

Supporting information

Synthesis of Cu(In,Ga)(S,Se)₂ thin films using an aqueous spray-pyrolysis approach, and their solar cell efficiency of 10.5%.

Md. Anower Hossain^a; Zhang Tianliang^a; Lee Kian Keat^a, Li Xianglin^a; Rajiv R. Prabhakar^a;
Sudip K. Batabyal^a, Subodh G. Mhaisalkar^{ab}, and Lydia H. Wong^{ab*}.

^a Energy Research Institute @ NTU (ERI@N), Nanyang Technological University, Singapore.

^b School of Materials Science & Engineering, Nanyang Technological University, Singapore.

**email: LydiaWong@ntu.edu.sg*

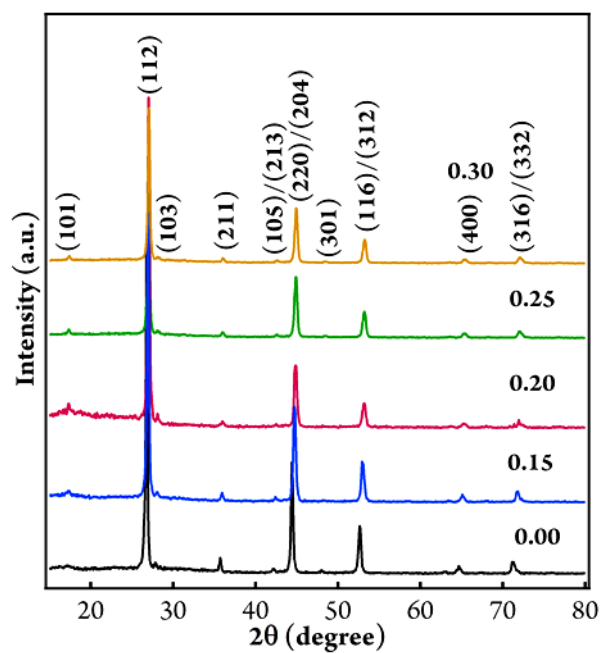


Figure S1. XRD patterns of CISSe and CIGSSe thin film prepared onto microscopic glass slides.

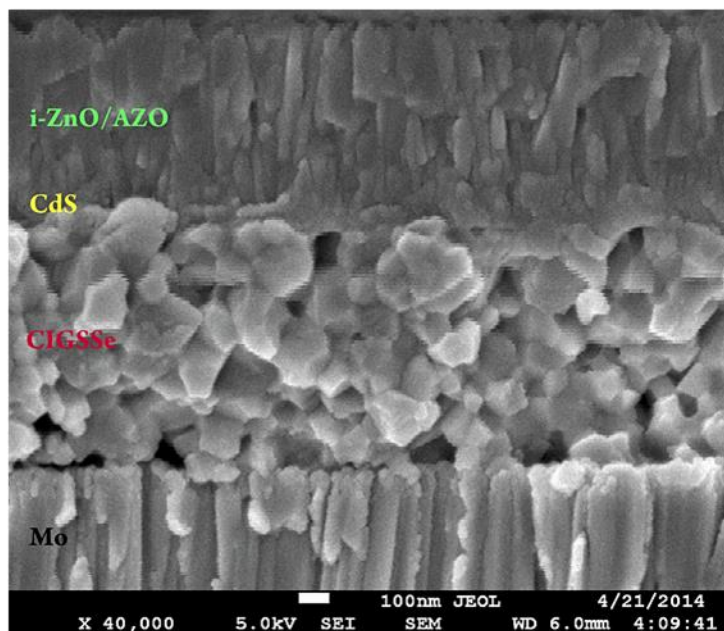


Figure S2. Cross-sectional image of a solar cell made of CIGSSe thin film with $\text{Ga}/(\text{In}+\text{Ga}) = 0.30$. The CIGSSe film is consisted of 100-200 nm crystal grains.

Table S1. Shows the EDS elemental analysis of CISSe and CIGSSe films.

Precursor's Ga/(Ga+In)	Cu (at%)	In (at%)	Ga (at%)	S (at%)	Se (at%)	Cu/(In+Ga)	Ga/(Ga+In)
0.00	20.22	24.51	-	7.08	48.19	0.83	-
	20.71	24.6	-	8.41	46.28	0.84	-
0.15	20.31	20.73	3.97	10.12	44.87	0.82	0.16
	20.35	21.21	3.24	9.15	46.05	0.83	0.13
0.20	20.78	20.02	4.26	8.43	46.51	0.85	0.18
	20.05	19.58	4.22	9.51	46.64	0.84	0.18
0.25	20.58	19.13	5.92	9.12	45.25	0.82	0.24
	19.87	18.39	5.46	10.13	46.15	0.83	0.23

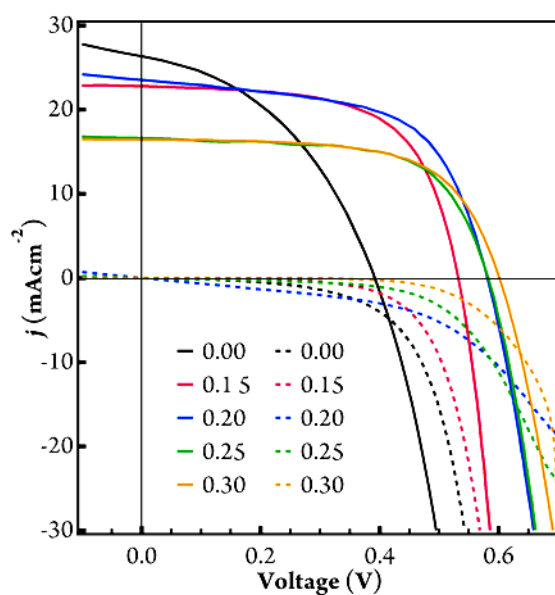


Figure S3. The j - V characteristics of solar cells made with CISSe and CIGSSe films and characterized under AM 1.5, 100 mW cm^{-2} illuminations (solid lines) as shown in the main text (Table 2), and in dark (dashed lines). The numeric values of 0.00, 0.15, 0.20, 0.25 and 0.30 represents the Ga/(In+Ga) ratio of the CISSe and CIGSSe films.