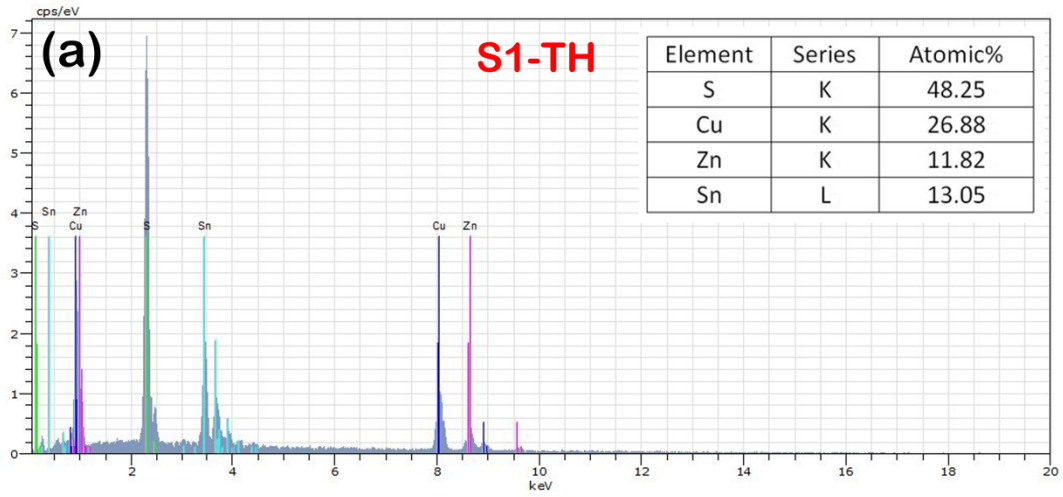
Electronic Supplementary Material (ESI) for RSC Advances.

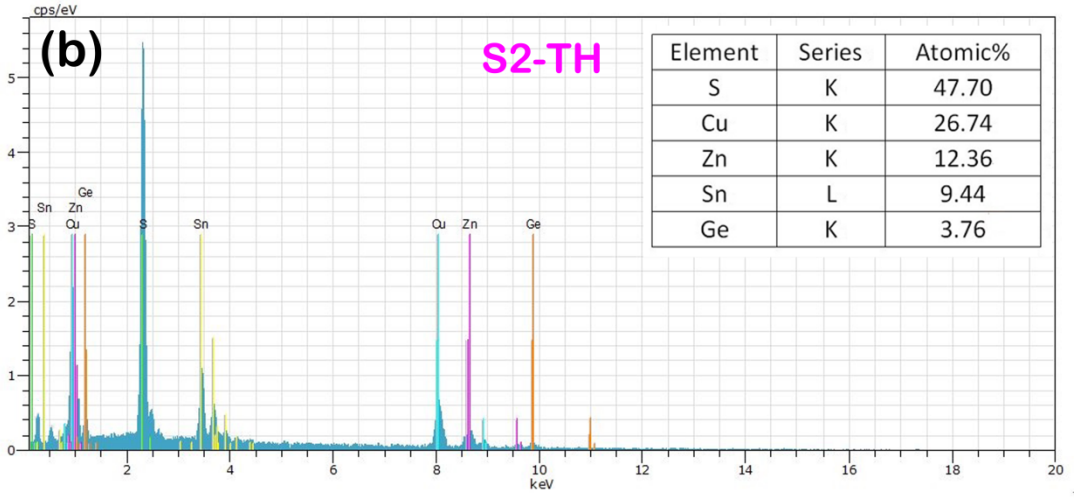
Supporting information

Colloidal $Cu_2Zn(Sn_{1-x}Ge_x)S_4$ Nanocrystals: Electrical Properties and their Comparison between Wurtzite and Kesterite Structure

Yingwei Li, Wuding, Ling, Qifeng Han*, and Wangzhou Shi

Key Laboratory of Optoelectronics Materials and Devices, Shanghai Normal University, Shanghai, China





