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Effect of different densification methods on microstructural and mechanical properties of superhard ceramic with addition of nanoparticles.

Abstract

The Si_3N_4 based ceramic were prepared in two stages. In the first stage, the material was compacted using different methods: isostatic, High pressure-High Temperature and Shock Compaction. In the second stage, obtained green body samples were sintered by the free sintering method. Powder mixtures, in wt%, Si_3N_4-$6Al_2O_3$ -$6Y_2O_{2(nano)}$, were based on commercial micro and nanopowders.

After the first stage, for the HP-HT and Shock Compaction densification method, the relative density of composite was the highest respectively 86% and 82%. It is 30% of increase in density of Shock Compaction green body samples compared to those obtained with isostatic densification method. Microstructure of Shock Compaction green body samples allowed to hardness measurement. Hardness of these samples was according to the load was: 0,3kG – 1133GPa, 0,5kG – 1118GPa, 1kG – 1081 GPa.

After free sintering process of green body, samples obtained by HP-HT and Shock Compaction, had higher values of relative densities than isostatic compacted composites. For the HP-HT method, the relative density was the highest (95%). For HP-HT composite Young's moduli was 284 GPa and for the compacted by isostatic was in the range 236–241 GPa. Materials prepared using the Shock Compaction densification method were characterized by the highest hardness. Vickers hardness's were about 1170HV1 for the isostatic, 1480HV1 for the HP-HT and 1760HV1 for Shock Compaction composite. Shock and HP-HT compacted and then free sintered Si_3N_4-based composites were characterized by the best combination of physical and mechanical properties.

Keywords: Si_3N_4 composite, nanopowder Y_2O_3, densification, pressure compaction, sintering, properties