Low-Dimensional All-Inorganic Cu(I) Halide Single Crystals as Efficient X- and γ-ray Scintillators

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Recently, low dimensional perovskite-like metal halides for light emitting and scintillation applications have drawn tremendous attention due to their extremely high photoluminescence quantum yields (PLQYs) and large Stokes shift, among which ternary copper(I) halides are the most studied ones because of their excellent photophysical properties and decent stability. For instance, Tang reported the ultrahigh LY (~90,000 photons/MeV) of Rb_2CuBr_3 scintillators with an emission peak at 385 nm [1]. Other copper halide scintillators have also been investigated, such as Rb_2CuCl_3, $Cs_3Cu_2Cl_5$ and (TBA)CuX_2 (TBA = tetrabutylammonium cation; X = Cl, Br) in the forms of single or poly-crystals. However, one serious shortage for Rb_2CuBr_3 scintillator is that the Rb element shows high natural radioactivity, which may hinder its practical application in scintillator materials.

This work reports a series of high-performance cesium copper(I) halide scintillators with strong self-trapping exciton (STE) emissions, such as $Cs_3Cu_2I_5$, $CsCu_2I_3$, and $Cs_5Cu_3Cl_6I_2$ [2-4]. They show simultaneously high effective atomic number (Z_{eff}), non-hygroscopic, self-absorption free, low afterglow, high scintillation yield, and excellent energy resolution characteristics which is absolutely unique feature among scintillation materials. Moreover, after doping with Tl^+ and In^+, the X-ray and gamma-ray detection performance of $Cs_3Cu_2I_5$ was further improved thanks to the enhanced harvesting of charge carriers (and excitons) [5,6]. They show simultaneously high effective atomic number (Z_{eff}), non-hygroscopic, self-absorption free, low afterglow, high scintillation yield, and excellent energy resolution characteristics which is a unique feature among scintillation materials. Thus, they can serve as versatile scintillators covering a wide range of radiation energies for various applications incl. homeland security and medical imaging.

References

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