Contribution ID: **168** Type: **poster**

Development of optical-guiding Tl:Cs3Cu2I5 crystal scintillator plates for high-resolution and high-sensitivity radiation imaging

Scintillator-based radiation detectors are widely used to detect alpha, beta, gamma, X-rays, and neutrons for high-energy physics, non-destructive inspection, homeland security, resource exploration, and medical imaging applications. X-ray imaging, in particular, has been utilized in product inspection and developing battery materials, aircraft parts, and more. This has driven a strong demand for detectors with higher resolution and sensitivity. This detector's performance depends on a scintillator material that absorbs the X-rays and converts them into visible light. Our research group has proposed GdAlO3/Al2O3 eutectic [1] and Optical-guiding Crystal Scintillator (OCS) [2-4] as structured scintillators that simultaneously achieve high resolution and sensitivity. The OCS consists of a low refractive index glass cladding and a high refractive index scintillator core, and the scintillator light is guided like in a bundled optical fiber. Therefore, the selection of the core material and the precise control of the core diameter are crucial for device performance.
In this research, OCS plates composed of Tl-doped Cs3Cu2I5 scintillator core and glass cladding were fabricated. Tl:Cs3Cu2I5 crystals were grown from the melt in the glass cladding under an inert gas atmosphere. The 5 x 5 mm² size OCS plates were fabricated with a Tl:Cs3Cu2I5 core diameter ranging from several to 10 μm. With this structure, the OCS can work as both an optical fiber and a scintillator. The X-ray excited emission peaking within the range of 400-500 nm was observed consistent with previously reported results for Tl:Cs3Cu2I5 single crystals [5]. Imaging tests were conducted using microfocus X-ray tubes and commercially available X-ray test charts. The resolution was evaluated by calculating the contrast transfer function (CTF). CTF of the Tl:Cs3Cu2I5 OCS was higher than that of commercially available CsI whiskers. In our presentation, the detailed fabrication process, results of EBSD, radiation response, and imaging test will be shown.

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Workshop topics

Sensor materials, device processing & technologies

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