Abstract

This investigation deals with laser remelting of flame and plasma sprayed alumina and chromia coatings. The time-temperature history of the laser remelted zone was recorded using an infrared pyrometer during the remelting operation. Cooling rates, under varying scanning speed, were determined from the time temperature curve. Surface morphology, microstructure, and phases of the laser treated and as-sprayed coatings were characterized using scanning electron microscopy, optical microscopy, X-ray diffraction, respectively. X-ray diffraction was also employed to measure the surface residual stress of the coatings. Inherent features of plasma sprayed coatings like porosity and inter-lamellar boundary were obliterated upon laser remelting. Both alumina and chromia remelted layers present a dendritic structure on their surfaces and a columnar grain growth perpendicular to the laser scanning direction. The range of roughness of the as-sprayed coatings reduced from 6-8 µm to 1-2 µm in the remelted layers. For both coatings, more than 90% reduction in porosity was found upon laser remelting. A phase change from γ to α-alumina also occurred. Upon remelting, hardness, elastic modulus, and indentation fracture toughness of the remelted coatings were found to improve. Surface residual stress of the as-sprayed alumina and chromia coatings was found to be tensile and compressive, respectively. Within the limits of the testing condition, the tensile residual stress of the remelted layers increased substantially in both coatings. This tensile stress showed a tendency to increase with an increase in the cooling rate. Scratch resistance and failure load of plasma sprayed, and laser remelted coatings were assessed under constant and variable load. Upon laser remelting, failure load and cohesive strength of the coatings increased by up to 65% and 94%, respectively. Scratch wear resistance increased by up to 88%. The wear coefficients of the laser remelted chromia and alumina coating respectively were 80% and 72% lower than those of the as-sprayed coatings. Principal mechanisms of failure of the coatings were plastic deformation, tensile cracking, and spallation.