

Experimental Thermochemistry of Neptunium Compounds

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Neptunium forms compounds that are analogues to natural uranyl minerals and also forms nanoclusters. Due to its long half-life, toxicity, and potential mobility, thermodynamic data for Np compounds are critical for evaluating stability and environmental transport. We have synthesized and characterized a variety of neptunium compounds with high purity, including neptunium oxides (NpO₂ and Np₂O₅), neptunium phosphate in the meta-autunite group (K(NpO₂)(PO₄)(H₂O)₃ and Rb(NpO₂)(PO₄)(H₂O)₃), neptunium monomer (Ca₂(NpO₂)(O₂)₃(H₂O)₉), and Np₂₄ nanocluster (CsNp₂₄ and RbNp₂₄-Np). We have developed direct oxide melt solution calorimetric measurements of neptunium compounds [1], and studied the formation enthalpies of these materials and enthalpies of reactions of interest. The calorimetric methodology is straightforward and produces reliable data using milligram quantities of radioactive materials, and can be applied to many other transuranium compounds. We are starting to expand the thermodynamic database for neptunium compounds.

[1] Zhang *et al.* (2018) *J. Nucl. Mater.* **501**, 398-403.