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News From Institutes and Research Centers Around the World

This column is a forum to inform the thermal spray community on current activities in institutes and research centers active in the field of the thermal spray. Research efforts carried out in these organizations are oftentimes the starting point of significant developments of the technology that will have an impact on the way coatings are produced and used in industry. New materials, more efficient spray processes, better diagnostic tools, and clearer understanding of the chemical and physical processes involved during spraying are examples of such developments making possible the production of highly consistent performance coatings for use in more and more demanding applications encountered in the industry.

This column includes articles giving an overview of current activities or a focus on a significant breakthrough resulting from research efforts carried out in institutes and research centers around the world. If you want to submit an article for this column, please contact: Dr. Jan Ilavsky, UNICAT, APS Bldg 438E, Argonne National Laboratory, 9700 S. Cass Ave., Argonne, IL 60439; tel: 630/252-0866; fax: 630/252-0862; e-mail: ilavsky@aps.anl.gov.

Product Development with Advanced Surface Technologies at IMTCCC

Process and product development with advanced surface technologies is a key strategy and core business in the (IMTCCC) at the University of Stuttgart, Germany. A special focus is the application of state-of-the-art thermal spray technologies to create performing layer composites with a broad variety of substrate materials, functional coatings, and industrial applications. Furthermore, chemical processing and liquid phase technologies are applied for coatings based on ceramic precursors, special lacquers, and microscale and nanoscale dispersions in high-end polymer coatings.

In the field of thermal spraying, IMTCCC concentrates on high-temperature hypersonic flame spraying with high-pressure gas and kerosene high-velocity oxyfuel (HVOF) systems, both integrated in advanced steering and control systems according to industrial manufacturing standards of leading OEM. The second center of activities is in atmospheric plasma spraying with a focus on functional ceramic coatings on sensitive substrate materials and components. Electric arc spray deposition by the use of light metal alloy wires and even complex multiphase powder and fiber-filled wires are a further field of research and development.

Besides the research in thermal spray processing and production engineering with integrated systems, IMTCCC deals with composite technologies as a fundamental and essential tool to optimize the chemical and mechanical compatibility in various layer composites. Modeling and simulations using FEM tools and coupled stress-temperature analysis are performed to manage the impulse, heat, and mass transfer during the coating formation and deposition as well as the occurring residual stresses. Thermally induced stresses in combination with load stresses under operation conditions in thermal engines are limiting factors for any type of advanced coating under severe or extreme operation conditions.

Based on the experience and hardware capacities in chemical and ceramic engineering in IMTCCC, the full manufacturing chain for advanced powders and agglomerates for thermal spraying is available from the preparation of aqueous and nonaqueous slurries, fine milling technologies, spray dry granulation, and finally calcination and HT treatment up to 2000 K.

Industrial manufacturing with advanced coating technologies includes all necessary measures to achieve high process stability, availability of the equipment, reproducibility, and last but not least the reliability of the product. Therefore, modern systems and tools of total quality management (TQM) are a further center of activity.

Lanthanum Hexa-Aluminate Thermal Barrier Coatings

Lanthanum hexa-aluminate in magnetoplumbite structure is a promising competitor to yttria partially stabilized zirconia (Y-PSZ) as a thermal barrier coating (TBC), since most zirconia coatings age significantly including densification at temperatures exceeding 1100 °C.

Coatings consisting of lanthanum hexa-aluminate have a platelet-containing microstructure. The magnetoplumbite crystal structure is characterized by a highly

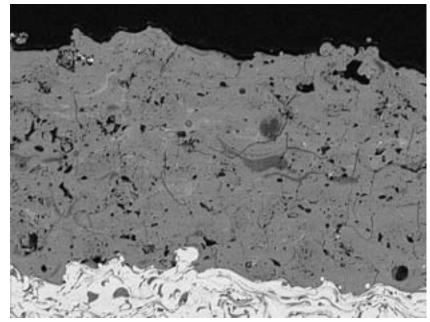


Fig. 1 Cross-section micrograph of thermally sprayed La-MP coating

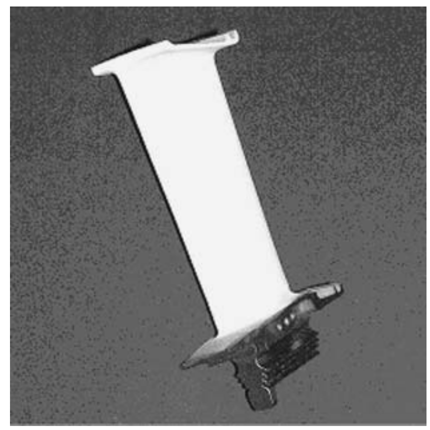


Fig. 2 La-MP plasma coated turbine blade

charged La^{3+}-cation located in an oxygen position in the hexagonal closest-packed structure of oxygen ions. Diffusion is strongly suppressed due to the crystallographic structure, and the material nearly shows no postsintering during operation. Operating temperatures above 1100 °C (up to 1600 °C) are possible because of the thermal stability of lanthanum hexa-aluminate.

IMTCCC has developed an optimized thermal spray powder by spray drying technique of aqueous slurries. Additionally, the APS deposition process of these granulates has been optimized in order to produce homogeneous crystalline coatings with controlled microporosity and residual stresses. Due to the superior qualities of this new material it can replace conventional PSZ-TBC in future.

