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ZnO@CdS Heterostructure: An Efficient Photoanode for Photoelectrochemical Water Splitting

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Characterizations:

Shimadzu Spectrophotometer (model no. UV-2450) with a deuterium and tungsten-halogen lamp was used to study ultra-violate visible spectroscopy. Horiba Jobin Yvon Spectroflourimeter (Fluoro max-4) was used to measure the photoluminescence (PL) spectra. Powder X-ray analysis was carried out using Rigaku Mini Flex II diffractometer with incident radiation of Cu-Kα. Whole analysis was carried out keeping the scanning rate 2° per min. Microscope version, XT Platform version, XT UI version, Modal- "APREO S" FE-SEM was used to investigate the morphology of the synthesized ZnO and CdS decorated ZnO samples. EDS Analysis was carried out for these samples using the EDS attachment with FESEM which is Aztec (software), X-MaxN, NS: 77887 (Detector) of Oxford company. Raman analysis was carried out using HORIBASCI Raman instrument (model no LabRAM HR EVO). The detector is thermoelectrically cooled charged coupled device (CCD) detector of 576×384 pixels. Raman analysis is carried out upon excitation with 532 nm laser power.

Photoelectrochemical Measurement:

In this present case, photoelectrochemical study was conducted in a three-electrode system. PEC water splitting was carried out 0.5 M Na_2SO_4 as the electrolyte. In the cell silver chloride electrode was applied as reference electrode, Pt as the counter electrode and sample deposited FTO as working electrode. Xenon lamp was used to illuminate the PEC cell with fixed light intensity of 100 mW/cm^2. CH Instrument (CHI604E) was used to record all the electrochemical data at 25 °C. Initially, linear-sweep voltammogram (LSV) was recorded for ZnO and ZnO@CdS photoanode upon applied potential from -0.9 V to 1 V vs. Ag/AgCl keeping scan rate 20 mV/sec. Chronoamperometry study was carried out under potential of 0.0 V vs. Ag/AgCl.

Electrochemical Impedance Study:

Electrochemical impedance measurement was also performed in a three electrode system. It was performed at a bias of 0.0 V vs Ag/AgCl electrode with the sweeping of frequency from 50 kHZ to 1 Hz. Xenon lamp was used to illuminate the PEC cell with fixed light intensity of 100 mW/cm^2.

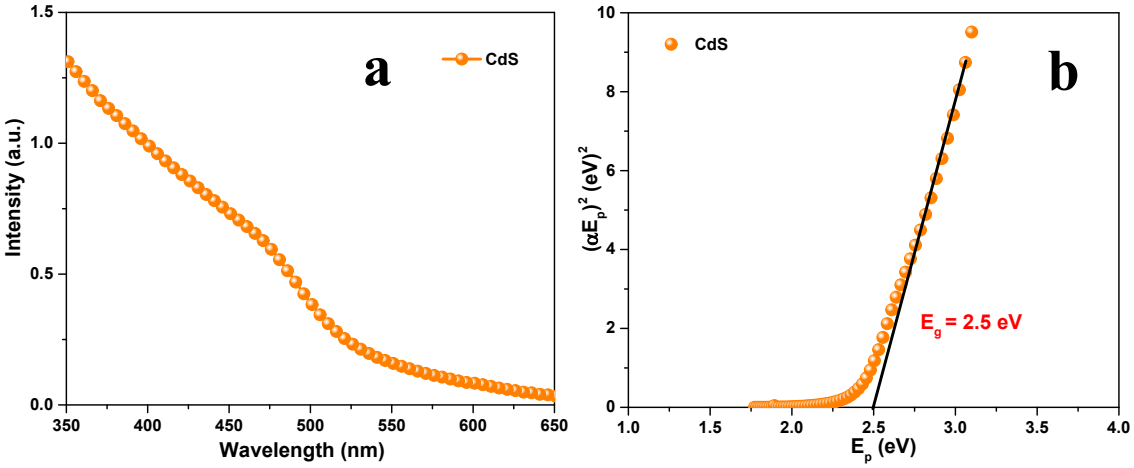

Fig. S1: (a) UV-vis absorbance spectra and (b) calculated bang gap value of CdS nanoparticles.

