

Supporting Information

Copolymers of Poly(3-thiophene acetic acid) with Poly(3-hexyl thiophene) as Hole Transporting Material for Interfacially Engineered Perovskite Solar Cell by Modulating Band Positions for Higher Efficiency

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Table S1: Comparison of FTIR stretching frequencies of different P3TAA-co-P3HT copolymers

Polymer	–OH stretching (cm ⁻¹)	>C=O stretching (cm ⁻¹)		Thiophene ring stretching (cm ⁻¹)
		Free	H-bonded	
P3HT	-	-	-	1450
P1	3476	1748	1716	1415
P2	3443	1746	1718	1412
P3	3453	1738	1708	1412
P4	3456	1744	1707	1419
P3TAA	3485	1746	1695	1434

Table S2: Device parameters of PSCs with Spiro-MeOTAD as HTM

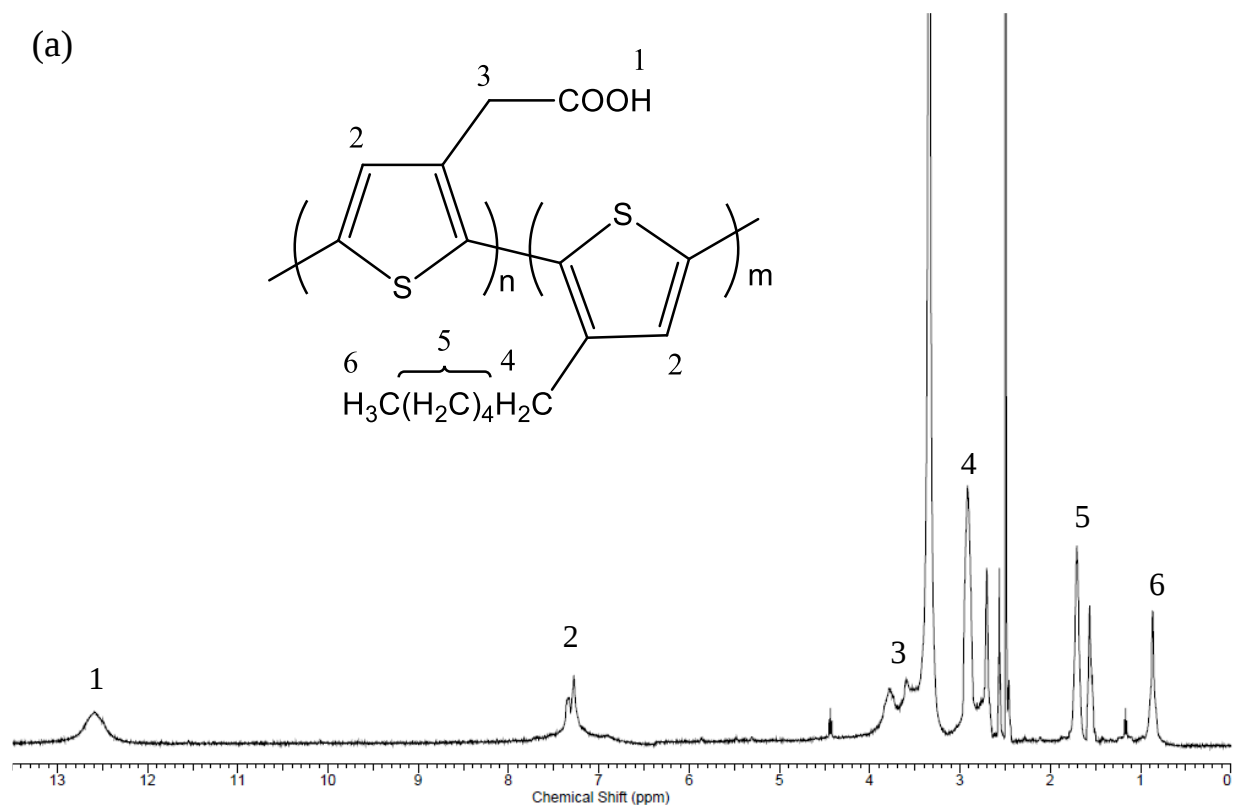
J_{sc} (mA.cm ⁻²)	V_{oc} (V)	FF	PCE (%)
<i>12.69</i>	<i>0.990</i>	<i>0.52</i>	<i>6.53</i>
12.27±0.46	0.983±0.008	0.51±0.01	6.14±0.39

Parameters for best cell is italicized. Average values are calculated based on eight devices.

