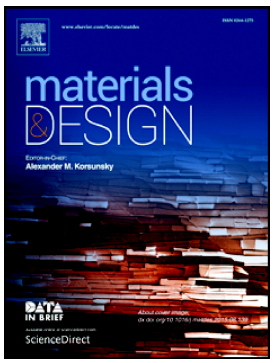

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Densification behavior, microstructural evolution, and mechanical properties of TiC/316L nanocomposites fabricated by selective laser melting

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Abstract

Here we investigate the influence of the volumetric laser energy density (η) utilized in selective laser melting (SLM) on the phase evolution, densification behavior, microstructure evolution, and mechanical properties of TiC/316L stainless steel nanocomposite parts. Correlations between the SLM processing parameters and the microstructures, mechanical properties, and metallurgical mechanisms of the fabricated parts were established. In SLM, low η values induced disordered liquid solidification fronts with significant balling and pore chain defects, which arose from the low-viscosity and highly unstable flow behavior caused by densification-limiting Marangoni convection. Conversely, high η values in SLM significantly enhance densification but induce fine spherical pores and thermal microcracks by increasing liquid lifetimes and thermal stresses. The diffraction angles of the γ-Fe peaks were shifted from their standard locations by the lattice distortion from laser-induced thermal stress. The samples processed at η of 67 J/mm^3 showed the most refined microstructures formed under exposure to the highest cooling rates, which led to higher compressive yield strengths than those of samples processed at η of 300 J/mm^3. Pole figures obtained for the γ-Fe phase depicted no significant directionality in the texture of any of the components; however, a significant texture intensity increase was reported with increasing η.

Keywords: Additive manufacturing; Selective laser melting (SLM); Nanocomposite; 316L stainless steel; Densification; Solidification