JTTEE5 13:13-20
DOI: 10.1361/10599630418815
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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. Christian Moreau, National Research Council Canada, Industrial Materials Institute, 75 de Mortagne, Boucherville (Québec), Canada J4B 6Y4; tel: 450/641-5228; fax: 450/641-5105; e-mail: christian.moreau@cnrc-nrc.gc.ca.

Thermal Spray Research at Tampere University of Technology, Institute of Materials Science, Tampere, Finland

Introduction

The Institute of Materials Science (IMS) at Tampere University of Technology (TUT) combines education and research activities in the fields of structure, properties, and processing of metallic, ceramic, and polymer materials and their composites. The institute was founded in 1968 and now has about 120 employees. Research is done in six laboratories specializing in metallic materials, manufacturing technology, polymers and elastomers, ceramic materials, electron microscopy, and surface engineering. The surface engineering laboratory educates surface engineering specialists and performs high-level research with domestic and international research partners as well as with the industry. The laboratory has 12 employees, but shares several other scientists from other laboratories on project basis. Although the main activities recently have concentrated on different aspects of thermal spraying and laser coating, the scope of the laboratory covers processes from atomic and molecular deposition processes, such as chemical vapor deposition (CVD) and physical vapor deposition (PVD), to thermal spraying, laser coating, and feedstock materials development. The goal in activities is to understand the materials-processing-properties interrelationships that are essential in advancing industrial applications of the coatings.

The thermal spray methods used in the laboratory include high-velocity oxyfuel (HVOF) spraying, atmospheric plasma spraying (APS), flame spraying (wire, powder), electric wire arc spraying, detonation gun spraying (DGS), polymer flame spraying, and laser coating (or laser spraying/laser cladding). The spray process itself is monitored and characterized with advanced on-line monitoring diagnostic equipment SprayWatch (Oseir Ltd., Tampere, Finland). Research equipment of the institute is shared by the laboratories. These include wide range of characterization and testing tools, for example various electron microscopes (SEM, TEM) with microanalytical tools, optical microscopes, x-ray diffractometer, different universal mechanical testing machines, and corrosion and wear testing equipment (erosion, abrasion, sliding, high-temperature erosion, corrosion-wear, etc.). In-house powder feedstock development can be performed utilizing ultrasonic gas atomization (USGA) unit, powder sizing by attritor or ball mills. Powder development is done also in the area of agglomerated and sintered powders. The most important powder characteristics can be measured using in-house tools.

Research is funded by contracts from industry, the National Technology Agency of Finland (TEKES), Academy of Finland, Nordic Industry Fund and Commission of European Union. Industry is actively participating in all of the projects as funding partner and as the end-user of the research results and developments. Some of the projects and activities are reviewed here.

Wear and Corrosion Properties of Thermal Sprayed Coatings

Wear and corrosion properties of various thermal sprayed coatings have been a subject of number of extensive studies during the last several years. The corrosion properties of coatings made of metals, alloys, cermets, ceramics, and polymers have been evaluated using immersion tests and electrochemical methods. For example, corrosion properties of HVOF sprayed cermet coatings were recently studied in electrolytes simulating paper mill white water. This electrolyte contains chlorides and sulfates, chemicals that tend cause corrosion of the sprayed coating. Table 1 presents results from a 30-day immersion test. The amounts of dissolved ions from the coating material in the electrolyte are presented. This environment seems to be aggressive. The measured dissolution values of tungsten are very high and originate probably from tungsten-rich phases formed during spraying. Chromium alloying clearly improves the corrosion resistance. The Cr_3C_2-25NiCr coating generally performed the best of the coatings in this environment.

In a collaboration project with the Nordic industry and research institutes, new corrosion-resistant hard metal powders and coatings are also being developed. Commercial and experimental WC, Cr_2C_3, and TiC coatings with corrosion-resistant binder phase are wear and corrosion tested. Various prealloyed corrosion-resistant metals (Ni- and Co-base alloys) are used as binder in order to increase corrosion resistance of hardmetal coatings in comparison with standard WC-CoCr coatings.

Table 1 Amount of Dissolved Ions in mg/L Detected by the ICP Analysis

Coating	W	Co	Cr	Ni	Fe
WC-12Co	300.3	204.4	…	…	3.6
WC-10Co-4Cr	258.0	70.0	8.1	…	2.6
WC-20Cr_3C_2-7Ni	221.0	…	2.6	15.4	6.8
Cr_3C_2-25NiCr	…	…	11.1	85.7	0.5
AISI 316L	…	…	0.05	0.06	+

Test conditions: 30 days in synthetic paper mill white water at pH 4.5 and 50° C.

Microstructural Characterization of Plasma Sprayed Ceramic Coatings with Inorganic Sealing

Thermally sprayed ceramic coatings can be an effective way to increase wear resistance. However, the corrosion resistance of these coatings is limited because of open porosity that allows corrosive agents to penetrate into the interface between the coating and the substrate. This open porosity can be sealed with aluminum phosphate sealant. Microstructural characterization of aluminum phosphate sealed alumina and chromia coatings, as well as of as-sprayed coatings and aluminum phosphate sealant, was carried out in order to study the chemical compositions, phase structures, and determine the coating morphology. The study was directed toward finding the microstructural features that explain the strengthening and sealing mechanism of aluminum phosphate sealant in the alumina and chromia coatings.

