

Surface Chemistry of Steel Powder and its Changes during HIP Processing

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Metal powders are characterized by the large surface area that results in high surface reactivity of the powder. This is especially important in case of complex alloys containing elements with high sensitivity to oxygen (Cr, Mn, Si, V, Zr, etc.) such as tool steels, Ni-base super-alloys, stainless steels, etc. The residual surface oxides hinder the metallic bonding between the powder particles and remain as crack propagation sites. Therefore, knowledge concerning initial state of the powder before HIP as well as oxide transformation during HIP process is of vital importance to assure defect-free manufacturing of HIP components.

In this study the effect of the surface oxide composition in high alloyed steels such as austenitic steel E316L and two tool steels (X40CrMoV5-1 and HS6-5-3) are being examined. The oxides present on the initial powder surface are examined by means of X-ray photoelectron spectroscopy (XPS) and high-resolution scanning electron microscopy (HRSEM+EDX). Results indicate that the base powder is covered by a heterogeneous surface oxide layer, formed by thin iron oxide layer (<5 nm) with the presence of fine particulates of thermodynamically stable (Cr, Mn, V, Si-rich) oxides, sizing about 30 nm, that also form larger agglomerates in some sites. The mechanical properties of the HIPed material are studied and the results are discussed with regard to the influence of residual surface oxides on the mechanical behavior. Based on the experimental finding and thermodynamic simulation of the oxide stability, a generic model of the oxide distribution and its changes during HIP processing is developed.

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Materials

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