In The News

New Literature/Data

Cathodic Protection Video

"Cathodic Protection of Steel Reinforced Concrete Using Zinc Thermal Spraying," a new video describing both impressed and passive systems utilizing zinc metallizing is available from The Platt Brother Company (Waterbury, CT). Only eight minutes in length, the video explains the use of zinc in cathodic protection systems and the field work done to date in both Oregon and Florida.

Zinc thermal spraying process being applied on the Seven Mile Bridge in Key West, Florida, 1992.

Circle (1)

The Thermal Spray Source Program—MS Card

The Thermal Spray Source Program is a powerful program ***to determine the best coatings for a specific application,*** as well as how and where the coatings are used. The database contains detailed information for more than 1300 thermal spray applications, provides a listing of domestic and foreign suppliers. Parts and components are organized into 25 broad industrial groups. This comprehensive, easy-to-use program consists of four major sections:

The materials information section provides description of product availability using the following fields: Powder size, wire diameter, and rod size; chemistry and material description; end-user specification; supplier; and supplier designation number. Materials are categorized into 12 classifications for search purposes: Iron-based materials, nickel-based materials, cobalt-based materials, nonferrous metallic-based materials, refractory-based materials, tungsten carbide-based materials, chrome carbide-based materials, other and mixed carbide-based materials, ceramic oxide-based materials, nonoxide ceramic-based materials, cermet-based materials, and plastic-based materials.

Coatings applications are listed according to more than 1300 applications organized by these fields: coating function (e.g., abrasive wear, adhesive wear); commonly used coatings and processes; newly recommended coatings and processes; feedstock materials used; industry-specific coatings and processes; and part and component-specific coatings and processes.

Supplier information software provides address and product information for suppliers worldwide; i.e., full supplier address and phone number, supplier profile/specialties, form of feedstock (e.g., powder, rod) listed by supplier, and extensive product list for each supplier.

The glossary of *thermal spray terms* consists of terminology frequently used in the industry. Some of the material covered includes amorphous alloys, arc spraying, deposition efficiency, liquid-stabilized plasma spray, mechanofusion, plasma, partially stabilized zirconia, rapid solidification process, RF plasma, sol-gel powder, and thermal barrier coatings.

The program consists of six 3.5-in. diskettes and a short manual. It will run on any IBM 286, 386, 486, or compatible computer with 640K RAM. It requires DOS and six megabytes of hard disk space.

Circle (2)

Ceramics for Structural Applications

Treating concepts in simple, nonmathematical terms, ***"Fiber and Whisker-Reinforced Ceramics for Structural Applications"*** by David Belitskus, discusses production and properties of suitable fibers and whiskers, the criteria for selecting matrix and reinforcement materials, toughening mechanisms and composite fabrication processes, characterization and testing, machining, joining, and structural design, and current and developing applications. This reference book examines every important aspect of whisker- and fiber-reinforced ceramic science and technology, offering a balanced account of the latest developments in the field.

With over 140 explanatory figures and tables as well as a careful selection of key bibliographic citations that facilitate in-depth explorations of specific topics, it is a practical resource for materials, manufacturing, mechanical, ceramic, aerospace, and civil engineers; ceramists; and upper-level undergraduate and graduate students in these disciplines.

Circle (3)

3 Volumes on Corrosion

Corrosion Case Histories 1993: Processes and Prevention—A follow-up report to the 1991 edition, picks up where the 1991 edition left off, (covering January '92 to March '93) to bring you 1000 research studies from 800 corporate organizations. Use this report to learn what other organizations are doing with regard to corrosion processes, their impact on materials used in industry, and the strategies now available or under development to identify and counteract corrosive mechanisms.

Corrosion Prevention/Inhibition Digest—Provides 100 monthly summaries on current corrosion prevention/inhibition research and technology. Each monthly issue will keep you informed of

the latest developments in corrosion control, corrosion resistance, prevention of corrosion, corrosion protection, and influence of coatings. The latest developments are subdivided by subject and include author and corporate author indexes.

Corrosion Prevention/Coating/Surface Finishing Bibliographies—Provides access to computer-generated bibliographies (also called Search-in-Prints) derived from METADEX and Engineered Materials Abstracts databases. Produced on demand to give the most up-to-date references, each Search-in-Print provides up to 250 references to journal articles, conference papers, patents, books, and reports. Each bibliography contains details of the title, author, bibliographic source, language of the paper plus in most cases, an informative abstract (in English) summarizing the contents of the paper. Indexes quickly lead you to that specific subject, author, or company. Complete copies of most articles can be ordered.

Circle (4)

Data Sheet Describes Patented Nickel-Based Hard-Surfacing Alloy

A new data sheet, ***Colmonoy Technical Data Sheet No. Ni-4.4B***, describes Colmonoy 88, a patented nickel-based hard-surfacing alloy made of complex bi- and tri-metallic borides and carbides for maximum abrasion and corrosion resistance. Available from Wall Colmonoy Corporation (Madison Hts., MI) the data sheet includes the results of wear tests comparing Colmonoy 88 to typical hard coatings. Available alloy forms are also listed: atomized powder for spray-and-fuse, HVOF, and PTA applications, as well as rod and wire. Applications include glass mold plungers, pump plungers and sleeves, valve seats, centrifuges, and plastics processing screws and barrels.

Circle (5)

Literature on Lead Paint Removal

In this ever-changing area of the ***industrial maintenance coatings industry***, keeping up with new developments in regulations and technology is a critical concern for owners and contractors alike. The Steel Structures Painting Council (SSPC) is committed to industry awareness and to providing the latest information on industrial lead paint removal and abatement. Six books in this topic area are:

"The Steel Structures Painting Manual" is the industry's source of information on maintaining industrial structures with protective coatings. Volume One, *Good Painting Practice* is a practical encyclopedia on painting methods, equipment, and systems for painting structural steel. Volume Two, *Systems and Specifications* is a source of all SSPC specifications, guides, and commentaries. It contains SSPC standards for surface preparation, painting systems, paints, paint application, and more.

