Supplementary Information

Understanding the Role of Interface Layers in the Photostability of PM6:Y7-based Organic Solar Cells under Different Degradation Conditions

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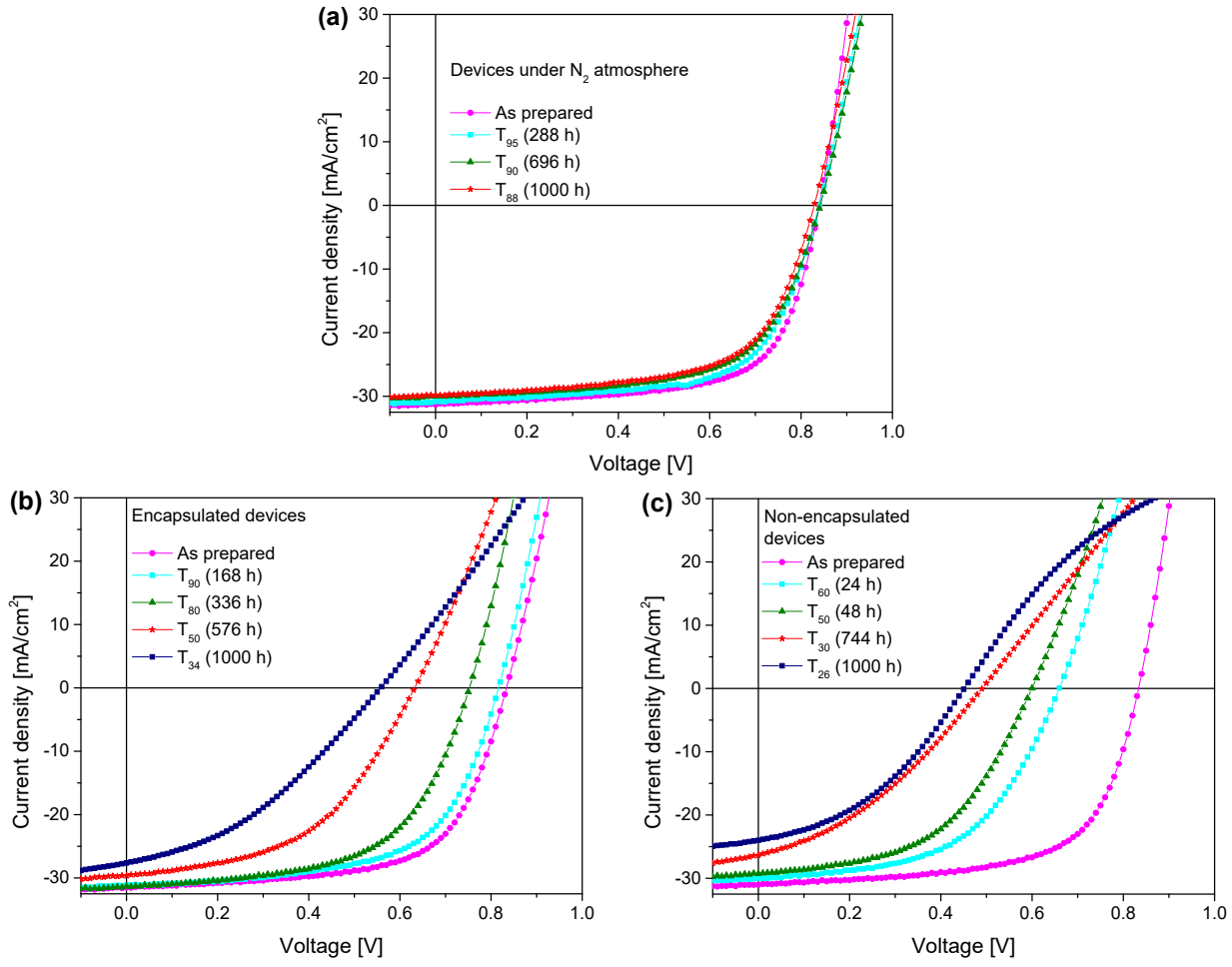

Figure S1. The current density-voltage (J-V) characteristics curves under illumination conditions of PM6:Y7 based NFA-OSCs under three different degradation conditions: (a) N_2 atmosphere, (b) encapsulated devices and (c) non-encapsulated both exposed under ambient environment over shelf storage time.

