Separation of Tc from fission products with the extraction system MicroSISAK

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MicroSISAK is a miniaturized apparatus developed for performing fast and continuous liquid-liquid separations on a µl-scale, e.g., for chemical studies of the heaviest elements or for process studies with new types of ligands that are only available in very small amounts. The main components are: (i) an inlet with inter-digital channels for intense mixing of the phases [1]. The mixture is subsequently fed into (ii) a filter unit with a teflon membrane (0.5 µm pore size) for phase separation [2]. The inner volume of these units is in the order a few mm^3. All parts are made of Ti and mounted into a Ti-housing. Previously, this set-up has been applied for off-line extractions of Gd, Hf, and Tc [2].

Recently, it could be demonstrated that Tc can be separated from a fission product mixture [3]. For this, a ^{235}U-target covered with a 15 µm thin Al-foil has been installed in one of the beam ports of the research reactor TRIGA Mainz. Using a gas-jet system, the fission products, attached to KCl-aerosol particles, were transported to the Automated Liquid Online Heavy Element Apparatus ALOHA. Here, the aerosol particles are deposited on a Ta-disc. After a certain collection time the deposit is dissolved with 0.1 M H_2SO_4 containing 0.05 M $KBrO_3$ and subsequently pumped into MicroSISAK (see figure 1). In the mixer unit the aqueos phase is contacted with 10^{-4} M tetraphenylarsonium-chloride (TPAC) dissolved in $CHCl_3$ for selective separation of Tc(VII).

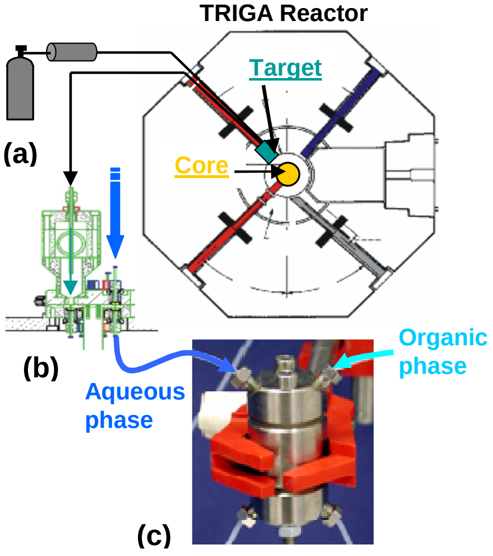


Figure 1: Set-up for the separation of Tc from fission products: (a) Gas-jet system. (b) ALOHA, (c) MicroSISAK housing (see text for details). The arrows indicate the inlet of the two phases.

Aliquots of the outgoing phases were collected and the extraction yield for Tc was concluded from a simultaneous measurement of the 18 min-^{104}Tc-activity (358 keV, 531 keV) in both phases with two detectors. Two different types of mixing units have been used (see table 1).

Table 1: Configuration of the mixer units as used for the separation of Tc with MicroSISAK. Shown on the right a microscopic picture of a mixer unit (type A).

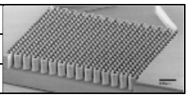
Type	Channels	Width	
A	2x15	30 µm	
B	2+1	30 µm	

Figure 2 comprises the results for the extraction of Tc for different flow rates of the aqueous and the organic phases, respectively. For efficient extraction a surplus of organic phase improves the extraction yield significantly (blue curve/mixer B). With increasing total flow rates phase separation becomes more and more inefficient and thus the extraction yield is decreasing (red curve/mixer A). The relatively low extraction yield of the batch experiments indicate incomplete formation of Tc(VII) in the aqueous phase.

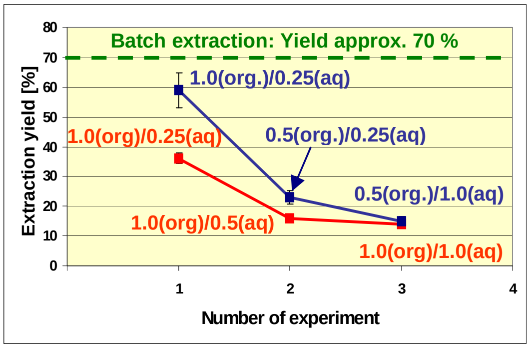


Figure 2: Extraction of Tc(VII) into TPAC/$CHCl_3$ with MicroSISAK. The red curve corresponds to configuration A, the blue one to mixer type B. The numbers indicate the flow rate [ml/min] of the two phases (org/aq).

A new version of MicroSISAK with up to 3 subsequent separation units is currently under development at the Institut für Mikrotechnik, Mainz.

References

[1] W. Ehrfeld et al., Microreactors, Wiley-VCM Weinheim (2000).
[2] K. Eberhardt et al., Institut für Kernchemie Annual Report, A5 (2004).
[3] see: www.safe.uio.no/ESFCTE05/Talks/ESFCTF05_Eberhardt.ppt