The complex chemistry of light actinides

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The actinides (An) are exclusively radioactive, highly chemo-toxic, and play an important role in chemical engineering and environmental science related to the nuclear industry or nuclear waste repositories. In contrast to the strongly shielded 4f electrons of the lanthanides, 5f electrons of particularly the early An are found to participate in bonding, e.g. to organic ligands. Another characteristic of the An is their huge variety of possible oxidation states, typically ranging from +II to +VII for early actinides, making their chemistry complex but interesting. A suitable approach to explore fundamental physico-chemical properties of the actinides is to study series of isostructural An compounds in which the An is in the same oxidation state. Observed changes in e.g. the binding situation or magnetic effects among the An series may deliver insight into their unique electronic properties mainly originating from the f-electrons. A question still remaining in the field of An chemistry is the degree of "covalency" in compounds across the actinide series, which may be addressed by systematic studies on series of An compounds, including transuranium (TRU) elements.

We investigate the coordination chemistry of low-valent actinides using organic N-, O-, or Sdonor ligands. Information on covalency trends as well as mutual ligand influences can be obtained by the analysis of solid-state structures derived by SC-XRD in combination with quantum chemical calculations (QCC) and high-energy-resolution fluorescence detection Xray absorption near edge spectroscopy (HERFD-XANES). In solution, NMR spectroscopy permits to draw conclusions about the complex speciation in solution, the intrinsic magnetic properties of the actinides, or subtle changes in covalency in the ligand-actinide-bonding.