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Dynamics of electron transfer and exciton formation at interfaces

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The combination of inorganic semiconductors with organic molecules to hybrid systems promises superior functionality of the interface compared to optoelectronic properties of the single materials. We have investigated the electron dynamics of the ZnO(10-10) surface and the influence of hydrogen and several organic molecules on the electronic structure using time-resolved two-photon-photoemission (2PPE) spectroscopy. Hydrogen termination leads to the formation a metallic ZnO surface, whereas e.g. by pyridine adsorption a substantial work function reduction up to 2.9 eV is achieved, which can be useful controlling the energy level alignment at inorganic/organic interfaces. Furthermore, we directly monitor the hot electron relaxation in the ZnO conduction band and the formation of an excitonic state at the surface within a few ps, which decays mediated a thermal activated process on a 100 ps timescale. In a second set of experiments we have studied the dynamics of photoinduced electron transfer and solvation processes at the water ice-metal interface and the effect of co-adsorbed alkali ions (Na, K, Cs). Time-resolved 2PPE provides direct access to elementary processes like electron injection and the subsequent solvation dynamics which competes with the electron transfer back to the Cu(111) substrate. In particular, we study the electronic structure changes and ultrafast dynamics for the bulid-up of a solvation shell (up to about 6 water molecules) around individual alkali atoms at the metal surface. For ice mulitlayers doped with alkali ions we observe the formation of longlived electron alkali-water complexes.