When it was introduced, Kenneth A. Trimber's ***"Industrial Lead Paint Removal Handbook"*** served as a guide for managing lead paint removal operations. Now revised and updated, the second edition provides one of the most up-to-date references available. The sections on worker protection, containment systems, lead paint removal methods, preparing specifications, and verifying compliance with regulations have been revised. The Handbook also contains relevant excerpts from the Code of Federal Regulations, as well as OSHA's interim final standard on lead exposure in construction (29 CFR 1926.62) in its entirety.

In answer to the ongoing need for new and improved industry standards, SSPC produced the following standards: the ***Lead Paint Removal Guides***, which contains both SSPC-Guide 61 (CON) Guide for Containing Debris Generated During Paint Removal Operations and SSPC-Guide 71 (DIS) Guide for the Disposal of Lead-Contaminated Surface Preparation Debris; and SSPC-QP 2(l) Standard Procedure for Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint.

For those faced with the challenge of keeping up with the most recent developments in lead paint removal and abatement, SSPC offers ***"Industrial Lead Paint Abatement: Approaches, Alternatives, and Advances."*** This new publication reports on such areas as responsibility, liability, and awareness; advances in containment and removal; costs and alternatives for abatement; waste handling and environmental monitoring; and worker protection.

In addition SSPC offers ***series on lead paint removal***. This six part set includes the proceedings from the first five annual SSPC Lead Paint Removal Conferences, as well as Removal of Lead Based Bridge Paints: Report on FHWA Workshop.

"Bridge Paint: Removal, Containment, and Disposal" provides a detailed review of current practices in bridge paint removal and containment; disposal and reuse alternatives; environmental and health considerations; containment and disposal costs; and alternate maintenance strategies.

Circle (6)

Steel Bridges and Lead Paint

185,928 of the 208,505 steel bridges (89.2%) carrying public roads in the National Bridge Inventory of the United States are believed to be protected with lead-based paint. These figures include bridges on city streets, county roads, state highways, any privately owned bridges that are part of a public facility, and bridges owned by Federal land management agencies.

Approximately 103,191 of the 208,505 steel bridges (49.5%) in the National Bridge Inventory are classified as deficient and eligible to receive Federal Highway Bridge Replacement funds. Other Federal aid funds may be used for repainting the remaining bridges.[1]

Lead Paint usage in 1992[2] includes:

Total Surface Area Still Coated with Lead Paint in 1992: 35 billion square feet
Total Residential: 30 billion square feet
Total Nonresidential: 5 billion square feet
Total 1992 Contractor Revenue from Lead Paint Remediation: $200 million
Total 1992 Consumption of Coatings for Lead Paint Remediation: $40 million

BCC—A Market Research and Publishing Firm

Business Communications Co., Inc. (BCC) is a market research/publishing firm, founded in 1971, specializing in

[1] From the statement of E. Dean Carlson, Executive Director of the Federal Highway Administration, to the House Subcommittee on Health and the Environment, March 3, 1993. Reprinted from SSPC's Lead Paint Bulletin, Summer 1993.

[2] From Lead Based Paint Remediation Markets and Materials in the United States, published by WEH Corporation, 1993. Reprinted from SSPC's Lead Paint Bulletin, Summer 1993.

high-tech areas such as chemicals, plastics, new materials and composites, membranes, electronics, optics, foods, biotechnology, medical technologies, and packaging. Multiclient studies represent the majority of the business-market research reports and range from 200 to 350 pages. Each report is compiled utilizing a variety of resources, including trade literature, database searches, patent reviews, and in-house materials. The focus of the reports, however, is the primary research conducted by our analysts in the form of direct phone interviews with industry participants (R&D directors, marketing managers, product specialists, engineers, etc.). Using the information from these industry contacts, the analyst compiles market profiles, projections, new product information, pricing trends, and other useful analytical data. The studies usually take about 4 months of full-time, exclusive work on the part of the individual analyst. The reports are "multiclient" (i.e., not contracted by a specific company), and available to the open market. BCC also offers consulting services on an individual, proprietary basis.

In addition to these services, BCC publishes 16 monthly newsletters on such topics as ceramics, optics, flame retardancy, electronics, and other high-tech topics. Finally, BCC sponsors 2 to 3 conferences annually dealing with membranes and flame retardancy.

Circle (7)

New Products

Net Shape Ceramic Components with Dimensional Control and Smooth Surface Finish

Net shape ceramic components with precision internal dimensional control; as close as ±0.001 in. (25 μm) and ultra surface smoothness down to 32 rms, are available from Technetics Corporation, DeLand, FL. The high temperature components, produced using plasma flame spray techniques, find application in industries such as electronics, aviation, medical and laser, among others.

Net shape ceramic components can be produced from most liquid phase, plasma sprayable materials. Candidate materials include aluminum oxide, partially and fully stabilized zirconias, magnesium zirconate, and magnesium aluminate-spinel. The ceramic materials exhibit high temperature durability, insulating capability, high thermal expansion and resistance to thermal shock (depending upon the ceramic selected). Practically any cross-section shape; e.g., rectangular, circular, elliptical, can be produced with wall thickness up to 0.125 in. (3.2 mm), and with variable component outside dimensions.

The computerized robotic plasma spray facility applies engineered metallic and ceramic coatings for applications such as turbine seals, combustor liners, composite engine and aircraft parts, and other high temperature components. Coatings on a wide variety of materials such as fiber metals, metallic, polymer, and ceramic substrates, are applied by robotic spray rigs using stringent process controls to achieve uniformity and reproducibility.

Circle (8)

Miller Thermal Introduces New Equipment

Miller Thermal Inc. (Appleton, WI) announces the development of the Model 3202 Water Booster Pump, Model 3702 Plasma Spray Control Console and Model MT 400i Inverter Arc Spray Power Supply.

