Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information

High-Yield Production of Stable Antimonene Quantum Sheets for Highly Efficient Organic Photovoltaics

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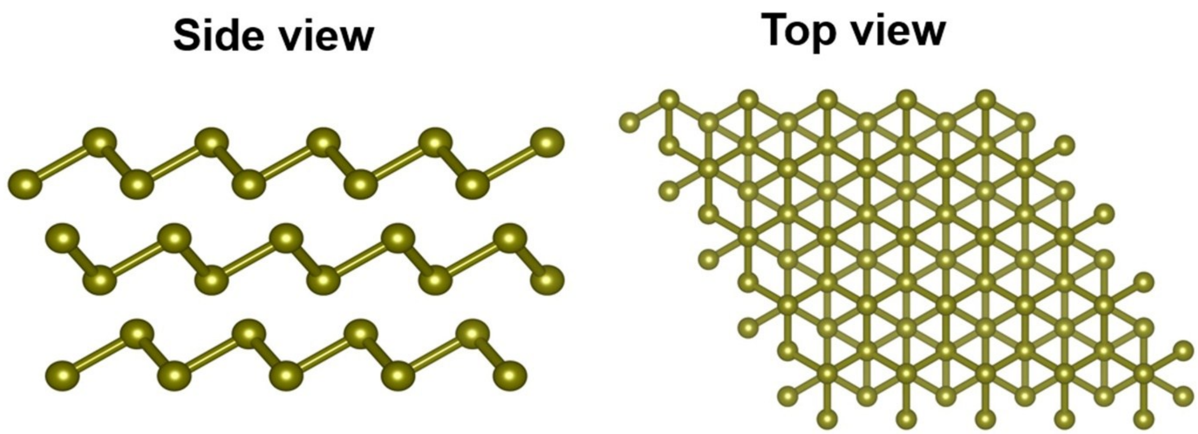

Fig. S1 Atomic structure of β-phase antimony.

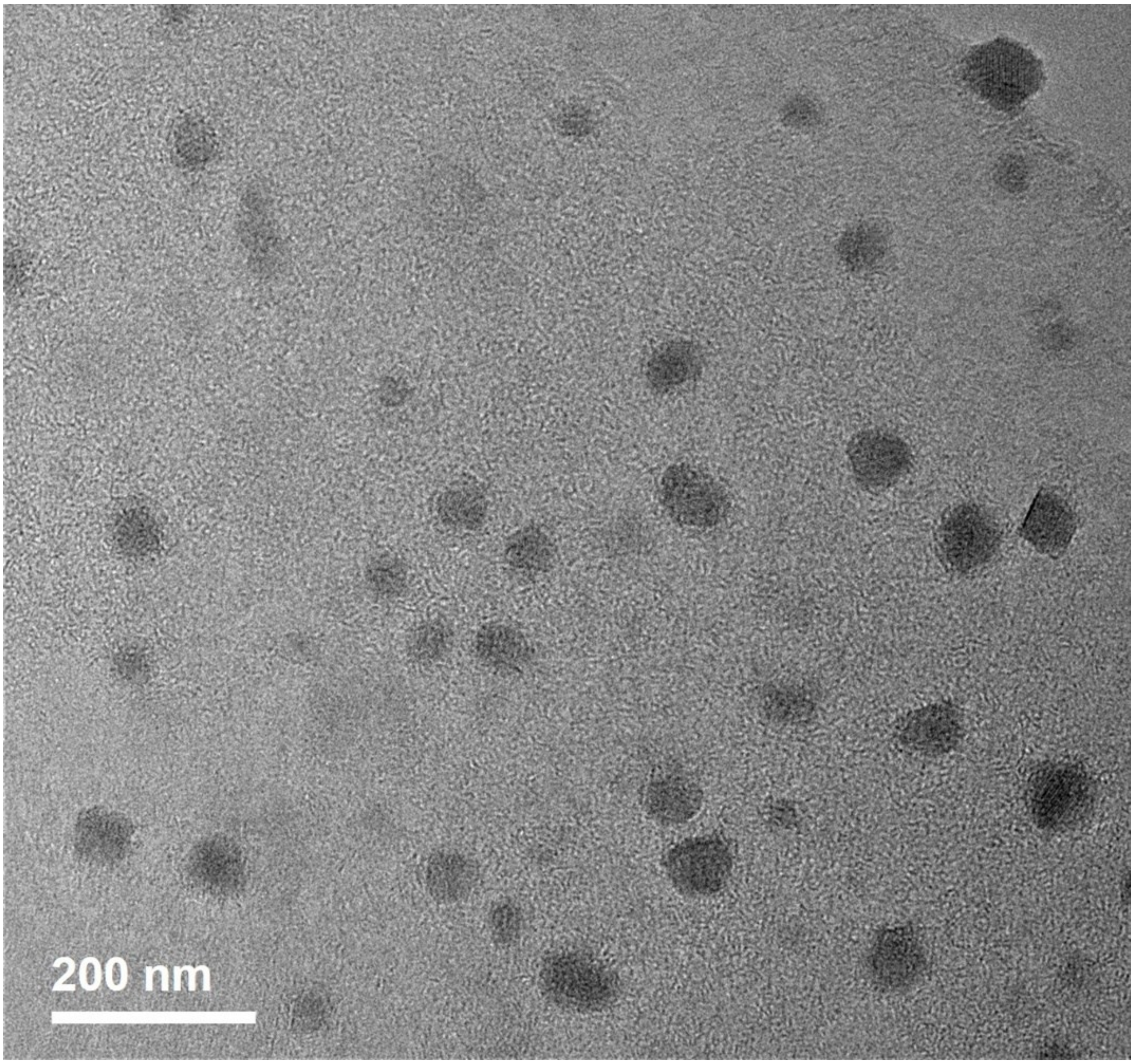

Fig. S2 TEM image of AM nanosheets.

