PROPERTIES OF DIAMOND SYNTHESIZED IN THE Ni-Ti-B-C SYSTEM

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The synthesis of semiconductor diamond powder opens prospects for their use in non-traditional areas, as well as the application of new methods for creating tool. This paper presents the results of investigation of the boron and titanium introduction in the charge on the properties of diamond synthesized under high pressure in the presence of a solvent. In system Ni–Ti–B–C nickel is the graphite solvent. The conductivity of diamond is created by forming the p-type conductivity centers at entering of boron into the diamond crystal lattice (CL) as a substitutional impurity atoms. Titanium is a nitrogen getter. It is adding to prevent nitrogen atoms in diamond-crystal lattice, because their interaction with impurity atoms of boron reduces the amount of uncompensated conductivity centers.

The single crystals of diamond were synthesized in the system of Ni-Ti-B-C at a pressure of 6 GPa and a temperature of 1500 °C and a weight ratio of graphite and alloy solvent is 2:1. The content of boron and titanium in the alloy was varied from 1 to 10 % (at.). Absorption of synthesized crystals in the IR region was studied by Fourier transformation infrared (FTIR) microspectroscopy method. Investigation of electrical properties of the samples was carried out at the stand based of the electrometer Agilent 4339B (A), that developed for measuring the conductivity of powders of superhard materials in a wide range of voltages. The impurity composition of single crystals was evaluated on the basis of the spectra measured in the one-phonon area absorption and natural oscillations of diamond-crystal lattice absorption.

It was established that the crystals synthesized in Ni-C system, are type Ib. The total concentration of nitrogen impurity (in the form of substitutional atoms - C- centers) is from $1 \cdot 10^{18}$ to $5{,}5 \cdot 10^{19}$ cm^{-3}, electrical resistivity - $\rho = 2{,}3 \cdot 10^{12}$. This crystals are electrical insulators. Introduction of 1% boron in the growth system Ni-C does not lead to the appearance of the diamond lattice uncompensated acceptor centers (D-centers), whereas addition of 1% B and 5% Ti (nitrogen getter) causes appearance of such centers (the concentration of $N_A - N_D \sim 10^{14}$ cm^{-3}). In this case, synthetic diamond crystals have semiconducting properties. Their resistivity is about $1{,}2 \cdot 10^7$ Ohm·cm. Among the investigated diamond powders, the powder, synthesized with 10% B and 1 % Ti impurities in the charge has the greatest concentration of D-centers ($N_A - N_D \sim 10^{15}$ cm^{-3}) and accordingly, the highest level of conductivity (resistivity ~ $5{,}4 \cdot 10^6$ ohm·cm). All investigated diamond powders have intensive absorption bands with maxima at 1344 and 1430 cm^{-1}, the interpretation of which requires further research.