Thermally Sprayed Multilayer Coatings as Electrodes and Dielectrics in High-Efficiency Ozonizer Tubes

The aim of this research and development project is a novel, powerful ozonizer tube that cuts down the production cost and

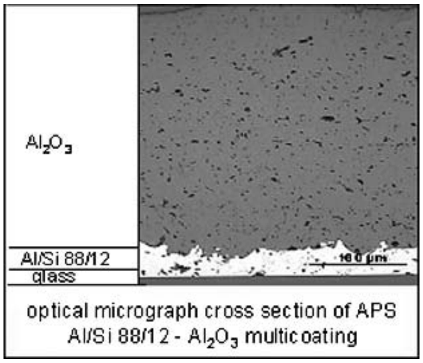


Fig. 3 Metal-ceramic layer composite plasma sprayed on borosilicate glass

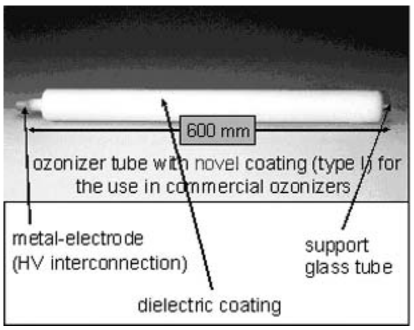


Fig. 4 Glass tube with applied metal-ceramic layer composite

thus causes ozone to be an economically competitive alternative in comparison to traditionally used chlorine compounds. Standard ozonizer tubes consist of a borosilicate glass tube with a metal coating applied to the inner surface of the tube serving as the HV-electrode. In this arrangement, the tube itself serves as a dielectric. In order to increase the ozone production efficiency, one possibility is to increase the capacity of the ozonizer tubes. For this reason, the use of a material with a higher permittivity is needed.

IMTCCC has developed a novel concept of atmospheric plasma spraying (APS) sprayed tubes where a plasma sprayed ceramic layer serves as the dielectric. It is deposited together with the metal electrode on top of the glass tube. The ceramic reaches a layer thickness up to 1000 µm. An increase of up to approximately 30% (for type I) and 60% (for type II) in ozone production efficiency could be achieved.

Ceramic-Polymer Coating Systems with Advantageous Tribological Properties

In mechanical engineering, there is an increasing demand for lightweight design and materials engineering from the viewpoints of weight reduction, reduction of

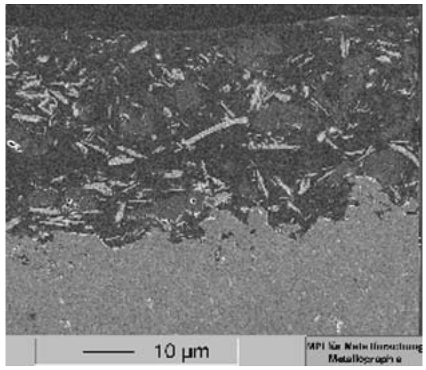


Fig. 5 Scanning electron micrograph of combined TiO_2/lubricating varnish coating

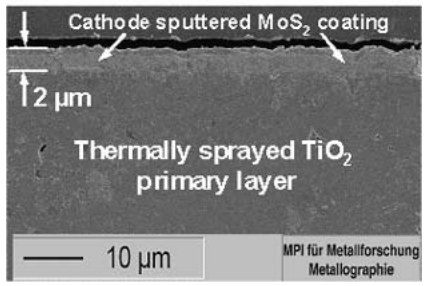


Fig. 6 Cross section of thermal spray thin film combined coating (TiO_2/MoS_2)

consumed energy, and upgrading of performance. One major drawback of light metal alloys is their poor tribological properties concerning friction and wear under high surface loadings. IMTCCC focuses on the development of combined coatings on light metal substrates that show high wear resistance and low friction coefficients under dry sliding conditions. The combined coatings consist of a thermally sprayed ceramic or metallurgical primary coating to provide the wear resistance. Subsequently, a coating with dry lubricating ability is deposited to achieve a low friction coefficient, either by application of lubricant lacquer containing microscale solid lubricant particles (e.g., PTFE, MoS_2), by cathode sputtering of MoS_2 or by deposition of pure carbon containing coatings (a-C:H) by plasma assisted CVD.

Advanced Coatings for Ultra-Lightweight Engines with Thermally Sprayed Cylinder Liners and Crankcases

The reduction of fuel consumption and pollution emissions, the improvement of the engine efficiency as well as the cost reduction in manufacturing and assembly are in the focus of actual research activities in the automotive industry. Most of these requirements can be fulfilled by a

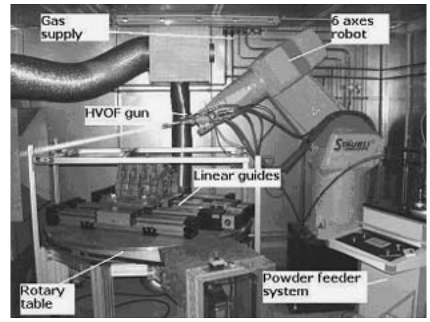


Fig. 7 Cylinder liner coating facility at the IMTCCC with robot-guided HVOF torch and rotary table to move the engine block

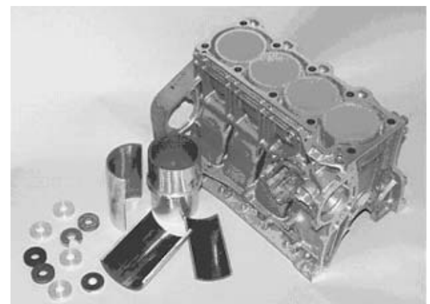


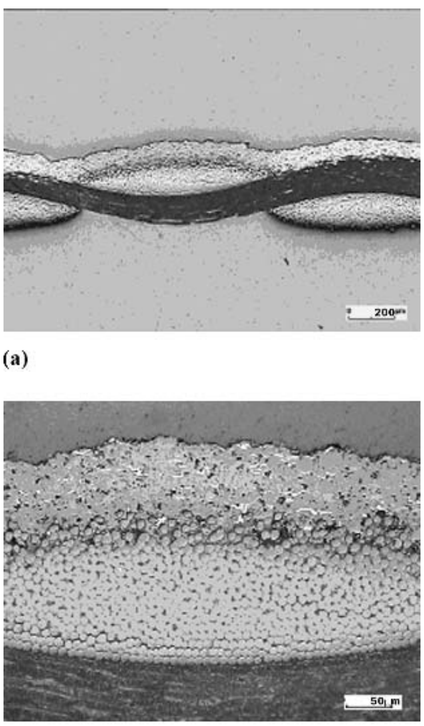
Fig. 8 Coating development includes coating of tribo-samples, single bushes, and complete light metal engine blocks

reduction of the total vehicle weight. This results in an increasing utilization of light metals for chassis, body and engine components. Significant weight savings are obtained by changing the engine block material from cast iron to aluminum. Due to the harsh operation conditions, the aluminum cylinder must be reinforced. Approaches to increase combustion as well as operation efficiency and lifetime of light metal engines are thermally sprayed APS and HVOF coatings on cylinder liners of the aluminum crankcases.

