

Electronic Supplementary Information for

Solvent-Free Synthesis of $\text{Cu}_2\text{ZnSnS}_4$ Nanocrystals: A Facile, Green, Up-scalable Route for Low Cost Photovoltaic Cells†

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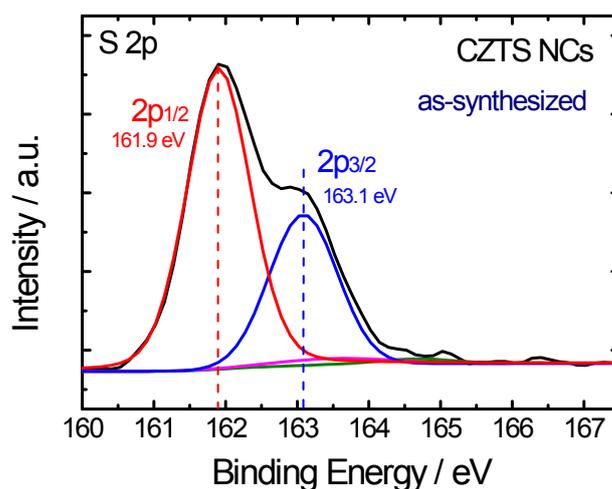


Fig. S1. XPS spectrum for S 2p of the as-synthesized $\text{Cu}_2\text{ZnSnS}_4$ nanocrystals (NCs). Note that the as-synthesized CZTS NCs are free from the oxidized species such as sulfates.

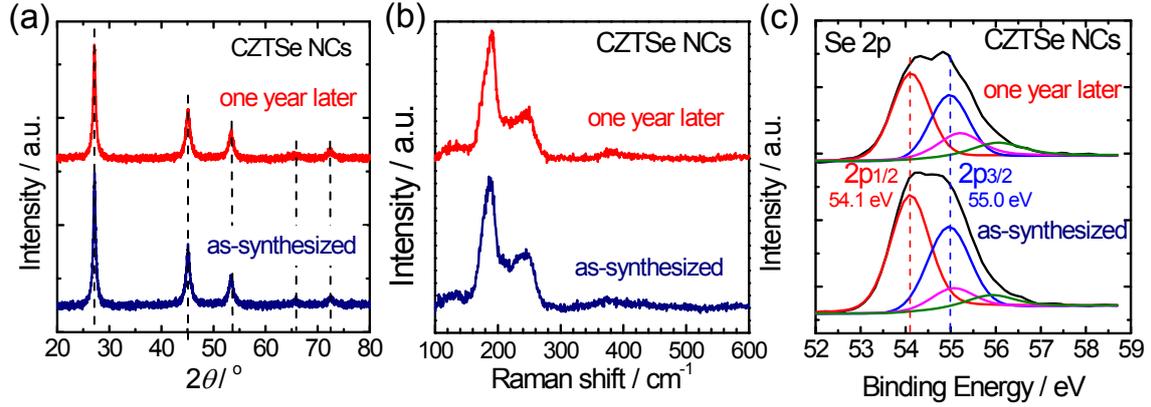


Fig. S2. Characterizations of $\text{Cu}_2\text{ZnSnSe}_4$ NCs immediately after the synthesis and after being stored on a bench top for one year: (a) XRD patterns, (b) Raman spectra, and (c) XPS spectra for Se 2p.

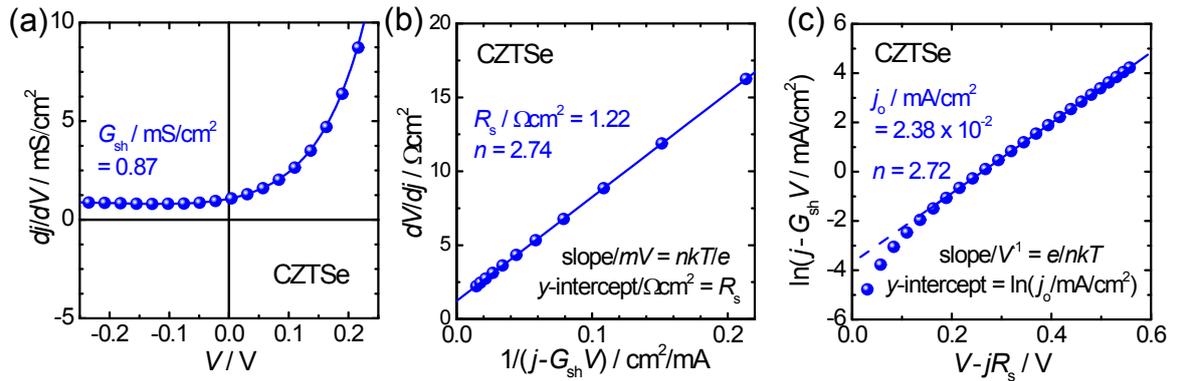


Fig. S3. A diode analysis on the $\text{Cu}_2\text{ZnSnSe}_4$ solar cell: (a) a plot of dj/dV vs. V , where G_{sh} was extracted from the plateau value assuming that a linear shunt current predominates the diode current in the range of $V < 0$, (b) a plot of dV/dj vs. $1/(j - G_{\text{sh}}V)$, where R_s and n were evaluated from the y -intercept and the slope, respectively, in the high bias regime, and (c) a semi-logarithmic plot of $(j - G_{\text{sh}}V)$ vs. $V - jR_s$ for determination of n and j_0 . The ideality factor (n) is determined in part b and c, respectively. Note that both values are in good agreement, thus supporting the validity of this analysis.

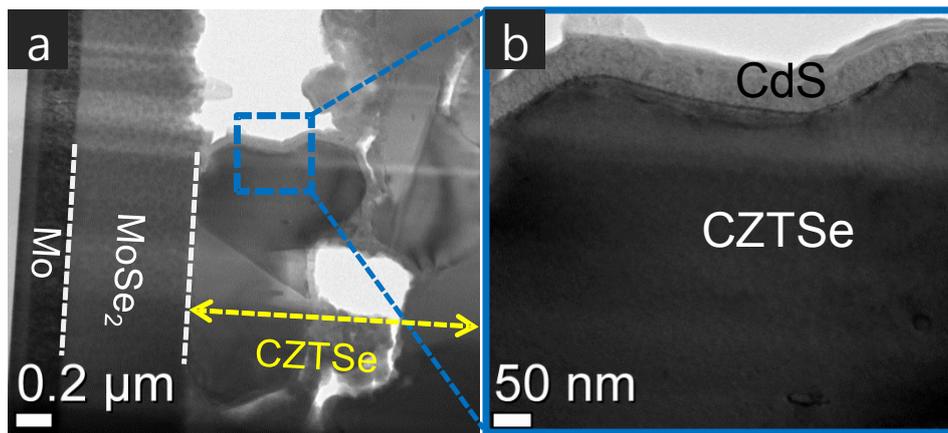


Fig. S4. TEM cross sectional images of the $\text{Cu}_2\text{ZnSnSe}_4$ solar cell with low (a) and high (a) magnification.