

Docket #: S18-189

Low temperature, cost-effective process for manufacturing silicon radiation detectors

Researchers at the SLAC National Accelerator Laboratory have developed a cost-effective method for using low temperature microwave annealing to create diode termination contacts on silicon sensors. By eliminating the need for high temperatures, this process enables fabrication of important structures that could not otherwise be built. This includes shallow entrance windows for radiation detectors, thinned sensors for high energy particle physics (HEP), and post -processed backside for high resistivity CMOS sensors and CCD's. For example: in entrance windows, low temperature annealing avoids driving dopants deeper; for HEP sensors, diode arrays can be built on standard-thickness wafers which are thinned after the frontside is complete; and for CMOS image sensors, the backside can be annealed without damaging the frontside that is already fabricated. This technology could be used to manufacture sensors for detecting soft x-rays, optical light, UV light, low energy electrons or ions.

Stage of Research

The inventors have used this microwave annealing technique to build a prototype for the backside contact on planar sensor wafers. Bench measurement of the reverse bias diode currents show reasonable dark current and no junction breakdown up to 200V, comparable to junctions annealed by conventional techniques. The inventors have also validated the prototype sensor device by successfully measuring an Fe-55 x-ray spectrum.

Applications

- **Semiconductor sensor processing and manufacturing** - microwave annealing for diode termination contacts with end user applications such as:

- shallow entrance windows for radiation imaging sensors/detectors (soft x-rays, optical light, UV light, low energy electrons and ions)
- thinned sensors (100um) with high radiation hardness for high energy particle physics
- post-processed entrances for CCDs or CMOS image sensors for scientific imaging with x-rays and gamma rays

Advantages

- **Low temperature, backside process:**
 - allows features to be annealed to the backside of a wafer substrate without damaging structures already fabricated on the frontside
 - in shallow entrance window applications, does not drive dopant deeper
- **Cost-effective** - microwave annealing is less expensive than molecular beam epitaxy or laser annealing (for shallow entrance windows) or silicon-on-insulators (for thinned sensors)
- Compatible with **high throughput fabrication**

Patents

- Issued: [11,295,962 \(USA\)](#)

Innovators

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