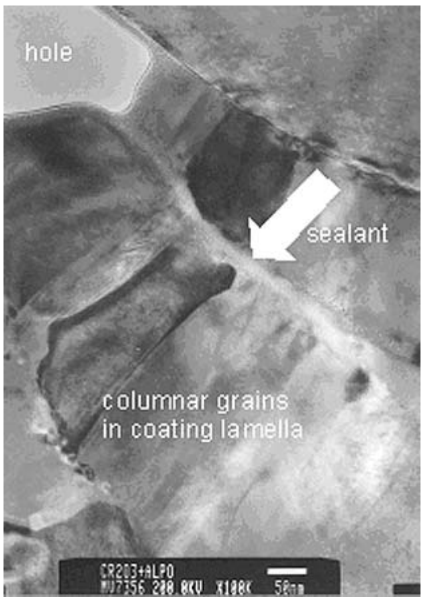


Fig. 1 Analytical transmission electron micrograph of a sealed plasma sprayed Cr_2O_3 coating. Coating lamellae consist of columnar α-Cr_2O_3 grains extending through the lamellae thickness and aluminum phosphate sealant, marked with an arrow, has filled the gap between the lamellae.

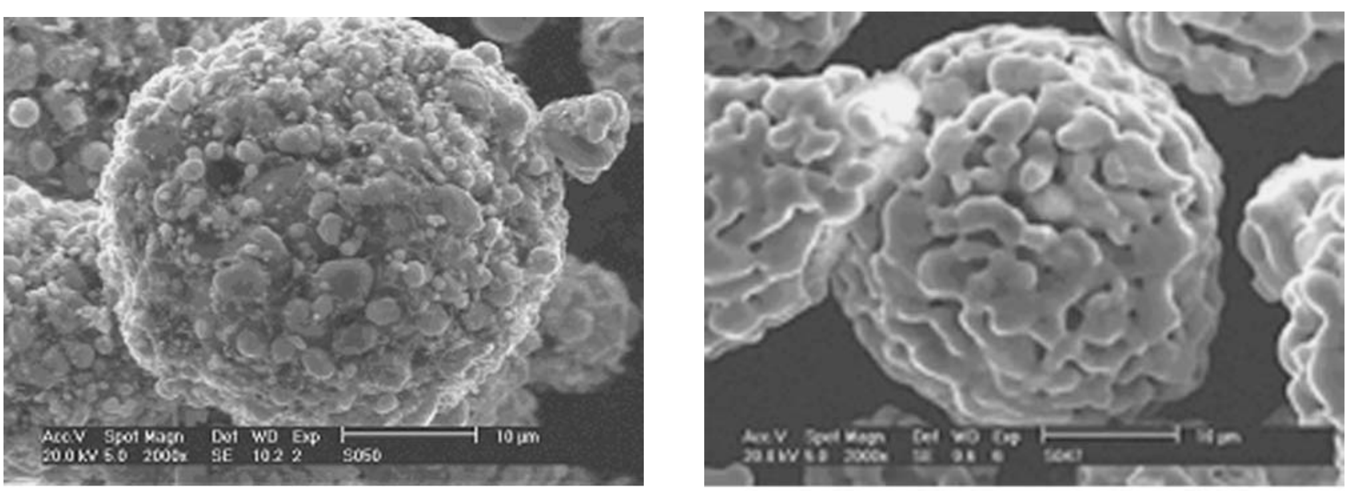
The results showed that aluminum phosphate sealant penetrated effectively into the coatings via structural defects such as gaps and voids between the lamellae and microcracks in the lamellae and thus also improved mechanical and corrosion properties by sealing and bonding the coating lamellar structure. In the aluminum phosphate sealed alumina coating the aluminum phosphate reacted with the alumina lamellae, forming a 20 nm thick reaction layer of berlinite-type aluminum orthophosphate $AlPO_4$ at the interface between the amorphous sealant and the alumina lamella surface. In the aluminum phosphate sealed chromia coatings, the interface between the amorphous sealant and the chromia lamellae indicated no reactions. Thus, the bonding mechanism of the aluminum phosphate sealant in the alumina coatings is based on chemical reaction, whereas in the chromia coatings the bonding mechanism is based only on adhesive binding due to attractive forces between the sealant and the coating. Despite the different bonding mechanisms in the alumina and chromia coatings, the effect of the sealing on the coating properties was significant in both cases. Figure 1 is an example of the microstructure found in a sealed plasma sprayed chromia coating.

Solid Lubricant Containing Powders for HVOF Spraying

High-velocity oxyfuel sprayed carbide/metal coatings are used widely to prevent wear of engineering components. However, under sliding conditions with high surface pressures, these coatings may develop unacceptable levels of sliding friction, especially in case of lubrication failure in the tribocontact of the mating surfaces. Another example is operation at high temperatures, where oil lubrication cannot be used. Powders and coatings with addition of solid lubricants have potential to solve these problems. The function of solid lubricants in coatings is to improve sliding properties especially in dry friction. The aim of this work is to study manufacturing and properties of multicomponent powders and coatings. Powders were prepared by spray drying and sintering. The four different solid lubricants tested were Ca_2F, BN, WS_2, and MnS. Samples of coatings were prepared by the HVOF method. The authors' results clearly proved that after HVOF spraying the solid lubricant phases were still found in the coatings. Figure 2 presents SEM images of chromium carbide powders with two different kinds of solid lubricant additions.