For this purpose, IMTCCC developed an HVOF coating process (with different fuel gases/fluids) together with the complete kinematics control of HVOF torch and engine block. Unlike in other coating techniques where a rotating miniaturized torch is inserted into the cylinder liner, the HVOF torch is operated externally. It follows an elliptically shaped moving path, whereas the cylinder liner is rotating. This enables an improved coating microstructure (less porosity) and superior coating adhesion. The HVOF coatings are homogeneous, with a dense, bulk like microstructure, a low porosity ($\leqslant 3\%$) and surface roughness as well as a superior coating adhesion compared to APS coatings.

Ceramic Coatings on Fiber-Woven Fabrics

There is an increasing demand for ceramic and cermet coatings on all kinds of fiber fabrics as they can significantly extend the functionality of these flexible materials in many applications. Based on thermal spray technologies, IMTCCC has developed a coating process for temperature-sensitive fiber substrates that allows the coated fabrics to retain their flexibility. High-speed and high-rate cermet and ceramic coatings are deposited with simultaneous substrate cooling in order to apply thick, hard, and refractory cermet and oxide ceramic coatings. These coatings can be applied, e.g., on lightweight aramide fabrics without damaging the fibers. This way, a fully flexible, highly tenacious, and lightweight fabric with a hard and refractory top coating has been realized. One key application is the stab and ballistic protection. The penetration of bullets, knives, and blades through such hard material coated multilayer fabrics can be effectively prevented. Other applications cover heat- and fire-resistant flexible materials for human protection, for use in biomedical applications, and many more applications.



(a) (b)

Fig. 9 Cross section of a thermally sprayed Al_2O_3 coating on a Twaron fabric

Other Major Activities

- Bioceramic coatings and composites for implants and prostheses in modern surgery
- Residual stress measurement and modeling for ceramic layer composites
- High-velocity oxygen fuel (HVOF) metallurgical coatings for high-temperature erosion protection of diesel engine pistons
- Prepreg fabrication for MMC production by thermal spray coating of reinforcement fiber fabrics

Novel Coating and Optical Monitoring Technology for Ceramic Coatings from STS

Southside Thermal Sciences Ltd. (STS) is a spinout from Imperial College London, created to develop a novel coating and optical monitoring technology for ceramic coatings. STS sees the first application of the technology in the gas turbine sector for power generation and jet engines. In November 2002, STS received the European Technology Innovation Award from the *Wall Street Journal Europe* for its novel technology approach.

The sensor coating works by adding small amounts of a phosphor into standard thermal barrier coatings (TBCs) commonly used on hot section components of gas turbines. When illuminated with excitation light, the sensor coating phosphoresces provide information about temperature, erosion, and phase changes of the coating. Measurements can be carried out on static or moving components. The sensor works completely remote since it is based on optical excitation and observation.

STS's most recent developments include yttria-stabilized zirconia (YSZ) based powders with temperature measurement capabilities up to 1200 °C. Thermally sprayed sensor coatings (APS) were produced to industrial standards, which withstood severe thermal cycling regimes without losing the monitoring capabilities. Further, sensor coatings can be utilized to monitor structural changes due to chemical or physical attack. A sensor coating with high-temperature measurement capability will be available for R&D purposes by the end of 2004.

Applications of the Sensor Coating:

- **Design tool—faster development of coatings and turbines.** Use the monitoring capabilities of the sensor coating to reduce development times of new coatings and engineering designs.
- **Reduced maintenance and operational costs.** Check coating condition through monitoring at shutdowns and during operation to assess remaining component life, shorten outage times, and improve predictive maintenance.
- **Higher efficiency, lower fuel costs, lower emissions.** Measure temperature and collect data for life prediction during operation to run turbines at optimal/higher temperatures while minimizing the risk of exceeding temperature limits. This application is particularly relevant for power sector gas turbines where efficiency could be increased by up to 1%.
- **Platform technology.** STS believes that the technology can be introduced into other industrial sectors to monitor the status of coatings.
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Industrial News

TiNano Coat, a New Thermal Spray Product from Altair Nanotechnologies

Altair Nanotechnologies, Inc., a company engaged in developing nanomaterials, titanium dioxide pigment technology, and materials science focused on nanostructures, has announced that its novel nanomaterials thermal spray grade powder, TiNano Coat, demonstrated significantly superior mechanical properties in a competitive study performed by the National Research Council (NRC) of Canada. The study was performed at NRC's state-of-the-art Industrial Materials Institute facilities in Boucherville, Quebec, from November 2003 through February 2004.

Fig. 1 Computerized complex for ultrasonic peening of materials, parts, and welded elements

"The outstanding test results from the NRC further validate not only our TiNano Coat product itself, but provide additional proof-of-concept of our patented technology platform as the foundation from which we can drive commercialization of nanotechnology," said Dr. Rudi E. Moerck. "With testing complete, we are now focused on revenue generation and have retained a leading international business development firm, Global Strategy, to assist us in aggressively marketing and distributing both TiNano Coat and ZNano Coat products worldwide."

Testing Methodology and Results

The competitive performance study compared two versions of TiNano Coat powders to commercially available titania products, both nano and standard powders, in air plasma spray (APS) and high-velocity oxygen fuel (HVOF) coating applications. Tests included porosity (the percentage of pores that could absorb harmful fluids or gases), hardness, abrasion resistance, and bond strength. Altair's nanostructured TiNano Coat produced the optimal mechanical properties for either HVOF or APS spray devices, compared to conventional materials. Test results also determined that HVOF is the best application process for Altair's TiNano Coat materials, as the low bond strength problem associated with conventional coatings is completely eliminated by Altair's materials, while simultaneously producing the low porosities typical of HVOF grade materials.

