Enhanced semiconductor nano-film electrodes in solar energy conversion: new achievements at An-Najah N. University

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Abstract

Semiconductor (SC) surfaces are useful electrodes in photo-electrochemical (PEC) processes. Solar light that reaches Earth is mostly in visible and infrared regions, with little UV. Thus, metal chalcogenide films with medium band gap (2.4 -1.8 eV; 550 – 700 nm) are heavily investigated. Unfortunately, such SC materials are unstable and degrade under PEC conditions. Therefore, stabilizing them is imperative. In these laboratories, the students' earlier works showed how chemical anchoring metalloporphyrin complexes to monolithic SC (GaAs, Si) surfaces enhanced their efficiency but not the stability. Later on, the students used metalloporphyrin/polymer matrices to enhance both efficiency and stability of these electrodes. Nano-film SC electrodes are being considered as alternative for monolithic SC electrodes due to cost and environmental considerations. Same technique has then been used for nano-film electrodes (CuS, CuSe, CdTe, etc) with known low efficiency and stability. Compared to reported conversion efficiencies in the range 0.5 - 5.0%, the systems described here exhibit very high conversion efficiency values of 14%, 18% and 19% for CuSe, CuS and CdTe films, respectively. Such results have not been preceded by known metal chalcogenide nano-film electrodes. The metalloporphyrin cations are responsible for such enhancement. By lowering the SC flat band edge position, and by speeding up the hole transfer across solid/liquid junction, the metalloporphyrin ions enhanced SC short-circuit current, conversion efficiency and stability. The type of the polymer coating also affects the conversion efficiency. Details of these new findings will be presented together with the model that best explains mode of action of metalloporphyrin ions.

Keywords: Metal chalcogenide nano-films, PEC; solar energy conversion; efficiency and stability enhancement.

Acknowledgments: This work is a continuation of 16 year continued work, with participation from many students and colleagues, whose works were presented earlier. This presentation is focused on recent CuSe, CuS and CdTe film electrodes.