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About the cover
Image of a droplet forming from a liquid that has been exposed to an electric field, created using a finite element computation modeling technique. Courtesy of Purdue University, School of Chemical Engineering, West Lafayette, Ind.
Dear Thermal Spray Community and TSS Membership:

On behalf of the TSS Board I would like to wish you a happy, prosperous, and successful year 2008. Overall, 2007 has been a positive year for the thermal spray industry. The global economy has been strong, most of our customer industries recorded growth, and thermal spray companies did fairly well. Also for TSS, 2007 was another year of progress and positive news. Here are a few highlights that I would like to share with you:

**ITSC 2007 Beijing**
In May 2007, we brought the International Thermal Spray Conference (ITSC) for the first time to China. The conference was very well attended and received, and we were able to provide an effective platform to build bridges and enable relationship building between the international thermal spray community and Chinese industry, academia, and government. China will be one of the fastest growing markets for thermal spray for a long time to come, and together with our partner DVS, we provided an important stepping stone into this important market.

**Industrial Advisory Committee**
During the first months of 2007, we formed a new advisory committee for TSS, the Industrial Advisory Committee (IAC), which comprises top executives from leading industry players from Europe, North America, and Asia. The group’s main focus will be to advise the TSS Board about market and industry needs and trends; provide strategic direction for TSS policies, products, and services; and promote cooperation between TSS and their respective organizations. This was an important step for TSS to be able to create value for our industrial members and supporters.

**Integrated Enterprise Internet Environment**
During ITSC2007, our brand new website was launched. This impressive integrated enterprise solution provides our members and other interested parties with a host of information and services that are highly relevant to the thermal spray community. Just to name a few: a searchable database with over 80,000 documents, downloadable ITSC and JTST papers, chat rooms, TSS discussion forum, and much more than able to list here. Please check it out yourself at http://tss.asminternational.org/portal/site/TSS/

**Cold Spray Conference**
In October 2007, we had yet another successful event in our series of topical conferences. This one was again dedicated to cold spray and took place in Akron, Ohio. Arguably the hottest technology in our industry, the event attracted a record number of participants from around the world. My personal thanks go out to ASB Industries, Barberton, Ohio, the main sponsor and organizer of this event.

There are of course many more positive developments to report on, such as our growing membership, outstanding committee and volunteer work, a dedicated Board, many new initiatives for future programming and other services, developing partnerships and others. I would like to conclude by thanking all our members for their continuous support of our society, as well as all active committee members who always provide the heart, soul, and fuel for the society’s progress. I hope to see you all during the upcoming ITSC 2008 in Maastricht, the Netherlands June 2-4, so please mark your calendars. In the meantime keep on spraying and enjoy the new issue of ITSSe!

Peter Hanneforth
ASM TSS President
Xiom Introduces Marine Protective Coating

Xiom Corp., West Babylon, N.Y., a manufacturer of polymer powder spray systems, polymer coatings, and polymer/ceramic one-step coatings, for onsite application developed a high performance, environmentally safe, self-cleaning, marine vessel hull protective coating.

The “stay-clean” coating for both steel and fiberglass boat bottoms significantly reduces maintenance costs and fuel consumption caused by marine growth. The inexpensive, easy-to-apply polymer/ceramic-based coating contains no TBT (tributyl tin) or VOCs (volatile organic chemicals), and does not ablate or wear away.

The patent-pending powder coating has a network of evenly dispersed active copper oxide and silver ions in a polymer matrix, which melts when applied using the company’s proprietary thermal spray process. The polymer matrix serves to hold the copper oxide in place for years. Even if there should be a break or tear in the coating, there is a nylon-modified fuse bonded epoxy between the hull and coating, maintaining integrity. With paints that contain copper oxide, the copper particles closest to the surface quickly ablate, leaving a space so that water gets leverage on the surface of the paint, which accelerates ablation, limiting coating life. The active ingredients are always strongly held and available in the coating, and the coating ablates at less than 10% of the ablation rate of paints, while providing superior protection. Xiom’s ship and boat bottom protective coating reduces the expense involved in maintaining and operating boats and ships. The coating lasts five times longer than paints. www.xiom-corp.com.

New Technology ‘Cools’ Thermal Spray Coating Applications

Air Products and Chemicals Inc., Lehigh Valley, Pa., has introduced a new thermal spray cooling technology to the North American market that uses cryogenic nitrogen vapor at a temperature of -320°F (-196°C) to maintain part temperature during thermal spray coating applications. The U.S. patent-pending technology makes high-quality thermal spray coatings possible by maintaining part temperature within a predefined narrow range, even for heat-intensive spraying processes. The technology can enable the user to apply coatings faster and at a lower cost than traditional cooling methods.

Exposing a part to too much heat can negatively impact coating adhesion, substrate and coating hardness, fatigue life, corrosion resistance, and dimensional tolerances. One method used by thermal spray applicators to keep part temperatures within a closely set range is forced air cooling combined with interpass breaks. This traditional practice, however, increases downtime and reduces productivity, as well as wastes powder and process gases.

According to Dr. Rana Ghosh, project manager, cryogenic cooling applications at Air Products, the company developed a thermal spray cooling technology that can maintain a part’s temperature within a much tighter range during the spray operation versus traditional cooling methods by varying the cooling intensity to match the heat generated in the spraying process. Use of the technology is said to improve part quality, lower costs by reducing powder and process gas waste, enable the use of inexpensive flexible masking, and allow better use of the thermal spray equipment and booth.

Air Products’ thermal spray cooling nozzles can be mounted directly on the robotic arm next to the thermal spraying gun. During spray application, the cryogenic vapor jet follows the thermal spray plume to maintain the part’s temperature within the specified range. Multiple cooling lines provide additional part cooling, if needed. The part is continuously monitored using a thermal imaging camera and/or infrared sensors that provide temperature feedback to the computer-controlled cooling nozzles, which allows the cooling system to automatically maintain the substrate temperature set by the spray booth operator. Part temperature history also can be recorded and archived for future audit purposes.

Compatible with existing thermal spray systems, the technology offers a variety of system designs for application-specific use. The technology can be used in the aerospace, automotive, and heavy industries; oil fields; and job shops. Currently used by a major aircraft parts service facility, the method cut in half the spraying time and the amount of powder and process gases consumed in the coating of aircraft landing gear axles. www.airproducts.com/cooling.

Lasershot Peening of Landing Gear Components

A final report entitled “Lasershot Peening of Landing Gear Components” is available from National Center for Manufacturing Sciences (NCMS), Ann Arbor, Mich. A variety of landing gear components are failing without having reached their desired service lives. The failures are due primarily to stress corrosion cracking (SCC) and fatigue. The objective of this project was to improve the fatigue life and SCC resistance through the application of laser peening technology to selected components. Project team members included the Aging Landing Gear Life Extension Program (ALGLE) at Ogden Air Logistics Center, Lawrence Livermore National Laboratory (LLNL), University of California (Davis), and Metal Improvement Co. The project was funded and managed through NCMS Commercial Technologies Maintenance Activities (CTMA) program.