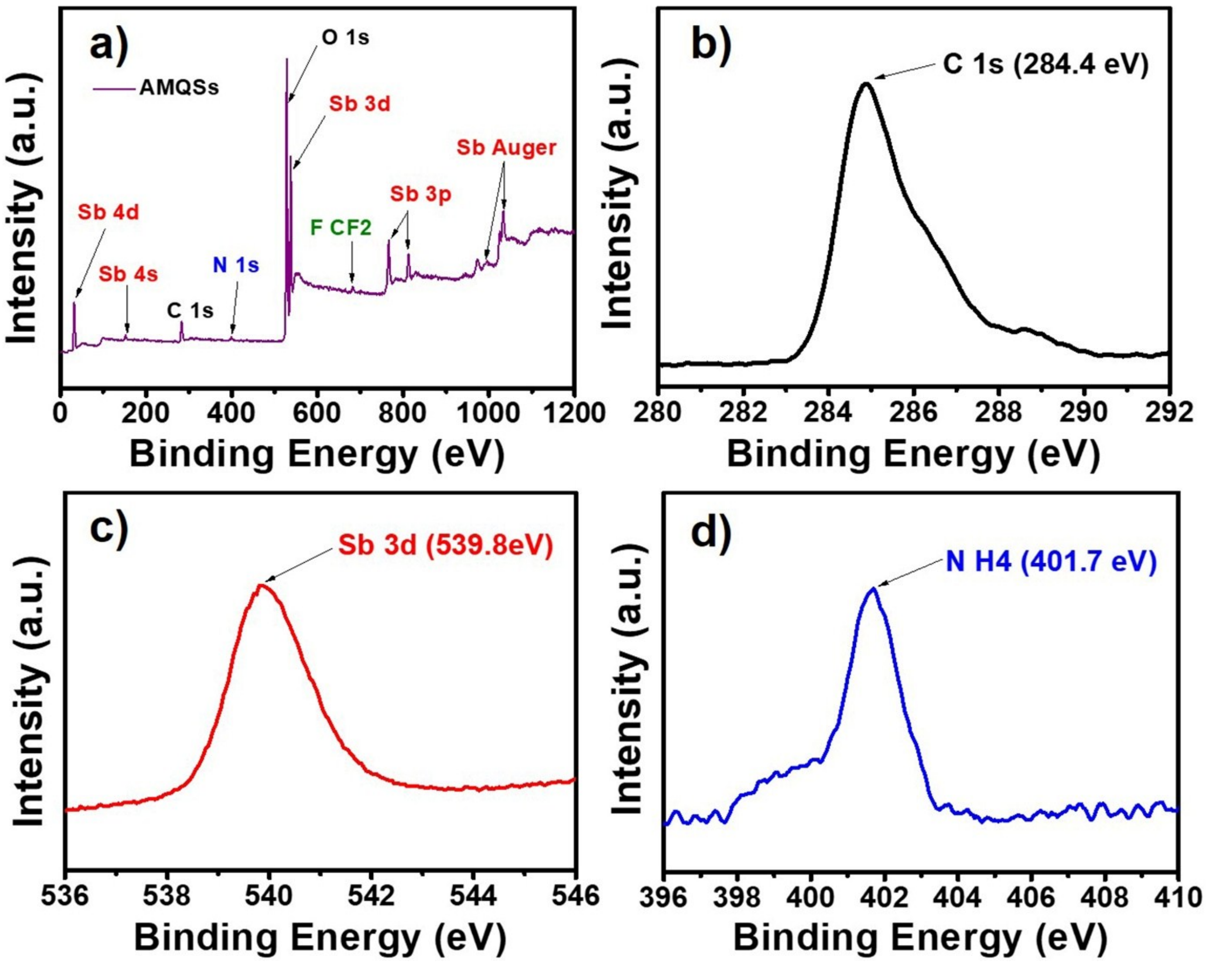

Fig. S3 XPS survey spectra of AMQSs. (a) Full scan XPS spectrum of as prepared AMQSs. Partial scan of AMQSs for C 1s (b), Sb 3d (c) and NH_4 (d).

