Supporting Information

Efficient Quantum Dot-Sensitized Solar Cells through Sulfur-rich Carbon Nitride Modified Electrolyte

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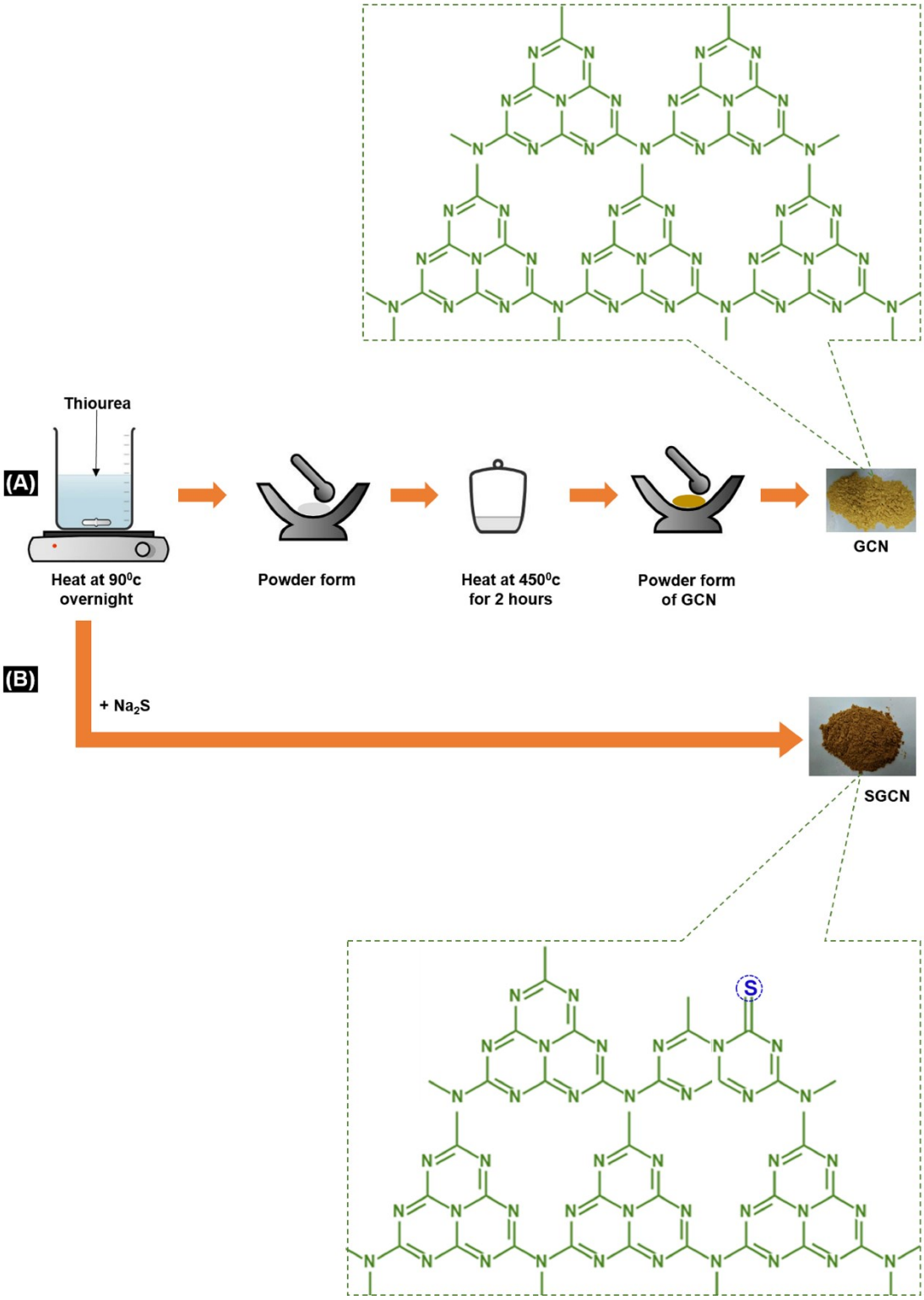

Scheme S1. Schematic diagram elucidating the steps involved in the synthesis of (A) GCN (B) SGCN. Outside of panel (A and B) are the chemical structures of GCN and SGCN.