This final report can be purchased online at http://products.ncms.org/dept_rpt/rpt140158.htm. Price is $100.00 for NCMS members and $150.00 for non-members. For more information, contact customercare@ncms.org.
Defense Industry Honors NCMS for Thermal Spray Technology

Each year the U.S. Department of Defense (DoD) spends multi-millions of dollars repairing vehicle components damaged by corrosion. The National Center for Manufacturing Sciences (NCMS), Ann Arbor, Mich., managed a cross-industry collaborative team that developed a new kinetic spray technology championed by the Delphi Research Laboratory. The new technology will impact DoD by significantly reducing corrosion-related maintenance across all military services. “The adoption of this new technology will also benefit automotive and aerospace companies who will save millions of dollars in their facilities,” said NCMS Senior Program Manager Steve Hale.

The NCMS team was recognized by a “Defense Manufacturing Excellence Award” presented by the National Center for Advanced Technologies (NCAT). The award recognizes outstanding cooperative efforts on technology development between government, industry, and academia. NCMS has received six of these awards for their amplified efforts in cross-industry collaboration in the Department of Defense Commercial Technologies for Maintenance Activities (CTMA) program.

Uddeholm’s New Steel Grade Wins EPMA Award of Merit

Uddeholm, Stockholm, Sweden, says its Uddeholm Vancron 40 is the most exciting tool steel it has launched in many years. The tool steel for cold work applications in the powder compacting industry, which offers low friction properties, excellent galling resistance, and superior adhesive wear resistance, was awarded the 2007 EPMA (European Powder Metallurgy Association) Award of Merit in the category Equipment/Materials.

Uddeholm Vancron 40 is alloyed with nitrogen, creating a steel having an integrated “surface coating,” resulting in a tool surface with very low friction that provides better resistance to galling, cladding, and adhesive wear. In cold work applications like forming of advanced high-strength steels, stainless steels, and mild steels, galling and adhesive wear are often the dominating tool failure mechanisms. This can also be the case in powder compacting, cold extrusion, deep drawing, and blanking. Until recently, the common way to increase galling resistance has been to nitride the tool or to apply surface coatings such as CVD, PVD or TD (Toyota Diffusion). By comparison, the new tool steel does not have to be surface treated or coated, which eliminates time and cost factors associated with the coating operations.

The material was designed with help of the Thermo-Calc Software Inc.’s, (McMurray, Pa.; www.thermo-calc.com) software and databases for calculations involving computational thermodynamics and diffusion-controlled simulations. Based on previous experience, Uddeholm believed that a martensitic tool steel having a high volume of dispersed, hard nitrocarbides (primarily vanadium-rich nitrocarbides) would have the necessary material and functional properties. It was then possible to calculate the steel composition having the required amount and composition of the different phases.

The production of Uddeholm Vancron 40 involves solid state nitriding of the as-atomized powder; that is, by introducing a high amount of nitrogen to the powder before hot isostatic pressing (HIP) the die. This makes it possible to produce a tool steel with nitrogen content higher than possible when using the conventional technology involving nitrogen alloying of the steel melt. During the hot isostatic pressing stage, the nitrogen is evenly distributed throughout the steel.

Industrial experience with Uddeholm Vancron 40 in powder compacting tooling has been very good. The ejection force is up to 30% lower than for press tooling manufactured from commonly used conventional tool steels. Benefits for the tool user include improved, consistent quality of the manufactured parts (especially regarding surface finish) and fewer interruptions in production. www.uddeholm.com.

ArcMelt Debuts Materials Breakthrough

ArcMelt, St. Louis, Mo., has introduced what is claimed as a breakthrough in high-performance, complex metal alloys for use in protection against severe industrial environments. The alloys provide overlay composite structures (OCS) that extend the service life of power-generation boilers, digesters, scrubbers, and other equipment. Oak Ridge National Laboratory (Oak Ridge, Tenn.; www.orl.gov) and other international corporations are evaluating the alloyed composites. Results show the composite structures withstand extreme heat, corrosion, wear, and other conditions in environments where conventional overlay structures fail. They offer economic and performance advantages compared with conventional film-forming, non-joining weld overlays, and sheet clad.

The technology combines multiple metal and nonmetal powders with other elements into high-performance alloys. OCS extends mean time between failures (MTBF) and shortens mean time to repair (MTTR). The company recommends multi-element alloys to overcome limitations inherent in binary and ternary combinations. The most recent OCS alloy contains eight elements. One product the company is considering for protecting gasification equipment is a W-Cu-Ni-Co-Fe-Cr-Ti-Sn alloy. Potential markets include power generation, refining, mining, and pulp and paper manufacturing. www.arcmelt.com.
Technogenia S.A., Saint-Jorioz, France, opened a Lasercarb Technology Center in Conroe, Tex., just north of Houston. The facility houses a unique machine that deposits anti-abrasion material onto industrial parts. The Technogenia Lasercarb Technology Center is the first in the U.S. to use the latest diode laser technology. It includes a 4-kW high-power diode laser coupled with custom designed five-coordinate axis NC machine and can handle parts up to 40 ft (12 m) long and weighing as much as 5,000 lb (2,270 kg).

Lasercarb is a laser cladding process that uses a laser power source to apply Technogenia’s Spherotene powder. The coating is composed of various sizes of spherical tungsten carbide particles held in place by a nickel base matrix. The powder is injected through a coaxial nozzle into the laser beam. The combination of the laser power and the digital control generates a highly controlled deposit. The spherical tungsten carbide particles produced by Technogenia exhibit a hardness of 3000 ±500 HV. The spherical shape produces a high-density deposit reducing stress and cracking.

This technology coupled with an advanced CAD/CAM system allows depositing a precise coating on the most complex geometry. Therefore, the process ensures consistency and high quality on each part. Applications include rotors, scrapers, shaft bearings, stabilizers, sleeves, and non-magnetic stainless steel components. www.technogenia.fr.

The Lasercarb welding process uses a laser power source to apply spherical cast tungsten carbide for hard facing industrial parts.

