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SiC NUCLEAR RADIATION DETECTORS BASED ON 4H-SiC EPITAXIAL LAYER

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Very perspective material for fabrication radiation-tolerant electronics, high-temperature electronics as well as for nuclear radiation detectors of ionizing radiation for working in harsh environments is silicon carbide (SiC). Mainly, 4H-SiC polytype is mostly investigated for its physical properties, e.g.: the band gap energy is 3.26 eV, the mean energy of electron-hole pair creation is 7.78 eV, the electron saturation drift velocity is 2x107 cm/s and the breakdown voltage is 2x106 V/cm at room temperature. Detectors based on high quality epitaxial layer of 4H-SiC show a high radiation hardness [1] and good spectroscopic resolution at room and also at elevated temperatures (>300℃) [2].
Our detector structures [3] were prepared on a 25 µm or 50 µm thick nitrogen-doped 4HSiC layer (donor doping ˜ l x 1014 cm-3) grown by the liquid phase epitaxy on a 4" SiC wafer (donor doping ˜ 2 x 1018 cm-3, thickness 350 µm). Circular Schottky contact (diameter 3.0 mm) to 4H-SiC layer (Ni/Au with thicknesses 10/30 nm) was formed through a contact metal mask, while full area contact (Ti/Pt/Au with thicknesses 10/30/90 nm) was evaporated on the other side (substrate).
Electrical characteristic of prepared SiC detectors were measured using Keithley measuring complex, which consisted of 4200A-SCS Parameter Analyzer, 2657A High Power System and CVIV Multi-Switch. Current-voltage (I-V) and capacity-voltage (C-V) measurements were performed up to 300 V. The reverse breakdown voltage exceeded 300 V and the reverse current was below 10 pA. The forward parts of the I-V curves were analysed on the basis of the thermionic emission theory. The barrier height, the ideality factor and the series resistance of 4H-SiC Schottky detector diodes were determined. From C-V measurements the depletion thickness and doping concentration profile were calculated. Spectroscopic parameters were measured with alpha sources 226Ra and 238Pu and FWHM of SiC detectors varied round of 20 keV for 5.5 MeV α-particles energy.
SiC detectors were used in experiments at the IC-100 cyclotron of the Joint Institute for Nuclear Research in Dubna. We studied the degradation of our detectors under impact of the high-energetic beam of heavy ions of Xenon, as well as the effect, which is known in the literature as Pulse Height Defect [4]. High radiation resistance and their good energy resolution allow to use these SiC detectors for long-term monitoring of heavy ion beams.

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