Supplementary Information

A strategy to enhance efficiency in dye-sensitized solar cells by highly efficient TiO_2/ZnS photoanode

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X-ray diffraction pattern was investigated to identify the crystallographic phase of CoS film which is shown in Fig. S1. The diffraction peaks appeared at $2\theta = 30.62^{o}$, 35.30^{o}, 54.44^{o}, 63.76^{o} and 73.16^{o} assigned to the [1 0 0], [1 0 1], [1 1 0], [2 0 0] and [0 0 4] crystal planes of the hexagonal structure (JCPDS card No. 03-065-3418.

Fig. S2 shows the optimization of ZnS SILAR cycles on TiO_2 photoanode. The adhesion depends strongly on the rate of separation of the bond surfaces, deposition temperature and time etc.[1] In this study, development of adhesion and its strength with deposition time is not considered; care was taken to obtain adhesion through ZnS SILAR cycles on TiO_2. We have observed strong adhesion between the substrate, photoanode and sensitizer until 4 SILAR cycles. Later on, the electrolyte was absorbed by the sensitized

photoanode from ZnS6 to ZnS8. As the SILAR cycles are increased, the material started to peel off from the substrate.

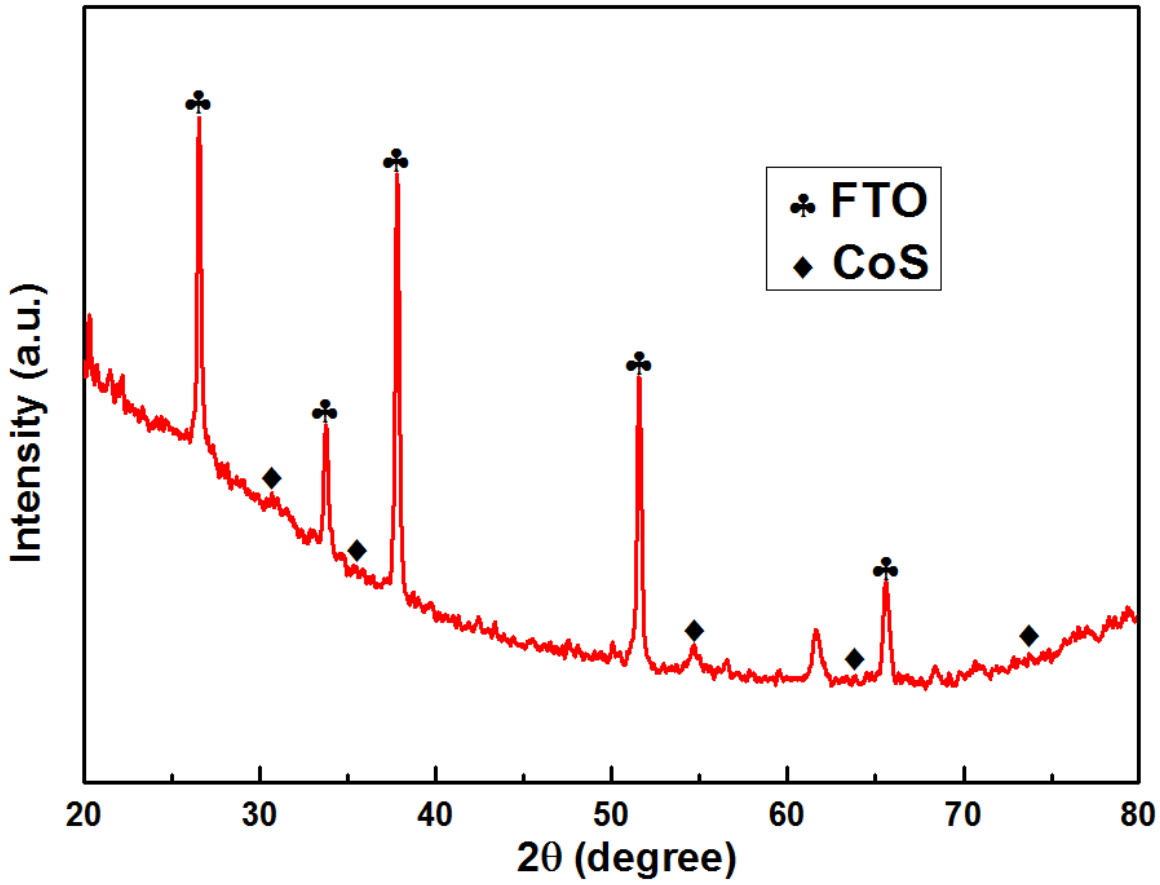

Fig. S1. X-ray diffraction results of CoS thin films on FTO substrate.

