Studies of charge transfer in photocatalytic materials by resonant scattering methods.

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Refined X-ray spectroscopies can become a powerful tool to elucidate charge transfer phenomena, which play a key-role in functional materials. We have developed a differential illumination RIXS and HERFD-XAS method to investigate charge transfer phenomena with chemical sensitivity. On the ID26 beamline of ESRF we have studied two materials systems in which TiO_2 nanostructures are modified to extend light absorption to the sub band – gap spectral region: in one case by loading with Au nanoparticles and in the other by V – doping. In the first case, we have shown that light induced excitation of the surface plasmon resonance in Au gives rise to hot electron transfer to the TiO_2 matrix (1); in the second, that visible light absorption is predominantly due to excitation of electrons from states centered on substitutional V ions. In both cases, the electrons are trapped in charge transfer – induced, low coordination defective Ti sites, where they have a long (ms) lifetime (2, 3). We complement these differential X-ray spectroscopy studies with transient optical absorption measurements with 50 fs time resolution; finally, we will discuss the outlook for measurements with FELs.

References

(1) L. Amidani et al., Angew. Chem. Internat. Ed. 54, 5413 5416 (2015). DOI: 10.1002/anie.201412030

(2) G. Rossi et al., Journal of Physical Chemistry C 120, 7457-7466 (2016). DOI: 10.1021/acs.jpcc.5b12045

(3) G. Rossi et al., Phys. Rev. B 96, 045303 (2017) DOI: 10.1103/PhysRevB.96.045303