NASA SBIR/STTR Technologies

S1.09-9261 - Next Generation Gamma/Neutron Detectors for Planetary Science.

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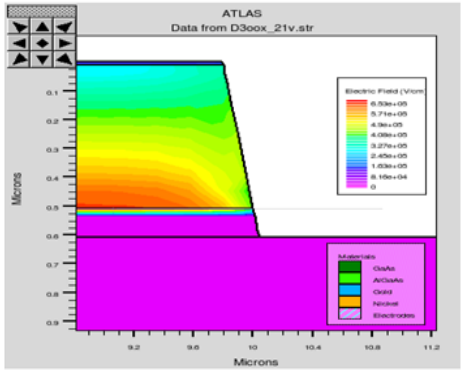
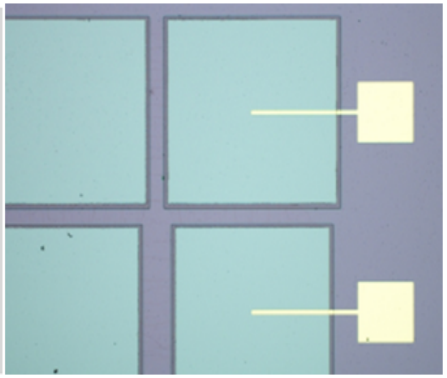
Identification and Significance of Innovation

Gamma-ray and neutron spectroscopy are well established techniques for determining the chemical composition of planetary surfaces, atmospheres, and small cosmic bodies such as asteroids and comets. We propose to develop gamma-ray and neutron detectors based on wide-band-gap (WBG) solid-state photomultipliers (SSPM) coupled to emerging scintillation materials for gamma and neutron spectroscopic studies of small cosmic bodies. The WBG SSPM is based on Aluminum Gallium Arsenide (AlGaAs) exhibits at least 10x lower dark noise, improved radiation hardness, and excellent energy resolution compared to Si-SSPM detectors. The aluminum concentration can be tailored to optically match the emission spectrum of emerging scintillation materials such as CLYC and CeBr3, which provide gamma/neutron detection/discrimination, and high light yield, respectively. These complimentary advantages are an ideal pair for this project.



Phase-1 demonstrated the feasibility of AlGaAs GPD designs with both mesa and planar guard-ring structures



Phase-1 demonstrated a recipe for fabricating AlGaAs devices and fabricated AlGaAs test diodes using preliminary recipe

Estimated TRL at beginning and end of contract: (Begin: 1 End: 3)

Technical Objectives and Work Plan

Technical Objectives:
1) Optimize process recipe for AlGaAs Geiger Photodiode (GPD) and SSPM fabrication;
2) Provide an AlGaAs GPD with high sensitivity in blue/UV range;
3) Provide an AlGaAs SSPM prototype;
4) Provide a detector prototype using advanced scintillation materials.

To be completed by conducting studies on the fabrication of the Geiger photodiode on an AlGaAs substrate to ensure a reliable and reproducible high-performance diode. The diode will be optimized by reducing the dark current and improving the quantum efficiency. In addition, studies on the scintillation materials will provide specifications for optimizing detector systems for space flight.

Work Plan Summary:

Year 1
a) Establish process recipe for fabrication of Geiger photodiodes in AlGaAs;
b) Evaluation of Geiger photodiodes for further device optimization;
c) Characterization of state-of-the-art scintillators for space science studies;

Year 2
a) Development of solid-state photomultipliers using an AlGaAs epitaxy;
b) Testing of the photodetector for further optimization, performance and radiation hardness;
c) Commercialization

NASA Applications

The proposed innovative technology is a suitable component for many future gamma-ray and neutron spectrometer instruments to study chemical composition of cosmic objects and planetary surfaces. The nominal NASA application for this technology will be for a gamma-ray and neutron spectrometer. The complete spectrometer can be used for Earth science missions, planetary missions, exploration of small cosmic bodies such as asteroids and comets, satellite radio-imaging, and space exploration probes.

Non-NASA Applications

The development of the new detectors has a myriad of applications in the science, homeland security, and medical fields. The AlGaAs SSPM, with low thermal noise and radiation hardness, is a direct replacement for photomultiplier tubes. The instrument can also be used for dosimeters for radiation therapy and detectors in medical imaging applications such as PET & SPECT.

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NON-PROPRIETARY DATA