Altair owns a proprietary technology for making nanocrystalline materials of unique quality, both economically and in large quantities. The company is currently developing special materials with potential applications in pharmaceuticals, titanium pigment and metal, batteries, fuel cells, solar cells, advanced energy storage devices, thermal spray coatings, catalysts, cosmetics, and environmental remediation.

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Ultrasonic Peening of Materials, Parts, and Welded Elements

Intense levels of high-frequency acoustic energy or high-power ultrasonics, have found practical use in many industrial processes, of which cleaning, welding, and drilling are well-known examples. Other applications include metal forming, treatment of molten metals, chemical processing, and even therapeutic and surgical uses in medicine. In most industrial applications, high-power ultrasonics involves power levels of hundreds to thousands of watts and ultrasonic systems operating in the frequency ranges from 15-100 kHz. Typical amplitudes range from about 10-40 μm. Such an ultrasonic system operating at 20 kHz creates a cyclic acceleration of around 50,000 g (acceleration of gravity).

One of the promising directions in using of the high-power ultrasonics for industrial applications is the ultrasonic peening (UP) of materials, parts, and welded elements (Fig. 1). The UP technique is based on the combined effect of the high-frequency impacts of the special strikers and ultrasonic oscillation in treated material.

The developed system for UP includes an ultrasonic transducer, generator, and laptop with software for UP optimal application—maximum possible increase in fatigue life of parts and welded elements with minimum cost, labor, and power consumption.

The UP produces a number of beneficial effects in metals and alloys. Foremost among these is increasing the resistance of materials to surface-related failures, such as fatigue and stress-corrosion cracking. The UP technology could be applied effectively for eliminating of distortions caused by welding and other technological processes, residual stress relieving, increasing the hardness of materials.

In fatigue improvement, the beneficial effect is achieved mainly by relieving the harmful tensile residual stresses and introducing compressive residual stresses into surface layers of metals and alloys, decreasing stress concentration of weld toe zones, and enhancing the mechanical properties of the surface layer of the material. The fatigue testing of welded specimens showed that the UP is the most efficient and economical improvement treatment compared with traditional techniques such as grinding, TIG-dressing, heat treatment, hammer peening, shot peening, etc. See Fig. 2.

For the effective application of UP for different materials, a software package was developed based on original predictive model. The main functions of the developed software are:

- determination of the maximum possible increase in fatigue life of welded elements by UP, depending on the mechanical properties of material, the type of welded element, parameters of cyclic loading, and other factors;
- determination of the optimal technological parameters of UP (maximum possible effect with minimum cost, labor, and power consumption) for every considered welded element;
- quality monitoring of UP process; and
- final fatigue assessment of welded elements or structures after UP, based on detailed inspection of UP treated zones and computation.

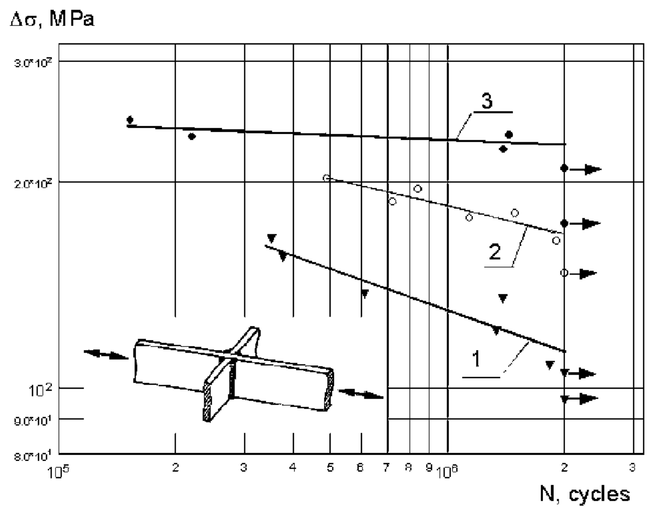

Fig. 2 Fatigue curves of non-load-carrying fillet welded joint: 1, in as-welded condition; 2 and 3, after application of the UP by using technology A and technology B (optimized)

The developed computerized complex for UP was successfully applied in different applications for increasing the fatigue life of welded elements, eliminating of distortions caused by welding and other technological processes, residual stress relieving, increasing of the hardness of the surface of materials and surface nanocrystallization.

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- "Method of Treatment of Welded Elements of Metal Structures by High-Frequency Peening," PCT UA02/00025, 2002

- **Contact:** Integrity Testing Laboratory Inc., 80 Esna Park Dr., Units 7-9, Markham, Ontario L3R 2R7, Canada; tel.: 905/415-2207; fax: 905/415-3633; e-mail: ykudryavtsev@itlinc.com; Web: www.itlinc.com.

New Technology Worth Its Weight in Chrome

A powdered blend of tungsten carbide and cobalt used to coat jet engine parts, and new thermal-spray technology used to apply it are being tested by people at the Oklahoma City Air Logistics Center.

The powder is emerging as the military's best bet for replacing cancer-causing chrome, officials said. "Chrome repair has been around for 60 years," said Johnny Tsiao, Propulsion Directorate aerospace engineer. "It works great, and it's cheap." However, chrome is a carcinogen and an Environmental Protection Agency-banned substance. Air Force, Army, and Navy officials organized the Propulsion Environmental Working Group to find an environmentally friendly alternative that would at least match chrome in durability. The sprayed-on powdered-blend coating actually fares far better than chrome. Endurance tests show the coating lasts as long as chrome. "We're confident it'll last twice as long," Mr. Tsiao said. "We'd like to test it to see if it can (last) three times as long."