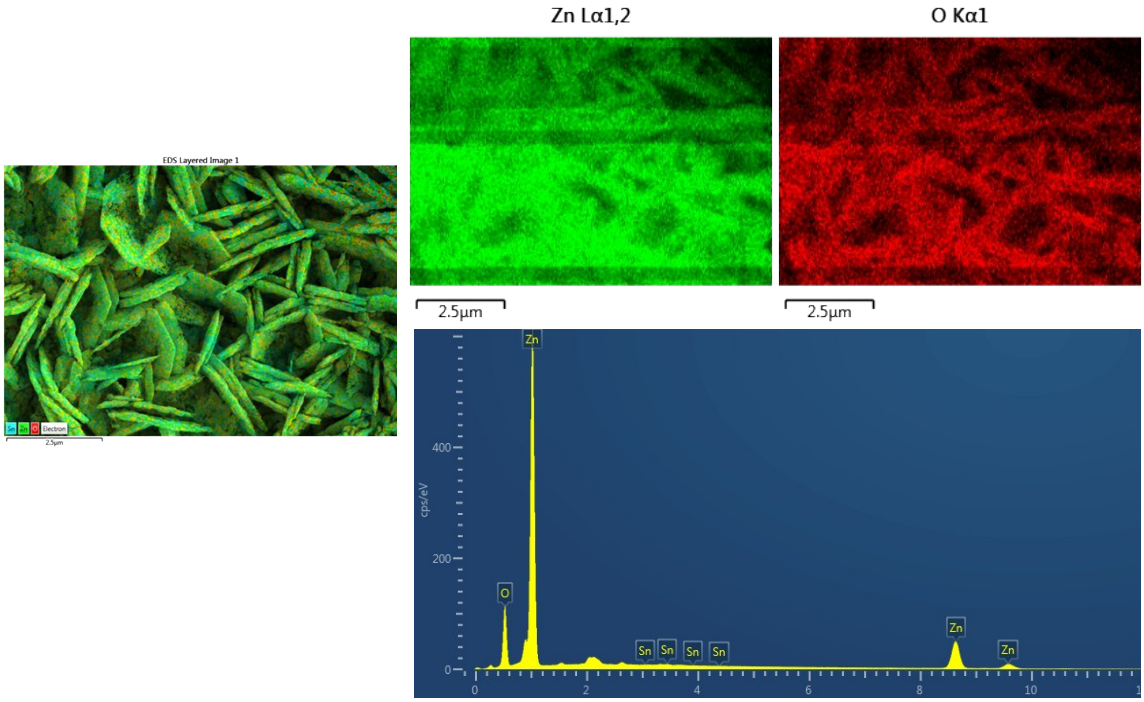

Fig. S2: EDS analysis of ZnO nanosheets on FTO which shows the uniform distribution of ‘Zn’ and ‘O’.