Surface Characterization of Plasma Sprayed Oxide Coatings

The purpose of this study is to characterize the most important surface chemical



(a) (b)

Fig. 2 Morphology of solid lubricant containing powders for HVOF process. **(a)** Cr_3C_2-25Ni 10 vol.% WS_2. **(b)** Cr_3C_2-25Ni 10 vol.% CaF_2.

properties of common plasma sprayed oxides (Al_2O_3, Cr_2O_3, and TiO_2 and their mixtures) including surface composition and oxidation state, crystallographic structure, chemical stability, and chemical reactivity. Samples are atmospheric plasma sprayed. Applied characterization methods and equipment in this work include: wetting angle and surface energy measurements using sessile drop method; material stoichiometry testing using thermal gravimetric studies; characterization of surface charges using streaming potential studies; adsorption of inert and reactive gases; and surface acidity measurements using titration methods. Also, other surface sensitive research methods, for example, x-ray photoelectron spectroscopy, are available with cooperation with other Finnish and international universities. Wetting characteristics of different plasma sprayed coating materials are very similar. The surface pretreatment methods (e.g., different cleaning methods) and surface topography were found to influence the wetting properties more than the coating composition. Water adsorption studies of plasma sprayed Cr_2O_3 and TiO_2 have shown that the stoichiometry of these materials influences the water adsorption. Surface acidity (point of zero charge, pzc) of most studied oxides is near the value of traditionally manufactured oxide counterparts. On the other hand, in case of some oxides (e.g., Cr_2O_3) the obtained surface acidity values deviate radically and the acidity values change as a function of water exposure times. Wetting angle measurement image of Cr_2O_3 is presented in Fig. 3. Future work includes characterization of influence of water exposures at different pH on dissolution behavior, surface charging (zeta-potential), and changes in oxidation states of plasma sprayed oxides. The project aims to understand the effect of thermal spraying on surface properties of oxide materials, which are important in controlling the friction, adhesion to the surfaces in different process conditions, or their self-cleaning behavior. The photocatalytic behavior of different TiO_2-base coatings is also studied.

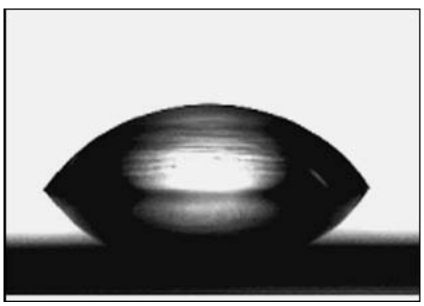


Fig. 3 Wetting angle characterization at TUT. Plasma sprayed Cr_2O_3 wetting angle 45°.

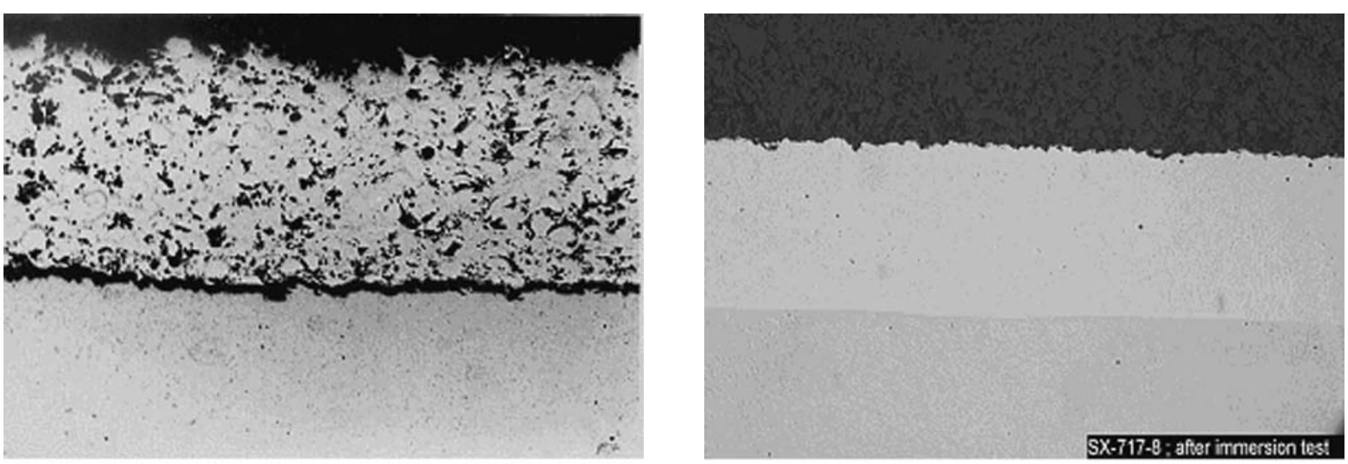
Laser Coating (Laser Spraying) and Laser Remelting of Thermal Spray Coatings

New high-power lasers are effective tools in producing coatings directly from powder or in fusing (remelting) thermal sprayed coatings. The laser coating process is a competitive method to weld overlay coatings produced for example by plasma transfer arc (PTA). In the laser coating process heat input can be carefully controlled, and therefore dilution of base material into coating materials can be minimized. Thermally sprayed coating can also be laser fused, and nearly 100% pore-free coatings can be produced. This is a significant advantage in the development of corrosion-resistant coatings. Figure 4 shows a comparison of two microstructures after an immersion saltwater corrosion test. The difference in corrosion resistance is obvious. In a large laser coating project wear- and corrosion-resistant coatings are developed together with overall development and knowledge enhancement of laser coatings and coating process.

