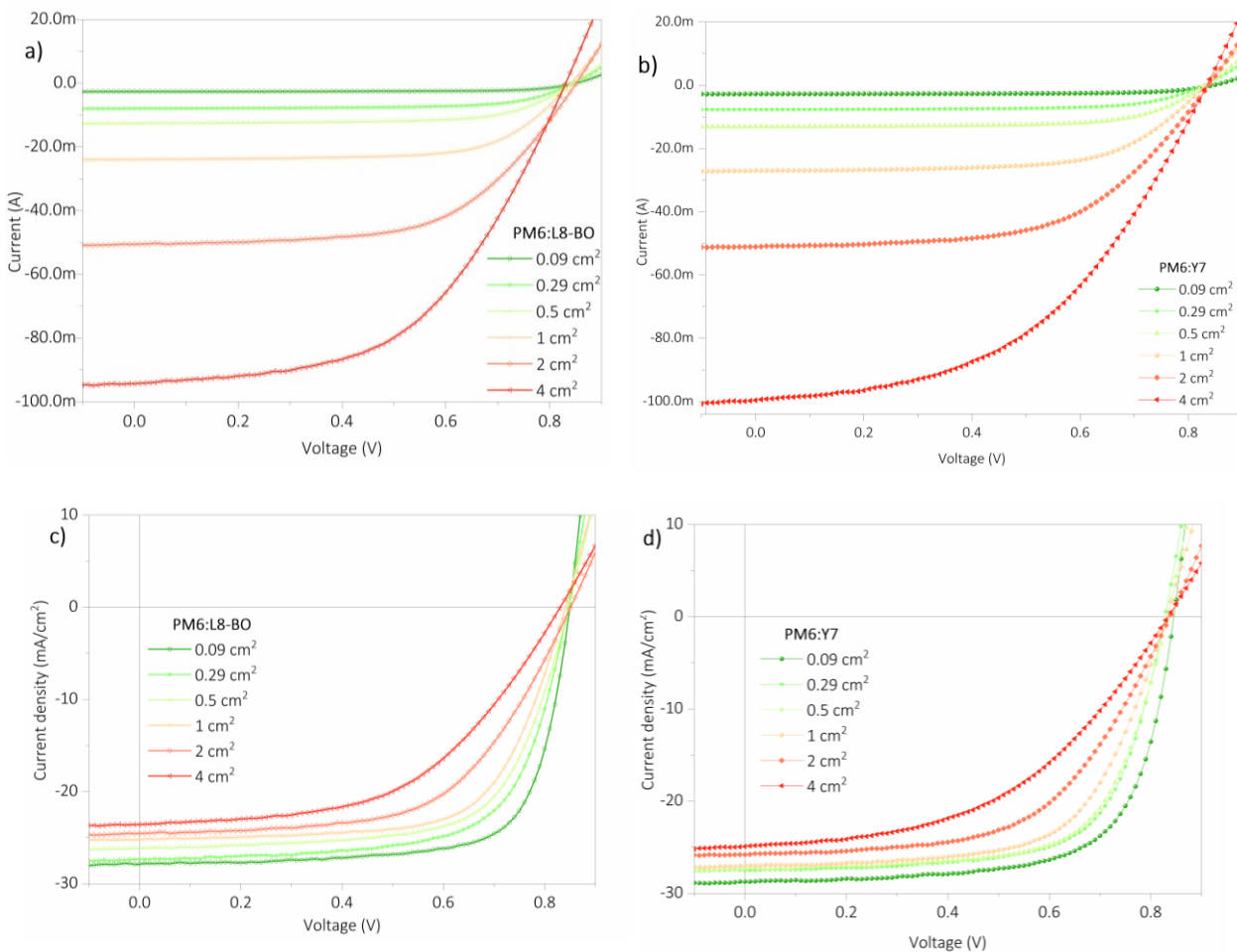


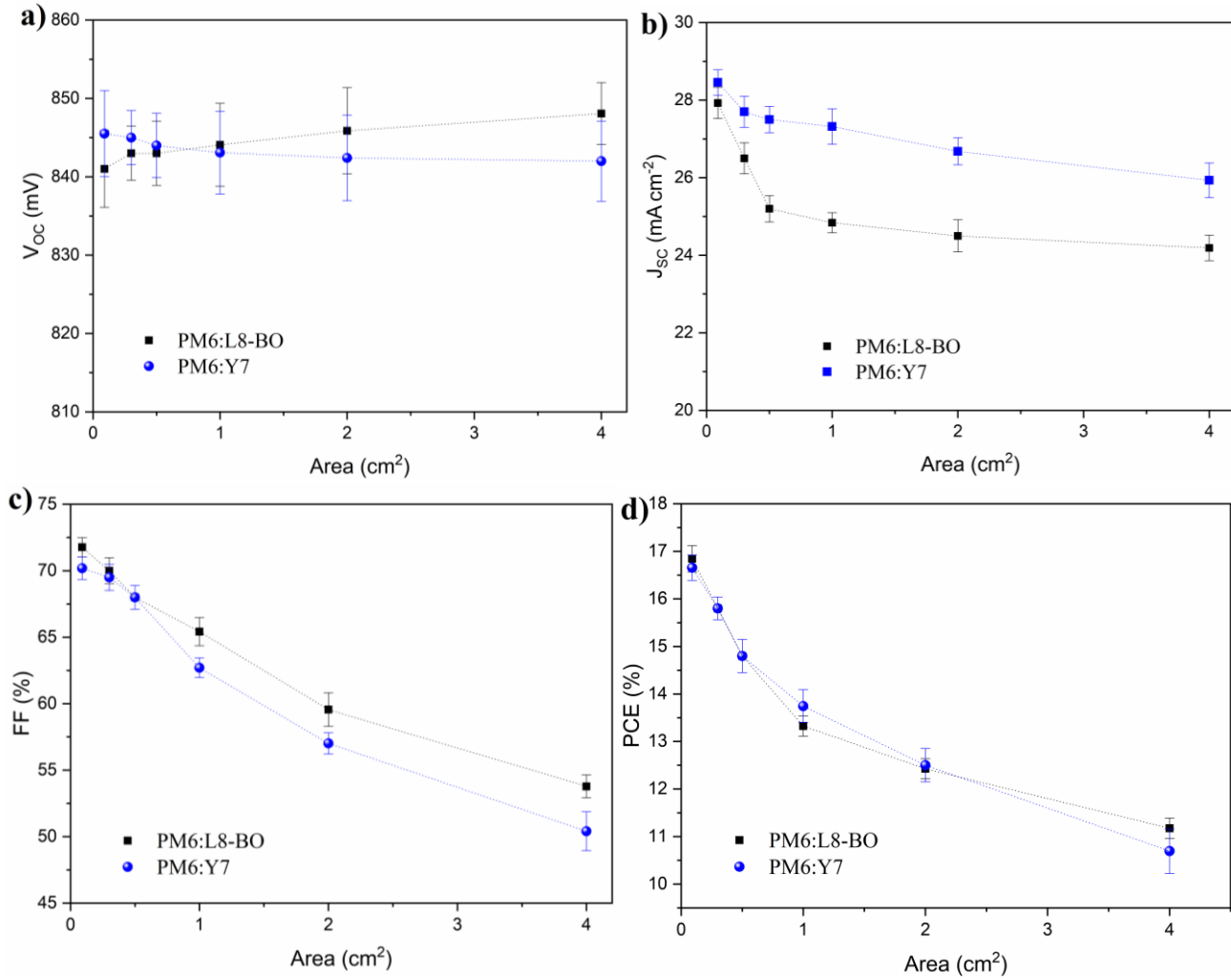
Impact of Area Scaling on the Performance and Stability of Spin-Coated Organic Solar Cells: From 0.09 to 4 cm²

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Supporting information



S1. Experimental *I-V* and *J-V* curves for devices with small and scaled active areas for PM6:L8-BO (a and c) and PM6:Y7 (b and d), respectively.



S2. Performance parameters of fabricated OSCs with different active areas and material layers (PM6:Y7 and PM6:L8-BO). (a) Open circuit voltage (V_{oc}), (b) short circuit current density (J_{sc}), (c) Fill factor (FF), and (d) Power conversion efficiency (PCE). All parameters were averaged over twenty devices.

The characteristic photo-resistance:

$$R_{ph} = \frac{V_{oc}}{J_{sc}} \quad (1)$$

The parameter in Equation (1) not only informs on how much photovoltage is produced per unit photocurrent under a given illumination intensity but also introduces a practical indication on whether the parasitic resistances may affect the FF .

