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Supplementary Information

Aqueous Solution-Processed CuO_X film as an Anode Buffer Layer for Efficient and Stable Organic Solar Cells

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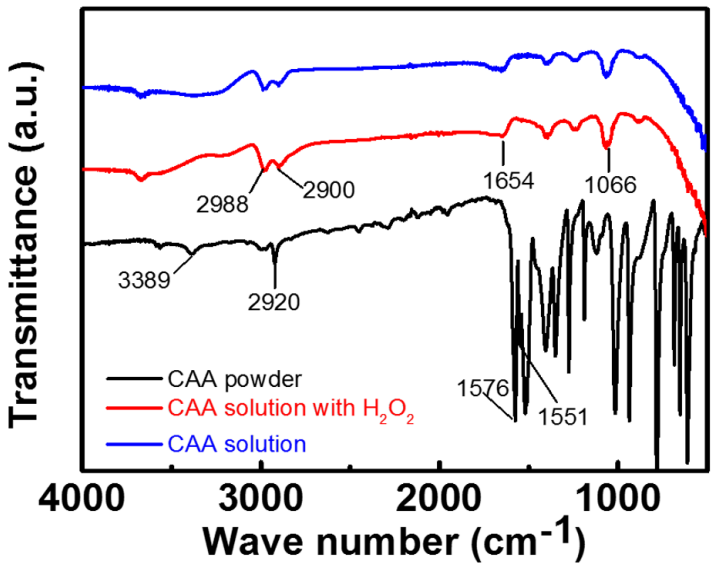

Figure S1. FTIR spectra of CAA powder, CAA solution with and without H_2O_2.

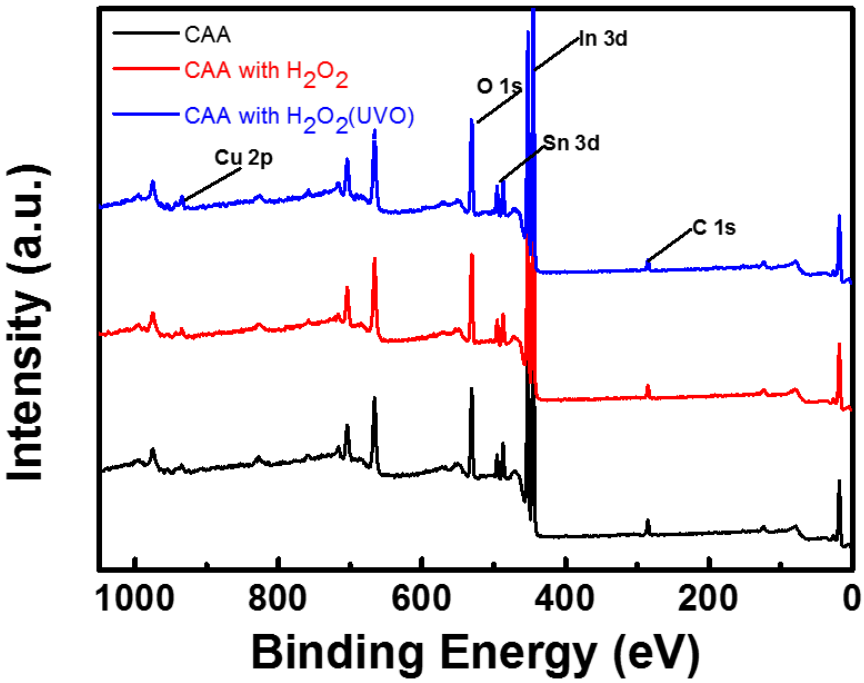

Figure S2. XPS survey scans of CAA based films. The substrate is ITO glass.

For CAA powder, the peaks around 1576 cm^{-1} and 1551 cm^{-1}, represent the stretching modes of C=O and C=C. After CAA was dissolved in water with acetic acid as additive, the peaks at 1576 cm^{-1} and 1551 cm^{-1} disappeared, implying the rupture of conjugated π bonds, which indicates there was chemical reaction between CAA and acetic acid. The peaks around 1654 cm^{-1} and 1066 cm^{-1} represent the stretching modes of C=O and C-O, respectively. It indicates that the CAA reacted with the acetic acid and copper acetate (Cu^{2+}) formed. Furthermore, in the case of the precursor aqueous solution with H_2O_2 as additive, no obvious difference was observed in the FTIR spectra with respect to that obtained from the pure CAA precursor solution, indicating they have similar chemical composition.

