Basic Science & Engineering

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2:00 p.m. - 2:25 p.m.

Structure and Adhesion of Ni and Ni-WC Plasma Spray Coatings

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The adhesion of Ni plasma spray coatings on stainless steel foil substrates was characterised using the peel adhesion test (PAT). The Ni coatings were produced from narrow particle size distribution powder of either coarse (~75 micrometer) or fine (~20 micrometer) average particle size.

Deposition parameters and substrate treatment were the same for all coatings. A variety of microstructural features, such as splat diameter and thickness, pore size and distribution, density, and inclusion size and frequency, were also characterised, and correlations with the measured peel force explored. These microstructural features were also compared with the results of recent numerical modelling conducted in related studies.

2:25 p.m. - 2:50 p.m.

Modelling Thermal Spray Coating Formation

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Formation of a thermal spray coating was studied using both numerical simulations and experiments. In the experiments, nickel particles were sprayed onto stainless steel and glass substrates using a dc plasma torch. In-flight particle temperatures were measured at the substrate using a ratio pyrometer. Particle tracking velocimetry was used to obtain particle impact velocities. The substrate was heated by an electric heater and its temperature was monitored with a thermocouple. We studied changes in splat shape as a function of substrate temperature.

A 3D model of free-surface flows with heat transfer, including solidification, was used to simulate the impact of nickel particles onto the substrate. The impact conditions of the particles were those of the experiments. The nickel particles were 61 mm in diameter and had a temperature of 2050°C (i.e. 600°C above the melting point). The impact velocity was 48 m/s. Fluid flow in impinging particles was modelled using a finite difference solution of the Navier-Stokes equations in a 3D Cartesian co-ordinate system. The surface profile of the deforming particles was defined using the "fractional volume of fluid" scheme. The enthalpy method was used to solve the energy equation for the liquid and solid phases of the particles at the same. Heat transfer within the substrate was by conduction only. Thermal contact resistance between the splat and substrate was included in the model. We treated the solidified regions of the particles using a modified version of the fixed velocity method.

Computer generated images of impacting nickel particles on the substrate were obtained using the numerical model; the images were then compared with experimental photographs. Different scenarios of particle impact were considered. These scenarios included the impact of a particle besides a solidified splat, on top of a splat, and at the edge of a splat. Several characteristics of a coating layer build-up such as porosity formation, particle splashing, splat re-melting, and formation of small satellite droplets and rings around the splat were studied. The effects of particle size, impact velocity, and initial particle and substrate temperatures during the impact were also shown. The results of this study confirmed the suitability of the developed numerical model for simulating typical thermal spray coating processes.

2:50 p.m. - 3:10 p.m. Break