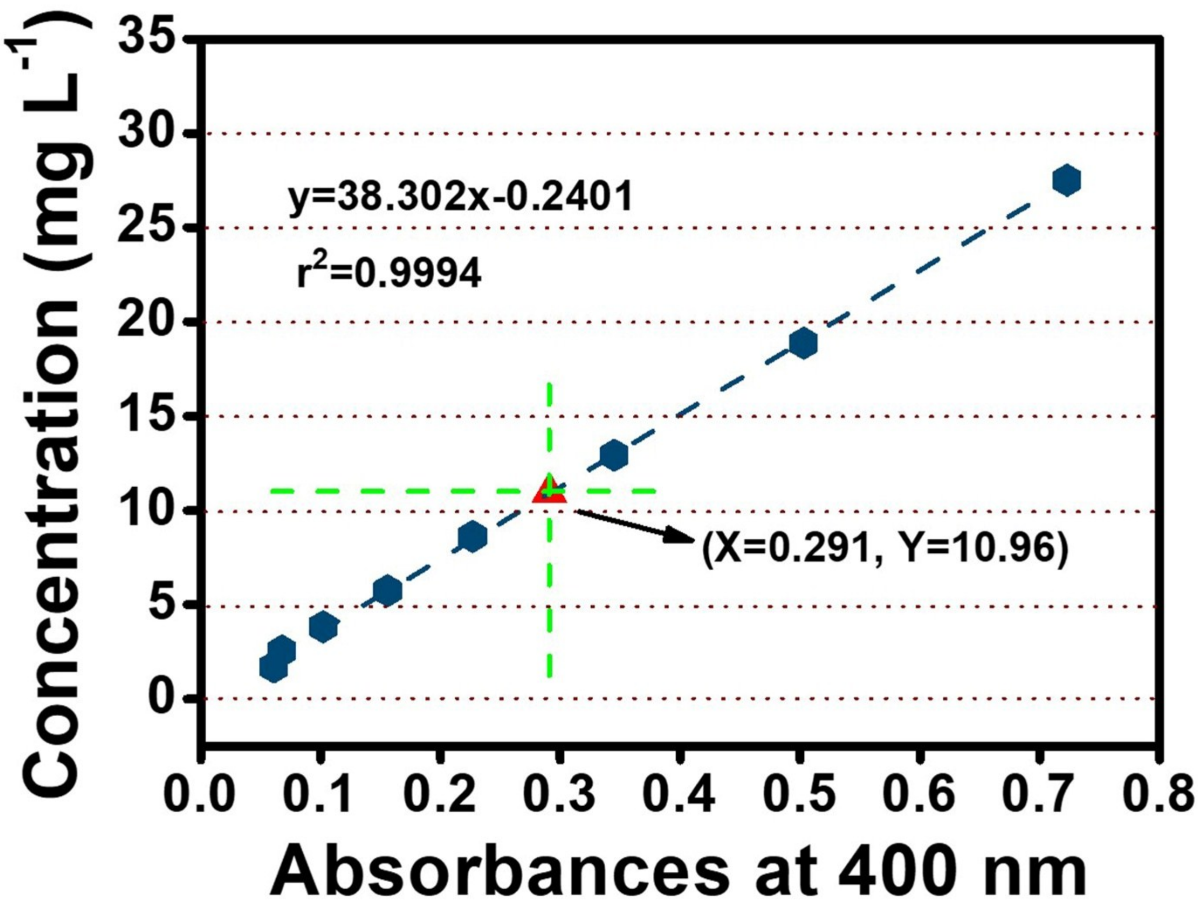

Fig. S4 Standard curves of absorbance *versus* concentration (mg L^{-1}) at different concentrations of AMQSs diluted 100 times for λ=400 nm in [Emim]CF_3COO.

