

Nanocomposite Scintillator Films for Enhanced Gamma-Ray Interaction

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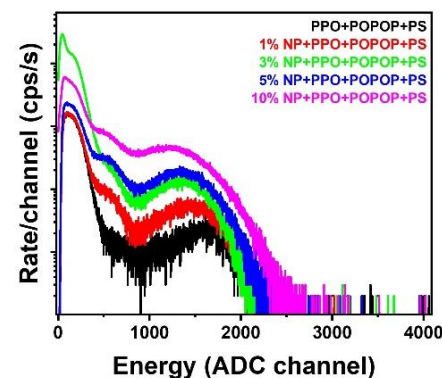
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The detection and identification of nuclear materials remain major challenges in nuclear security and radiation safety. Plastic scintillators are widely used in portable radiation detectors due to their low cost, mechanical robustness, and scalable fabrication. However, their low effective atomic number (Z_{eff}) leads to poor interaction probability and limited sensitivity to high-energy gamma (γ) radiation. Recent advances in nanomaterials have enabled the development of nanocomposite scintillators, in which high-Z nano-objects are incorporated into polymer matrices [1-3]. This approach enhances γ -ray interaction while preserving fast scintillation response and relatively high light yield.

In this work, several inorganic nano-objects were incorporated into a polystyrene matrix to fabricate luminescent nanocomposite films. Structural, optical, and scintillation properties were investigated using transmission electron microscopy and spectroscopic techniques as a function of nanoparticle concentration, fluorophore presence, and film thickness. These characterizations were performed to evaluate film homogeneity, light yield, and counting rate under Am-241 γ -ray exposure. Various types of nano-objects were investigated, including nanoplatelets, metals, metal oxides, and metal halides. Among these, metal halides exhibited particularly promising properties in terms of achievable loading and scintillation performance, as detailed below.



Am-241 pulse height spectra of undoped and Tb^{3+} :BaGdF₅ doped plastic scintillators.

For nanocomposites incorporating BaGdF₅:Tb³⁺ nanoparticles, a counting rate enhancement of up to 21 times was observed for a scintillator loaded with 10 wt% nanoparticles compared to a reference undoped scintillation film. The improved γ -ray interaction demonstrated by these nanocomposite scintillators highlights the strong potential of this material class for high-energy gamma detections.

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