Probing the actinide bonding properties by high resolution X-ray spectroscopy

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The actinide elements have complex and fascinating chemical and bonding properties not well understood and thus intensively investigated. We are specifically focusing on developing novel high energy resolution X-ray spectroscopic techniques to elucidate electronic structures and bonding properties of actinide elements. We aim to reveal relations between bond stability and bond covalency of the actinide-ligand chemical bonds.[1] For example, the stabilization mechanisms of uranyl(V) ($U(V)O_2^{1+}$) by Fe(II) in natural systems remains an open question in uranium chemistry.[2] Stabilization of uranyl(V) by Fe(II) against disproportionation was also demonstrated in molecular complexes. However, the relation between the Fe(II) induced stability and the change of the bonding properties or uranyl(V) was until recently an open question. A study of a model system will be discussed where we demonstrated that U(V) – Oaxial bond covalency decreases upon binding to Fe(II) inducing redirection of electron density from the U(V) – Oaxial bond towards the U(V) – equatorial bonds thereby increasing bond covalency.[3] We also apply the high resolution X-ray spectroscopic tools to answer specific questions related to safe disposal of nuclear waste. Examples of studies of geochemical systems and highly radioactive waste like vitrified nuclear waste and spent nuclear fuel will be discussed.[2, 4]

References:

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