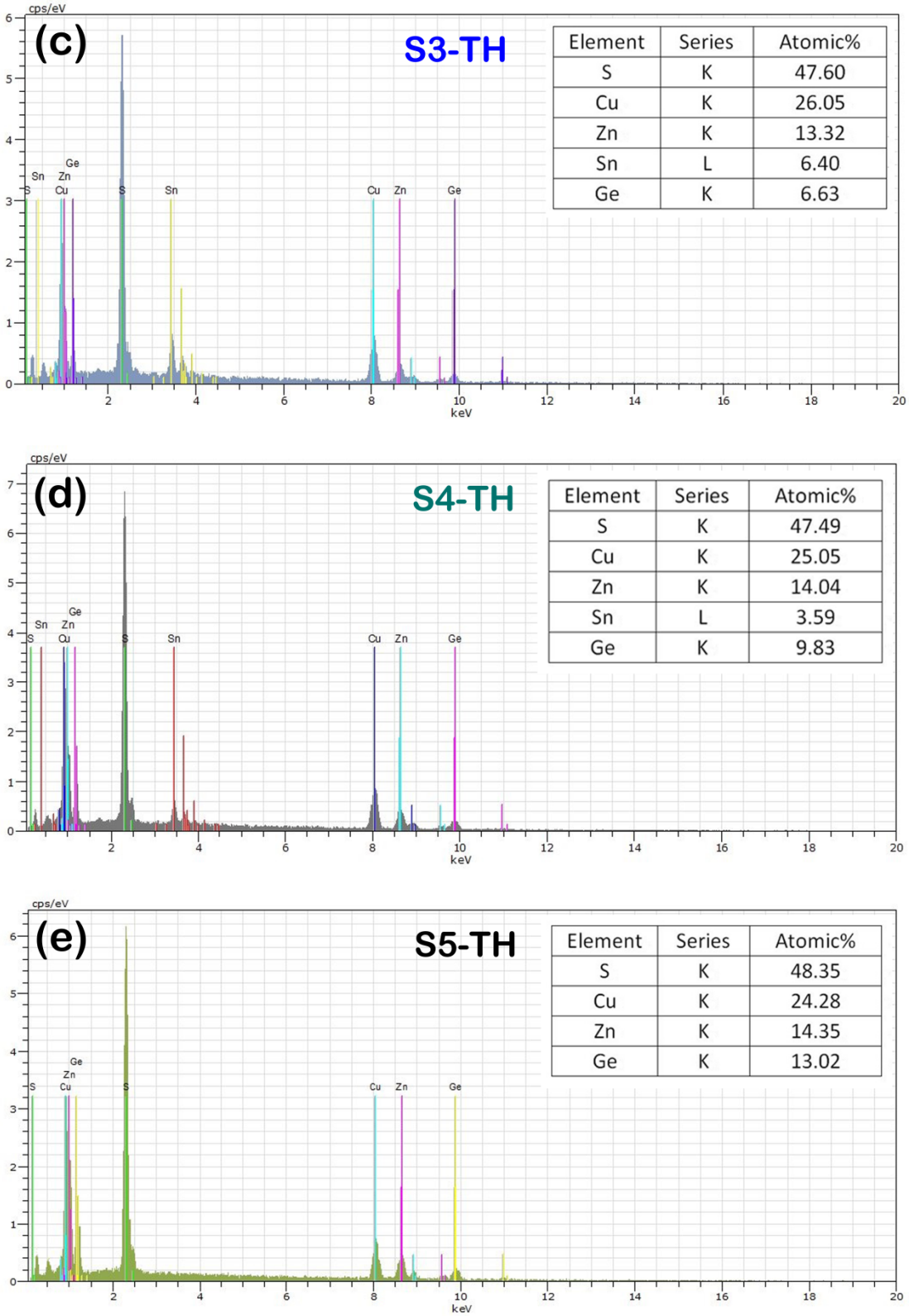


Figure S1 EDS results for (a) S1-TH, (b) S2-TH, (c) S3-TH, (d) S4-TH, and (e) S5-TH NCs prepared with $SC(NH_2)_2$, suggesting CZTS NCs are Cu-rich and Zn-poor while CZGS NCs are of more satisfactory Cu-poor and Zn-rich constituent.

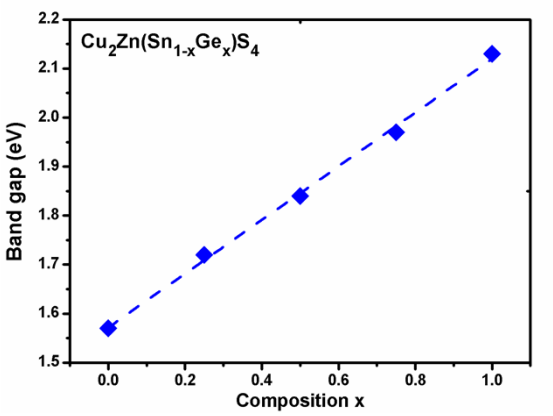


Figure S2 Band gap of wurtzite-dominant $Cu_2Zn(Sn_{1-x}Ge_x)S_4$ as a function of composition *x*.

