

SES07-2007-020007

Abstract for an Invited Paper
for the SES07 Meeting of
the American Physical Society

Detector Development in the Kansas State University SMART Laboratory

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Novel radiation detectors are under investigation in the Semiconductor Materials and Radiological Technologies (SMART) Laboratory at Kansas State University. These detectors include CdZnTe Frisch ring high-resolution gamma ray spectrometers and reactive ion etched perforated Si-based neutron detectors. The CdZnTe Frisch ring detectors consist of parallelepiped semiconductor bars configured in a simple planar detector configuration. They are transformed into high-resolution devices by coating them with an insulating material followed by a conducting material. Room temperature energy resolution for 662 keV gamma rays approaching 1.0% FWHM has been achieved with the simple configuration. In addition, perforated semiconductor diode detectors have been under development for several years at Kansas State University for a variety of neutron detection applications. The fundamental device configuration is a pin diode detector fabricated from high-purity float zone refined Si wafers. Perforations are etched into the diode surface with inductively-coupled plasma (ICP) reactive ion etching (RIE) and backfilled with ^6LiF neutron reactive material. The perforation shapes and depths can be optimized to yield a flat response to neutrons over a wide variation of angles. The highest efficiency devices thus far have delivered over 12% thermal neutron detection efficiency. The miniature devices are 5.6 mm in diameter and require minimal power to operate, ranging from 3.3 volts to 15 volts, depending upon the amplifying electronics. The battery operated devices have been incorporated into compact modules with a digital readout. Further, the new modules have wireless readout technology and can be monitored remotely. The neutron detection modules can be used for neutron dosimetry and neutron monitoring. When coupled with high-density polyethylene, the detectors can be used to measure fission neutrons from spontaneous fission sources. Measurements with a ^{252}Cf source have been conducted for verification. Efforts are now underway to incorporate the high-resolution Frisch ring devices into the compact packages in order to make wireless neutron counter/gamma ray spectrometer units for remote radiation sensing.