In the absence of ohmic losses (i.e., $R_s \rightarrow 0$, $R_{sh} \rightarrow \infty$) the FF can be expressed as a function of the photovoltage. For normalized photovoltages $v_{oc} = \frac{V_{oc}}{mV_{th}} > 10$, being m the ideality factor and $V_{th} = 26$ mV at room temperature, the FF can be accurately approximated to¹

$$FF_0 = \frac{v_{oc} - \ln[v_{oc} + 0.72]}{v_{oc} + 1} \quad (2)$$

However, the closer the values of R_s or R_{sh} to R_{ph} , the higher the reduction of FF due to these parameters, which limits the validity of Equation (2). Therefore, new expressions are introduced

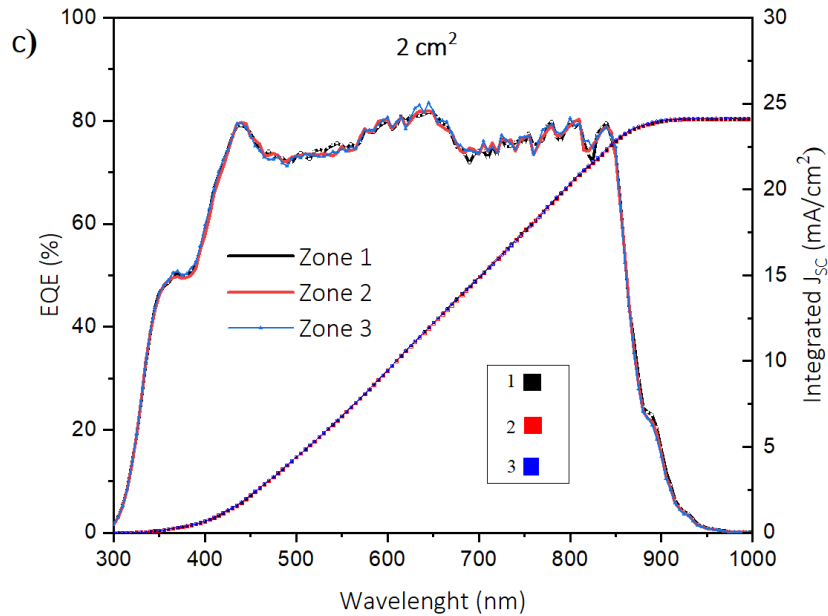
for isolating the parasitic ohmic effects. The FF as a function of sole series resistance effects can be calculated with the empirical equation:¹

$$FF_s = FF_0 \left(1 - \frac{R_s}{R_{ph}} \right) \quad (3)$$

Similarly, the FF as a function of sole shunt resistance effects can be calculated with the empirical equation:¹

$$FF_{sh} = FF_0 \left(1 - FF_0 \frac{(v_{oc} + 0.7) R_{ph}}{v_{oc} R_{sh}} \right) \quad (4)$$

For the studied samples, R_{ph} was reported in the range $\sim 33 \Omega \text{ cm}^2$ which suggests that significant influence would be expected in the FF for $R_s > 3 \Omega \text{ cm}^2$ and $R_{sh} < 300 \Omega \text{ cm}^2$. This is better illustrated in Fig. 2 (main paper), where the experimental FF is much closely resembled by the theoretical prediction of Equation (3) than Equation (4), confirming the main contribution of series resistance to the FF reduction upon upscaling.



S3. EQE and calculated J_{sc} obtained from three different locations of a single 2 cm^2 PM6:Y7 OSC device.

