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Advanced 4H-SiC Solid-State Detectors: Electric Field Mapping and High-Temperature Neutron Irradiation Studies

Silicon carbide (SiC) detectors are emerging as promising candidates for high-performance radiation detection in extreme environments, thanks to their wide bandgap, high thermal stability, and radiation hardness. This contribution present a comprehensive study on the characterization and optimization of 4H-SiC p–n junction detectors through two complementary approaches: the Optical Beam Induced Current (OBIC) technique and high-temperature neutron irradiation analysis.
The first approch, OBIC, it investigated the internal electric field distribution in SiC bipolar diodes with varying epitaxial thicknesses (10 µm and 100 µm). The technique, based on UV laser excitation, enabled spatial mapping of the photo-generated current, revealing the influence of device architecture and reverse bias on electric field uniformity. TCAD simulations confirmed the experimental observations, highlighting the role of edge structures and metallization layers in shaping the field profile. The second evaluated the radiation response of 250 µm-thick 4H-SiC detectors subjected to 14 MeV DT neutron irradiation at 773 K. Electrical measurements (I–V, C–V) and deep-level transient spectroscopy (DLTS) revealed significant defect formation, which impacted carrier mobility, leakage current, and built-in voltage. Despite the degradation, the detectors maintained operational stability, confirming their suitability for neutron detection in fusion reactor environments.

Title

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Topic

Solid state sensors

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