CORRECTIONS
The bylines of the Thermal Spray Tips appearing on page 8 and page 12 of the November 2007 iTSSe were inadvertently left off the pieces. The authors are Douglas G. Puerta, director of metallurgical engineering, IMR Test Labs, Lansing, N.Y., and Dr. Richard Knight, FASM, auxiliary faculty member, Dept. of Materials Science and Engineering, Drexel University, Philadelphia, Pa., respectively. Dr. Knight’s Tip also should have the following as a reference rather than the source: Handbook of Thermal Spray Technology, Ed. Davis, J. R., ISBN 0-87170-795-0, ASM International, Materials Park, Ohio, 2004. We apologize for any misunderstanding this may have caused.
Toolmakers Select Laser Engineered Net Shaping (LENS) System

Optomec Inc. (Albuquerque, N. Mex.) announced that the Toolmakers Cluster of Slovenia (TCS) purchased their first LENS (laser engineered net shaping) 850-R system. (LENS is a registered trademark of Sandia National Laboratories, Sandia, N. Mex.; www.snl.gov.) The system was bought by a consortium of companies who are members of TCS including RITS Ltd., EMO Orodjarna Ltd., and VALJI Store Ltd. The LENS facility will be located in Technopolis Technological Park, Celje, Slovenia, and will be known as TIC LENS. TCS customers include leading names in the Automotive Industry, such as BMW, Ford, Steyr-Daimler-Puch, Motorteknich, Volvo, and many more. TCS is known as a world leader in the toolmaking industry.

The main objectives of TCS are to increase production volume and competitiveness for Slovenian toolmakers in foreign markets, to accelerate technology transfer between companies, to shorten the time between research and production, and to increase the development and implementation of new technologies. TCS members possess a wide range of the most advanced scientific equipment and their new LENS system will allow them to position the Slovenian toolmaking industry as the world leader in the most demanding toolmaking applications. One immediate application for TCS’ LENS system will be to deposit wear-resistant coatings on tooling to improve useful life and decrease overall manufacturing costs. The Slovenian LENS facility will serve as a global center of excellence for toolmaking applications, focusing on the production, repair and upgrade of tools for sheet metal processing, molds and dies.

Optomec is a worldwide provider of additive manufacturing systems for use in high-performance applications in the aerospace & defense, electronics, and biomedical markets. These systems use Optomec’s proprietary M3D aerosol-jetting technology and LENS powder-metal fabrication technology. www.optomec.com.

Laser Peening Technology Used on Power Generation Components

Curtiss-Wright Corp., Roseland, N.J., announced that Siemens Power Generation (www.powergeneration.siemens.com) started using Curtis-Wright’s laser peening technology to improve the fatigue strength of titanium last row blades on certain of their advanced steam turbines. The last row blades extract energy from the steam to drive electrical generators. Although laser peening technology has been used for several years to strengthen critical titanium components in commercial and military turbine engines, this application represents its first production use in power generation steam turbines.

Laser peening technology enables Siemens to extend the life of a critical component in its advanced steam turbine design, and thus improve the overall system reliability. By enhancing the durability and reliability of critical components, peening already provides economic benefits on jet engines and it is anticipated that its use will grow in applications in aerospace structures, nuclear power generation, medical implants, oil and gas drilling, and performance racing applications.

The laser peening technology is based on a neodymium glass laser technology, which was originally developed by Curtiss-Wright in conjunction with the Lawrence Livermore National Laboratory (www.llnl.org). The laser beam with a peak power output of 1,000 MW is pulsed and directed at the surface of metal parts to be treated. High-pressure waves (10^6 psi, or 690 GPa) are generated at the surface, which compress the metal and leave behind a protective residual compressive stress layer beneath the surface. This compressive stress serves to increase the component’s resistance to failure mechanisms such as fatigue, fretting fatigue, and stress corrosion cracking, which, in turn, translates into increased component life and reduced maintenance costs.

Curtiss-Wright provides this service through its Metal Treatment segment, which has production facilities in Livermore, Calif. and Earby, UK. Laser peening continues to gain momentum as a premier metal surface treatment for highly stressed components of steel, titanium, aluminum and other metals, where extended life or improved durability is important. www.curtisswright.com.

PVD Global Market Expected to Grow Over Next Five Years

According to a new technical market research report entitled “Physical Vapor Deposition (PVD): Global Markets” from BCC Research, Wellesley, Mass., the world PVD industry will be worth an estimated $9.9 billion in 2008, and should reach $16.7 billion by 2013, a compound annual growth rate (CAGR) of 11% over the 5-year period. The market is broken down into applications of PVD equipment, materials deposited and services. Of these segments, the PVD equipment will remain the largest market as shipments grow at CAGR of 9.6% to reach an estimated $7.1 billion in 2008 and then increase to $11.9 billion in 2013, at a CAGR of 10.9%. Materials deposited hold the second largest share of the market. Worth an estimated $1.3 billion in 2007, this segment is expected to be worth $1.5 billion in 2008 and $2.7 billion in 2013, a CAGR of 12.4% over the forecast period. The value of services will increase from $1.2 billion in 2007 to $1.3 billion in 2008, and will increase at a CAGR of 9.9% to reach $2.0 billion by 2013.

The microelectronics industry, encompassing semiconductors, components and flat panel displays, represent the largest market for PVD equipment, materials and services. Data storage is still a rapidly growing sector 2007 2008 07 08 07-08 13 08-13 Value of global PVD industry through 2013 ($ millions)

<table>
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<th>2008</th>
<th>2007-08</th>
<th>2013</th>
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</table>
Para Tech Coating Inc. (PTC), Aliso Viejo, Calif., celebrates 40 years in the commercial application of Parylene coating technology (Union Carbide Corp.’s poly-para-xylylene film coating process). Over the years, PTC’s work with Parylene included coating ferrite cores, military components, items destined for outer space, aerospace assemblies, disposable and implantable medical devices, sensors and keypads. Additionally, the firm’s contributions to equipment design have provided significant benefits to coating uniformity and reduced process time and material consumption.

The Parylene molecule was isolated by a researcher at the University of Manchester, England, in 1947. Film developed at this laboratory was the world’s first vapor deposited poly-para-xylylene or PPX, which in purer colorless form is known today as Parylene N. Union Carbide developed a simpler means of producing the dimer that is the raw material from which Parylene film is deposited. Union Carbide tested many chemical alternatives and introduced a commercially viable Parylene coating system in 1965 that consisted of a family of three polymers (Parylenes N, C and D) and a vacuum deposition method.

Because the thin Parylene film is formed by heating a powdered raw material to form a gas that ultimately polymerizes on surfaces in a room-temperature vacuum chamber, it has no liquid phase. The film is absolutely conformal and pinhole free, and builds with equal thickness on all surfaces, including over edges and in crevices. There is no cure phase and no mechanical stress associated with Parylene. It can be applied in layers as thin as 0.1 micron or as thick as 75 microns in a single pass, with a typical rate of film buildup of approximately 5 microns/hr.

