An electrochemical approach for routine radioanalytical separations

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The decommissioning of nuclear facilities, the radioactive waste management or contamination monitoring require reliable measurements of radionuclide-specific radioactivity. Such radionuclide-specific routine measurements are typically carried out with liquid scintillation counting, as well as α-, γ-, and mass-spectrometry. However, to overcome interferences arising from the different radionuclides in the sample, prior chemical separation is required. Common approaches for pre-analytical separation of radionuclides are based on ion-exchange or reverse-phase chromatography as well as precipitation/co-precipitation[1,2]. Meanwhile, methods based on electrochemistry have been scarcely used for radionuclide separations. Such approaches would provide a different selectivity, when compared to conventional methods, limit the introduction of impurities (e.g., from chromatographic resin or chemicals), and high resistance towards radiation damage. Thus, this work aims to explore the selective electrodeposition of radioisotopes of different elements as an alternative separation approach. An electroanalytical characterization of simple electrochemical systems by means of voltammetry was used to implement separation procedures based on controlled-potential electrolysis. In addition, a special electrochemical flow-through cell with a working electrode featuring a high surface area, was designed and tested for the in-flow separation of radionuclides from solutions. As a result, the approach yielded fast and efficient separations of simple mixtures of elements (i.e., their [radio]isotopes). Furthermore, the herein presented electrochemical method can be directly combined with other flow systems, such as chromatography. Therefore, the method can readily be used as a building block for more complex separation procedures and is now used for the analysis of radionuclide mixtures of increasing complexity.

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