

# Chemical Studies of Element 104, 105 and 106 Homologues: Zirconium, Niobium and Molybdenum in the Extraction System HBr / TOPO

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There have been several chemical studies in preparation for exploring the chemical properties of elements 104, 105 and 106, but only a few utilized an extraction system with hydrobromic acid.<sup>1,2</sup>

The HBr system is of special interest in approaching the chemistry of 106. Bromide, as weak 'Pearson' base, together with the  $106\text{O}_2^{2+}$  ion, should form a relatively strong 'Pearson' acid, the neutral complex,  $[106\text{O}_2]\text{Br}_2$ . In comparison, with 104 and 105, which are stronger 'Pearson' acids, negatively charged bromide complexes should dominate.

To test if this behavior occurs we have investigated the HBr-TOPO (tri octyl phosphine oxide) system, where we expect a selective extraction according to:



Results presented for the HCl-TOPO system<sup>3</sup> indicate that element 106 homologues behave according to this effect. In this experiment, short-lived  $^{88}\text{Mo}$ ,  $^{88g}\text{Nb}$  and  $^{85g}\text{Zr}$  isotopes were produced on-line, under conditions similar to those used for chemical studies of the transactinides. Most of the earlier investigations were performed using long-lived tracers and often discrepancies between tracer and single-atom experiments have been observed.

A natural copper target was bombarded with a  $^{28}\text{Si}^{9+}$  beam (80 MeV, 60 enA). The short-lived isotopes observed here were produced via  $\alpha\text{pxn}$ -,  $\alpha\text{xn}$ -, and  $\alpha\text{pxn}$  reactions. The reaction products were transported with a He/KBr-aerosol gas-jet to the collection site and the activity-bearing aerosol was collected under vacuum in a HDPE (high density polyethylene) cone. The accumulated aerosol was dissolved in a small volume of HBr. A small volume of the TOPO phase was added, and after extensive mixing, certain volumes of each phase were transferred

to two separate centrifuge cones and measured by  $\gamma$ -ray spectroscopy.

The most promising Mo-separation results were seen in the system 0.01 mol/L TOPO-toluene with HBr, see Fig. The best separation was achieved with HBr concentrations below 1 mol/L. Zr acts as expected by forming nonextractable negative complexes. At low acid concentrations the small fraction of the Zr extracted is probably in the form of  $\text{ZrBr}_4 \cdot 2\text{TOPO}$ . Niobium, which tends to form  $\text{NbO}_2^+$ , has a low extraction yield at all HBr concentrations, with slightly increasing yields at the highest HBr and TOPO concentrations.

These results should be regarded as preliminary because of low counting statistics, due to low transport and collection yields, as well as activity loss due to sorption processes on the HDPE cone. The dissolution yield was 50 %.

## Footnotes and References

1. C.D.Kacher et al., Radiochem.Acta<sup>75</sup>, 127-133 (1996)
2. M.K.Gober et al., Radiochem.Acta<sup>57</sup>, 77-84 (1992)
3. K.Eberhardt et al., GSI Scientific Report 1993, p. 239

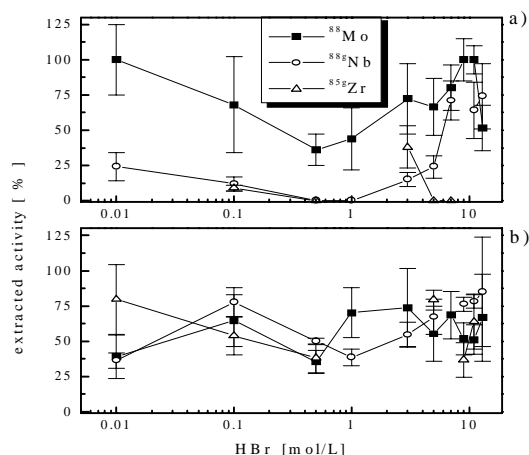


Fig. Extraction behavior of Zr, Nb and Mo in the HBr-TOPO system; extracted into a) 0.01 and b) 0.1 mol/L TOPO in toluene.