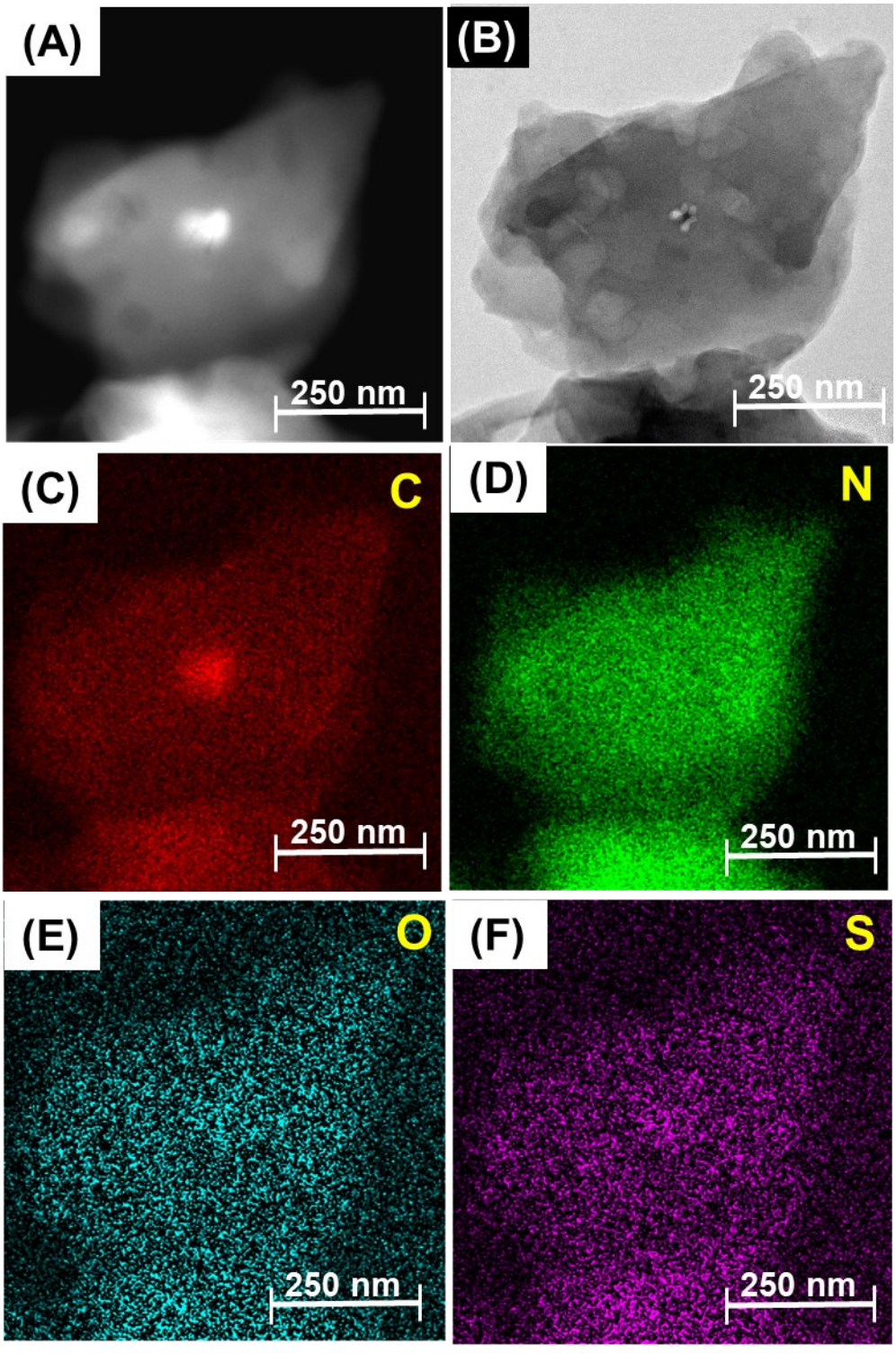

Figure S1. (A) STEM and (B) HAADF images of the GCN samples, and (C-F) C (red), and N (green), O (cyan), and S (pink), elemental mapping images.

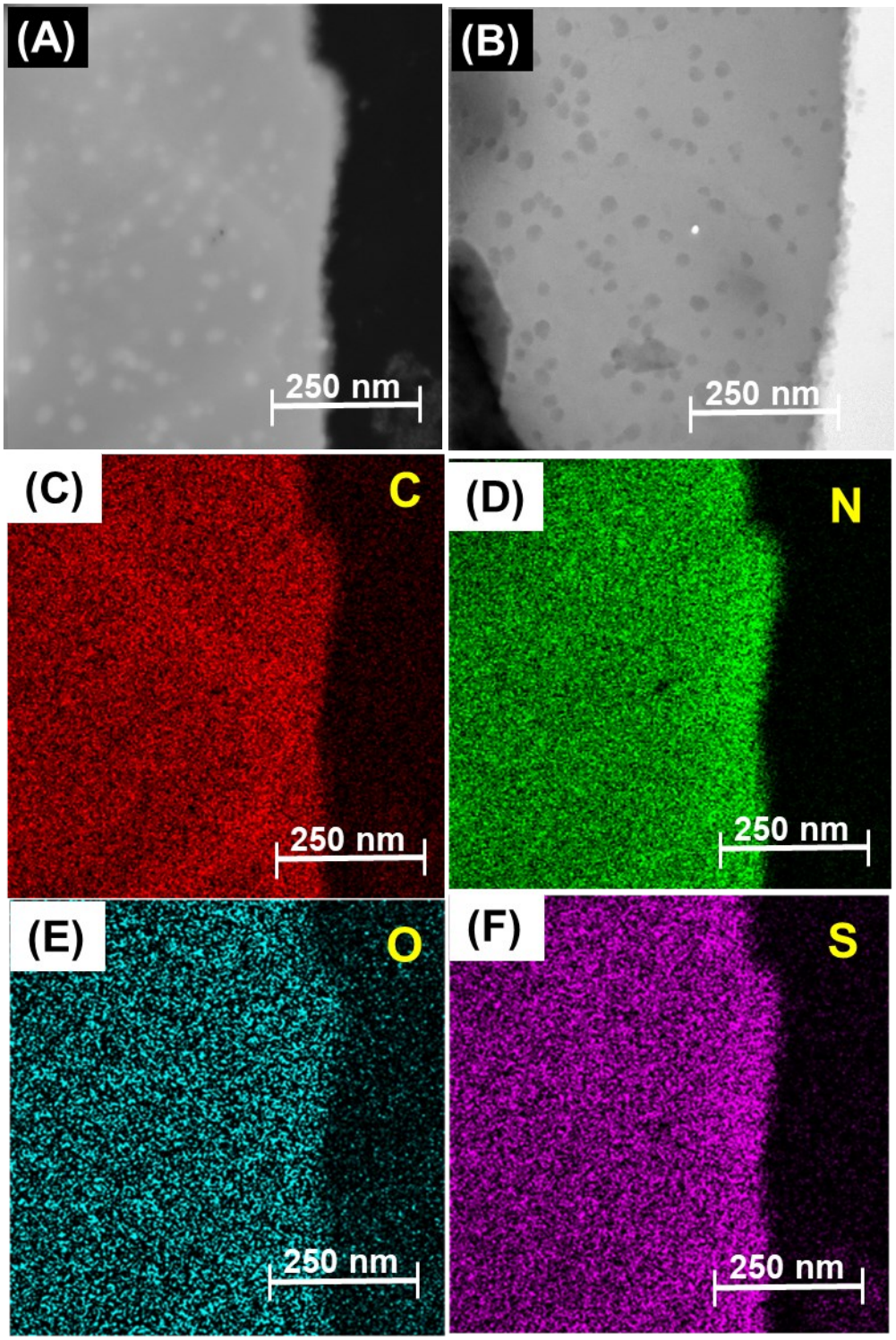

Figure S2. (A) STEM and (B) HAADF images of the SGCN samples, and (C-F) C (red), and N (green), O (cyan), and S (pink), elemental mapping images.

