

Title: Development of Low-cost, High Resolution, Single Crystal CsPbBr₃ Radiation Detectors

Abstract:

The development of room temperature radiation detecting materials is necessary for the fields of homeland security, nuclear imaging, and industrial detection. Candidate materials require good chemical and thermal stabilities, while exhibiting a set of desirable optoelectronic properties. The all-inorganic perovskite CsPbBr₃ has been a strong candidate for new room temperature radiation detecting single crystal materials. With a high stopping power, a large bandgap, and a high $\mu\tau$ product for both holes and electrons, CsPbBr₃ contains all the properties required of a room temperature detector. Unfortunately, the development of high-quality crystal samples requires purification and sublimation of reagents across multiple reaction vessels, prior to crystal growth.

We have developed a modified zone refining method that allows for simultaneous crystal growth and purification. Here, we report the development of high quality, detector grade CsPbBr₃ single crystals from low-cost, solution synthesized materials. Crystal ingots of up to 240 g have been grown from this method. Ingots have high purity (2.34 ppm across 73 elements), shown from powder x-ray diffraction and glow discharge mass spectrometry. Devices made from crystal wafers exhibit resistivities up to $2.0 \times 10^8 \Omega$, and high photocurrent responses. Samples are able to detect α -particle radiation and produce a pulse height spectrum with an estimated $\mu\tau_H$ of $1.45 \times 10^{-3} \text{ cm}^2/\text{V}$.