Supporting Information

Wet-chemical etching of cadmium telluride photovoltaics for enhanced open-circuit voltage, fill factor, and power conversion efficiency

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1. EDS Analysis

Table SI. Energy dispersive X-ray spectroscopy (EDS) Analysis of etched CdTe surface

Elements	CdTe films treated with solution of			
	Standard (untreated)	Iodine (I_2)	Ammonium Iodide (NH_4I)	mixed I^-/I_3^-
Cd L	53.3±0.3	40.7±2.9	47.4±2.7	45.2±2.9
Te L	46.7±0.3	54.7±3.2	50.0±1.7	51.2±3.1
I L	-	4.6±0.7	2.6±1.5	3.6±0.1
Cd:Te	1.14	0.74	0.95	0.88

2. Summary of device parameters

Table SII. Summary of average J-V characteristics of CdTe solar cells with iodine etching of various concentration

Device	V_{OC} (mV)	J_{SC} ($mAcm^{-2}$)	FF (%)	Eff. (%)	R_s ($\Omega.cm^2$)	R_{sh} ($\Omega.cm^2$)
Standard	814±2	20.6±1.2	73.4±1.2	12.3±0.7	3.0±0.5	2091±429
62.5 mM-I_2	810±10	21.4±0.3	72.0±2.6	12.5±0.6	3.0±0.8	1765±873
125 mM-I_2	797±21	21.7±0.3	67.0±4.7	11.7±1.1	3.4±0.3	1176±704
250 mM-I_2	793±19	20.1±0.4	62.8±5.5	10.8±1.2	5.3±1.6	703±235
375 mM-I_2	804±14	20.8±0.2	66.4±4.7	11.1±1.0	3.8±1.1	1081±543
500 mM-I_2	793±32	21.6±0.6	70.5±4.5	11.6±1.1	3.1±0.9	1813±1067
1 M-I_2	796±13	21.4±0.7	70.3±2.8	11.9±0.8	3.8±1.1	1200±500

Table SIII. Summary of average J-V characteristics of CdTe solar cells with ammonium iodide (NH_4I) etching of various concentration.

Device	V_{OC} (mV)	J_{SC} ($mAcm^{-2}$)	FF (%)	Eff. (%)	R_s ($\Omega.cm^2$)	R_{sh} ($\Omega.cm^2$)
Standard	800±8	21.2±0.4	71.5±2.2	12.1±0.2	2.6±0.5	1697±525
NH_4I-62.5 mM	813±7	21.1±0.3	72.2±1.0	12.4±0.3	3.0±0.8	1650±276
NH_4I-125 mM	811±6	21.4±0.6	71.7±1.0	12.5±0.3	3.6±0.2	1551±292
NH_4I-250 M	818±4	21.5±0.3	72.0±1.1	12.7±0.2	3.3±0.8	1584±272
NH_4I-375M	815±8	21.1±0.4	73.6±0.5	12.7±0.2	3.7±0.4	2308±132
NH_4I-500M	821±5	21.0±0.4	73.7±1.5	12.7±0.3	3.5±0.8	2052±332