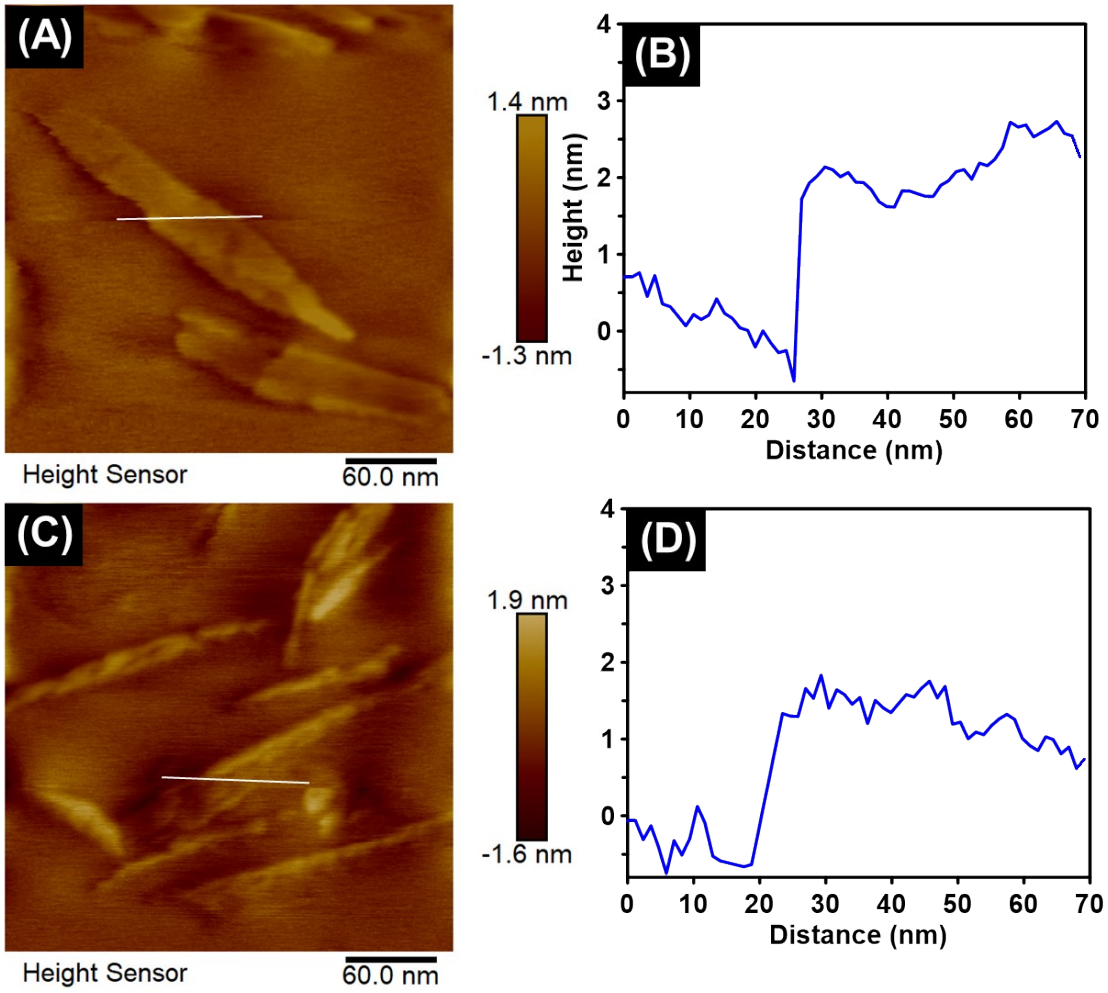

Figure S3: AFM topographic images and their corresponding height profiles of GCN (A&B) and SGCN (C&D) samples, respectively.

