2026-11-03

Ph.D. Departmental Seminar

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Friday, November 27th, 2026

Chernoff Hall, Room 117

Zone Refining-Assisted Purification and Bridgman Growth of $CsPbBr_3$ Crystals for γ-ray Spectroscopy

$CsPbBr_3$ has emerged as a pivotal semiconductor material for room-temperature radiation detection across various radioactive sources and a broad energy range. In this study, we expand the investigation of $CsPbBr_3$ production through an organic-free solution synthesis that achieves an 89% yield from 2N-purity precursors. $CsPbBr_3$ crystals were produced by a two-stage growth strategy combining zone refining and Bridgman growth. Zone refining was employed as a preliminary purification step, and a purified segment was used as the charge for Bridgman growth. This approach yielded a high-purity, single-crystal $CsPbBr_3$ bulk measuring ∅22 × 55 mm, with a mass of 92 g. X-ray diffraction confirmed phase purity and high crystallinity. Inductively coupled plasma mass spectrometry (ICP-MS) tracked impurities throughout the process, with a final impurity level of 166 ppm in the middle section of the Bridgman-grown boule. Current-voltage measurements of the detector with an asymmetric AuIn/$CsPbBr_3$/Au configuration revealed a high bulk resistivity of 5.7×10^9 Ω·cm and a dark current of 62 nA at 50 V, while time-dependent photosensitivity measurements delivered an SNR of 85 at the same bias. The detector resolved gamma peaks from calibration sources of ^{241}Am and ^{57}Co, achieving energy resolutions (FWHM) of 8.9% at 59.5 keV and 8.0% at 122 keV.

These findings highlight the effectiveness of our sequential purification process as an adaptable and cost-effective route to convert low-purity reagents into high-purity $CsPbBr_3$ crystals for gamma-ray spectroscopy, while providing a strong basis for further refinement of the purification and growth processes to improve material properties and detector performance.