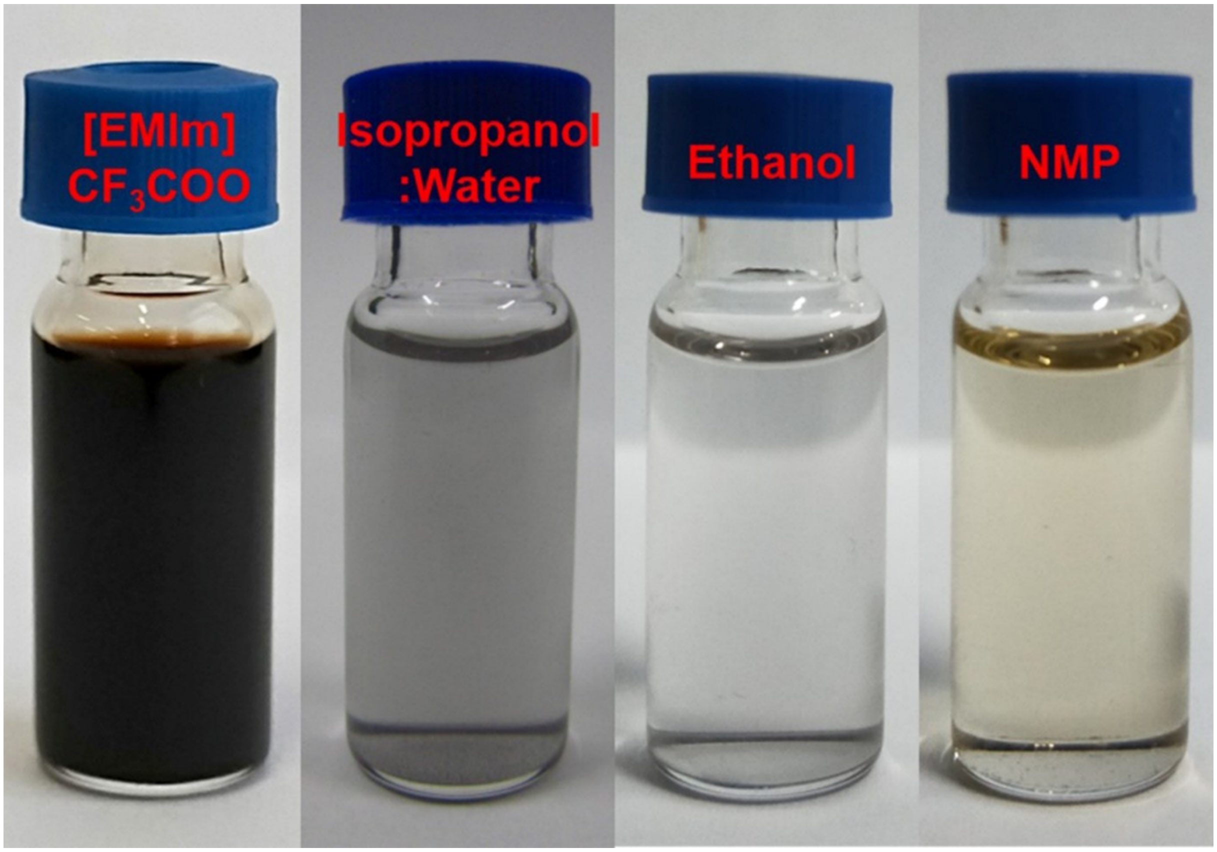

Fig. S5 photos of the original supernatant of samples prepared by different solvents, [Emim]CF_3COO (this work), Isopropanol:Water,[1] Ethanol[2] and NMP[3].

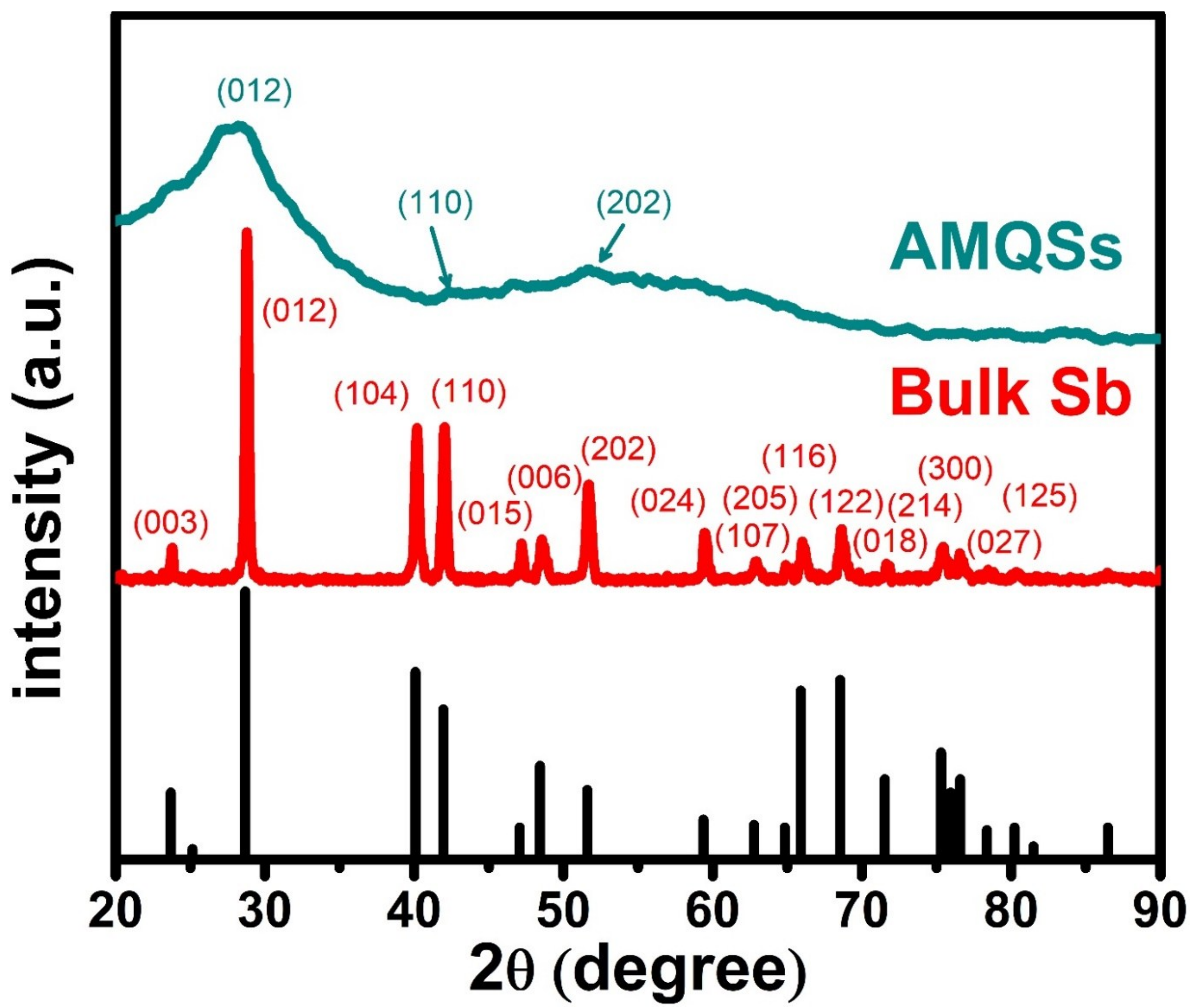

Fig. S6 XRD spectra of AMQSs and bulk Sb.