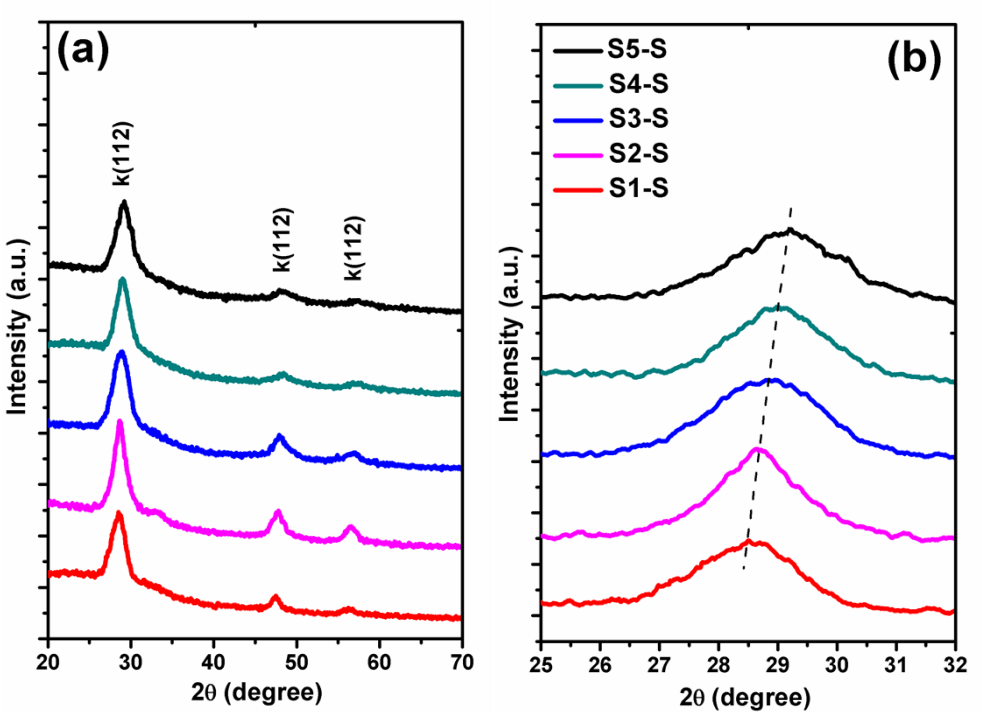


Figure S3 (a) XRD patterns of kesterite $Cu_2Zn(Sn_{1-x}Ge_x)S_4$ NCs.(b) Enlarged view in which the peaks ascribing to (112) planes of tetragonal structure shift to higher 2θ due to incorporation of Ge.