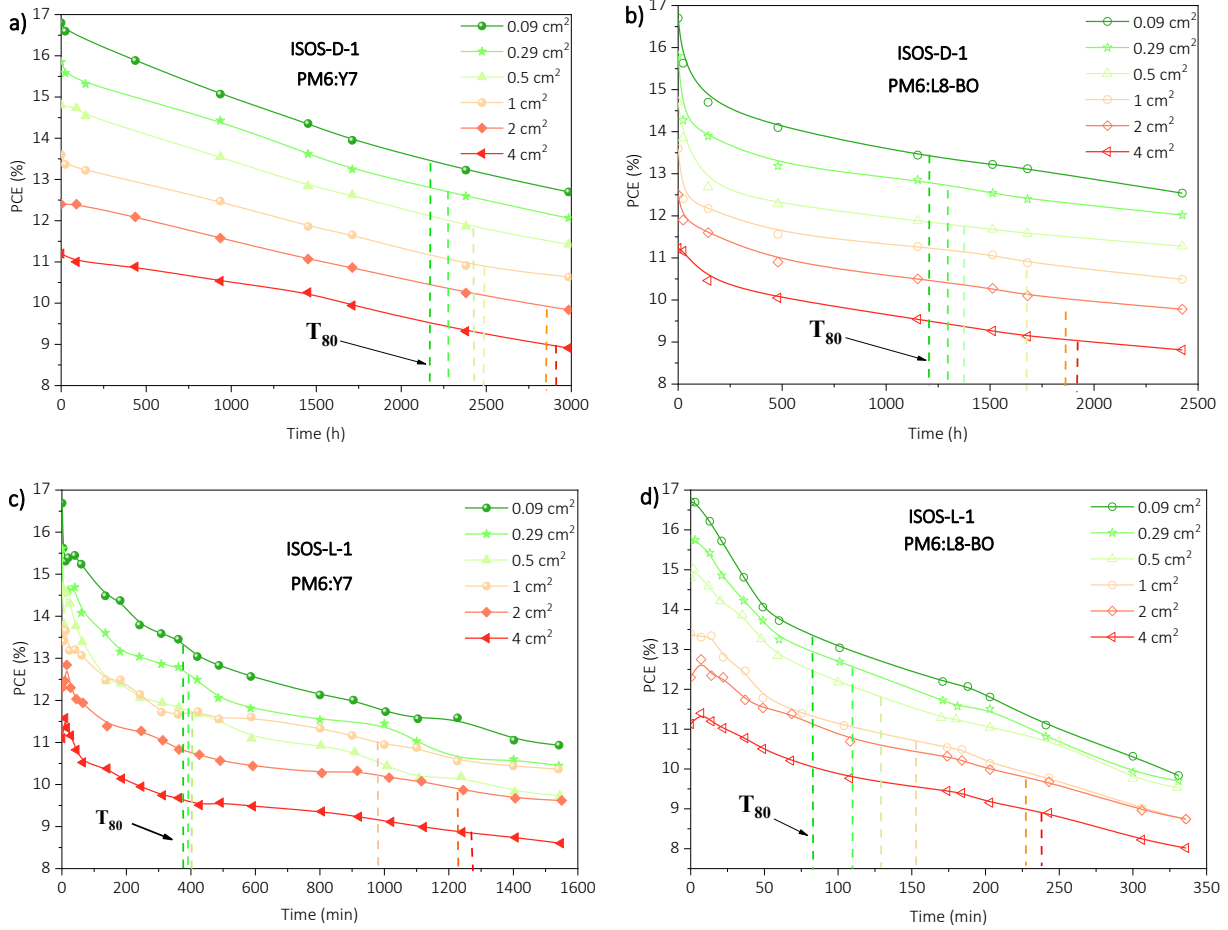
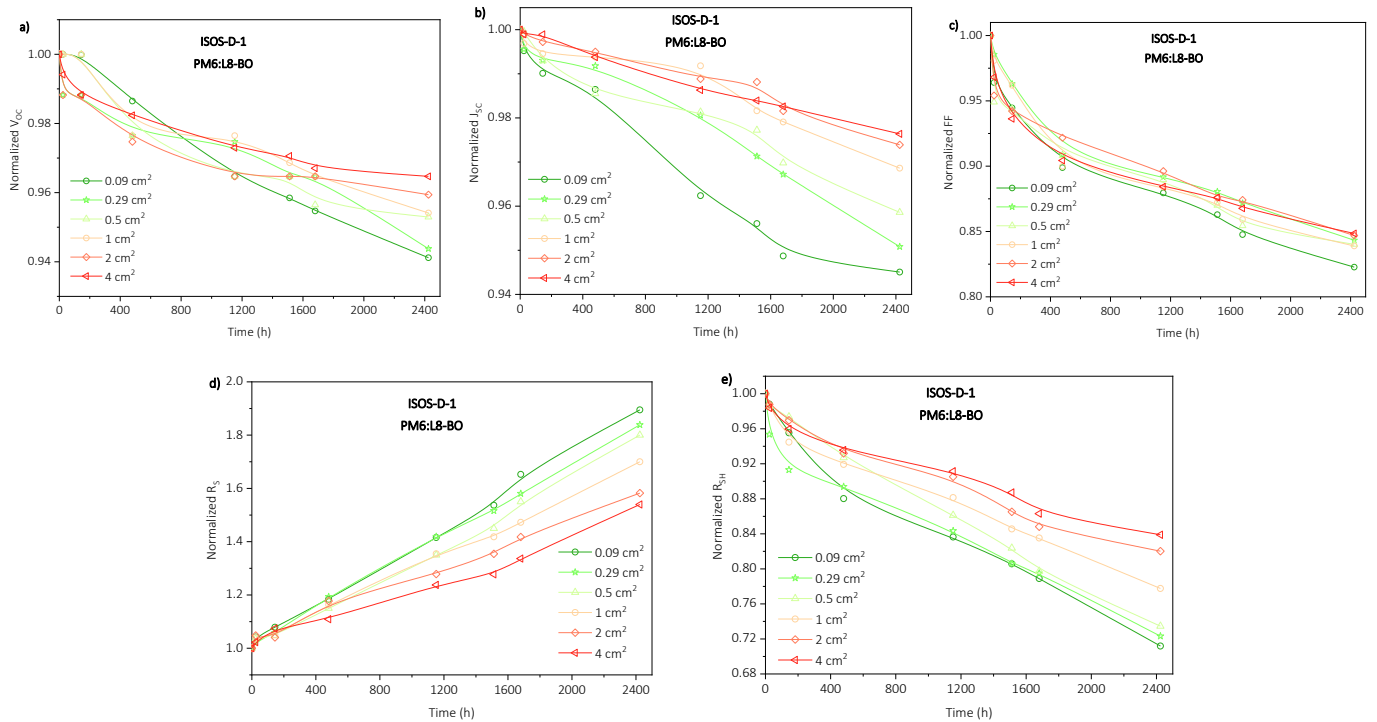
