usefulness of the abrasive is over as soon as it strikes the surface being cleaned. Then comes the collection and disposal of large quantities of spent abrasive which is intermingled and contaminated with a comparatively small quantity of removed paint flakes. If the contaminants are considered hazardous, current EPA regulations require not only that the blasting site be contained to avoid environmental contamination, but also that the spent, contaminated abrasive be disposed of at a hazardous waste site at considerable expense. Even when the abrasive can be separated from the contaminants, this can still become a very expensive chore. However, with iceblasting, no solid waste abrasive remains to be cleaned up. There may be some liquid waste from melted ice particles in traditional iceblasting, but this can usually be separated and recycled efficiently. In the case of supersonic abrasive iceblasting, the ice microparticles are further pulverized upon impact, so residual moisture tends to evaporate, leaving little trace of the abrasive, and only the removed coating material requires disposal. Supersonic abrasive iceblasting was developed by the Penn State University Gas Dynamics Lab under an NSF Small Grant for Exploratory Research. The idea was to determine, in a laboratory setting, whether or not ice microparticles could be produced as already described, and whether or not they would have the desired abrasive effect. "Major technical challenges had to be overcome, and it looked at first as if the idea just might not be feasible in practice," Settles said. "The feedwater spray refused to freeze, the nozzle froze up and several "blind alley" design changes to the apparatus were pursued and later abandoned. However, perseverance eventually paid off when a real abrasive effect was demonstrated due to ice particles which are almost too small to be visible to the unaided eye."

The laboratory device built for this purpose needs some further development before it could be made available as a commercial device. The assistance of the coatings removal industry will be sought for this purpose. The eventual applications of supersonic abrasive iceblasting are believed to include relatively light or delicate work such as aircraft depainting and metal-part degreasing, but not the heavier-duty jobs like removal of paint and rust from highway bridges

Court Upholds NSF Policy on Withholding Reviewers' Names

The US District Court for the District of Columbia has ruled that the National Science Foundation properly protected the confidentiality of its peer reviewers — outside scientists and engineers who evaluate grant applicants and their proposals — in rendering its decision on "Smith" v. United States Department of Commerce and the National Science Foundation. In hearing the case, the court addressed for the first time whether a federal agency could withhold, under the Privacy Act, the names of reviewers who evaluate grant proposals.

The lawsuit was in response to a NSF decision not to award a grant to the Smiths to study the usefulness of a devise designed to test the stability of soil in earthquake-prone areas. The case challenged NSF's long-standing policy of withholding the names of peer reviewers. NSF routinely provides verbatim copies of all grant proposal reviews — minus the reviewers' names in order to promote candor — to the applicant once a decision has been made about whether to fund the proposal. The court found that the NSF's actions were proper under exemption (k)(5) of the federal Privacy Act, which protects the identities of sources of information used to determine qualifications for a "federal contract." In doing so the court rejected Smith's claim that federal grants are not "federal contracts."

Company News

Wall Colmonoy Met. Lab Awarded "NADCAP" Accreditation

Wall Colmonoy Corporation, a supplier of hard-surfacing and brazing materials to aerospace and other industries, was awarded NADCAP accreditation for materials testing. The audit process of the National Aerospace and Defense Contractors Accreditation Program is recognized by participating prime contractors for providing the highest assurances of quality.

Direct inquiries to: Tanya Anandan, Marketing Communications Manager, Wall Colmonoy Corporation, 30261 Stephenson Hwy, Madison Heights, MI 48071. Tel (810) 585-6400, Fax (810) 585-7960.

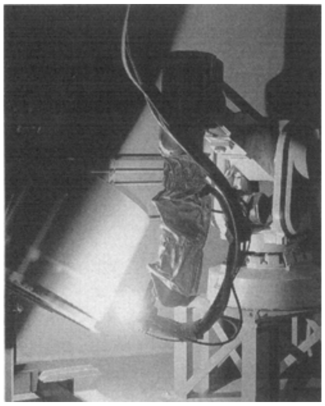
Turbine Overhaul at Wall Colmonoy

An IRB 2000 robot with a System 3 controller from ABB Flexible Automation (formerly ABB Robotics) was installed in the plasma spray station of Wall Calmonoy's turbine engine overhaul facility in San Antonio, Texas. Attached to the six-axis robot is an 80 kW high-energy plasma unit, which together will significantly enhance Wall Colmonoy's plasma spray capabilities of complex components.

