Electronic Supplementary Information for:

7.1% efficienct co–electroplated Cu_2ZnSnS_4 thin film solar cells with sputtered CdS buffer layers

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Experimental

CdS thin films preparation

The CdS thin films were prepared in a radio frequency (RF) magnetron sputtering system. A sintered ceramic CdS target (99.999% purity, 2 inches diameter) was employed as source material. The separation between target and substrate was about 6 cm in the on-axis geometry. The base pressure of the deposition system was 4×10^{-5} Pa and the growth pressure was fixed at 2.7 Pa. The sputtering power was fixed at 30 W. The deposition was carried out in pure argon gas (99.999%) at a constant substrate temperature of 200 °C during 25 min after 5 min of pre-sputtering.

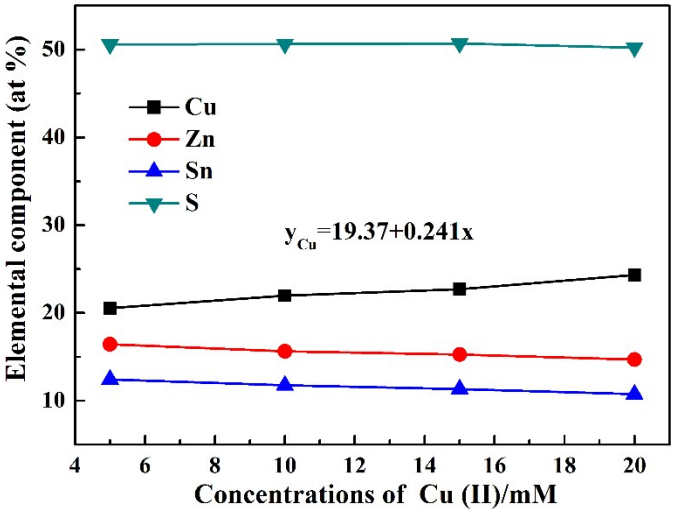

Figure S1. Dependence of Cu, Zn, Sn and S content in the CZTS thin films as a function of different concentrations of Cu (II) concentrations in the electrolyte solutions.

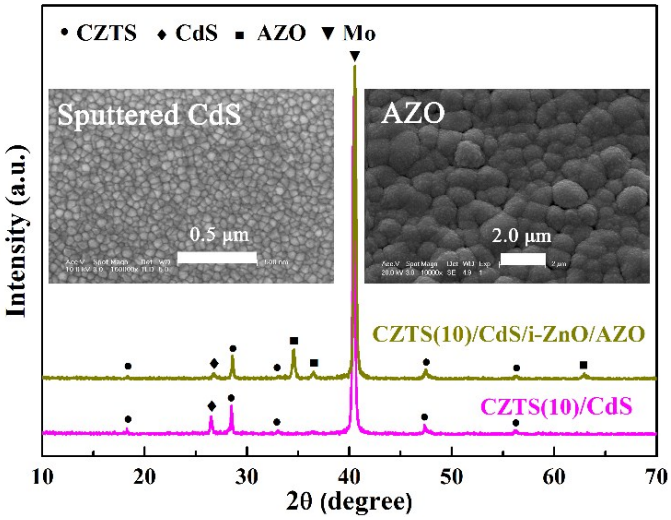

Figure S2. XRD pattern of a CdS thin film deposited on the CZTS(10)/Mo/glass substrate and then an AZO film successively deposited on CdS/CZTS(10)/Mo/glass substrate by RF magnetron sputtering. Inset SEM image shows the plain view of the CdS and AZO thin films, indicating smooth and dense film morphology.

