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## **Solution Process to Fabricate $\text{CuIn}_{0.9}(\text{Al, Ni, Co})_{0.1}(\text{S,Se})_2$ Thin Film and Their Application in Solar Cells**

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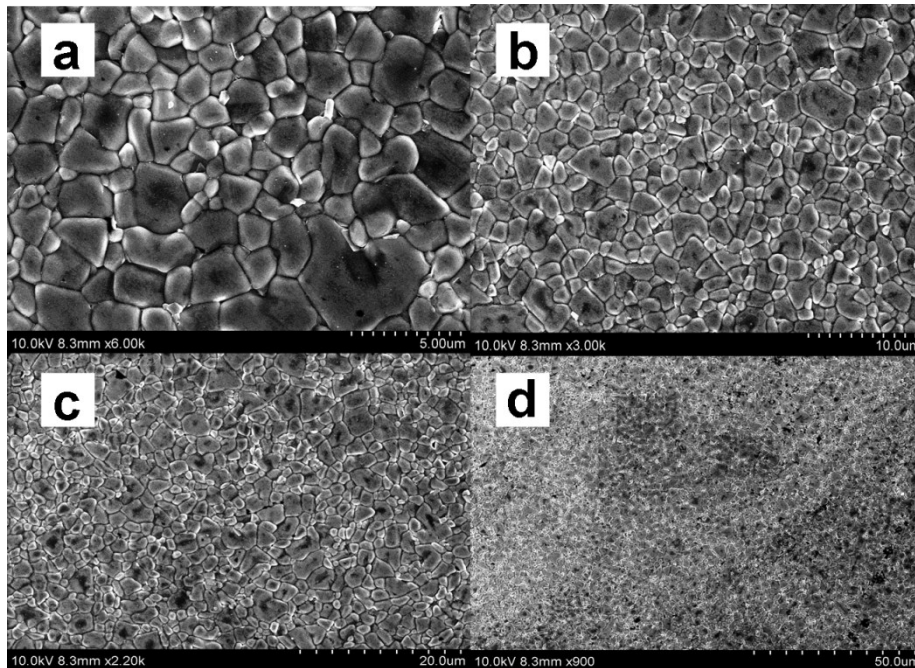
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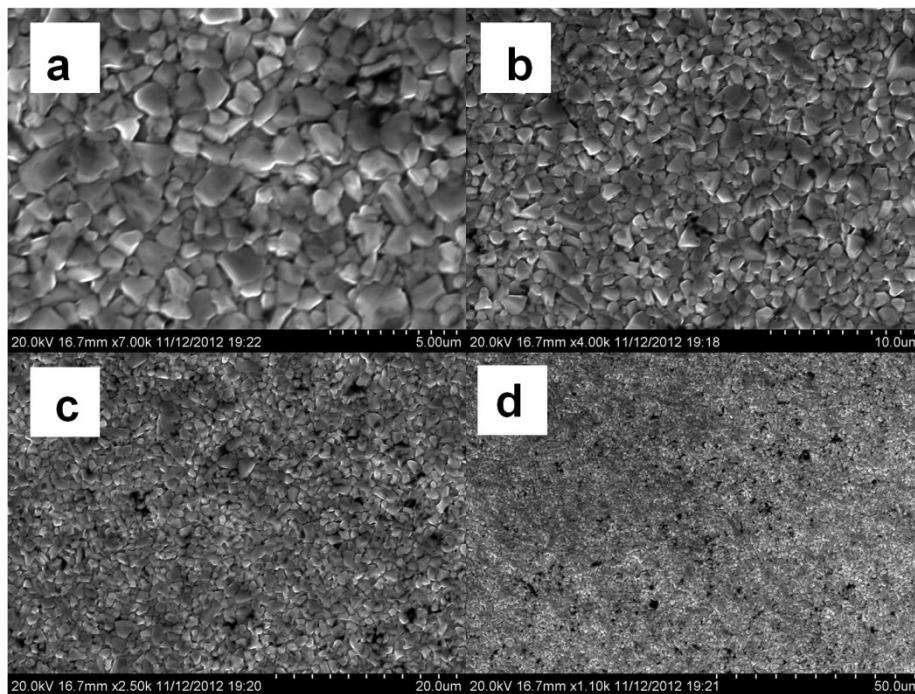
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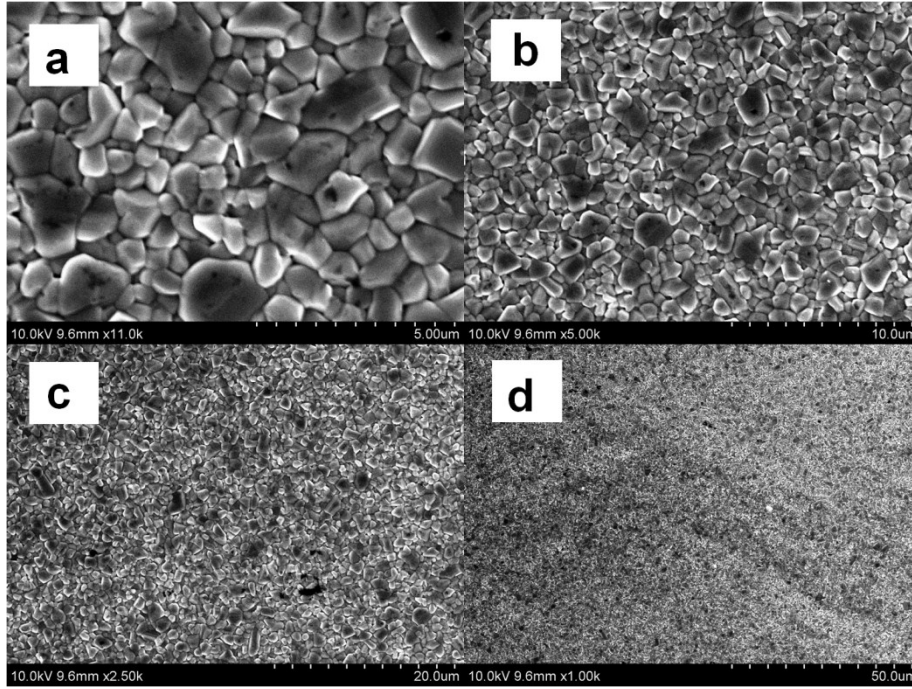
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**Fig. S1** Top-view SEM images of  $\text{CuIn}_{0.9}\text{Al}_{0.1}(\text{S,Se})_2$  thin film at different scale bar. (a)  $5\mu\text{m}$ , (b)  $10\mu\text{m}$ , (c)  $20\mu\text{m}$ , (d)  $50\mu\text{m}$ .



