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Gd-PMMA: a novel neutron tagging technology for low background detectors

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Low background detectors, such as those used in direct dark matter searches, require high-efficient neutron veto to reject nuclear recoil backgrounds. Gadolinium-doped polymethyl methacrylate (Gd-PMMA) has emerged as a promising solid neutron tagging material, with high hydrogen content for moderating neutrons and gadolinium content for capturing thermal neutrons and exploiting subsequent emission of high-energy gamma rays. This talk introduces a novel Gd-PMMA material based on a complex compound called gadolinium methacrylate, which will be used in the DarkSide-20k experiment, a direct dark matter search experiment with liquid argon.

The Gd-PMMA will serve as both a neutron tagging material and the main structural material of the dual-phase argon Time Projection Chamber (TPC) in the DarkSide-20k detector. This design allows for the Gd-PMMA to be located as close as possible to the detector's active volume to tag any possible neutrons from intrinsic backgrounds. With liquid argon buffers on both sides of the Gd-PMMA, gamma rays released during neutron capture can be effectively detected. To maximize neutron veto efficiency, a ~1% gadolinium mass fraction with 15 cm thick Gd-PMMA surrounding the TPC's active volume is required. Radiopurity control of this material is also being studied to ensure its suitability for use in low-background experiments.

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