Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supplementary Information

Ultrathin MoS_2-MoO_3 nanosheets functionalized CdS photoanodes for effective charge transfer in a photoelectrochemical cell

A. Pareek[a,b] H.G.Kim,[c] P. Paik[b] and P. H. Borse[a]

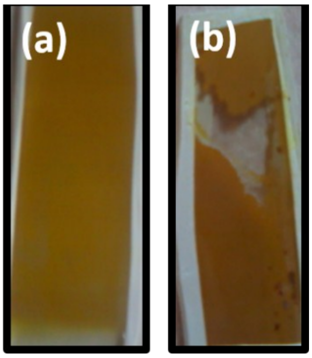

Figure SI 1. Photograph of spray deposited CdS thin film modified with MoS_2-MoO_3 for (a) 7 min impregnation time (b) 9 min impregnation time

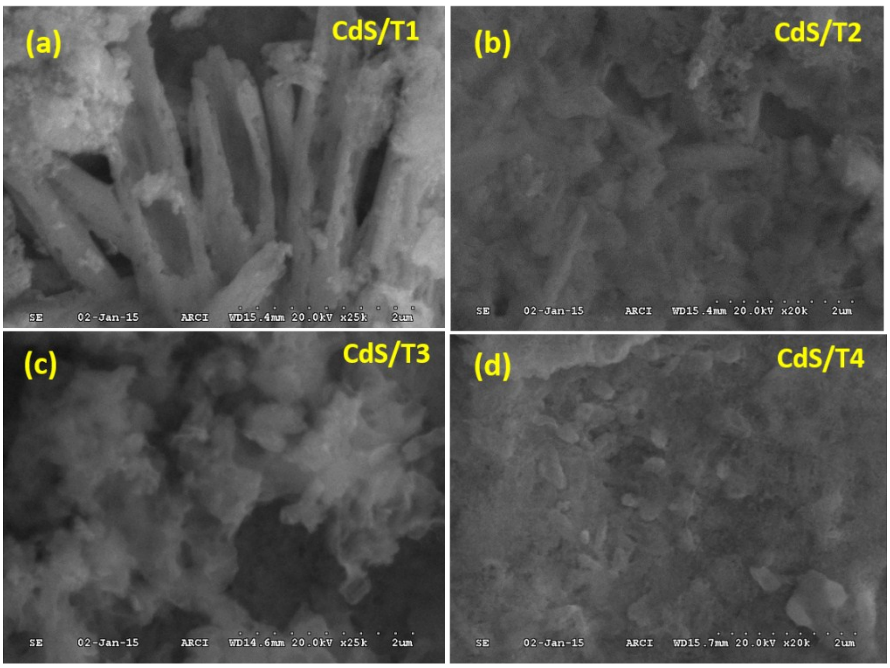

Figure SI 2. FESEM images of CdS modified with MoS_2-MoO_3 nanostructures synthesized at different reaction time (T1-10 hrs, T2-15 hrs, T3-24 hrs and T4-36 hrs).

1.1 Preparation of exfoliated MoS_2 nanostructures

MoS_2 powder purchased from sigma Aldrich was used for the preparation of exfoliated MoS_2 nanostructures. As received powder was dispersed in aqueous solution with concentration varying from 5 to 20 wt %. The above prepared dispersion was ultrasonicated for different time period *viz.* 30 min, 60 min and 90 min. The exfoliated MoS_2 nanostructures were then obtained and used for modification of CdS surface.

The surface of CdS thin films was modified with exfoliated MoS_2 dispersion by simple chemical impregnation method.