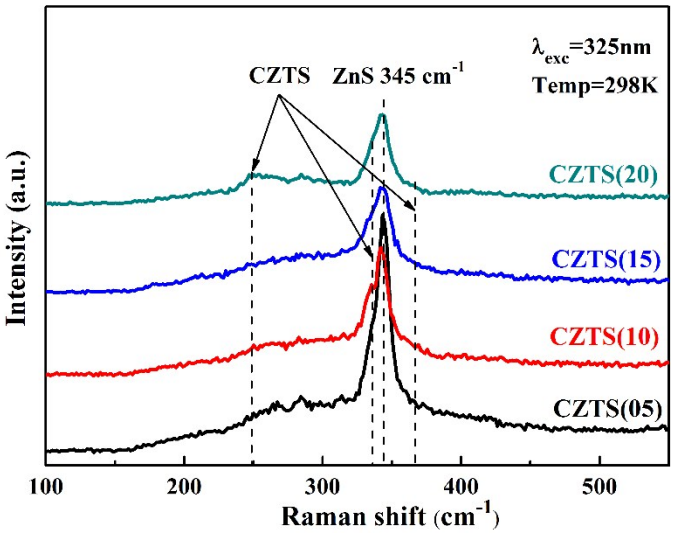

Figure S3. Raman spectra (325 nm excitation) of the sulfurized CZTS thin films deposited with various Cu (II) concentrations.

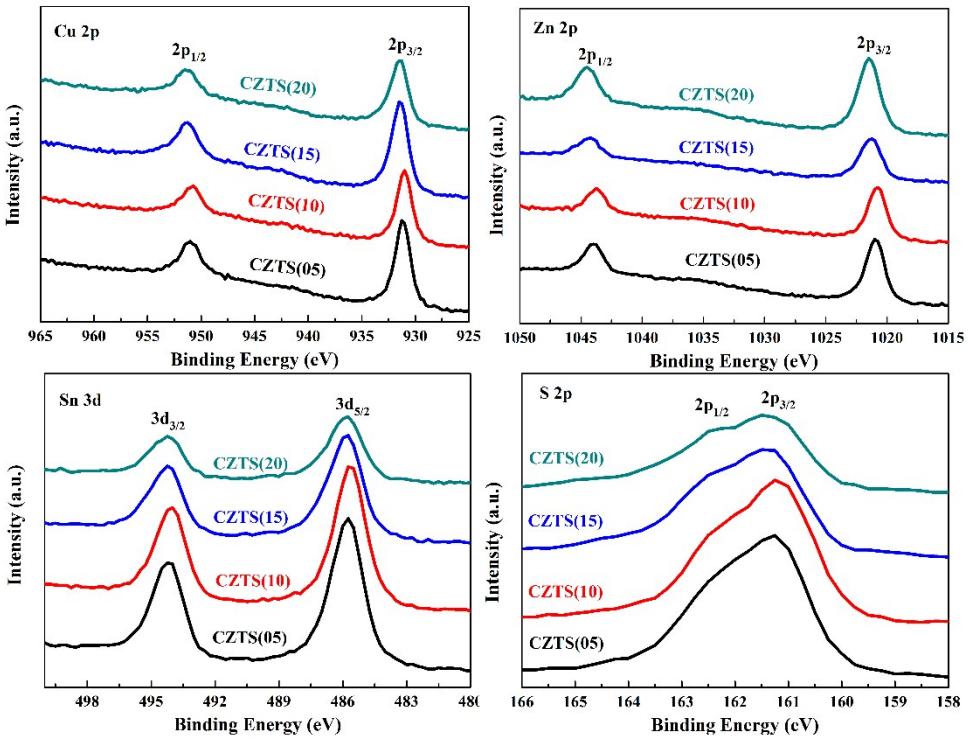

Figure S4. High-resolution XPS spectra of (a) Cu 2p, (b) Zn 2p, (c) Sn 3d and (d) S 2p for the CZTS thin films recorded at room temperature.