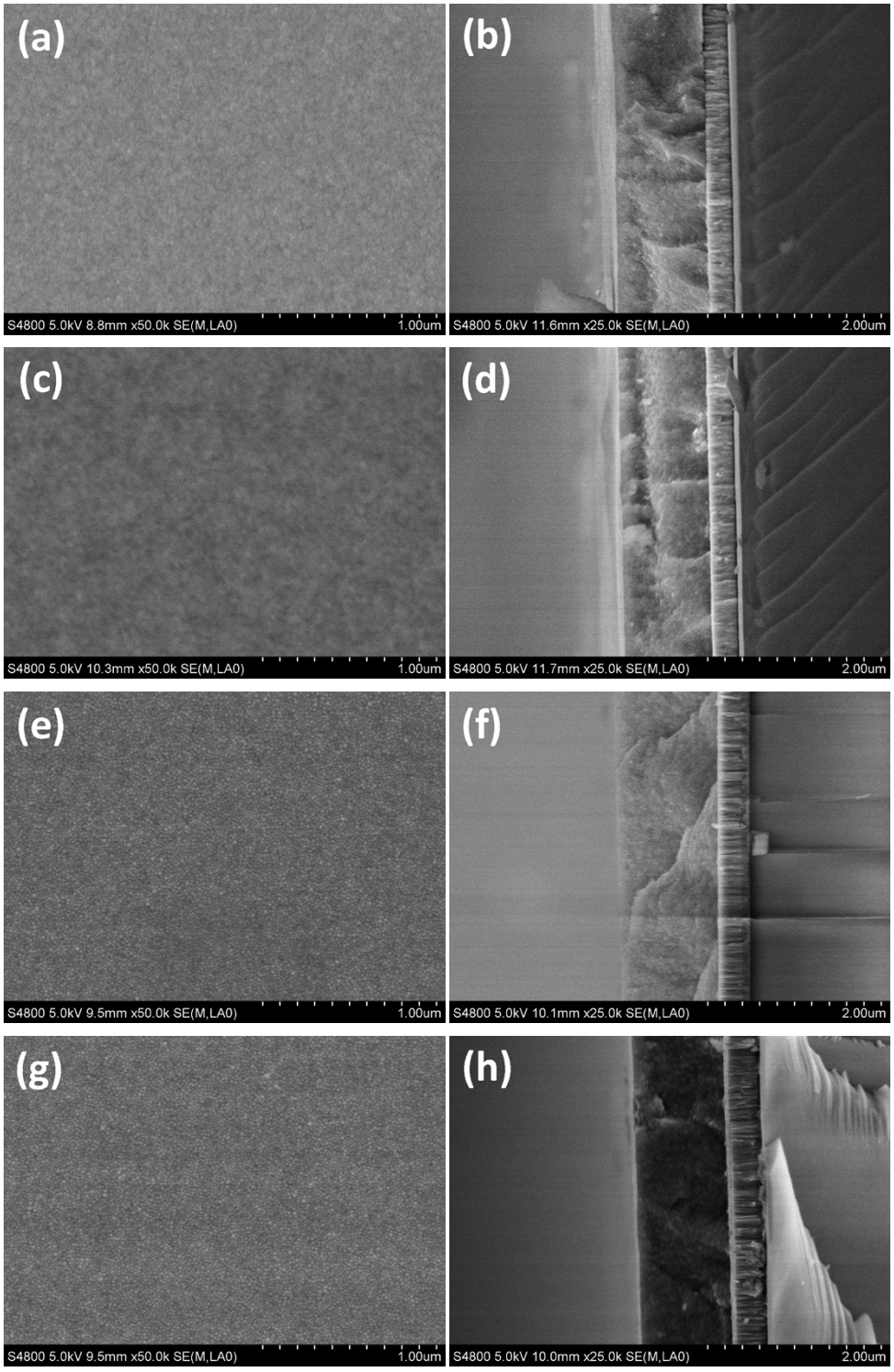
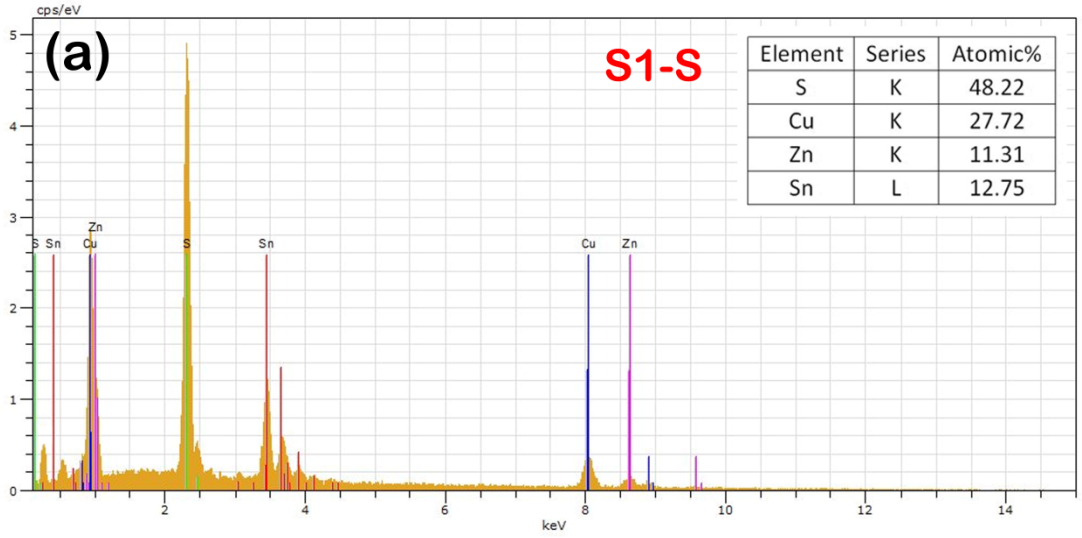
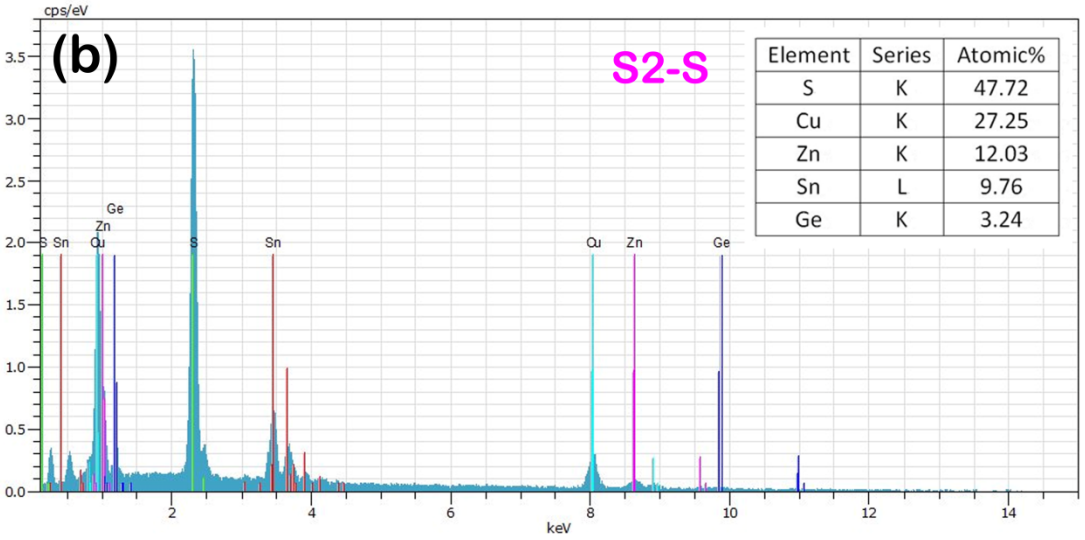


