

Growth and Performance Progress of Dual Detection Mode Tl-based Elpasolite Scintillators with Single and Dual Dopants

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Elpasolites, which is a double perovskite crystal structure, usually consist of four or more atomic constituents. A variety of unique crystal and physical properties are conceivable due to different combinations of the atomic constituents. One of such properties is the incorporation of neutron sensitive materials such as lithium to create a neutron detecting crystal. Dual mode gamma neutron elpasolites scintillators have been in development for more than twenty years. One of the latest novel compositions, ⁶LiCl enriched cerium doped Tl₂LiYCl₆ or TLYC, has recently been grown up to 2-inch in diameter by the vertical Bridgman method at Fisk University. TLYC is the Tl equivalent of Cs₂LiYCl₆:Ce or CLYC, however, the inclusion of Tl makes the physical density and effective atomic density of TLYC higher than CLYC. Phase issue that plagues CLYC crystal growth is also much less than a factor in TLYC. Consequently, the growth yield of TLYC (i.e., the percentage of usable crystal boule) is higher than CLYC.

Recently crystals of TLYC co-doped with Ce³⁺ and alkali metal ions have been grown and studied at Fisk. Because very rarely intrinsic compounds are reasonable scintillators, much attention is given to the types of dopants used on scintillators. In many cases a single dopant, such as Ce³⁺ in TLYC, is used and the performance is good for many detection and imaging applications. Sometimes, however, use a new dopant or co-dopants may create new opportunities due to improved scintillation properties. In this study, Mg²⁺, Ca²⁺, Sr²⁺, and Ba²⁺ are each used as co-dopants along with Ce³⁺ in TLYC.

In this presentation the progress of the TLYC scale-up crystal growth effort as well as the growth and characterization of co-doped TLYC is reported. Growth and corresponding scintillation characterization results, such as energy resolution, light yield, decay time, and non-proportionality, from 16-mm diameter to 2-inch diameter crystals will be summarized and compared. Measurements with both gamma-ray and neutron sources will be presented. Other relevant radiation detection characterizations will also be presented.

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