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Study of surface contamination in ultralow background (ULB) materials

The intrinsic radioactive contamination of detector components and surrounding materials is typically the most relevant and limiting source of background for experiments studying rare events, such as those searching for direct evidence of dark matter or neutrinoless double beta decay. Primordial radionuclides Th-232 and U-238 and their daughters, as well as K-40 are of primary concern. Based on the detector characteristics, limits on their content for each material to be included are set using simulation techniques. These limits can be extremely stringent and become even more strict with increasing mass and with greater proximity to the active target. Limits for Th-232 and U-238 can be in the pg/g (or microBq/kg) range or even lower.
Such demanding radioactivity requirements pose a difficult challenge on the selection and confirmation of purity for materials, but also on their storage and handling after validation. At such high purity levels, surface contamination can be a major issue. Significant accumulation of radiocontaminants on material surfaces can occur during machining, transportation, handling, storage or even from exposure to air in controlled environments, such as clean rooms or glove boxes. Though care is usually taken, surface contamination processes are not fully understood and are difficult to control, oftentimes creating a "dogma-based" approach to handling materials that relies more on hunches (perhaps via informed assumptions) rather than scientific understanding. This makes even validated clean materials a potential source of limiting backgrounds, that unfortunately cannot be determined until directly observed in the detector. This study aims at providing tools to understand, identify, quantify and control surface contamination in validated ultralow background materials during design and construction of rare event detectors.

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