Other Activities

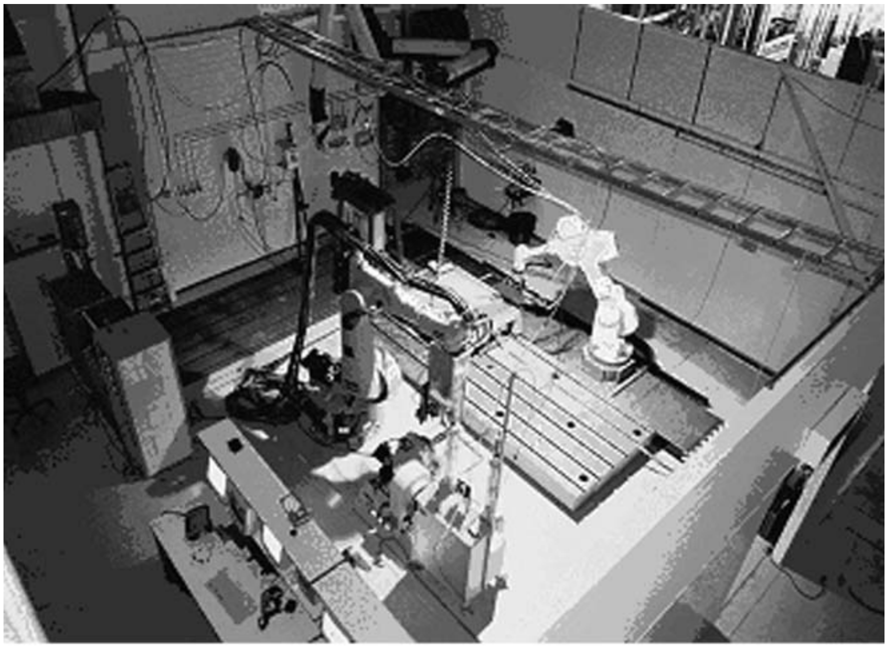
The following research topics have been studied during the last years:

- HVOF and VPS NiCoCrAlYRe coatings,
- Flame sprayed polymer coatings for corrosion protection in chemical and process industry,
- Development of polymer coatings for natural gas pipeline components and field joints,
- Plasma sprayed ceramic thick thermal barrier coatings; surface densification methods for thick thermal barrier coatings,
- Properties of thick ceramic coatings by WSP process,
- Wear and corrosion properties of HVOF sprayed WC-CoCr coatings,
- On-line monitoring of thermal spray processes,

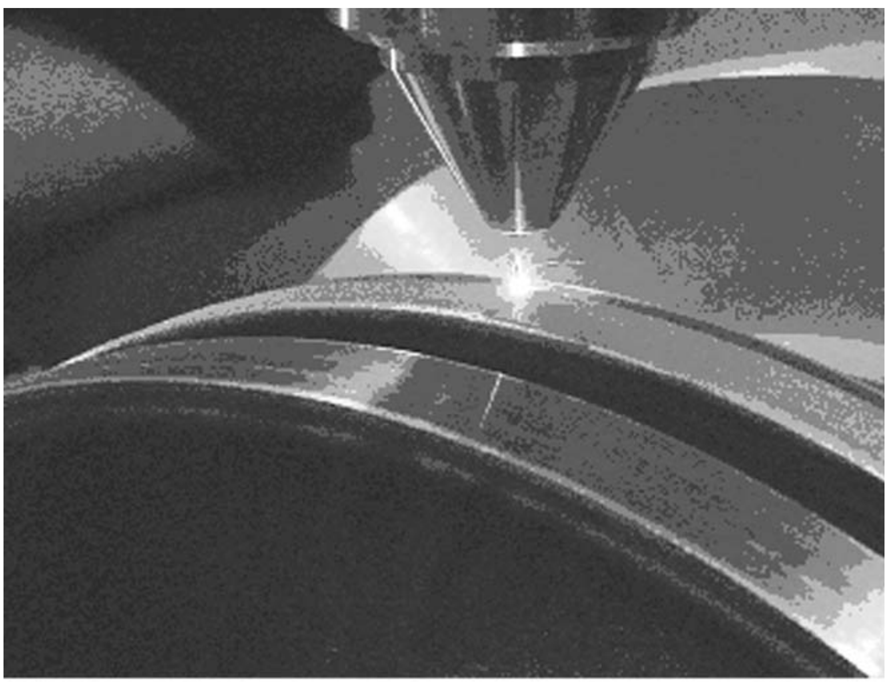


(a) **(b)**

Fig. 4 Comparison of **(a)** HVOF and **(b)** laser remelted high-Cr NiCr coatings after a corrosion test in 3.5 wt.% NaCl solution.



