Hybrid semiconductor-metal nanoparticles as photocatalysts

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Hybrid nanoparticles (HNPs) combine disparate materials onto a single nanosystem thus providing a powerful approach for bottom-up design of novel architectures. Beyond the fundamental development in synthesis, the interest in HNPs arises from their combined and often synergetic properties exceeding the functionality of the individual components. These ideas are well demonstrated in hybrid semiconductor-metal nanoparticles, which are the focus of this talk. The synergistic optical and chemical properties of hybrid nanoparticles resulting in light-induced charge separation and charge transfer, allow photocatalytic activity which can promote surface chemistry redox reactions, and open a pathway for converting solar energy to chemical energy stored in a fuel. An additional area of interest is in use of the HNPs for light-induced generation of radicals opening options for light-induced on-demand radicals formation.

We will report on the effects of the surface coating and the co-catalyst metal size on the photocatalytic function of metal tipped semiconductor nanorods as a model hybrid nanoparticle system. Both tested parameters were found to influence the photocatalytic efficiency and charge transfer dynamics. The work combines advances in synthesis of well-controlled hybrid nanoparticles, hydrogen evolution efficiency measurements, steady state and time resolved emission measurements, as well as ultrafast transient absorption measurements to gain a complete view on the effects of these parameters on photocatalysis with metal tipped semiconductor nanorods. A model was devised to capture the essential effects of the size of the metal tip on the photoctalytic efficiency. The understanding of the effects of the hybrid nanosystems properties on the photocatalytic processes contribute to the rational design of hybrid nanostructures in photocatalytic applications. Moreover, use of the HNPs in generation of reactive hydrogen species and its application for controlling enzymatic activity and additional processes will also be highlighted.