

## Electronic Supplementary Information

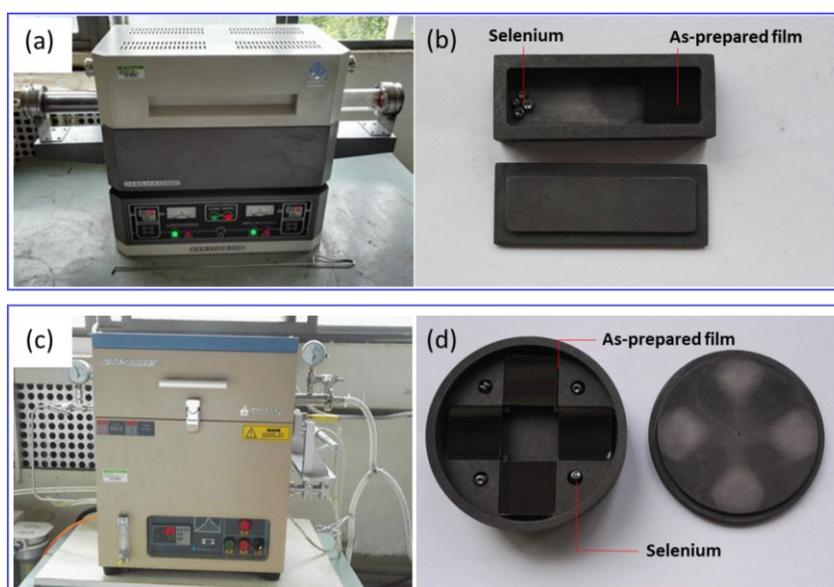
### Eliminating Fine-Grained Layer in $\text{Cu}(\text{In,Ga})(\text{S,Se})_2$ Thin Films for Solution-Processed High Efficient Solar Cells†

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**Fig. S1** The digital photographs of (a) tubular furnace, (b) rectangle graphite box, (c) RTP furnace, and (d) round graphite box.

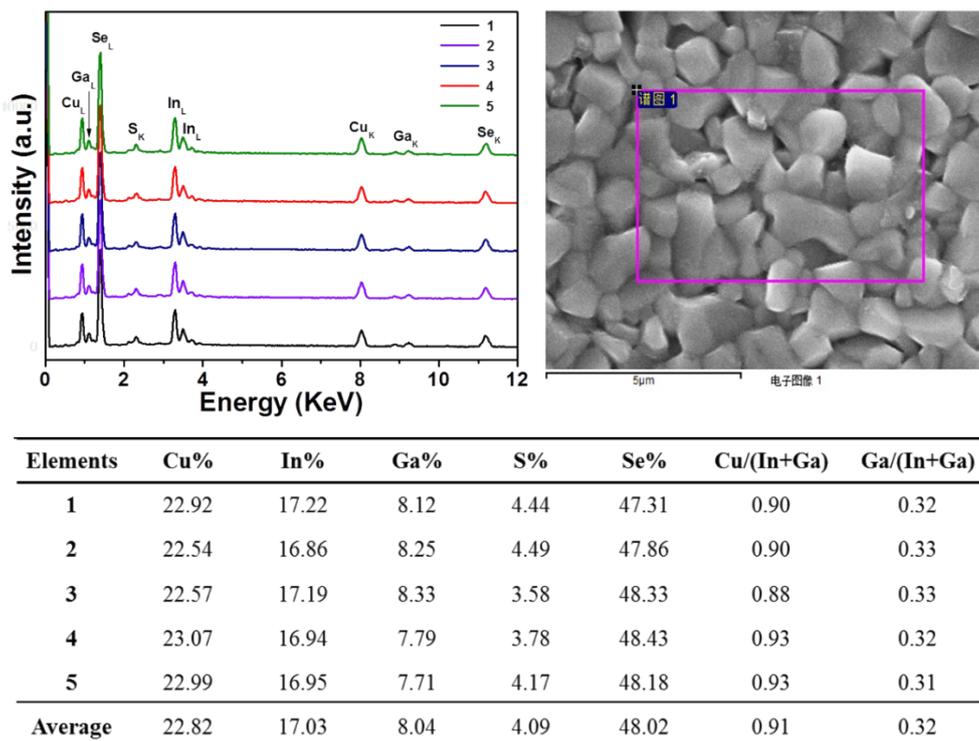


Fig. S2 EDS spectra, and chemical compositions of the selenized CIGSSe thin film.