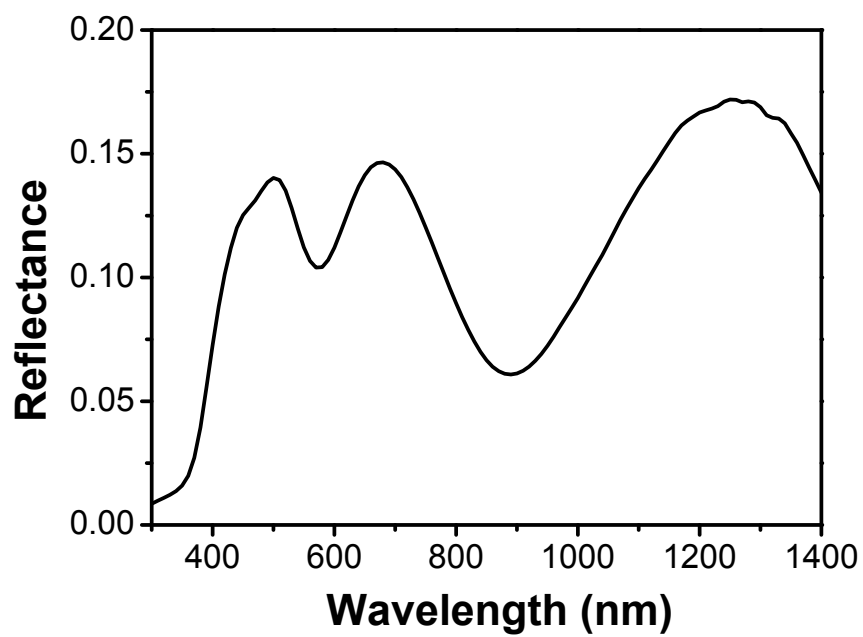
**Fig. S2** Top-view SEM images of  $\text{CuIn}_{0.9}\text{Ni}_{0.1}(\text{S,Se})_2$  thin film at different scale bar. (e)  $5\mu\text{m}$ , (f)  $10\mu\text{m}$ , (g)  $20\mu\text{m}$ , (h)  $50\mu\text{m}$ .



**Fig. S3** Top-view SEM images of  $\text{CuIn}_{0.9}\text{Co}_{0.1}(\text{S,Se})_2$  thin film at different scale bar. (i)  $5\mu\text{m}$ , (j)  $10\mu\text{m}$ , (k)  $20\mu\text{m}$ , (l)  $50\mu\text{m}$ .

**Tab. S1:** Series resistance and shunt resistance for the CIASSe, CINSSe and CICSSe thin film solar cells.

Material	Series resistance ( $\Omega/\text{cm}^2$ )	Shunt resistance ( $\Omega/\text{cm}^2$ )
CIASSe	33.22	100.54
CINSSe	167.66	53.27
CICSSe	41.57	38.41



**Fig. S4** The reflectance spectra of the CIASSe solar cell.