

EXTRACTION SYSTEMS FOR THE STUDY OF DUBNIUM

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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 in these studies are limited by the short half-lives of the isotopes and the small production rates of atoms per minute or even atoms per week. In the initial investigations, the chemistry used had to be very selective to the periodic group of interest to separate the transactinide atom from all the other unwanted nuclear reaction products, e.g., transfer products. By using the Berkeley Gas-filled Separator (BGS) as a physical preseparator, we are able concentrate on systems

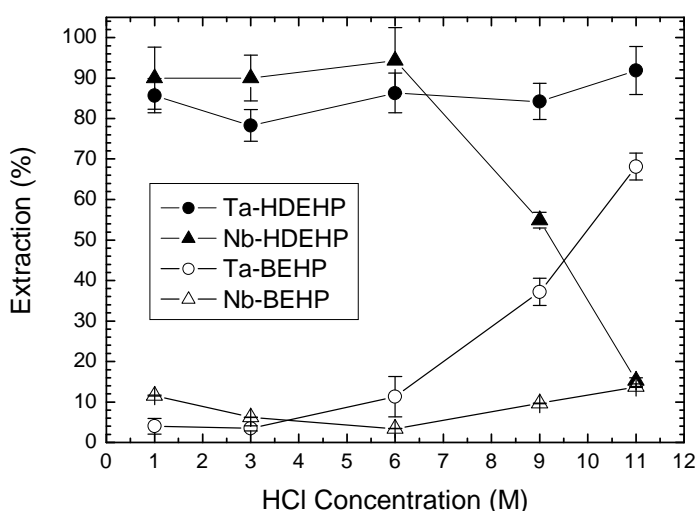


Fig. 1: Yields for the extraction of niobium and tantalum from HCl by bis-2-ethylhexyl hydrogen phosphate (HDEHP) and bis-2-ethylhexyl hydrogen phosphite (BEHP).

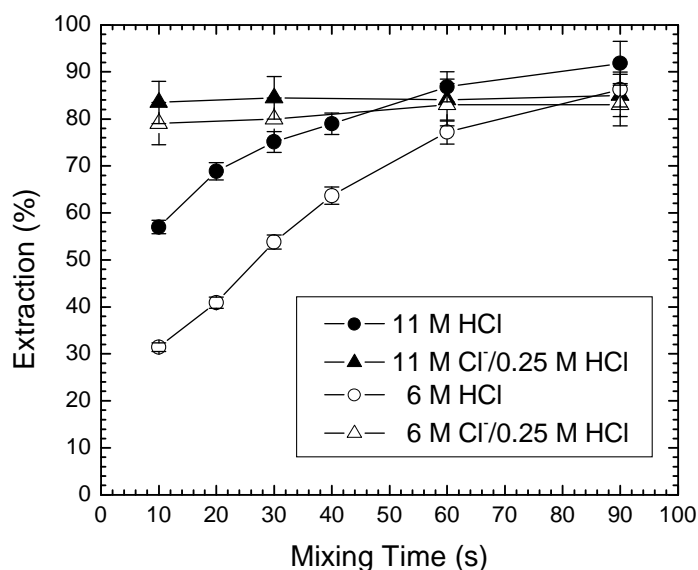


Fig. 2: Comparison of the rate of extraction of tantalum by HDEHP from HCl and mixed LiCl/HCl media.

that are selective between the members of the group of interest, because all other interfering products and the beam are being suppressed by the BGS [1].

We are developing suitable extraction systems for the study of element 105, dubnium. For this purpose we have studied the extraction of niobium and tantalum, the lighter homologs of dubnium, from mineral acids with different organophosphorous compounds. All studies were performed on-line, using short-lived niobium and tantalum produced in the $^{124}\text{Sn}(^{51}\text{V},5n)^{170}\text{Ta}$ and $^{74}\text{Se}(^{18}\text{O},p3n)^{88}\text{Nb}$ reactions. This allowed for the study of the lighter homologues at metal concentrations of 10^{-16} M. At these low metal concentrations, the formation of polymeric species is largely prohibited. As seen in Fig. 1, by varying the extractant and the hydrochloric acid concentration from 1 to 11 M, we are able to see a difference in extraction behavior between niobium and tantalum. While the system is suitable for determining chemical differences between the lighter homologues, the extraction of tantalum from hydrochloric acid shows slow kinetics. Figure 2 shows that after 90 seconds of mixing, the system is not in equilibrium. However, experiments indicate that equilibrium is reached faster at higher acid concentrations. We have studied the influence of hydrogen ion concentration on the extraction kinetics. By varying the chloride concentration while holding the hydrogen ion concentration at a low, fixed value, equilibrium can be reached in less than 10 s. Results for different extractants and various aqueous phase compositions will be presented and discussed.

References:

- [1] Ch.E. Düllmann et al., Nucl. Inst. Meth.: A, **551**, 528 (2005).