The Model 3202 is ***a water booster pump*** designed to raise the pressure of plant water to that required for cooling thermal spray guns. A front panel mounted control is for setting water flow. Pressure gages are provided. The unit also incorporates a water flow sensor to detect loss of coolant and provide a shut-down signal to the thermal spray control of the user. Fittings on the rear of the cabinet provide easy connection to the thermal spray gun, plant water, and drain. Model 3202 benefits include capacity for a full range of plasma guns, ability to operate under a variety of input water pressures, and a signal showing when there is a water loss.

The Model 3702 is ***a basic reliable control*** for plasma spray systems. The unit integrates power supply and gas controls for both the plasma gun and powder feeder in a single, compact cabinet. Operation controls are arranged for easy manual start-up and spray operation. Cooling water and gas flow sensors quickly shut down the plasma if failure occurs. The power supply controller allows the user to preset parameters before starting and monitor the voltage and current on digital panel meters. The use of critical orifice flow control and large easy-to-read pressure gauges provides accurate display and setting of gas flows. Model 3702 benefits include precise, repeatable parameter control and an automatic shutdown that prevents damage to the plasma gun in case of cooling water or gas failures.

The Model MT 400i represents the application of state-of-the-art ***power source*** technology to the needs of arc spray users. The electrical efficiency of the design provides 400 amps, 100% duty cycle performance in a compact, rugged package suitable for field and shop use. The high-speed switching capability of the inverter allows the unit to sense quickly and adjust to varying conditions and maintain a constant, stable arc. This technology also makes it possible to develop arc conditions that spray finer, denser and more adherent coatings. Model MT 400i benefits include easy transportability; a fast response for a more stable arc over a wide range of conditions and materials; lower noise and less dust.

Circle (9)

Gas Flow Rate Calibrators—Support ISO 9000 Certification

The NGS Division of MKS Instruments, Inc. (Walpole, MA) offers ***two gas flow rate calibrators*** to help thermal sprayed product manufacturers using rotameters, critical orifices, mass flow controllers, etc. meet ISO 9000 requirements.

NGS Microcal II™ Transfer Standard calibrator

Both calibrators feature NIST-traceable accuracy and permit automated data collection during calibration, thus satisfying ISO 9000 requirements.

Systems available include the Microcal II™ Transfer Standard system which provides an accuracy better than 0.5% or 1.0% of F.S. in the range from 10 sccm to 200 slm (425 scfh), and the A-200 Primary Standard which provides an accuracy of 0.2% of Reading from 1 sccm to 50 slm (106 scfh). The systems are available in fully automated computer controlled configurations, thus permitting automated data collection and saving valuable technician time.

Circle (10)

United Airlines Selects Waterjet Workcell for Coating Removal

Jet Edge, Inc.'s model 55-150 ***ultra-high water pressure intensifier pump*** has been sold to United Airlines as an integral component of Pratt & Whitney's Waterjet Systems, Inc. Engine ARMS™ waterjet coatings removal system. This ARMS™ (Automated Robotic Maintenance System) workcell uses only ultra-high pressure (up to 55 ksi [380 MPa]) water under robotic control to remove coatings from engine components whose removal required substantial chemical or other hazardous processing. It will be installed at United's Maintenance Operations Center at San Francisco International Airport to remove coatings, gaskets, seals, and honeycomb from an array of engine parts ranging in size from a 6 in. (15 cm) diameter shaft through a 120 in. (~3 m) fan inlet case.

The Waterjet Systems' ARMS™ design features a pedestal-mounted Fanuc S-420 industrial robot, the new Jet Edge 55-150 ultra-high water pressure intensifier pump, and Waterjet Systems' specialized quick-change end affectors, nozzles, and design features. The design allows United to meet all current part refurbishment requirements as well as those expected for tomorrow's engines.

Jet Edge Inc. has, since 1986, built pumps and components that operate at pressures above 30 ksi (207 MPa). These can be operated manually, integrated into existing systems, or customized with a turnkey system. Jet Edge is a leading supplier of waterjet and abrasivejet cutting and cleaning systems. The waterjet systems cut materials such as foam, cork, rubber, and food and the abrasivejet systems are used for cutting heat-sensitive materials, plastics and composites. The cleaning systems are used in industrial markets for purposes including paint stripping plants, tough coating removal in chemical and oil refineries and general plant cleaning applications. Jet Edge systems offer cost-effective solutions to problems associated with traditional cutting and cleaning methods.

The system features a complete closed-loop operation: the only waste product will be the coatings removed from the parts. Even the water vapor generated during the waterjet process will be collected and the water reused. "We believe that United comes out way ahead with a flexible waterjet system," said Paul Davis, a United process engineer. "In addition, we expect it to pay for itself in less than one year." Ray Tanner, president of Waterjet Systems, Inc., added that "United is the second major airline to place its confidence in P&W developed waterjet technology, an environmentally sound process with great promise of productivity enhancement for engine maintenance facilities. We are proud to be working with United on this important project."

Pratt & Whitney Waterjet Systems Inc., Huntsville, AL, is a wholly owned subsidiary of United Technologies Corporation, reporting to Pratt and Whitney's Overhaul and Repair Operation, East Hartford, CT.

Circle (11)

New Family of High Velocity Coatings

hiROC, a thermal spray coating system, is the subject of a new color brochure available from Hitemco. hiROC, which permits the application of very high density carbides, alloys and metals to a wide range of metal parts, offers higher density, hardness and bond strength, lower oxide content, better wear resistance, and improved corrosion protection over standard HVOF applied coatings.

The hiROC brochure gives a full explanation of how hiROC provides a superior coating when combined with the most powerful, robotically controlled system available. Additional topics discussed include hiROC coating applications and advantages. Comparative charts assist the reader in identifying which hiROC process will best apply to their particular requirement. Also useful are graphs that compare coating hardness as it relates to different thermal spray processes and thermal spray velocities and how these thermal spraying methods affect hardness.

