Ultrafast electron dynamics at interfaces

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Charge transfer processes across hybrid interfaces, such as formed by the connection of molecules to semiconductors, play an increasingly important role in a variety of emerging technologies. Detailed understanding of interfacial charge transfer in these systems, however, remains a major challenge for experiments and theory. In my talk I will present a new approach to monitor photo-induced electron transfer from a molecule to a semiconductor material with sub-picosecond temporal resolution and from the perspective of well-defined atomic sites [1]. Combining femtosecond time-resolved X-ray photoelectron spectroscopy with constrained density functional theory, we are able to identify the nature of an intermediate electronic state that precedes free charge carrier generation in a film of dye-sensitized ZnO nanocrystals after photoexcitation of the dye with visible light. The findings demonstrate a new capability to monitor charge transfer in complex hybrid materials. This presentation will further include our latest results of electron dynamics at interfaces.

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Theory of transfer processes in nano-hybrid systems

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The talk reviews recent work on photoinduced processes in hybrid systems formed by metal nano-particles, supramolecular systems, and semiconductor nano-crystals. In a first part a brief overview is given on metal nano-particle induced transient enhancement effects on molecular emission spectra [1,2]. Work related to a nano-laser is emphasized [3]. Then, studies are presented on excitation energy transfer among semiconductor nano-crystals and single molecules [4] as well as molecular aggregates [5,6]. Finally, current computations on metal-core semiconductor-shell systems are presented. The talk is closed with an outlook on planned work.

References

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