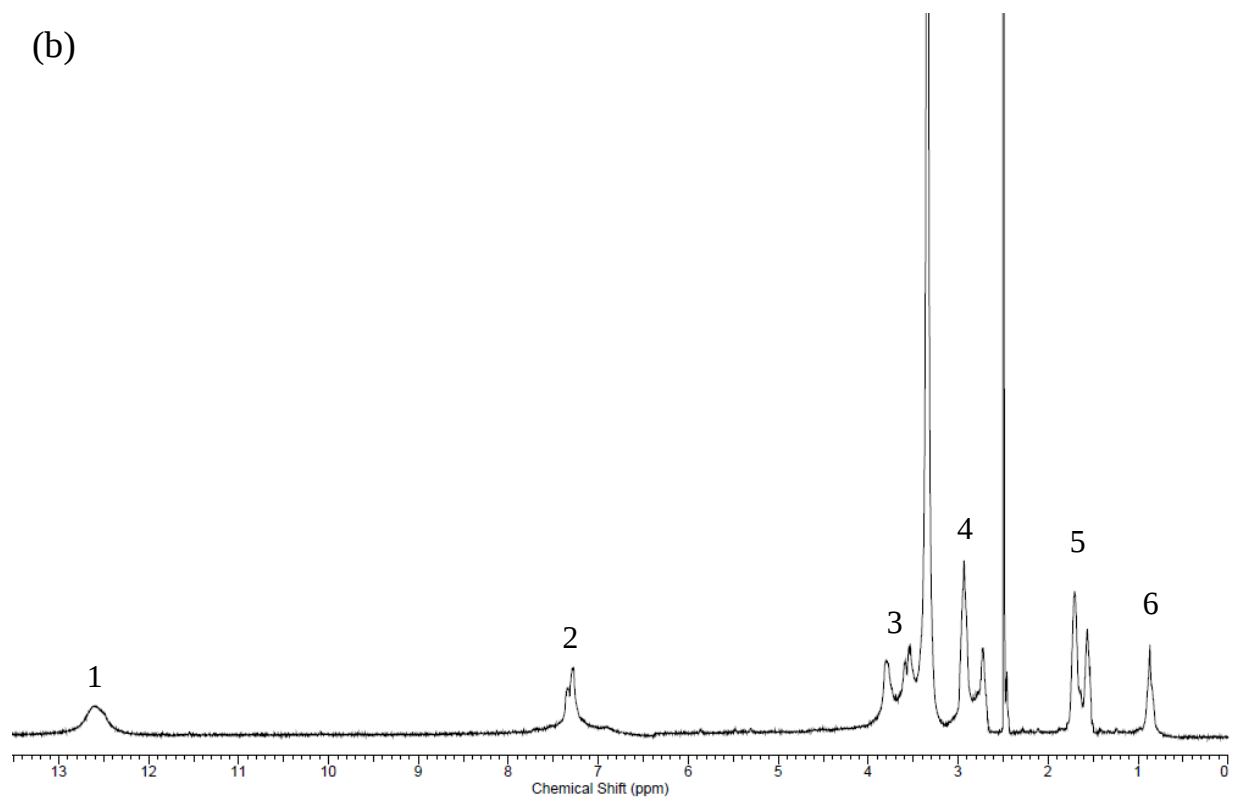
Table S3: Comparison of FTIR frequencies of MAPbI₃ with different P3TAA-co-P3HT copolymers

Sample	N-H stretching (cm ⁻¹)	Shift (cm ⁻¹) from pure MAPbI ₃	N-H bending (cm ⁻¹)	Shift (cm ⁻¹) from pure MAPbI ₃	>C=O stretching (cm ⁻¹)	Shift (cm ⁻¹) from that of pure copolymer
MAPbI ₃	3171	-	1584	-	-	-
MAPbI ₃ /P3HT	3171	-	-	-	-	-
MAPbI ₃ /P1	3186	15	1591	7	1698	18
MAPbI ₃ /P2	3194	23	1600	16	1691	27
MAPbI ₃ /P3	3201	30	1605	21	1685	23
MAPbI ₃ /P4	3205	34	1607	23	1682	25
MAPbI ₃ /P3TAA	3220	49	-	-	1636	59

(a)



(b)



