Radiopure flexible cables for rare-event physics detectors

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Readout cables for signal sensors are a fundamental component of rare event searches for dark matter and neutrinoless double beta decay. While they possess unique electrical and mechanical properties, polyimide-based flexible cables can be a significant contributor to the total detector background, due to their relatively high content of long-lived primordial radionuclides like ^{238}U and ^{232}Th and their progeny, as well as ^{40}K. Commercially-available flexible cables have ^{232}Th and ^{238}U measured in the mBq/kg range, making them incompatible with the stringent levels required for ultralow background next-generation rare event detectors. In previous work, we investigated and successfully sourced low-background (µBq/kg) copper-polyimide laminates which serve as the starting material for flexible cable manufacturing. However, even when starting with low-background materials, cable manufacturing processes result in finished cables several orders of magnitude higher in radioactivity (mBq/kg range) due to contamination during processing. In collaboration with a commercial cable manufacturer, we completed a systematic investigation of the manufacturing process and alternative materials. We then developed a cleaning method that reduced the radioactivity levels of the final cables from mBq/kg to nearly that of the starting laminate – a few tens of µBq/kg. In this work, we have rigorously tested our cleaning method and are incorporating the method on a commercial scale. In addition, we are investigating multi-layer impedance-controlled cables and superconducting cables in our quest for the highest functioning and most radiopure cables commercially available.