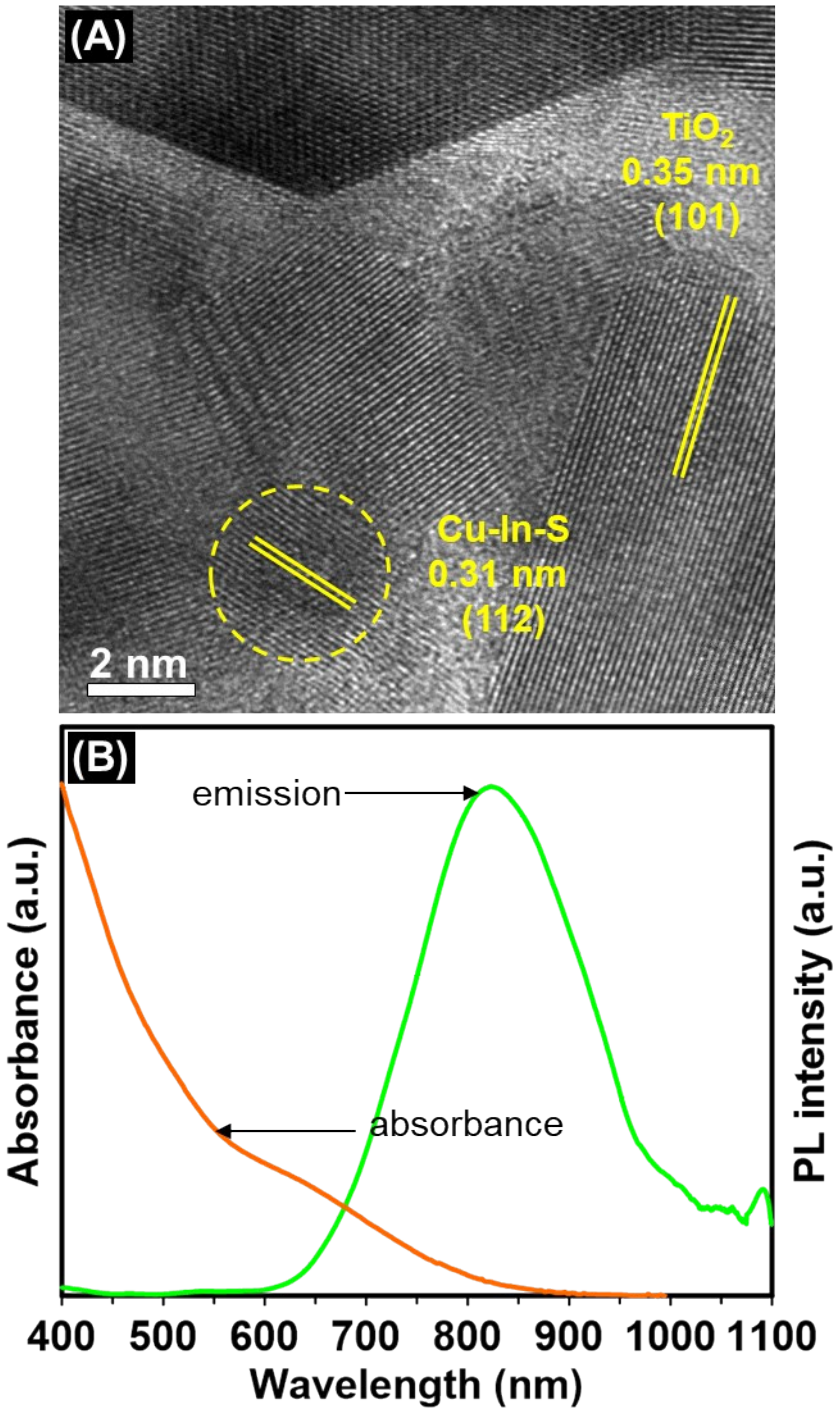

Figure S4. (A) HRTEM image and (B) Absorption and photoluminescence spectra of the as-prepared Cu-In-S QDs.

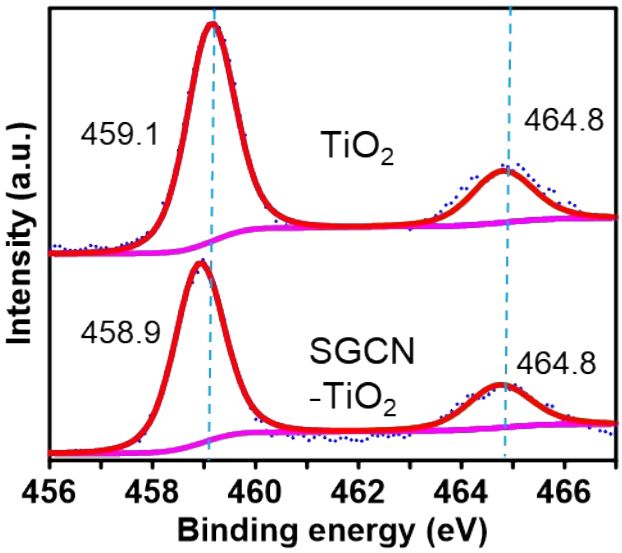

Figure S5. Ti 2p XPS spectra of pure TiO_2 and SGCN treated TiO_2.

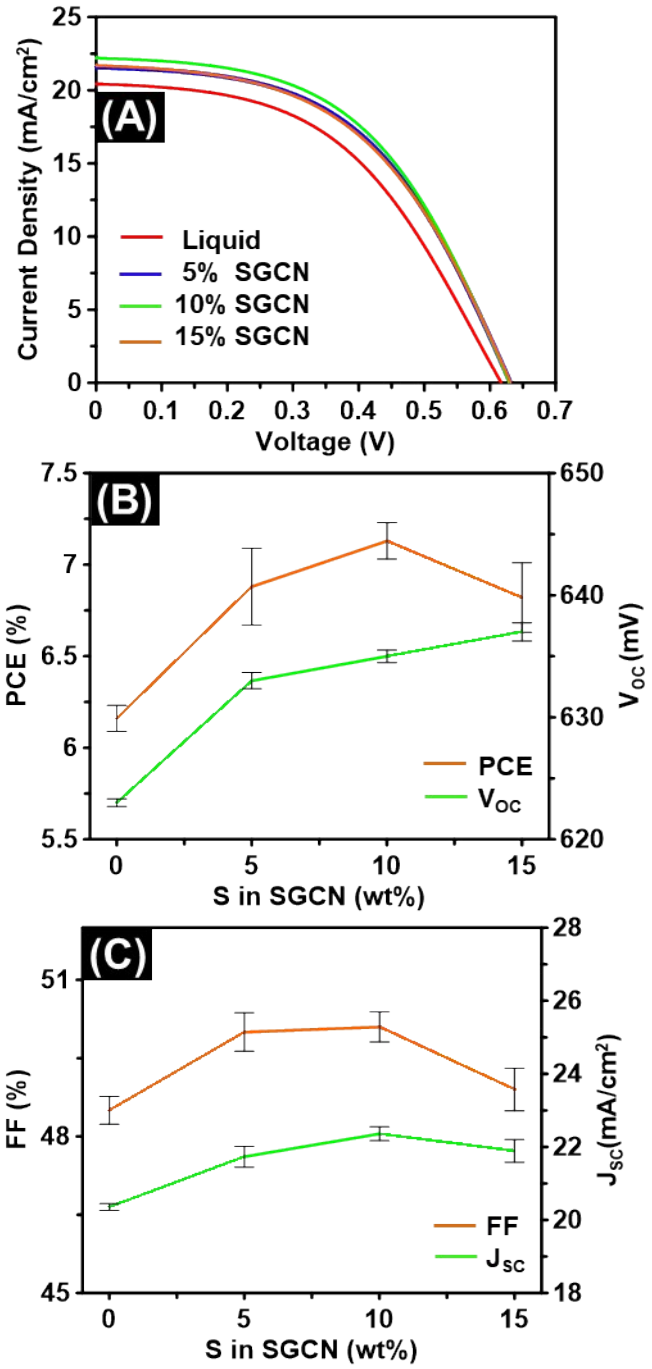

Figure S6. (A) *J–V* curves of the Cu-In-S QDSSCs with different weight ratios of S in SGCN electrolyte under one sun illumination (AM1.5G, 100 mW cm^{-2}). (B) Average PCE and V_{OC} along with (C) FF and J_{SC} of Cu-In-S based QDSSCs with different weight ratios of S in SGCN electrolyte.

Table S1. Photovoltaic parameters of Cu−In−S QDSSCs based on various amounts S in SGCN additive under the illumination of AM 1.5G, 100 mWcm^{-2} sunlight.