Circle (12)

Applications for Polymer Coatings

Vertical Pumps for Specialty Chemical Manufacturer

Plastic FLAMECOAT® Systems, Inc., (Indianapolis, IN) announced the successful ***coating of eight vertical pumps*** for Reilly Industries, a specialty chemical manufacturer in Indianapolis, IN. The specialty chemicals are manufactured in a highly corrosive environment.

In September of '92, Carmel Engineering was hired by the specialty chemical manufacturer to coat these pumps. Most of the pumps that were coated with the Plastic FLAMECOAT® are used to handle water in a cooling tower. Rust is the main problem for these pumps. The other pumps are used in water softening for boiler room feed water. This latter environment can be somewhat acidic, especially when the softeners are regenerating. Recently, some of the pumps used in the softening process were pulled and inspected. It was reported

that they were in very good condition. Plastic FLAMECOAT® Systems' powder coating can be applied in the shop or on-site in the field. It is used chiefly to protect against corrosion on such objects as pipes, tanks, pilings, piers, and other steel structures.

Support Structures for TRI-MER Corporation

Tri-Mer Corporation (Owosso, MI) manufactures air pollution control systems in a highly corrosive environment. Tri-Mer has been using the Plastic FLAMECOAT® process to protect against corrosion since 1984 in *applications to coat support structures*, substructures such as tank farm assemblies, raised walkway platforms and fan A-frames, and other miscellaneous parts such as bracketing off and on over the last nine years.

Rod Lab, purchasing manager of Tri-Mer, commented, "Plastic FLAMECOAT® is extremely durable in our hazardous environment. It has been an excellent coating for us." Mr. Lab continued, "We like the simple straightforward application process. It's very practical for in-house coating. And, it's not a multistep process like in the case of painting."

Primary Gate System for Water Treatment Plant

The City of Indianapolis Water Treatment Plant is a 60 million gallon a day plant. This is a very high pressure plant which, coupled with the characteristics of waste water, has proven to be very hard on the primary gate system, rust being the main culprit. Plastic FLAMECOAT® Systems, Inc., announced the successful *coating of the primary gate system*. The primary gate system is 8 ft wide, 12 ft tall and 4 in. thick (~2.4 m × 3.7 m × 10 cm). It is used to shut off water channels during repair and maintenance periods. During these periods, the gate system is exposed to large amounts of waste water.

In the past, the Plant has tried coating the gate system with an epoxy paint. However, the epoxy paint would only last one year before showing signs of rust. Due to this annual event, coating the system became a very costly process. ProSeal introduced Plastic FLAMECOAT® to the Plant as a viable option. In March of '92, the gate system was removed, sand blasted, coated then reinstalled. After one year, there was no sign of rust or breakdown.

Lou Beam, Preventive Maintenance Supervisor with the City of Indianapolis Water Treatment Plant, commented, "We are very impressed by and very happy with Plastic FLAMECOAT®. It was easy to apply and very durable. And, most importantly, it has and will save us a lot of time and money. We plan to use Plastic FLAMECOAT® on several other structures within the Plant. These include electrical conduit boxes, scum beaches and clarifier: scrapers as well as electro substation cabinets."

Circle (13)

News from Government Agencies

STA Fellowship Program in Japan

The Science and Technology Agency (STA), an administrative organ of the Government of Japan, established the STA Fellowship Program in 1988 to offer *opportunities for promising young foreign researchers* in the fields of science and technology to conduct research at Japan's national laboratories and public research corporations (excluding universities and university-affiliated institutes). The Program is also a response to calls from the international community of science and technology for greater international cooperation through the exchange of promising researchers.

Since 1 Oct 1989, the Program has been managed by the Research Development Corporation of Japan (JRDC), a statutory organization under the supervision of STA, in cooperation with the Japan International Science and Technology Exchange Center (JISTEC).

Each applicant for the STA Fellowship should:

1. Possess a doctoral degree in a scientific, technological, engineering, or medical field, or have an equivalent qualification. If professional, or other, experience indicates a level of competence equivalent to that required to earn a doctoral degree, the applicant may be considered for a Fellowship.
2. Be no greater than 35 years of age.
3. Be of sufficiently good health to pursue research activities in Japan.
4. Have sufficient language ability to pursue research activities in Japan. Japanese language ability is preferable, but English is sufficient in most cases. With the agreement of the host research institute, other languages may suffice.

The tenure will be from 6 months to 2 years, to be decided upon through negotiation between the candidate and the host institute. The agreed tenure may be reduced by JRDC for budgetary reasons. The field of research will also be decided upon through negotiation between the candidate and the host institute. The results of research activities produced during the tenure will be subject to the regulations of the host institute.

Circle (14)

Scientific Agencies Enter Agreement To Boost U.S. Technology

The National Science Foundation (NSF) and the Commerce Department's National Institute of Standards and Technology (NIST) has agreed to coordinate key research programs in order to boost the technology competitiveness of important domestic industries. The signing of the memorandum of understanding (MOU) between the two federal research agencies covers four areas: advanced materials and processing; manufacturing technology; chemical science and engineering, including biotechnology; and high performance computing and communications.

Walter Massey, NSF director, said the agreement "will be very rewarding for both agencies and for the nation. NIST, with its long-standing ties to private industry, will help NSF and the academic researchers it supports become more at-

tuned to industrial research needs. Similarly, NSF will help NIST draw upon the excellence of the research university system."

"This agreement draws on the considerable strengths of NIST and NSF," said Raymond Kammer, acting NIST director. "Both agencies have a lot in common, and our hope is that by combining forces, we can make many important research contributions directly related to our national economy."

Both NIST and NSF have long histories of supporting and conducting a variety of science and technology research programs. NIST's work is directed heavily toward industrial needs, while NSF primarily supports research and education by academic institutions in the sciences and engineering. The new agreement links NSF and NIST efforts in four important sectors of the U.S. economy. Two areas of development that might be of special interest to thermal sprayers are listed below.[3]

Advanced Materials and Processing NSF has supported basic curiosity-driven materials research programs at U.S. universities for years and proposes to provide about $328 million in support of these activities in fiscal year 1994. NIST works with industry to develop strategic and emerging materials technologies affecting U.S. competitiveness. Common NSF and NIST research programs in intelligent processing of materials, electronic packaging, high-temperature superconductors, and other areas involve a variety of industries. The agreement will allow both agencies to strengthen their research programs, improve education opportunities, and help bring new materials to market quickly. It will also expand and strengthen partnerships between the agencies at existing and future facilities, such as the current NSF/NIST partnership at Northwestern University's Advanced Cement Based Materials Science and Technology Center.