The group selected a TF33 engine as a test subject, and engineers identified seven engine parts for application and endurance tests. It also designed and equipped specialized booths to apply the coating. The booths cost about $1 million each, and the group has two of them, with a third booth under construction. Unlike other plasma spray booths, these have 12-foot ceilings, because a shaft selected as one of the seven test parts measures 5 ft long, and engineers wanted to be able to spray it while it is upright.

The process will work with number of different powder compositions. Contracted engineers selected tungsten carbide and cobalt. A seven-axis robot applies the spray at a velocity of Mach 2.5. Because the high velocity generates so much heat, an infrared pyrometer monitors the temperature. The temperature of the part must be kept below 400 °F, and cooling jets blow air on the part. Other equipment in the booth includes a powder feeder and dust collector. The high velocity also generates noise levels to rival a jet engine, so the booths are soundproofed. Between 5 and 10 lb of powder is needed to coat one part with 17% Co and 83% tungsten carbide. With upfront costs for the booths, the cost savings of the new process are not immediately apparent, but over time it is believed the Air Force will recoup the investment. The Air Force's payback will not come in dollars, but in mission capability.

The downside to the new process is that it is "a line-of-sight" application only, meaning some engine parts that are out of reach will continue to require chrome; at least until the group can tackle that problem using new technologies.

Contact: Jeanne Grimes, Oklahoma City Air Logistics Center Public Affairs.

Courtesy of *Air Force Print News.*

CINDAS Materials Properties Databases

CINDAS LLC provides critically evaluated materials properties databases for thermal, mechanical, electrical, physical, and other properties of various materials. It provides CD-ROM and Web-based applications for searching and comparing continually updated data. Free demos of the web-based applications of both the MPMD and the TPMD are on the Website at http://cindasdata.com/.

Table 1 Material Groups and Properties for MPMD and TPMD

Microelectronics Packaging Materials Database (MPMD)		Thermophysical Properties of Matter Database (TPMD)	
Material Groups	**Properties**	**Material Groups**	**Properties**
Adhesives	Density	Coatings	Specific heat
Bonding wire alloys	Dielectric constant	Metallic elements and alloys	Thermal conductivity
Ceramics and glass-ceramics	Diffusivity	Nonmetallic liquids and gases	Thermal diffusivity
Dielectric polymers	Electrical conductivity	Nonmetallic solids	Thermal expansion
Elemental materials	Emissivity		Viscosity
Encapsulants	Fracture toughness		Thermal radiative
Intermetallics	Hardness		• Emittance
Lead frame alloys	Heat capacity		• Reflectance
Leaded and lead-free solders	Impedance		• Absorptance
Metal-matrix composites	Interfacial tension		• Transmittance
Molding compounds	Poisson's ratio		
Neat and filled epoxies	Porosity		
Polymer matrix Laminates	Shear stength		
Semiconductors	Specific heat		
Thermal management materials	Stress strain		
	Tensile strength		
Underfill materials	Thermal conductivity		
	Thermal expansion		
	Thermal radiative		
	Viscosity		
	Young's modulus		

Microelectronics Packaging Materials Database (MPMD)

The MPMD (see Table 1) contains data and information on thermal, mechanical, electrical, and physical properties of electronics packaging materials. It was initially developed through both basic and applied research, using experimental techniques and literature searches by CINDAS at Purdue University in conjunction with the Semiconductor Research Corporation (SRC). There are more than 600 materials and more than 11,000 data curves in the MPMD.

Thermophysical Properties of Matter Database (TPMD)

The TPMD database (see Table 1) contains thermophysical properties such as thermal expansion, thermal conductivity, specific heat, and thermal diffusivity, as well as thermal radiative properties like total emittance, spectral reflectance, spectral transmittance, and spectral and solar absorbance. Data is provided for non-metals and metals, ferrous and nonferrous alloys, single, binary, and tertiary oxides and mixtures of oxides, nonoxide compounds, minerals, polymers, composites, and animal and vegetable natural substances. This database contains approximately 50,000 data curves on more than 5000 materials.

CINDAS LLC is a privately owned company formed exclusively to disseminate materials properties data collected and analyzed by the Center for Information and Numerical Data Analysis and Synthesis (CINDAS) at Purdue University. Sponsorship for the many years of research at CINDAS was provided by DoD, NASA, NIST, the Air Force Materials Laboratory, Semiconductor Research Corporation, and many others. CINDAS also operated four Information Analysis Centers (IACs) for the U.S. Department of Defense. These were the High Temperature Materials, Metals, Ceramics and Metal-Matrix Composite IACs. CINDAS LLC has exclusively licensed all of the CINDAS/Purdue materials property data from the Purdue Research Foundation. It is committed to carrying on the tradition of providing reliable materials properties data in easily accessible and searchable electronic format.

Contact: CINDAS LL, P.O. Box 3814, West Lafayette, IN 47996-3814; tel/fax: 765/746-2039; toll free (U.S. and Canada only): 800/696-7549; e-mail: info@cindasdata.com; Web: http://cindasdata.com.

New Products and Industry News

Hypersonic Flame Spray Coats Auto Aluminum Cylinder Liners

Several high-velocity oxygen fuel (HVOF) coating processes for aluminum cylinder liners were compared in a study at the University of Stuttgart and Federal-Mogul Friedburg GmbH, both of Germany. Results of the study were reported in a paper presented at the 2004 SAE World Congress in March. "New Approaches in the Hypersonic Flame Spray Coating for Cylinder Liners in Aluminum Crankcases" (SAE paper 2004-01-0601) was prepared by A. Candel, R. Gadow, and D. Lopez of the University of Stuttgart; and M. Buchmann of Federal-Mogul.

The various thermal spray processes offer the possibility of applying a broad variety of materials, including metals, cermets, and ceramics. Average coating thickness on cylinder liners in the study ranged from several microns to a few millimeters. Results showed that the HVOF coatings are superior to other coating deposition methods, in terms of hardness, wear resistance, homogeneity, microstructure, and friction behavior.

To minimize costs, new approaches are focused on processes with higher kinetic energy, which would reduce surface roughness and eliminate a polishing step. However, to avoid deleterious residual stresses with this approach, the cooling system must be enhanced.