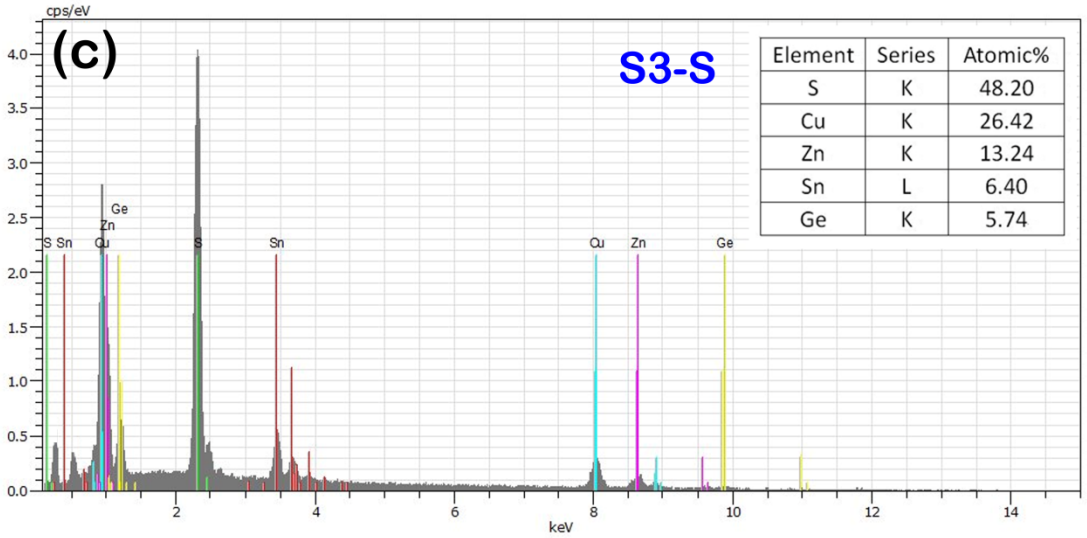
Figure S4 Top-view SEM images for (a) wurtzite CZTS, (c) wurtzite CZGS, (e) kesterite CZTS, and (g) kesterite CZGS films fabricated from corresponding NCs dispersions, and annealed at 350^{o}C for 5 min. Cross-section SEM images for (b) wurtzite CZTS, (d) wurtzite CZGS, (f) kesterite CZTS, and (h) kesterite CZGS films.



