Colloidal metal-decorated semiconductor nanocrystals for photocatalytic hydrogen generation

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Solar hydrogen is considered as a clean fuel for future energy supply. It can be generated via solar cell-powered electrolysis, in photo(electro)chemical cells, or photocatalytically using dispersed, catalyst-loaded semiconductor nanoparticles. Colloidal semiconductor nanoparticles offer a number of advantages over bulk electrodes including control of their shape, size, composition and thus optical and electronic properties via advanced colloidal chemistry.

In this presentation I will discuss our recent work on photocatalytic hydrogen generation. Pt-decorated CdS nanorods show quantum efficiencies of up to 3.9% for hydrogen generation in presence of a hole scavenger [1,2]. Interestingly, already sub-nm sized Pt clusters act as efficient photocatalysts implying that hydrogen generation with reduced amounts of Pt is possible. Transient absorption spectroscopy was employed to study the charge carrier dynamics under hydrogen generation conditions [3]. Surprisingly, the photoelectron transfer to the catalytically active Pt clusters is slowed down under hydrogen generation conditions, i.e., in presence of hole scavenger, as compared to situations in which no significant hydrogen is generated. This phenomenon can be explained via the Coulomb interaction-mediated collective electron hole-dynamics on the nanostructure which leads to different degrees of delocalization of the electron wavefunction and thus different transfer rates. It further demonstrates that a mere optimization of transfer rates does not necessarily improve performance of a photocatalytic nanosystem.

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2. A. Vaneski, A.S. Susha, J. Rodríguez-Fernández, M. Berr, F. Jäckel, J. Feldmann, A.L. Rogach, Hybrid Colloidal Heterostructures of Anisotropic Semiconductor Nanocrystals Decorated with Noble Metals: Synthesis and Function. *Adv. Funct. Mater.* **21**, 1547-1556 (2011).

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