Table S1. Device performance parameters of the NFA-OSCs measured under AM 1.5G with 100 mW/cm^2 intensity exposed to three degradation conditions: N_2 atmosphere, encapsulated and non-encapsulated devices under ambient conditions. The row displays the average and the standard deviation of the photovoltaic parameters obtained from over 8 devices.

Standard lifetime	Time [h]	V_{OC} [mV]	J_{SC} [mA/cm^2]	FF [%]	PCE_{avg} [%]	PCE_{max} [%]	R_S [Ω cm^2]	R_{SH} [Ω cm^2]
	N_2 atmosphere							
T_{100}	1	836 ± 5	31.30 ± 0.45	66.63 ± 1.07	17.43 ± 0.30	17.53	1.74 ± 0.14	359 ± 79
T_{95}	288	839 ± 4	30.35 ± 0.47	64.65 ± 1.18	16.46 ± 0.41	16.71	2.46 ± 0.40	352 ± 120
T_{90}	696	831 ± 4	30.84 ± 0.65	61.57 ± 0.82	15.78 ± 0.14	15.84	2.38 ± 0.21	278 ± 62
T_{88}	1000	830 ± 2	29.78 ± 0.04	62.43 ± 0.40	15.43 ± 0.10	15.45	2.69 ± 0.04	309 ± 19
	Encapsulated devices							
T_{100}	1	828 ± 7	31.25 ± 0.83	65.00 ± 1.54	16.80 ± 0.12	16.97	2.15 ± 0.63	296 ± 134
T_{80}	336	745 ± 8	31.40 ± 0.06	57.99 ± 0.32	13.57 ± 0.16	13.63	2.39 ± 0.01	274 ± 26
T_{50}	576	630 ± 2	28.92 ± 0.49	48.39 ± 0.82	8.82 ± 0.18	9.06	5.47 ± 0.23	156 ± 21
T_{34}	1000	556 ± 5	27.57 ± 0.15	36.96 ± 0.39	5.67 ± 0.03	5.70	10.10 ± 0.12	71 ± 2
	Non-encapsulated devices							
T_{100}	1	830 ± 2	30.59 ± 0.72	64.70 ± 0.97	16.43 ± 0.30	16.46	1.84 ± 0.02	337 ± 72
T_{60}	24	659 ± 4	29.80 ± 0.34	53.30 ± 0.88	10.26 ± 0.22	10.52	3.56 ± 0.21	231 ± 22
T_{50}	48	605 ± 5	29.06 ± 0.22	47.48 ± 3.08	8.35 ± 0.54	8.89	5.10 ± 0.82	159 ± 15
T_{30}	744	479 ± 11	26.33 ± 0.21	38.09 ± 3.12	4.80 ± 0.35	5.30	13.89 ± 2.75	73 ± 16

