Synthesis and Growth of Bulk Cs_2TeX_6 (X = Cl, Br) Crystals for Various Scintillation Applications

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Emerging scintillator materials, like the anti-fluorite-type A_2BX_6 compounds (A = monovalent cation, B = tetravalent cation, and X = halide), have gained rapid interest in optoelectronic and scintillation applications. The materials' compositionally versatile $[BX_6]^{2-}$ octahedra allow for tunable optoelectronic properties by altering the metal-halide bonding. Furthermore, the ability to incorporate tellurium, including the neutrinoless double beta decay ($0\nu\beta\beta$) candidate isotope ^{130}Te, motivates the development of bulk Cs_2TeX_6 (X = Cl, Br) single crystals as potential scintillating bolometers, which can simultaneously detect heat and light to improve background rejection, resulting in enhanced experimental sensitivity.

This seminar will present the development of a highly reproducible, high-yielding solution synthesis method for synthesizing Cs_2TeX_6 (X = Cl, Br) powder using inexpensive, low-purity TeO_2 and Cs_2CO_3, followed by the first reported bulk single-crystal growth using the Bridgman-Stockbarger method. Cs_2TeBr_6 crystals were grown up to ∅8 × 45 mm, and Cs_2TeCl_6 crystals were grown up to ∅21 × 70 mm with excellent phase purity. Elemental impurities were tracked throughout the production process by inductively coupled plasma mass spectrometry. Single-crystal X-ray diffraction, photoluminescence (PL), and Raman spectroscopy provided insights into the lattice dynamics and luminescence properties. Furthermore, Cs_2TeCl_6 scintillation measurements with a silicon photomultiplier show an improved full-width at half-maximum energy resolution from 38% at room temperature to 18% at 91 K for the ^{137}Cs 662 keV photopeak. Moreover, future cryogenic bolometer measurements of Cs_2TeCl_6 crystals will evaluate these materials' potential as scintillating bolometers at ~10 mK.

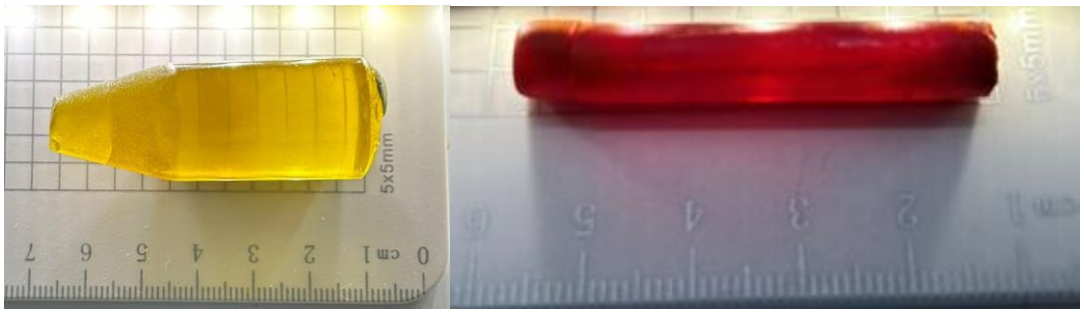


Figure 1. *Grown single crystals of Cs_2TeCl_6 (left) and Cs_2TeBr_6 (right).*