Over the years, PTC founder Jeffrey Stewart developed and patented eight useful improvements in the Parylene deposition process that dramatically increased the performance, consistency and reliability of the Parylene vacuum deposition process. These PTC innovations continue to distinguish PTC as an industry leader, setting the standard for Parylene deposition efficiency and precision in the company’s coating centers as well as in PTC coating systems designed and built for on-site customer use.

“Parylene is unique in the realm of conformal coating,” says Stewart. “While the basic technology is essentially unchanged after forty years, Parylene is used today in critical coating applications that were unimaginined in the 1960s before the advent of medical implants, micro-electronics, nanotechnology and sophisticated aerospace and industrial applications.”

Thermal Spray Society Committees Looking for Your Involvement

The Thermal Spray Society (TSS) has nine active committees of volunteers working on tasks and projects to provide increased services and value to its members. Membership on the Journal of Thermal Spray Technology Committee is by invitation only. The other eight committees are always looking for new members, and summaries of these committee’s missions and tasks are given below to help you decide if you want to participate. To get involved, you should contact the committee chair directly.

**TSS Membership, Marketing, and Outreach Committee**

*Chair:* Dr. Ann Bolcavage, senior materials engineer, Rolls-Royce Corp.; e-mail: ann.bolcavage@rolls-royce.com

*Co-Chair:* Ms. Deborah K. Curtis, chief estimator, ASB Industries; e-mail: deborah@asbindustries.com

The committee focus is on actively increasing ASM TSS membership, adding and improving benefits for current members, and promoting TSS and thermal spray technology to engineers, operators, and the technical community at large. Ongoing responsibilities of the committee are to personally welcome new members, contact and solicit feedback from those who have let their memberships lapse, and develop strategies for recruiting new members to the society. The Committee supports initiatives by coordinating the resources needed to announce and market valuable products and services. Initiatives planned for 2008 include the introduction, dissemination, and archiving of Spray Tips, as well as the creation of a thermal spray applications reference library for TSS Community registered users.

**TSS Accepted Practices Committee on Metallography**

*Co-Chair:* Mr. Frederick C. Anderson, metallurgical laboratory supervisor, IMR Test Labs; e-mail: fred@imrtest.com

*Co-Chair:* Mr. Douglas G. Puerta, director of metallurgical engineering, IMR Test Labs; e-mail: dpuerta@imrtest.com

The Accepted Practices Committee on Metallurgy collects and presents recommendations for the metallurgical preparation of aerospace gas turbine coatings, which helps keep the industry abreast of new developments and techniques as they apply to coating metallurgy. The collection of industry trends and practices in metallurgy is being accomplished by round-robin testing across the numerous coating families. After each round robin, the Committee distributes a summary of its findings and recommendations through articles in the Journal of Thermal Spray Technology (JTST) and through the Thermal Spray Society Web site. The success of the projects undertaken by this committee is highly dependent on support from the aerospace industry. Successfully identifying positive trends and procedures within this industry is contingent upon strong industry involvement.

**TSS Safety Committee**

*Chair:* Mr. Greg Wuest, director of materials QESH, Sulzer Metco (US) Inc.; e-mail: gregory.wuest@sulzer.com

The mission of the TSS Safety Committee is to develop and disseminate safe practices for the installation and use of thermal spray equipment and processes. The charter includes working with and supporting other international bodies, standards groups and/or other experts for the collection and unbiased evaluation of information. After the committee achieves consensus, it writes guidelines, which are approved by the TSS Board and published on the TSS Web site. Committee members represent academia, users from various industries, and suppliers of thermal spray equipment, materials, and services. The committee is looking for two to three persons who can add a much-needed European and/or Asia/Pacific-Rim perspective to its activities.

**TSS Programming Committee**

*Chair:* Dr. Andrew Gouldstone, assistant professor, Suny at Stonybrook; e-mail: andrew.gouldstone@stonybrook.edu

The TSS Programming Committee is responsible for organizing various forums for the exchange of information and networking within the global thermal spray community including technical programs and seminars, conference proceedings, and regional and international conferences and expositions at TSS-sponsored events or in conjunction and cooperation with other technical or commercial conferences.

The Committee has worked to develop Best Practice documents for the administration and organization of these events. In addition, the committee is meeting the demands of TSS members in creating additional value by developing conference programs earlier to improve the marketing of these events.

**TSS Awards Committee**

*Chair:* Prof. Joachim Heberlein, FASM, University of Minnesota; e-mail: jvrh@me.umn.edu

ASM International and TSS have several awards to recognize special accomplishments, and the TSS Awards Committee is encouraging nominations for these awards. In particular, nominations of TSS members for the TS Hall of Fame Award and for the Fellow of ASM Award are regularly submitted. Awards Committee members are selected from a diverse community, both geographically and with regard to technical fields, and serve for one year with reappointment possible. Committee members annually review TSS members that might qualify for an award by going through the contributions to ITSC and to the society functions. The committee also assists in preparing nominations, in particular in the selection of authors for letters of support, and committee members usually prepare the bulk of the nomination paperwork.

**TSS Training Committee**

*Chair:* Ms. Andrea Loppnow, QA manager, Thermal Spray Technologies Inc.; e-mail: aloppnow@tscoatings.com

The TSS Training Committee is currently
tasked with the support of a thermal spray operator training and certification program being implemented through ASM International. A multi-society certification subcommittee under the ASM Education Committee has been established to create the foundation for all certification programs. Initially, we are evaluating thermal spray certification programs already existing globally against the requests and needs of the TSS community. The results of this assessment will become the basis for partnerships and/or creation of training and testing materials within TSS. The thermal spray operator-certification program will be one of the very first ASM certification program launches. The Training Committee and ASM staff will continue to support updates of current training materials, develop a thermal spray presence at ASM Materials CampSM, and coordinate thermal spray courses at various professional conferences throughout 2008.

**Journal of Thermal Spray Technology Committee**

**Chair:** Chris Berndt, FASM, professor of surface and interface engineering, James Cook University; e-mail: christopher.berndt@jcu.edu.au

**Editor:** Dr. Christian Moreau, group leader, National Research Council; e-mail: christian.moreau@nrc-cnrc.gc.ca

The Journal of Thermal Spray Technology (JTST) is a TSS publication, initiated in 1992. The regular issues of JTST are published quarterly, and in addition there is one special double issue containing the peer-reviewed proceedings of the International Thermal Spray Conference, for an annual volume size of ~1,000 pages. JTST is organized around the Editorial Committee, chaired by Professor Chris Berndt, which functions as the policy-making body for JTST on behalf of the TSS Board and ASM International, and the International Board of Review, led by JTST Editor Dr. Christian Moreau, which is responsible for maintaining the high quality and content of JTST.

JTST Committee membership, unlike other TSS committees, is by invitation only. However, anyone interested in working with JTST is encouraged to contact either Prof. Berndt or Dr. Moreau, as we are always looking for new input.

