Scintillation properties of flexible scintillator composed of PMMA and nanocrystals

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1. Introduction

Owing to their low cost, easy fabrication, and fast response time, organic scintillator materials have become widely used as detectors in nuclear/particle physics, as well as in homeland security applications [1-3]. Most organic scintillators comprise solvents, primary solutes (such as p-terphenyl (1, 4-Diphenylbenzene), PPO (2, 5-diphenyloxazole) and butyl PDB (2-4(biphenyl)-5-(4-tert-butylphenyl)-1, 3, 4-oxadiazole)), and secondary solutes (like POPOP (5-phenyl-2-[4-(5-phenyl-1, 3-oxazol-2-yl)phenyl]-1, 3-oxzole)) [4-5].

Due to the scintillating properties of the primary and secondary solutes, most organic scintillators exhibit an emission wavelength around 400 nm. Additionally, the low effective atomic number of organic scintillators poses a challenge in detecting high-energy X-rays and γ-rays.

Nanocrystals are utilized in light-emitting diodes (LEDs) and as sensors for bio-imaging [6]. As the size of the nanocrystals increases, their emission wavelength shifts from blue to red. The size increase also enhances their absorption efficiency for X-rays and γ-rays, attributable their high atomic number (Z).

Organic scintillators easily accommodate the mixing of additional dopant materials, enabling the fabrication of nanocrystal-doped organic scintillators.

In this paper, we present the scintillation properties of nanocrystals doped into PMMA-based organic scintillators.

2. Methods and Results

In this section, we describe the scintillation properties of the flexible scintillator composed of PMMA and nanocrystals.

2.1 Flexible Scintillator

We fabricated a flexible scintillator composed of PMMA and $CsPbBr_3$ nanocrystals at a concentration of 0.5 g/mL. Figure 1 shows the photoluminescence (PL) spectrum of the $CsPbBr_3$ nanocrystals, with an emission peak at 518 nm under excitation at 365 nm. Figure 2 shows a photograph of the flexible scintillator showcasing its composition of PMMA and $CsPbBr_3$ nanocrystals.

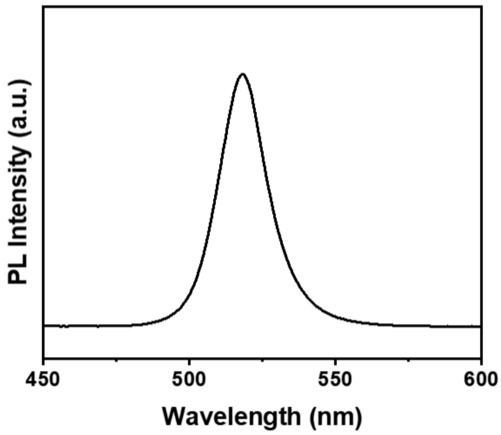

Fig. 1. PL spectrum of $CsPbBr_3$ nanocrystals.

Fig. 2. Photograph of flexible scintillator composed of PMMA and $CsPbBr_3$ nanocrystals.

2.2 Radioluminescence spectrum

Figure 3 shows a schematic diagram of the experimental setup used to measure the X-ray induced radioluminescence. The flexible scintillator, composed of PMMA and $CsPbBr_3$ nanocrystals, is irradiated with X-rays at an intensity of 70 kV and a current of 25 mA. Figure 4 shows the radioluminescence spectrum, where the flexible scintillator exhibits an emission peak at 518 nm, mirroring the photoluminescence spectrum of $CsPbBr_3$.

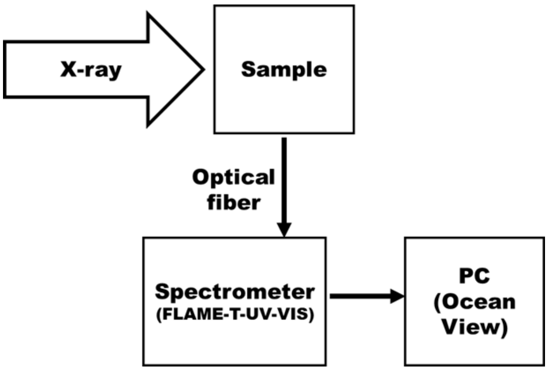

Fig. 3. Schematic diagram of the experimental setup for the measurements of the X-ray induced radioluminescence spectrum.

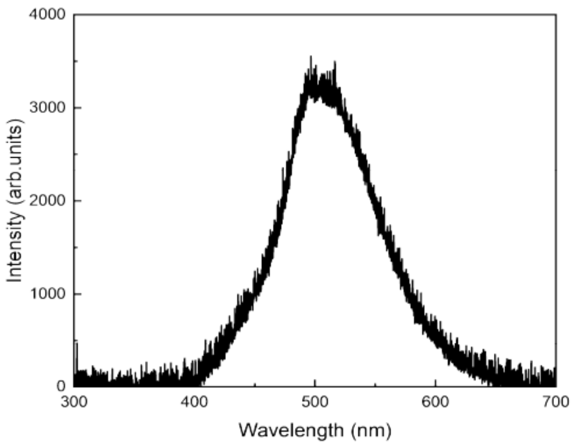

Fig. 4. Radioluminescence spectrum of flexible scintillator composed of PMMA and $CsPbBr_3$ nanocrystals...

3. Conclusions

In this experiment, we measure radioluminescence of flexible scintillator composed of PMMA and $CsPbBr_3$ nanocrystals. Considering the potential variation in the interaction mechanism between nanocrystals and PPO with changes in the thickness of the nanocrystal-polymer composite, further research is necessary to explore the interaction mechanism with various primary scintillators beyond PPO.

ACKNOWLEDGEMENT

This work was supported by the Korea Atomic Energy Research Institute (KAERI) Institutional Program (Project No. 523160-24 and 523510-24). This work was also supported by Grant RS-2022-00144108 funded by the Ministry of Trade, Industry and Energy of the Korean government.

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