3D Numerical simulation of ceramic droplet impact on different roughness surfaces in plasma spray process

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Abstract

A computational program using finite element method has been developed to simulate the 3D impact and flattening of a ceramic droplet impacting onto a solid surface with different surface roughness occurring in the plasma thermal spray. The model is based on Navier-Stokes equations combining with a volume of fluid (VOF) tracking algorithm is used to track the droplet-free surface. Thermal contact resistance at the droplet-substrate interface is also included in the model. Specific attention is paid to the simulation of droplet impact under plasma spraying conditions. To understand the effect of solidification on the droplet impact dynamics and splat morphology, the simulations were run with smoothed and roughened surfaces considering different roughness magnitude .
Results indicated that the increase in magnitude of the mean substrate roughness promotes splat instability (jetting and/or satellite break-up) and formation of radial fingers. It was also observed that the increase in general surface roughness may result in the lower spreading ratio (Dfinal / Dinitial) of thermally sprayed ceramic particles. The spreading process of a droplet is governed not only by the inertia and viscous forces, but also by the thermal contact resistance in the substrate surface.

Keywords: plasma sprayed coating, smoothed surface, roughened surface, different roughness magnitude

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