Study of the effect of plate thickness on spatial resolution in novel optical guiding crystal scintillator

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Scintillators, which convert radiation into visible light, are widely utilized in various fields, including medical diagnostics and non-destructive testing of industrial products. In X-ray imaging applications, achieving high resolution and sensitivity simultaneously is essential for obtaining clear images with short exposure times. However, conventional scintillator materials typically exhibit a trade-off relationship between resolution and sensitivity. To overcomes this issue, our research group previously proposed the use of structured scintillators, which can achieve both high resolution and high sensitivity. These are $GdAlO_3$/ α-Al_2O_3 eutectic composites utilizing total internal reflection [1, 2] and optical-guiding crystal scintillators (OCS) [3-5]. The OCS consists of a low-refractive-index glass cladding and a high-refractive-index scintillator core, where scintillation light is guided like optical fibers through total internal reflection. This configuration facilitates the concurrent attainment of high resolution and high sensitivity by refining the core diameter and increasing the plate thickness.

This study employed Tl-doped $Cs_3Cu_2I_5$ scintillators as the core material and fabricated OCS plates ranging from 200 μm to 800 μm thick. These OCS plates, with 1 and 4 μm core diameters and a 5 $\times$ 5 mm^2 active area, were successfully fabricated. X-ray transmission images of resolution test charts were acquired using these OCS plates, along with commercially available Tl:CsI whiskers. The contrast transfer function (CTF) was then calculated for each line width to assess spatial resolution. The fabricated OCS plates exhibited higher light yield and superior spatial resolution than the commercial Tl:CsI whiskers. Notably, at 10 lp/mm, the CTF values were 39% for the OCS plate versus 23% for the Tl:CsI whiskers, indicating significantly improved spatial resolution. This presentation will detail the fabrication process, EBSD analysis and correlation between OCS plate thickness and spatial resolution.

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