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Separations of the heaviest actinoids

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Overall goal of this project is to contribute to the knowledge of the heaviest actinoids. The research was carried out in two main directions: development of a method for radiochemical separation of actinoid series by liquid chromatography, including a model for determining separation parameters in non-equilibrium processes at one-atom-at-a time level (JINR Dubna), and novel methods for An(II) and An(III) separations for the studies of Md, No and Lr, including assembly of a setup for the electrochemistry studies of NCA radionuclides (CTU in Prague).
During development of the model algorithm for describing the chromatographic peak, the numerical integration of the mass transfer equations with and without diffusion was performed under conditions corresponding to the processes in the CIX - α-HIB chemical system. The main result of this work is the proposed machine learning algorithm for determining the distribution coefficients of α-HIB for Am, Cm and Cf.
Chromatographic experiments were carried out on a glass column at room temperature. The cation exchange resin was used as a sorbent. The initial solution of α-HIB at a given pH containing the radioisotopes Am, Cm, and Cf was fed into the column under an inert gas. The equilibrium concentration of the ligand at a given pH of the solution was calculated via the α-HIB dissociation constant. Analysis of the data obtained on the effect of diffusion on the chromatographic process allows to conclude that the process is in equilibrium when studying the behavior of actinide at micro-concentrations in the cationite - α-HIB system.
To simulate the conditions in experiments with transfermium elements, the studies of methods for An(II) and An(III) separations were performed in a radiochemistry laboratory at the U-120M cyclotron (Institute of Nuclear Physics, Řež) equipped by a He gas-jet system. The nuclides used were produced by irradiating self-supporting metallic target foils with 3He2+ ion-beam. Products recoiling out of the target foil were stopped in a recoil chamber filled with He-gas, transported by a He gas-jet seeded with KCl aerosols and collected on glass-microfiber filters. The aerosols with the radionuclides were then dissolved and used for the liquid–liquid extraction experiments.
Thulium, prepared by irradiation of holmium, was used as a simulant of trivalent ions while cadmium, prepared by irradiation of palladium, was used as a divalent ion. HDEHP in kerosen was used as the extractant. The extractions were carried out from the medium of nitric acid. The data obtained confirmed that HDEHP is a suitable candidate for the separation of carrier-free di- and trivalent ions of cyclotron-produced short-lived radionuclides in acidic solution.
An extensive search of methods already used in practice for influencing the oxidation states of (radio)nuclides at low concentrations was performed and completion and commissioning of an electrochemical equipment was carried out. The basic components of this electrochemical apparatus are the potentiostat, electrochemical cells, and a large spectrum of electrodes. The first experiments were aimed at verification of the correct functionality of all present components, including the correctness of the calibrations.

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