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guyson.net
Cold Spray 2007: A Resounding Success

Cold Spray 2007, an intensive two-day conference held on October 8-9, 2007 in Akron, Ohio, was a highly successful event, following the successful Cold Spray 2002 and Cold Spray 2004 meetings. Co-sponsored by the ASM Thermal Spray Society (TSS) and ASB Industries, Barberton, Ohio, the event featured a Keynote lecture by Victor Champagne of Army Research Lab., Aberdeen, Md., as well as 17 presentations from cold spray experts from around the world. The meeting also featured a Panel Discussion, in which academic, research, and industrial experts elaborated their views, followed by a question & answer session involving the entire audience. The international event was attended by more than 170 participants from 15 countries, allowing the attendees to receive updates on global R&D programs and also network with world’s top experts. The meeting also featured a table-top exhibition which included eight organizations who displayed their products and services. In addition, to accommodate the demands of cold sprayers around the globe, a Poster Session was introduced at the last minute, in which a total of eight technical posters were presented.

As a part of the meeting, ASB Industries graciously hosted a tour of its facility, where attendees witnessed demonstration of high-pressure (CGT Kinetics 4000 system, Germany) and low-pressure (SST Portable System, Canada) cold spray systems, as well as the DESY high-pressure nitrogen-supply system of Linde Gas.

At the event dinner, Peter Heinreich, executive member of the board, Gemeinschaft Thermisches Spritzen e.V., or GTS (Association of Thermal Sprayers), Unterschleissheim, Germany, presented the GTS Ring of Honour to Albert Kay, president of ASB Industries.

As Mr. Heinreich noted, the GTS Ring of Honour had, so far, been conferred seven times. The award distinguishes those personalities who have made a great contribution to thermal spray and have committed themselves to the ideas of GTS including:

- To set a high quality standard for thermal spray
- To actively promote innovation
- To spread the thermal spray word and the GTS highlights
- The Triple S including Solidarity, Sincerity, and State of the Art

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“Al Kay has given the GTS ideas his full support in the U.S. and also worldwide.
However, it is not only Albert Kay’s contribution to thermal spray which distinguishes him. He also excels in the way he takes on new challenges and achieves the objectives he sets himself with a tremendous farsightedness. We only need think of cold spray, for example,” said Heinreich. “For me personally, Albert Kay, with his wealth of experience, warm-hearted manner, and above all, his generosity has, if I may take this liberty, become a true friend.”

ASM Thermal Spray Member Receives Prestigious Award

Professor Maher Boulos, University of Sherbrooke, Sherbrooke, Quebec, Canada, was awarded the “Lionel Boulet” prize by the Government of Québec at an event in the national assembly building at Québec city on November 6, 2007, an event at which the Prix du Québec, the most prestigious award attributed by the Government of Québec in all fields of culture and science is bestowed.

The Prix du Québec have existed in their current form since 1977. Each year, the government attributes six such awards in the cultural field and five in the scientific field. The purpose of this tribute is to recognize the career of women and men who have demonstrated a passion for their calling. These individuals are ones who stand out due to their creative and/or innovative spirit and whose work has contributed to the influence of Québec around the world and to the evolution of Québec society in their respective fields.

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MECC Maastricht Congress Centre
Maastricht, The Netherlands

ITSC, the world's foremost international conference and exposition for thermal spray technologists, researchers, suppliers, and end-users this year will be held in Maastricht, The Netherlands. ITSC 2008 follows the successful path of the previous events in Basel (2005), Seattle (2006), and Beijing (2007), and will present the latest status of application, research and development in the field of thermal spray. ITSC 2008 will take place at the MECC Maastricht Congress Centre, a state-of-the-art conference and exhibition center designed with the conference attendee in mind.

Visitors can attend ITSC 2008, dine, and also have their room accommodations at the center. Everything is under one roof. This outstanding annual event in the world of thermal spray technology is jointly organized by the German Welding Society (DVS), the ASM Thermal Spray Society (TSS) and the International Institute of Welding (IIW). Event sponsors are NIL - Netherlands Institute of Welding and VTS - Vereniging voor Thermische Spuittechnieken.

The organizing team looks forward to meeting you in Maastricht. ITSC 2008 is an event not to be missed!

Thermal Spray Courses at ITSC 2008

(All courses held at Maastricht Expositie & Congres Centrum Maastricht, The Netherlands, prior to the technical conference)
For registration details, visit http://asmcommunity.asminternational.org/portal/site/ASM/ITSC2008/.

Instruction Language: All course instruction and materials will be in English.

Thermal Spray Technology
May 29-31
8:00 a.m. – 5:00 p.m.
This course provides: (1) a thorough grounding and understanding of thermal spray processes, (2) depicts the quite complex scientific concepts in terms of simple physical models, and (3) integrates this knowledge to practical engineering applications and commonly accepted thermal spray practices. Participants receive the Handbook of Thermal Spray Technology and hard-copy of the instructor's presentation materials. The instructors have been collaborating on this course since 1996.
Instructors: Dr. Christoper C. Berns, FASM, Professor, Swinburne University of Technology, Hawthorn, Victoria, Australia; Dr. Richard Knight, FASM, Auxiliary Prof., Drexel University, Philadelphia, Pa.

Registration Fees (US$): ON or BEFORE May 14 (AFTER May 14)
TSS/DVS/IIW Member 995 (1,045)
ASM Member 1,055 (1,105)
Non-Member 1,195 (1,245)
Student 295 (345)

Understanding and Improving Thermal Spray Technology
May 30-31
8:00 a.m. – 6:30 p.m.
This course will review the processing science of a wide range of thermal spray coating processes. The theory of operation and practice of the coatings will be presented, including thermal spray process control, coating application, characterization, and testing. Practical coating systems for electric arc, combustion, and plasma spray will be reviewed using case studies.
Instructors: Dr. Maher Boulos, TS-HoF, Prof., University of Sherbrooke, Sherbrooke, Quebec, Canada; Dr. Pierre Fauchais, FASM, Prof., Université de Limoges, Limoges, France; Dr. Joachim Heberlein, FASM, TS-HoF, University of Minnesota, Minneapolis, Minn.

Registration Fees (US$): ON or BEFORE May 14 (AFTER May 14)
TSS/DVS/IIW Member 795 (845)
ASM Member 835 (885)
Non-Member 975 (1,025)
Student Fee 255 (305)

The Metallographic Preparation of Gas Turbine Coatings
May 31
8:00 a.m. – 5:00 p.m.
This course covers a wide range of topics relating to the metallographic preparation and evaluation of gas turbine coatings with emphasis on equipment and consumables selection and how these choices influence the observed coating structure. Common issues encountered with various coating families (hardcoats, ceramic TBCs, etc.) also will be discussed.
Instructor: Douglas G. Puerta, Director of Metallurgical Engineering, IMR Test Labs, Lansing, N.Y.