Wall Colmonoy overhauls hot section turbine components from Pratt & Whitney PT6, PW100, JT15D, and PW901 series; Allison 250; and Garrett TPE331 and TFE731 series engines. Wall Colmonoy also provides turbine overhaul services for land and marine use; contract furnace brazing and heat treating;

and specialized prototype and OEM development.

For more information, contact John Kasavich, Wall Colmonoy Corporation, San Antonio, Texas. Tel (210) 924-5061, Fax (210) 924-0129.



New robot at Wall Colmonoy applies a thermal barrier coating to components used in F100 engines for the US military's F-15 and F-16 Fighter aircraft.

Engelhard Acquires Certain Assets of Advanced Plasma, Inc.

Engelhard Corporation announced today it has purchased for an undisclosed amount certain assets and the business of Advanced Plasma, Inc. Advanced Plasma is a North American supplier of advanced coating technologies and services. The company applies metallic, ceramic and carbide thermal spray coatings for wear resistance, and metallic-ceramic coatings for corrosion resistance in the aircraft, land-based gas turbine, printing, textiles, diesel, automotive and other industries.

Under the terms of the agreement, Engelhard has acquired Advanced Plasma's West Palm Beach, Florida coating facility, and will operate a new facility in Greenville, South Carolina, which is currently gearing up for production by mid-1995. The transaction enables Engelhard to broaden its existing line of thermal spray coatings to include metallic-ceramic technology.

According to Daniel J. Parker, President of Engelhard's Surface Technologies business unit, the acquisition significantly strengthens the Company's Competitive position, particularly in the gas turbine and printing industries. He said, "Besides expanding our technology base, the acquisition improves our supply and distribution network by enabling us to provide faster, more responsive service to customers. In addition, through this acquisition we are now able to provide our customers with comprehensive structural repair services."

Operating as part of Engelhard's Surface Technologies business unit, the West Palm Beach and Greenville facilities will be managed by current Advanced Plasma president Robert Bradley, who will report to Mr. Parker. Engelhard's Surface Technologies business unit also operates coatings facilities in East Windsor, Connecticut and Woburn, Massachusetts.

Contact: Jon Lederman, Engelhard Corp., 101 Wood Avenue, Iselin, NJ 08830-0770. Tel (908) 205-6244.

Services

Market on the "Information Superhighway" with Tenagra Corp.

The Internet is the core of a new revolution in communications that links individuals, learning centers, and businesses to each other, whether they are across the street or across the planet. The "Net" already has many thousands of sites and millions of users. It's growing at 10% per month.

Until recently, only scientists, academics, and giant international corporations made serious use of the Internet. The Internet is also a new frontier for businesses. The Tenagra Corporation works with companies to promote them internationally via correct and accepted Internet protocol. This "international" service complements traditional advertising and marketing.

The Tenagra Corporation, founded in April, 1993, helps organizations and companies to use the Internet to enhance their business and market their products and services to a worldwide audience. Tenagra is a member of the NASA Johnson Technology Commercialization Center, operated by the IC2 Institute (which is the International Research Center for the Study of Innovation, Creativity and Capital, at the University of Texas at Austin).

Contact: Dr. Clifford Kurtzman, The Tenagra Corporation, 2200 Space Park Dr. #200, Houston, TX, Tel (713) 335-1072, Fax (713) 333-9285, Email: Info@Tenagra.com, access on WWW by: http://arganet.tenagra.com/

"Thermal Spray Technology and Applications Center" at Drexel U.

Drexel University's Center for the Plasma Processing of Materials (CPPM) announces its new Thermal Spray Technology Applications Center (TAC). Designed for industrial "problem-solving," the TAC is providing short and intermediate term thermal spray coating solutions for industrial problems. TAC is employing the results and expertise developed by the CPPM during 10 years of industrial research as its chief resources. TAC initiatives include:

- Coatings to replace chromium plate.
- Tool & die coatings for component life extension.
- Aqueous corrosion-resistant coatings.
- Automotive coatings.
- New wear-resistant materials.

