

## Chemistry of the Transactinides

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In this review, advanced methods that have been developed and applied to study the chemical properties of the transactinide elements in comparison with their lighter homologs are presented. These include thermochromatography and isothermal chromatography in the gas phase as well as ion-exchange and reversed-phase liquid chromatography in the aqueous phase, liquid-liquid extraction, and electrodeposition.

Latest applications of these methods to studies of the chemistry of the transactinides are shown. From a systematic study of the anion-exchange behaviour of Rf, it has been concluded that the properties of Rf in HCl and HNO<sub>3</sub> solutions are similar to those of Zr and Hf [1-3]. However, in HF solutions, the fluoride complex formation of Rf is significantly different to that of its homologs [4-8]. In dilute HNO<sub>3</sub>/HF, the nitrate ion is the counter ion that removes RfF<sub>6</sub><sup>2-</sup> more effectively from the binding sites of the anion-exchange resin than ZrF<sub>6</sub><sup>2-</sup> and HfF<sub>6</sub><sup>2-</sup>. In strong HF solutions, it is the HF<sub>2</sub><sup>-</sup> ion that removes RfF<sub>6</sub><sup>2-</sup> much earlier from the anion-exchange resin than the much stronger fluoride complexes ZrF<sub>7</sub><sup>3-</sup> and HfF<sub>7</sub><sup>3-</sup> [6,7].

Chloride and fluoride complexation of Db has been studied in reversed-phase extraction chromatography with an aliphatic amine [9]. Chelating of Db with  $\alpha$ -hydroxyisobutyrate was shown to be much stronger than for tetravalent and trivalent metal ions [10].

Sg has been eluted from a cation-exchange column as SgO<sub>2</sub>F<sub>2</sub> or SgO<sub>2</sub>F<sub>3</sub><sup>-</sup> [11]. In 0.1 M HNO<sub>3</sub>, hydrolysis of Sg is weaker than that of Mo and W [12]. Successive deprotonation leads to a cationic species for Sg while for Mo and W, neutral hydrolysed species are eluted from the cation-exchange column. In the gas phase, Sg was volatilized as SgO<sub>2</sub>Cl<sub>2</sub> [13] and as SgO<sub>2</sub>(OH)<sub>2</sub> [14]. Elements 107 and 108 were transported in the gas phase as BhO<sub>3</sub>Cl [15] and HsO<sub>4</sub> [16], respectively. In [17], the highly volatile HsO<sub>4</sub> was deposited on a thin layer of NaOH in the presence of water vapor, thus forming a salt in analogy to the formation of an osmate(VIII) according to OsO<sub>4</sub> + 2 NaOH → Na<sub>2</sub>[OsO<sub>4</sub>(OH)<sub>2</sub>]. This shows that HsO<sub>4</sub>, like OsO<sub>4</sub>, is an acid anhydride.

Most recently, first chemical studies were performed with elements 112 [18] and 114 [19]. Element 112 in its atomic state was shown to be very volatile, but unlike radon, reveals a metallic interaction with a Au surface [18]. Preliminary results on the volatility of element 114 in its atomic

state indicate that it is a very volatile element with a weaker metallic interaction with a Au surface than 112 [19]. This surprising result needs to be confirmed.

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