Registration Fees (US$): ON or BEFORE May 14 (AFTER May 14)
TSS/DVS/IIW Member 475 (525)
ASM Member 525 (575)
Non-Member 645 (695)
Student Fee 195 (245)
W hen a liquid is subject to a sufficiently strong electric field, it can be induced to emit thin fluid jets from conical tip structures that form at its surface. Such behavior has both fundamental and practical implications, from raindrops in thunderclouds to pendant drops in electrospray mass spectrometry. But the large difference in length scales between these microscopic/nanoscopic jets and the macroscopic drops and films from which they emerge has made it difficult to model the electrohydrodynamic (EHD) processes that govern such phenomena. Researchers at Purdue University report simulations and experiments that enable a comprehensive picture of the mechanisms of cone formation, jet emission and break-up that occur during EHD tip streaming from a liquid film of finite conductivity. Simulations show that EHD tip streaming does not occur if the liquid is perfectly conducting or perfectly insulating, and enable us to develop a scaling law to predict the size of the drops produced from jet break-up.

Chemical engineers at the School of Chemical Engineering, Purdue University, West Lafayette, Ind., are the first to mathematically describe precisely how droplets form when liquids are exposed to electric fields, an advance that could have applications in areas ranging from manufacturing to medical diagnostics. The technique of using small droplets created by subjecting liquids to electric fields is vital in a variety of applications, from industrial painting called electrospaying, to a method for analyzing molecules in analytical chemistry, to manufacturing micro- and nanoparticles for research and industry. “Despite its importance, industry doesn’t really understand exactly how the drops form,” says Osman Basaran, the Reilly Professor of Fluid Mechanics in Purdue’s School of Chemical Engineering. New findings show that a liquid’s viscosity plays a vital role in drop formation and size, a discovery that contradicts conventional wisdom, Basaran says. The researchers first created simulations to describe droplet formation mathematically, and then they performed experiments to support the computational work. “Computational simulations are now making it possible to understand such phenomena,” he said. “But you always want to back up simulations with experimental data if at all possible.”

The findings are detailed in a paper entitled “Electrohydrodynamic Tip Streaming and Emission of Charged Drops from Liquid Cones,” coauthored by doctoral student Robert T. Collins, undergraduate student Jeremy J. Jones, professor Michael T. Harris, and Basaran, all in the School of Chemical Engineering. Researchers have known for decades that applying an electric field to liquid drops causes the formation of structures that have a perfect cone at the leading edge. “Each drop takes on the shape of a chocolate kiss,” Basaran said. Then, a thin ribbon-like strand of fluid is emitted from the leading edge of the droplet and breaks up into smaller droplets. “This was discovered about a century ago,” Basaran said. “Nobody could really show precisely how it happened, but technologically it became very important.”

The method could make possible future technologies for creating flexible electronic circuits and solar cells by spraying material in ultrathin layers. “Making small drops and controlling drop size is important, and there are many techniques being worked on to be able to model these computationally or theoretically,” Basaran said. “There are many applications that would benefit by knowing the drop size. You cannot predict the drop sizes unless you have simulations to tell you how the strand is going to develop and break up into little droplets.”

The same phenomenon occurs in rain clouds. As rain droplets pick up an electrical charge, they take on an elongated football shape. Thin strands form at each end of the football, and those strands, in turn, form small droplets. The ends shoot the little strands or jets, which break up into drops, which has been suspected for a century to play a major role in how thunderstorms work. Understanding how the drops form is difficult because the strands are many times thinner than the original liquid from which they formed, which makes the mathematics especially challenging.

These equations have not been solved in their full form before because they are very difficult, and the Purdue researchers now have solved them without any approximations. Conventional modeling methods use diffuse interface techniques, which do not precisely predict how the strands and droplets form. The Purdue researchers used a more precise method called finite elements with elliptic mesh generation, a technique that breaks down a material into many small segments and solves the mathematical equations governing the behavior of each segment separately. Using the method enables researchers to understand the dynamic, changing shapes of each segment making up the drop-forming strands and the droplets. The technique allowed the engineers to negotiate the dramatic size differences between the strands and original liquid, a process that falls in the realm of “multiscale modeling.” The approach allows conducting this multiscale modeling in one big calculation.

In the experiments, an electric voltage was applied to a small metal rod positioned about an inch from a puddle of liquid. The liquid was pulled toward the tip of the rod, taking on a conical appearance. Strands of liquid, which subsequently broke into droplets, were then emitted from the liquid cone. The researchers conducted experiments using liquids having large viscosities, including those similar to fuels, whereas past research has concentrated on lower viscosity fluids like water.

This may prove to be important in combustion applications because fuel is sprayed into engine cylinders using fuel injectors. Higher viscosity fluids were studied to see the effect of viscosity, which other people had never seen before. It turns out that the viscosity actually has a big effect on droplet size.

Future research will continue to study how droplet formation is influenced by other characteristics of a liquid including the electrical conductivity of fluids and the surface tension, the latter being responsible for the beading of water droplets on a recently waxed
The researchers believe they are just scratching the surface because there is such a large range of viscosities and other characteristics of fluids that affect droplet formation and size. The research has been funded by the U.S. Department of Energy. For more information: Osman Basran is the Reilly Professor of Fluid Mechanics, School of Chemical Engineering, Purdue University, West Lafayette, Indiana 47907, USA; tel: 765-494-4061; e-mail: obasaran@ecn.purdue.edu.

Electrohydrodynamic (EHD) Tip Streaming

A sufficiently strong electric field can destabilize a fluid interface separating a drop from the surrounding air. An unstable interface takes on a conical shape, now referred to as a Taylor cone, and typically either a stream of drops or a fine jet that subsequently breaks up into drops is emitted from the cone’s tip. Such electrohydrodynamic (EHD) tip streaming or cone-jetting phenomena, which are often referred to as electrospraying, occur widely in nature and technology. Well-known examples of cone jetting include ejection of streams of small charged drops from pointed tips of raindrops in thunderclouds and the popular technique of electrospray mass spectrometry, which is used for assaying large biomolecules. Currently, electrosprays are finding application in an ever-growing number of areas including separations, powder synthesis, coatings and encapsulation for controlled release.