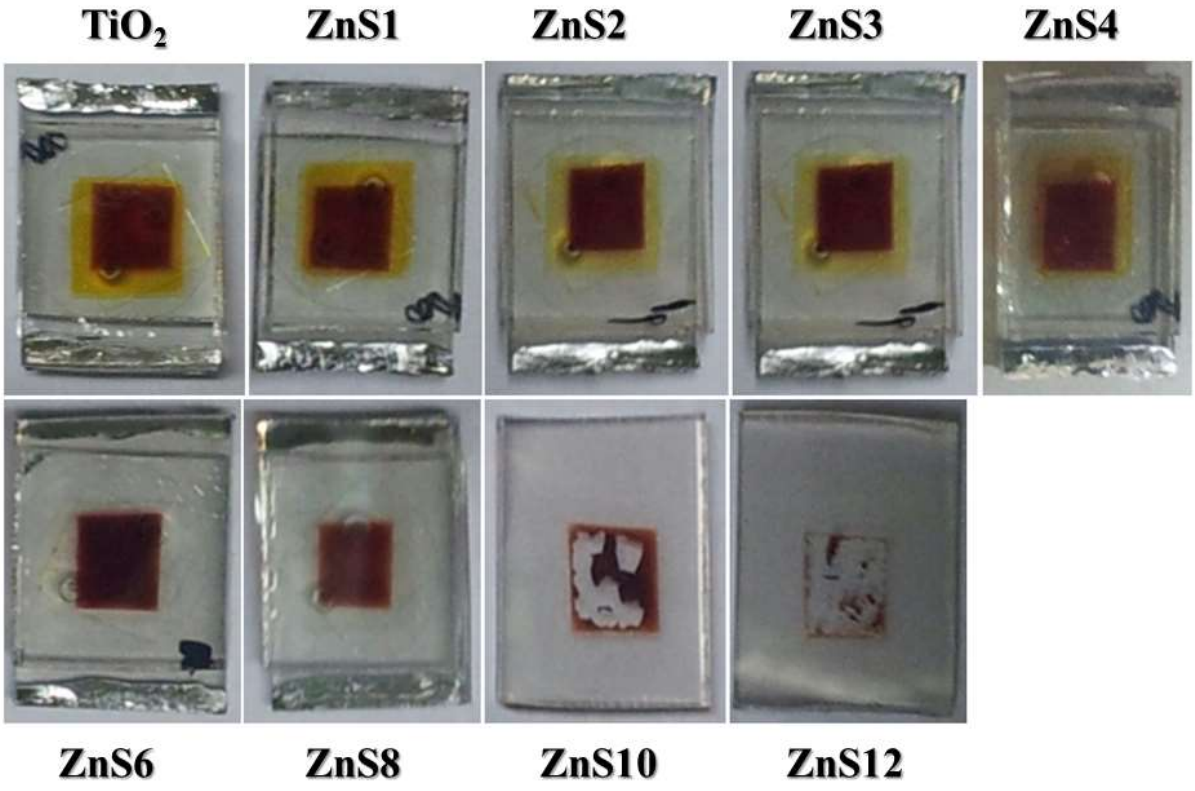

Fig. S2. Optimization of ZnS SILAR cycles on TiO_2 electrode.

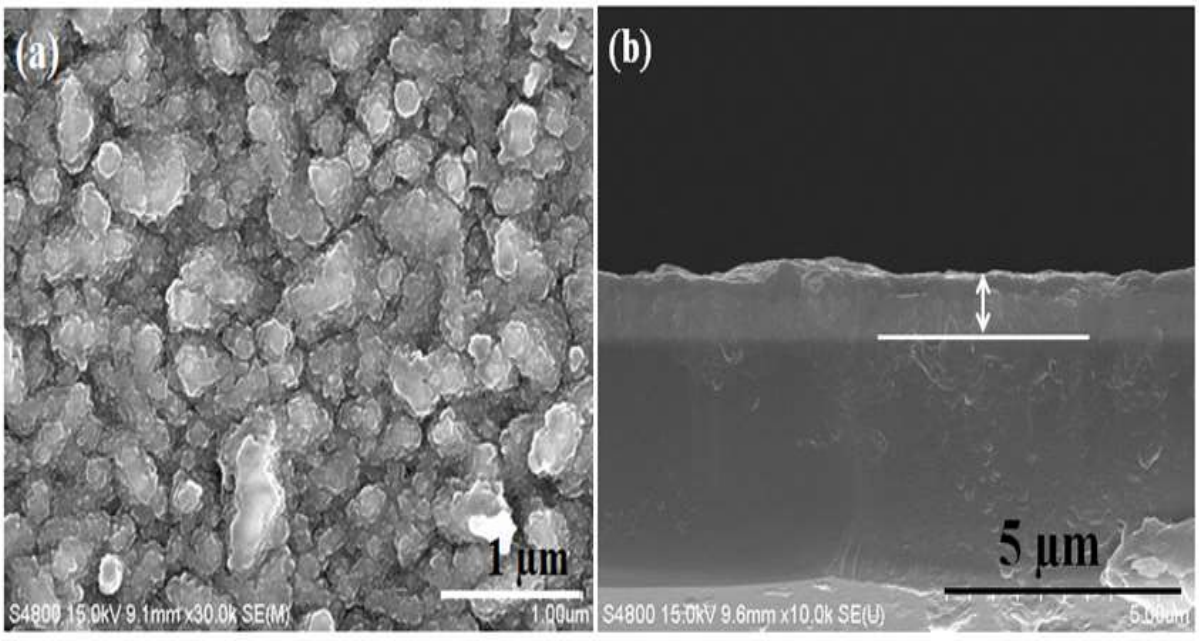

Fig. S3. SEM and cross sectional SEM images of the CoS thin film on FTO substrate.

FE-SEM and Cross sectional SEM images were conducted to identify the surface morphology and thickness of CoS thin films on FTO substrate and the resultant figures are shown in Fig. S3. Adhesion of material on FTO substrate plays a key role in determining the power conversion efficiency. When the deposition temperature was 80 ^{o}C for 2 h, the active material shows good adhesion to the substrate and hence long-term stability was observed in I^-/I_3^- electrolyte. The diameter of the CoS is approximately 157 nm. Fig. S3(a) shows a rough scale-like structure and accumulated nanoparticles, which renders it highly catalytically active in the CE. The thickness of the CoS film is about 1 μm from SEM image cross section (Fig. S3(b)).

References

1 A.N. Gent and R.P. Petrich, *Proc. Roy. Soc. A.* 1969, **310**, 433-448.