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CHARGE TRANSFER CATALYSIS TO ENHANCE METAL CHALCOGENIDE FILM ELECTRODE STABILITY AND PHOTO-ELECTROCHEMICAL CONVERSION EFFICIENCY

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Attachment of electro-active species to the surface of a given semiconductor (SC) electrode permanently affects its photo-electrochemical (PEC) properties. Depending on the charge of the electro-active species, the flat band potentials may be shifted up (more negative) or down (more positive). The shift value depends on the applied ion charge density at the surface. Up to 300 mV shifting has been achieved here. Moreover, the electro-active species behaves as charge transfer catalyst across the electrode/redox junction. This increases the charge (holes or electrons depending on the type of the SC) transfer rate between the SC electrode and the redox couple. By doing so, the SC electrode can become more stable to photo-corrosion. All such advantages can be gained simply by attaching the proper electro-active materials to the proper SC electrode. The attachment can be performed by either chemical linkage or more recently by embedding the electro-active material inside a polymer matrix. The new technique has been successfully applied to monolithic and to polycrystalline SC electrode systems. Monolithic n-GaAs electrode showed up to eight fold enhancement in conversion efficiency. Polycrystalline film electrodes, involving nano-particles of semiconductors (CuS, CuSe, CdSe, CdTe, and others), are are globally known to be unstable and yield low conversion efficiency (in the order of 1.0% or less) under PEC conditions. Stability and efficiency of such new types of electrodes have been enhanced here by the new technique. Conversion efficiency values of 4.4, 8.0, 15.0% and 18.0% have been observed from CdSe, CdTe, CuS and CuSe film electrodes, respectively. Such values have not been reported for pristine metal chalcogenide film electrodes before. This presentation will show a critical survey of our results observed throughout the last 15 years, as compared to other literature. The new model proposed for the efficiency and stability enhancement will also be rigorously presented. Future prospects of this work will also be discussed.

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