

Supporting Information

Self-assembled nanometer-scale ZnS structure at the CZTS/ZnCdS hetero-interface for high efficiency wide bandgap $\text{Cu}_2\text{ZnSnS}_4$ solar cells

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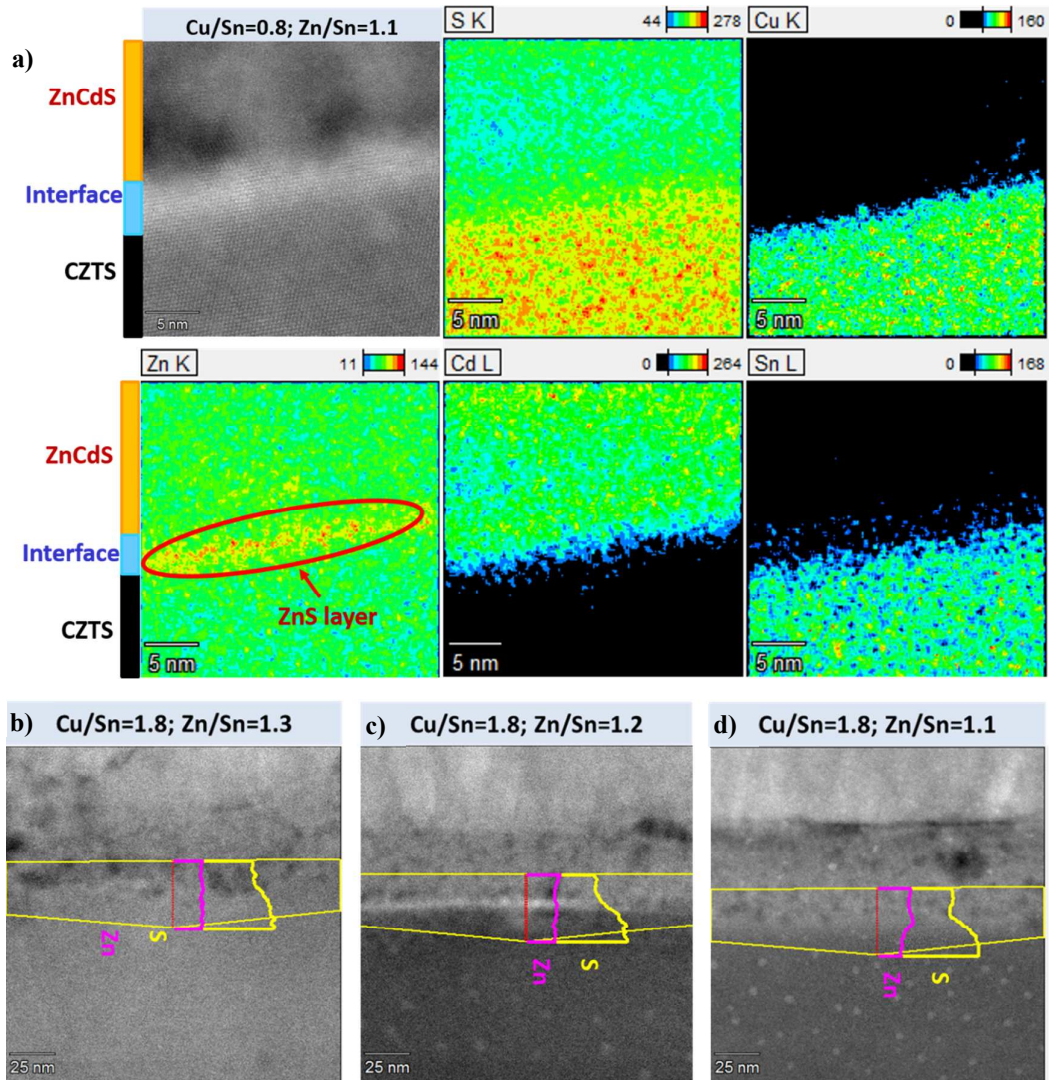


Figure S1. a) Enlarged EDS mapping of the interface region of “Zn/Sn = 1.1” sample. It is obvious that Zn distribution shows a superfluous layer at the immediate vicinity with the absorber. Line scan of the interface region from CZTS device fabricated using absorber of different composition b) Zn/Sn = 1.3, c) Zn/Sn = 1.2, d) Zn/Sn = 1.1. (Zn and S only). Comparing these three samples, Zn profile in “Zn/Sn = 1.1” sample demonstrates a distinct rise when scanning to the region where ZnCdS and CZTS contact with each other.