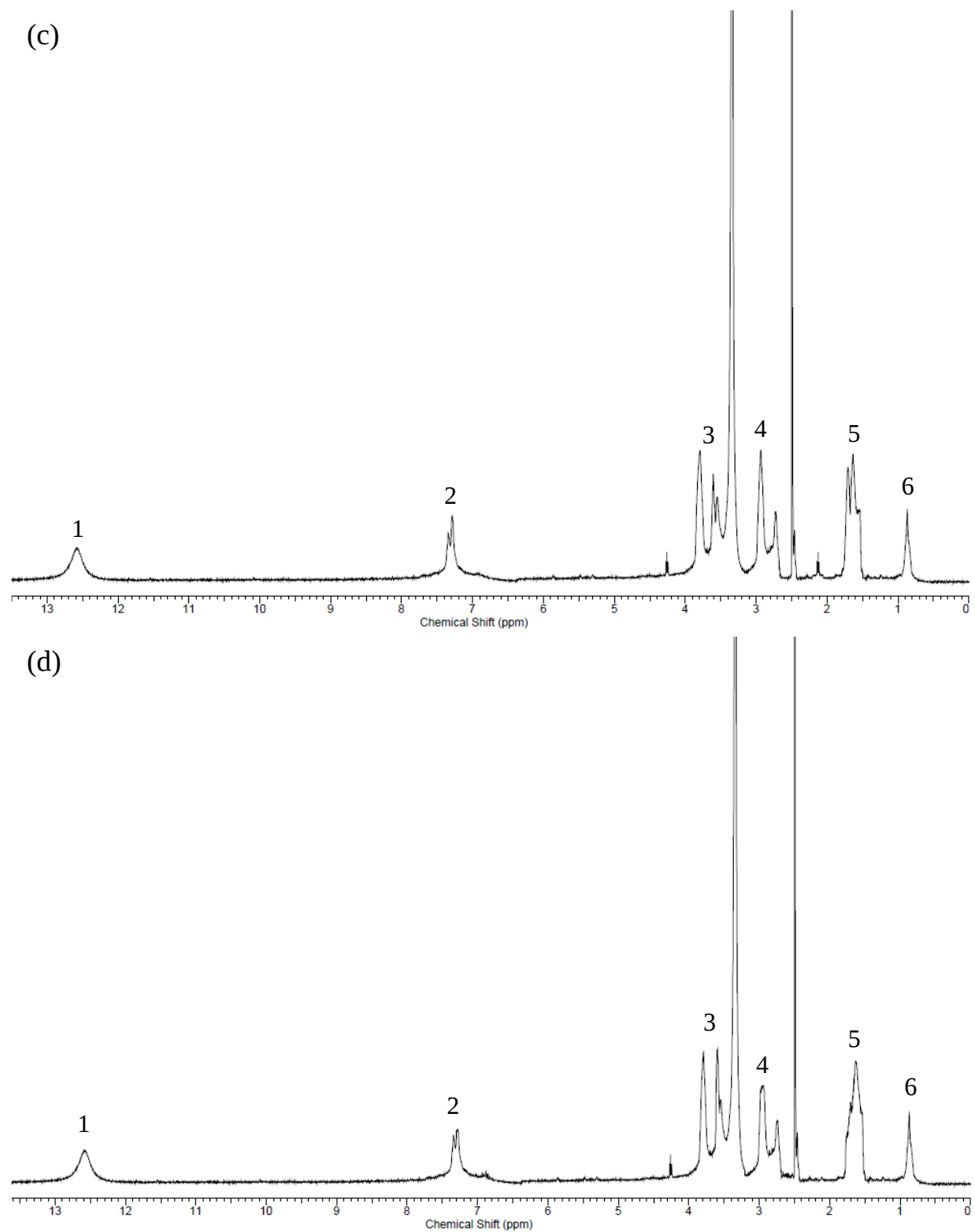


Fig. S1: ^1H NMR spectra of (a) P1, (b) P2, (c) P3 and (d) P4 copolymer