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Excerpted with permission from *Advanced Materials and Processing, 162*(5), May 2004.

Operator John Cooper adjusts a Diamond Jet HVOF spray gun fueled by a G-TEC Natural Gas Torch Booster

New Natural Gas HVOF System from ASB

ASB Industries, Barberton, OH, and G-TEC Natural Gas Systems, Buffalo, NY, are testing a new natural gas delivery system that will lower operating costs and increase productivity for high-velocity oxy-fuel (HVOF) flame spray applications.

The TB-500 H Torch Booster, manufactured by G-TEC, elevates low-pressure utility natural gas service to 150 psi at a volume of 1000 ft^3/h, sufficient to supply two Diamond Jet HVOF spray guns.

The TB-500 H Torch Booster elevates gas pressure and supplies spray guns in real time without external storage tanks. With a small 2 by 2 ft footprint, the system is easy to install and can be located in the same area as the HVOF equipment. Using the system is as simple as turning it on, and the booster is ready to work immediately.

Because natural gas does not liquefy in cold conditions and has higher flame velocities than propane or polyproylene, its use is preferred in HVOF operations, according to William Rusch, Manager-Process Development at Sulzer Metco. Natural gas is not more widely used because most gas utilities cannot provide the pressures required. The TB-500 H Torch Booster is significantly less expensive to purchase and simpler to install than the existing gas-compression equipment.

G-TEC is developing a family of systems priced under $10,000 that will serve flame spray applications ranging from a single combustion gun to multiple HVOF guns. The company has manufactured pressure booster systems for torch cutting, brazing, heating, and other industrial applications for more than 15 years.

Contact: Ed Howard, G-TEC Natural Gas Systems, 401 William Gaiter Pkwy., Suite 4, Buffalo, NY 14215; tel: 800/451-8294; e-mail: ehoward@gas-tec.com.

Metallisation Launches New Arc Systems

Metallisation has recently launched two new Arc 140 models to complement the company's existing Arcspray 140 system, which offers a revolution in the use of arc spray for producing all thermal spray coatings.

The Arc 140E, aimed at the engineering sector, and the Arc 140GP are medium-capacity, lightweight, arc spray systems. The pistols are lightweight because there is no motor on the pistol, due to a unique flexible drive system. Both the Arc 140E and Arc 140GP feature new, powerful, precisely controlled electric drive units. The benefits of electric drive are: repeatable and consistent wire speed control, which gives a consistent spray; soft start, which gives a smooth start up; and a sealed motor for reliability in industrial environments.

Both new systems offer the proven, unique constant geometry (CG) head, which ensures reliable alignment of the wire for long periods, giving consistent spray quality and ease of maintenance.

The Arc 140E can be used for the application of engineering coatings (with a 250A energizer), for reclamation of a variety of parts, including bearing and seal surfaces, print rollers, anti-spark coatings, and wear coatings. Over and above the engineering applications, the Arc 140GP can be employed to apply anticorrosion coatings (with a 250A or 450A energizer) and engineering coatings to structural steelwork, pylons, boilers, lock gates, oil rigs, tanks and vessels, military vehicles, ships, and decorative steelwork.

The Metallisation Arcspray 140 system is the ultimate solution to today's demands for high-performance arc spray equipment. The patented "Syncrodrive" push/pull system on the 140GP provides constant, reliable, and trouble-free operation, utilizing two gearboxes linked by a flexible drive. The drive system guarantees that the "push" and "pull" elements cannot be out of synchronization, which ensures consistent wire feed over a long range, of up to 20 m.

The benefits of the Arc 140 system include a choice of coating textures, low running costs, high throughput, portable wire dispensing, safety interlocks, and steel-reinforced conduits.

In the Metallisation Arcspray process, the raw material, a pair of metal wires, is melted by an electric arc. The molten material is atomized by a cone of compressed air and propelled toward the workpiece. This spray solidifies when it hits the surface of the workpiece to form a dense coating, which protects against corrosion or repairs components. Sprayed coatings may also be used to provide wear resistance, electrical and thermal conductivity or for free-standing shapes.

Major advantages of the Arcspray process are that the coatings are available for almost immediate use, with no drying or curing time; there is no risk of damaging the component; the deposits possess a higher degree of bond strength than most other thermally sprayed deposits; and the use of only compressed air and electricity mean more economical coatings.

Contact: Metallisation; tel: +44 (0)1384 252 464; Web: www.metallisation.com. Or contact: Tracey Halstead; tel: +44 (0)1663 734 789; mobile: 07876 504 754; e-mail: thalstead@amstel.freeserve.co.uk.

Portable Plasma Preweld Surface Cleaning Cuts Costs

Thermionic cleaning is a new portable plasma surface cleaning method being investigated by the Edison Welding Institute (EWI), Columbus, OH, and several aerospace companies for the Propulsion Environmental Working Group (PEWG). It is an alternative to caustic cleaning methods based on acids and solvents.

Thermionic cleaning utilizes vaporization and ion bombardment to clean with minimal generation of secondary waste. Current practice is to chemically clean components. However, these processes are capital-intensive, generate significant waste streams, and typically require batch processing. The thermionic cleaning process eliminates all of these issues, is portable, and is easy to apply.

Plasma-based cleaning has frequently been used as a last-step surface preparation technique. An electrical field must be applied to a gas such as oxygen to generate a plasma. The field removes electrons from the atoms, causing them to become positively charged ions with the ability to conduct electricity. Thermionic cleaning is similar to plasma cleaning, but is much faster, and the equipment costs are lower. Initial financial analysis has indicated that thermionic cleaning is essentially a cost-neutral substitute for mechanical or chemical cleaning, if those methods are currently available to a manufacturer.

Contact: David Phillips, Edison Welding Institute, 1250 Arthur E. Adams Dr., Columbus, OH 43221-3585; tel: 614/ 688-5190; e-mail: david_phillips@ewi.org; Web: www.ewi.org.