Manufacturing Technology NSF has supported considerable manufacturing research during the last 10 years through individual research projects and joint efforts such as the Engineering Research Centers. Its fiscal year 1994 budget for this area is $130 million. NIST helps industry improve manufacturing competitiveness through new computer-based technologies, modernized production processes and improved quality assurance. NIST also transfers manufacturing technology to small and medium-sized companies through its regional Manufacturing Technology Centers. A multi-agency initiative, Advanced Manufacturing Technology, is expected to start in fiscal year 1994. It will initially focus on intelligent manufacturing cells; integrated tools for product, process and enterprise design; and advanced manufacturing technology infrastructure. The MOU will also help implement the Technology Reinvestment Project, administered by the Defense Technology Conversion Council.

Circle (15)

[3]Note that this press release has been edited.

New International Meetings

1st Czech National Thermal Spray Conference

Brno, 19-21 April 1994

The Division of Thermal Spraying of the Czech Welding Society together with Plasmacentrum, Ltd. Prague, Technical University Brno and CONMET, Ltd. Brno are organizing the ***"1st National Conference on Plasma and Thermal Coatings"*** with international participation. The main topics will include: plasma, D-gun, electric arc and flame coatings; combined coatings processes; coatings properties and applications; and materials for deposition.

The conference will be held at the Technical University Brno, 19-21 April 1994. Simultaneous translation will be provided. All accepted contributions will appear in a Proceedings which will be distributed at registration. For further details, registration forms, etc. write, call, or fax to: J. Musil, Plasmacentrum, Ltd. Purkynova 118, 612 00 Brno, ph/fax: +42 5 4112 0484.

Circle (16)

Plasma-Technik Seminar in Singapore

Sulzer Surface Tech announces their second ***Plasma-Technik Seminar on Surface Engineering*** in Singapore on 21-22 Feb 1994. The increasing importance of surfacing technologies in general in the Pacific Rim countries and in Thermal Spray Technologies in particular focuses our attention in this Seminar on: "Productivity and Cost Savings using Thermal Spraying." Contact PLASMA-TECHNIK, Coating Systems S.E.A Pty. Ltd., Attn. Mr. C.T. Tan, Block 37, Defu Lane 10 No. 02-51, Singapore.

Circle (17)

International Seminar on Heat And Mass Transfer under Plasma Conditions

4-8 July 1994, Cesme, Izmir, Turkey

The seminar provides an opportunity for scientists and engineers to present the state-of-the-art and recent advances in the field of ***plasma transport phenomena***, discuss current problems and research needs in the area of plasma physics, covering recent developments in plasma fundamentals and applications. The emphasis will be to discuss basic phenomena and their applications.

Topics include: Turbulence Phenomena in Thermal Plasmas; Non-Equilibrium Effects in Thermal Plasma Systems; Radiative Transport under Plasma Conditions; Plasma Particulate Interactions; Solid Bodies Heating by Extremely High Heat Fluxes; Rapid Solidification During Plasma Deposition; Particle Nucleation and Growth in Plasma Reactors; Plasma-Wall Boundary Layers and Electrode Erosion Phenomena; Electromagnetically Induced Flow Effects in Plasma Systems; Transport Processes in Dusty Plasmas; Diagnostic Techniques in Plasma Chemical Applications; and New Branches of Plasma Physics and Transport Phenomena (MAD, Improved MHD, EHD, D4, and DL Currents).

Potential authors should submit abstracts of papers (by postage or E-Mail on the above topics, including title, author(s) name(s), and complete correspondence address, to: Prof. Dr. Faruk ARINC, Acting Secretary General of ICHMT, Mechanical Engineering Department, Middle East Technical University, 06531 Ankara, Turkey , Tel:

90-4-210 1000 Ext.: 2567 Fax: 90-4-210 1331, E-Mail: ICHMT at TRMETU.BITNET or ICHMT at VM.CC.METU.EDU.TR

Circle (18)

News from Brazil

ABTS—***Associacão Brasileira de Tratamentos de Superficie*** is commemorating its 25th anniversary this year. It was founded in August 1968 as ABTG—Associacão Brasileira de Tecnologia Galvânica (Brazilian Electroplating Technology Association) and changed to its present name in 1985 to reflect its extended interest range. Since its beginning the Association has been accredited as the Brazilian "ABTS Branch" of AESF, the American Electroplaters and Surface Finishers Society.

The Association has held monthly meetings since its foundation in São Paulo; all with technical presentations by both local and visiting experts. Since 1976 ABTS has also been very active in educational matters. A news bulletin started to be published shortly after the foundation of the Association. This became in 1972 the *Noticiario da Galvanoplastia* and is now the bimonthly technical journal *Tratamento de Superficie*.

The first EBRATS—Encontro Brasileiro de Tratamento de Superficie (Brazilian Surface Treatment Encounter) was held in 1979. Since then it has been held every two years, except 1991, when it was postponed to coincide with INTERFINISH 92, the quadrennial main international surface treatment event, sponsored by IUSF—the International Union for Surface Finishing—and organized, for the first time in the Americas and in the Southern Hemisphere, by ABTS. The biennial occurrence of EBRATS will be resumed in 1994 and the VIII EBRATS will be held on 17-20 Oct in São Paulo; accompanied by an Industrial Exposition.

