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Neutron detection and High resolution imaging using large area 6LixNa1-xI:Eu

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Here, we report on the synthesis and application of a novel scintillator material for neutron detection: a mixed halide compound: Eu-doped 6LixNa1-x (6LNI:Eu). 6LNI:Eu screens were made using physical vapor deposition. Additionally, we have grown single crystals of the same composition to compare with the thin films. In particular, a pseudo hot wall evaporation (HWE) approach was used to increase the efficiency of materials usage, which is importenter code hereant for controlling the cost. The ability to make 6LNI:Eu scintillators into a large format is particularly advantageous for detecting specular reflections in neutron scattering and diffraction experiments. The as-deposited material exhibit a microcolumnar structure that channels the scintillation light along the length of the column, thereby reducing the lateral spread of light and increasing the spatial resolution to as high as 50 um, vastly exceeding that of other solid (non-gaseous) neutron scintillators. While our primary application is detection of neutrons, this also makes them suitable for neutron radiography. Enriched 6Li was used to increase the neutron absorption cross section of the thin films, while preserving the brightness of the scintillation response. We performed a variety of tests on the 6LNI:Eu scintillator screens, including in house X-ray measurements to provide quick feedback on brightness and resolution, as well as neutron measurements at reactor facilities. For instance, the films were tested at the High Flux Isotope Reactor (HFIR) at ORNL. For a 650 μm thick film we have measured neutron detection efficiencies as high as 58% for 4.2 Å neutrons. Another 485 μm thick film demonstrated brightness 50% higher than commercial GS20 screens, and an FWHM resolution of 320 μm when coupled to an SiPM based detector, which is the highest reported resolution for a neutron sensitive Anger Camera.

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