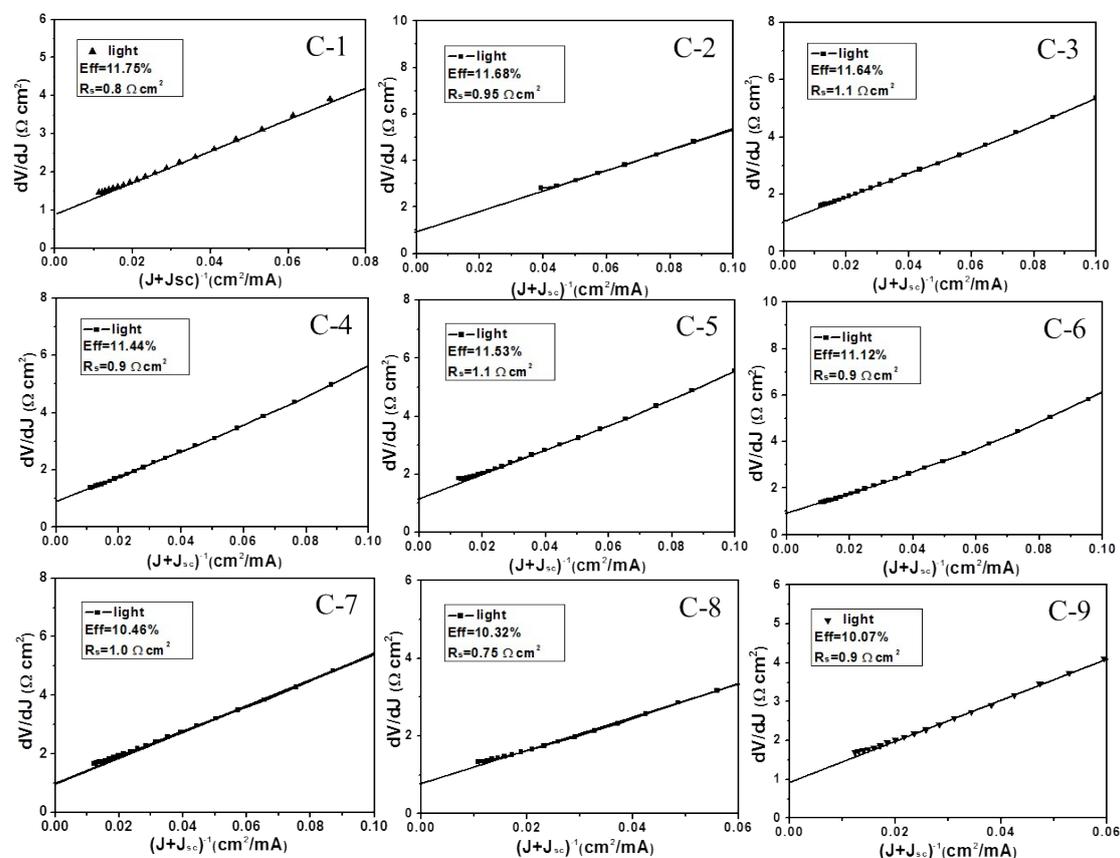
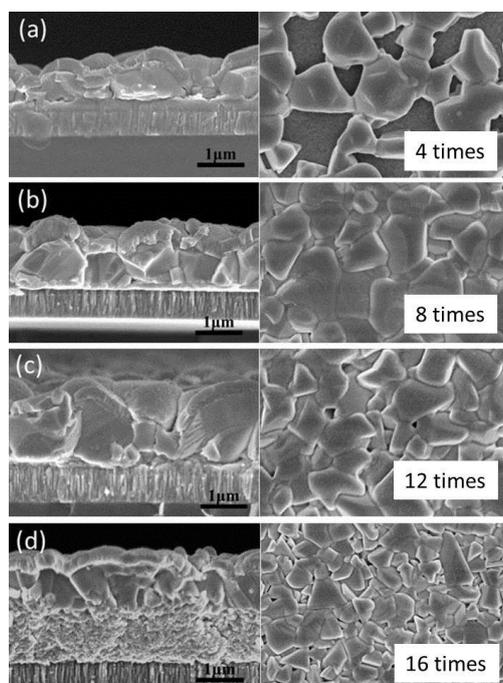


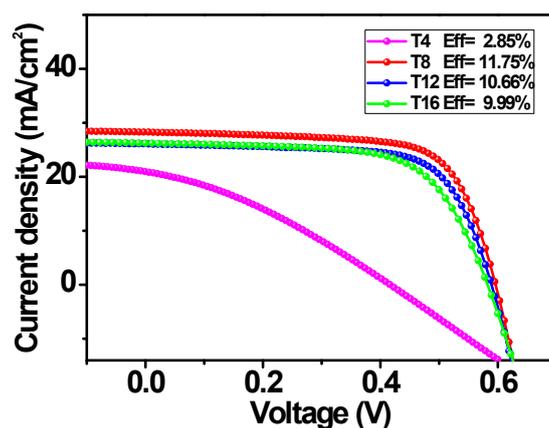
Fig. S3 Plots of  $dV/dJ$  vs  $(J+J_{sc})^{-1}$  redrawn from the standard light  $J$ - $V$  curves of nine CIGSSe solar cells on the same substrate (C-1~ C-9).

**Table S1** Devices parameters of the solar cells in our previous work and the present work.<sup>1</sup>

Solar cells	Efficiency	$V_{OC}$	$J_{SC}$	FF	$R_S$	$R_{Sh}$
	[%]	[mV]	[mA/cm <sup>2</sup> ]	[%]	[ $\Omega$ cm <sup>2</sup> ]	[ $\Omega$ cm <sup>2</sup> ]
S-1	9.50	528	26.64	67.48	1.50	1565
C-1	11.75	596	28.25	69.80	0.80	2011



**Fig. S4** Cross-sectional SEM images of the CIGSs solar cells (the left) and top-view SEM images of the CIGSs films (the right) with different spin-coating/sintering cycles.



**Fig. S5** Typical  $J$ - $V$  curves of the CIGSs solar cells with different spin-coating/sintering cycles under one sun AM 1.5G condition

**References:**

1. D. Zhao, Q. Tian, Z. Zhou, G. Wang, Y. Meng, D. Kou, W. Zhou, D. Pan and S. Wu, *J. Mater. Chem. A*, 2015, **3**, 19263.