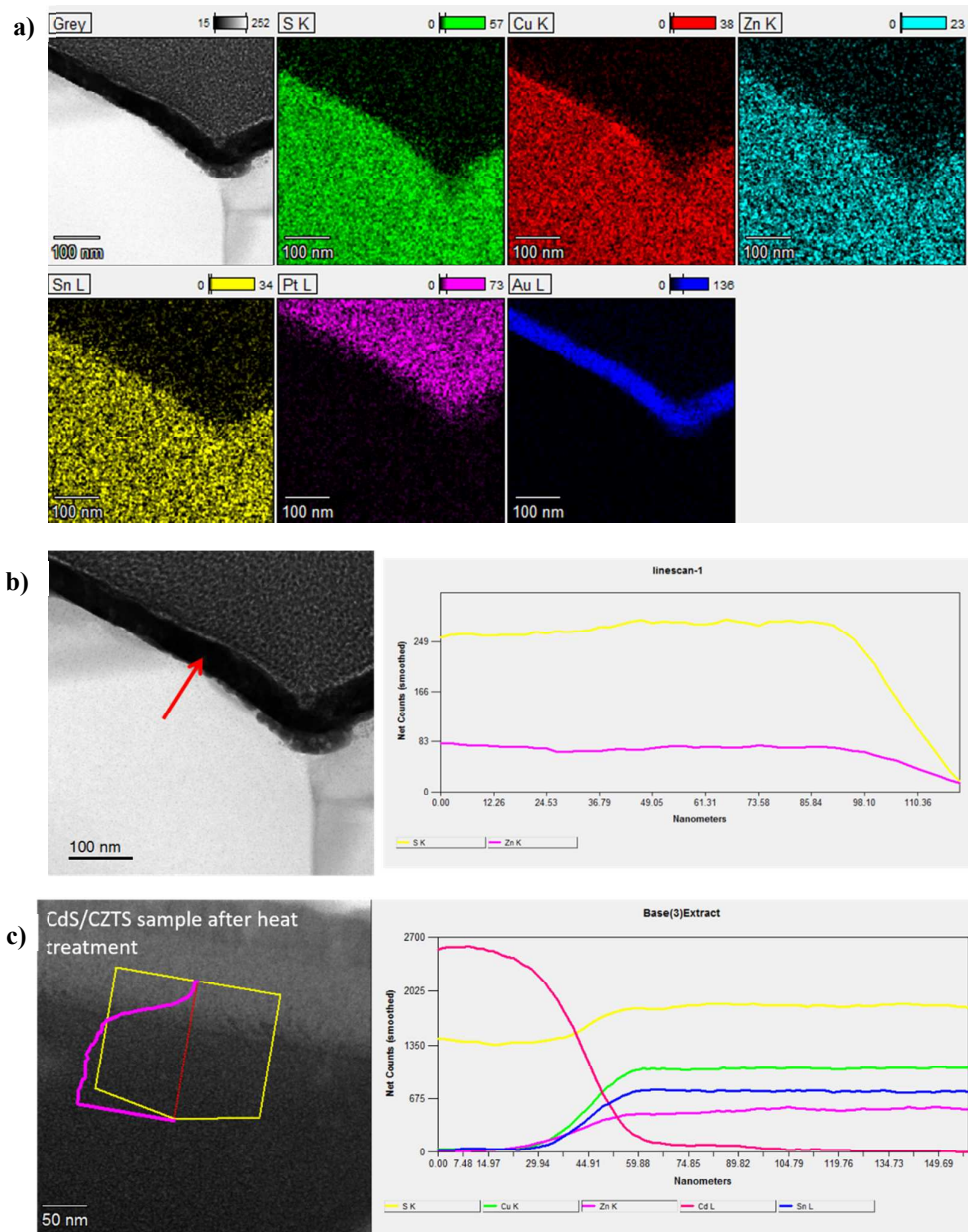


Figure S2 a). EDS mapping, b). Line scan from surface region of bare CZTS absorber with low Zn ratio composition and c) Line scan on CdS/CZTS sample subjected to the same heat treatment as in ZnCdS case. No Zn segregation is observed at the surface of CZTS absorber from both EDS mapping and line scan on samples with or without heat treatment.

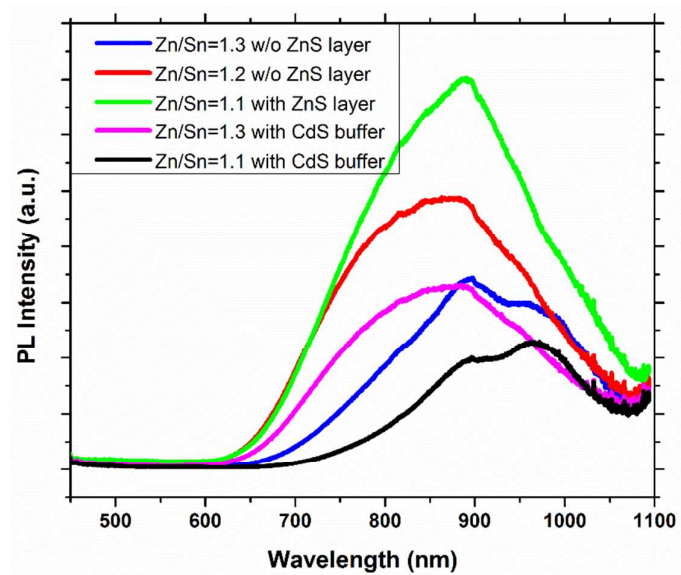


Figure S3. Photoluminescence (PL) spectra of CZTS devices applying CdS buffer and ZnCdS buffer with and without ZnS nanodot layer from absorbers of different composition.

Table S1. Device characteristic of all the cells of three groups of samples.

(Highlighted are the best cells among each group of samples)

Device	Efficiency (%)	Voc (mV)	Jsc (mA/cm ²)	Fill Factor
Zn/Sn=1.3 w/o ZnS layer				
Cell 1	7.58	711.89	18.42	57.77
Cell 2	7.51	709.67	18.25	57.96
Cell 3	7.56	704.24	18.21	58.96
Cell 4	7.51	696.25	18.31	58.90
Cell 5	7.52	696.71	18.66	57.86
Zn/Sn=1.2 w/o ZnS layer				
Cell 1	8.18	715.71	19.25	59.36
Cell 2	8.19	711.08	19.38	59.46
Cell 3	8.26	710.37	19.63	59.21
Cell 4	8.23	704.72	19.84	58.88
Cell 5	8.22	698.81	19.72	59.64
Cell 6	8.28	711.87	19.56	59.47
Zn/Sn=1.1 with ZnS layer				
Cell 1	9.16	735.57	20.06	62.13
Cell 2	9.25	735.25	20.11	62.53
Cell 3	9.12	728.98	19.88	62.95
Cell 4	9.07	727.07	20.23	61.68
Cell 5	8.82	723.33	19.97	61.09