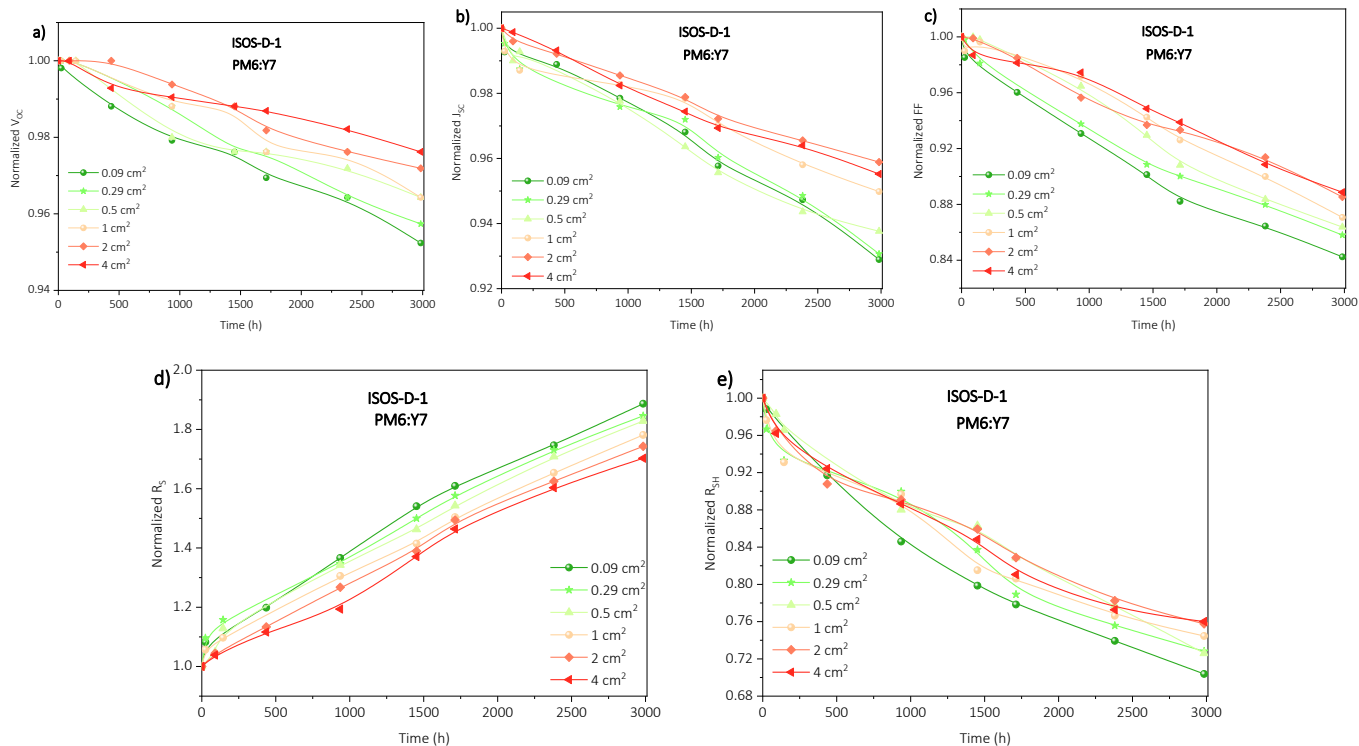