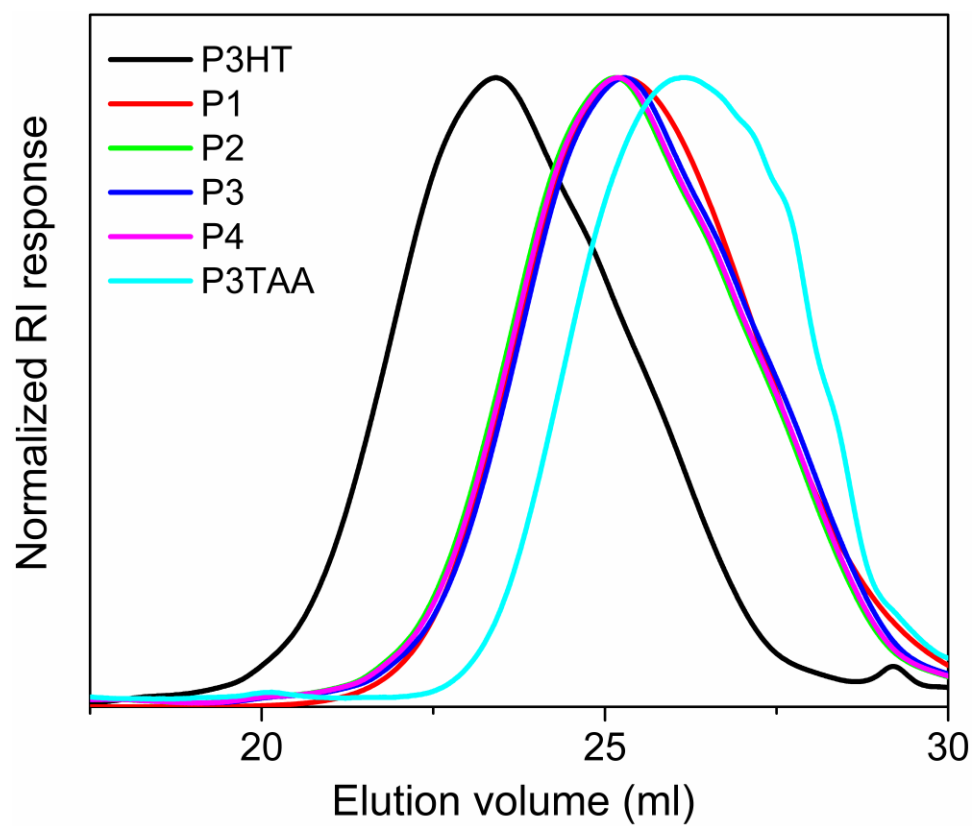


Fig. S2: GPC traces of P3HT, P1, P2, P3, P4 and P3TAA using THF as an eluent at 40 °C.