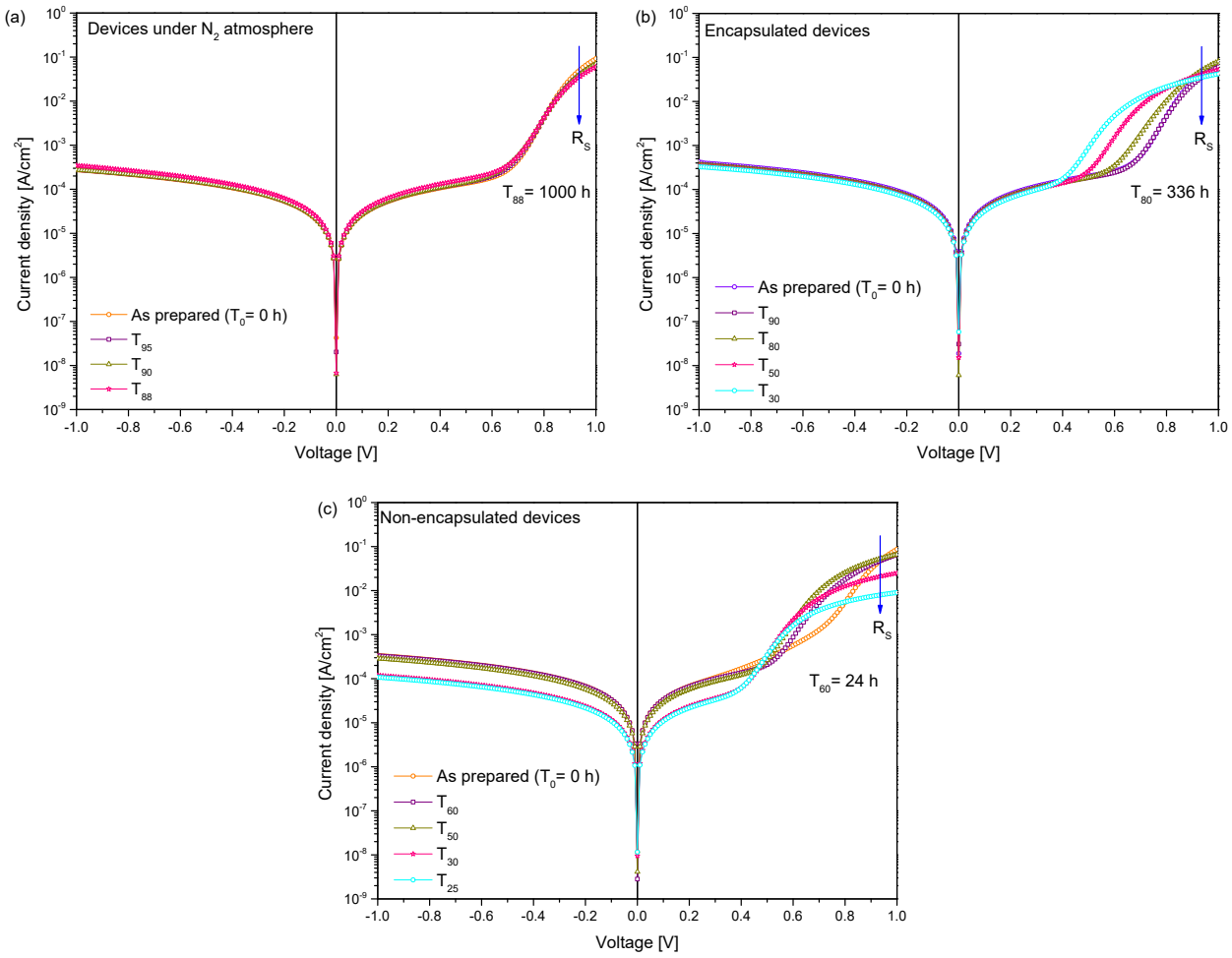

Figure S2. Dark J-V characteristic of PM6:Y7-based devices under degradation different conditions: (a) N_2 atmosphere, (b) encapsulated devices, and (c) non-encapsulated devices both exposed to ambient conditions over storage time. T_{80} and T_{60} are the time the devices took to decay 20% and 40% from their initial power conversion efficiency (PCE), respectively.