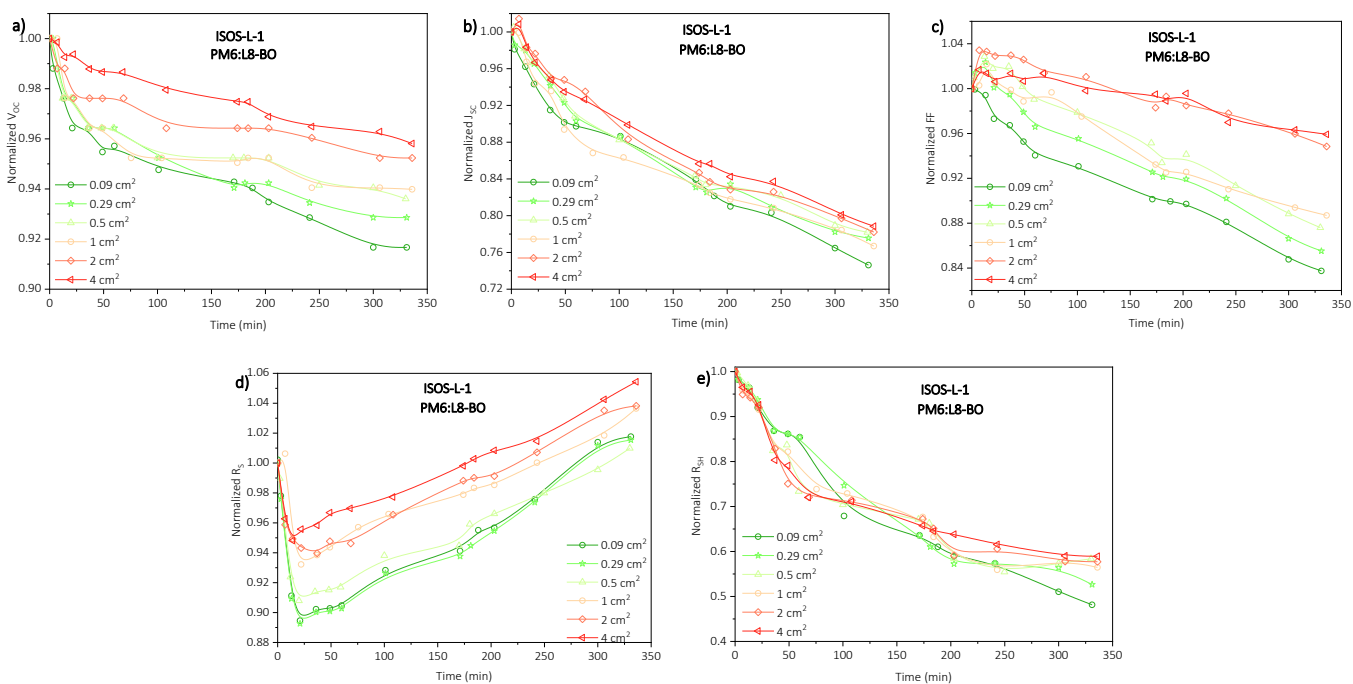
Fig. S4 PCE over time of each device area with **PM6:Y7** and **PM6:L8-BO** active layer under dark and continuous illumination following the **ISOS-D-1** (a-b) and **ISOS-L-1** protocols (c-d).



