Nanocomposites and nanomaterials

Mechanism of sintering diamond nanopowders by high pressure

O.O. Bochechka

V. Bakul Institute for Superhard Materials, Natl. Acad. of Sci. of Ukraine.
Avtozavodska, 2, Kyiv-04074, Ukraine.
E-mail: bochechka@ism.kiev.ua

The analysis of compacting mechanism of static synthesized diamond powders micron and submicron range under high pressure and high temperature was carried out. Features of the structure formation of pores during sintering these powders are considered. Decisive role of these factors during sintering detonation synthesized diamond nanopowders have been shown.

It was found that back pressure that occurs due to the presence of air in the pores reduces the density of sintered polycrystals slightly in the absence of chemical interaction of oxygen with diamond compared to graphitization of diamond nanoparticles through such interaction. The value of back pressure is significantly lower Laplace pressure that occurs at the contact surface between the particles.

The main barrier to further increasing the density of polycrystals sintered from detonation synthesized diamond powders prepared for sintering by surface modification of diamond particles carrying degassing by heat treatment in a vacuum with sealing high pressure working volume was defined. That barrier is the structure of pores single crystals, formed from the diamond agglomerates of initial nanoparticles that leads to counteracting between the capillary forces and forces arising through the action of external pressure.

One way to improve the density and, consequently, the level of physical and mechanical properties of polycrystals under consideration conditions is a significant increasing working pressure in the high pressure apparatus (HPA). This is due to the use of another HPA class. Those increase the cost of the product and reduce its size.

Without a change of pressure in the HPA the non-alternative way to improve the physical and mechanical properties of polycrystalline materials, sintered from detonation synthesized diamond nanopowders, is to find additives which promote the formation of required composite structure and to find temperature, pressure and technological conditions of its formation.