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Reference Materials for Neptunium Determination

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Content

Neptunium-237 is the longest lived isotope of neptunium, and is the parent nuclide of the '4n+1' decay series and is also produced in the decay of plutonium and americium:
Pu-241=>Am-241=>Np-237=>Pa-233=>U-233=>Th-229=>(5 alpha, 3 beta)Bi-209
Neptunium-237 has been produced in tonne quantities through the various global nuclear power programmes and has entered the environment from weapons test fall out and effluent from nuclear fuel reprocessing. In addition, measurement of Am241:Np-237 and Np-237:U-233 atom ratios can be used for age dating nuclear materials, and as one of the parameters contributing to the spatial attribution of nuclear material.
Although Np-237 has been produced in tonne quantities since 1945, it remains the least studied of the actinides between thorium and curium (with the possible exception of protactinium) and the analysis of Np-237 is complicated by difficulties in identifying a suitable isotope dilution tracer.
In the first part of this paper, we concentrate on the efforts being made to produce an isotope dilution tracer for mass spectrometry and the availability of suitable reference materials for 237Np analysis; this concentrates on nuclear forensics measurements based on mass spectrometry, but the lessons learned and the materials production routes are applicable to the wider community measuring Np-237 in different matrices for a variety of applications.
Then, the reasons for selecting Np-236 (1.55(8)×105 a) as the only practical isotope dilution mass spectrometry tracer for Np-237 will be briefly described.
Production of Np-236 by charged particle irradiation and fast neutron irradiation will be described, as well as the detailed separation and chemical processing and purification of this nuclide, utilising oxidation state control, solvent extraction and extraction chromatography will be examined in detail, as will the measurement of this nuclide by γ-spectrometry.
Some additional comments on other radionuclides generated as by-products of this process will also be made.
Finally, the current state-of-the-art will be summarised, along with the future plans for the routine production of Np-236 for use in nuclear forensics and other measurements.

About the Presenter

Simon Jerome has been a member of the NPL Radioactivity Group at NPL since 1989. In his time there, he has worked on many aspects of radionuclide metrology including:
Nationwide radioactivity measurement proficiency testing
Production of actinide tracers and standards
Radiochemical analysis techniques
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In his current role as Head of Radiochemistry, he leads the NPL effort on metrology in support of threat reduction.

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