Fabrication of an Implanted SiC Diode for Neutron Detection

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Abstract:

A basic neutron detector can be constructed using a reverse-biased neutron-sensitive diode, coupled with auxiliary readout circuitry. Generally, these particle sensitive diodes and readout electronics have been constructed with silicon. However, this group has been focusing on using Silicon Carbide (SiC) instead due to the increased temperature range, low dark current, and radiation hardness compared to traditional silicon. The SiC op-amps in the readout circuits have already been designed and are undergoing fabrication in collaboration with SUNY Polytechnic Institute. Currently, we are designing and planning to fabricate an implanted SiC diode for use in our neutron detection circuit. Initial simulations of the design show promising results with sub-picoampere of leakage current during standard reverse-bias operation with 10^{16} cm^{-3} doping. The student also plans on fabricating epitaxial diodes following the completion of the implanted diodes, due to the theoretically lower leakage current. The student is presently receiving training at The Ohio State University's cleanroom lab, Nanotech West, in preparation to fabricate these diodes. A large majority of the fabrication steps will be completed in-house at Nanotech West. Some process steps, such as aluminum implantation and implant activation, must be sent out due to the limits of the lab. Before fabrication, the process will first be carried out on a standard Si wafer to finalize and iron out the process steps. Finally, the diodes will be constructed on a 1200V SiC diode wafer, doped at $8*10^{15}$ cm^{-3}, followed by a 10kV, low doped wafer. After fabrication, the diodes will be integrated with the read-out circuitry following initial validation and characterization. Lastly, the entire system will be tested at Ohio State's reactor to verify the operation of the SiC neutron detector, which will be designed completely by OSU.