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SiC Nuclear Radiation Detectors for Detection of Heavy Ions

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In the last decade, silicon carbide (SiC) has obtained increasing interest in the field of radiation detectors due to achievement of a high purity level in the crystal structure and considerable thickness (> 100 μm) in the epitaxial layer. SiC is 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. SiC is mostly investigated for its physical properties, e.g.: the band gap energy of the polytype 4H-SiC 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, good spectroscopic resolution and can operated at room and also at elevated temperatures (˜300℃) [1,2].
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 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. 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 effect, which is known in the literature as Pulse Height Defect [4], as well as the degradation of these detectors under impact of the high-energetic beam of heavy ions of Xenon. Prepared SiC detectors shown good energy resolution and high radiation resistance and can be used for long-term monitoring of heavy ion beams.

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