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From single silicon carbide detector to pixelated structure for radiation imaging camera

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Silicon carbide belongs to wide band gap semiconductor materials. The 4H-SiC polytype is very perspective for radiation detector fabrication. Nowadays, the high-quality material of 4H-SiC is commercially available. The 4H-SiC has the band gap energy of 3.23 eV at room temperature, breakdown voltage of 3-5×10E6 Vcm-1, carriers saturation velocity of 2×10E7 cms-1 and excellent physical and chemical stability. A large band gap energy is advantageous for low leakage current and high radiation tolerance. In our previous works we studied electrical and also spectrometric performance of fabricated SiC detectors [1, 2]. We observed high energy resolution for X-rays and also for alpha-particle detection.

Today we are concentrated on preparation of pixelated structures based on 4H-SiC high-quality epitaxial layer. As a base material we used two wafers with different thickness of epitaxial layer 80 and 100 um. We prepared Ni pixelated Schottky contact on the one side and full area Ti/Pt/Au ohmic contact on the other side. The pixel pitch is 55 um and the structures are optimized for Timepix/Timepix3 readout chips. Motivation of this work is that detectors based 4H-SiC reach high energy resolution comparable to Si detectors, Schottky barrier structures have low current density (<100 pA/cm2), are stable up to 500 ℃ with reasonable leakage current, have higher radiation hardness in comparison to Si for more than two orders of magnitude according to our measurements, high reaction rate due to high electric field at operated bias. The drawback of SiC semiconductor material is low detection efficiency for X- and gamma-rays but comparable to Si detectors and its price. The main utilization of SiC detectors is perspective mainly in heavy ion detection and operation in harsh radiation environment and also at elevated temperatures.

[1] Zaťko, B., Hrubčín, L., Šagátová, et al., Applied Surface Sci 536 (2021) 147801.
[2[Osvald, J., Hrubčín, L., Zaťko, B., Mater. Sci. Semicond. Process. 140 (2022) 106413.

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