Cadmium Zinc Telluride Crystal Growth
for
Ambient Temperature Radiation Detectors

Center for Materials Research
Washington State University

Cadmium Zinc Telluride is an excellent candidate for room temperature radiation detection. It has a number of important properties, including a large atomic number, good carrier mobilities, and a large band gap. Large atomic number gives the material excellent stopping power for high efficiencies, high carrier mobilities for quick response and a large band gap for room temperature operation. These properties will revolutionize radiation detection field for homeland security and medical imaging. It will allow for smaller, more efficient devices at a cheaper cost.

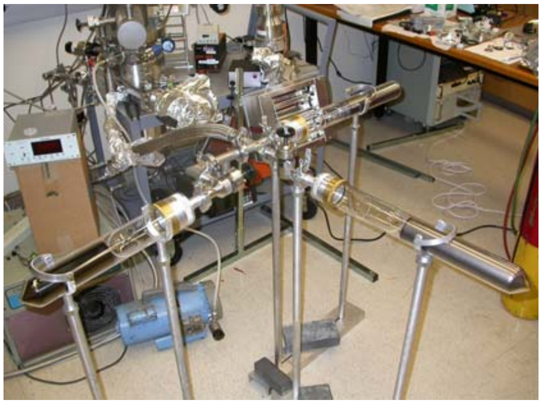
Cadmium Zinc Telluride (CZT) Ingot

Cadmium Zinc Telluride (CZT) Growth is carried out in an Electro-Dynamic Gradient Freeze (EDG) 43-Zone Quadrant Sunfire Furnace. The EDG is a modified Bridgman furnace, capable of vertical or horizontal growths, and can operate continuously at temperatures up to 1300°C.

The temperature gradient can be programmed to traverse the length of the furnace bore without movement of the furnace or the working charge. Each zone of the furnace is separately controlled to ±0.1°C throughout the process.

To improve the temperature control within the furnace chamber, an 8-inch section is configured with 32 controlled quadrant zones. Each one of them has an individual heater to optimize the circumferential and radial temperature within these zones.

The Center for Materials Research (CMR) Crystal Growth and Characterization of CZT as a Radiation Detector process has been performed in the following way:



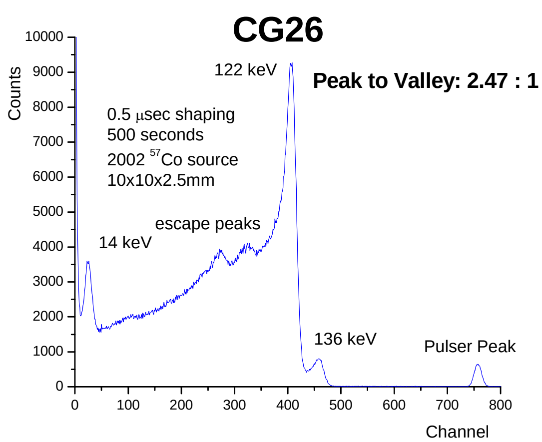
- Preparation of raw high purity CZT charge and dopants under clean room conditions; loading and sealing of the quartz ampoule in a high vacuum system.

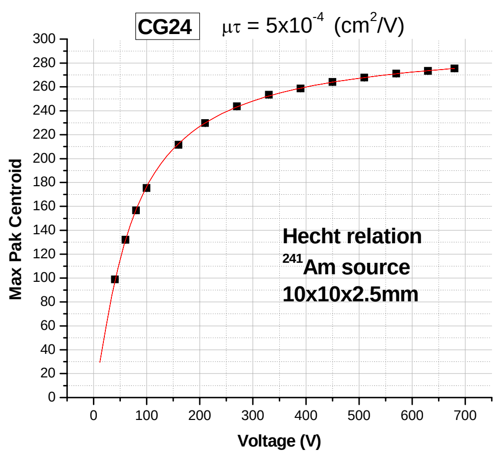
- Furnace temperature profiling which produces well defined crystal growth conditions and crystal growth runs.

- Ingot removal, CZT sample preparation to produce spectroscopic grade radiation detectors.

- Material characterization: thermally stimulated spectroscopy (TEES and TSC), Hall Effect measurements, deep level transient spectroscopy (DLTS), positron annihilation spectroscopy (PAS), I-V characteristics, infrared microscopy, optical spectroscopy, photoluminescence, glow discharge mass spectroscopy (GDMS), alpha and gamma spectroscopy.

Radiation spectroscopy is preformed on many of the samples prepared at WSU. A multi-channel analyzer (MCA) measures the response to ionizing radiation produced by the CZT detector. ^{241}Am, ^{57}Co, and ^{137}Cs isotopes are tested and recorded. Samples resolution and efficiency are measured. By using the Hecht relation the $\mu\tau$ values can also be measured and recorded.





Researchers at WSU have grown compensated and uncompensated CZT with less than 400 ppb atomic total impurities. Among universities, WSU has produced the best radiation detector material for CZT, and all growth and most characterization is performed at WSU. We have grown crystals with purity rivaling laser crystal and commercially available scintillators.