QDSSCs	J_{SC} (mA cm^{-2})	V_{OC} (mV)	FF (%)	PCE[a] (%)	PCE[b] (%)
Liquid	20.35	623	48.5	6.16	6.10±0.07
05% S in SGCN	21.73	633	50.0	6.88	6.73±0.21
10% S in SGCN	22.36	635	50.1	7.13	7.01±0.10
15% S in SGCN	21.71	637	48.9	6.82	6.71±0.19

a. The performance of the champion cell. b. Average efficiency and standard deviations from four independent cells.

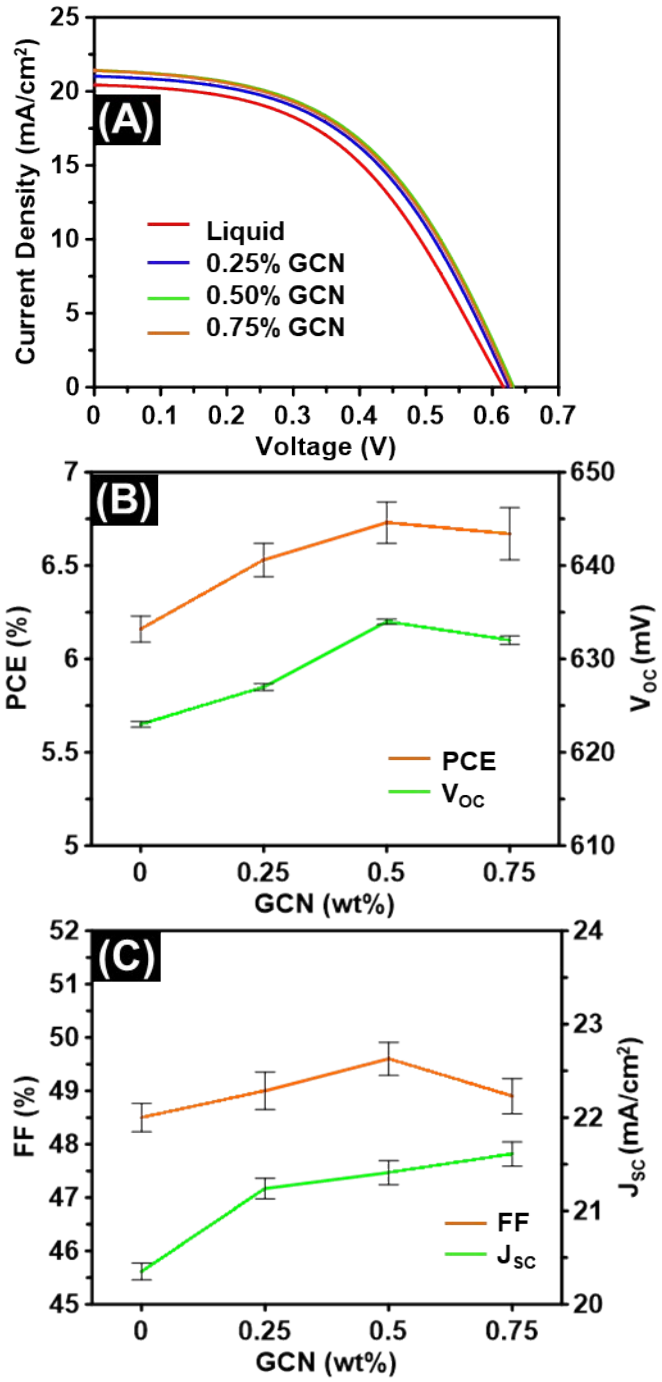

Figure S7. (A) *J–V* curves of the Cu-In-S QDSSCs with different concentration of GCN electrolyte under one sun illumination (AM1.5G, 100 mW cm^{-2}). (B) Average PCE and V_{OC} along with (C) FF and J_{SC} of Cu-In-S based QDSSCs with different concentration of GCN electrolyte.

Table S2. Photovoltaic parameters of Cu−In−S QDSSCs based on various amounts of GCN additive under the illumination of AM 1.5G, 100 mWcm^{-2} sunlight.

QDSSCs	J_{SC} (mA cm^{-2})	V_{OC} (mV)	FF (%)	PCE[a] (%)	PCE[b] (%)
Liquid	20.35	623	48.5	6.16	6.10±0.07
0.25 % GCN	21.24	627	49.0	6.53	6.41±0.09
0.50 % GCN	21.41	634	49.6	6.73	6.67±0.11
0.75 % GCN	21.61	632	48.9	6.67	6.45±0.14

a. The performance of the champion cell. b. Average efficiency and standard deviations from four independent cells.

