Sam HY HSU et al., Int J Earth Sci Geol. 2018
http://dx.doi.org/10.18689/2642-1569.a1.002

Hybrid Perovskite Solar Cells to Combat Climate Change

Sam HY HSU*, Chengxi ZHANG, Chun Hong MAK and **Rugeng LIU**
City University of Hong Kong, Hong Kong

A variety of $PbI_2/MAPbI_3$ perovskites were prepared and investigated by a rapid screening technique utilizing a modified scanning electrochemical microscope (SECM) in order to determine how excess PbI_2 affects its photoelectrochemical (PEC) properties. An optimum ratio of 2.5% $PbI_2/MAPbI_3$ was found to enhance photocurrent over pristine $MAPbI_3$ on a spot array electrode under irradiation. With bulk films of various $PbI_2/MAPbI_3$ composites prepared by a spin-coating technique of mixed precursors and a one-step annealing process, the 2.5% $PbI_2/MAPbI_3$ produced an increases photocurrent density compared to pristine $MAPbI_3$ for 2mM benzoquinone (BQ) reduction at − 0.4 V vs Fc/Fc+. As a result of the relatively high quantum yield of $MAPbI_3$, a time-resolved photoluminescence quenching experiment could be applied to determine electron-hole diffusion coefficients and diffusion lengths of $PbI_2/MAPbI_3$ composites, respectively. The diffusion coefficients combined with the exciton lifetime of the pristine 2.5% $PbI_2/MAPbI_3$ (τ_{PL} = 103.3 ns) give the electron and hole exciton diffusion lengths, ~ 300 nm. Thus, the 2.5% $PbI_2/MAPbI_3$ led to an approximately 3.0-fold increase in the diffusion length compared to a previous report of ~ 100 nm for the pristine $MAPbI_3$ perovskite. We then demonstrated that the efficiency of liquid-junction solar cells for 2.5% excess PbI_2 of p-$MAPbI_3$ was improved from 6.0% to 7.3%.

Biography:

Sam H. Y. Hsu's research interests involve the material design, synthesis, processing, imaging, spectroscopy and solar energy application, aiming to explore fundamental properties and interactions of hybrid perovskite semiconductors and functional metallopolymer materials for developing efficient solar energy conversion processes. He has keen interests in photoinduced charge transfer processes, interfacial electron transfer, electrochemical hydrogen generation, and photoredox reactions for photovoltaics and solar fuel production. The investigations between material phenomena rely heavily on concepts and techniques of material and physical engineering, consisting of photophysics, electrochemistry, photoelectrochemistry, scanning photoelectrochemical microscopy imaging, ultrafast transient absorption and time-resolved photoluminescence spectra.