$CsCu_2I_3$ Single Crystals via Bridgman Technique for Scintillator Applications

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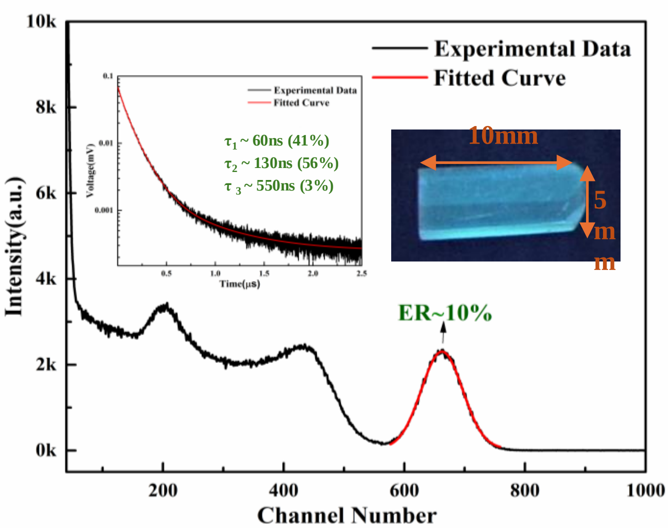
Copper-based metal halide perovskites have attracted considerable attention due to their reduced toxicity compared to lead-based perovskites, while still maintaining excellent optical properties that enable emerging optoelectronic and radiation detection applications[1,2].Among them, $CsCu_2I_3$ is a promising material for scintillation-based γ-ray and X-ray detection owing to its relatively high density (5.01 g/cm³) and high effective atomic number (Z_{eff} ≈ 51.9). In this work, the Bridgman growth of $CsCu_2I_3$ single crystals and their scintillation properties are presented.



Pulse height spectra of processed crystal under ^{137}Cs γ-ray irradiation and inset shows the scintillation decay curve under ^{60}Co γ-ray source & as-grown $CsCu_2I_3$ single crystal.

According to the phase diagram, $CsCu_2I_3$ is a congruently melting compound, making it suitable for melt-based single-crystal growth [3]. Single crystals were grown using the vertical Bridgman technique in a cylindrical 13mm Φ OH-free quartz crucible equipped with a grain selector. Prior to crystal growth, phase-pure starting material was synthesized by solid-state reaction of stoichiometric amounts of CsI and CuI. The synthesized charge was loaded into the crucible, which was then placed in the Bridgman furnace. A temperature gradient of approximately 20 °C/cm and a slow translation rate of 0.5 mm/h were employed during growth. After completion of the growth process, the furnace was cooled at a rate of 5°C/h**.** Transparent samples were prepared by cutting and polishing the as-grown crystal for optical and scintillation measurements. A $CsCu_2I_3$ single crystal with dimensions of approximately 30 mm × 13 mm was obtained.

During crystal growth and post-growth processing, several challenges were encountered. In particular, cracking during the cooling stage was observed, indicating that the material is sensitive to thermal stress. Despite these challenges, scintillation characterization demonstrated promising performance. Pulse-height spectra measured with ^{137}Cs γ-ray excitation yielded an energy resolution of approximately 10% at 662 keV. Furthermore, scintillation decay measurements under ^{60}Co excitation revealed a tri-exponential decay behavior, with fast and slow components of about 60 ns, 130 ns and 550 ns, respectively. The successful melt growth of $CsCu_2I_3$ single crystals demonstrates the feasibility of producing high-quality bulk crystals, which are essential for practical scintillator applications.

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3. Wojakowska, Alina, et al. "Phase diagram of the system copper (I) iodide+ cesium iodide." *Journal of Chemical & Engineering Data* 48.3 (2003): 468-471.

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