Supporting Information

High Efficiency CIGS Solar Cells by Bulk Defect Passivation through Ag Substituting Strategy

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Figure S1 Digital photograph of CIGS precursor solution and Ag precursor solution.

Figure S1 Digital photograph of CIGS precursor solution and Ag precursor solution.
Figure S2 Digital photo of the assembled cell, each cell was divided into nine small batteries, each of which has an effective area of 0.21 cm².
Figure S3 Statistical box diagrams of photovoltaic parameters of Device A-D: (a)$J_{SC}$, (b)$V_{OC}$, (c)FF, (d)PCE. Thirty cells were selected for each sample for analysis.
Figure S4 The bandgap can be determined from the long wavelength absorption edge of the EQE curves by the linear extrapolation of \((E \times \ln(1-EQE))^2\) versus Eg.
Figure S5 J-V curves of device A-D under light and dark state.
\[
\ln(t \ast V_{th} \ast N_v) = \ln(X_p \sigma_p) - \frac{E_a - E_v}{kT} \tag{S1}
\]

\[
N_T = 2N \frac{\Delta C}{S_{C_R}} \tag{S2}
\]

\[
V_{th} = \frac{\sqrt{3kT}}{m_p} \tag{S3}
\]

\[
N_V = 2\left(\frac{2\pi m^*_p kT}{k^2}\right)^{\frac{3}{2}} \tag{S4}
\]

\[
N_S = \frac{2C^2}{qEA}(V + V_d) \tag{S5}
\]

Where, \(\tau, V_{th}, N_V, \sigma_p\) and \(X_p\) are respectively the emission time constant, the thermal rate of the carrier, the effective density state of the carrier, the capture cross section of the carrier, the entropy factor of the carrier, \(T, k, E_a, E_v, N_S, \Delta C\) and \(C_R\) are temperature, boltzmann constant, valence band energy level, activation energy, the capacitance under reverse bias at equilibrium, capacitance transient amplitude and density of shallow defects, respectively.\textsuperscript{1,2}
Table S1 Summary of photovoltaic parameters for solution processed CIGS solar cells. EDT and En are 1, 2-ethanedithiol and 1, 2-ethylenediamine respectively.

<table>
<thead>
<tr>
<th>Device</th>
<th>PCE (%)</th>
<th>$V_{OC}$ (mV)</th>
<th>$J_{SC}$ (mA/cm$^2$)</th>
<th>FF (%)</th>
<th>solvent</th>
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<tr>
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<td>71.5</td>
<td>DMSO</td>
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<tr>
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<td>35.2</td>
<td>71.5</td>
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<tr>
<td>Ref 5</td>
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<td>660</td>
<td>35.78</td>
<td>73.4</td>
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<td>15.82</td>
<td>630</td>
<td>34.44</td>
<td>72.90</td>
<td>EDT and En</td>
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References