(a)



(b)

Fig. 5 Laser Application Laboratory at TUT. **(a)** General view of LAL, with two robots and two high-power lasers; 4 kW Nd:YAG fiber-coupled laser and 6 kW high-power diode laser (HPDL) with off-axis and coaxial powder nozzles. **(b)** Laser coating process with 4 kW Nd:YAG laser.

- Corrosion- and erosion-resistant coatings for power plants, and
- Development of recycled cermet powders.

Several other, mainly industry-funded, projects are ongoing. These projects address different kinds of thermal spraying problems and manufacturing issues, often linked to industrial applications.

Thermal Spray and Laser Coating Facilities

TUT/IMS is well equipped with several different types of thermal spray processes. In addition to thermal spraying, also laser coating (laser spraying) is currently studied. Thermal spray research and development is performed in two spray booths with total floor area of 55 m^2. The available thermal spray processes are:

- Atmospheric plasma spraying: Sulzer Metco A3000 S 4/2 with F4 gun and PT-10 powder feeder,
- HVOF spraying: Sulzer Metco Diamond Jet system with DJ Standard gun, DJH Hybrid 2600 and 2700 guns; Sulzer Metco 9MP-DJ powder feeder,
- Electric wire arc spraying: Metco 6R,
- Powder flame spraying: Metco 6P-II oxy-acetylene gun,
- Wire flame spraying: Metco 12E oxy-acetylene gun,
- Detonation gun spraying: Perun P type D-Gun,
- Polymer flame spraying: Eutectic&Castolin TeroDyn 3500 flame spray gun,
- Electrostatic powder spraying: Gema system,
- Laser spraying (laser cladding): 4 kW Nd:YAG fiber-coupled cw laser (Trumpf) and 6 kW high power diode laser (Rofin) with off-axis and coaxial powder nozzles,
- Spraywatch on-line monitor: Spray-Watch Professional system (Oseir Ltd. Finland),
- One- and two-axis gun manipulators, and
- Turntables for part rotation.

Two state-of-the-art high-power lasers are used for surface hardening and laser coating with powder in Laser Application Laboratory (LAL) (see Fig. 5), which is a joint research laboratory of two institutes at TUT; Institute of Production Engineering, and Institute of Materials Science. Both laser coating processes are robotized and fully computer controlled. With the high-power diode laser (HPDL), powder feed rates of the order of 100 to 200 g/min have been achieved, owing to sophisticated powder feeding technology and high process efficiency.

National and International Collaboration

In the area of thermal spray research, TUT/IMS has collaborated with several national and international organizations and industry. One of the most important is collaboration with Fraunhofer Institutes in Dresden, Germany (FhG-IKTS and FhG-IWS). Joint research work has been done in the area of spray powder development and coating characterization and testing. TUT/IMS has several other scientific andtechnological collaborators in Europe, Japan, and the United States.

In the area of laser coating, the main collaborators are The Central Ostrobothnia Technology Centre KETEK (Kokkola, Finland) and FhG-IWS (Dresden, Germany).

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Industrial News

Wall Colmonoy Corporation Celebrates 65 Years in Business

For 65 years Wall Colmonoy Corporation has been making metals work harder. The manufacturer of Ni-base self-fluxing alloys was founded in 1938 under the tradename Colmonoy. In 1950, they introduced Nicrobraz brazing filler metals. Soon after, they established brazing facilities in North America, and later in the United Kingdom, to promote and sell the concept of metal joining using Ni-base brazing filler metals.

Nickel Base Self-Fluxing Alloys

Metallurgists Norman Cole and Walter Edmonds formed Colmonoy, Inc., after they were granted a patent for an alloy they named Colmonoy (from COLe, EdMONDs, and allOY). Soon after, A.F. Wall (owner of a large industrial gas company) purchased the fledgling firm, named it Wall Colmonoy Corporation, and moved the operation from California to Detroit.

In 1938, Colmonoy alloys were distinctive because they contain chromium-boride crystals with hardness values (4100 DPH) nearly equal to diamonds. Chromium-boride crystals make Colmonoy alloys ideal for hard surfacing use—the protection of metal parts from excessive wear by welding on a layer of wear-resistant material. To this day, Colmonoy alloys are the only wear-resistant hard-surfacing materials that contain chromium-boride crystals.

Contract Processing

Wall Colmonoy Corporation's contract processing facilities are an international source for high-tech alloy processing, metalworking, and repair development. Each facility has its own specialties.

- Wall Colmonoy Dayton, founded in 1959, specializes in brazing, heat treating, and hard surface coating services of all types of metals.
- Wall Colmonoy San Antonio, founded in 1961, specializes in repair development and turbine engine component overhaul.
- Wall Colmonoy Oklahoma City, founded in 1965, specializes in metal fabrication, shaping, metal forming, aircraft exhaust systems, and fin and plate and tubular type heat transfer equipment.
- Wall Colmonoy Limited (UK), founded in 1950, specializes in manufacture of Ni-base self-fluxing alloys and brazing filler metals, precision investment and spun castings, as well as subcontracting services for brazing, heat treating, and hard surface coating services of all types of metals.

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New Power Supply for Wet Atomizing System

Wall Colmonoy Corporation's Los Lunas alloy manufacturing plant purchased and installed a new Inductotherm 325 kw furnace power supply for a wet atomizing system that is an essential system to their business.