EHD tip streaming from a liquid film predicted by simulation and observed in experiment is shown in Fig. 1. In the simulations, the liquid is treated as a Taylor–Melcher leaky dielectric or semi-insulator. Figure 1b shows the Taylor cone, the tip streaming jet, the transition region between them, and the small drop that is about to pinch-off from the tip of the thin jet predicted by simulation. The inset of Fig. 1b shows a magnified view of the jet’s tip, and also shows a micro-thread connecting the about-to-form drop to the jet. Figure 1c–f shows, in 2 ms intervals, the development of a tip streaming jet from a thin film of canola oil in an experiment that has been captured at 1,000 frames/second. As shown in Fig. 1, the tip of the conical meniscus sharpens dramatically in the time interval separating Fig. 1c and d. A jet is clearly visible in Fig. 1e and well developed in Fig. 1f. Agreement between experiment and simulation is excellent.
Metal or thermal spray is a technology used to apply coatings that protect and/or extend the life of a wide variety of products in the most hostile environments and in situations where coatings are vital for safety and performance. Metallisation has been providing equipment for surface coating since 1922.

Metallisation Ltd.'s Polish distributor, SciTeeX, was awarded a repeat order from Malmor in Gdansk, Poland, to expand the metal spray process for a range of ocean-going trawlers. Malmor provides corrosion protection to a number of industries in Poland and other Eastern European countries. Originally concentrating on ships and ship repairs, Malmor has also diversified into other industries such as food, agriculture, and energy. The latest marine-related projects involve rescue vessels, otherwise known as “floating hospitals,” fishing trawlers, and fish-processing vessels.

Corrosion is a major problem for the shipbuilding and fishing industries. Metallisation has the experience and understanding of how to protect this expensive equipment from the ravages of rust. To ensure long-term anticorrosion protection of ocean-going vessels, Malmor applies Al-Zn metal spray coatings to various parts of the vessels using Metallisation Arc 140 arc spray equipment. Many parts of the vessels are specified to be metal sprayed for improved safety, durability, and, therefore, life-cycle costs. Metal spray is much more durable than paint; independent European standards (EN14713 and EN2063) show that a life to first maintenance of 20 years or more can be achieved in sea water-splash zones. The deck and the hull, which sits above the waterline, have to be metallized to protect them against the harsh sea environment.

Other parts of the vessels metal sprayed include refrigerated sea-water (RSW) tanks, where fresh fish are stored on board, fish-processing rooms, chutes into the fresh-fish tanks, net-winching sheaves and drums, masts and the trawl boards. Not only are these elements exposed to the corrosive sea environment, but also they are exposed to daily wear and tear of the equipment used in the trawling process. The durability of metal spray coatings means that maintenance downtime to repaint these areas is greatly reduced.

A thermal spray Al-Zn coating is applied to fish shoots to protect them from corrosion in the marine environment.

To ensure a metallized surface is effective and to meet the long-term corrosion protection, it is essential to prepare the surfaces in advance. During recent projects, the vessels and parts were either blasted using copper slag to SA 2.5 standard at the shipyard, or blasted using chilled iron grit to SA 2.5 in a state-of-the-art blast room at the Malmor site. The surfaces were then sprayed using a coating between 50 and 200 µm thick of aluminium-zinc alloy or pure zinc. The final surface was coated with a sealing layer according to the shipbuilding specifications. In some instance, a further topcoat of paint is specified and applied.

SciTeeX says it is pleased with the outcome of the project. The Metallisation Arc 140 system is ideal for the type of metallized coating that Malmor has to provide to its shipbuilding customers, which must meet the strict specifications laid down by the supervising body of the shipbuilding industry. Malmor also uses the Metallisation equipment and processes with other customers to protect tanks, steel constructions, and artistic blacksmith items, such as gates and fences.

The Arc140 system was recommended based on the needs of Malmor due to its flexibility, ease of use, and reliability. The customer was trained on correct working practices plus basic preventative maintenance at Metallisation and on their site in Gdansk. Since the start of using the equipment, both systems have worked well and are popular with the metal spray applicators. www.metallisation.com

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A thermal spray Al-Zn coating is applied to fish shoots to protect them from corrosion in the marine environment.
Metallisation Launches New HVOF System

Metallisation Ltd. (Dudley, West Midlands, UK) introduces its new MET-JET 4L liquid fuel HVOF system, the latest development in its kerosene-fuelled HVOF systems. It is a mass flow-controlled system to ensure repeatable, dense metallic and carbide coatings. Coatings can be compressively stressed, allowing thick layers to be applied without fear of spalling. A modified pistol combustion chamber is cleaner burning, and achieves higher quality coatings, and a simplified nozzle arrangement reduces the running costs of consumable spares. The powder feeder has mass flow-controlled carrier gas and closed-loop motor control for reliable, repeatable powder feed rates. The operator interface is now via a touch screen rather than pushbuttons. The system also provides a range of unlimited recipes, which can be preset using the parameter recording facility to ensure consistent coating quality, which in turn, saves operator time. The MET-JET 4L can also be programmed to start up and shut down automatically or manually. Hydrogen start-up ensures a smooth lighting sequence, reducing the loading on the pistol. The use of kerosene in place of hydrogen fuel makes the MET-JET 4L more economical to run while maintaining the highest quality coatings. The system is ideal for use in applications for surfaces such as CGL mill rolls, oil/gas ball and gate valves, paper rolls, hydraulic rams, aircraft landing gear, suspension components, hydroelectric turbines, automotive valves, wire drawing block, and in general as an alternative to hard chrome plating.


MEC Introduces HVOF System

Metallizing Equipment Co. (MEC) Pvt. Ltd., Rajasthan, India, introduces what is claimed to be the world’s lightest HVOF gun (1.85 kg / 4 lb) with high spray capacities for high-performance powders, such as WC-12%Co, Cr3C2-25%NiCr, etc.

It offers similar coating characteristics to those of competitive products. The patented HIPOJET-2700 HVOF spray gun can be fitted with HYBRID for increased particle velocity and dense coating. Both auto ignition and manual operational versions are available. A 6 kg (payload) robot is sufficient for this system resulting in great saving of capital and operating costs. A simple pressure feed type powder feeder is supplied with the system. The user-friendly ergonomically designed system is compact and mounted on trolley with dimensions of about 700 mm long × 600 mm wide × 1,900 mm high (27.5 × 23.5 × 75 in.). The HVOF gun conforms to EN safety standards (CE marked).

www.mecpl.com

Low-Temperature PVD Coatings

Oerlikon Balzers, Elgin, Ill., introduces its Balinit Artic low-temperature line of physical vapor deposition (PVD) coatings for molds and components. An innovative arc technology allows coatings to be applied at temperature of 200°C (390°F), substantially lower than standard PVD coatings that are applied between 400 and 500°C (750 and 930°F), which makes it possible to coat polymer-processing cold-working steels and die steels that are commonly tempered at 200°C, as well as copper alloys. The coatings have no loss of performance compared with coatings deposited at higher temperatures. The lower deposition temperature allows mold materials with lower tempering thresholds to be coated without distortion, loss of hardness, or reduction in corrosion resistance.