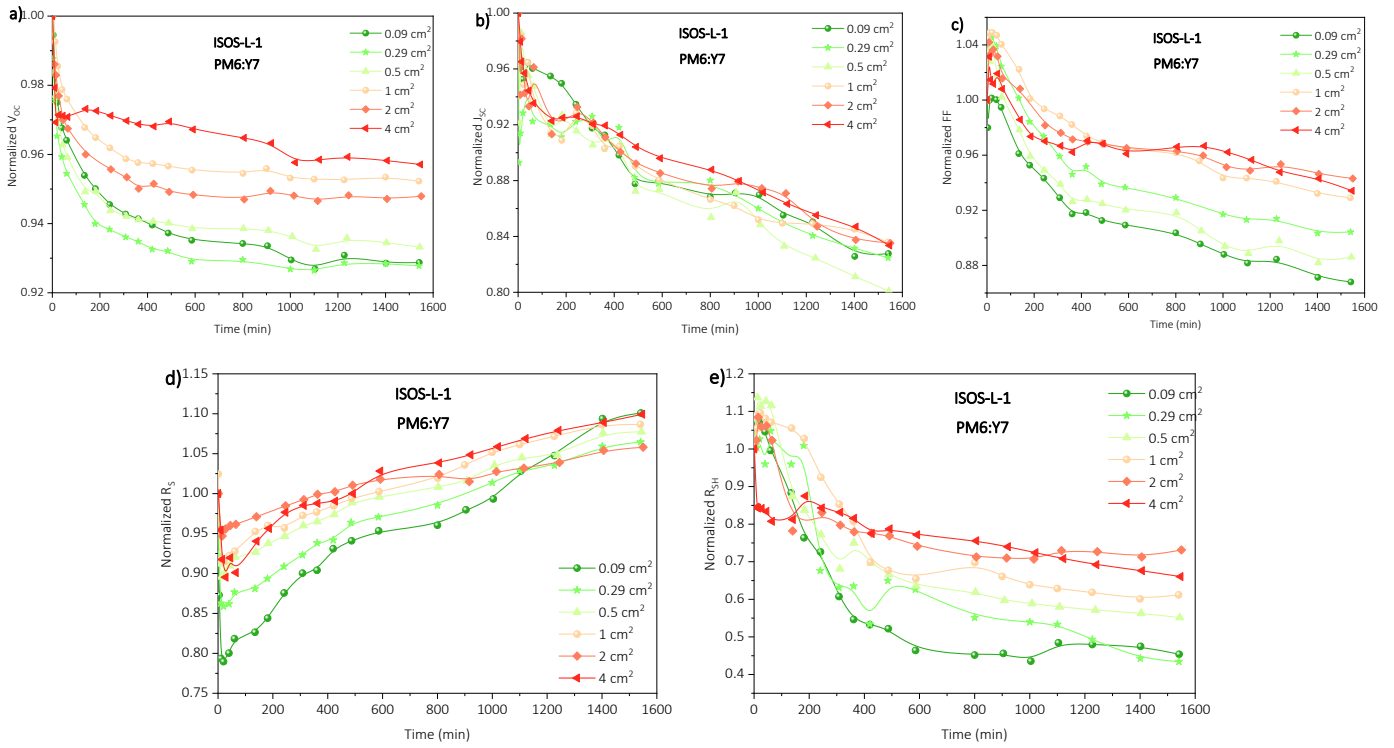
S5. Normalized device performance parameters over time of each area of **PM6:L8-BO** OSCs under dark and N_2 following the **ISOS-D-1** protocols a) V_{oc} b) J_{sc} c) FF, d) R_s , and e) R_{sh} .



