

Separation of fission products with ALOHA and subsequent electrochemical deposition

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The separation of fission products was studied with a coupling of the ALOHA system [1] and an electrochemical deposition device. A ^{235}U -Target (see fig. 1), which was covered with $15\ \mu\text{m}$ Al to suppress the heavy-mass fission products, was irradiated at the TRIGA reactor. The light mass fission products recoiling from the target, were stopped in He and transported with a KCl-cluster gasjet to the ALOHA system. After impaction onto a Ta-disc, the disc was stepped into the dissolution position and the fission products were dissolved in 0.1M HClO_4 and transferred into the electrochemical cell by continuously cyclic pumping at a flow rate of $1\text{-}2\ \text{ml/min}$.

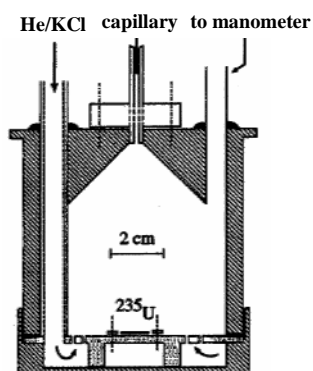


Fig. 1: Set-up of the ^{235}U -target and recoil chamber used for fission product production

The overall impaction and dissolution yield in ALOHA compared to a direct catch on a glassfiber filter (measured via the gross γ -activity) was about 80%, if the Ta-disc was stepped in intervals of 5s and longer. For shorter stepping times, the dissolution volume was low compared to the dead volume of the dissolution position, thus leading to a decrease in yield to about 60%. The impaction and dissolution yield for a specific fission product can be determined, if the fractional and the cumulative fission yield are in the same dimension. For ^{84}Se (fractional yield: 0,66%, cumulative yield: 0,99%), $55\pm 10\%$ of the activity was recovered from the gas-jet.

The potential dependence of the electrodeposition yield was investigated. Pd working electrodes and a Pt counter electrode were used. The potential was controlled potentiostatically vs. a Ag/AgCl reference electrode. The fission-products were collected for 5 min., then the electrodeposition was performed for 5 min. at a given potential under vigorous stirring. After that, the deposited activity was measured. The experiment was carried out for various electrode potentials.

Even at -1000mV , only $^{101/104}\text{Tc}$ and ^{84}Se were deposited. ^{101}Mo , ^{93}Sr , ^{90}Rb and ^{94}Y remained in solution. Fig. 2 shows the potentials, at which the electrodeposition of Tc and Se start (critical potential).

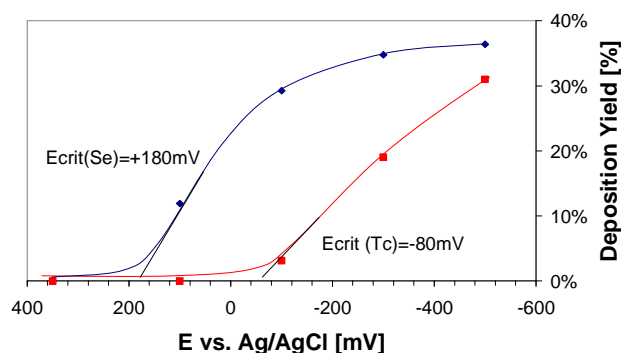


Fig. 2: Critical potentials for the electrochemical deposition of Tc and Se from 0.1M HClO_4 on Pd electrodes

In experiments with fission products with a longer half-life, ^{103}Ru and $^{99\text{m}}\text{Tc}$ could also be electrodeposited onto Pd. At $-500\ \text{mV}$, $^{97/95}\text{Zr}$, ^{96}Nb and ^{99}Mo remained in solution. Fig. 3 shows the critical potential for the deposition of Ru.

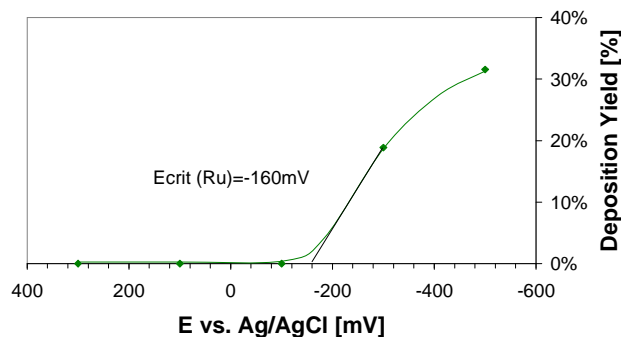


Fig. 3: Critical potential for the electrochemical deposition of Ru from 0.1M HClO_4 on Pd electrodes

In superheavy element chemistry, the coupling of ALOHA with an electrochemical deposition device may be suitable for experiments with Bh (homolog of Tc) and Hs (homolog of Ru). Further experiments with Re and Os, the heavier homologs of Bh and Hs, are necessary to confirm this assumption.

References

[1] H. Hummrich et al., this report