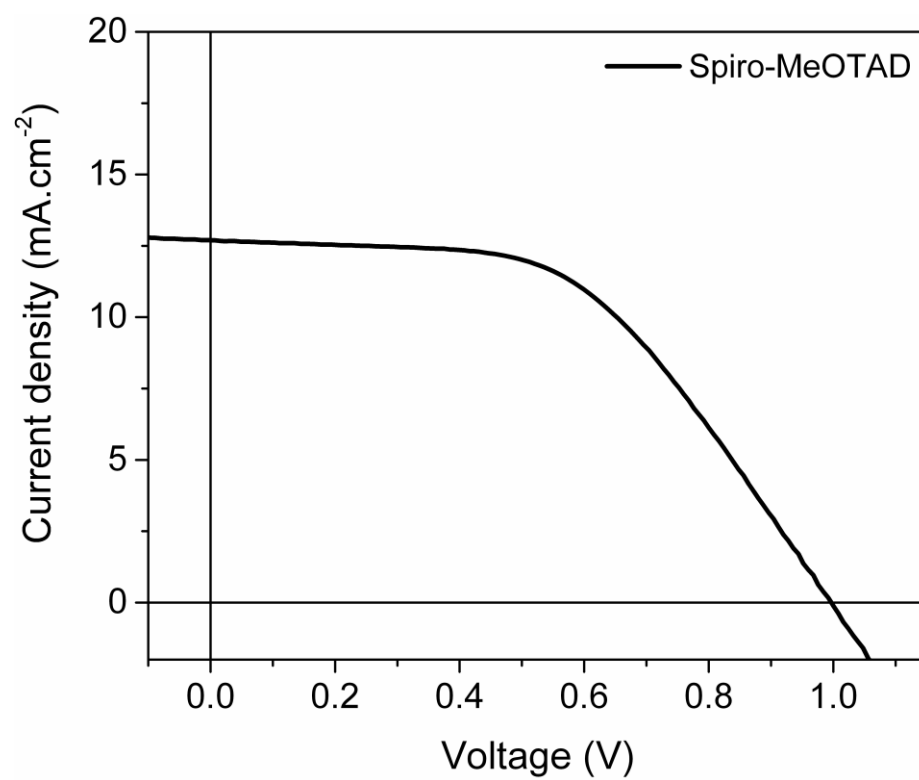


Fig. S3: J-V plots of best performance PSCs containing Spiro-MeOTAD HTM

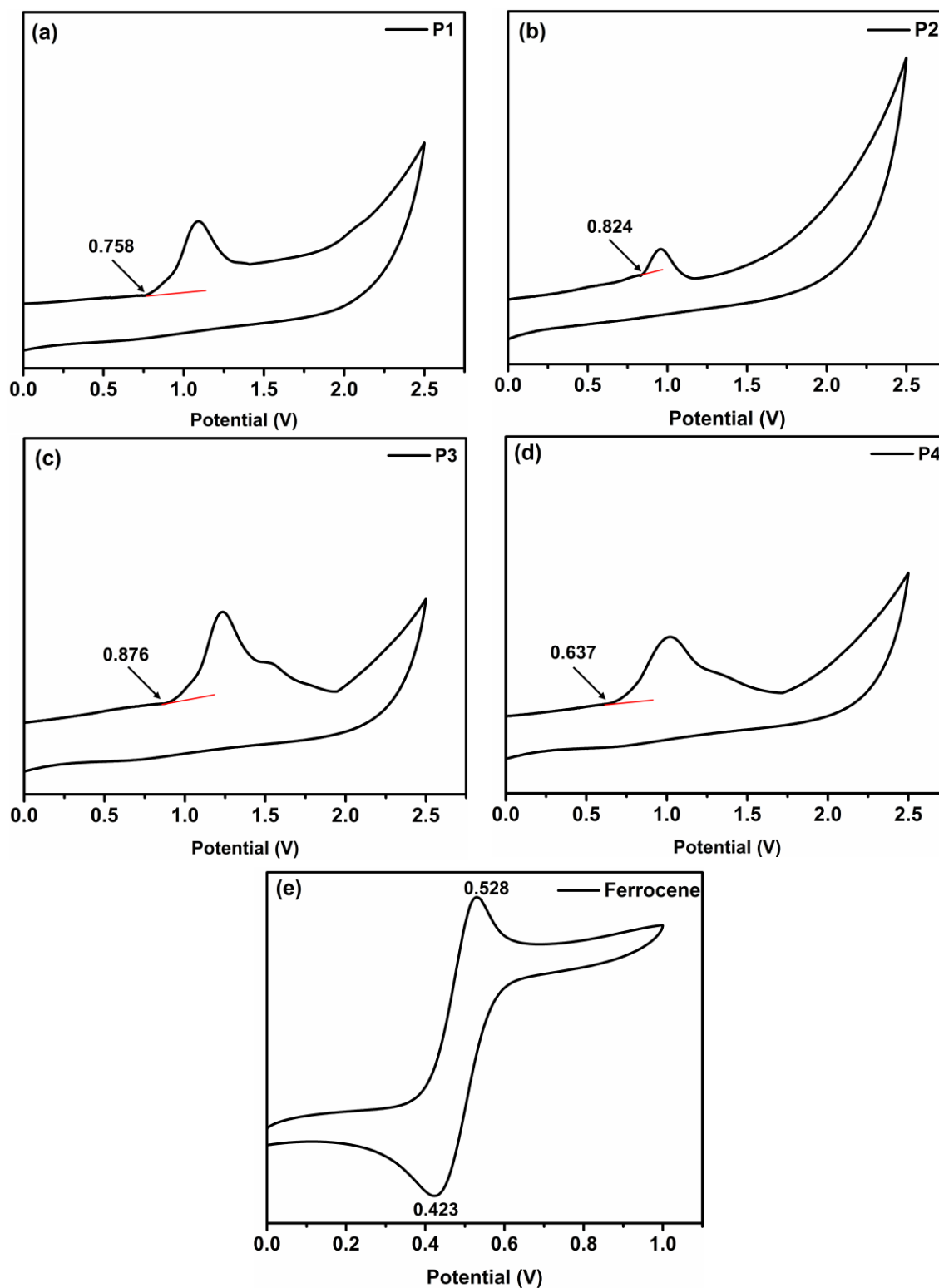


Fig. S4: Current-voltage curve obtained from cyclic voltammetry for (a) P1, (b) P2, (c) P3, (d) P4 copolymer and (e) Ferrocene standard

