Hybrid Nanostructures for Efficient Solar Energy Harvesting

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Abstract

World energy requirement is increasing day by day as human race is progressing and this forces us to look for new and efficient energy sources to meet our energy demands. With depleting fossil fuels, renewable energy sources are becoming the choice to meet this demand. Amongst many renewable energy sources, solar energy is one of the most abundantly available energy to us which can be harvested by using solar cells to produce electricity. To do so various architectures of solar cells using different light active materials have been investigated till date and in this regard scientists and engineers have been continuously working towards the development of innovative light harvesting materials and device structures. Especially with the emergence of nanotechnology in the last three decades, significant growth in research in the area of light harvesting nanomaterials for energy and environmental applications is reported. For a given material, the light harvesting efficiency is a function of amount of light absorbed by the material followed by the photogenerated charge separation and transport within the material. Therefore in order to achieve high efficiency, it is crucial to understand the fundamental photogenerated charge movement within the material itself as well as the transfer of charges across the device/system. In this regard hybrid nanostructures composed of combination of nanomaterials have shown great potential in boosting the energy conversion efficiency through high light absorption bandwidth, efficient charge separation and stability. In this presentation, various strategies to design efficient light harvesting hybrid nanostructures will be presented, including defect engineered nanostructures, plasmonic nanocomposites and porphyrin/semiconductor systems. Energy bands of such hybrid nanostructures can be modulated to harvest a wide region of the solar spectrum (from ultraviolet to visible) and these can be easily prepared according to the energy requirement. The detailed photogenerated charge transfer dynamics within the hybrid nanostructures will be presented and their twin applications using solar energy in energy conversion and water purification will be discussed. The talk will also provide information on future of energy materials, their applications and challenges in order to harvest solar energy efficiently.