Modeling plasma sprayed nanostructured Al2O3–13wt%TiO2 coatings

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Abstract

In plasma spraying, a coated layer is formed on a substrate surface by spraying melted powders into a substrate at a high speed using a high-temperature plasma heat source. The plasma spraying is an economical and effective method applied to various machine parts to reduce the surface degradation. Plasma-sprayed ceramic coatings have been widely used for structural applications in order to improve resistances to wear, corrosion, oxidization, erosion, and heat. Recently, nanostructured materials having excellent properties have received attentions, and thus many efforts have been made to fabricate nanostructured ceramic coatings with nanopowders and to improve surface properties. Many researchers reported that the Al2O3–TiO2 coating containing 13 wt.% of TiO2 showed the most excellent wear resistance. However, since the coating microstructures including splats, pores, partially melted regions, and unmelted regions are quite complex, it is needed to accurately investigate mechanisms involved in the wear resistance by analyzing and modeling various microstructural factors. In this work, numerical model is developed using CFD software to simulate the process of droplet impact, spreading and solidification onto the substrate. The model simultaneously takes into account the fluid flow and heat transfer in the liquid particle and the surrounding gas, and the heat transfer in the substrate. The results show a substantial build up of temperature at the surface and large temperature gradients throughout the thickness, which are due to due to the differences in the melting point, specific heat and latent heat of fusion of alumina and titania, as well as the difference in their particle sizes.

Keywords: Plasma spray coating, nanostructured materials, Al2O3–TiO2 coating, flattening process, heat transfer

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