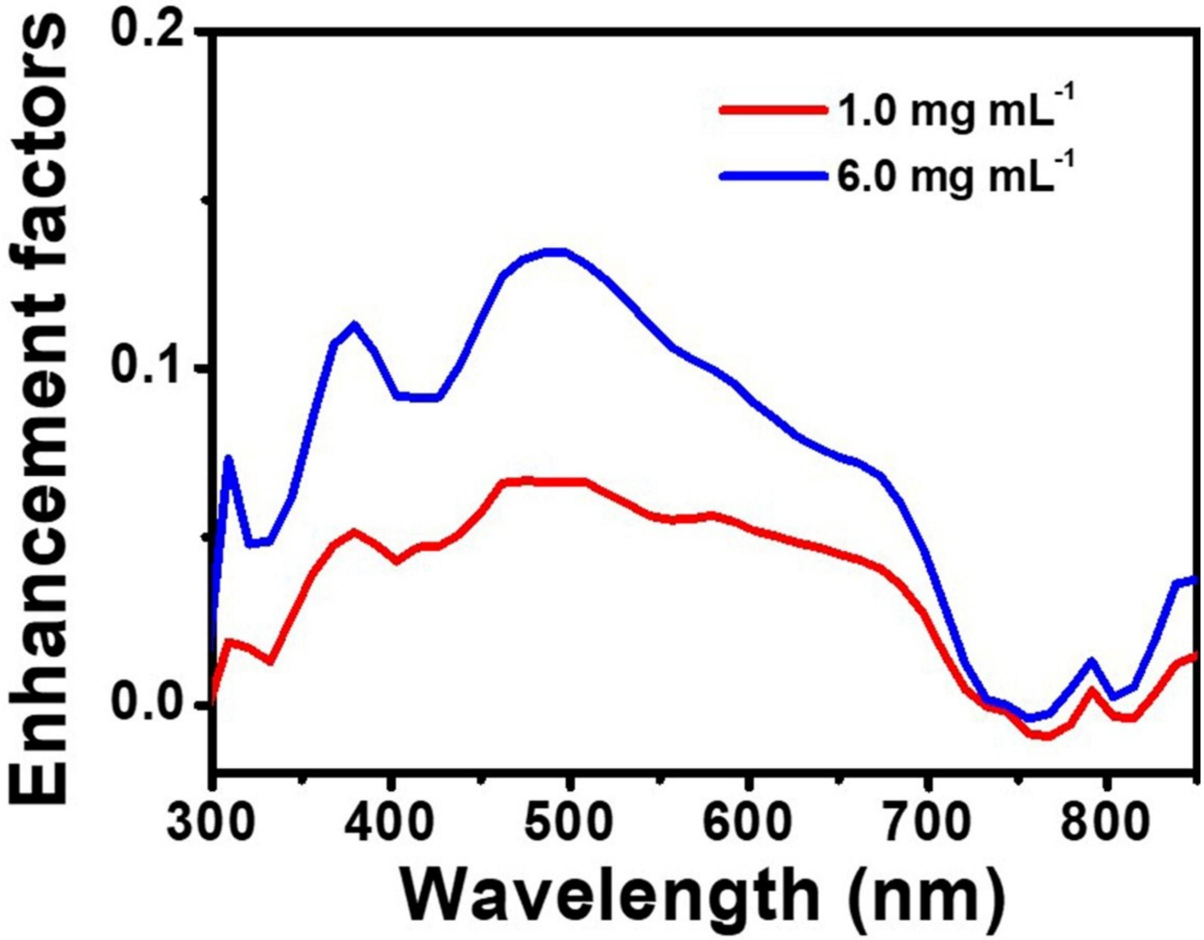

Fig. S7 Enhancement factors of the UV-vis absorption of the ITO/ZnO/PTB7:$PC_{71}BM$ film with AMQSs. The difference between the AMQSs-doped film and the reference film is divided by the value of the reference film.

