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Energy and charge accumulation and release in xenon and argon dual-phase detectors

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Xe and Ar dual-phase detectors cannot detect nuclear recoils with energies below 200 eV because of the limitations of ionization processes. Still, the number of excitations and defects in these detectors, which can store energy and produce delayed or excess background electron and photon emission, is lower than in solid-state sensors. Combined with larger mass, this can provide superior sensitivity of dual-phase detectors to nuclear recoil in the 200-2000 eV energy range. We discuss differences in backgrounds observed in detectors with different designs and possible microscopic energy and charge release mechanisms. Uncontrolled accumulation of unextracted electrons on liquid-gas interphase can lead to instabilities of the charged liquid surface in the electric field, delayed electron emission events, and changes in electron extraction efficiency. Different experiments indicate trapping and delayed release of electrons in bulk liquid by yet unidentified mechanism. We discuss design changes and R&D required to decouple, investigate, and suppress these mechanisms. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. LLNL-PRES-855099Xe and Ar dual-phase detectors cannot detect nuclear recoils with energies below 200 eV because of the limitations of ionization processes. Still, the number of excitations and defects in these detectors, which can store energy and produce delayed or excess background electron and photon emission, is lower than in solid-state sensors. Combined with larger mass, this can provide superior sensitivity of dual-phase detectors to nuclear recoil in the 200-2000 eV energy range. We discuss differences in backgrounds observed in detectors with different designs and possible microscopic energy and charge release mechanisms. Uncontrolled accumulation of unextracted electrons on liquid-gas interphase can lead to instabilities of the charged liquid surface in the electric field, delayed electron emission events, and changes in electron extraction efficiency. Different experiments indicate trapping and delayed release of electrons in bulk liquid by yet unidentified mechanism. We discuss design changes and R&D required to decouple, investigate, and suppress these mechanisms. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. LLNL-PRES-855099

Early Career

No

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