MCoMpa30-006

Characterization of a gelcast aisi 310 ss matrix composite reinforced by alumina and gnp particles

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Gelcasting is a fluid forming technique that allows the use of a wide variety of powders on its preparation, including ceramic and metallic particles, at any solids concentration, being of potential applicability for composite materials obtaining. Despite the suitability of gelcasting process to obtain such materials, metal matrix composites reinforced by alumina and graphene particles is still scarce in the literature. This work describes the application of the gelcasting process for preparing a metal matrix composite consisting of AISI 310 stainless steel reinforced with additions of 1, 3 and 5 vol.% of nanosized alumina particles and 0,5 vol.% of graphene nanoplatelets (GNPs). Prior to specimen preparation, special attention was given to the rheology of suspension and to the interaction between metallic and ceramic particles, which is one of the central aspects of this study. AISI 310 and alumina particle sizes are 10 µm and 600 nm, respectively. The GNPs have between 30-50 layers of 10 µm each. A thermal analysis was held to define the sintering temperature and assure that any issue regarding to densification would be avoided. Images obtained by scanning electron microscope (SEM) and optical microscope were taken from slices of a sintered sample to evaluate the dispersion of alumina and GNPs particles in stainless steel matrix composite. Compression tests were performed at room temperature (RT) and at 800°C, in addition to Vickers microharness and microstructural characterization of the sintered ones. The average yield strength achieved was 240 MPa for RT, being 285 MPa the highest value of all, and average of 115 MPa for 800 °C ones, being 140 MPa the highest among all, both upper than standard ASTM A351/A351M-18e1 value of 240 MPa for RT and data published value of 100 MPa for 800°C. Alumina particles distribution after sintering was found to be homogeneous in this work process conditions, being the one with 3 vol.% the best of all. Alumina and GNP additions have led to a microstructure refinement in comparison to pure stainless steel, as well as enhanced yield strength resistance. The gelcasting process showed to be feasible for obtaining dense metal matrix composite parts, closer to theoretical density, with good mechanical properties and low cost of manufacturing.