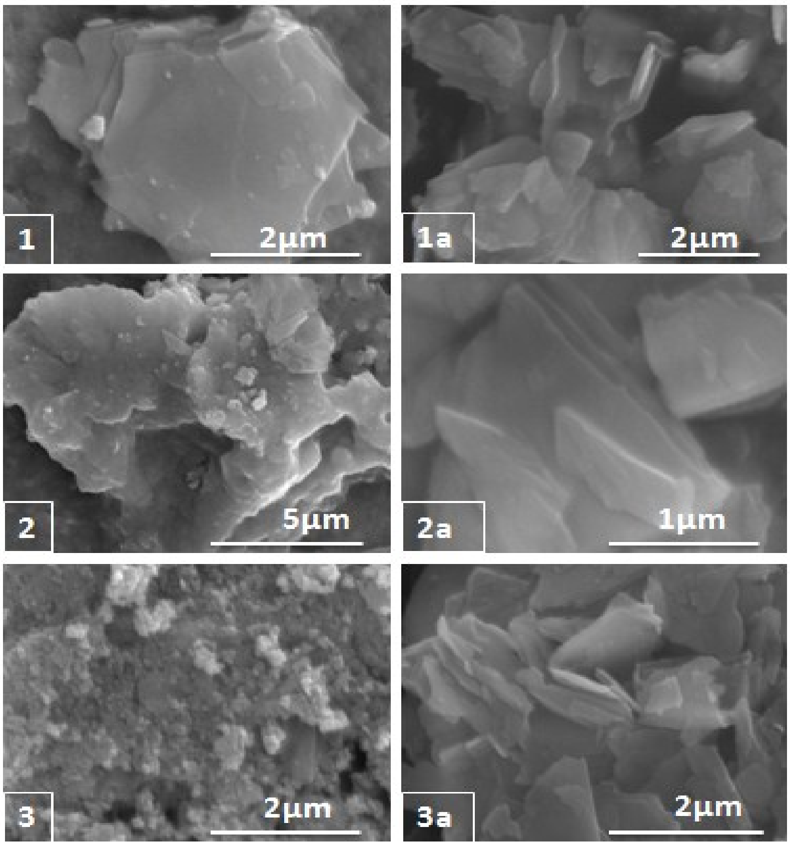

Figure SI 3. FESEM images of CdS modified with MoS_2 (1-3) with its corresponding exfoliated MoS_2 dispersions (1a-3a) of varying sonication time of 30, 60& 90min

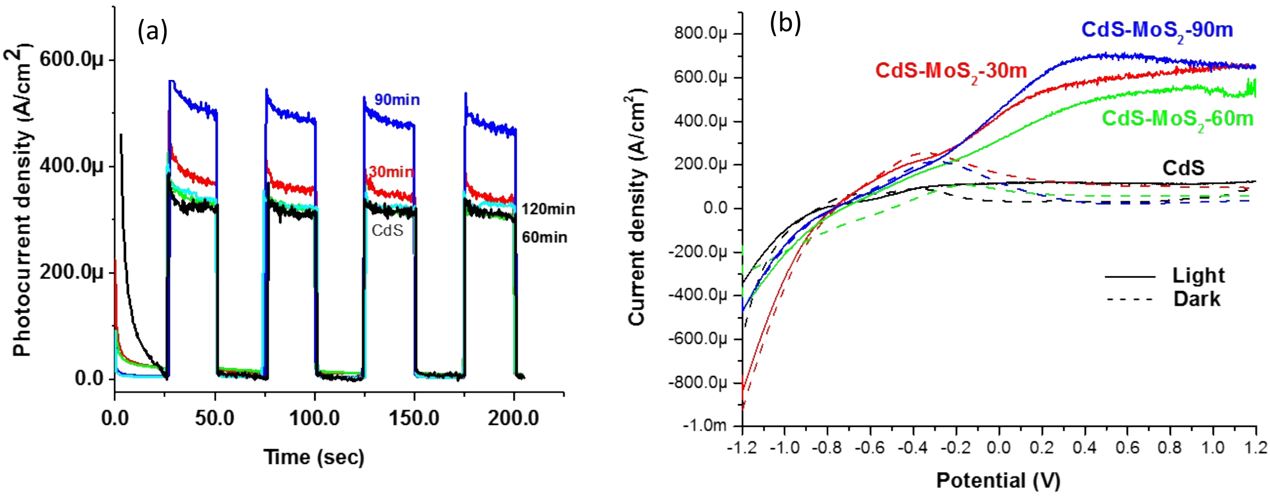

Figure SI 4 (a) Chronoamperometric curve at 0.2V (b) IV curve of CdS modified with exfoliated MoS_2 for different sonication time.

