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#11-220 Neutron Measurement Using Pulse Shape Discrimination Method with 3D-Printed Plastic Scintillator

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Neutron measurement technologies are being studied due to the demand in nuclear fusion, accelerator facilities, nuclear non-proliferation treaty, etc. Since neutron fields are typically present with gamma-ray, the separation technique is necessary such as pulse-shape discrimination (PSD) for neutron detection. Organic scintillators, such as plastic scintillators, are capable PSD using different decay times depending on particles. Plastic scintillators can be manufactured by 3D-printing technique based on digital lighting processing (DLP).

The PSD performance of plastic scintillators composed of polymer, which is doped with the 2,5-diphenyloxazole (PPO), is affected by concentration of PPO. In this study, 3D printing resin contain PPO concentration of up to 30wt%, and the scintillator based on these resins can measure fast neutron. The PPO and wave length shifter concentration were optimized, and 6LiF was doped for thermal neutron detectable scintillator. The scintillators, which have diameter of 2.54 cm and thickness of 1.27 cm, were connected to PMT (Hamamatsu-H6410) and FADC (Notice-NGT400). Data acquisition (DAQ) system based on ROOT framework was operated in PC through Ethernet. For neutron irradiations of this work, ^{252}Cf source (88.3 μCi), which shielded with 5 cm of lead and moderated with high density polyethylene of 11 cm, was used. The energy calibration was performed with Gaussian fitted integral through Compton edge peaks of 137Cs source (10.4 μCi) and 22Na source (5.0 μCi), as an organic scintillator calibration method. The PSD capability were evaluated by Figure of Merit (FOM) value. The reasonable definition of the capability of PSD for well separated is FOM ≥ 1.27 similar to that of single crystals. The three samples, which were 3D printed with high concentration PPO and 6LiF, met the target value in measurable energy region. It is expected that the 3D-printed scintillators which are comparable to the existing commercial detectors, can be developed through continuous research and optimization.

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