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#10-229 Fast-Cured Plastic Scintillators and Additive Manufacturing for Radiation Detection

Additively manufactured radiation detectors offer the potential to boost performance and lower production costs for a variety of detection applications. One example is fast neutron radiographic imaging, where traditional fabrication methods require hundreds of man-hours to produce the required pixelated plastic scintillator arrays. Recent efforts have identified novel scintillator resins capable of rapid polymerization under ultraviolet light, which produce mechanically hard and optically clear plastic scintillators with performance comparable to commercially available options (including pulse shape discrimination). These photo-curable scintillator formulations, which polymerize within seconds to minutes, may significantly accelerate bulk scintillator production processes and enable the possibility of directly 3D printed pixelated structures or other non-trivial geometrical configurations. This work presents progress in the development of additively manufactured plastic scintillators that enable novel geometries or capabilities not feasible or possible using traditional thermally polymerized plastics. For instance, an automated assembly machine has been constructed that leverages robotic arms to cure solid layers of plastic scintillator from liquid resin in alternation with bonded layers of Enhanced Specular Reflector (ESR) material to optically isolate detector elements. The attached figure shows a side view of a four-layered one-dimensional pixel array (55 mm by 70 mm) constructed using this automated system, taking about one hour from liquid resin to cured array, including the ESR layers in between scintillator slabs. The evident strong purpling color fades away over the course of one to three days. In addition, we also discuss progress made in the development of meta-scintillators, in which a scintillator is constructed from multiple distinct scintillator materials that give the meta-scintillator unique capabilities beyond those of the original components. A meta-scintillator was successfully fabricated and characterized using fast and photocurable plastic resins. We also present new photo-curable resins with loading agents designed for specific radiation detection goals, such as offering thermal neutron capture efficiency, gamma-ray sensitivity, and high light yield.

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