Electronic Supplementary Material (ESI) for RSC Advances.

A Straightforward Chemical Approach for Superb In_2S_3 Electron Transport Layer applied in Hybrid Perovskite Solar Cells

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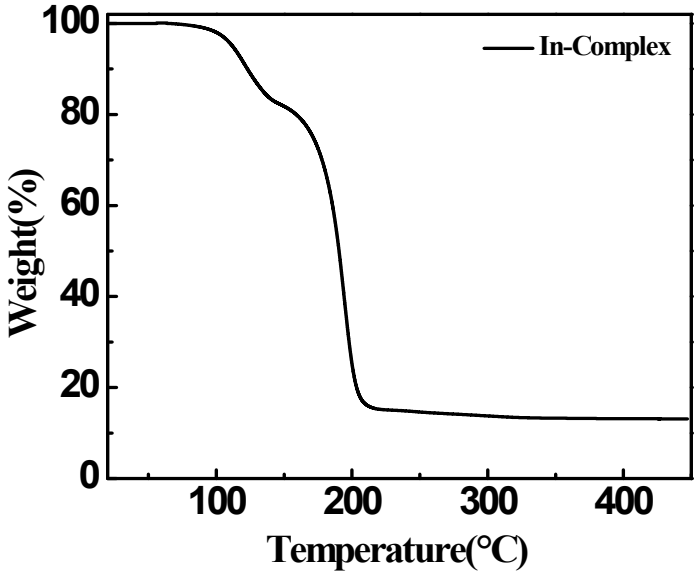

Figure S1. Thermogravimetric (TG) analysis curves of In-complex powder.

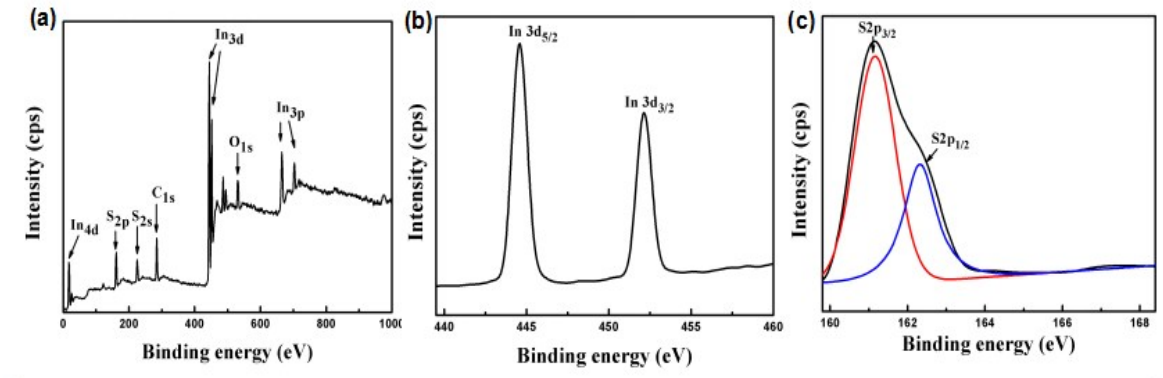

Figure S2. (a) the surface-sensitive XPS (X-ray photoelectron spectroscopy), (b) In_{3d} peaks and (c) S_{2p} peaks of In_2S_3 films.

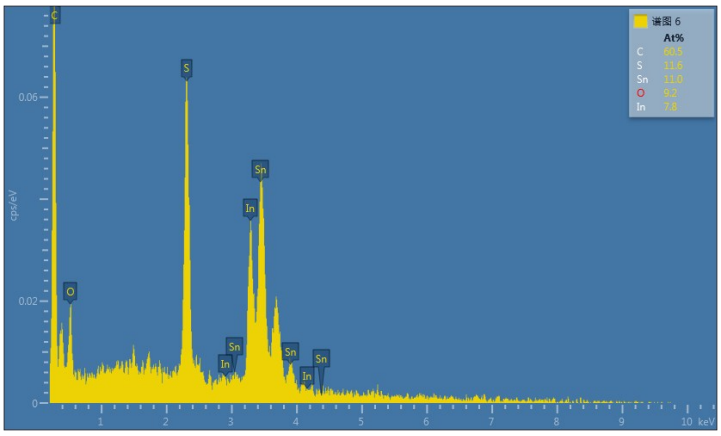

Figure S3. The SEM-EDS image of In_2S_3 films.