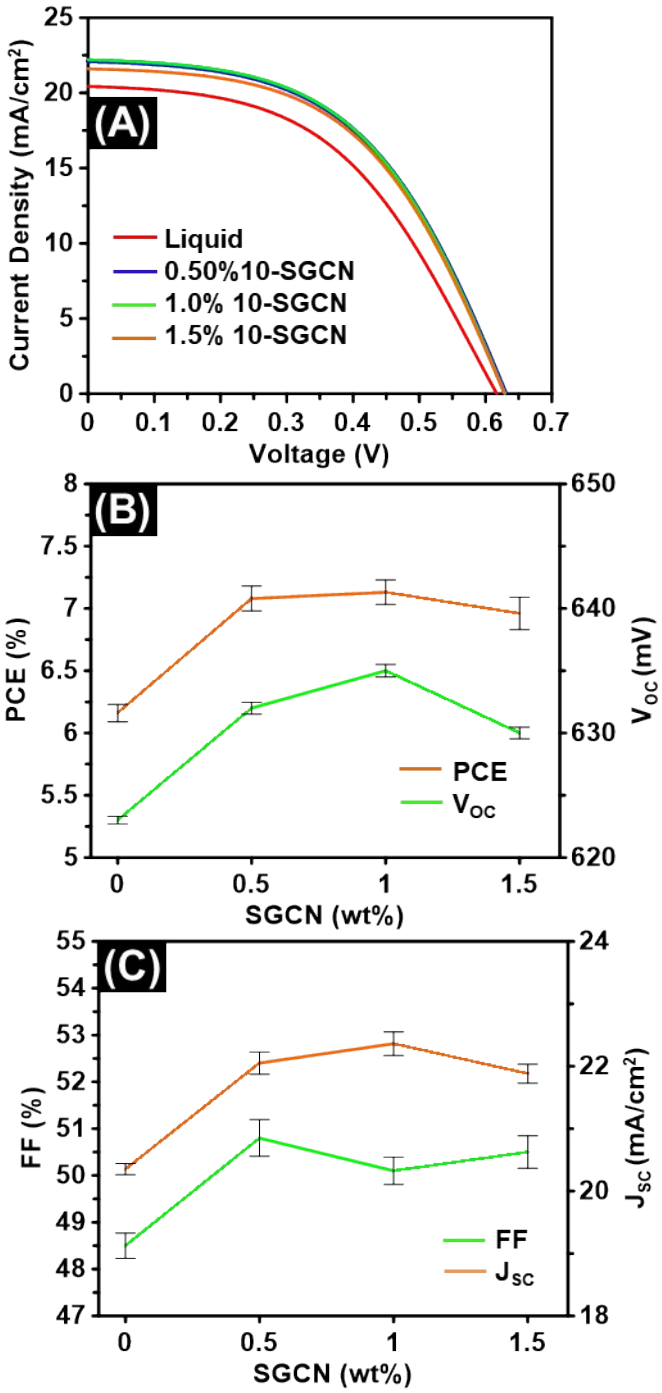

Figure S8. (A) *J–V* curves of the Cu-In-S QDSSCs with different concentration of SGCN electrolyte under one sun illumination (AM1.5G, 100 mW cm^{-2}). (B) Average PCE and V_{OC} along with (C) FF and J_{SC} of Cu-In-S based QDSSCs with different concentration of SGCN electrolyte.

Table S3. Photovoltaic parameters of Cu−In−S QDSSCs based on amount of SGCN additive under the illumination of AM 1.5G, 100 mWcm^{-2} sunlight.

QDSSCs	J_{SC} (mA cm^{-2})	V_{OC} (mV)	FF (%)	PCE[a] (%)	PCE[b] (%)
Liquid	20.35	623	48.5	6.16	6.10±0.07
0.5 % SGCN	22.05	632	50.8	7.08	6.79±0.10
1.0 % SGCN	22.36	635	50.1	7.13	7.01±0.10
1.5 % SGCN	21.88	630	50.5	6.96	6.92±0.13

a. The performance of the champion cell. b. Average efficiency and standard deviations from four independent cells.

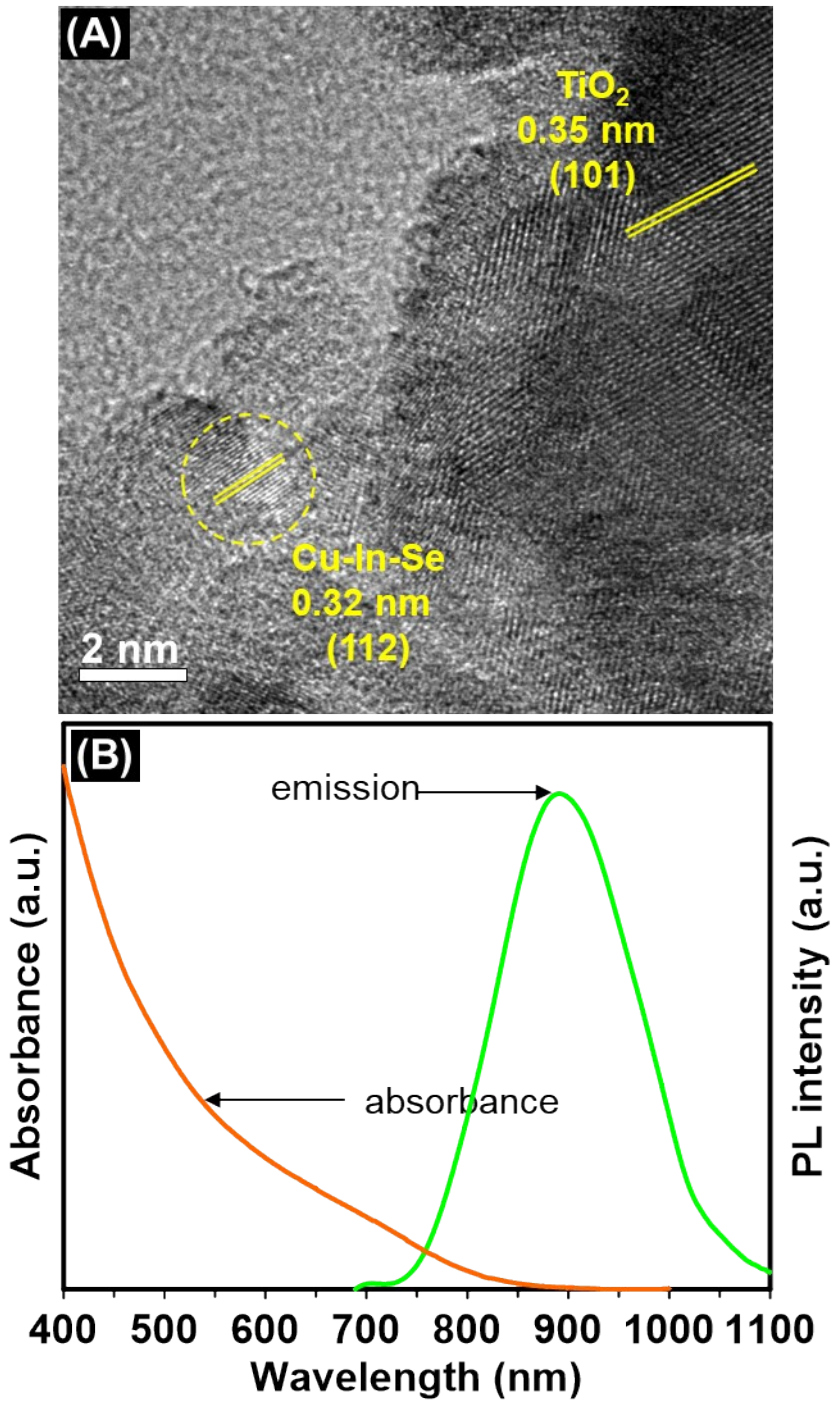

Figure S9. (A) HRTEM image and (B) Absorption and photoluminescence spectra of the as-prepared Cu-In-Se QDs.

