Tailored Bifunctional Polymer for Plutonium Monitoring

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Monitoring of actinides in various matrices with sophisticated conventional methods is affected by matrix interferences, spectral interferences, isobaric and polyatomic interferences. To circumvent these limitations, a bifunctional polymer, having both phosphonic acid and sulfonic acid functionalities, was developed in the present work for acidity-dependent selectivity towards Pu(IV). The bifunctional polymer was found to be better than the polymer containing either a phosphate group or a sulfonic acid group in terms of higher Pu(IV) sorption efficiency at 3−4 mol L$^{-1}$ HNO$_3$, selective preconcentration of Pu(IV) in the presence of a trivalent actinide such as Am(III) and preferential sorption of Pu(IV) in the presence of a large excess of U(VI). The bifunctional polymer was tailored as a self-supported disk by bulk polymerization and also anchored as a 1−2 μm thin layer on a microporous poly(ether sulfone) (PES) membrane by surface grafting. Pu(IV) preconcentrated on a single bifunctional bead was used for determination of the Pu isotopic composition by thermal ionization mass spectrometry with minimal sample manipulation and reasonably good accuracy. Use of a single-bead loading also improved the ion collection efficiency of the TIMS instrument. The membrane-supported bifunctional polymer was used for preconcentration and subsequent quantification of Pu(IV) by α spectrometry using the absolute efficiency at a fixed counting geometry. The analytical performance of the membrane-supported-bifunctional-polymer-based α spectrometry method was found to be highly reproducible for assay of Pu(IV) in a variety of complex samples.