The new system will allow Wall Colmonoy Los Lunas to efficiently meet the production and quality needs of the plant's most demanding melting operations. Wall Colmonoy Los Lunas employs both wet and dry atomizing systems. The upgraded equipment will be used to power and control the wet atomizing process used particularly for processing higher-temperature melting powders such as Colmonoy 88 and many others made to precise customer specifications.

The Inductotherm's melt rates are guaranteed, and its ability to deliver a 94% power conversion efficiency rating will allow Wall Colmonoy Corporation to produce 6% more metal per kilowatt than its previous system.

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New Literature Available on Colmonoy 62 SM Alloy

Wall Colmonoy Corporation has made available a two-page technical data sheet on Colmonoy 62 SM, a new atomized Ni-base alloy designed for spray-and-fuse applications using combustion spray powder systems.

The data sheet has detailed information on the chemical and physical properties of Colmonoy 62 SM and has a 50× micrograph that identifies the constituents of the alloy. Methods of application, methods of finishing, typical uses, and lists of base metals that can be overlaid are also provided.

Typical hardfacing applications for Colmonoy 62 SM are shafts, sleeves, pump plungers, sucker rod couplings, bed knives, camshafts, bushings, mill guides, mixer blades, seal rings, brick manufacturing equipment, and conveyor screws.

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Sulzer Metco Expands Materials Business

Subject to antitrust board approval, Sulzer Metco is acquiring WOKA GmbH, a family-owned carbides manufacturer with 70 employees and sales totaling about CHF 20 million (EUR 14 million) for 2002.

This step widens the Sulzer Metco offering of thermal spray coating and welding materials, thus opening up new markets. WOKA GmbH mainly supplies customers in the paper industry, oil and gas sectors, earthmoving, and machine tool industries. The parties have agreed not to reveal the price of this transaction.

WOKA GmbH carbide-based materials are mainly sold in Europe, the Far East, and increasingly in the United States. The 70 employees work in Barchfeld, Germany, where the construction of a modern plant five years ago represented a milestone in the company's quarter-century history.

For optimal integration, WOKA managing director and former majority owner Eberhard Findeisen will remain on a full-time basis.

Bruno Walser, head of Sulzer Metco, said, "We are delighted to join forces with such a highly competent and innovative partner in materials technology."

In the opinion of Sulzer CEO Fred Kindle, "As another step in the Sulzer Metco divisional expansion strategy, this acquisition will further strengthen our materials business."

According to Eberhard Findeisen, managing director and former majority owner of WOKA GmbH, "Transferring this business to Sulzer is certainly the best solution for our customers as well as our employees. By staying on, I shall help to ensure optimal integration and a smooth transfer to my successor over the next few years."

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News from NASA

Scandia-and-Yttria-Stabilized Zirconia for Thermal Barriers

Zirconia stabilized with both scandia and yttria in suitable proportions has shown promise of being a superior thermal-barrier coating (TBC) material, relative to zirconia-stabilized with yttria only. More specifically, a range of compositions in the zirconia/scandia/yttria material system has been found to afford increased resistance to deleterious phase transformations at temperatures high enough to cause deterioration of yttria-stabilized zirconia.

Yttria-stabilized zirconia TBCs have been applied to metallic substrates in gas turbine and jet engines to protect the substrates against high operating temperatures. These coatings have porous and microcracked structures, which can accommodate strains induced by thermal-expansion mismatch and thermal shock. The longevity of such a coating depends on yttria as a stabilizing additive that helps to maintain the zirconia in an yttria-rich, so-called "non-transformable" tetragonal crystallographic phase, thus preventing transformation to the monoclinic phase with an associated deleterious volume change. However, at a temperature greater than about 1200 °C, there is sufficient atomic mobility that the equilibrium, transformable zirconia phase is formed. Upon subsequent cooling, this phase transforms to the monoclinic phase, with an associated volume change that adversely affects the integrity of the coating.

Recently, scandia was identified as a stabilizer that could be used instead of, or in addition to, yttria. Of particular interest are scandia-and-yttria-stabilized zirconia (SYSZ) compositions of about 6 mol.% scandia and 1 mol.% yttria, which have been found to exhibit remarkable phase stability at a temperature of 1400 °C in simple aging tests. Unfortunately, scandia is expensive, so that the problem becomes one of determining whether there are compositions with smaller proportions of scandia that afford the required high-temperature stability. In an attempt to solve this problem, experiments were performed on specimens made with reduced proportions of scandia. The criterion used to judge these specimens was whether they retained the "nontransformable" tetragonal phase after a severe heat treatment of 140 h at 1400 °C. On the basis of this criterion and limited data, the locus of favored compositions is specified as follows: mole percent of yttria = 8.55 – 1.5 × (mole percent of scandia) between and near the compositional end points of:

- 4.9 mol.% scandia and 1.2 mol.% yttria and
- 3.7 mol.% scandia and 3.0 mol.% yttria.

In addition, it appears that a composition of ~3 mol.% scandia and ~2.5 mol.% yttria may confer the desired phase stability at 1400 °C.