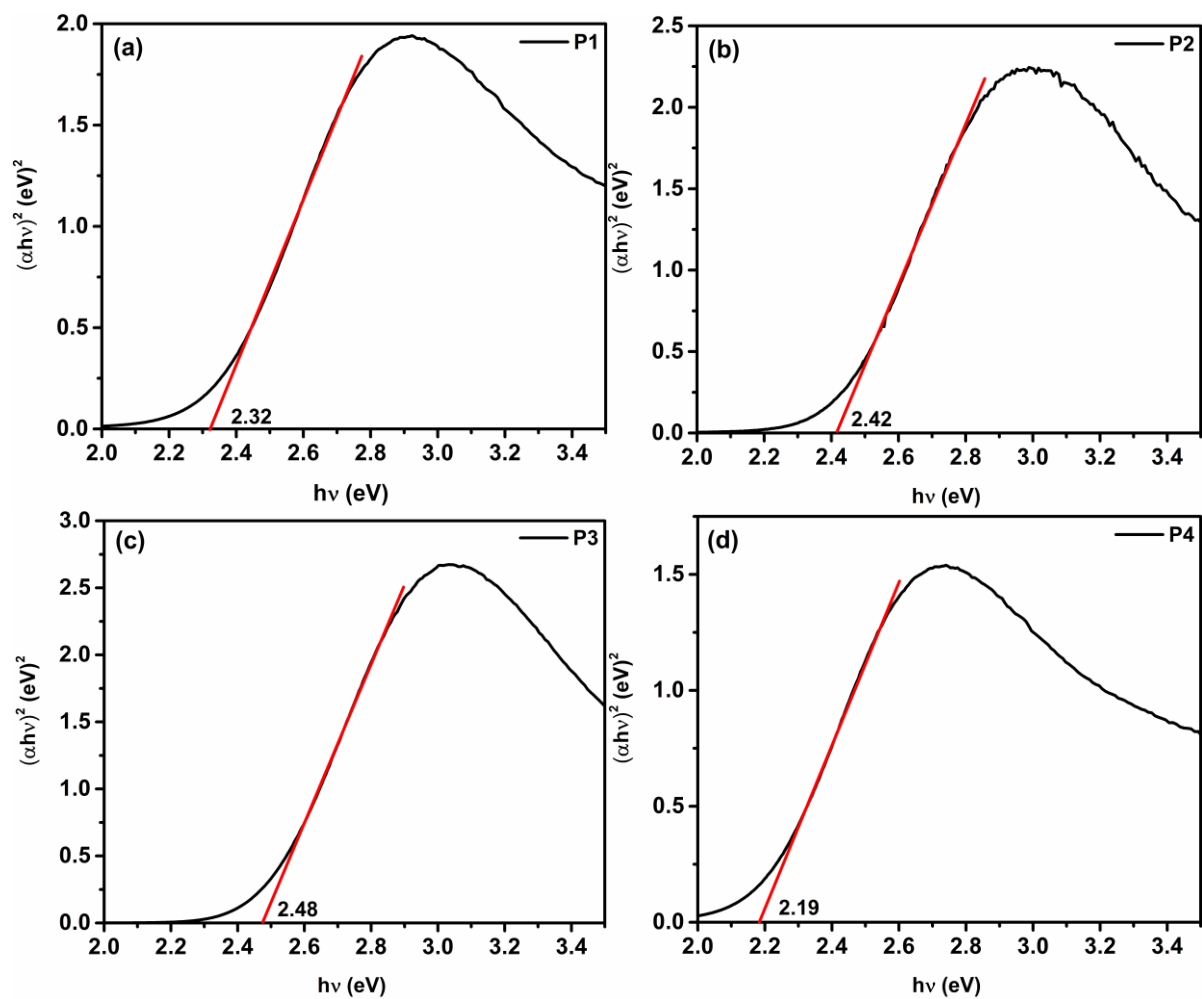


Fig. S5: Tauc's plot of (a) P1, (b) P2, (c) P3 and (d) P4.