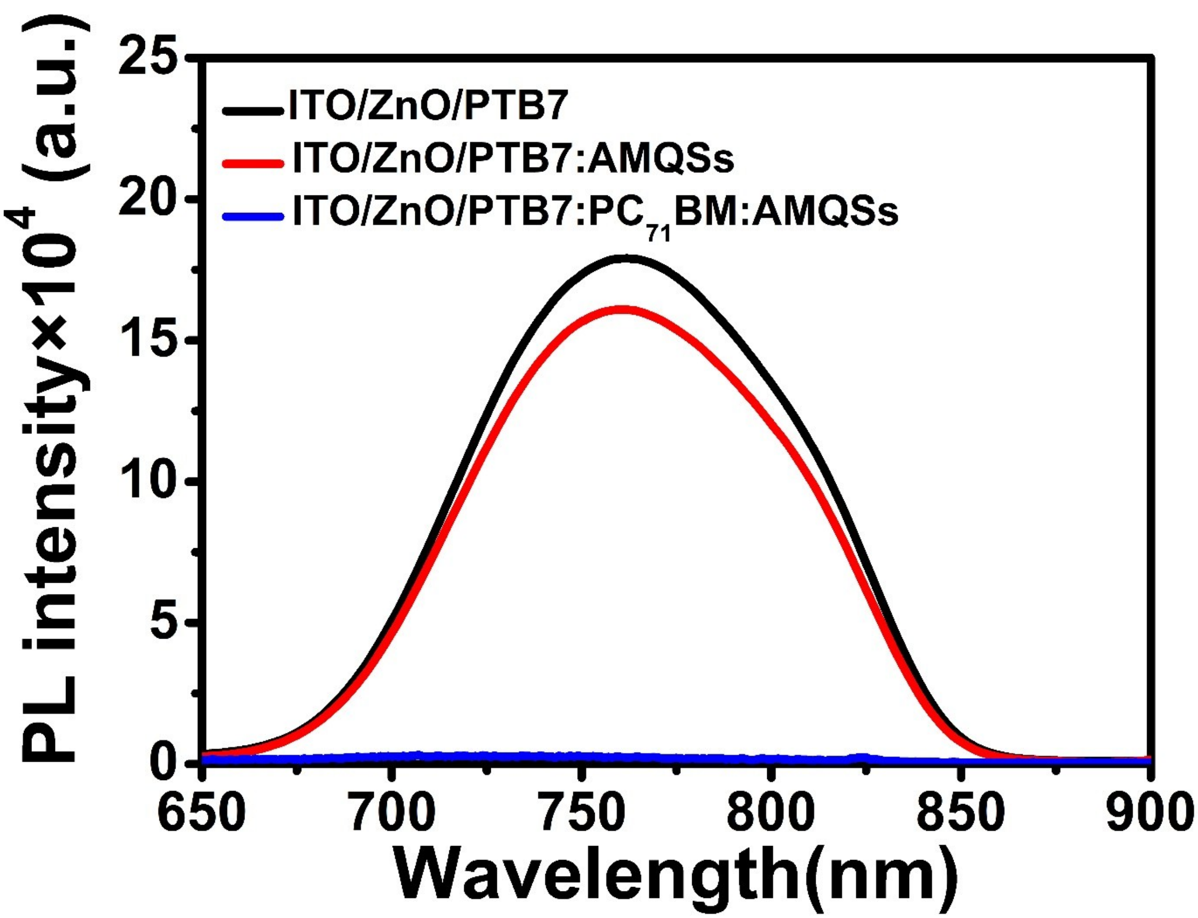

Fig. S8 PL spectra of diferent blend layers. The addition amount of AMQSs is 1 mg ml^{-1}.

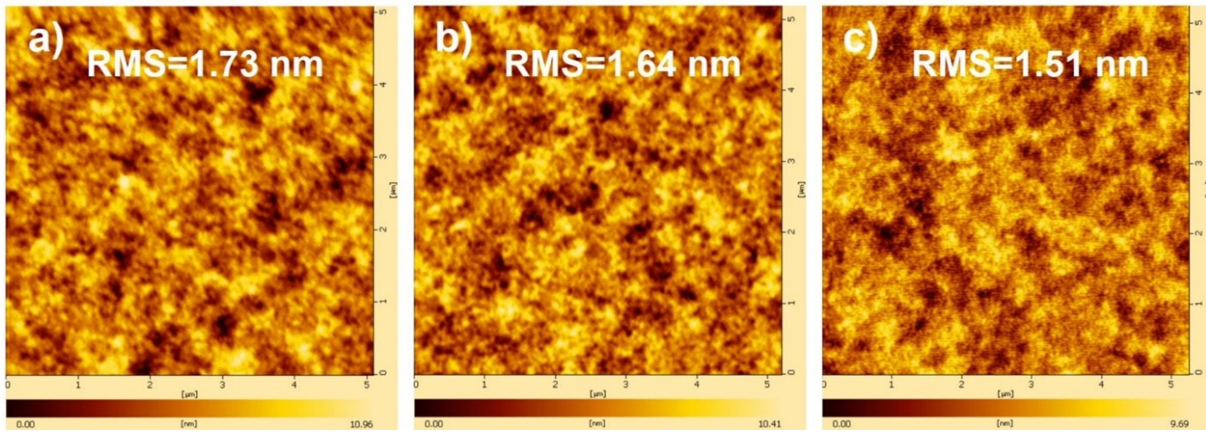

Fig. S9 AFM images (5.0 × 5.0 μm^2) measured for the surface of the active film. (a) Pristine ZnO/PTB7:$PC_{71}BM$, (b) ZnO/PTB7:$PC_{71}BM$/AMQSs (1.0 mg ml^{-1}) and (c) ZnO/PTB7:$PC_{71}BM$/AMQSs (6.0 mg ml^{-1}).