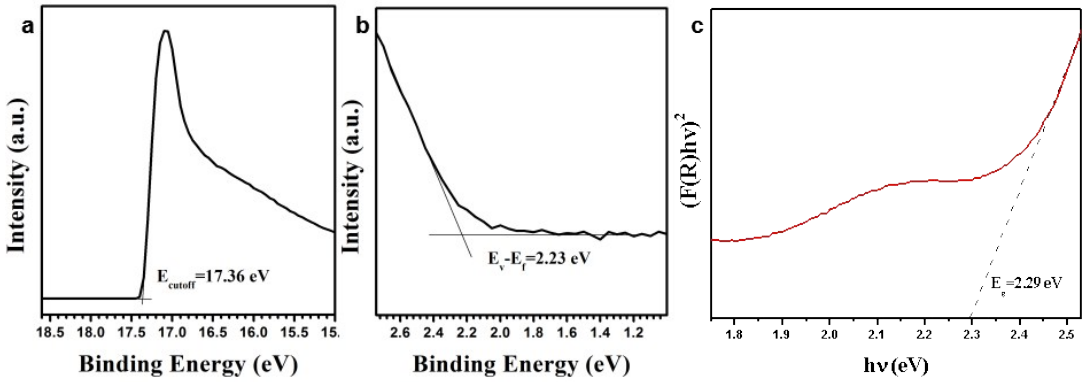

Figure S4. Ultraviolet photoelectron spectra illustrating (a) the secondary electron emission cut-off ($E_{cut\text{-}off}$) and (b) valence band maximum (VBM) of In_2S_3 thin film. (c) Tauc plot for evaluating the optical bandgap of In_2S_3 film.

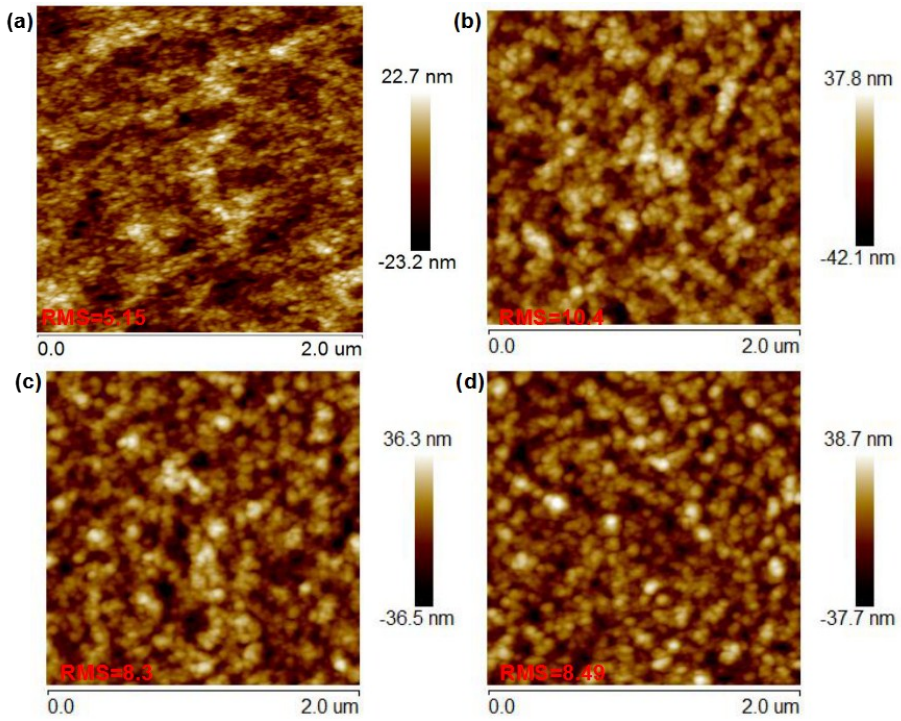

Figure S5. AFM height images for 220 mmol/L(a); 110 mmol/L(b); 75 mmol/L(c) and 50 mmol/L(d) In-complex precursor processed In_2S_3 films.

