

UV-Induced Photo-Bleaching and Scintillation Performance Degradation in 3D-Printed Plastic Scintillators

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Plastic scintillators are widely used in radiation detection due to their short scintillation decay time, ease of fabrication, and low cost. Recent advances in 3D printing have enabled complex geometries and compositional control, expanding their applicability. However, many organic scintillators are susceptible to UV-induced photo-bleaching, which degrades scintillation performance and limits long-term stability. In this study, we investigate the photo-bleaching behavior and scintillation property changes of 3D-printed plastic scintillators under UV irradiation to assess their long-term performance stability.

The scintillator investigated was RMPS470 (Raymetrics, Korea), fabricated using a digital light processing (DLP)-based 3D printing technique and prepared as $1 \times 1 \times 1$ cm³ cubic samples. UV irradiation was performed using a 365 nm source with an intensity of 1000 mW/cm² for exposure times ranging from 30 to 180 s. For comparison, a commercial plastic scintillator, BC408 (Luxium Solutions, USA), irradiated for 180 s, and an RMPS470 sample stored under room conditions for two years were also evaluated. RMPS470 exhibited progressive yellowing with increasing UV exposure time, whereas BC408 showed no noticeable color change (Figure 1).

Emission spectra measured using a UV–visible spectrometer (340 nm excitation) showed that the emission peak of RMPS470 gradually shifted from 470 nm toward approximately 385 nm with increasing UV exposure. This shift is attributed to UV-induced degradation of the secondary fluor, resulting in dominant emission from the primary dye, PPO. In contrast, BC408 exhibited no change in emission wavelength after UV irradiation.

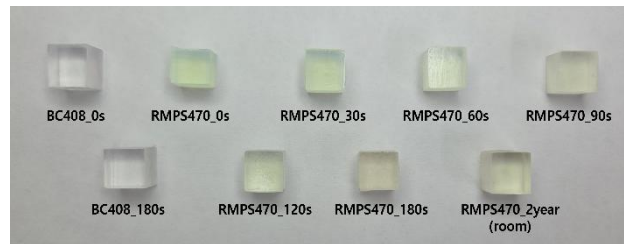


Figure 1. Visual color changes of plastic scintillators induced by UV irradiation.

Photo-bleaching effects were further confirmed through gamma-ray energy spectra measured using a Cs-137 source.[1] Compton edge of RMPS470 decreased by approximately 11.2% for samples irradiated by 120 s or longer, indicating a significant reduction in light output. BC408 also showed a Compton edge shift toward lower channels after UV exposure, suggesting reduced light output despite the absence of spectral changes.

These results demonstrate that plastic scintillators exposed to open environments can undergo UV-induced photo-bleaching, with the resulting scintillation degradation strongly dependent on material composition. Improved understanding of UV-sensitive components and mitigation strategies will be essential for enhancing long-term stability and ensuring reliable radiation and dose measurements.

1. HC Yang, *et al.* “Development of 3D-Printed Plastic Scintillators with Long Emission Wavelength”, Korea Nuclear Society Autumn Meeting (2024): 24-25.

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