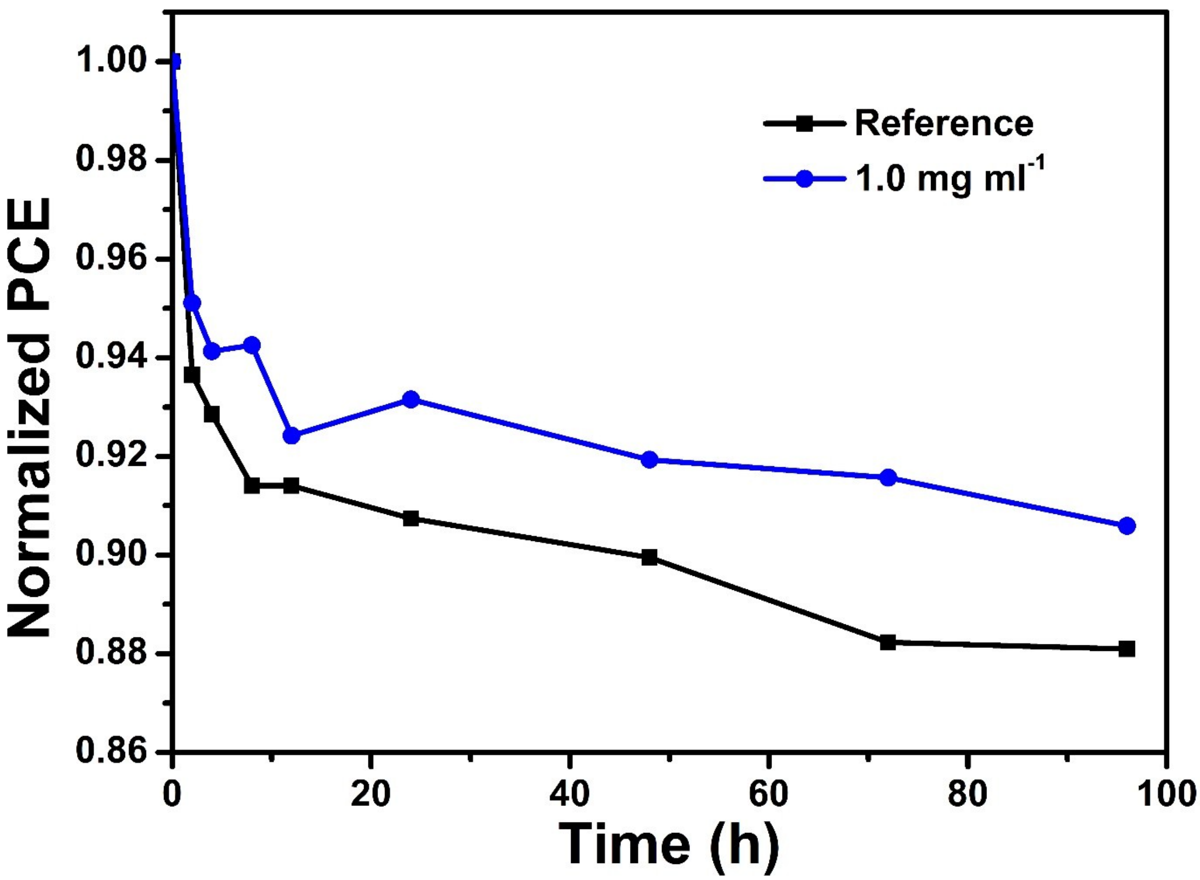

Fig. S10 Normalized PCE versus aging time measured for PTB7:$PC_{71}BM$-based OPVs without and with AMQSs in air. After measured, the devices are immediately placed in a nitrogen-protected glove box.