Contact: Dr. Ronald W. Smith, Mr. Michael Kim, or Dr. Richard Knight, Tel (215) 895-1844 or 1990, Fax (215) 895-2332.

Water-Jet System from Aqua-dyne, Inc. Replaces Sandblasting

Aqua-Dyne, Inc. is a Houston based company that has specialized in state-of-art, high-pressure industrial pumps and nozzles for over 20 years. These high-pressure pumps, nozzles, and systems have been employed in many projects; from aircraft parts to scouring oil tankers, chemical tanks, and cleaning buildings and parking lots. Some of the industries served are automobile, leather, meat products, aerospace, ship building, and cleaning. The power of water is being harnessed by Aqua-Dyne at a time when environmental concerns are rising and the alternative use of chemicals and other methods are being scrutinized by the EPA.

Contact: George Rankin, Aqua-Dyne, Inc., 3620 West 11th St., Houston, TX. Tel (713) 864-6929, Fax (713) 864-0313.

Metallurgical Technologies, Inc. Produces Thermal Spray Powders

Metallurgical Technologies, Inc. (MTI) has been producing thermal spray powders at its manufacturing plant in Pearland, Texas, USA since 1984. A full line of ceramic, carbide, and alloy materials are produced; including those for high velocity oxygen fuel (HVOF) and plasma applications. Some of the industries which MTI services include aircraft engines, automotive, land-based turbines, power generation, chemical, steel mill, and petroleum.

Metallurgical Technologies, Inc.'s successes include:

- Completion of facility audits resulting in approvals from General Electric Aircraft Engines and Textron Lycoming for the manufacturing of thermal spray powders.
- Similar approvals from both Pratt & Whitney and SNECMA.
- Projected ISO 9002 certification by March 1995.
- A full line of fused powders primarily based upon Al_2O_3, TiO_2, and Cr_2O_3.

These powders require tight control over powder morphology and particle size distribution to insure excellent coating performance. These products enhance MTI's existing wide range lines of:

(1) Tungsten carbide and chromium carbide based HVOF powders;

(2) Molybdenum based products used in the automotive and aerospace industries;

(3) Yttria stabilized zirconia and abradable materials.

Development of a full line of special ceramic powders to meet the growing demand for very tightly sized, free flowing materials for thermal spraying. Because of the unique properties of these materials, they are currently being used in traditional flame and plasma spray and also newly developed high performance HVOF applications.

Contact: Jim Huddleson, Metallurgical Technologies, Inc., 14435 Max Road, Pearland, TX 77581 Tel (713) 485-7765, Fax (713) 485-0211.

Northwest Mettech Corp.'s Axial Feed Plasma Spray System

Northwest Mettech Corp. announces the development of its *Axial III* Plasma Spray system. The *Axial III* Plasma Spray system incorporates an axial powder feed design that enables high deposition efficiencies and powder feed rates to be achieved for carbide, metal, and ceramic type coatings. Typical deposition efficiencies and powder feed rates for a selection of materials are as follows:

Material	Deposition Efficiency*	Powder Feed rates g/min. (lbs/hr)
WC-17% Co	>90%	160 (21 1)
Titanium (CP)	>90%	56 (7.4)
Al_2O_3-TiO_2	>90%	50 (6.6)

* All materials sprayed at 12 cm^3/min for illustrative purposes only Higher spray rates can be achieved.

The *Axial III* Plasma Spray system also has a simple, bolt-on shroud attachment which permits reactive materials such as titanium, zirconium, and MCrAlYs to be sprayed without the use of a vacuum chamber. Two examples of coatings produced with the *Axial III* Plasma Spray System are detailed below.