Even though EBRATS is nominally a Brazilian event, the presentation of papers by foreign authors is traditional and very welcome. Papers are being called for in the following areas: Zinc coatings, Copper-nickel-chromium coatings, Precious metals coatings, Alloy and composite coatings, Electroless coatings, Light metal treatments, Phosphate coatings, PVD and CVD, Thermochemical treatments, Severe corrosion-resistant coatings, Severe wear-resistant coatings, Special coatings, Printed circuits, Painting—Processes and Equipment, Analyses and Tests, and Environmental protection.

The official languages will be Portuguese and English. Papers will be published in the Proceedings, with abstracts in both languages. Simultaneous translations will be available during presentation of the papers. Inquiries, including abstracts, and correspondence should be addressed to: ABTS—Associacão Brasileira de Tratamentos de Superficie, Att. Alfredo Levy, Av. Paulista 1313, 6º andar, conj. 913, 01311-923—São Paulo, SP—Brazil, FAX: 55-11-251-2558.

Circle (19)

People in The News

Marc Froning Joins the H.C. Starck Team

Marc Froning is the most recent addition to the Amperit Thermal Spray powders Division of H.C. Starck. He will be located in the new HCST facility in Newton, MA. Marc received his BS & MS degrees in Metallurgical Engineering from the University of Cincinnati. While working at GE Aircraft Engine, Marc was granted his first patent, and GE's Manufacturing Engineering Award. His involvement lead to the installation of GEAE's first HVOF system. Marc continued his thermal spray career as engineering/production Manager at Plasma Technology Inc., CT. As part of HCST's quality mission, Marc will be responsible for providing technical support and assisting customers to develop new market applications.

Senior VP Position for Edmund Aversenti at General Magnaplate

Charles P. Covino, Chairman of the Board and CEO of General Magnaplate Corporation, Linden, NJ, has announced the promotion of Edmund V. Aversenti to the newly created position of Corporate Director of Operations, a Senior VP Position. Aversenti will assume overall responsibility for direction and coordination of technical, sales, production and processing activities for all corporate subsidiaries. He will also assist the company's offshore licensees and affiliates in this connection.

Aversenti is currently serving as Senior Vice President, Corporate and as Vice President of Magnaplate's wholly owned Materials Technology Center subsidiary in Wisconsin. He also has direct responsibility for general management of the company's Materials Technology Center in New Jersey. The new oversight duties represent expanded authority; Aversenti retains his corporate Senior VP title and responsibilities.

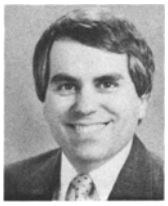
Aversenti joined General Magnaplate eight years ago and has held a variety of high-level responsibilities in plant, process and operations management, sales and marketing. Prior to joining Magnaplate, he held sales and sales management positions with M&T Chemicals.

E.V. Aversenti

General Magnaplate Corporation (GMCC: NASDAQ) specializes in the application of high-technology surface enhancement metallurgical coatings which, when applied to metal parts and manufacturing equipment components in many industries, provide corrosion resistance, wear resistance and dry-lubricated surfaces. Magnaplate has wholly owned subsidiaries in Arlington, Texas; Ventura, California; Racine, Wisconsin; and Ontario, Canada. Offshore licensees and affiliates are located in: Japan, Sweden, Great Britain, Israel, and The Netherlands.

Zanchuk Named President of Hobart Tafa Technologies

Walter A. Zanchuk has been appointed President of Hobart Tafa Technologies, Inc. (Concord, NH). Mr. Zanchuk succeeds Merle Thorpe, Hobart Tafa's founder, who recently retired from the company.



W.A. Zanchuk

Hobart Tafa is a worldwide leader in the manufacturing and supply of thermal spray equipment and consumables, and thermal spray automation. Hobart Tafa supplies major airlines, the military, jet engine manufacturers, major automotive companies, and other OEM' s and job shops. Hobart Tafa is a wholly owned subsidiary of Hobart Brothers Company (Troy, Ohio). Hobart Brothers Company is a major producer of welding products and power conversion equipment.

M. Thorpe

Mr. Zanchuk had been General Manager of Hobart Tafa. Previously, he held executive positions with Air Products and Chemicals, New Jersey Zinc Company, and Phelps Dodge Copper Products Corporation. He graduated from Lehigh University (Bethlehem, Pennsylvania) with both BS and ME degrees in Metallurgy and Materials Engineering. Mr. Zanchuk is a member of ASM International and AIME and holds a Professional Engineering license.

New Fellows of ASM International

Four new inductees to the "Class of '93 Fellows of ASM International" have special ties to the thermal spray community.

Dr. Yoshiaki Arata, academician, The Japan Academy and Professor Emeritus, Osaka University, Ibaraki, Osaka, Japan. "For pioneering efforts in the development and application of ultra high energy density heat sources, such as laser, electron beam and plasma welding technology." Prof. Arata has international recognition for his work on thermal spray coatings and processes.

Dr. William W. Scott, Jr., technical director, ASM International, Materials Park, Ohio. "For outstanding contributions and leadership as technical director of ASM International in promoting, developing and maintaining excellence in the society's various services and products." Dr. Scott has been instrumental in initiating and managing The Journal of Thermal Spray Technology within ASM International.

Dr. Richard D. Sisson, Jr., professor of Mechanical Engineering, Department of Materials Science and Engineering, Worcester Polytechnic Institute, Worcester, MA. "For significant contributions toward understanding the environment behavior of materials, especially hydrogen effects, thermal barrier coatings, and MCrAlY."

Dr. Mark F. Smith, senior member, Technical Staff, Thermal Spray Research laboratory, Sandia National Laboratories, Albuquerque, NM. "For sustained contributions to the advancement of the science and technology of thermal spray processes, especially low-pressure plasma spray depositions."

Abstracts of Recent Theses[4]

Thermal Spray-Forming of Metals and Their Composites

By ***Rajesh Tiwari*** (Ph.D. in Materials Science and Engineering, State University of New York at Stony Brook, USA, 1992)

Thermal spraying can be used as a high rate composite processing technology, involving the high-velocity codeposition of matrix and reinforcement, yielding a dense deposit. Rapid solidification is an inherent characteristic of thermal spraying and is beneficial in that it yields chemically homogeneous and fine grain-sized microstructures. Also, thermal spray forming yields composites in which the reinforcement has little opportunity to react with the molten matrix. Thermal spray-forming of composite materials represents a synergism of rapid solidification and composite materials technology.