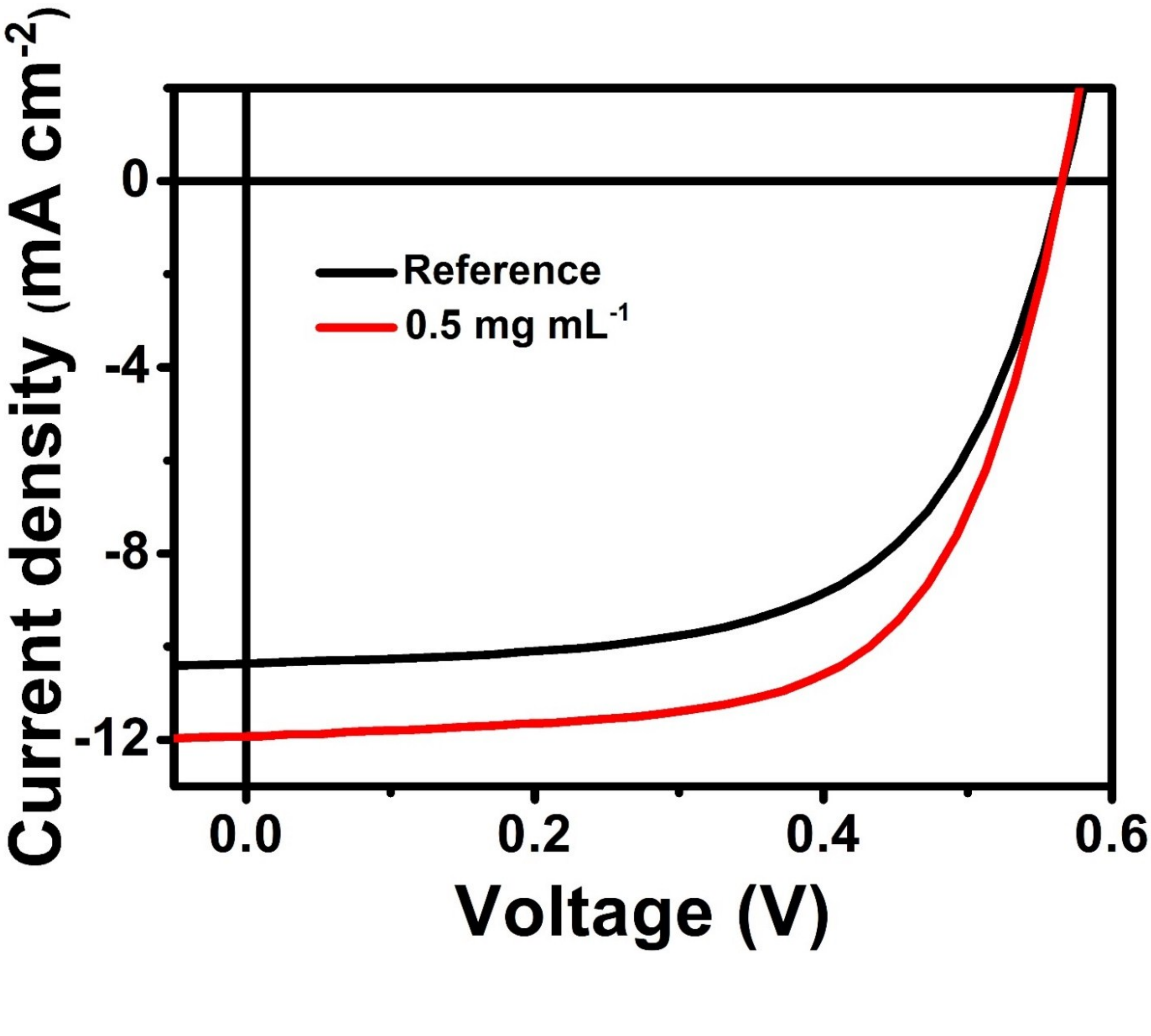

Fig. S11 *J-V* curves of the best reference device and the device with optimal concentration of AMQSs in active layer based on P3HT:PC_{61}BM.

Table S1. Summary of parameters of inverted OPVs based on $PTB7:PC_{71}BM$ (95 nm) with different concentration of AMQSs in active layer.

OPVs	V_{oc} **(V)**	J_{sc} **(mA cm^{-2})**	**FF (%)**	**PCE (%)**
Reference	0.74±0.01	15.72±0.12	66.3±0.7	7.76±0.15
0.5 mg mL^{-1}	0.74±0.01	16.78±0.17	71.2±0.9	8.85±0.18
1.0 mg mL^{-1}	0.74±0.01	18.34±0.16	71.9±0.6	9.75±0.16
1.5 mg mL^{-1}	0.74±0.01	17.45±0.13	70.8±1.0	9.22±0.13
2.0 mg mL^{-1}	0.74±0.01	17.03±0.13	70.3±0.7	8.92±0.10
6.0 mg mL^{-1}	0.74±0.01	16.47±0.11	69.4±0.6	8.45±0.14

Table S2. Summary of PCEs and the corresponding PCE enhancement of optimal OPVs using different additives in active layer.

Additive type	PCE (%)	Relative PCE Enhancement (%)	Year	Reference
AMQSs	From 7.76 to 9.75	25.6	/	This work
ICBA	From 7.35 to 8.24	12.1	2014	4
Au NP-BCNTs	From 8.31 to 9.81	18.1	2015	5
GO-TPP	From 7.39 to 8.58	16.1	2015	6
N-GCDs	From 7.30 to 8.60	17.8	2016	7
FA	From 7.25 to 9.04	24.7	2016	8
P(NDI2OD-T2)	From 8.02 to 10.1	25.9	2016	9
PS	From 7.61 to 8.92	17.2	2016	10
BPQDs	From 7.92 to 8.71	10.0	2017	11
CHN	From 6.86 to 7.31	6.6	2017	12
DTS	From 6.30 to 7.60	20.6	2017	13
Brbh	From 7.04 to 8.13	15.5	2017	14
P2VP	From 7.37 to 8.67	17.6	2017	15
DPP-TP6	From 6.50 to 7.85	17.2	2017	16

OPVs were based on PTB7:$PC_{71}BM$ with 1,8-diiodooctane.

Table S3. The values of the fitted α and slopes for the cell with different concentration of AMQSs in active layer.

Concentration(mg mL^{-1})	0	0.5	1	1.5	2	6
α	0.953	0.965	0.982	0.971	0.966	0.960
S	1.14	1.11	1.02	1.06	1.08	1.10

Table S4. Summary of PCEs and the corresponding PCE enhancement of optimal OPVs using different additives in active layer based on P3HT:$PC_{61}BM$.

OPVs	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF (%)	PCE (%)
Reference	0.57	10.12	61.6	3.55
0.5 mg mL^{-1}	0.57	11.91	64.2	4.32

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