Extraction of Gd, Hf, and Tc with the fast and continuous liquid-liquid-extraction System MicroSISAK

K. Eberhardt[1], S. Andersson[2], C. Ekberg[2], B. Horn[3], J.V. Kratz[1], P. Löb[3], M. Nilsson[2], G. Skarnemark[2], N. Trautmann[1]
[1] Institut für Kernchemie, Universität Mainz, D-55099 Mainz, Germany; [2] Chalmers University of Technology, S-41296 Göteborg, Sweden; [3] Institut für Mikrotechnik Mainz, D-55133 Mainz

MicroSISAK is a miniaturized apparatus developed for performing fast and continuous liquid-liquid separations. It is designed to provide a separation time of about 1 s at a flow rate of 60 ml/h (≅ 0.02 ml/s), as required, 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. MicroSISAK consists of a stack of microstructured [1] discs with a diameter of 8 mm made of Ti and sealed in a Ti-housing. The main components are:

1. a micromixer (Fig. 1a) with interdigital channels for intense mixing of the phases. Here, small droplets are formed with typical diameters in the range of the channel dimension (see Table 1 for details) yielding an emulsion. The emulsion is subsequently fed into
2. up to three filter units (teflon membrane, 0.5 µm pore size) for phase separation, as shown in Fig. 1b. A differential pressure Δp (10-50 mbar) regulated via a valve must be applied across the membrane in order to ensure proper phase separation [2].

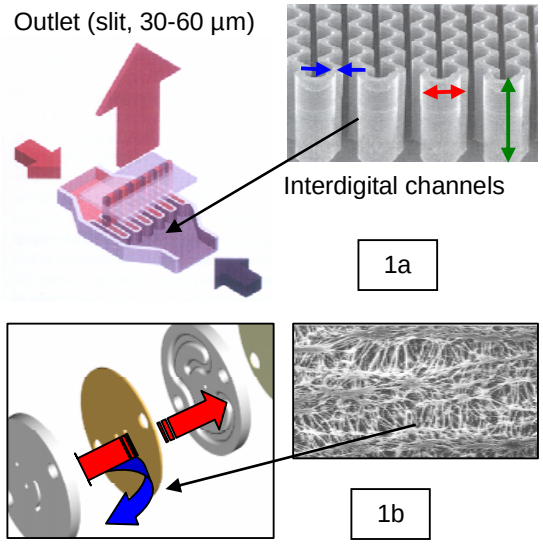

Figure 1: Mixer (Fig. 1a) and filter unit (Fig. 1b) for MicroSISAK. Different mixer types are used (see table 1).

The MicroSISAK set-up has been applied for extraction studies with Gd, Hf, and Tc. Here, different types of mixers have been used in order to optimize the extraction efficiency. Table 1 gives the dimensions of the different types of mixers.

Table 1: Dimensions of the mixer units as used for MicroSISAK (see also Fig. 1a)

Type	Channels	Width	Height	Wall
A	2 x 16	45 µm	100 µm	60 µm
B	2 x 15	30 µm	100 µm	60 µm
C	2 + 1	30 µm	100 µm	60 µm

Figure 2 comprises the results for the extraction of Gd, Hf, and Tc with MicroSISAK. Extraction yields and phase purities have been determined by means of γ-ray spectroscopy. For this, aliquots of the outgoing phases were measured after neutron activation at the TRIGA Mainz. ^{99m}Tc-activity was obtained by milking a commercial Mo-generator. To monitor phase purity, Na_2CO_3 was added to the aqueous phase prior to extraction. The yield depends on the extraction kinetics, the flow rate (hold-up time), and the mixer structure (droplet size).

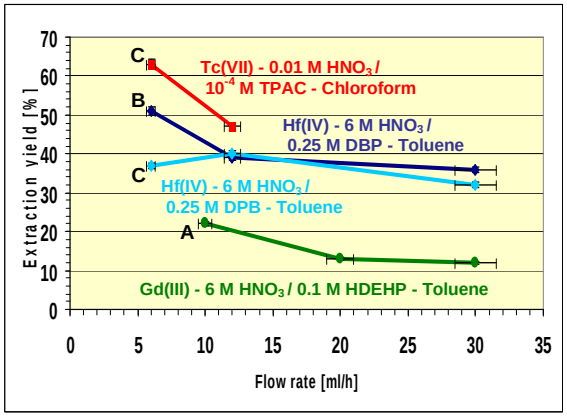

Figure 2: Extraction of Gd, Hf, and Tc with MicroSISAK. A, B, and C indicate the mixer type.

Further experiments are planned to measure the total hold-up time of the system and to optimize the extraction yield for flow rates ≤ 60 ml/h (≅ 0.02 ml/s). For this, different combinations of mixer- and filter units will be investigated.

References

[1] W. Ehrfeld et al., Microreactors, Wiley-VCM Weinheim (2000)
[2] K. Eberhardt et al., Institut für Kernchemie Annual Report (2003)