



New Literature

High Velocity Oxy-Fuel Spraying—Theory, Structure-Property Relationships and Applications

V.V. Sobolev, J.M. Guilemany, and J. Nutting. Maney Publishing for Institute of Materials, Minerals, and Mining, 2004. 320 pages. Hardback. ISBN: 1-902653-72-6. £96.00/\$163.00; Institute of Materials, Minerals and Mining members price: £76.80/\$130.40

This book covers the main aspects relating to fundamentals and applications of high-velocity oxyfuel (HVOF) spraying. The HVOF spray systems are presented in the first two chapters, which describe of the process, gaseous and liquid fuels for HVOF spraying, HVOF spray guns, and future trends in HVOF spraying. The issues related to feedstock powders for HVOF spraying (powder materials and methods of powder manufacturing and evaluation) are described in the third chapter. The in-flight behavior of the powder particles during the spray process is discussed in the fourth chapter, which includes combustion and spraying gas dynamics, fundamentals of the in-flight behavior, and the results of mathematical modeling.

The fifth chapter is dedicated to the coating deposition, flattening of droplets, and formation of splats on the substrate sur-

face and covers the issues related to the influence of solidification and surface roughness, effect of wetting and surface phenomena, influence of substrate deformation, flattening of the composite powder particles, splat-substrate mechanical interaction, dynamics of splashing, spraying at off-normal angles, and influence of oxidation on the splat formation.

The coating solidification and formation of the coating structure are considered in the sixth chapter, which is related to the coating-substrate thermal interaction, formation of the interfacial region, development of the coating crystalline and amorphous structure, formation of the coating gas, and shrinkage porosity and chemical inhomogeneity. The development of the substrate-coating adhesive bonds is described in the seventh chapter, which includes different mechanisms of adhesion (mechanical, thermal, diffusive, and chemical), influence of oxidation and residual stresses on the substrate-coating bonding.

The theoretical results are compared with the experimental data for the HVOF sprayed coatings. When these data are available, the presented analytical results (e.g., those established in the chapter 5) that are valid for the deposits prepared by different types of thermal spraying are compared with the experimental data for the plasma sprayed coatings.

The eighth chapter deals with the basic methods of characterization of materials

structure, which include optical microscopy, transmission electron microscopy, and scanning electron microscopy. There are many references in literature relating to the standard methods of characterization; however, a very simple general view on these issues would help the readers to refresh their memories. The chapter also includes the methods of coating evaluation and evaluation of the coating structure and properties.

Chapter 9 to 13 deal with the structure-property relationships the coatings formed by HVOF spraying of the different cermet powders (WC-Co, WC-Co-Cr, Cr₃C₂-NiCr, and TiC-Ni). Microstructure of the substrate interfacial region developed during HVOF spraying of these coatings is analyzed in chapter 13. The results on the structure-property relationships in the coatings manufactured from metals (stainless steel and superalloys), ceramic and polymers are presented in the chapters 14 and 15.

Some engineering applications of HVOF sprayed coatings are discussed in chapter 16.

Finally, chapter 17 is devoted to a new technology for HVOF spray forming and describes preparation of the powders for forming, experimental procedure, results on evaluation of the structure, and properties of the formed components.

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Recent Conferences

The 29th International Conference & Exposition on Advanced Ceramics & Composites

January 24-28, 2005, Cocoa Beach, Florida

This conference, organized by The Engineering Ceramics Division of the American Ceramic Society, included a symposium on "Advanced Ceramic Coatings for Structural, Environmental and Functional Appli-

cations." This symposium covered numerous topics related to ceramic coatings, including thermal barrier coatings (TBCs).

Monday morning started with the plenary session, which included four invited talks—the TBC area was well represented by a presentation by R. Steinbrech titled "Plasma Sprayed Thermal Barrier Coatings: A Microstructural Approach to Thermomechanical Behavior." This plenary session was followed over the next few days by a series of symposia meetings, generally introduced by invited talks.

The symposium of particular interest to readers of this journal was the symposium on advanced ceramic coatings, which contained several talks on thermal barrier coatings. These talks covered both electron-beam physical vapor deposited (EBPVD) and thermally sprayed coatings. All aspects—manufacturing, applications, optimization, characterization, feedstock manufacturing—were addressed in a number of talks. The sessions included invited talks giving an overview on topics of interest for the participants and contributed talks, oftentimes pre-

sented by students, that covered recent developments on specific topics and talks from industry describing new instruments, processes, or materials.