This work was done by Derek Mess of Cambridge Microtech, Inc., for Glenn Research Center. For further information, access the Technical Support Package (TSP) free on-line at www.techbriefs.com/tsp under the Materials category. Excerpted from *NASA Tech Briefs,* Oct 2003, p 48.

Sandia Develops Ultrahigh-Temperature Ceramics to Withstand 2000 °C

Researchers at the Department of Energy's Sandia National Laboratories have developed a new lightweight material to withstand ultrahigh temperatures on hy personic vehicles, such as the space shuttle.

The ultrahigh-temperature ceramics (UHTCs), created in Sandia's Advanced Materials Laboratory, can withstand up to 2000 °C (about 3800 °F).

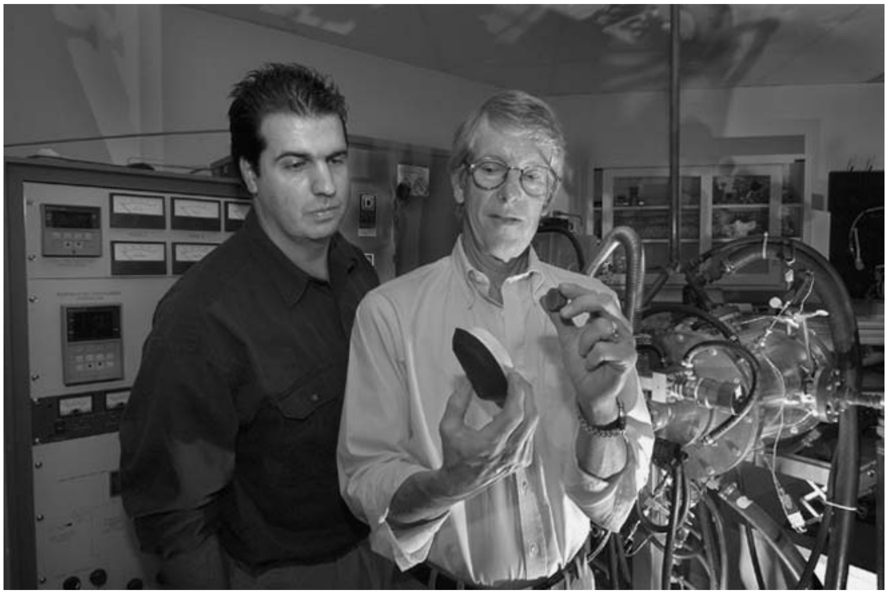
Ron Loehman, a senior scientist in Sandia's Ceramic Materials, said results from the first seven months of the project have exceeded his expectations.

"We plan to have demonstrated successful performance at the lab scale in another year with scale-up the next year," Loehman said.

Thermal insulation materials for sharp leading edges on hypersonic vehicles must be stable at very high temperatures (near 2000 °C). The materials must resist evaporation, erosion, and oxidation, and should exhibit low thermal diffusivity to limit heat transfer to support structures.

Composite Materials

UHTCs are composed of zirconium diboride (ZrB_2) and hafnium diboride (HfB_2) and composites of those ceramics with



Sandia researchers Ron Loehman, right, and Dale Zschiesche check out material that can withstand twice the amount of heat compared to a conventional piece of a shuttle tile. (Photo by Randy Montoya)

silicon carbide (SiC). These ceramics are extremely hard and have high melting temperatures (3245 °C for ZrB_2 and 3380 °C for HfB_2). When combined, the material forms protective, oxidation-resistant coatings, and has low vapor pressures at potential use temperatures.

"However, in their present state of development, UHTCs have exhibited poor strength and thermal shock behavior, a deficiency that has been attributed to inability to make them as fully dense ceramics with good microstructures," Loehman said.

Loehman said the initial evaluation of UHTC specimens provided by the NASA Thermal Protection Branch about a year ago suggests that the poor properties were due to agglomerates, inhomogeneities, and grain-boundary impurities, all of which could be traced to errors in ceramic processing.

During the first seven months, the researchers made UHTCs in both the ZrB_2 and HfB_2 systems that are 100% dense or nearly so. They have favorable microstructures, as indicated by preliminary electron microscopic examination. In addition, the researchers have hot-pressed UHTCs with a much wider range of SiC contents than ever before. Availability of a range of compositions and microstructures will give system engineers added flexibility in optimizing their designs.

Collaborations

The project is part of the Sandia Thermal Protection Materials Program and represents the work of several Sandia researchers. The primary research team consists of Jill Glass, Paul Kotula, David Kuntz, and University of New Mexico doctoral student Hans-Peter Dumm.

Kuntz said his primary responsibility is to compute aeroheating, design thermal protection systems (heat shields), compute material thermal response on high-speed flight vehicles, and to develop tools to improve these capabilities.

"If a vehicle flies fast enough to get hot, we analyze it," Kuntz said. "Our tools consist of a set of computer codes that compute the flowfield around a high-speed flight vehicle, the resultant heating on the surface of the vehicle, and the subsequent temperatures and ablation of the materials which form the surface of the vehicle."

Glass works with high-temperature mechanical properties and fracture analysis, and Kotula performs microstructural and microchemical analysis on the ceramic materials.

Kotula applies the Automated eXpert Spectral Image Analysis (AXSIA) software (developed by Kotula and Michael Keenan, and recently patented and winner of a 2002 R&D 100 award) to the characterization of hafnium and zirconium diboride/silicon carbide UHTCs. Kotula looks at these materials at the micron to subnanometer length scale for grain size and phase distribution as well as impurities or contaminants that can adversely affect their mechanical properties.

