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Application of the dusty plasma technology for diamond ceramics production

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High pressure and high temperature sintering of a diamond powder is a method to obtain a polycrystalline diamond material that is analogous to the natural carbonado. Cobalt additive is a catalyst for transforming graphite to diamond and stimulates recrystallization of carbon through the liquid phase to form diamond-diamond contacts. The problem is in homogeneous injection of a small amount of Co to the diamond powder. The plasma dusty technology makes it possible to deposit nanolayers of an activating additive upon each particle of the diamond powder and to create favorable conditions for achieving a qualitatively new level for physical and mechanical properties of polycrystalline diamond materials.
The magnetron sputtering method was used to deposit a Co coating of ~10 nm in thickness upon 3-7 mcm synthetic diamond particles. During the deposition the diamond particles were injected into an RF discharge dusty plasma trap and levitated inside it. The disperse composite material (DCM) consisting of diamond particles with the uniform Co coating and Co content 1 – 3 mass percentage was obtained.
The diamond compacts (5-6 mm in size) were produced by DCM sintering under the pressure of 8-9 GPa and the temperature of 2000-2100 K in high-pressure chambers of the “toroid” type. All the procedures on the production of compacts were fulfilled in argon owing to the high chemical activity of Co, particularly in nanoscale. To remove gaseous components out of the DCM and to reduce Co oxides, the material was previously annealed in a quartz reactor under the argon flow before the sintering process.
The produced compacts showed extremely high values of Young’s modulus of about 920 GPa and bulk modulus of about 500 GPa, which indicated the formation of rigid bonds between the diamond particles.

Keywords
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