1.2 Solar to hydrogen conversion efficiency (STH)

STH (η_{STH}) was calculated for bare CdS and the most stable modified electrode at 0.2 V / SCE using following equation (1 & 2) [5]:

$$\eta_{STH}\ (\%) = \frac{(V_{rev} - V_{app}) * J_p}{I_0} * 100 \qquad \text{.....................................} (1)$$

Here V_{rev} is standard reversible potential *i.e.* 1.23 V, I_0 is power intensity of source *i.e.* 80 $mWcm^2$ and

$$V_{app} = V_{meas} - V_{oc} \qquad \text{...} (2)$$

Where, V_{oc} is open circuit potential and V_{meas} is the potential at which photocurrent measurements are carried out with respect to a reference electrode (SCE).

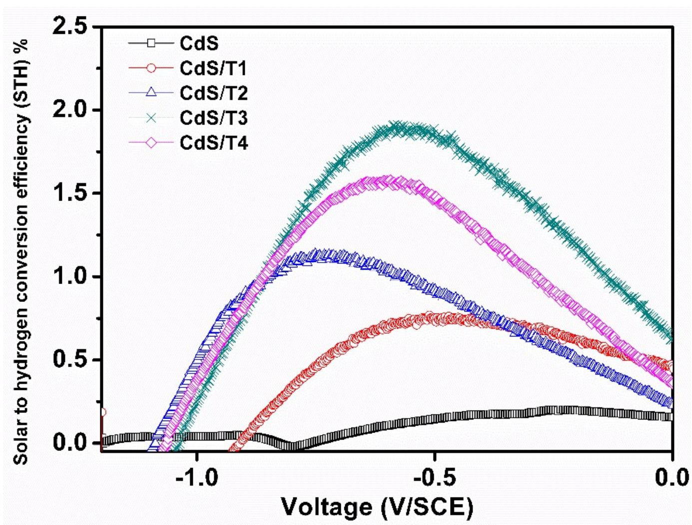

Figure S5. STH variation with applied bias of CdS thin photoanode modified with MoS_2-MoO_3 nanostructures synthesized at different reaction time (T1-10 hrs, T2-15 hrs, T3-24 hrs and T4-36 hrs)

1.3 Incident photon to current conversion efficiency (IPCE)

IPCE is one of the most important characterizations for PEC devices. It describes the photocurrent collected per incident photon flux as a function of illumination wavelength. IPCE was calculated for bare CdS and modified electrodes using the equation (3) [5]:

$$IPCE = \frac{1240 * J_{ph}}{P * \lambda} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where J_{ph} the photocurrent density in $mAcm^{-2}$, P is power of source in $mWcm^{-2}$ and λ is wavelength in nm.

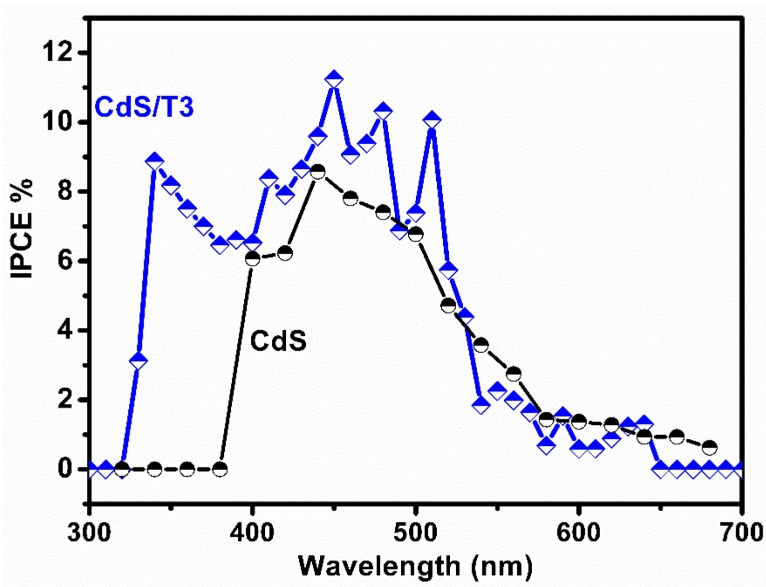

Figure SI 6 IPCE measurements of CdS and CdS/T3 films.

