

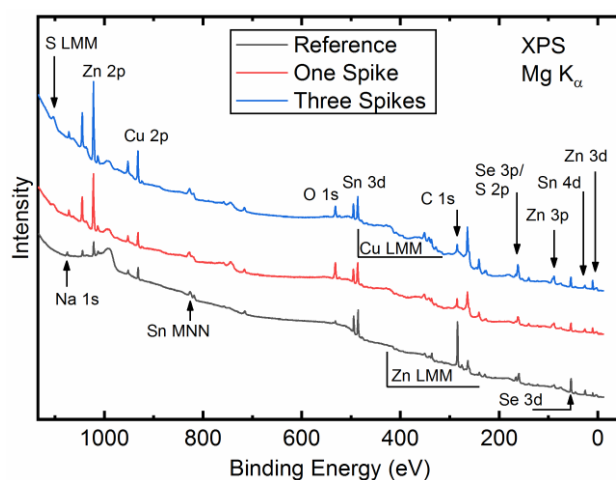
## Supporting Information

### Steep Sulfur Gradient in CZTSSe Solar Cells by H<sub>2</sub>S-Assisted Rapid Surface Sulfurization

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This Supporting Information section contains material to support the main hypotheses raised in the main manuscript.



**Figure S1.** Mg K<sub>α</sub> XPS survey spectra of the CZTSe reference (black), one-spike (red), and three-spike (blue) samples. Prominent photoelectron and Auger features are labeled.

**Table S1:** Saturation current ( $J_0$ ), ideality factor ( $A$ ), shunt resistance ( $R_{sh}$ ), and series resistance ( $R_s$ ) of the best-performing devices from each H<sub>2</sub>S-assisted rapid surface sulfurization treatment. The analysis was performed with Shockley's one-diode model on the illuminated current-voltage curves.

Sample	$J_0$ (mA/cm <sup>2</sup> )	$A$	$R_{sh}$ (Ω.cm <sup>2</sup> )	$R_s$ (Ω.cm <sup>2</sup> )
Reference	3.0E-02	2.0	200	0.05
40%P	3.0E-02	2.1	250	0.05
45%P	4.0E-02	2.1	250	0.05
50%P	2.1E-01	2.5	75	0.05
50%P+Selenium	6.5E-02	2.2	200	0.05