

Chemical Properties of Element 105 in Aqueous Solution: Back Extraction from Triisooctyl Amine into 0.5 M HCl

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Abstract

Previous studies of the halide complex formation of element 105 and its anion exchange with triisooctyl amine (TIOA) were continued. The experiments were performed on a one-minute time scale with the computer-controlled liquid chromatography system ARCA II on a mixture of 34-s ^{262}Ha and 27-s ^{263}Ha produced in the $^{249}\text{Bk}(^{18}\text{O},5n)$ and $^{249}\text{Bk}(^{18}\text{O},4n)$ reactions at a beam energy of 99 MeV. The Ha isotopes were detected by measuring the spontaneous fission and α -activities associated with their decay, and the α -decays of their daughters, 4-s ^{258}Lr , and 6-s ^{259}Lr . Time-correlated pairs of parent and daughter α -particles were also registered. $^{262,263}\text{Ha}$ was absorbed on the TIOA columns from either 12 M HCl/0.01 M HF or 10 M HCl, and was subsequently eluted in 0.5 M HCl/0.01 M HF like its homolog niobium, and the pseudohomolog protactinium, and unlike the closest homolog, tantalum, which remains in the amine phase under these conditions. The effluent was divided into an early Pa fraction and a subsequent Nb fraction. By varying the cut between the Pa fraction and the Nb fraction in rough steps, it was shown that the elution of element 105 occurs closer to the Pa elution position, i.e., earlier than the elution of Nb. These results confirm the non-tantalum like behavior of element 105 in 0.5 M HCl/0.01 M HF, and corroborate previously suggested structural differences between the halide complexes of element 105, niobium, and protactinium, on the one hand, and those of tantalum on the other hand.

1. Introduction

Studies of the aqueous chemistry of element 105 have provided expected results as well as surprises [1–3]. The sorption of 34-s ^{262}Ha on glass surfaces after fuming with nitric acid was compared with tracers of the group 4 elements Zr and Hf and the group 5 elements Nb and Ta produced under similar conditions [1]. Even after washing with 1.5 M HNO_3 , Ha

was found to adhere to the glass, a property characteristic of the group 5 elements. Experiments to investigate whether Ha is extracted into methylisobutyl ketone (MIBK) under conditions in which the lighter homolog Ta extracts but the next lighter homolog Nb does not, were also conducted [1]. It was expected that Ha would behave more like Ta than Nb but, surprisingly, Ha did not extract from mixed nitric acid/hydrofluoric acid solutions although Ta did. The formation of polynegative anions is a possible explanation.

Later, a large number of anion exchange chromatographic separations using triisooctyl amine (TIOA) on an inert support was performed in order to compare in detail the halide complexation of element 105 with the lighter group 5 elements Nb and Ta, and with the pseudo-group 5 element Pa [2]. Complete extraction-elution cycles were performed on a one-minute time scale with Ha, Nb, Ta, and Pa, produced under similar conditions. It was found [2] that Ha sorbs on the columns from either 12 M HCl/0.02 M HF or 10 M HCl like its homologs Nb, Ta, and Pa. In elutions with 4 M HCl/0.02 M HF (Pa-Nb fraction), and with 6 M HNO_3 /0.015 M HF (Ta fraction), the Ha activity was found in the Pa-Nb fraction showing that the anionic halide complexes of Ha are different from those of Ta, and are more like those of Nb and Pa, indicating a reversal in the trend in going from Nb via Ta to Ha. In another series of experiments, after the extraction into TIOA from 10 M HCl, elutions were performed with 10 M HCl/0.025 M HF (Pa fraction) and 6 M HNO_3 /0.015 M HF (Nb strip). The Ha activity was divided almost equally between these two fractions, showing again a behavior very different from Ta, and close to Nb and Pa [2]. It was suggested [2] that the non-tantalum like halide complexation of Ha is indicative of the formation of oxyhalide or hydroxyhalide