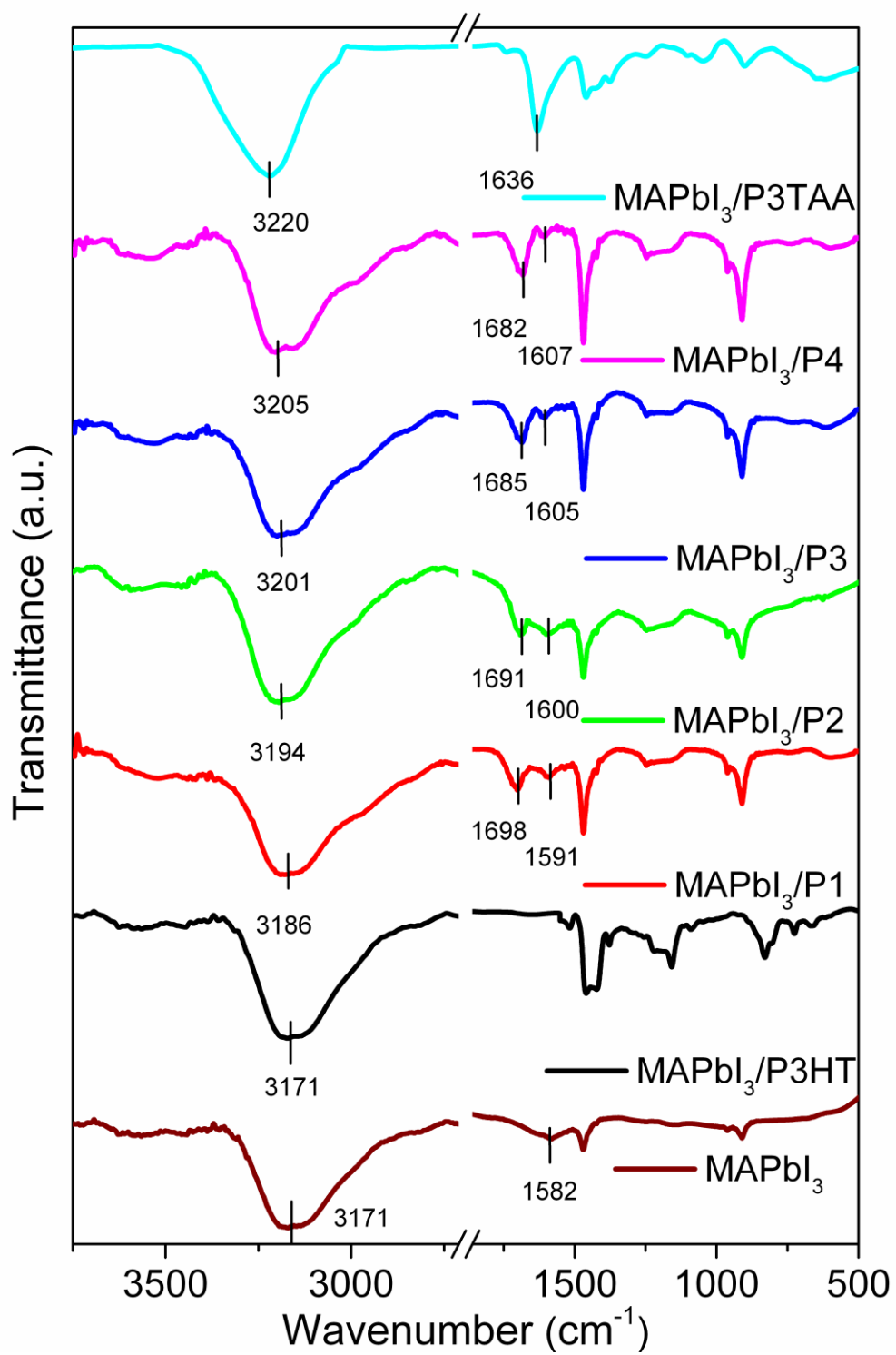


Fig. S6: FTIR spectra of MAPbI₃ with different HTMs.

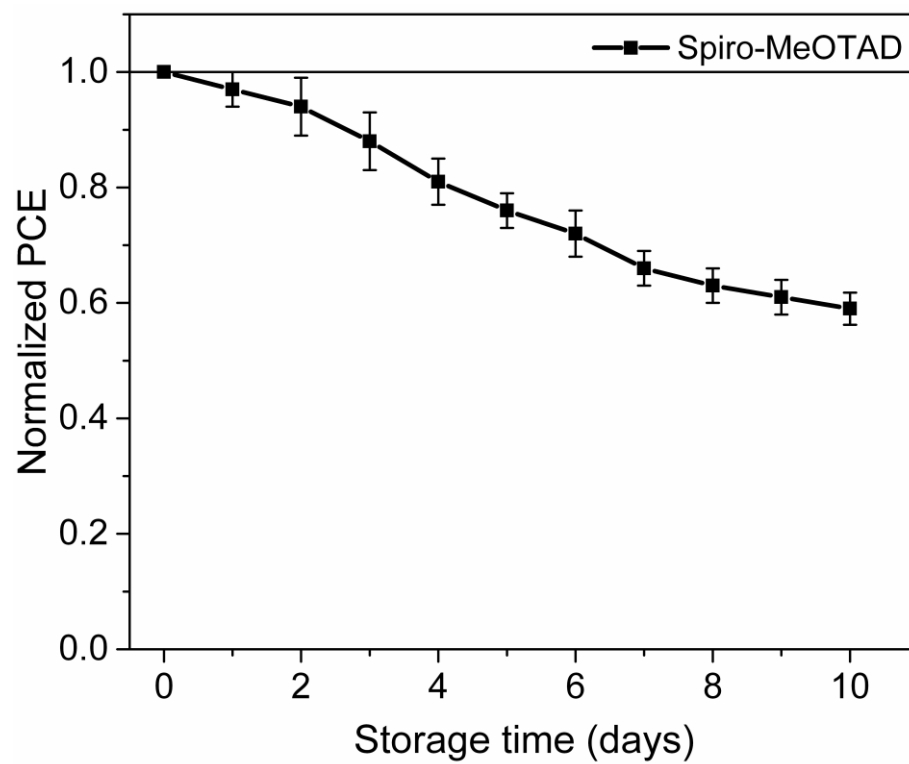


Fig. S7: Normalized cell efficiency plotted as a function of storage time for PSC containing Spiro-MeOTAD HTM under ambient condition without encapsulation.