CASE STUDY 1 - Titanium Coatings Extend Component Lifetimes

A large pulp & paper company contacted Mettech to refurbish the worn seal areas on a solid titanium shaft and to build up the bearing surface so that a larger bearing could be used. The rotating seal surfaces had become worn during operation to the point that leaks were occurring and the shaft had become un-usable. Mettech proposed that the shaft be repaired by applying *Axial III* titanium coatings to the worn seal areas and the shaft's bearing surface. The design of the *Axial III* system allowed for the application of clean titanium coatings to pieces previously considered impractical for vacuum applications. The original refurbished shaft has been in service for several months and has met or exceeded all expectations.

CASE STUDY 2 - Grip Roll for Paper Machine

In spring 1994, a paper company made the decision to build a replacement roll for a winder drum that was slipping while in operation in the paper mill. The roll was 22' long 26" in diameter and weighed approximately 15,000 lbs. Mettech proposed to coat the grip roll with a very coarse, WC-Co based, proprietary Mettech powder. Due to the axial powder feed design of the Mettech *Axial III* Plasma Spray system, Mettech was able to provide a sample of the coating material that was much coarser than anything the paper company had seen before. Approximately 45 lbs. of material were then deposited on the grip roll with an average spray rate of over 20 lbs/hr. The grip roll that was delivered to the paper company in June 1994. The grip roll that was previously slipping while in service was sent to Mettech in September 1994 and was also coated to the same standards.

Contact: Alan Burgess. Northwest Mettech Corp., 120-1200 Valmont Way, Richmond, B.C., Canada, V6V IY4. Tel (604) 244-1663, Fax (604) 244-1673.

RotoSystem™ for Automated Metallographic Preparation

The modular RotoSystem offers system flexibility and high reproducibility to

RotoSystem™ links components for optimized, automated metallographic sample preparation.

meet the diverse needs of medium-volume labs. The best combination of Struers "building block" components to meet the specific needs of the lab's applications are first grouped as RotoSystem™ modules, then electronically linked. Automatic control of all preparation parameters results in production of consistent samples.

Exactly the same preparation is achieved. Master + user-defined programs are stored in memory. Up to six lubricants or suspensions, including alumina and colloidal silica, can be applied without clogging. RotoSystem™ can record or download preparation programs through a PC, so custom preparation programs can be recorded at one site and downloaded to other sites. All labs can then be running the same procedure, resulting in organization-wide reproducibility.

Contact: Chris Sopko, Marketing Manager, Struers, 26100 First Street, Westlake, OH 44145-1438, Tel (216) 871-0071, (800) 321-5834, Fax (216) 871-8188.

News from the International Thermal Spray Association

New ITSA Membership Drive

Robert D. Dowell, Chairman of the International Thermal Spray Association (ITSA), has announced a broad, new membership drive for the Association. Members of the thermal spray community — worldwide — are invited to send for new member information by contacting the Association's Member Services office. Association membership is offered in one of three categories: Regular for thermal spray contract shops, Associate for manufacturers of equipment and consumables, and Research Associate for academic and research institutions.

In a recent newsletter to the membership, Chairman Dowell requested that each ITSA member nominate or recommend two candidate organizations to the Association and also share the responsibility of sponsoring future applicants.

The new drive comes in the wake of the Association's Fall Meeting where it was decided that selectively increasing the international membership of the Association was critical to the ITSA's long-term quality and growth goals. "Our association's growth in North America and throughout the world can match what the market is doing," said Chairman Dowell, "and we can most easily make that happen with the help of our members."

To support its international drive, the ITSA has prepared Association fact information in French, German, Japanese, Spanish, and English.

ITSA members are asked to send their nominations to Member Services, P.O. Box 693, Glastonbury, CT 06033, USA. Tel (203) 657-3440, Fax (203) 657-2252.

Australian Firm Attributes its Success to ITSA Members

In 1985, Keith Moore and his son, Richard Moore, launched United Surface Technologies (UST) to take advantage of the increasing demand for thermal spray services in the Pacific Rim and Australia — a promising market that Keith Moore helped develop with a former company.

The timing was good. The Government of Victoria was lending its support to local companies operating in the field of advanced materials, — and there were relatively few coating businesses in Australia. Keith Moore had visited ITSA member plants in the US in 1978 and attributes these associations, their continuing support, and advice as key factors in his company's success.