In this research program, thermal spray processes of arc-spraying and plasma spray processing have been used to fabricate freestanding near-net shapes of metals and intermetallic-based composites.

In this study, an important focus has been thermal spray-forming of alumina-particle reinforced aluminum alloy-based composites. A novel thermal spray-forming technique is used, combining two conventional thermal spray techniques, viz. high-velocity oxy-fuel flame spraying and electric-arc spraying.

In the case of thermal spray-formed aluminum alloy-based composites, the precipitation hardening behavior of the matrix in the absence of reinforcements, following solution treatment and quenching, is faster in thermal sprayed specimens than in normal bulk specimens. The presence of a reinforcement in the aluminum alloy matrix also leads to accelerated aging in the thermal spray formed aluminum alloy based composites. Calorimetric and resistivity studies conducted on the thermal spray-formed aluminum composites indicate that the reinforcing alumina particulates stabilize the equilibrium precipitates in the aluminum alloy matrix.

Strong matrix-particulate interfacial bonding has been observed in the alumina-particulate reinforced aluminum alloy based composite. Room temperature mechanical properties of the aluminum-based composites have shown that the presence of alumina particulates in the aluminum alloy matrix leads to an increment in the yield strength and elastic modulus as predicted by the enhanced dislocation density and Hashin-Shtrikman models, respectively.

Also examined was the thermal spray forming of dense deposits of boron-doped nickel aluminide (Ni_3Al + B) and molybdenum disilicide ($MoSi_2$) matri-

[4]The abstracts of recent Ph.D. and M.Sc. theses that have come to the attention of the editor are presented in this section of JTST. These abstracts have not been edited and are published in the "as-received" condition. These theses, if published in the US, are available through Microfilms International (Ann Arbor, MI) and ordering information can be found in Dissertations Abstracts. The editor invites other contributions, in English, from all Universities and places of learning.

ces reinforced with titanium diboride particulates. These were fabricated by vacuum plasma spraying. In the case of the aluminide matrices, uniform distribution of the particulates have been obtained. The room temperature mechanical properties show significant strengthening due to the presence of the reinforcing particulates and the fine grain size of the matrix. The degree of strengthening is shown to be greater than that obtained by other compositing routes. It is apparent that enhanced particle-matrix bonding is obtained by this processing technique.

Vacuum plasma spraying has been used to fabricate free-standing deposits of $MoSi_2$ matrices and composites. Chemically homogeneous deposits with very high density (98% theoretical density) $MoSi_2$ matrices have been studied for structure-property relationships. Very high hardness and fracture toughness values, as compared to that obtained by other processing techniques, have been observed in this study. It has also been observed that the inclusion of titanium diboride in the $MoSi_2$ matrix leads to toughening and strengthening of the thermal spray-formed intermetallic.

In this research program of thermal spray-forming of composite materials, of great overall importance is the observation that the degree of incorporation of reinforcements has been observed to be dependent upon the mechanical properties of the matrix material. A model has been developed for the incorporation of reinforcements during high-velocity spray forming. This model involves the embedding of reinforcement into the matrix by forming a crater on the surface of the matrix alloy during the codeposition process. The size of the crater is dependent upon the mechanical properties of the matrix alloy being codeposited. For incorporation of reinforcements, the crater should at least be of similar magnitude as the dimensions of the reinforcement. It is shown that mechanical locking is the primary mode of incorporation of reinforcements during high velocity spray-forming.

Mode II Fracture Toughness Testing of Thermal Spray Coatings

By ***Paul James Callus*** (Ph.D. in the Department of Materials Engineering, Monash University, Clayton Campus, Australia, 1993)

Thermal spray coatings are widely used to enhance the performance of engineering structures. Applications and deposition techniques range from very simple, as with a coating of aluminum on mild steel to prevent corrosion, through to very complex, as with coatings of high density Cr_3C_2-NiCr in nuclear reactors or overlays of porous, biocompatable materials on prosthetic devices. In common with many other techniques driven by commercial considerations the technology for thermal spraying has out stripped the fundamental understanding of the process, and the large number of thermal spray applications are primarily due to improvements in deposition equipment over the last thirty years. It is widely accepted that a vast number of new coating applications, and enhanced performance of existing coating systems, awaits a comprehensive understanding of the relation between their microstructure and service behaviour.

One aspect of service behaviour which is particularly important to establish is a failure criterion that accounts for the unique microstructure of these coatings. A literature review was conducted to investigate the microstructural features of thermal spray coatings, determine how these features influence the behaviour of coatings when subjected to operationally induced stresses, and whether current mechanical tests can adequately relate the microstructural features to operationally induced stresses (and therefore failure mechanisms). It was established that, (i) thermal spray coatings are extremely anisotropic, consisting of layers of pancake shaped discs, with 70 to 80% of the projected area between any two adjacent lamellae separated by thin porosity, (ii) most of the stress generated during deposition and in service acts parallel to the plane of the coating, and (iii) mechanical tests do not quantitatively predict coating performance because they do not accurately simulate the failure mechanisms of operational coatings. The review concluded that a mode II fracture toughness test could more closely simulate the loading direction and failure mechanism than any other currently performed mechanical test.

A review of mode II fracture toughness specimens was performed and the LeRC (NASA-Lewis Research Center) specimen, developed by Buzzard, Gross and Srawley (1984), modified to incorporate a thermal spray coating, was selected for further investigation. Photoelastic, and specimen displacement, analysis revealed considerable mode I loading within this specimen and four modifications of the basic geometry were made to increase the proportion of mode II loading. Although these trials met with limited success they provided an insight into the requirements for a mode II fracture toughness specimen. Details of a new specimen geometry, based on this work, are presented.

