

Radiation sensors based on perspective semiconductor materials

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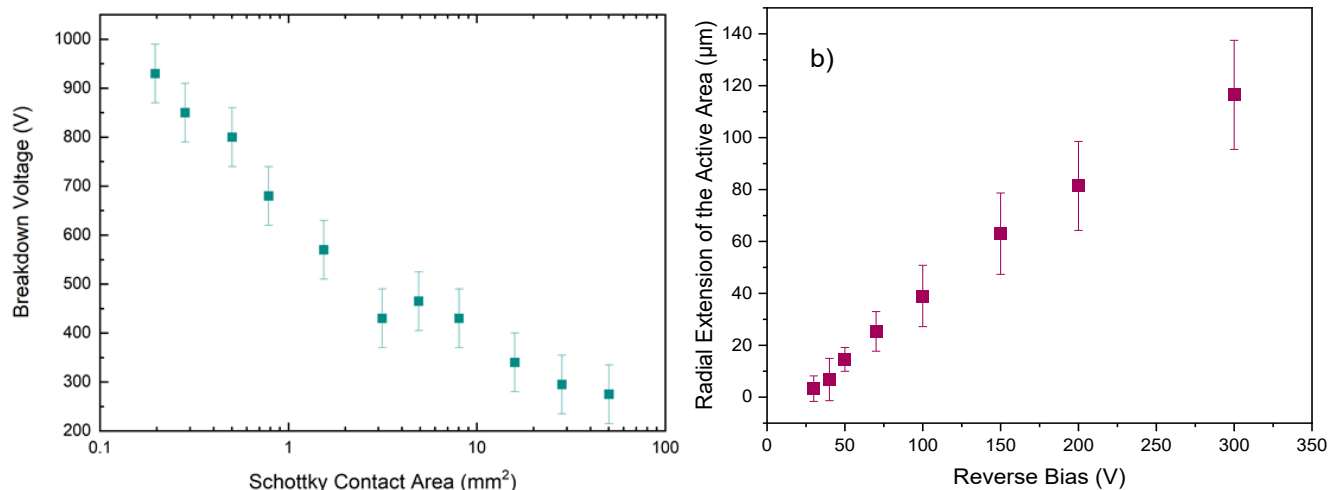
The development of radiation detectors based on gallium arsenide and silicon carbide is becoming more and more important for nuclear energy applications due to the extreme conditions in their environments. Compared to conventional silicon-based detectors, these materials offer superior properties, including higher radiation hardness, greater thermal stability for SiC and better γ -ray absorption for GaAs. These features make them ideal for long-term operation in nuclear-industry radiation monitoring systems, where reliability and efficiency are critical. Understanding the influence of design parameters, such as Schottky contact size, is essential for optimizing their performance in these demanding conditions.

In this study, semi-insulating GaAs (SI-GaAs) bulk and 4H-polytype SiC epitaxial radiation detectors with varying Schottky contact sizes were investigated to assess their electrical and spectroscopic performance. The Schottky contact sizes ranged from 0.1 to 1 mm for SI-GaAs detectors and from 2 to 3 mm for 4H-SiC detectors. Electrical properties were characterised using current-voltage (I-V) and capacitance-voltage (C-V) measurements, providing insights into leakage current, breakdown voltage, dopant concentration, and depletion region width. Additionally, alpha spectroscopy was performed to evaluate charge collection efficiency (CCE) and energy resolution, enabling a comprehensive comparison of the two material systems.

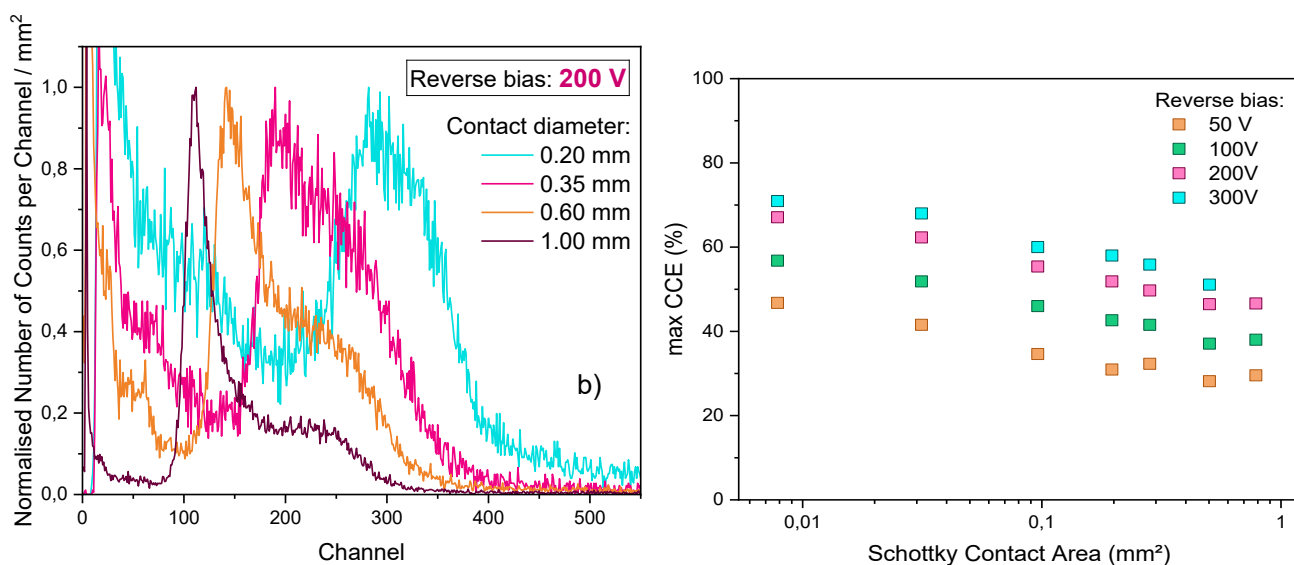
The results showed that in SI-GaAs detectors, decreasing the Schottky contact size led to lower leakage current, increased breakdown voltage, and improved CCE, while the energy resolution slightly deteriorated with smaller contacts. For 4H-SiC detectors, no significant influence of contact size was observed. Instead, these detectors were primarily affected by the thickness of the epitaxial layer, which plays a crucial role in their electrical and spectroscopic properties. These findings contribute to the development of advanced radiation detectors suitable for nuclear applications, ensuring enhanced reliability and efficiency in high-radiation environments.

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Dependence of breakdown voltage on the size of Schottky contact area for 350 µm SI GaAs detectors (left) and extension of the active region in 350 µm thick SI GaAs vs. reverse bias (right).



Representative α spectra of ^{241}Am measured at RT in vacuum using 350 µm SI GaAs detectors with various Schottky contact diameters measured at 200 V (left) and dependence of the maximum achieved charge collection efficiency (CCE) on the different Schottky contact area at various applied (right).