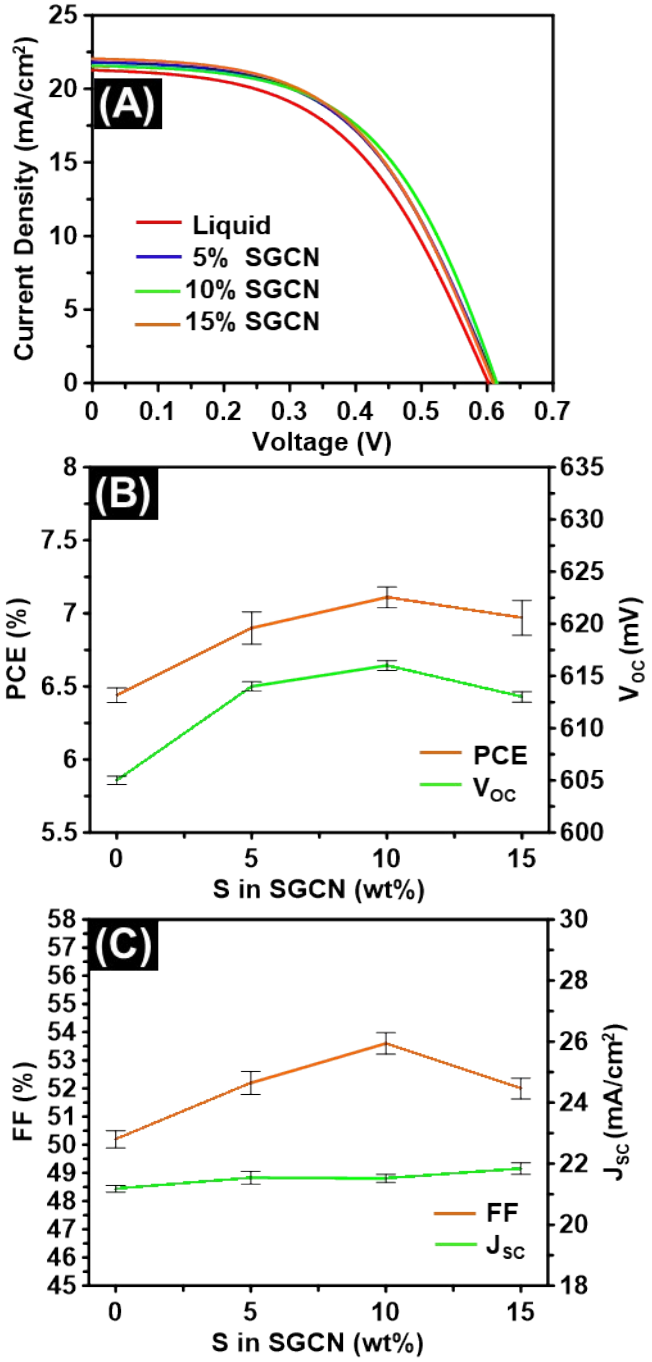

Figure S10. (A) *J–V* curves of the Cu-In-Se QDSSCs with different weight ratios of S in SGCN electrolyte under one sun illumination (AM1.5G, 100 mW cm^{-2}). (B) Average PCE and V_{OC} along with (C) FF and J_{SC} of Cu-In-Se based QDSSCs with different weight ratios of S in SGCN electrolyte.

Table S4. Photovoltaic parameters of Cu−In−Se QDSSCs based on various amounts S in SGCN additive under the illumination of AM 1.5G, 100 mWcm^{-2} sunlight.

QDSSCs	J_{SC} (mA cm^{-2})	V_{OC} (mV)	FF (%)	PCE[a] (%)	PCE[b] (%)
Liquid	21.18	605	50.2	6.45	6.39±0.05
05 % SGCN	21.54	614	52.2	6.90	6.86±0.11
10 % SGCN	21.52	616	53.6	7.11	7.02±0.07
15 % SGCN	21.84	613	52.0	6.97	6.83±0.12

a. The performance of the champion cell. b. Average efficiency and standard deviations from four independent cells.

