SiC Schottky Diode for Radiation Detection

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Goal: To design and fabricate an OSU Silicon Carbide (SiC) Neutron Detector, complete with a Neutron Sensitive SiC diode and readout circuitry

Motivation: As a Wide-BandGap (WBG) semiconductor, SiC has increased performance and reliability for neutron/radiation detection applications when compared to Si, such as:

- ♦ Higher critical electric field. ♦ Lower dark current. ♦ Higher operating temperature range.
- ♦ Higher radiation hardness, due to higher atomic displacement threshold energies.

$E_{g-Si} = 1.1eV \rightarrow E_{g-SiC} = 3.26eV$

Intrinsic carrier concentration: $n_i = \sqrt{N_C N_V} e^{-E_g/2kT}$

Leakage current remains negligible at high temperatures: $I_{leakage} \propto \frac{n_i}{\tau_g}$

Background: Basic semiconductor detectors are made from reverse-biased particle-sensitive diodes, coupled to fast and accurate readout circuitry.

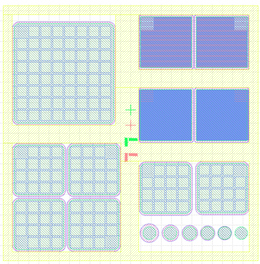
Present Work:.

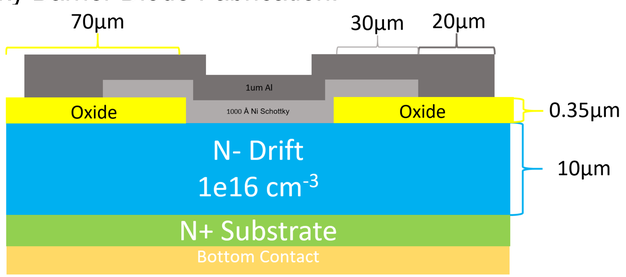
- ♦ SiC Schottky Barrier Diodes were designed and simulated using Silvaco Atlas device simulator.
- ♦ A custom mask was designed based on the simulated results, and the diodes were fabricated at Ohio State's cleanroom lab, Nanotech West (NTW) with a customized process flow.
- ♦ The electrical characteristics of the fabricated diodes were examined to determine their viability for use as radiation sensing devices, as shown below.
- ♦ A second run of devices with improved design and processes based on gained experience has begun.

Future Plans:

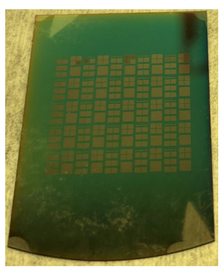
- ♦ Test the SiC diodes under different forms of radiation, such as alpha and neutron radiation.
- ♦ Complete fabrication and test of our second lot of SiC Schottky diodes, iterate and improve upon the design and process.
- ♦ Compare the performance between the epitaxial, implanted, and Schottky barrier diodes.
- ♦ Utilizing the SiC diodes, construct diode arrays to increase our detection area, and compare to single diode behavior. Different configurations will be attempted (common cathode/anode, etc.).

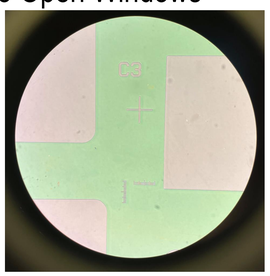
SiC Field Plated Schottky Barrier Diode Fabrication:



