Editorial

Progress on Diagnostics and Instrumentation in the Thermal Spray Process

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Thermally sprayed coatings are formed particle by particle with the characteristics of the individual impact, flattening, and solidification events giving rise to the characteristics of the coating produced. For a given particulate material (composition, size distribution, morphology, etc.) individual particles arrive at the substrate with a range of sizes, velocities, temperatures, molten fraction, angle of incidence, etc. While our ability to characterize the spray field prior to impact and our understanding of the relative contribution of various sources to the resulting statistical variation of in-flight parameters has become quite sophisticated, the fundamental question of which parameters are of primary importance is not yet fully answered. Are the particle parameters (including statistical distributions) of primary importance or is substrate preparation and temperature history during coating formation the controlling factor? It is likely that for a particular coating with certain desired characteristics there are several key conditions that must be simultaneously controlled to produce acceptable and reproducible coatings.

Ultimately the goal is to engineer coatings for a particular application. An example of an engineered coating is a functionally gradient thermal barrier applied to an exhaust valve or piston crown. The design of this coating to control thermal conductivity and residual stresses may be very different for the convoluted geometry of a piston crown versus the relatively simple geometry of an exhaust valve face. Ultimately by the term "engineer a coating" I mean the ability to *a priori* specify strength, adhesion, density, residual stress state, thermal conductivity, etc. then deliver a particle ensemble with the appropriate characteristics to a properly prepared and conditioned substrate to achieve this goal. The ability to perform this feat is somewhere in the future. Bridging this gap requires the development of a detailed fundamental understanding of coating performance characteristics on the overall process. This includes not only basic knowledge of the dependency of the resulting coating on in-flight particle parameters but also on substrate characteristics such as surface roughness, chemistry, temperature history, etc. In spite of the complexity of the problem, progress, both experimentally and theoretically (computationally), is being made. Experimentally most progress has been made in understanding spray gun behavior and the dependency of flow field characteristics on input parameters (gas mix, power, etc.) and nozzle wear, for example, and the interaction between the injected particulates and the hot gases. Good progress is now being made on understanding individual impact phenomena (flattening, cooling, solidification, etc.). With the help of the evolving sophistication of instrumentation and experimental technique (coupled with computational models), progress on the connection between controllable parameters (observables like particle temperature, velocity, substrate temperature, etc.), coating formation, and the resulting coating characteristics is progressing in a number of laboratories around the world.

Because of the rapid progress that has been made in the last several years in this area it is appropriate that recent developments in all aspects of instrumentation, diagnostics, and control relating to this problem be gathered into a special focus edition of the *Journal of Thermal Spray Technology.* Potential contributors are invited to indicate their interest to the author of this editorial or send their manuscripts to the journal editor at SUNY at Stony Brook.

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