Excerpted with permission from *Advanced Materials and Processing, 162*(4), April 2004.

HVOF Spray Forms Nanoscale Hypereutectic Aluminum Rings

Nanostructured hypereutectic aluminum rings have been formed on an aluminum substrate via high-velocity oxyfuel (HVOF) spray technology, reports Plasma Processes Inc., Huntsville, AL. HVOF spray can refine primary silicon efficiently by allowing less time for the growth of faceted primary silicon in hypereutectic aluminum alloys. Primary silicon can be further refined when gas-atomized powder is selected as feedstock for HVOF spraying, as the gas-atomization process itself is a rapid solidification process.

The extremely high cooling rate during HVOF helps the structure/coating not only to retain the refined silicon of gas-atomized powders, but also to achieve further refinement for both silicon and matrix grain size, which eventually modifies the mechanical properties of the alloys. Moreover, due to the high impact caused by high velocity in the HVOF process, higher density and better cohesion strength can also be achieved.

This information is from an article that appeared in the January 2004 issue of *JOM,* "Forming Nanostructured Hypereutectic Aluminum via High-Velocity Oxyfuel Spray Deposition," by T. Laha, Timothy McKechnie, and Arvind Agarwal.

Contact: Timothy McKechnie, Plasma Processes Inc., 4914 Moores Mill Rd., Huntsville, AL 35811; tel: 256/851-7653; fax: 256/859-4134; e-mail: tim.mck@plasmapros.com; Web: www.plasmapros.com.

Excerpted with permission from *Advanced Materials and Processing, 162*(4), April 2004.

Arc-Voltage-Controlled Feed System Patented by Thermion

A patent has recently been issued to Thermion, Inc. for a process in which the feed system is controlled by the arc voltage. This arc spray technology eliminates arc malfunctioning, resulting in a steady, smooth spray. Using this technology, the Auto Arc system has been designed to spray both cored and solid hard wires, producing wear- and corrosion-resistant coatings while maintaining the high qualities associated with a twin wire arc system. This system makes up for any voltage change by slowing or increasing the feed rate accordingly. This entire process takes place in milliseconds, and the operator never notices anything other than a constant arc.

Key features of the Auto Arc include remote operation capabilities, easy adaptability to plcs, and small size and light weight. It can be operated remotely using a basic pedant switch for turning the unit on and off or with a full-control console that allows the operator to monitor and control air, amperage, and voltage. Auto Arc interfaces with most plcs to produce semiautomatic or completely automated lines. The feeder weighs about 50 lb, allowing it to be operated from many different mounting systems such as automated robots, independent tool post pivoting swing arms, or most other hanging positions.

Contact: Thermionic Inc., Web: www.thermioninc.com.

Harper and Inometa to Produce Anilox Rolls for International Flexographic Markets

Harper Corporation of America (Charlotte, NC) and Inometa GmbH (Herford, Germany) have agreed to manufacture and market Harper's Platinum Anilox Rolls throughout the European market as well as in Africa and the Middle East under the company name "Harper Graphics, a Harper/Inometa Company." Harper Graphics will market Harper's platinum laser engraving technology for anilox rolls as well as HarperScientific Flexographic Supply Products and Harper GraphicSolutions Technical Consulting Services.

Harper Graphics is the master distributor for Europe and Africa and is in the process of setting up a manufacturing operation in Germany for the production of Platinum Anilox Rolls in early 2005.

Harper also has facilities in Charlotte, NC; Green Bay, WI; and Bangkok, Thailand

Contact: Harper Corporation, Web: www.harperimage.com.

HVOF and HIP Combine to Repair Jet Engine Airfoils

A process for repairing damaged airfoils in jet engines by combining high-velocity oxyfuel (HVOF) thermal spray technology with hot isostatic pressing has been developed by Flight Support Inc., North Haven, CT.

Called Recast, the process involves repairing the part with the same alloy of which it is composed, thus returning it to like-new condition. It provides the ability to cost effectively repair localized erosion or corrosion.

The process involves five steps. The first step is the HVOF thermal spray, which may be applied in thicknesses up to 0.06 in. The second step is the sintering process, in which the part is vacuum heat treated and cooled down after argon is inserted into the chamber. The third step is hot isostatic pressing, which raises the density of the material to match that of the parent metal. The fourth step is a solution annealing treatment that restores the original mechanical and physical properties to the part. The fifth step is precipitation heat treatment, only required for some alloys.

The Recast process produces an integral bond with the parent material, and it displays all of the mechanical properties of the parent metal.

Contact: James E. Arnold, Flight Support Inc., North Haven, CT; tel: 203/562-1415; e-mail: jim@flightsupport.net; Web: www.flightsupport.net.

Excerpted with permission from *Advanced Materials and Processing, 161*(12), Dec. 2003.

Microwave Drilling of Coatings

Microwave drilling has an inherent feature of materials selectivity, enabling for example, a distinction between ceramics and metals. Researchers at Tel Aviv University (Ramat Aviv, Israel) and General Electric Global Research (Schenectady, NY) have applied the microwave-drill technique to the removal of ceramic thermal barrier coatings (TBCs) from the opening of simulated cooling holes, such as would be found in turbine engine components.

This technique was successful in removing the ceramic layer without affecting the underlying metal. Microwave drilling is less expensive than laser-based drilling, but less accurate as well. Drilling holes using microwave drilling is suitable for TBC holes in the millimeter-diameter range.

Contact: E. Jerby; e-mail: jerby@eng.tau.ac.il.

Excerpted with permission from *Advanced Materials and Processing, 161*(2), Feb. 2003.

Awards Information

Roy W. Tess Award in Coatings

The American Chemical Society's Division of Polymeric Materials: Science and Engineering (PMSE) is seeking nominations for the "2005 Roy W. Tess Award in Coatings." This award of $2000 will be presented on August 29, 2005 at the National Meeting of the American Chemical Society in Washington, D.C.

This award recognizes outstanding individual achievements and noteworthy contributions to coatings science, technology, and engineering. It confirms PMSE's long-standing and continuing support and dedication to excellence in the coatings field.