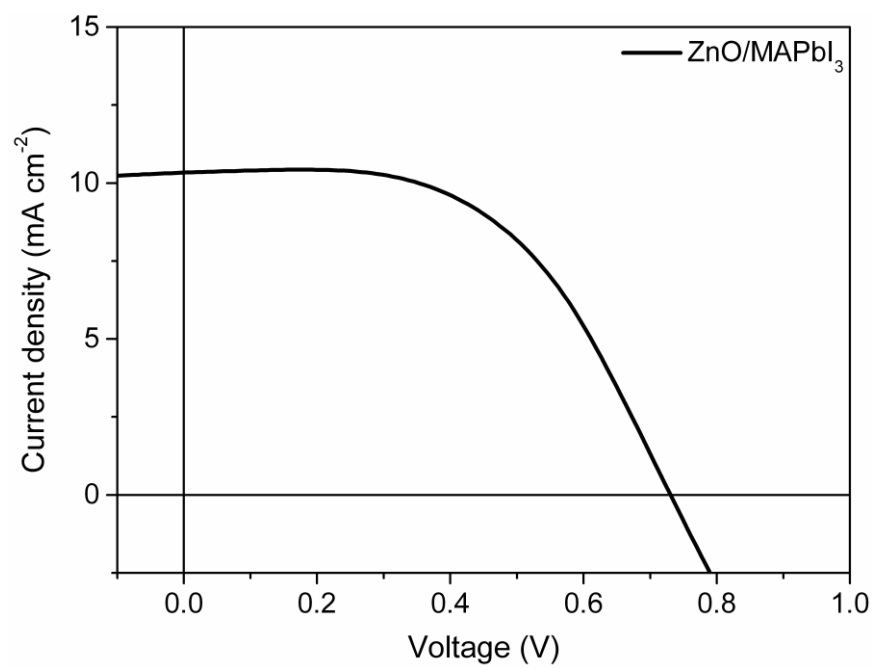


Fig. S8: J-V plots of best performance PSC without using HTM

J_{sc} (mA.cm ⁻²)	V_{oc} (V)	FF	PCE (%)
<i>10.34</i>	<i>0.732</i>	<i>0.54</i>	<i>4.08</i>
9.98±0.36	0.728±0.006	0.52±0.02	3.66±0.46

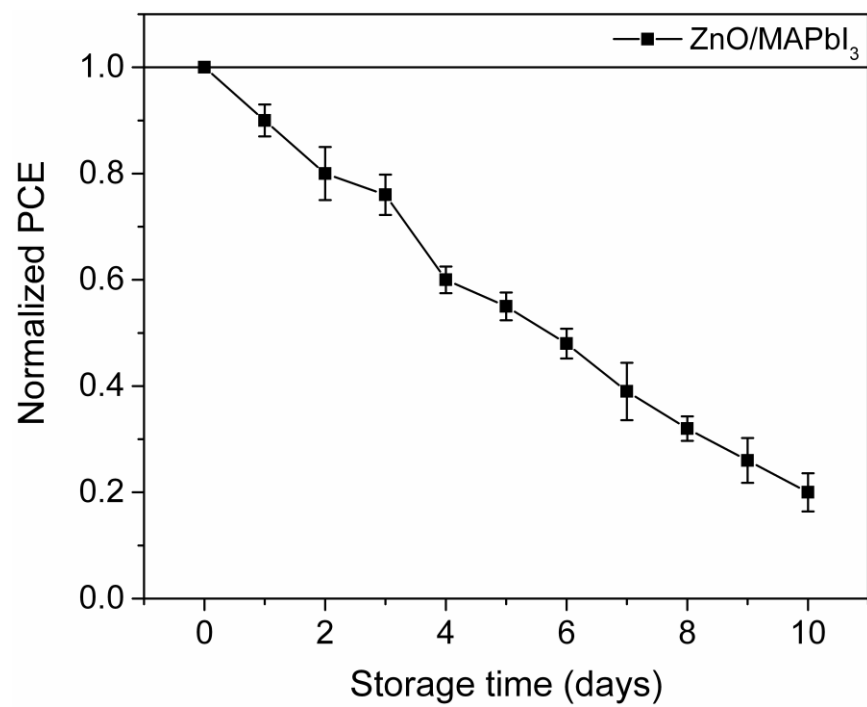


Fig. S9: Normalized cell efficiency plotted as a function of storage time for PSC without using HTM under ambient condition without encapsulation.