Electronic Supplementary Material (ESI) for Energy Advances.

Supporting Information

Study of Back Bandgap-Graded CZTGSSe Kesterite Thin-Films for Solar Cell Applications

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Preliminary sulfurization experiments were conducted to obtain CZTGSSe absorbers with potentially passivated top surface to possibly improve carrier lifetime. To do so, a short sulfurization step of 5 mins in H_2S at 470°C was added at the end of the high-temperature stage, in the same process described in the main text except for the N_2 pre-annealing part which was left out. As visible from the unchanged PL response and poorer IV parameters, it is not straightforward to preserve absorber quality and solar cell performance after adding a short sulfurization step to the developed process.

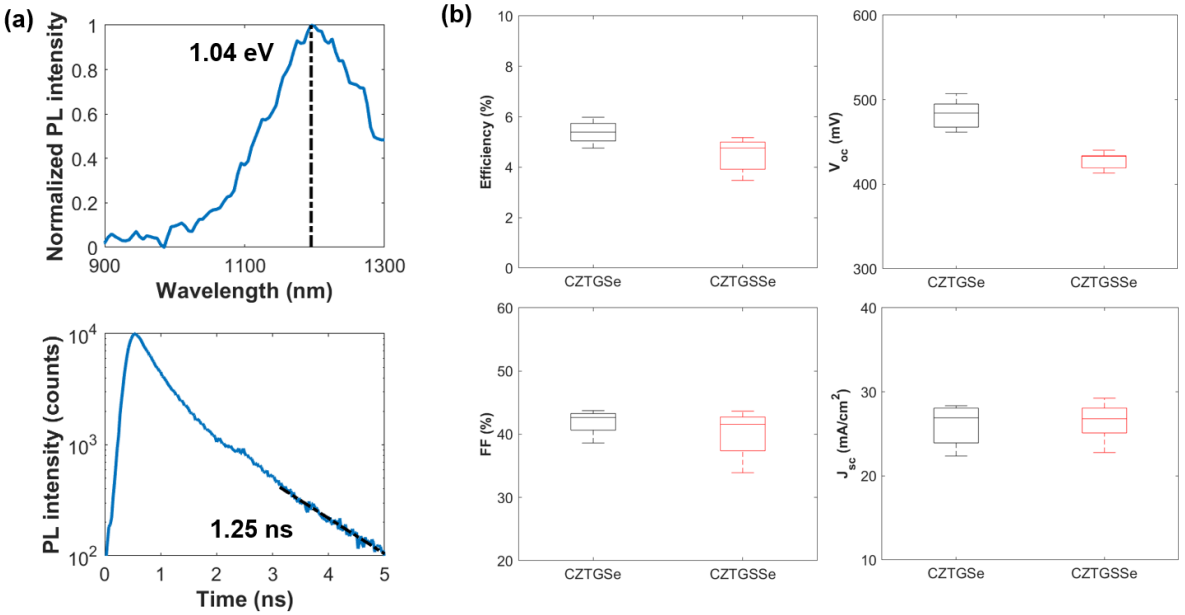

Figure S1. (a) PL spectrum and TRPL response of the CZTGSSe sulfurized absorbers, exhibiting a bandgap value of 1.04eV and a carrier lifetime of 1.25ns, barely changed following the sulfurization step. **(b)** Comparison of IV parameters for both CZTGSe and CZTGSSe solar cell devices, the former outperforms the latter.