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Meet Our New Colleagues

This column presents selected currently graduating Ph.D. students in the thermal spray field from around the world. Students planning to graduate in the area of thermal spray within next 3-6 months are encouraged to submit a short description (1-2 pages, preferably as Word document) of the projects they performed during their studies to Jan Ilavsky, JTST associate editor, address: Argonne National Laboratory, 9700 S Cass Ave., Argonne, IL, 60439; e-mail: JTST_Ilavsky@aps.anl.gov. After limited review and corrections and with agreement of the student's thesis advisor, selected submissions will be published in the upcoming issues JTST.

Swarnima Deshpande

Insights into Microstructural Evolution, Defects, and Sintering Behavior of Thermal Spray Coatings across Length Scales

Swarnima Deshpande, Ph.D. Candidate

Abstract of Research

Deshpande's research involves a detailed study of the complex layered microstructures of thermal spray coatings. These are being characterized across length scales in order to look at various features such as porosity and phases in coating cross sections, splat structure, splat interfaces, grain structure within splats, etc. This study incorporates the use of optical microscopy, scanning electron microscopy (SEM), and image analysis for low-magnification studies of ceramic and metallic systems and also the use of SEM and transmission electron microscopy (TEM) for high-magnification characterization. It explores and exhibits the necessity and applicability of each of these techniques for understanding the evolution of microstructure during formation of coatings. Porosity in partially stabilized zirconia (PSZ) top coats is characterized and categorized using image analysis, and results are correlated with more advanced techniques of porosity measurement. Importance of splat interfaces and their variation with respect to feedstock is also addressed. The mechanisms of single-splat formation and oxidation involved are studied, and schematic models are presented to explain the deposit formation of Ni-5Al bond coats in case of different processes such as atmospheric plasma spraying (APS), wire-arc, high-velocity oxyfuel (HVOF), and cold spray techniques. Having thus examined the microstructural intricacies in top coat and bond coat systems, this study then explores the sintering and oxidation behavior of the thermal barrier coating (TBC) system as a whole. The effects of heat treatment temperature, time, and environment, and effect of feedstock and bond coat spraying system used, are studied for single splats of PSZ, sprayed onto CoNiCrAlY bond coats. Sintering effects are investigated in single splats rather than thick deposit for better understanding at a fundamental level.

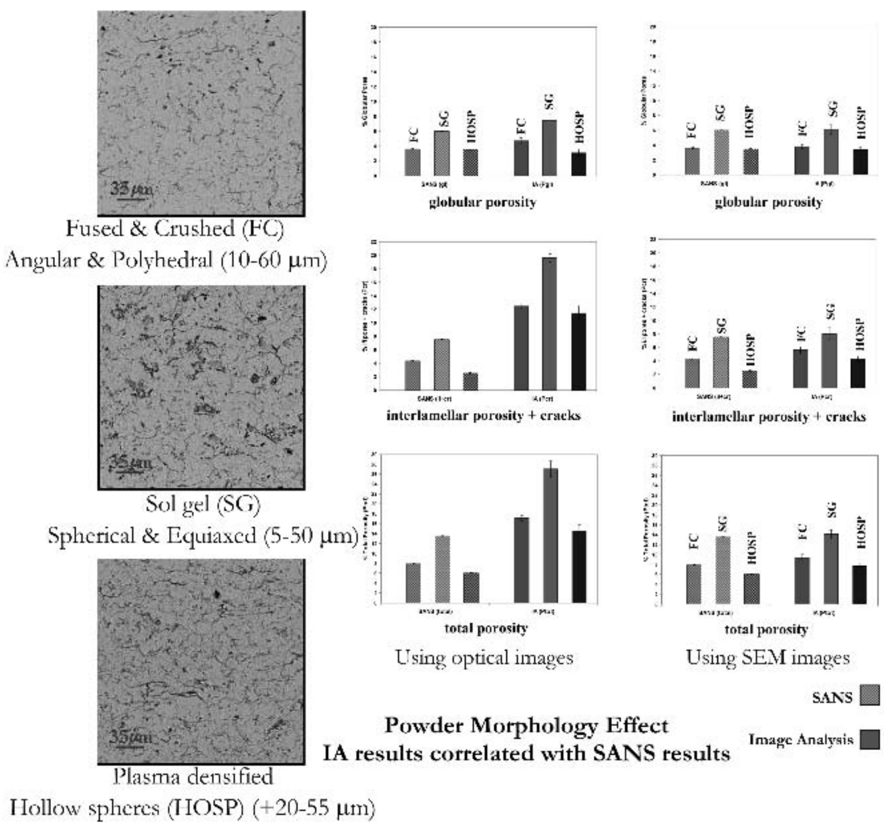

Fig. 1 Porosity in PSZ coatings (top coat)—application of image analysis

Key Results

Porosity in PSZ Coatings (Top Coat)—Application of Image Analysis (Fig. 1)