3. SEM Images and EDS analysis of CdTe films treated with Iodine solution with various concertation

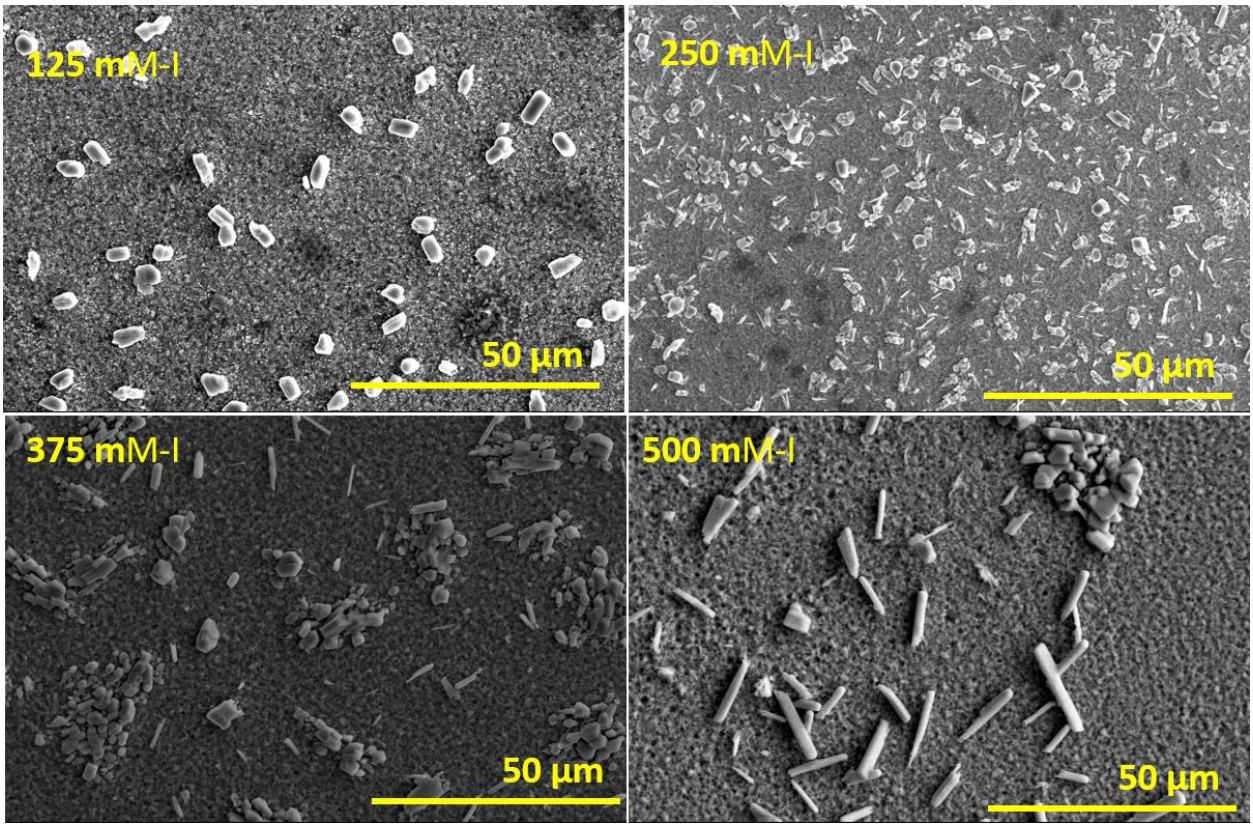

Figure S1. Scanning electron microscopy (SEM) images of CdTe films etched with various concentration of iodine solution in isopropanaol.

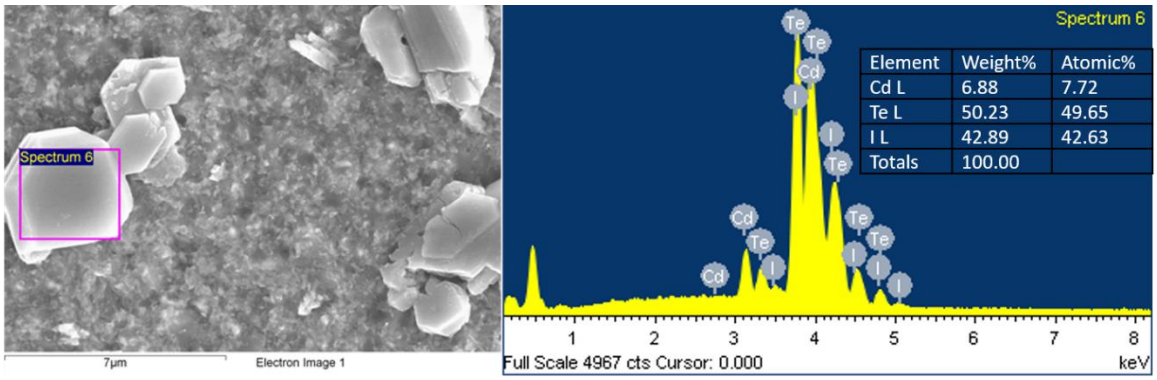

Figure S2. Typical EDS analysis of CdTe films etched with 250 mM iodine solution and its EDS spectrum with elemental composition

4. External Quantum Efficiencies of CdTe devices treated with varying I^-/I_3^- Concentration

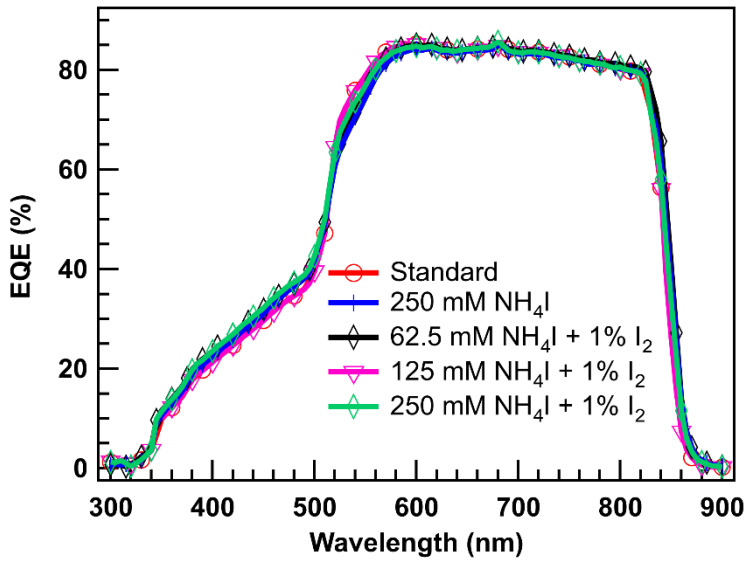

Figure S3. External quantum efficiencies of CdTe devices etched with I^-/I_3^- solutions. The corresponding J-V characteristics of these cells are shown in Figure 4.