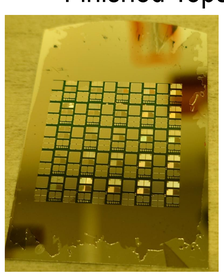


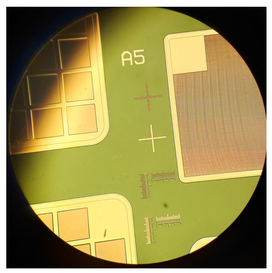
Oxide Etch to Open Windows

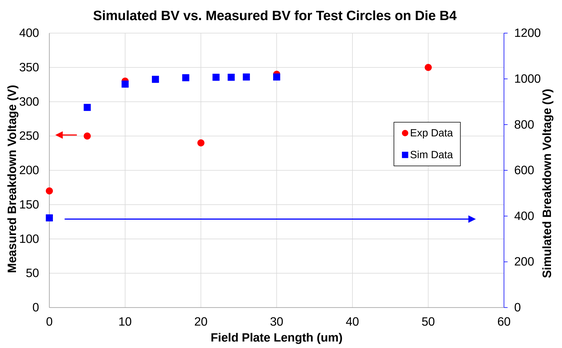




Finished Topside with Aluminum

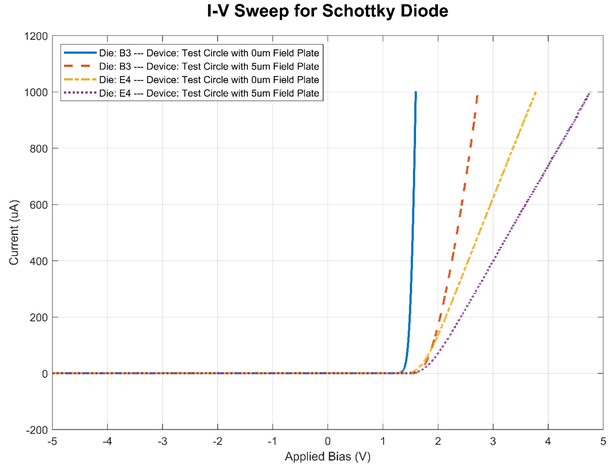


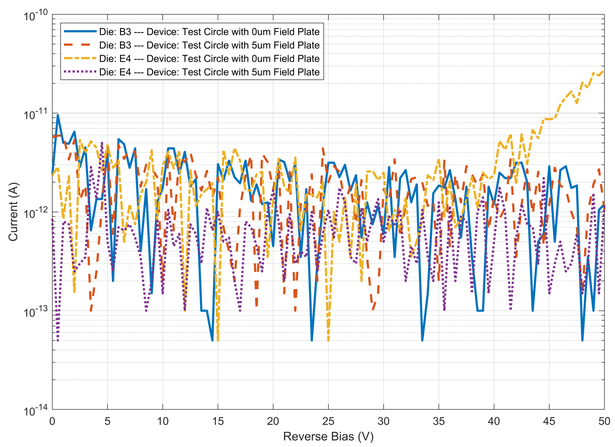


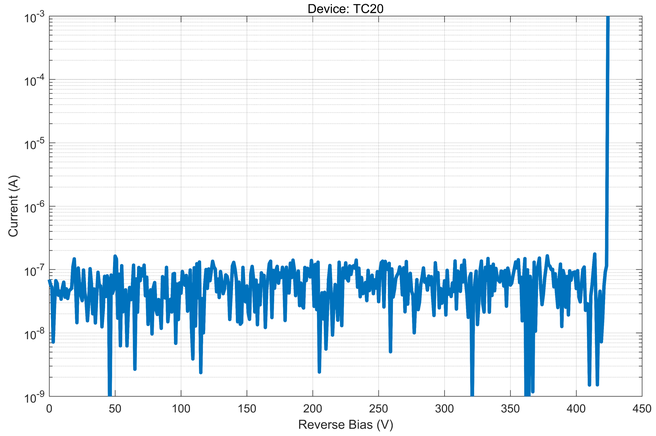


Custom 30 Step Process

Step	Tool	Description
1	Wet Bench	RCA Clean
2	Wet bench	BOE + DI rinse + Dry
3	CVD02	Deposit oxide across wafer
4	Wet bench	RCA Clean
5	TUB04	Densify Oxide
6	COT03/COT04/OVN03	(Cover front) Spin resist & bake
7	Wet Bench	Remove backside oxide
8	PVD03	Deposit Ni backside
9	Wet Bench	Strip PR on Frontside
10	RTA02	Anneal in Ar or N
11	COT03/COT04/OVN03	Spin resist & bake
12	MLA01	(Oxide mask) Apply mask
13	Wet Bench	BOE + DI rinse + Dry
14	ETC04	Etch windows in oxide 90%
15	Wet Bench	BOE remaining oxide 10%
16	Wet Bench	Strip PR
17	COT03/COT04/OVN03	Spin resist & bake
18	MLA01	(Ni mask) Apply mask
19	Wet Bench	BOE to prepare surface
20	PVD03	Nickel application
21	Wet Bench	Strip PR
22	RTA02	Anneal in forming gas
23	COT03/COT04/OVN03	(Al mask) Spin resist & bake
24	MLA01	Apply mask
25	EVP03/PVD03	Aluminum application
26	Wet Bench	Strip PR
27	COT03/COT04/OVN03	(Cover front) Spin resist & bake
28	ETC04/PVD03	Remove backside carbon
29	EVP03	Backside metal stack
30	Wet Bench	Strip PR frontside







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