High energy resolution X-ray spectroscopy in the Tender and Hard X-ray ranges

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In recent years, scientists have progressively recognized the role of electronic structure in the characterization of the chemical and physical properties of materials. High-energy resolution X-ray spectroscopy emerged as a promising direction because this method can probe material properties at the atomic and molecular levels[1,2]. Such experiments are performed at the synchrotron facilities, which offer a number of unique advantages. One of them is the element-selectivity using the energy of incident X-rays, which can be tuned and thus allows one to probe electronic transitions on a very small amount of sample without vacuum conditions. Moreover, synchrotron methods are non-destructive and bulk sensitive to the materials being studied.

This contribution will provide an overview of the recently performed studies[2–11] at the Rossendorf Beamline (ROBL) of the European Synchrotron (ESRF) in Grenoble (France). This innovative and worldwide unique experimental station was used to study actinide systems by several experimental methods: X-ray absorption spectroscopy in high energy resolution fluorescence detection (HERFD) mode, Resonant Inelastic X-ray Scattering (RIXS) at the An L_3 and $M_{4,5}$ edge and X-ray diffraction (XRD). I will show that the experimental data, analysed by electronic structure calculations are able to a) provide fingerprint information on the actinide oxidation state and ground state character b) probe 5f occupancy, non-stoichiometry, and defects c) investigate the local symmetry and effects of the crystal field[4,5,7–12]. It might be of interest for fundamental research in chemistry and physics as well as for applied science.

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