Element	Series	Atomic%
S	K	48.22
Cu	K	27.72
Zn	K	11.31
Sn	L	12.75



Element	Series	Atomic%
S	K	47.72
Cu	K	27.25
Zn	K	12.03
Sn	L	9.76
Ge	K	3.24



Element	Series	Atomic%
S	K	48.20
Cu	K	26.42
Zn	K	13.24
Sn	L	6.40
Ge	K	5.74

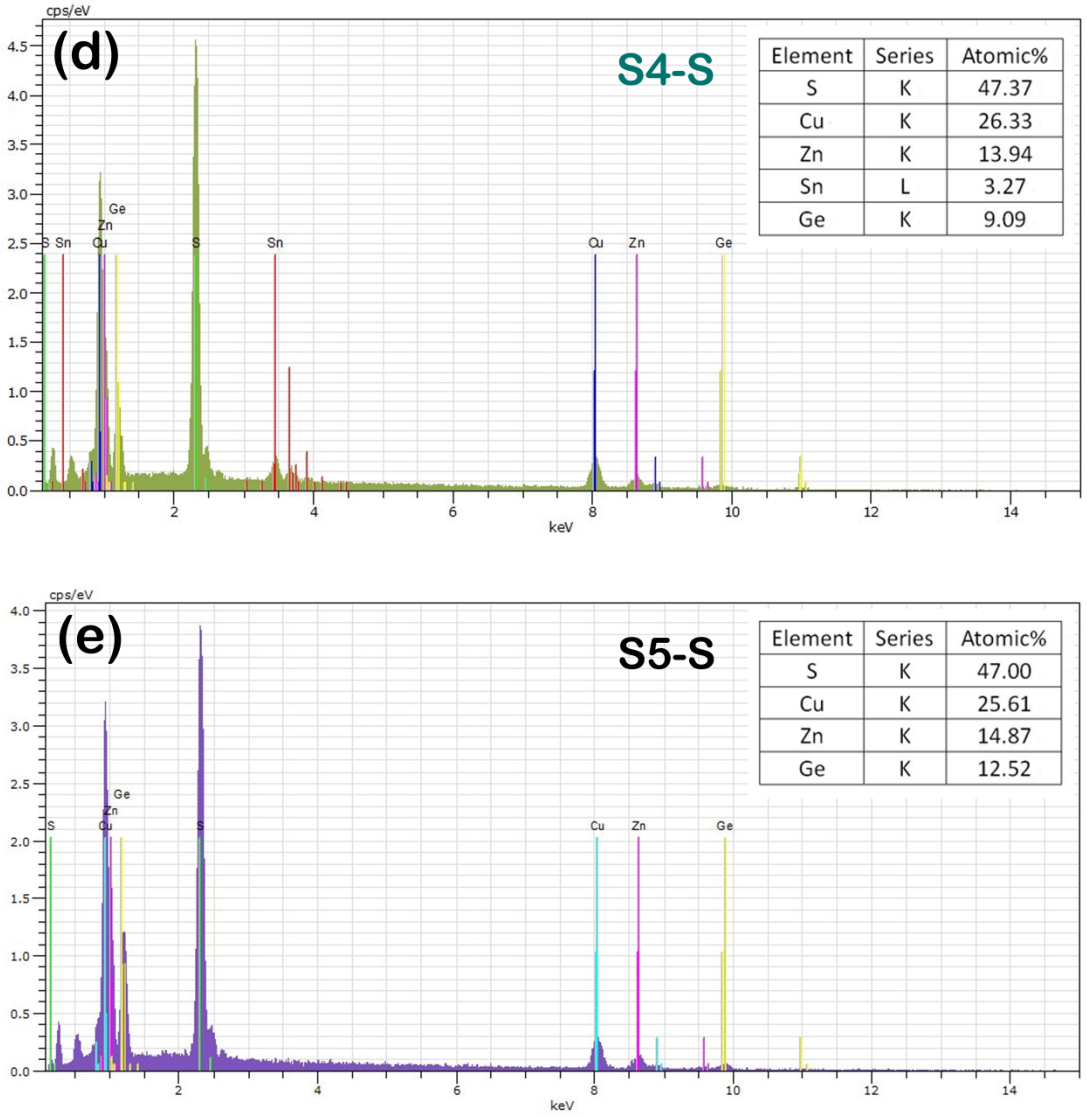


Figure S5 EDS results for (a) S1-S, (b) S2-S, (c) S3-S, (d) S4-S, and (e) S5-S NCs prepared with sulfur element.