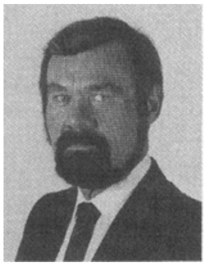
Today, points out Keith Moore, there are approximately 30 companies in the thermal spray or related business, each helping service markets that include Indonesia, Malaysia, Philippines, Taiwan, and New Zealand.

In 1993, to accommodate a growing global market, UST expanded its facility by merging with Halkys Precision Hardfacing and relocated to a new plant. Halkys was a company with twenty years of experience in the field of precision hard facing and eight years in Plasma Transferred Arc (PTA) applications, as well as HVOF and other thermal spray systems. Keith Moore brought his years of experience in thermal spray operations to both the US and UK. As an inventor, he has received three provisional patents for coating pipeline elbows, coating internal pipelines and for ceramic coatings. Richard Moore, who now serves as UST's Director of Sales and Marketing, was formerly Quality Assurance Manager for Graham Campbell Foundries.

Keith Moore

From the beginning, the company has included research and development in its planning, with many of UST's research achievements made possible with organizations such as Materials Research Laboratories (MRL), Commonwealth Scientific Industrial Research Organization (CSIRO), and Monash University (in Melbourne). Keith Moore feels that the company's thermal spray services compare favorably on a worldwide scale and he expects a growth rate of about 15 to 20% a year. UST (formerly Ceramcoat) has been a member of the ITSA since 1989.

Sokol - General Manager of Miller Thermal, Inc.



Larry S. Sokol

Larry S. Sokol has been promoted to General Manager of Miller Thermal in Appleton, WI. Mr. Sokol will assume management responsibility for the company. He joined Miller Thermal in 1993 as General Manager of the company's Alloys International division in Baytown, TX. Mr. Sokol was previously Vice President of Engineering and Research at Gator-Gard in Baynton Beach, FL, where he was responsible for all research, development, and engineering.

Foster - Sales Manager of Miller Thermal, Inc.

Daniel Foster has become the Sales Manager for Miller Thermal. Most recently Mr. Foster has served as a District Sales Manager, based in Palatine, IL. He has been with Miller since 1988. Mr. Foster has been responsible for technical customer service, application recommendations, in-house sales demonstrations, and training on Miller Thermal equipment. He has also performed on-site installation, training, and troubleshooting.

Sundarajan Mutialu Joins Miller Thermal

Miller Thermal, Inc. announces the addition of Sundarajan Mutialu as Special Projects Manager. In this capacity Mutialu will serve Miller Thermal accounts in the western United States as well as specific national accounts.

Mutialu has a diverse background in advanced materials, materials processing, coating and surface modifications fields, including thermal spray. In the past 16 years, he has served as Vice President of Plasma Technik, AG Switzerland; General Sales Manager of Airco Temescal Evaporated Products, Berkeley, CA (presently Chromalloy American); and Assistant to the President, Jet Avion, Hollywood, FL.

Mutialu has been an independent consultant for the past six years. He has consulted for Sermatech International, Leybold Heraeus, Multi-Arc Vacuum Systems, Scientific Coatings, US Air Force, Control Data Corporation, Crystallume Inc., and Spire Corporation, among others.

Mutialu is on the Council for the Thermal Spray Society of ASM. He is Publicity Chairman and Co-Chair of the Sales and Marketing Committee of the National Thermal Spray Conference for ASM. Mutialu has also served as Executive Member and Exhibits Chairman for at least four National Materials and Coatings conferences.

Contact: Miller Thermal, Inc., P.O. Box 1081, N670 Communication Drive, Appleton, WI 54912, Tel (414) 734-9292, Fax (414) 734-2160.

Dr. Jokiel Joins Hilti AG

Dr. Paul Jokiel, a graduate of the Technical University of Aachen, has joined Hilti Corporation in Schaan, Liechtenstein. He will be responsible for all surface technology matters within the Corporation's research department, particularly in the area of wear resistance.

Contact: Dr. Jokiel, Hilti AG, Konzernforschung-IWO, FL-9494 Schaan, Tel 0041/75/236-2225, Fax 0041/75/236-2379.