S6. Normalized device performance parameters over time of each area of **PM6:Y7** OSCs under dark and N_2 following the **ISOS-D-1** protocols a) V_{oc} b) J_{sc} c) FF, d) R_s , and e) R_{SH} .



S7 Normalized device performance parameters over time of each area of **PM6:L8-BO** OSCs under continuous illumination following the **ISOS-L-1** protocols a) V_{oc} b) J_{sc} c) FF, d) R_s , and e) R_{SH} .



S8 Normalized device performance parameters over time of each area of **PM6:Y7** OSCs under continuous illumination following the **ISOS-L-1** protocols **a) V_{oc}** **b) J_{sc}** **c) FF**, **d) R_s** , and **e) R_{sh}** .

Table S1: Performance parameters of OSCs with different active layer areas deposited by Spin Coating.

Area cm ²	Active layer	V _{oc} (V)	J _{sc} (mA cm ⁻²)	FF (%)	PCE (%)	Ref.	
0.0315	PM6:L8-BO	0.869	26.35	79.60	18.23	2	
0.04	PM6:L8-BO	0.881	26.50	77.90	18.20	3	
0.04	PM6:L8-BO	0.867	25.24	78.20	17.90	4	
0.041	PM6:L8-BO	0.900	26.60	79.40	19.00	5	
0.06	PBDB-TF:BTP-4Cl-8 SC	0.872	25.20	74.30	16.10	6	
	PBDB-TF:BTP-4Cl-12 SC	0.858	25.60	77.60	16.60		
	PBDB-TF:BTP-4Cl-16 SC	0.862	24.20	74.00	15.20		
0.08	PM6:L8-BO	0.888	25.70	79.90	18.20	7	
0.08	PM6:L8-BO	0.870	25.72	81.50	18.32	8	
0.09	PBDB-TF:BTP-4Cl	0.866	25.20	73.70	16.10	9	
0.09	PM6:Y7	0.836	31.30	66.60	17.50	10	
0.09	PM6:Y7	0.850	29.10	67.00	16.52	11	
0.09	PM6:Y7	0.846	28.45	70.18	16.65	This Work	
	PM6:L8-BO	0.841	27.93	71.80	16.84		
0.29	PM6:Y7	0.845	27.56	69.54	15.85		
	PM6:L8-BO	0.843	26.50	70.54	15.80		
0.50	PM6:Y7	0.844	27.45	68.12	14.82		
	PM6:L8-BO	0.843	25.20	68.45	14.80		
0.81	PBDB-TF:BTP-4Cl-8 SC	0.863	24.90	71.10	14.80		6
	PBDB-TF:BTP-4Cl-12 SC	0.849	25.50	73.80	15.50		
	PBDB-TF:BTP-4Cl-16 SC	0.854	24.00	71.80	14.20		
1	PBDB-T-2F:N3:P(NDI2OD-T2)	0.854	24.74	66.80	14.12	12	
1	PM6:Y6	0.820	22.70	63.00	11.60	13	
1	PBDB-TF:BTP-4Cl	0.857	24.90	69.00	14.80	9	
1	PM6:PYT-1S1Se	0.906	24.30	65.90	14.50	14	
1	PM6:BTP-eC9	0.830	24.90	73.00	15.10	15	
1	PBDB-TF:BTP-eC11	0.843	25.30	72.20	15.40	16	
1	PBDB-TF:IT-4F	0.840	19.87	67.00	11.18	17	
1	PBDB-TF-T1:BTP-4F-12	0.842	24.40	72.00	14.80	18	
1	T1:IT-4F	0.877	20.90	75.00	13.70	19	
1	PBDB-TF:IT-4F	0.860	21.10	72.00	13.20	20	
1	PBDB-T-SF:IT-4F	0.860	18.93	68.20	11.10	21	
1	B1:BTP-eC9	0.831	24.22	64.00	12.88	22	
1	PM6:PYF-T-o	0.900	22.70	70.70	14.50	23	
1	PM6:PYT1	0.934	21.33	57.40	11.43	24	
1	PM6:ICBA:IT-4F	0.871	20.64	73.30	13.17	25	
1	PM6:Y6 (BHJ)	0.835	25.52	65.74	14.01	26	
1	PM6:IDIC	0.950	16.90	71.00	11.40	27	
1	PCT-EHp:Y6	0.790	26.68	63.70	13.42	28	
1	J71:ITC6-IC	0.973	16.16	65.79	10.35	29	
1	PTQ10:IDIC	0.965	15.89	67.90	10.42		
1	PFA1:PTzBI-oF	0.890	23.99	65.79	14.03	30	
1	PM6:L8-BO	0.844	24.84	65.42	13.32	This Work	
	PM6:Y7	0.843	27.31	62.70	13.74		
2.4	PM6:BTP-eC9	0.770	22.80	63.00	11.40	31	

2	PM6:L8-BO	0.845	24.50	59.56	12.42	This Work
	PM6:Y7	0.842	26.68	57.01	12.51	
4	PM6:Y6	0.800	20.92	61.00	10.21	¹³
4	PM6:L8-BO	0.848	24.20	53.77	11.17	This Work
	PM6:Y7	0.842	25.93	50.40	10.69	

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