Table S1. Device parameters of the OSCs based on H-CuO_x with different H_2O_2 and CAA solution volume ratios under the illumination of AM 1.5G, 100mW cm^{-2}.

$[H_2O_2]$:[CAA]	V_{OC} [V]	J_{SC} [mA cm^{-2}]	FF	PCE [%]		Rs [Ω·cm^2]
				best	average	
3:2	0.71	15.07	0.66	7.09	7.02±0.05	3.3
1:1	0.71	15.60	0.63	7.03	6.98±0.04	3.5
2:3	0.72	15.38	0.70	7.78	7.73±0.05	2.9
1:3	0.71	15.27	0.68	7.42	7.38±0.04	2.9

Series resistance (Rs) for PSCs under the illumination is obtained at around 1 V.

Table S2. Device parameters of the OSCs based on H-CuO_X with different UV-Ozone treatment times under the illumination of AM 1.5G, 100 mW cm^{-2}.

Time [min]	V_{OC} [V]	J_{SC} [mA cm^{-2}]	FF	PCE [%]		R_s [$\Omega \cdot cm^2$]
				best	average	
0	0.72	15.38	0.70	7.78	7.73±0.05	2.9
5	0.73	15.11	0.70	7.68	7.58±0.09	2.8
10	0.74	15.69	0.72	8.31	8.19±0.06	1.2
15	0.74	16.44	0.71	8.68	8.52±0.08	2.5
20	0.73	15.89	0.71	8.26	8.19±0.07	2.1

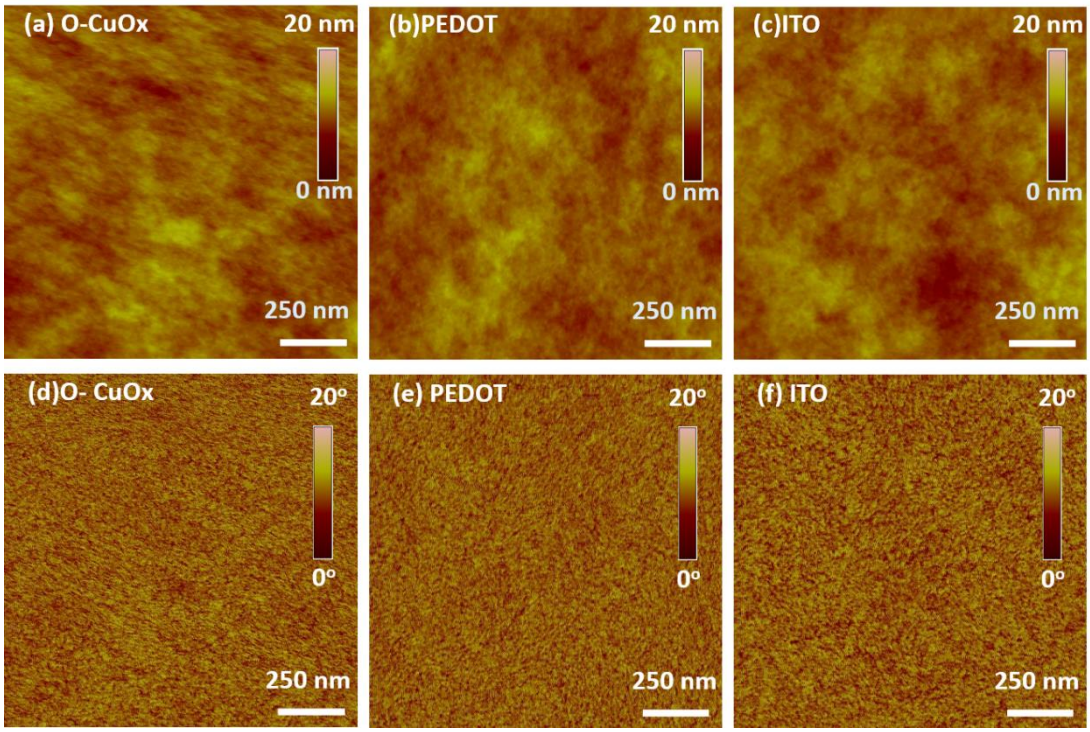

Figure S3. AFM height (a)-(c) and phase (d)-(f) images of PTB7:$PC_{71}BM$ on ITO/O-CuO_x (a,d), PEDOT:PSS/ITO (b,e), bare ITO (d,h) substrate with 1 μm × 1 μm scan size, height rms roughness is 0.80, 0.80, and 0.81 nm from left to right.