Abstract

In the first study; photo-current enhancements in a dye sensitized photo- electrochemical cell (PEC) with a Cu/p-CuI/M-C_{18} photo-electrode and a dye sensitized solid state photo-voltaic cell (DSSC) with Cu/n-Cu_2O/M-C_{18}/p-CuI were studied by controlling the formation of dye aggregates of M-C_{18} Langmuir-Blodgett (LB) films on the p-CuI layer. LB films of M-C_{18} were deposited under biasing conditions during the LB deposition process on Cu/p-CuI, Cu/n-Cu_2O/p-CuI and conductive glass plates with the three-electrode configuration setup coupling to the LB trough. LB films prepared under positive biasing conditions enhance the photo-current quantum efficiencies for both PECs and DSSCs controlling and minimizing the formation of dye aggregates. The electrolyte used for LB deposition and photo-current measurements was (10^{-2} M)Fe^{2+}/Fe^{3+}(10^{-2} M) and 1×10^{-2}M NaH_2PO_4-Na_2HPO_4, pH = 6 buffer solution respectively. Maximum photo-current quantum efficiencies (ϕ%) obtained are ≈22% for PEC and ≈20% for DSSCs, where the M-C_{18} LB film deposition applied potentials +0.3 V versus Ag/AgCl. The mechanism of the photo-current enhancement is discussed through the CANs model equation, $\phi = AD_0 - BD_0^2$, where $A = k_1k_2/F$, $B = Ik_1{}^2k_2\ [2k_6/F^3 + k_2k_4/k_3{}^2X^2F^2]$, $F = k_2 + k_5\ Y + k_7 + k_1\ I\ [1 + k_2\ /k_3X]$, presented from recent studies. Experimental evidences for the formation of the aggregates of M-C_{18} LB films for the negative applied potentials and suppression of the aggregates with positive applied potentials are presented from absorption spectra, AFM pictures and fluorescence measurements of the samples. Conversion efficiency obtained is ≈2.5%, V_{oc} ≈750 mV and I_{sc} ≈5.8 mA cm for DSSC fabricated with +0.3 V versus Ag/AgCl applied deposition potential of M-C_{18}

LB films.

In the second study; well cleaned commercially available copper sheets were heated maintaining different temperature profile heating rates to fabricate p-Cu_2O nano-surfaces. Initially a heating rate 10 °$Cmin^{-1}$ was provided inside the furnace with copper sheets starting from the room temperature until the temperature reaches 300 °C, 400 °C, 450 °C and 700 °C, and then the temperature kept constant for 30 min and cooled down to room temperature. A single phase nano-p-Cu_2O found for 300 °C, 400 °C and 450 °C temperature profiles may be due to maintaining a slow heating rate avoiding the formation of CuO. Samples prepared from 700 °C temperature profile contained both p-Cu_2O and CuO phases. Different surface morphologies were observed from AFM michrographs for samples prepared with different temperature profiles. A photo-current enhancement was found for the photo-electrochemical cell (PEC) with p-Cu_2O nano-surfaces produced from 450 °C temperature profile compared with that of the samples prepared from other temperature profiles. Material characterization from XRD, AFM and FTIR spectra, Diffuse reflectance spectra, VI characteristics, time development of the photo-current and estimated band positions were presented to discuss the mechanism of the photo-current enhancement and the remarkable stability exhibited for 450 °C temperature profile produced p-Cu_2O PEC. Considerable H_2 evolution rate was observed in the presence of 1M Na_2SO_4 electrolyte buffered at a pH of 4.9 for the nano-surfaces produced from 450 °C temperature profile, compared with the recently exhibited H_2 evolution systems studied by Gratzel and co-workers.