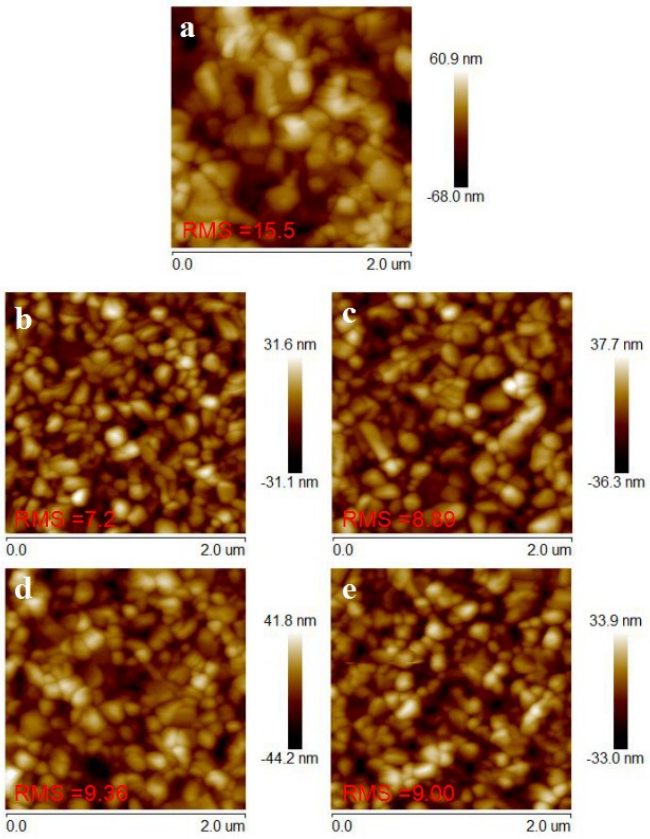

Figure S6. AFM height images for perovskite films based on 220 mmol/L(a); 110 mmol/L(b); 75 mmol/L(c) and 50 mmol/L(d)In-complex precursor processed In_2S_3 ETLs.

Table S1. The thickness of In_2S_3 film deposited with different metal concentration.

Concentration	220 mmol/L	110 mmol/L	75 mmol/L	50 mmol/L
Thickness(nm)	99.4	43.9	24.6	17.5

Table S1. Influence of the concentration of In_2S_3 precursor photovoltaic parameters of the best PSC devices.

Concentration	J_{SC} (mA/cm^2)	V_{OC} (V)	*FF* (%)	*PCE* (%)
220 mmol/L	20.15	1.05	65.93	13.99
110 mmol/L	20.78	1.05	65.39	14.33
75 mmol/L	21.00	1.06	69.53	15.48
50 mmol/L	21.03	1.03	57.61	12.54

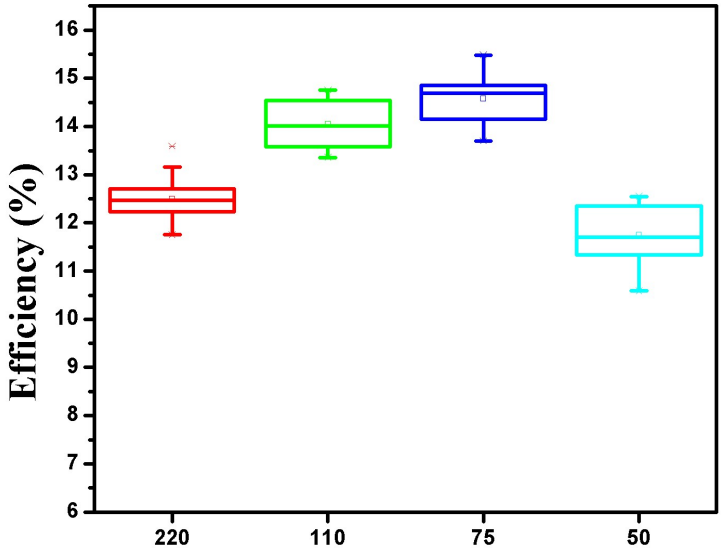

Figure S7. PCE distribution of PSCs based on different concentration (mmol/L) In_2S_3 ETLs. All the devices were measured under AM 1.5 G solar irradiation.

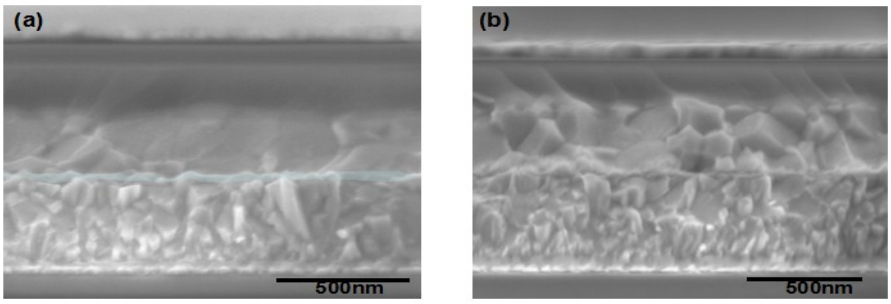

Figure S8. Cross-sectional SEM image of the perovskite devices based on In_2S_3 (left) and TiO_2 (right).

The cross-sectional SEM images of the complete cells are displayed in Figure S8. The thickness of the $CH_3NH_3PbI_3$ film is about 350 nm, based on the In_2S_3, the perovskite film has a better cystallinity.