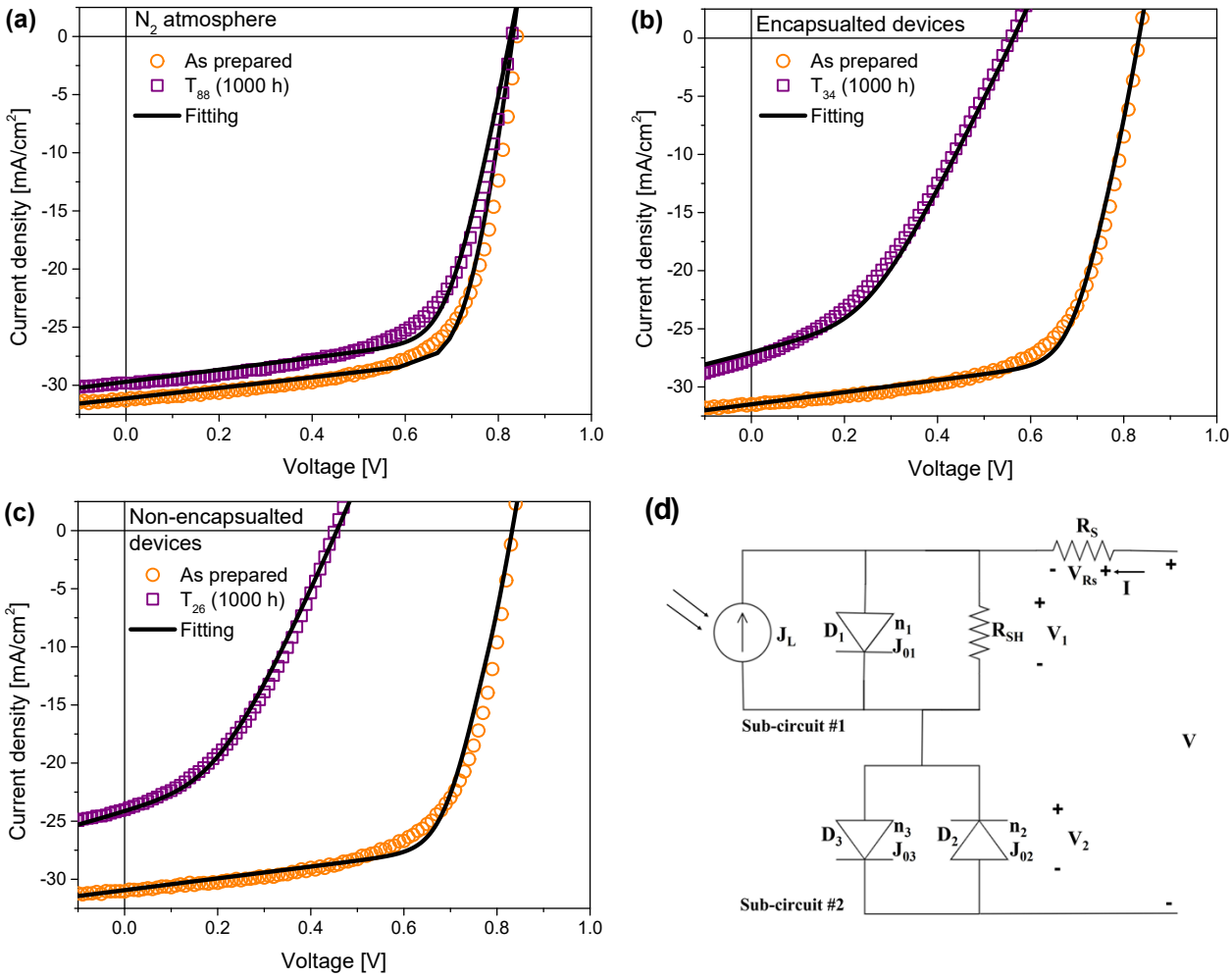

Figure S3. Fitting *J-V* characteristic under AM 1.5 G illumination spectrum of fresh and degraded NFA-OSC at 1000 h exposed to degradation different conditions: (a) N_2 atmosphere, (b) encapsulated devices, and (c) non-encapsulated devices both exposed to ambient conditions over storage time. (d) the equivalent circuit proposed by García-Sánchez et al. [1,2] used in this work for the fitting of the *J-V* characteristic.

Table S2. The fitted parameters obtained from Circuital model shown in Fig. S3(d).