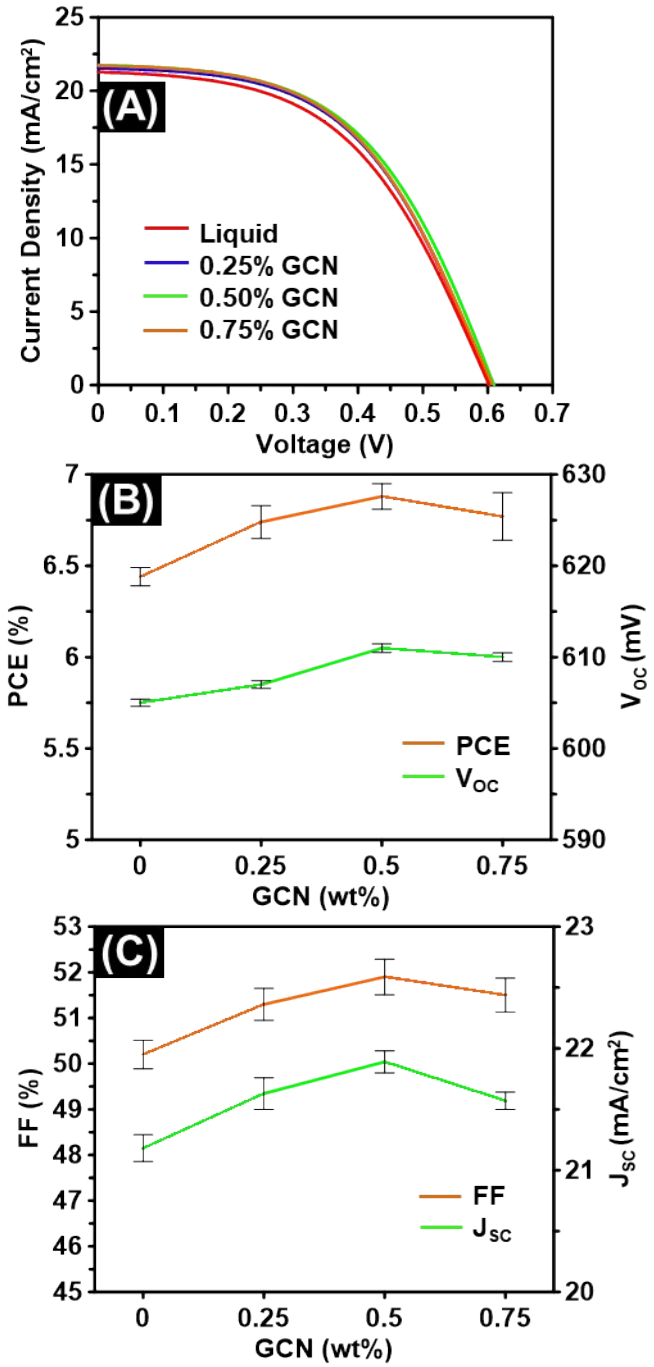

Figure S11. (A) *J–V* curves of the Cu-In-Se QDSSCs with different concentration of GCN electrolyte under one sun illumination (AM1.5G, 100 mW cm^{-2}). (B) Average PCE and V_{OC} along with (C) FF and J_{SC} of Cu-In-S based QDSSCs with different concentration of GCN electrolyte.

Table S5. Photovoltaic parameters of Cu−In−Se QDSSCs based on various amounts of GCN additive under the illumination of AM 1.5G, 100 mWcm^{-2} sunlight.

QDSSCs	J_{SC} (mA cm^{-2})	V_{OC} (mV)	FF (%)	PCE[a] (%)	PCE[b] (%)
Liquid	21.18	605	50.2	6.45	6.39±0.05
0.25 % GCN	21.63	607	51.3	6.74	6.69±0.09
0.50 % GCN	21.71	611	51.9	6.88	6.77±0.07
0.75 % GCN	21.57	610	51.5	6.77	6.71±0.13

a. The performance of the champion cell. b. Average efficiency and standard deviations from four independent cells.

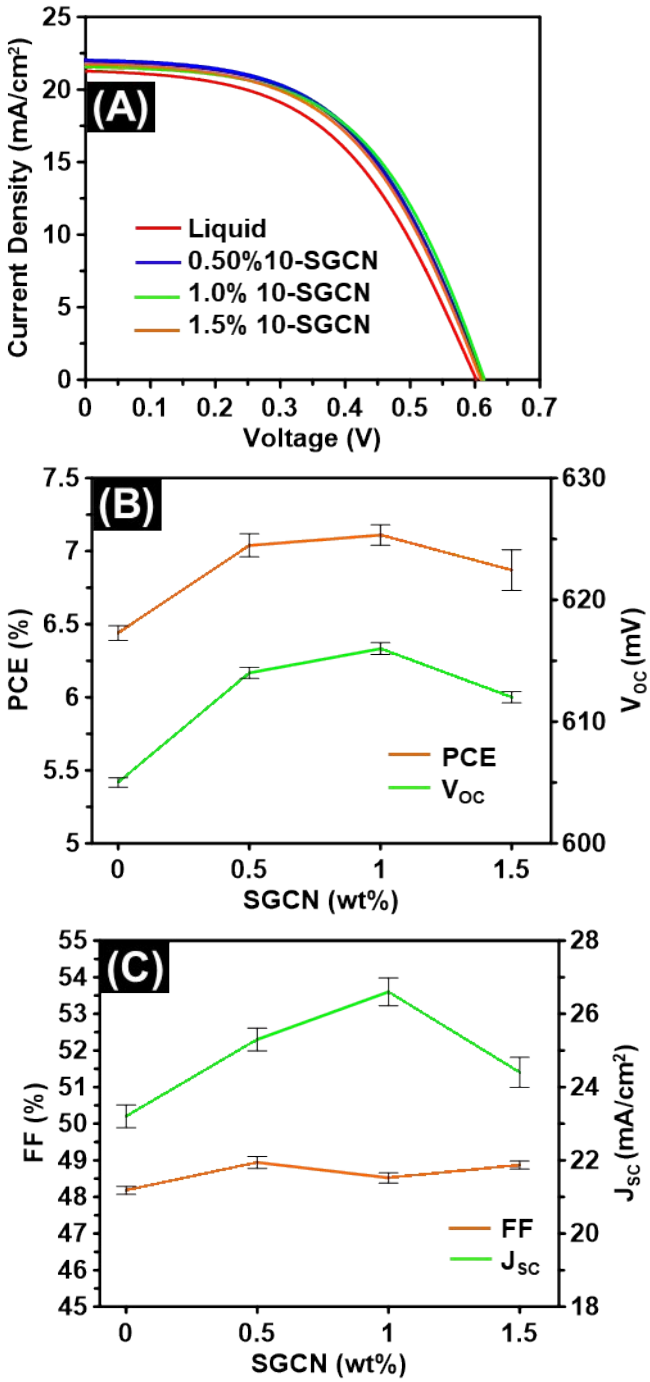

Figure S12. (A) *J–V* curves of the Cu-In-Se QDSSCs with different concentration of SGCN electrolyte under one sun illumination (AM1.5G, 100 mW cm^{-2}). (B) Average PCE and V_{OC} along with (C) FF and J_{SC} of Cu-In-S based QDSSCs with different concentration of SGCN electrolyte.

Table S6. Photovoltaic parameters of Cu−In−Se QDSSCs based on amount of SGCN additive under the illumination of AM 1.5G, 100 mWcm^{-2} sunlight.

QDSSCs	J_{SC} (mA cm^{-2})	V_{OC} (mV)	FF (%)	PCE[a] (%)	PCE[b] (%)
Liquid	21.18	605	50.2	6.45	6.39±0.05
0.5 % SGCN	21.94	614	52.3	7.04	6.92±0.08
1.0 % SGCN	21.52	616	53.6	7.11	7.02±0.07
1.5 % SGCN	21.87	612	51.4	6.87	6.75±0.14

a. The performance of the champion cell. b. Average efficiency and standard deviations from four independent cells.