Three coating versions are Balinit A Artic (TiN) having a surface hardness of 2300 HV and a coefficient of friction against steel of 0.4; Balinit D Artic (CrN) having a surface hardness of 1750 HV and a coefficient of friction against steel of 0.5; and Balinit Futura Nano Artic (TiAlN), a nano-layered coating that has a surface hardness of 3300 HV and a coefficient of friction against steel of 0.5. The coatings are extremely thin and are characterized by exceptional hardness and markedly reduce friction and wear. www.oerlikon.com/balzers/us/.

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JTST HIGHLIGHTS

The Journal of Thermal Spray Technology (JTST), the official journal of the ASM Thermal Spray Society, publishes contributions on all aspects—fundamental and practical—of thermal spray science, including processes, feedstock manufacture, testing, and characterization. As the primary vehicle for thermal spray information transfer, its mission is to synergize the rapidly advancing thermal spray industry and related industries by presenting research and development efforts leading to advancements in implementable engineering applications of the technology.

JTST editor Christian Moreau has announced that the March issue 17(1) is a special issue focusing on suspension/solution thermal spraying, an emerging technology. Guest editor for this issue is Prof. Pierre Fauchais, University of Limoges. Several articles are highlighted here.

In addition to the print publication, JTST is available online through www.springerlink.com. For more information, please visit www.asminternational.org/tss.

“Parameters Controlling Liquid Plasma Spraying: Solutions, Sols, or Suspensions”

P. Fauchais, R. Etchart-Salas, V. Rat, J.F. Coudert, N. Branland, and K. Wittmann

This paper presents our current knowledge in plasma spraying of suspension, sol, and solution to achieve fine or nano-structured coatings. First, it describes the different plasma torches used, the way liquid jet is injected, and the different measurements techniques. Following this is a discussion of drops or jet fragmentation, especially the influence of arc root fluctuations for direct current plasma jets. The heat treatment of drops and droplets is described successively for suspensions, sols, and solutions, both in direct-current and radio-frequency plasmas, with a special emphasis on the heat treatment during spraying of beads and passes deposited. Comments on the resulting coating morphologies are presented, and, finally, examples of applications are presented: solid oxide fuel cells, thermal barrier coatings, photocatalytic titania, hydroxyapatite, WC-Co, complex oxides or metastable phases, and functional materials coatings.

“Thermal Barrier Coatings Made by the Solution Precursor Plasma Spray Process”

Maurice Gell, Eric H. Jordan, Matthew Teicholz, Baki M. Cetegen, Nitin Padture, Liangde Xie, Dianying Chen, Xinqing Ma, and Jeffrey Roth

The solution precursor plasma spray (SPPS) process is a relatively new flexible thermal spray process that can produce a wide variety of novel materials, including some having superior properties. The SPPS process involves injecting atomized droplets of a precursor solution into the plasma. The properties of resultant deposits depend on the time-temperature history of the droplets in the plasma, ranging from ultrafine splats, to unmelted crystalline particles, to unpolymerized particles. By controlling the volume fraction of these three different constituents, a variety of coatings can be produced, all with a nanograin size. In this paper, we review research related to thermal barrier coatings, emphasizing the processing conditions necessary to obtain a range of microstructures and associated properties. The

Schematic of the solution precursor plasma spray delivery system.
SPPS process produces a unique strain-tolerant, low thermal conductivity microstructure consisting of: (i) three dimensional micrometer and nanometer pores, (ii) through-coating thickness (vertical) cracks, (iii) ultrafine splats, and (iv) interpass boundaries.

“Application of Suspension Plasma Spraying (SPS) for Manufacture of Ceramic Coatings”
Holger Kassner, Roberto Siegert, Dag Hathiramani, Robert Vassen, and Detlev Stoever

Conventional thermal spray processes such as atmospheric plasma spraying (APS) have to use easily flowable powders with a size up to 100 μm. This leads to certain limitations in the achievable microstructural features. Suspension plasma spraying (SPS) is a new promising processing method that uses suspensions of submicron particles as feedstock. Therefore, much finer grain and pore sizes, as well as dense and also thin ceramic coatings can be achieved. Highly porous coatings with fine pore sizes are needed as electrodes in solid oxide fuel cells. Cathodes made of LaSrMn perovskites have been produced by the SPS process. Their microstructural and electrochemical properties are presented. Another interesting application is thermal barrier coatings (TBCs). SPS allows the manufacture of highly segmented TBCs still having relatively high porosity levels. In addition to presenting these specific applications, the paper also discusses the manufacture of new microstructures such as nanolayers and columnar structures.

“Technical and Economical Aspects of Current Thermal Barrier Coating Systems For Gas Turbine Engines by Thermal Spray and EBPVD: A Review”
A. Feuerstein, J. Knapp, T. Taylor, A. Ashary, A. Bolcavage, and N. Hitchman

The most advanced thermal barrier coating (TBC) systems for aircraft engine and power generation hot section components consist of EBPVD applied yttria-stabilized zirconia and platinum-modified diffusion aluminate bond coating. However, thermal sprayed ceramic and MCrAlY bond coatings still are used extensively for combustors and power generation blades and vanes. This paper highlights the key features of plasma spray and HVOF, diffusion alumizing, and EBPVD coating processes. The coating characteristics of thermally sprayed MCrAlY bondcoat, as well as low density and dense vertically cracked (DVC) Zircaloys TBCs are described. Essential features of a typical EBPVD TBC coating system, consisting of a diffusion aluminate and a columnar

EBPVD TBC, featuring a plurality of vertical, loosely-bonded columnar grains.

TBC, are also presented. The major coating cost elements such as material, equipment, and processing are explained for the different technologies, with a performance and cost comparison given for selected examples.
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27–28 Feb. 48th Israel Ann. Conf. on Aerospace Sciences: Tel Aviv and Haifa, Israel. Contact Dan Knassim Ltd., Ramat Gan, Israel; tel: 972-3-613340, ext. 207; fax: 972-3-7604829; Web site: www.aeroconf.org.il.

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22–26 June ASM Advanced Aerospace Mats. & Processes Conf. & Expo (AeroMat 2008): Austin, Texas. Contact Cust. Srvcs. Ctr., ASM Intl., Mats. Park, Ohio; tel: 800/336-5152 (ext. 0) or 440/338-5151 (ext. 0); fax: 440/338-4634; e-mail: customerservice@asminternational.org; Web site: www.asminternational.org.
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- Electrical properties
- Wear and erosion

Current production and applications:

- Aerospace: Turbine, landing gears and hard chrome replacement
- Mining: Ball valves and other components, corrosive and acidic slurries
- Power generation: Pulp and paper

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