1.4 Electrochemical impedance spectroscopy (EIS)

Electrochemical impedance spectroscopy was carried out to understand the charge transfer mechanism between photoelectrode and electrolyte using electrochemical workstation (PARSTAT 2273 Model). All the measurements were carried out in dark at an applied bias of 10 mV.

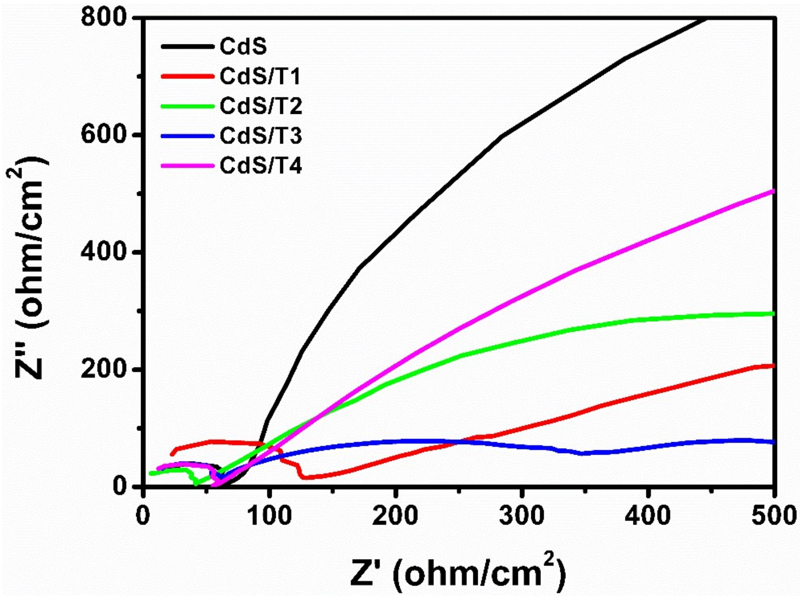

Figure SI 7. EIS of CdS thin film modified with MoS_2-MoO_3 nanostructures synthesized at different reaction time (T1-10 hrs, T2-15 hrs, T3-24 hrs and T4-36 hrs)

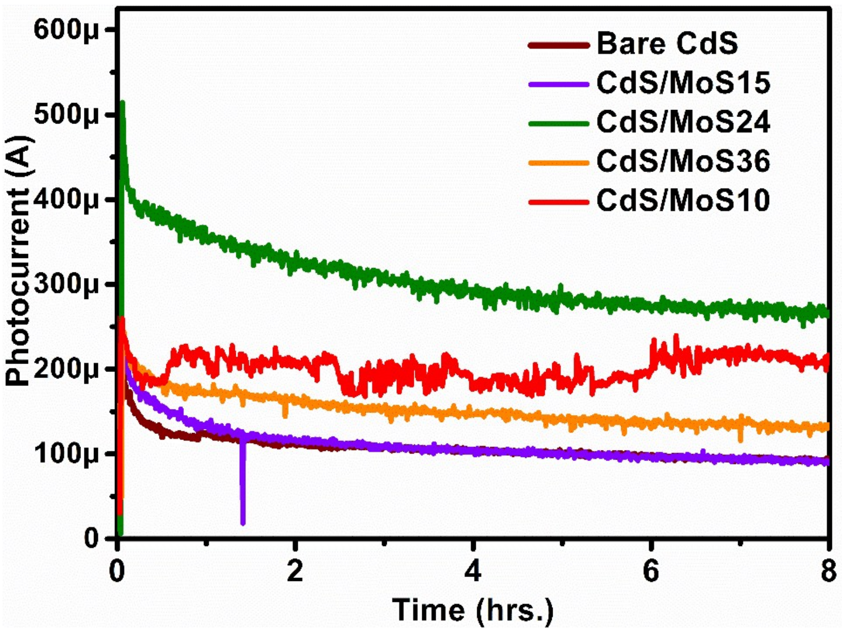

Figure SI 8. Stability of CdS thin film modified with MoS_2-MoO_3 nanostructures synthesized at different reaction time (T1-10 hrs, T2-15 hrs, T3-24 hrs and T4-36 hrs)