E-MRS 2019 Fall Meeting
16 - 19 September - Warsaw University of Technology - Poland

HPHT single crystal diamond substrate IIa type characterization for particle detectors

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In recent years, diamond detectors have been widely developed. Wide band gap (5.5 eV) and high resistivity (up to 10^{14} Ω·cm) together with high transport parameters of non-equilibrium current carrier give possibility for such detectors to be used up to a temperature – 300 °C with no serious change in their characteristics.

The paper presents the results of HPHT single-crystal diamond substrates IIa type characterization for particle detectors. The used diamond substrates [(100), with size 4 × 4 mm and with thickness 0.5 mm] were produced by company "New Diamond Technology". The diamond substrates were investigated by X-ray diffraction, Fourier transform infrared spectroscopy and by atomic force microscopy. It has been shown that substrates have significant crystalline perfection. No crystallites inclusions with a different orientation were detected. At rocking curves measuring, no physical broadening was detected. The dislocation density in the current substrates is at a level below of the method sensitivity < 10^3 cm^{-2}. The nitrogen and boron concentrations in the substrates were estimated at 10 and 50 ppb, correspondently.

To create a test detector, contacts (3.5 × 3.5 mm^2) based on Pt (thickness – 150 Å) were applied to both substrate sides. Deposition was made through a metal mask using ion-plasma sputtering. At a next step, the charge transport properties were investigated by alpha spectrometry method. For this, the dependence of the charge collection efficiency versus bias voltage under irradiation with α-particles (5.499 MeV) from ^{238}Pu and different polarities of the bias voltage on the detector was measured. The obtained results were correlated with the deep centers parameters investigation by the DLTS method.

This work received financial support from the Ministry of Education and Science of the Russian Federation (Subsidy Grant Agreement no. 075-02-2018-210 dated November 26, 2018, unique identifier of the agreement RFMEFI57818X0266).