

## Investigation of the Solvent Extraction of Tantalum and Niobium

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The study of the chemistry of transactinide elements ( $Z \geq 104$ ) is a topic of great interest in current nuclear chemistry research. The chemical systems that can be used to study these elements are limited due to the short half-lives of the nuclides and the small production rates of atoms per minute or even atoms per week. Liquid-liquid extraction chemistry has proved successful in overcoming the difficulties presented by transactinide research. Until recently, the chemical system had to be specific to one group of the periodic table, as it had to separate the element of interest from all the other unwanted nuclear reaction products, e.g. transfer products. Using the Berkeley Gas-filled Separator (BGS) [1] as a physical pre-separator allows us to concentrate on systems that are selective to the differences between the members of one group of interest, because all other interfering products and the beam are being suppressed by the BGS.

For the members of group five on the periodic table (niobium, tantalum and dubnium), it has been observed that relatively long periods of time are often necessary to reach chemical equilibrium. Preliminary results are reported for the investigation of extraction systems aimed at the study of dubnium (Db,  $Z=105$ ). The experiments were performed using the lighter homologues, niobium (Nb,  $Z=41$ ) and tantalum (Ta,  $Z=73$ ).

At the 88-Inch Cyclotron at Lawrence Berkeley National Laboratory, short lived  $^{88m}\text{Nb}$  ( $T_{1/2}=14.5$  min) and  $^{170}\text{Ta}$  ( $T_{1/2}=6.76$  min) were produced using the  $^{74}\text{Se}(^{18}\text{O},p3n)$  and  $^{124}\text{Sn}(^{51}\text{V},5n)$  reactions. The nuclear reaction products were separated by the BGS and were thermalized in the Recoil-product Transfer Chamber (RTC) [2]. A gas jet containing a mixture of  $\text{He}_{(g)}$  and potassium chloride (KCl) aerosols was continuously passed through the RTC. The reaction products were captured on the aerosols and transported through a 20-meter long capillary to an aerosol collection site in the chemical laboratory. The aerosols were collected for 10 minutes and then dissolved in an aqueous phase that consisted of 1-11 M hydrochloric acid (HCl). The aqueous phase was then contacted with an equal volume of the organic phase, 0.01 M bis-2-ethylhexyl hydrogen phosphate (HDEHP) in chloroform ( $\text{CHCl}_3$ ), and mixed for 10-90 seconds. Aliquots of the aqueous and organic phases were then counted using a high-purity germanium gamma detector and the extraction yield was determined.

As can be seen in Fig. 1, the niobium system reaches chemical equilibrium within 30 seconds for 1, 3, and 6 M HCl with an extraction yield of approximately 90% for all three concentrations. At concentrations of 9 and 11 M HCl, extraction yields of 50% and 15%, respectively, are reached after an equilibrium mixing time of 10 seconds. Fig. 2 shows the results for the extraction of tantalum from HCl by HDEHP.

In this system, the observed extraction yield of tantalum was greater than 80% for all studied acid concentrations. However, the system had not reached equilibrium within the allotted time of 90 seconds.

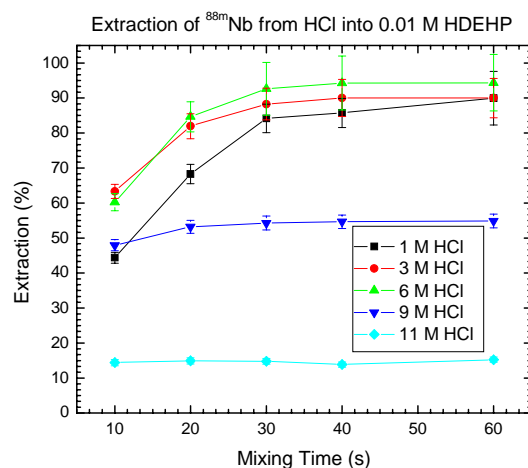


FIG 1: Extraction of niobium from HCl by HDEHP in  $\text{CHCl}_3$  as a function of mixing time.

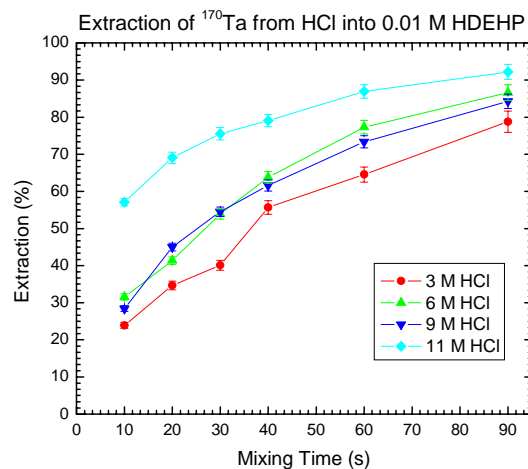


FIG 2: Extraction of tantalum from HCl by HDEHP in  $\text{CHCl}_3$  as a function of mixing time.

## REFERENCES

- [1] V. Ninov *et al.*, AIP Conf. Proc. 455 (1998) 704.
- [2] U.W. Kirbach *et al.*, Nucl. Instrum. Methods A484 (2002) 587.