Thin Film CdS/CdTe Diodes for Nuclear Radiation Detection
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Abstract
In this study we have investigated thin film, polycrystalline CdS/CdTe PN diodes as solid state charged particle detectors. Solid state neutron detectors rely on the indirect detection of neutrons via a nuclear reaction, which produces charged particles detected by a semiconductor diode. The CdS/CdTe diodes were evaluated in terms of their sensitivity to alpha and gamma radiation when connected to a charge sensitive preamplifier. The devices were found to have an alpha particle counting efficiency of > 90%. The pulse height response of these diodes due to alpha radiation is found to be a function of applied bias, angle of incidence, and energy of the incident alpha particles. Preliminary gamma sensitivity measurements indicate an intrinsic gamma detection efficiency of less than 1x10^6. The CdS/CdTe results were calibrated using a 1 cm² Ortec ULTRA silicon PIN detector and were also compared to data collected from silicon detectors fabricated at UT Dallas. The CdS/CdTe devices offer the possibility of large area neutron detectors with high gamma rejection rates and affordable production costs.

Results
Counting and Gamma Detection Efficiency
Assuming both the counting and the charge collection efficiency of the Ortec Si diode to be 100%, the intrinsic alpha particle counting efficiencies were calculated to be 94% for the 0.002cm² diode and 99% for the 0.1cm² diode. A gamma detection efficiency of 0.5x10^6 was based on data revealing zero pulses registered above 220keV and calculations showing 2x10^6 gamma rays were incident on the device.

![Image of counting and gamma detection efficiency](image_url)

Minimizing Noise
To reduce the internal noise, plastic based masks were placed over two 500μm diameter CdS/CdTe PN and Si PIN diodes to restrict the area where the alpha particles were incident on the devices.

![Image of minimizing noise](image_url)

Pulse Amplitude Characteristics
The average pulse height varied depending on bias and conditions applied to the source. The amplitude increased with reverse bias, increased when a moderator was applied, and decreased as the angle of incidence approached the normal.

![Image of pulse amplitude characteristics](image_url)

Conclusion
• We have demonstrated that CdS/CdTe diodes can function as charged particle detectors.
• The intrinsic detection efficiency of 661 keV gamma rays was measured to be less than 1x10^6 and is expected to be much lower [1].
• We believe these devices offer the possibility of fabricating large-area, low-cost thermal neutron detectors by utilizing current, well developed CdS/CdTe diodes [2].

References

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