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A Novel Methodology for the Ultratrace Determination of Uranium and Thorium in Polymer Materials

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Content

A quick and ultrasensitive dry ashing method was developed for determining the radiopurity, specifically the U and Th content, of a variety of polymer materials. Ultralow background polymers are needed in rare-event ultralow background physics experiments, *e.g.*, neutrino and dark matter studies, which require the effective screening of polymers for their inclusion in the detector. Historically, ultrasensitive assay required gamma counting kilogram-quantities of material on the world's most sensitive detectors for several months in order to determine the radiopurity of the materials to the levels necessary (*e.g.*, microBq/kg or pg/g). A quicker and more sensitive method was developed by employing a dry ashing technique using a quartz tube furnace with offline detection by inductively coupled plasma mass spectrometry (ICP-MS). Ratiometric methods utilizing non-natural Th-229 and U-233 tracer spikes were used for quantitation. As many types of commercially-available crucibles (*e.g.*, quartz, sapphire) can be problematic due to highly variable contributing backgrounds and/or poor recoveries, electroformed copper crucibles that were grown and constructed in-lab were used for ashing the polymers cleanly and most effectively. After ashing, the entire crucible and ash residue was digested in nitric acid. The copper matrix was removed from the analytes via anion exchange column separation before analysis by ICP-MS. Electroformed copper crucibles provided minimal background contribution and allowed for sub-ppt (*i.e.*, low microBq/kg) detection limits using small sample quantities (*ca.* 100 mg). Subsets of process blanks and samples were either spiked with tracer before or after ashing to test the effect of ashing on tracer recovery; recoveries were high and consistent across sample subsets. This new method allows for the ashing of *ca.* 30 samples per ashing cycle, and can be processed in a matter of days. Results for a variety of polymers will be discussed.

About the Presenter

Isaac Arnquist is currently a postdoc analytical chemist at Pacific Northwest National Laboratory focusing on ultralow background materials assay, primarily using ICP-MS. He enjoys long forays in the cleanroom and decadent double beta (hold the neutrinos) with a slice of dark matter.

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