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High Radiopurity Polymer Materials and Their Assay for Ultra Low Background Detector Applications

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Content

Ultra low-background radiation measurements are essential to several large scale physics investigations, such as those involving neutrinoless double beta decay, dark matter detection (such as SuperCDMS), and solar neutrino detection. The background radioactivity of the materials used to make and house radiation detectors must be minimized in order to achieve the lowest achievable levels of background signal from the detector. While prior work has focused on semiconductor crystals and metals, there remains a need for high radiopurity polymers and plastics as insulating dielectric materials. It is required that the materials be especially low in U, Th, and K. These materials are needed for structural components, electrical insulation for cables, and seals. Structural dielectric materials are of particular concern. In the past, commercial plastics have either been of poor radiopurity, or have been poor materials for structural insulating parts (e.g., certain polyethylene and polytetrafluoroethylene (Teflon) materials). In addition, plastics with high radiopurity, even if poor structurally, still are only available episodically in pure form. Then each new project needs to find a new source of radiopure insulating plastic. There is a need to move from materials with milliBq/kg levels toward those with low microBq/kg levels. These radiopurity requirements then drive needs for new methods to assay polymers to such low levels. Typical methods for sample preparation for analysis of ppm to ppb levels of metals in plastic are not always directly applicable to the determination of ppt levels of U in plastics, because sample preparation processes can introduce trace level U contamination using conventional methods and containers. In addition, there are no certified reference materials for U or Th in thermoplastics. This talk will describe PNNL's program in sourcing and analyzing polymers for low background applications. By focusing on industries that care about purity, i.e. semiconductor manufacture and biomedical implants, and by focusing on sourcing raw materials, we have identified a number of materials made commercially that have high intrinsic radiopurity. These are compared with a number of additional commerical polymer materials of potentially useful plastics. Using a new assay methods, we have determined levels down to the single digit microBq/kg. We will describe the polymers, the motivation for sourcing them, assay results by new assay methods, and comparison of solid materials with polymer raw materials.

About the Presenter

Dr. Jay W. Grate is a Laboratory Fellow at Pacific Northwest National Laboratory, where his research concerns polymer materials, radiochemical and mass spectrometric analysis, separations, surface chemistry, and sensors.

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