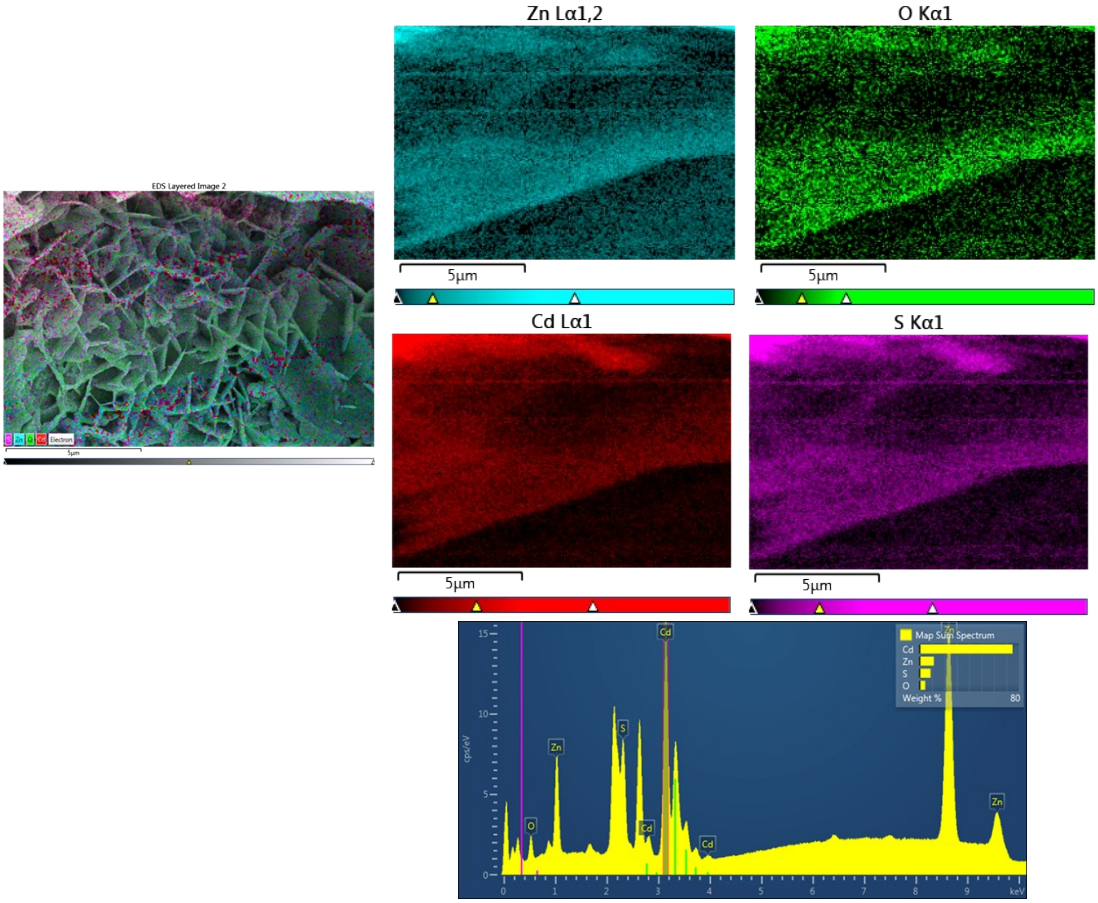

Fig. S3: EDS analysis of ZnO@CdS/20 nanosheets on FTO which shows the uniform distribution of ‘Zn’, ‘O’, ‘Cd’ and ‘S’.