5. Effecting of annealing CdTe surface while etching with I^-/I_3^- solution

To study the effect of heating after etching devices, SEM images were taken for samples with and without heating. Figure S4 represents surface topography of CdTe films without and with heating after I^-/I_3^- etching in Figure S4 (a) and (b) respectively. The Te grains were more visible in case of heated sample at 150 ℃ for about 10 mins. Here, I^-/I_3^- in etch with 250 mM NH4I and 1% I_2 solution (250 mM) produced uniform Te grains which are clearly visible on the CdTe surface.

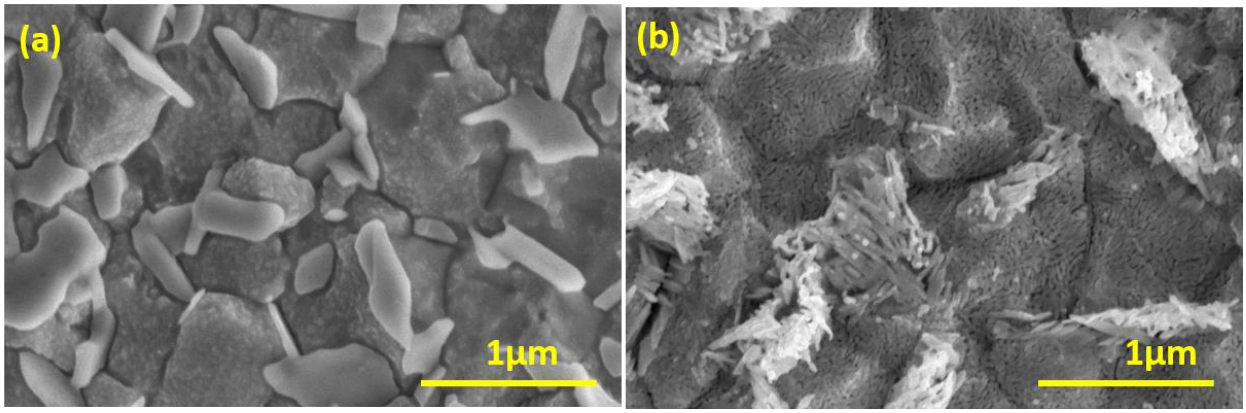

Figure S4. Scanning electron microscopy (SEM) images (a) surface morphology of CdTe film etched with 250 mM NH4I +1% I2 without heating and (b) with heating at 150 ℃ for 10 mins.

6. External Quantum Efficiencies of CdTe devices treated with varying FAI Concentration

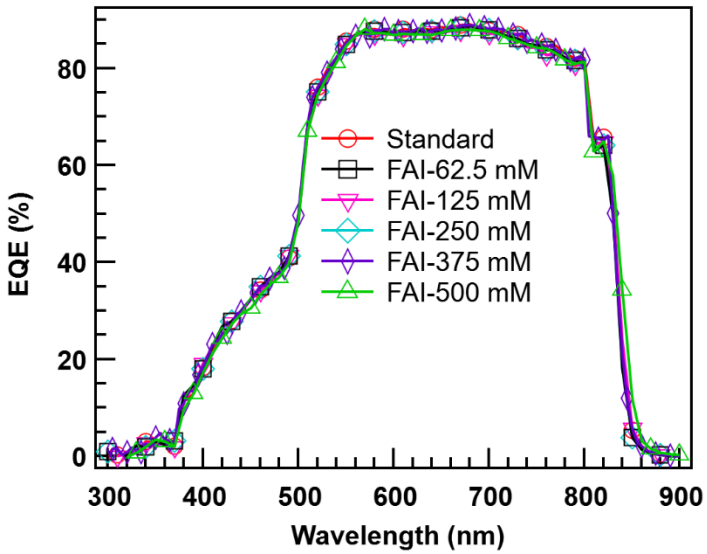

Figure S5. External quantum efficiencies of CdTe devices etched with FAI solutions. The corresponding J-V characteristics of these cells are shown in Figure 7.