HPHT Sintering of Nanostructured Diamond Composite
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Abstract – Nanosize diamond-based compacts represent the promising future of superhard materials. Under a physical mechanical point of view, nanostructured composites promotes higher properties than those of natural or synthetic monocrystals. The presence of small particles filling pores leads to the formation of a compact having a lower degree of porosity. Diamond composites with nanosize diamond crystals and nanosize SiC matrix were obtained at 6.5 to 7.7 GPa and temperatures varied between 1000 and 1600°C. X-ray diffractions of the obtained composites informed about crystallite size and dislocations.

Nanosize or ultra-dispersed diamond particles have been recently used as precursor for the development of a new generation of superhard composites[1]. Differences in the formation mechanism of these composites were found as a function of developed residual stress. In the present work, diamond composites were obtained by a compacting method at high pressure, almost hydrostatic, and high temperature conditions. Experiments were conducted inside a thoroidal type anvil of a high pressure device[2] with a 13.5 mm concavity installed in a 630 ton press. Temperatures of 1000 to 1600°C combined with pressures from 6.5 to 7.7 GPa were used for compacting. The composites were obtained by the infiltration method, using as starting materials: 48/40 µm and nano (0.01 to 0.004 µm) diamond particles, provided by FNPC “Altay”, and Si powder as the binder. The sintered samples have a cylindrical shape with 5.0 mm diameter and 4.5 mm height. The characterization indicates density values no greater than 2.86 g/cm³, a maximum hardness of 30.5 GPa and great homogeneity (Figure 1). These results can be explained by X-ray diffraction and suggest a plastic fragmentation of the larger initial particles. It contributes to an ultra-fine composite structure, revealed by the intensity of the lines <003> compared with the lines <111> of diamond. The compression strength of the polycrystalline diamond composites was found to be close to that of natural diamonds.

References