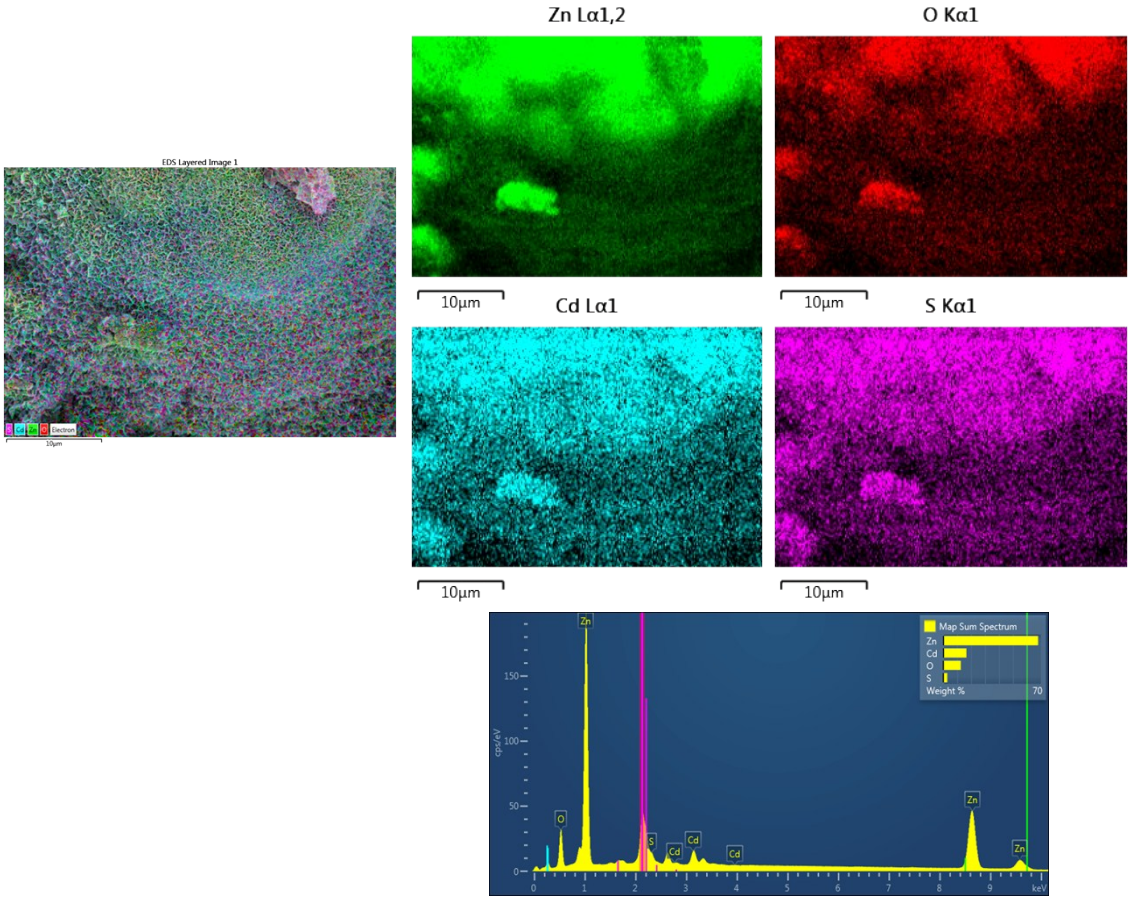

Fig. S4: EDS analysis of ZnO@CdS/5 on FTO which shows the uniform distribution of ‘Zn’, ‘O’, ‘Cd’ and ‘S’.