	J_L [mA/cm^2]	n_1	J_{01} [mA/cm^2]	n_2	J_{02} [mA/cm^2]	n_3	J_{03} [mA/cm^2]
N_2 atmosphere							
Fresh	31.46	1.10	5.86×10^{-12}	-	-	-	-
T_{88}	30.23	1.17	3.74×10^{-11}	1.00	9.19	1.00	8.89
Encapsulated devices							
Fresh	32.07	1.11	7.30×10^{-12}	-	-	-	-
T_{34}	30.04	1.40	7.30×10^{-5}	1.40	4.74	1.20	9.09
Non-encapsulated devices							
Fresh	31.50	1.11	7.19×10^{-12}	-	-	-	-
T_{26}	26.94	1.50	1.69×10^{-4}	1.50	25.18	1.30	11.09

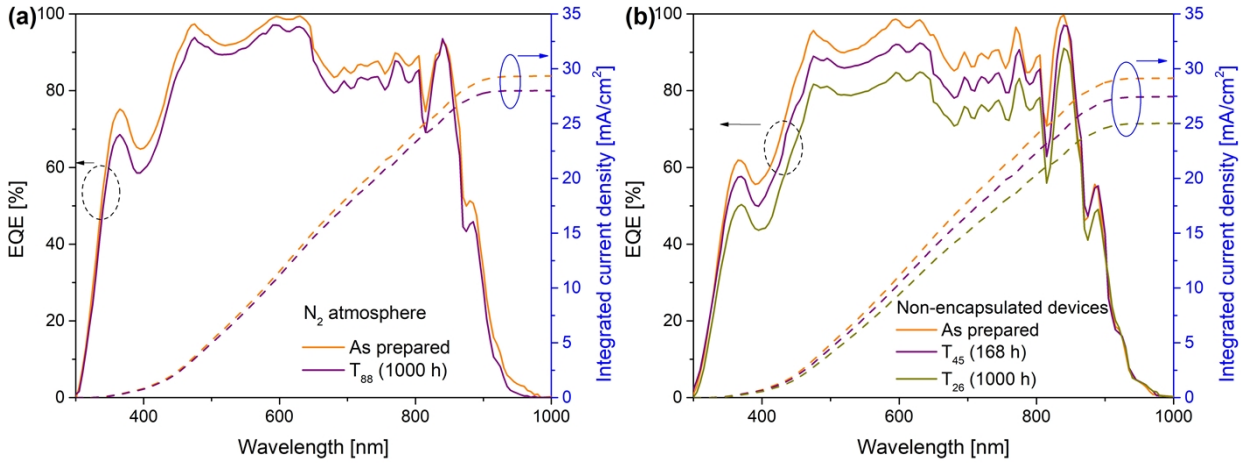

Figure S4. EQE spectra for NFA-OSCs exposed to (a) N_2 atmosphere, and (b) non-encapsulated cells.

Table S3. The fitted parameters, capacitance, and resistance values, of each layer for NF-OSCs exposed to N_2 atmosphere, encapsulated and non-encapsulated devices under ambient conditions. The IS measurement was carried out under AM1.5G at V_{OC}. The values were extracted by using the circuit model shown in Figure 4(f) of the main article.

	R_1 [Ω]	C_1 [nF]	R_2 [Ω]	C_2 [nF]	R_3 [Ω]	C_3 [nF]
N_2 atmosphere						
Fresh	6	5	3	2.8	16	26.6
T_{97}	6.7	5	3.2	2.8	16.7	26.6
T_{80}	10.5	5	3.2	2.8	19	26.6
T_{88}	10.6	5	3.3	2.8	19.1	26.6
Encapsulated devices						
Fresh	8	6	3.5	2.8	16	26.6
T_{90}	15	6.6	3.5	2.8	24	34.6
T_{34}	27	12	10	2.8	30	34.6
Non-encapsulated devices						
Fresh	9	6	3	2.8	18	26.6
T_{60}	22	8	6	2.8	20.5	39.6
T_{37}	39.5	9	10	3.5	29.5	45.6
T_{26}	48	12.5	12.5	3.5	42	55.6

SUPPLEMENTARY REFERENCES

1 F. J. García-Sánchez, D. Lugo-Muñoz, J. Muci and A. Ortiz-Conde, *IEEE J. Photovoltaics*, 2013, **3**, 330–335.

2 F. García-Sánchez, B. Romero, D. Lugo-Muñoz, P. Del, B. Arredondo, J. Liou and A. Ortiz-Conde, *Facta Univ. - Ser. Electron. Energ.*, 2017, **30**, 327–350.