- Porosity in thermal spray coatings very prominent and distributed in the form of globular pores, interlamellar pores, and microcracks
- Influenced by feedstock particle size and particle morphology
- Image analysis (IA) used for characterizing porosity and results correlated with small-angle neutron scattering (SANS)
- The pore volume fractions obtained by IA on optical images differ from SANS by a factor of 2, but this factor is reduced to about 1.25 when SEM images are used.
- Better depth resolution with SEM allows for definite detection of

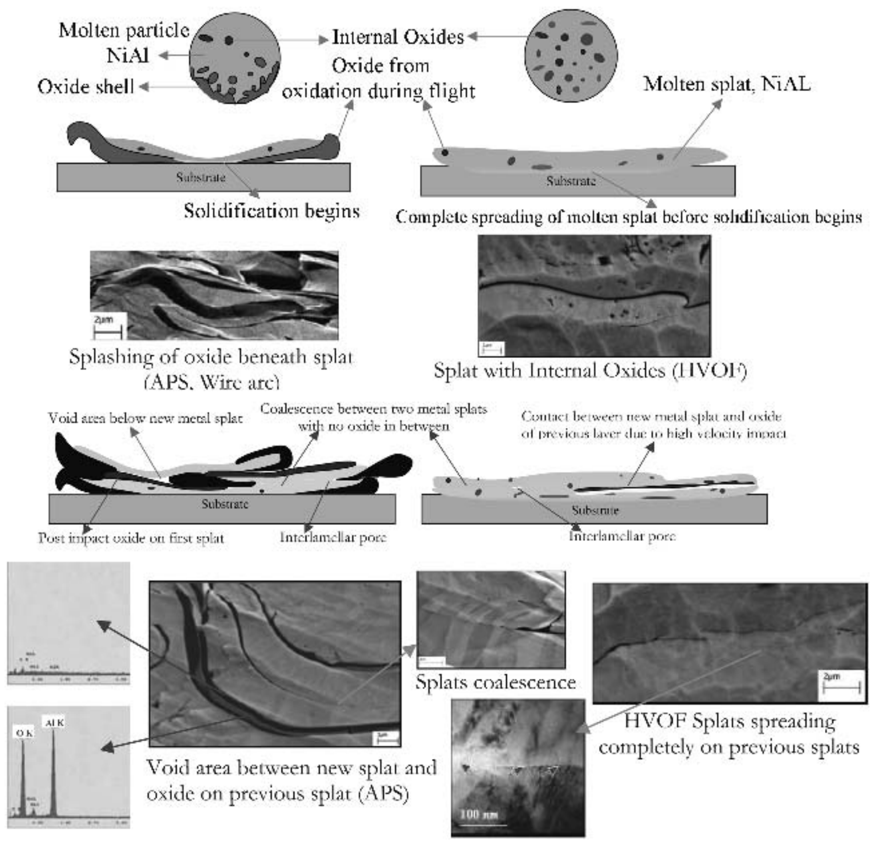

Fig. 2 Splat formation and oxidation mechanisms in Ni-5wt.%Al coatings (bond coat)

component pores and enables distinguishing between pores and pullouts

- Although the values from IA differ from SANS significantly, they do not alter the trends in porosity with respect to powder type.

Splat Formation and Oxidation Mechanisms in Ni-5wt.%Al Coatings (Bond Coat) (Fig. 2)

- Oxidation in metallic coating formation varies with spray process and has an impact on coating buildup.
- High particle temperature and strong gas mixing in the vicinity of the in-flight particle causes most of the oxide on the particle surface to be segregated toward one side of the particle.
- When this oxidized molten particle reaches the substrate, it starts to spread and splash with the oxide layer beneath the metal splat.
- If in-flight oxidation is well distributed and internal, then such oxide remains embedded in the splat.
- Postimpact oxidation of the splat surface occurs before the arrival of the subsequent splat.
- In the presence of such an oxide layer the wetting is lesser and the intersplat contact is poorer.
- In the absence of oxide layer, the intersplat contact is very good and splat coalescence is observed.

Publications

- S. Deshpande, A. Kulkarni, S. Sampath, and H. Herman, *Surf. Coat. Technol.,* Vol 187 (No. 1), Oct 1, 2004, p 6-16
- S. Deshpande, S. Sampath, P.I. Gouma, and H. Herman, *Proc. ITSC,* May 5-8, 2003 (Orlando FL), p 1419-1428

Contact: Swarnima Deshpande, Center for Thermal Spray Research, State University of New York at Stony Brook, Stony Brook, NY 11794-2275; e-mail: swarnima.deshpande@sunysb.edu.