Long-lived Charge Separation Across Interfaces with Semiconducting Single-walled Carbon Nanotubes

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Semiconducting single-walled carbon nanotubes (s-SWCNTs) are attractive absorbers for use in solar energy harvesting schemes because of their strong and energetically tunable optical absorption, and high charge carrier mobilities due to the delocalized nature of the π-electron system. Beyond their technological potential, s-SWCNTs offer attractive properties for fundamental studies of charge generation in strongly confined nanoscale systems and photoinduced electron transfer (PET) processes. For example, strong quantum confinement and low dielectric screening impart single-walled carbon nanotubes with exciton-binding energies substantially exceeding k_BT at room temperature. Additionally, the energetically narrow and distinct spectroscopic signatures for excitons and charges within s-SWCNT thin films enables the unambiguous temporal tracking of fundamental photophysical processes occuring at important photoactive heterojunctions designed for charge separation.

In this presentation, I will discuss recent studies that probe the generation and recombination of long-lived charges in samples consisting of heterojunctions between s-SWCNTs and various electron acceptors, both organic and inorganic. I will focus on the roles of important interfacial properties that can influence the kinetics and efficiency of the interfacial PET process and recombination of the resulting separated charges. These properties include the energetic energetic driving force for exciton dissociation, the amount of residual wrapping polymer on the highly enriched s-SWCNTs, the local dielectric enrivonrment, the presence or absence of an electric field, and geometrical factors of the interface that can be modified *via* structural properties of the acceptors. Better fundamental understanding of these model interfaces can inform the design of more efficient solar energy harvesting systems, photodetectors, and other opto-electronic devices.