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Chemical synthesis of one dimensional nanostructures for solar energy harvesting

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Absorption of sunlight and subsequent formation and separation of electron-hole pairs holds the key to harvesting solar energy with high efficiency. Nano-materials play an important role because of higher surface to volume ratio that enhances light absorption and availability of photo-generated charges. However, nanostructures with random and irregular morphologies results in unwanted scattering and hence lead to poor efficiency. In this context, one dimensional nano structures such as nanotubes, nanowires and nanorods help in unidirectional charge transport and hence, these are being extensively investigated. Among the various types of materials, transition metal oxides (such as TiO_2, Fe_2O_3, CuO) show superior chemical stability, ease of fabrication and flexibility of tuning properties. In the present work, we present the fabrication and characterization of these nanostructures through simple but scalable chemical techniques such as electrochemical anodization, hydrothermal synthesis and sol-gel techniques. Recent work in our lab on TiO_2 nanotubes, Fe_2O_3 nanorods and CuO nanowires show that the chemical techniques are highly effective in tuning structure, morphologies and defect chemistry, which in turn, control the light absorption characteristics. Our investigations of these materials for photo-electrochemical water splitting and photocatalytic CO_2 reduction will be discussed. Also, to enhance the separation of photo-generated charge carriers, reduced graphene oxide (RGO) layers are wrapped around the nanostructures. Such RGO layers along with CdS nanoparticles, form unique tri-component nanostructured composite material for high efficiency photo-electrochemical water splitting. A photocurrent density of about 12 mA/cm^2 has been obtained from CdS functionalized, RGO wrapped TiO_2 nanotubes.

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