Nominations are welcome from all sections of industry, academia, and government. Upon receipt of names, the Award Chairman will provide a documentation form requesting information on the nominee relevant to patents, publications, overall qualifications, etc. All finalized nominations for the 2005 Tess Award should be submitted prior to September 1, 2004, although nominations received after that date will be considered for the succeeding year's award.

Contact: David R. Bauer, Tess Award Chairman, Ford Motor Co., Research Laboratory-MD3182, P.O. Box 2053, Dearborn, MI 48121.

News from ASM-TSS

Training Series on Thermal Spray Technology Completed

Twenty-seven students participated in a six-part educational series "Thermal Spray Technology," conducted by the Indianapolis Chapter of ASM International. The series covered topics such as: introduction to surface science, equipment and theory, processing and design, materials, applications, and testing and characterization, and included a guided tour of the R&D facilities at Praxair Surface Technologies.

Instructors were Dr. George Meng, Dr. Daming Wang, William Jarosinski, and Dr. Ann Bolcavage from Praxair and Jeff Sloan from Rolls Royce. The classes were held at the Rolls-Royce Corporation training facility in Indianapolis.

Contact: Kenneth Ryan, Education Chairman, Indianapolis Chapter of ASM; e-mail: mrkenryan@heme.com.

People in the News

Henri Steinmetz Appointed Head of Sulzer Metco

Henri Steinmetz has been appointed as the new division president of Sulzer Metco. He started at Sulzer Metco on May 1, 2004 and succeeds Bruno Walser, who will retire by midyear. Steinmetz was executive vice president and general manager of polymer stabilizers at Great Lakes Chemical Corporation.

Praxair Surface Technologies Names Mohan Sangam Northeast Sales Manager

Praxair Surface Technologies has appointed **Mohan Sangam** as Northeast Regional Sales Manager, for the thermal spray consumables business. Sangam will be focusing on and supporting the growth of Praxair's thermal spray powders, wires, spare parts and equipment.

Mohan Sangam

Sangam has served in a variety of engineering and operations management positions in his 17 years at Praxair. Previously, he was employed at TRW as a coating specialist in the Turbine Airfoils Division.

Bob Unger Named Sales Manager of Polymet

Bob Unger has been appointed Sales Manager of Polymet, a leading manufacturer of thermal spray and welding wire.

Unger has been in the thermal spray industry for more than 20 years as Sales Manager for TAFA and later Praxair. He has been very active in the ASM Thermal Spray Society, serving on the Board of Directors since 1998.

Contact: Bob Unger, Polymet, 10073 Commerce Park Dr., Cincinnati, OH 45246; tel: 513/874-3586; fax: 513/874-2880; e-mail: runger@polymet.us; Web: www.polymet.us.

VanderStraten and Robbins Join Ellison Surface Technologies

Richard Vander-Straten

Richard VanderStraten has been appointed Plant Manager of the Hebron, Kentucky plant of Ellison Surface Technologies. VanderStraten formerly held key technical and management roles at Hitemco—Texas and New York, totaling 18 years of technical experience and 14 years within the thermal spray industry.

Larry Robbins has joined the Ellison Surface Technologies staff as Senior Technical Sales engineer. Robbins has held key technical and sales/sales management positions with Sundstrand Aerospace/Praxair/WOKA North America and most recently Liquidmetal Coatings Distribution. He brings 28 years of technical experience (13 years within thermal spray) to EST.

Larry Robbins

Contact: Richard VanderStraten; tel: 859/586-9300; e-mail: rvanderstraten@ellisonsurfacetech.com. Larry Robbins; tel: 423/494-0766; e-mail: lrobbins@ellisonsurfacetech.com.

R.A. Miller Forms Materials Engineering Consulting Firm

Robert A. Miller

Robert A. Miller announces the formation of his engineering consultant firm, R.A. Miller Materials Engineering LLC. The company has been established to provide private consulting services to industry in the areas of materials engineering, sourcing, quality assurance, applications, and business/market development. with primary concentration on the thermal spray coatings industry. Miller has 30 years of varying technical product development experience.

Contact: Robert A. Miller, 6533 Woodmere Circle, Indianapolis, IN 46260; tel: 317/259-7632; fax: 317/259-7651; e-mail: robert_a_miller@mymailstation.com; Web: www.ram-mat.com.

Peter Hanneforth Starts Global Component and Outsourcing Company

Peter Hanneforth

Peter Hanneforth, formerly Executive Vice President for the Sulzer Corporation, opened SpaCom, the Spare Part and Component Company (Long Island, NY), in January 2004. SpaCom supplies high quality, low cost industrial parts and components, as well as providing manufacturing outsourcing and supply chain management services. With its partner in China, SpaCom has access to more than 2000 ISO certified production facilities, manufacturing everything from castings to parts and components to complete machinery, according to Hanneforth.

Hanneforth brings more than 15 years of experience in business and general management, marketing and sales, product line management and business development with United States and European Fortune 500 industrial corporations.

Contact: SpaCom; tel: 631/757-7799 or 866/3SPACOM; Web: www.spacom.com.

Bill Mosier Elected New ITSA Treasurer

Bill Mosier

Bill Mosier has been elected Treasurer of The International Thermal Spray Association for a two-year term. As Treasurer, Mosier is responsible for management of all funds and securities of the Association as directed by the Executive Board. Mosier is President of Polymet Corporation in Cincinnati, Ohio.

Kathy Dusa Appointed ITSA Corporate Secretary

The International Thermal Spray Association membership has approved the Executive Committee recommendation that Kathy Dusa be named Corporate Secretary. This new, nonvoting, two-year position had previously been in conjunction with the Treasurer position. As Corporate Secretary, Dusa is responsible for membership records retention, providing minutes of the meetings, and serving as a focal point for communication with the Executive Board and member companies. Dusa is the ITSA headquarters Office Manager and Meeting Planner and Managing Editor of the SPRAYTIME newsletter.