Creative Analysis

Boron and carbon (C) are difficult to analyze because they give off low-energy or soft x-rays when excited with an electron beam as in a scanning or transmission electron microscope typically used for such analyses. Instead of using x-ray analysis techniques, the research team has developed other analytical capabilities based on electron energy-loss spectrometry to determine amounts and nanometer-scale lateral distributions of the light elements in the UHTCs.

Oxygen, in particular, is an important impurity since, in combination with the Si present in the UHTCs and other impurities, it can form glasses or other phases that typically cannot take the required high-operation temperatures and would melt or crack in service, causing the material to fail.

"If enough of the wrong contaminants find their way into the process, the material will have no high-temperature strength or stability," Kotula said.

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News from ITSA and TSS

JTST Extends Low Pricing to Professional Societies

The Journal of Thermal Spray Technology (JTST) is a publication of the Thermal Spray Society (TSS) of ASM International; see: http://www.asminternational.org/Content/NavigationMenu/Journals/JournalofThermalSprayTechnology/thermalspray.htm.

JTST, now entering its 13th year, has become established as the leading professional journal devoted to all aspects of thermal spray, and it is often referred to as "the voice of the industry." TSS has agreements with the following societies:

- The German Welding Society (DVS),
- The German Thermal Spray Society (GTS),
- The Japan Institute of Materials, (JIM),
- The Iron and Steel Institute of Japan, (ISIJ), and
- The Korean Thermal Spray Society

The members of these societies may subscribe to JTST for their own personal use at the discounted ASM member rate of $199.00 per year rather than $1,152.00.

In 2004 JTST will embark on a major activity to attract new subscribers. Thus, the policy of offering new subscribers the member rate will be broadened considerably.

Contact: Chris Berndt, Editor, e-mail: cberndt@notes.cc.sunysb.edu.

Thermal Spray Standards

Are you interested in participating in ISO standards development activities for thermal spray?

Historically, the secretariat of ISO/TC 107/SC 5 on Thermal Spray was held by AWS until 1999. The subcommittee was downgraded to a working group (ISO/TC 107/WG 1) mainly to mirror the work in Europe (CEN).

Currently, there is an initiative to raise interest in thermal spray at the ISO level and move it under ISO/TC 44, Welding and Allied Processes. This is because there is a shift in ISO to develop standards in ISO rather than CEN under the Vienna Agreement.

The AWS is looking for potential U.S. experts who may wish to participate in a new ISO group on thermal spray. There is no work program as of yet as ISO is waiting to see how many countries may be interested in the work before making a plan of action. They are looking for volunteers who are able to attend ISO meetings as well as experts who may wish to review ISO drafts as they are prepared.

If you are interested in participating in ISO standards development for thermal spray, please send an e-mail to nancy@aws.org with your contact details.

Contact: Andrew Davis, Director, Technical Operations and International Standards Development, American Welding Society, 550 N.W. LeJeune Rd., Miami, FL 33126; tel: 305/443-9353, ext. 466, or 800/443 9353, ext. 466; fax: 305/443-5951; e-mail: adavis@aws.org; Web: www.aws.org.

People in the News

Andrew R. Nicoll

Nicoll to Serve ASM as Vice President

ASM International has elected Andrew M. Nicoll, Director—PLM Global Materials for Sulzer Metco (U.S.) Inc., Westbury, NY, to serve as the Society's Vice President for 2003-2004.

A member of ASM since 1986 and European Council chair up to 2000, Andrew Nicoll was elected an ASM Fellow in 1995 and has served as an ASM trustee from 2000-2003.

Nicoll obtained an honors degree in metallurgy and materials technology from the University of Surrey (U.K.) in 1971. In his present position with Sulzer Metco, he is responsible for the Materials Development Group and is Product Line Manager for the global materials portfolio in addition to running materials development.

Contact: Web: www.asminternational.org or www.sulzer.com, or e-mail: andrew.nicoll@sulzer.com.

Praxair Surface Technologies Names Howard Kopech Plant Manager

Howard M. Kopech has been appointed Plant Manager of TAFA Inc., Praxair Surface Technologies' thermal spray equipment and consumables business located in Concord, NH.

Howard M. Kopech

Mr. Kopech has held several different positions in 6+ years with TAFA, most recently serving as Business Unit Manager for Wires and Spare Parts. Previous assignments included Strategic Market Development, and Powder and Equipment Product Management. In all, Mr. Kopech brings 17 years experience in the thermal spray and industrial markets to his new role.

He is a Bachelor of Arts graduate of Georgetown University and performed his MBA studies at the University of Rhode Island. He is a Six Sigma Green Belt and a certified Lead Auditor for ISO 9000-2000.

Praxair Inc., parent company of Praxair Surface Technologies, Inc. and TAFA Inc., is the largest industrial gases company in North and South America, and one of the largest worldwide, with 2000 sales of $5 billion. The company produces, sells, and distributes atmospheric and process gases, and high-performance surface coatings technologies.

Contact: Joan Rich, tel: 603/223-2108; e-mail: joan_rich@praxair.com.