
Supporting Information

An In-situ and Green Method to Prepare Pt-free $\text{Cu}_2\text{ZnSnS}_4$ (CZTS) Counter Electrodes for Efficient and Low-cost Dye Sensitized Solar Cells

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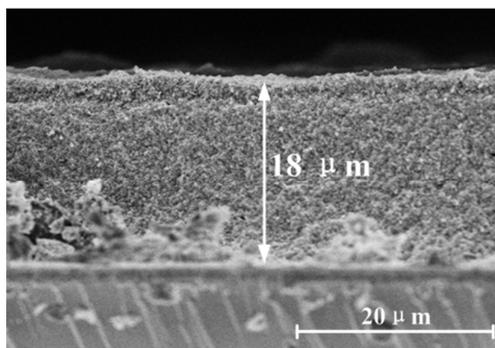


Figure S1. Cross-sectional SEM images of the TiO_2 photoanode

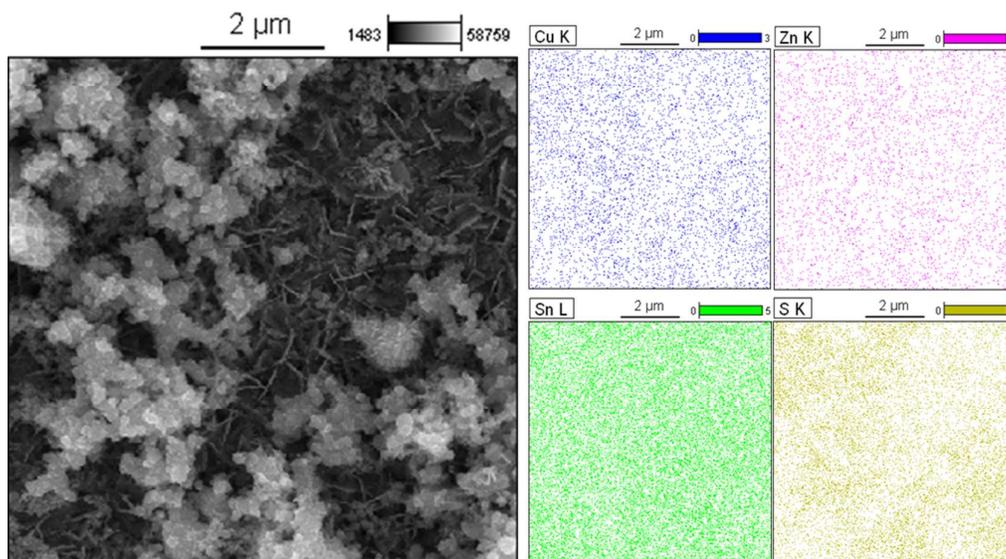


Figure S2. SEM image of CZTS 3 films, and corresponding EDS elemental mappings for Cu, Zn, Sn, and S.

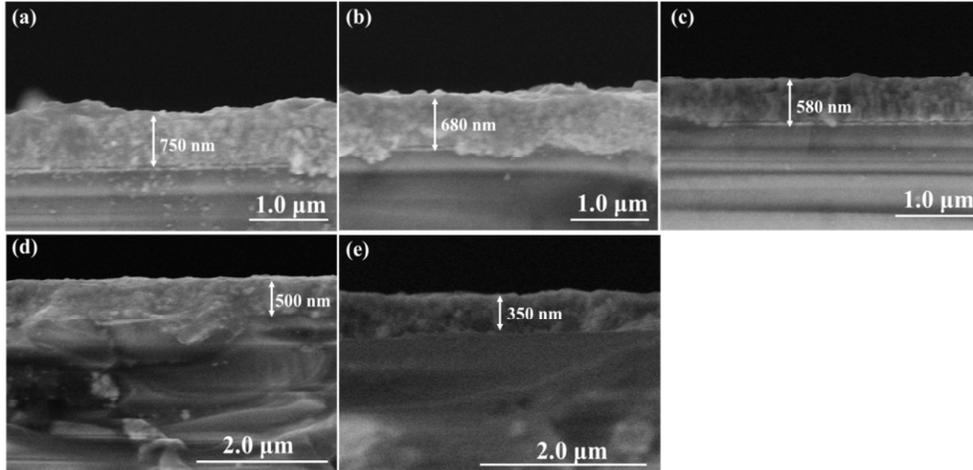


Figure S3. The cross-sectional FE-SEM images of the CZTS films for CZTS 1 (a), CZTS 2 (b), CZTS 3 (c), CZTS 4 (d), and CZTS 5 (e).

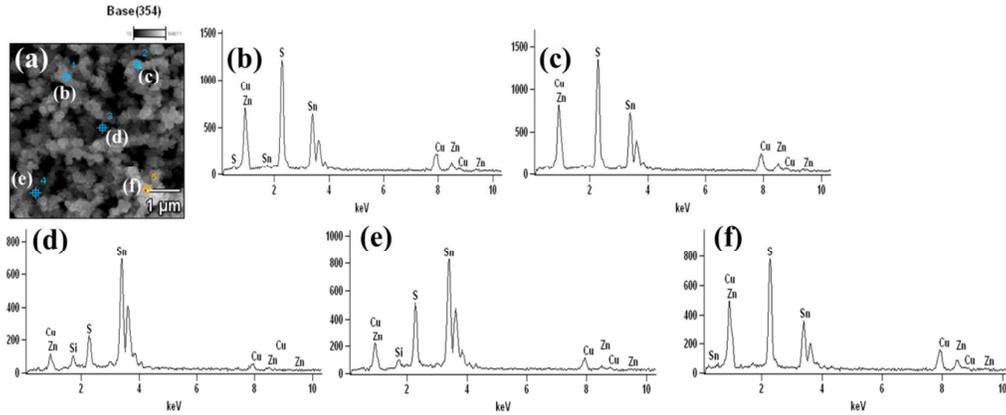


Figure S4. SEM image (a) of CZTS 3 film, and elemental spectrum (b-f) of several dots on the thin film. The Sn signal becomes larger than the S signal for (d) and (e) due to the X-ray contribution from the SnO/TCO layer, and is not completely representative of the thin nanosheet composition. However, the spectrum does reveal that the nanosheet is indeed CZTS.

Table S1. Elemental ratios of several dots on the CZTS 3 thin film.

Sample	EDS estimated composition	[Zn]/[Sn]	[Cu]/[S]
	(% atomic ratio Cu/Zn/Sn/S)	~1.25(Expected)	~0.5(Expected)
Dot 1	20.91/18.82/18.68/41.60	1.00	0.50
Dot 2	23.43/17.80/18.67/40.11	0.95	0.58
Dot 3	/	/	/
Dot 4	/	/	/
Dot 5	22.74/17.68/16.43/43.15	1.10	0.52