A program of testing thermal spray coatings was also conducted, using the various mode II specimen geometries as they were developed. Coating materials were chosen because they represented a cross-section of commercial applications. The coatings tested were; metals (NiAl, mild steel, Ti, TiNi), a ceramic (Al_2O_3), duplex coatings (NiAl then Al_2O_3, NiAl then Y_2O_3-ZrO_2, NiCoCrAlY then CeO_2-Y_2O_3-ZrO_2), and cermets (NiAl/Al_2O_3). These materials were deposited by flame spraying, air plasma spraying and low pressure plasma spraying.

The critical mode II stress intensity factor, K_{IIc}, was calculated for specimens with the LeRC geometry using an experimental Y_{II} calibration (Buzzard and Gross, 1988). All subsequent geometries used the compliance calibration technique and toughness was expressed as the critical mode II strain energy release rate, G_{IIc}. In general the toughness results followed the expected trends, for example metallic coatings exhibited higher toughness than ceramic coatings. However the mode II fracture toughness values were found to vary with crack length and were higher than the G_{Ic} for similar thermal spray coatings by up to three orders of magnitude.

A system for evaluating the quality of as-sprayed coatings, without mechanical testing, was proposed and trialled. Micrographs of the cross-section and surface of each batch of coatings were examined to determine the presence and extent of features such as unmelted particles, porosity, and microcracks perpendicular and parallel to the plane of the coating. From this examination, and by considering the relative importance of each feature in the failure process, a cross-sectional quality index, and surface quality index, was subjectively assigned to each coating. It was observed that for the same material, deposited by the same technique, a decrease in perceived coating quality (increase in the

sum of cross-sectional and surface quality indices) corresponded to a reduction in toughness.

A model to describe the failure mechanism of thermal spray coatings was presented. This model may be applied to both mode I and mode II loading and accounts for the appearance of failure surfaces. It can also explain the good performance of thermal spray coatings, despite the presence of many undesirable microstructural features.

The Effects of Elevated Temperatures on Ni- and Fe-Based Bond Coats

By ***Christos P. Perdikaris*** (M.Sc. in Materials Science and Engineering, State University of New York at Stony Brook, USA, 1993)

An investigation has been conducted to develop a bond coat for application as a thick thermal barrier coating (TTBC) within an internal combustion engine. The bond coat was designed to protect the metal substrate from oxidation as well as to provide a thermal expansion matching medium between the metal and the ceramic.

Selected materials included Ni- and Fe-based powder alloys which were subsequently sprayed by air plasma spray (APS) and high velocity oxygen fuel (HVOF), to determine the best spraying method. The long term effects of oxidation induced weight-gain were studied at elevated temperatures. Microstructural analysis was carried out to assist with understanding these results. Materials that displayed good corrosion resistant characteristics were further examined by incorporating them with ceramic to create cermets (ceramic and metal blends). Ni-based materials were found to exhibit better oxidation resistance than Fe-based materials regardless of spraying method and testing temperature.

Oxidation resistance of cermet coatings was found to be non-beneficial for bond coat applications. The ceramic constituent in such coatings appeared to accelerate the oxidation process.

Adhesion Testing of Thermal Spray Coatings on Flat Substrates

By ***Sang-Ha Leigh*** (M.Sc. in Materials Science and Engineering, State University of New York at Stony Brook, USA, 1993)

Adhesion strength between the coating and substrate is one of the most important properties of thermal spray coatings. There are numerous adhesion testing methods to evaluate the adhesion strength (or bond strength) of thermal spray coatings to the substrate. The adhesion test methods are divided into five parts; pull-off test, shear test, fracture mechanics method, scratch test, and ultrasonic test; and each of these are reviewed.

The tensile adhesion test (TAT) is simple to perform and is a popular method to measure the adhesion strength of coatings to a substrate. This test is reviewed and some techniques to analyze the TAT data are discussed.

This thesis is primarily intended to develop a tensile adhesion testing method of thermal spray coatings. A modified TAT, based upon ASTM C633-79, is devised to accommodate flat and wide substrates with the standard TAT method (i.e., ASTM C633-79) which specifies a 1 inch (25.4 mm) diameter cylindrical shape substrate. This modified TAT is compared with another common TAT method and the test results are compared. Weibull moduli and characteristic stresses for both test methods are obtained. The modified TAT, named a sandwich method, yields a higher Weibull modulus and characteristic strength than the double-bar method. It is shown that the different test results betw[redacted] the two methods arises from different stress distributions near the interface of the coating and substrate.

A Dimensional Index for the Microstructures of Thermal Spray Coatings

By ***Paul Michael Treadway*** (M.Sc. in Materials Science and Engineering, State University of New York at Stony Brook, USA, 1992

The influence of porosity upon thermal spray coating properties can be examined only when both the porosity and the property can be measured. Porosity is not a well controlled independent variable, and the question remains "According to what scale should porosity be measured?" Various scales are length, surface area, volume, shape, and clustering. The simplest situation is to define a property with respect to a single parameter, i.e. P(length). Unfortunately there is no single measurement of length for pores. Length is the average value from a normal or log normal distribution in a collection of measurements. This thesis examines a mathematical tool to index porosity and other microstructures of a coating. Although the microstructures of thermally sprayed coatings are specifically addressed in the study; the techniques that are developed can be applied to virtually any material that exhibits phase contrast between the constituents. The index value is the slope in a linear log-log relationship between the number of squares in a grid intersecting the pores and the grid spacing. The index is also known as the box counting dimension, and includes the integer valued topological dimensions for points, lines, and surfaces. The relationship has been found as linear for splats and oxides, but the porosity observed at 200× magnification was nonlinear. The amount of curvature in the relationship was reduced at 400× magnification, but not completely to zero. In a linear relationship the index value when correlated with pore volume has physical interpretations of clustering. The porosity of a coating containing low pore volume and high index (1.5-2.0) consists of connected pores, and the porosity of a coating containing low pore volume and low dimension (0.0-1.0) consists of small separated pores.