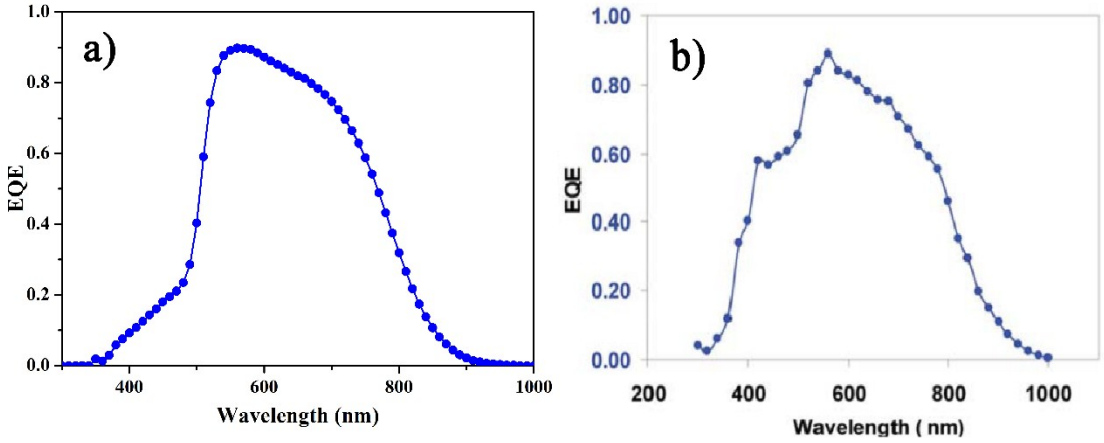

Figure S5. EQE measurements of the CZTS solar cells; (a) this work (CZTS(15) solar cell) and (b) Ref.[1]

1 S. Ahmed, K.B. Reuter, O. Gunawan, L. Guo, L.T. Romankiw and H. Deligianni, Adv. Energy Mater., 2012, 2, 253–259.

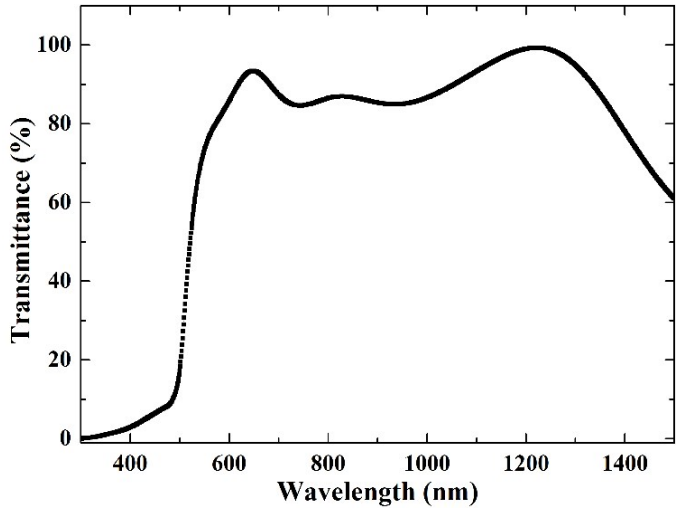

Figure S6. Optical transmittance spectra of the sputtered CdS thin film on a glass substrate.

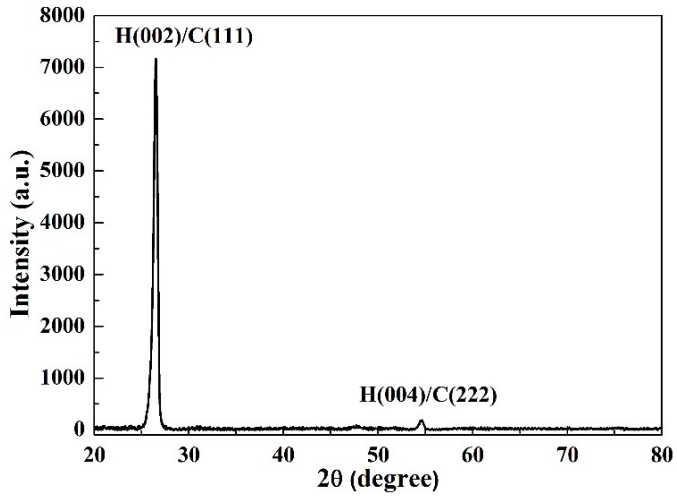

Figure S7. The XRD spectra of the sputtered CdS thin film deposited on a glass substrate.