Powder Hot Isostatic Pressing of Ni-MMCs for High Wear Resistance Applications

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Abstract: Mechanical seals are widely used in aerospace industry to minimize or eliminate the leakage in mixers, centrifugal pumps, and in other rotating equipment. They act as a seal along the interface between a rotating shaft and a stationary housing. In order to withstand the high operating speeds and loads in a highly corrosive environment, a material with a combination of good mechanical, tribological and corrosion properties is required.

In this work, powder hot isostatic pressing (P-HIP) of nickel (Inconel 625)-base metal matrix composite (Ni-MMC) was developed to improve the hardness and wear properties of the mechanical gas seals. Silicon carbide (SiC) fine powders used as the reinforcement with different ratios in order to improve the hardness and consequently the tribological properties of the developed Ni-MMC material. A detailed powder characterisation was performed on the blended powders to check the homogeneity of the mixed powders. The HIPped Ni-MMC microstructures, in regards to the formation of different phases, were analysed by X-ray diffraction (XRD) and scanning electron microscope (SEM) techniques. The HIPped material showed a fully dense microstructure with a continuous network of ceramic reinforcement particles at the prior particle boundaries (PPBs). Furthermore, microhardness tests were performed on IN625, IN625-5v.%SiC and IN625-10v.%SiC in order to understand the impact of the reinforcement on the microhardness. The volume percentage of SiC powder in Inconel 625 matrix plays a crucial role in achieving the higher hardness and the amount of different phases appearing in microstructure of the developed Ni-MMC material.

Finally, a canister was design & manufacture, filled with Ni-MMC blended powder and HIPped to manufacture a mechanical gas seal by P-HIP route in near net shape form.