Notable presentations included one by D. Roth-Fagaraseanu "Advanced TBS-Systems and Future Demand for Aero-Engine Applications," introducing the vision on the future of TBCs from the point of view of Rolls-Royce Deutschland. The session on modeling of TBCs and life predictions was introduced by E.H. Jordan, presenting an invited talk on "Finite Element Calculations of Stresses in Air Plasma Sprayed Thermal Barrier Coatings." The session on coatings testing and nondestructive evaluation was started by "Thermal Diffusivity and Thermal Conductivity Measurements of Air Plasma Sprayed Thermal Barrier Coatings" by H. Wang.

A particularly interesting session of the advanced ceramic coatings symposium was the symposium on multifunctional coatings and system integration, launched by S. Sampath with "Advanced Coatings with Embedded Harsh Environment Sensors." While the title may not have caught the eye of thermal sprayers, this lecture presented the use of a novel (miniaturized) thermal spray method to manufacture coating sensors (such as thermocouples) embedded within the coatings, which can be used as in service monitors of operating conditions, for example.

A number of other environmental, tribological, and wear/erosion coatings that may be potentially interesting to readers of this journal were discussed in subsequent sessions, but full listing and coverage is beyond the scope of this short column. More details (including abstracts) can be found at www.ceramics.org, the American Ceramic Society web page.

Cold Spray 2004: An Emerging Spray Coating Technology

September 27-28, 2004, Akron, Ohio

ASM International's Thermal Spray Society (TSS) and ASB Industries Inc, Barberton, OH, cosponsored a highly successful two-day workshop, "Cold Spray 2004: An Emerging Spray Coating Technology," on cold spray technology, the newest member of the thermal spray family, on September 27-28 at the Hilton Hotel in Akron (Fairlawn), OH. This intensive two-day meeting followed the successful Cold Spray 2002 meeting held in Albuquerque, NM, and featured pre-



Fig. 1 A view of the Technical Session



Fig. 3 Prof. Chris Berndt (TSS President) congratulating Dr. J. Karthikeyan (ASB Industries Inc), organizer of Cold Spray 2004



Fig. 2 The tabletop exhibition

sentations from more than a dozen of the world's foremost cold spray experts, who shared their knowledge and experiences on this emerging spray coating technology.

The meeting was attended by 150+ participants from 14 countries around the world, allowing the attendees to not only gain a basic understanding of the cold spray process, but also receive updates on global R&D programs on cold spray technology, receive first-hand information on industrial applications of cold spray, and also network with international experts. The meeting also featured a tabletop exhibition, in which 12 organizations from both the United States and abroad exhibited their products and services.

The meeting started with the Plenary session, chaired by Prof. Chris Berndt. Following the opening remarks by Prof. Rick Knight, Prof. Heinrich Kreye of University of Federal Armed Forces, Hamburg, Germany, gave a scintillating keynote presentation on "The Cold Spray Process and Its Potential for Industrial Applications." The talk covered all the aspects of the cold spray technology, including theory, modeling, spray experiments, application development, and global challenges. A session on "International Status" followed in which cold spray programs in Australia, Russia, South Korea, United Kingdom, and United States were dis-



Fig. 4 Demonstration of CGT Kinetic 3000 Cold Spray System at ASB Industries, Inc.

cussed by representative experts. A session on "Process Development" featured three presentations on different aspects of the cold spray process, including feedstock, spray optimization, and bonding mechanism. This was followed by a session on "Applications," in which targeted applications in aerospace, automobile, corrosion protection, and general industry were discussed by authors from Germany, Japan, and United States. Final session on "Systems" introduced various cold spray systems available in the market.

ASB Industries, Inc., sponsored the industrial visit to their facility, where attendees witnessed live demonstrations of various cold spray systems, including the patented ASB Mk-4 system (U.S.), Dynamet Portable System (Canada), and the CGT Kinetic 3000 system (Germany). Attendees saw cold spray processing of copper, titanium, and MMC powders and also were able to take home sprayed samples.

The meeting concluded with a "Panel Discussion" featuring academic, research, and industrial experts elaborating on their views on cold spray technology, followed by question-and-answer session, involving the entire audience.