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BETWEEN
BROOKHAVEN SCIENCE ASSOCIATES
AND
RADIATION MONITORING DEVICES

Project Entitled: Development of Field-Portable CdZnTe (CZT) Radiation Detectors to Monitor and Localize Special Nuclear Materials

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CRADA Final Report for IPP BNL-T2-183 (CRADA C-02-11)

“Development of Field-Portable CdZnTe (CZT) Radiation Detectors to Monitor and Localize Special Nuclear Materials Inclusion-free Stoichiometric Cadmium-Zinc Telluride for Nuclear Detector Applications”**1. Introduction**

For nearly 40 years, CdTe and later CZT have been the room temperature detector of choice for critical applications where traditional scintillators were inadequate and the cost and cooling requirements of germanium were prohibitive.

This situation has not changed.

At the low end of performance, the detector needs of the vast majority of commercial applications are satisfied with the very low cost scintillators, NaI(Tl) and CsI(Tl). Prices can be as low as a few dollars per cubic centimeter and in sizes up to thousands of cubic centimeters. The availability of these materials stifles the market driven incentive to develop more cost effective production techniques for semiconductor detector materials. Thus, it is unlikely that any semiconductor will replace these materials in the foreseeable future.

2. Work performed and Important Results

At the very high performance end, cryogenically cooled germanium detectors provide unparalleled performance. This performance comes with a high cost and the need for cryogenic cooling which limits the suitability of germanium detectors in many applications.

Research and development on new detector materials is an extremely active field with significant advances in both scintillator and semiconductor materials. The fundamental situation, however, has not changed significantly.

The advent of new scintillator materials such as LaBr₃ and CeBr₃ have led to an improvement in energy resolution that is opening some of the traditional markets of CZT and CdTe to scintillator based detectors. This has the unfortunate effect of further decreasing the market incentive for developing cost effective semiconductor detectors.

While these materials are very promising, they do not completely close the gap between scintillators and germanium. Certain applications, which are critical to national security, require achieving very high-energy resolution because where better energy resolution means the difference between interdicting a nuclear or radiological source and missing it. Germanium detectors have not been able to fill this gap.

In such applications, CZT and CdTe are still the detector materials of choice, but are severely limited by availability and price. The situation is more urgent now than it has ever been. New developments in detector configuration and readout have pushed the

limits of CZT to larger sizes and better performance, increasing its capabilities and placing even high demands on availability. In parallel to this the number of suppliers of CZT and CdTe have decreased.

The high cost of CdTe and CZT are driven primarily by low yield. Increasing the yield requires research and development. Because the commercial incentive to develop high yields of large crystals of very high quality CZT and CdTe is insufficient to support such development, and because the requirements of homeland security is so critical, it falls on the government to support this development.

The government is, indeed, supporting a number of significant programs to push semiconductor detector technology. However, the development specifically of cost effective processes to produce high yield CZT and CdTe is falling behind other developments. Enlisting former Soviet Union laboratories to support such development can be a very cost effective means of developing new techniques.

3. Marketing

At RMD, we use CdTe in our commercial products. The capabilities of these products are partly limited by the small size of economical CdTe crystals. A technology that would allow larger crystals to be produced at a lower cost would allow us to improve several of our products, providing us with a competitive advantage and hopefully leading to increased market share.

At RMD, we also have an active research program to produce CZT crystals with a higher yield, but the program is relatively small and would have to be significantly increased to have a near-term impact.

4. Summary

The communication between all of the laboratories should be increased and regular email/discussion schedule set up. There should be more joint discussion on potential experiments and more technical input from BNL and RMD. For example, alternative crystal growth processes should be considered, in particular THM, if available at the lab.