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Effect of cooling rate on residual stress and mechanical properties of laser remelted ceramic coating

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Abstract: Mild steel substrates were coated with commercially available alumina and chromia powders using the powder flame spraying process. The top layers of the flame sprayed coatings were remelted using a 2kW fiber laser. Thermo-cycles of the laser remelting process were monitored on-line using an infrared pyrometer. Cooling rates were varied using different laser scanning speeds. Surface morphology, microstructure and phases of the laser treated and as-sprayed coatings were investigated using optical microscopy, scanning electron microscopy, X-ray diffraction and X-ray tomography. Surface residual stress of the as-sprayed and laser treated coatings was measured using X-ray diffraction. The inherent defects like porosity and inter-lamellar boundary diminish to a great extent upon laser remelting. Surface residual stress of the remelted coatings tends to increase with increase in cooling rate. Surface crack density of the laser treated coating was reduced appreciably when coatings were preheated prior to laser remelting.

Keywords: Ceramic oxides, Powder flame spray, Laser remelting, Columnar microstructure, Residual stress

1. Introduction

Thermally sprayed alumina coating is suitable for wear resistance applications owing to its high hardness and chemical stability [1]. This type of coating is used in automotive and electronic industry [2, 3]. On the other hand, chromia coating is widely accepted for corrosion resistant application. These types of coating are used in printing rolls, piston rings of IC engines and pumps [4, 5].