COLLOIDAL NANOSTRUCTURES AND SOLAR ENERGY CONVERSION

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This presentation overviews research activities in the Center for Advanced Solar Photophysics with focus on nanoscale phenomena of relevance to solar energy conversion. One topic is "active" nanoplasmonic structures in which semiconductor quantum dots are coupled to nanoscale metals. These hybrid nanomaterials exploit plasmonic effects for enhancing the range of excitonic transport. The developed superstructures mimic the functions of biological light harvesting complexes and enable ca. 40 fold effective solar concentration within a nanoscale system. The second topic is carrier multiplication (multiple exciton generation by single photons) including the effect of nanostructure shape on multiexciton yields and the role of competing energy relaxation processes. Via comparative studies of quantum dots of three different compositions, we establish the factors that can allow one to relate the bulk material's properties to the expected carrier multiplication performance of the same material but in the quantum dot form. The final topic of this presentation is quantum-dot-based exploratory devices such as optical field-effect transistors. The use of these structures help elucidate the nature of conducting states in dark and under illumination and establish the important role of "hidden" mid-gap states in charge transport in quantum-dot assemblies.

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