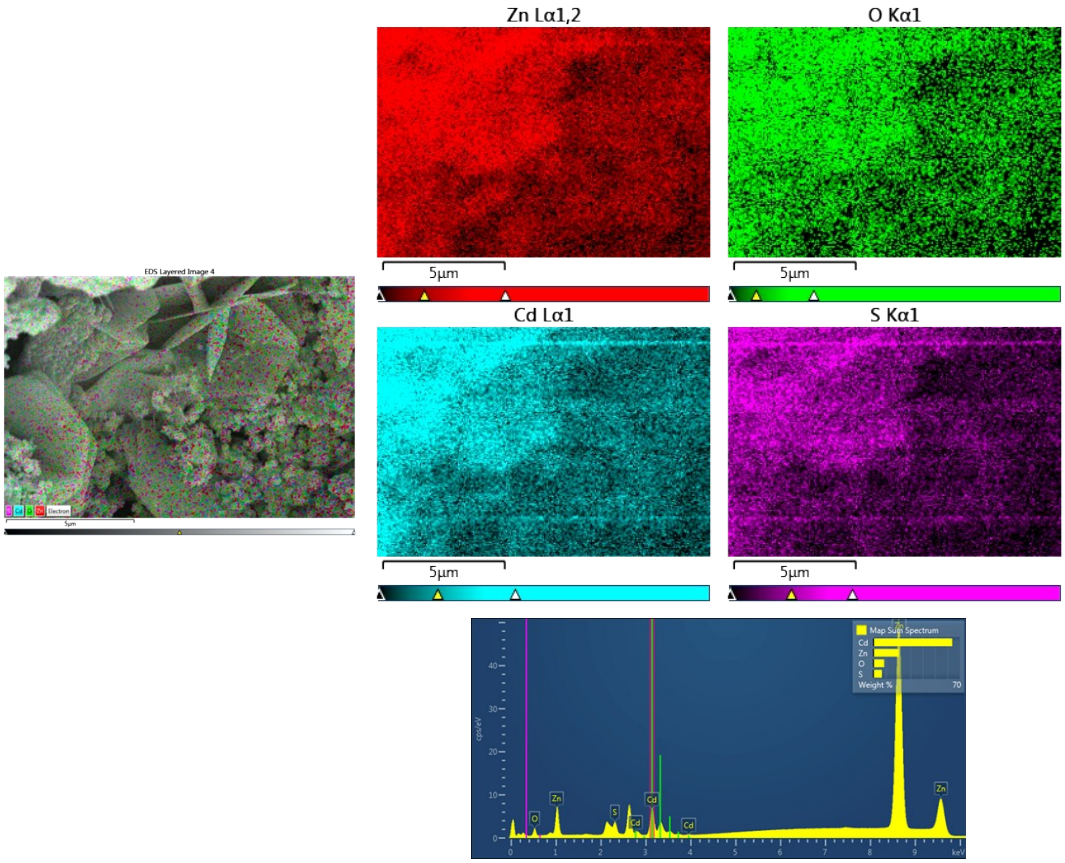

Fig. S5: EDS analysis of ZnO@CdS/30 on FTO which shows the uniform distribution of ‘Zn’, ‘O’, ‘Cd’ and ‘S’.

Table S1: ICP-OES result for ZnO@CdS/20 showing the presence of Zn:Cd of 5:1.

S. No. Test	Test parameter	UOM	Instrument used	Result
01	Zinc asZn	% by mass	ICP-OES	63.16
02	Cadmium as Cd	% by mass	ICP-OES	12.40

