Quantifying photoinduced polaronic distortions in transition metal oxides and halide perovskites with ultrafast X-ray and state-selective spectroscopy methods

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The development of next generation transition metal oxide (TMO) and halide perovskite-based optoelectronic devices critically relies on the understanding of the interaction between charge carriers and the polar lattice in out-of-equilibrium conditions. The possibility to address this challenge depends on the availability of new tools capable of characterising the complex interplay of nanoscopic electronic, structural, and spin degrees of freedom, and of connecting these properties to macroscopic responses, with enhanced signal sensitivity, site and chemical selectivity.

In this keynote talk, I will present how ultrafast X-ray and state-selective spectroscopy methods can be harnessed to reveal key fingerprints of polaron formation in TMOs and halide perovskites. In the spinel cobalt oxide Co_3O_4, a prototypical correlated TMO, I will show that the combination of ultrafast X-ray emission and broadband reflectivity can target selectively site-specific excitations, revealing Jahn-Teller polaron formation and local symmetry breaking associated to deformation potential and magnetoelastic coupling [1]. In lead halide perovskites, I will show how ultrafast X-ray Absorption Spectroscopy allows to reveal specific polaronic distortions and to quantify the associated structural changes with atomic-level precision, ruling out thermal effects to the photoinduced observed dynamics [2, 3].

The combination of these methods provides a comprehensive description of these systems' photophysics, offering novel insights on their light-induced responses their exceptional optoelectronic properties.

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