Effects of Sintering Temperature on Microstructure and Mechanical Properties of Nanostructured Ni-17Cr Alloy

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Abstract : Spark Plasma Sintering technique is a novel processing method that produces limited grain growth and highly dense variety of materials; alloys, superalloys, and carbides just to mention a few. However, initial particle size and spark plasma sintering parameters are factors which influence the grain growth and mechanical properties of sintered materials. Ni-Cr alloys are regarded as the most promising alloys for aerospace turbine blades, owing to the fact that they meet the basic requirements of desirable mechanical strength at high temperatures and good resistance to oxidation. The conventional method of producing this alloy often results in excessive grain growth and porosity levels that are detrimental to its mechanical properties. The effect of sintering temperature was evaluated on the microstructure and mechanical properties of the nanostructured Ni-17Cr alloy. Nickel and chromium powder were milled using high energy ball milling independently for 30 hours, milling speed of 400 revs/min and ball to powder ratio (BPR) of 10:1. The milled powders were mixed in the composition of Nickel having 83 wt % and chromium, 17 wt %. This was sintered at varied temperatures from 800°C, 900°C, 1000°C, 1100°C and 1200°C. The structural characteristics such as porosity, grain size, fracture surface and hardness were analyzed by scan electron microscopy and X-ray diffraction, Archimedes densitometry, micro-hardness tester. The corresponding results indicated an increase in the densification and hardness property of the alloy as the temperature increases. The residual porosity of the alloy reduces with respect to the sintering temperature and in contrast, the grain size was enhanced. The study of the mechanical properties, including hardness, densification shows that optimum properties were obtained for the sintering temperature of 1100°C. The advantages of high sinterability of Ni-17Cr alloy using milled powders and microstructural details were discussed.

Keywords : densification, grain growth, milling, nanostructured materials, sintering temperature
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