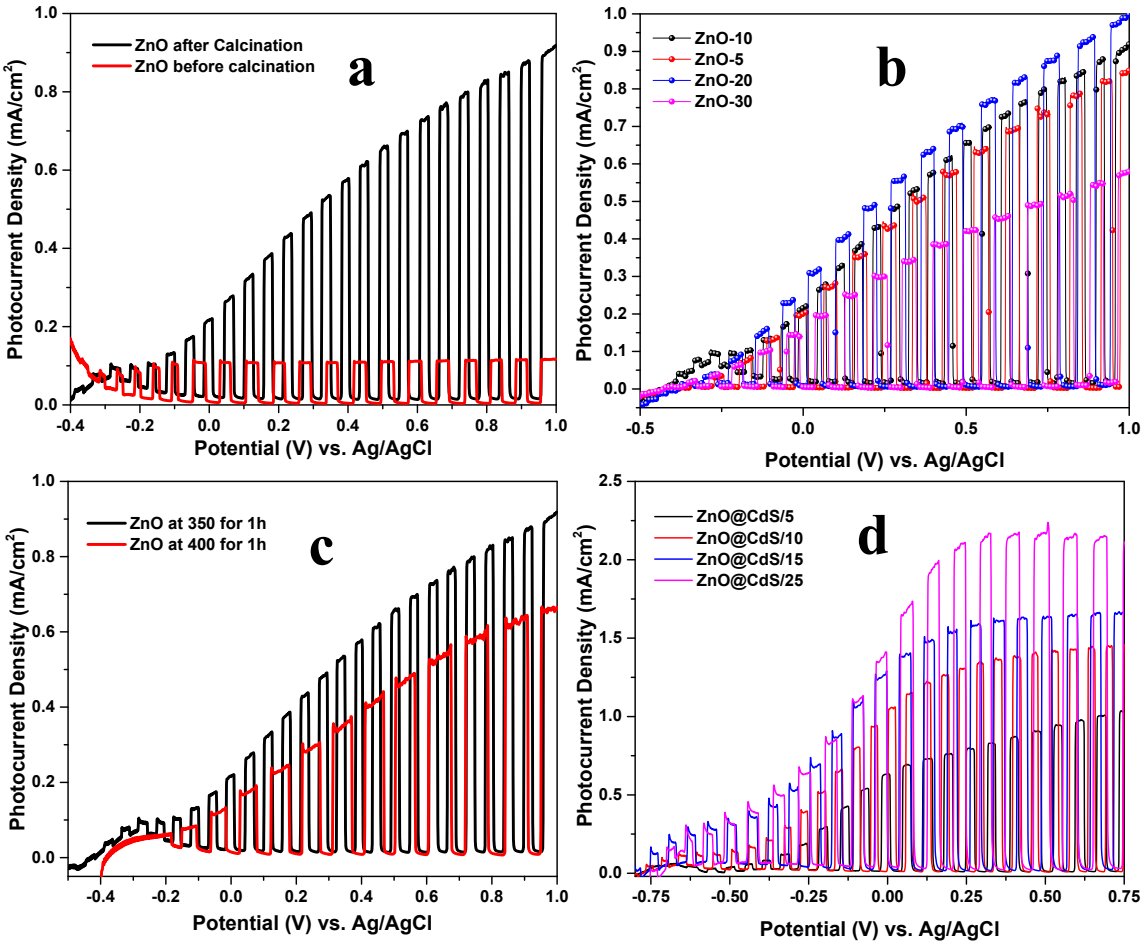

Fig. S6: (a) linear sweep voltammograms of ZnO nanosheets before and after calcination, (b) ZnO-5, 10, 20 and 30, (c) ZnO calcined at 350 °C and 400 °C for 1h under chopped illumination condition, (d) linear sweep voltammograms of ZnO@CdS/5, 10, 15 and 25 under chopped illumination condition,

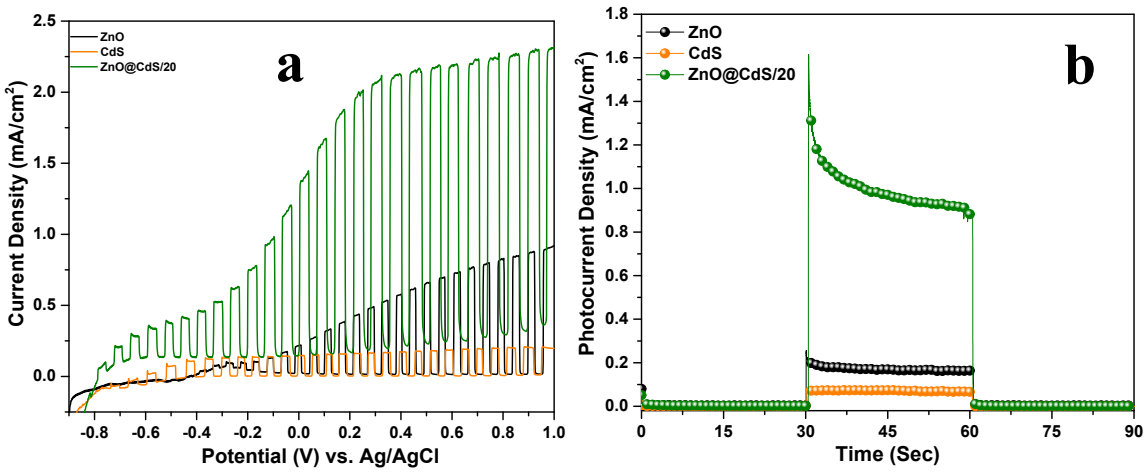

Fig. S7: (a) Comparative linear sweep voltammograms of ZnO nanosheets, CdS nanostructure and ZnO@CdS/20 under chopped illumination condition, (b) i-t plot of ZnO, ZnO@CdS/20 and CdS at a fixed potential of '0' V vs. Ag/AgCl observed for 90 sec.