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Fast Neutron Imaging with Semiconductor Nanocrystal Scintillators

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Fast neutrons offer high penetration capabilities for both light and dense materials due to their comparatively low interaction cross-sections, making them ideal for the imaging of large-scale objects such as as-built plane turbines, for which X-rays or thermal neutrons do not provide sufficient penetration. However, inefficient fast neutron detection limits the widespread application of this technique. Traditional phosphors such as ZnS:Cu embedded in plastics are utilized as scintillators in recoil proton detectors for fast neutron imaging. However, these scintillation plates exhibit significant light scattering due to the plastic–phosphor interface along with long-lived afterglow (on the order of minutes), and therefore alternative solutions are needed to increase the availability of this technique. Here, we utilize colloidal nanocrystals (NCs) in hydrogen-dense solvents for fast neutron imaging. The light yield, spatial resolution, and neutron-vs-gamma sensitivity of several chalcogenide (CdSe and CuInS2)-based and perovskite halide-based NCs are determined, with only a short-lived afterglow (below the order of seconds) observed for all of these NCs. FAPbBr3 NCs exhibit the brightest total light output at 19.3% of the commercial ZnS:Cu(PP) standard, while CsPbBrCl2:Mn NCs offer the best spatial resolution at ~2.6 mm.

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