Abstract

This investigation envisages the development of plasma sprayed mullite coatings for tribological application from a mixture of zircon and alumina powders. The parameters considered are arc current, stand-off distance, hydrogen gas concentration and powder injection angle. Laser remelting of selected coatings have been undertaken. The coatings have been studied under optical and scanning electron microscope (SEM) and high resolution transmission electron microscope (HRTEM). Mullite content of the coating has been measured using Rietveld analysis of the coating's X-ray diffraction data. The tribological performance of the coatings has been assessed using a pin-on-disk set up at various speed load conditions against steel and WC-Co counterbodies. The as-sprayed coatings have shown good microstrctural integrity as observed from their cross sectional SEM images. TEM examination shows equi-axed grains in the plane of the coating. It has been found that it is possible to produce a coating with around 36.2 wt% mullite using appropriate process parameters. Mullite yield depends on the powder melting condition. An increase in arc current, hydrogen gas flow rate and injection angle increases mullite content in the coating till the stand-off distance is increased from 75 to 125 mm. Beyond this distance the particles cool before reaching the substrate and the mullite content in the coating is reduced. An improvement in powder melting conditions also increases coating hardness and reduces coating porosity. The well molten, less porous and mullite rich coating renders the coating more wear resistant. The wear resistance of high yield mullite coatings has been higher than plasma sprayed alumina, a standard tribological coating. Upon laser treatment the hardness, porosity, mullite content and wear resistance of the coatings has been found to improve further. Wear progresses by plastic deformation in low load-speed condition and with increase in speed and load pulverisation becomes the dominant wear mechanism for both as-sprayed and laser remelted coatings. TEM observation has shown equi-axed and columnar grains in the coating plane and cross section, respectively in the laser treated coatings.

Keywords: thermal spray; plasma spray; mullite; hardness; XRD; SEM; wear