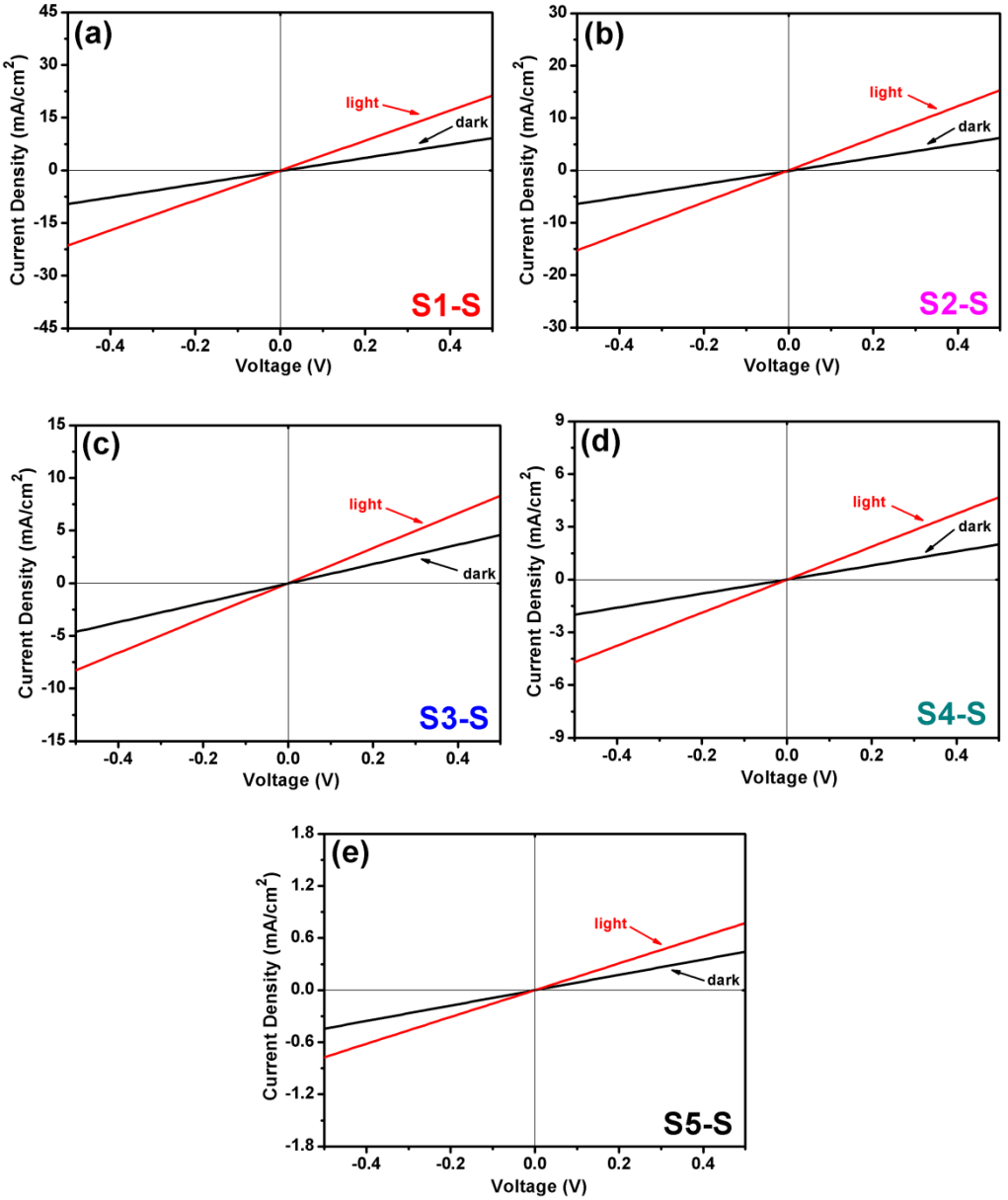


Figure S6 Current-voltage (*I-V*) curves of the $Cu_2Zn(Sn_{1-x}Ge_x)S_4$ films made from kesterite NCs dispersions of (a) S1-S, (b) S2-S, (c) S3-S, (d) S4-S, and (e) S5-S tested in dark (black) and under illumination (red).