

## SiC Nuclear Radiation Detectors for Detection of Heavy Ions

Friday 24 September 2021 17:45 (5 minutes)

L. Hrubčín<sup>1,2,a</sup>, B. Zat'ko<sup>1</sup>, Yu.B. Gurov<sup>2,3</sup>,  
P. Boháček<sup>1</sup>, S.V. Rozov<sup>2</sup>, V.A. Skuratov<sup>2</sup>

<sup>1</sup>Institute of Electrical Engineering, Slovak Academy of Sciences, Bratislava, Slovakia;

<sup>2</sup>Joint Institute for Nuclear Research, Dubna, Russia;

<sup>3</sup>National Research Nuclear University (MEPhI), Moscow, Russia

a)Corresponding author: ladislav.hrubcin@savba.sk

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 ( $> 100 \mu\text{m}$ ) 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  $2 \times 10^7$  cm/s and the breakdown voltage is  $2 \times 10^6$  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 ( $\sim 300^\circ\text{C}$ ) [1,2].

Our detector structures [3] were prepared on a  $25 \mu\text{m}$  or  $50 \mu\text{m}$  thick nitrogen-doped 4HSiC layer (donor doping  $\sim 1 \times 10^{14} \text{ cm}^{-3}$ ) grown by the liquid phase epitaxy on a 4" SiC wafer (donor doping  $\sim 2 \times 10^{18} \text{ cm}^{-3}$ , thickness  $350 \mu\text{m}$ ). 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  $^{226}\text{Ra}$  and  $^{238}\text{Pu}$  and FWHM of SiC detectors varied round of 20 keV for 5.5 MeV  $\alpha$ -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.

1. F.H. Ruddy and J.G. Seidel, NIM in Phys. Res. B 263, 163 (2007).
2. D. Puglisi and G. Bertuccio, Micromachines 10, 835 (2019).
3. B. Zat'ko et al., Applied Surface Science 536, 147801 (2020).
4. B.D. Wilkins et al., Nucl. Instrum. & Meth. 92, 381 (1971).

**Authors:** Dr ZAT'KO, Bohumir (Institute of Electrical Engineering, Slovak Academy of Sciences); Dr HRUBČÍN, Ladislav (Institute of Electrical Engineering, Slovak Academy of Sciences / JINR); Dr BOHÁČEK, Pavol (Institute of Electrical Engineering, Slovak Academy of Sciences); Dr ROZOV, Sergej (Joint Institute for Nuclear Research); Prof. SKURATOV, Vladimir (Joint Institute for Nuclear Research); Prof. GUROV, Yuriy (National Research Nuclear University (MEPhI) / JINR)

**Presenters:** Dr HRUBČÍN, Ladislav (Institute of Electrical Engineering, Slovak Academy of Sciences / JINR); Prof. GUROV, Yuriy (National Research Nuclear University (MEPhI) / JINR)

**Session Classification:** Poster session

**Track Classification:** Section 3. Modern nuclear physics methods and technologies.