Mechanical and thermal properties of sintered detonation nanodiamonds

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At present, the study of carbon and nanocarbon materials is of great scientific interest. Using the energy of the blast wave from the decomposition of carbon-containing explosives in a confined space allowed to organize industrial production process of detonation nanodiamonds.

As is well known diamonds have a number of unique properties such as high thermal conductivity and hardness. The combination of these properties make diamond an attractive material for modern microelectronics to create high-strength heat-removing panels and structures. Currently, for these purposes diamonds grown by CVD techniques. However, the size structures grown in such a way does not satisfy the required conditions. Therefore, the study of the possible use of detonation nanodiamonds to create high-strength heat-removing structures is relevant.

In this study we investigated the thermal conductivity and hardness of nanostructured composite materials sintered detonation nanodiamond under high pressures and temperatures. Sintering conducted at a high pressure type apparatus 'split-sphere' at temperatures of 1100 and 1200 ° C and a pressure of 5 GPa. Time thermobaric impact on reaching the maximum sintering parameters was 60 seconds.

It was found that the samples have a low thermal conductivity. The average value of thermal conductivity for the samples sintered at 1100 ° C is 2.5 W / (m • K), and for the samples sintered at 1200 ° C - 3.5 W / (m • K). However, sintering of detonation nanodiamonds under such pressure and temperature parameters leads to an increase in the strength of polycrystalline aggregates is more than an order of magnitude and of 8.8 and 8.9 GPa, respectively.

The low thermal conductivity of nanodiamond composites appears to be associated with defective structure obtained after sintering the material (in the detected microfractures samples pores), as well as the small size of the nanocrystals of diamond in the structure of the samples: studies have shown that the crystal size of nanodiamond after sintering does not exceed 5.2 nm (4.5 nm before sintering).