Supplementary Information For

Role of S and Se atoms on the microstructural properties of kesterite Cu$_2$ZnSn(S$_x$Se$_{1-x}$)$_4$ thin film solar cells

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Figure S1. Schematic diagram of the X-ray diffraction through the sample in grazing incidence geometry. Based on the attenuation law, the incident beam $I_0$ after traveling through the sample and being reflected will be reduced to $I_{zd} = I_0 \cdot e^{-\mu (L_1 + L_2)} = I_0 \cdot e^{-\mu \left( \frac{z}{\sin \alpha_i} + \frac{z}{\sin (2\theta - \alpha_i)} \right)}$. If the penetration depth $z$ is defined as the depth at which the intensity of the X-rays is reduced to 1/e (about 37%) of its original value, then based on the ratio $I_0 = e \cdot I_{zd}$, the penetration depth can be calculated as $z = \frac{1}{\mu} \left( \frac{1}{\sin \alpha_i} + \frac{1}{\sin (2\theta - \alpha_i)} \right)^{-1}$. 
Figure S2. Le Bail fits of the XRD patterns measured with 0.5, 1, 2 and 5° incidence angles of two representative CZTSSe samples with (a) \([S] / ([S] + [Se]) = 0.27\) and (b) \([S] / ([S] + [Se]) = 0.65\) anion compositions.
Figure S3. Raman spectra of front, back and substrate for two representative CZTSSe samples measured with 532 nm excitation wavelength.