Supporting Information for

Towards 15 % energy conversion efficiency: A systematic study of the solution-processed organic tandem solar cells based on commercially available materials

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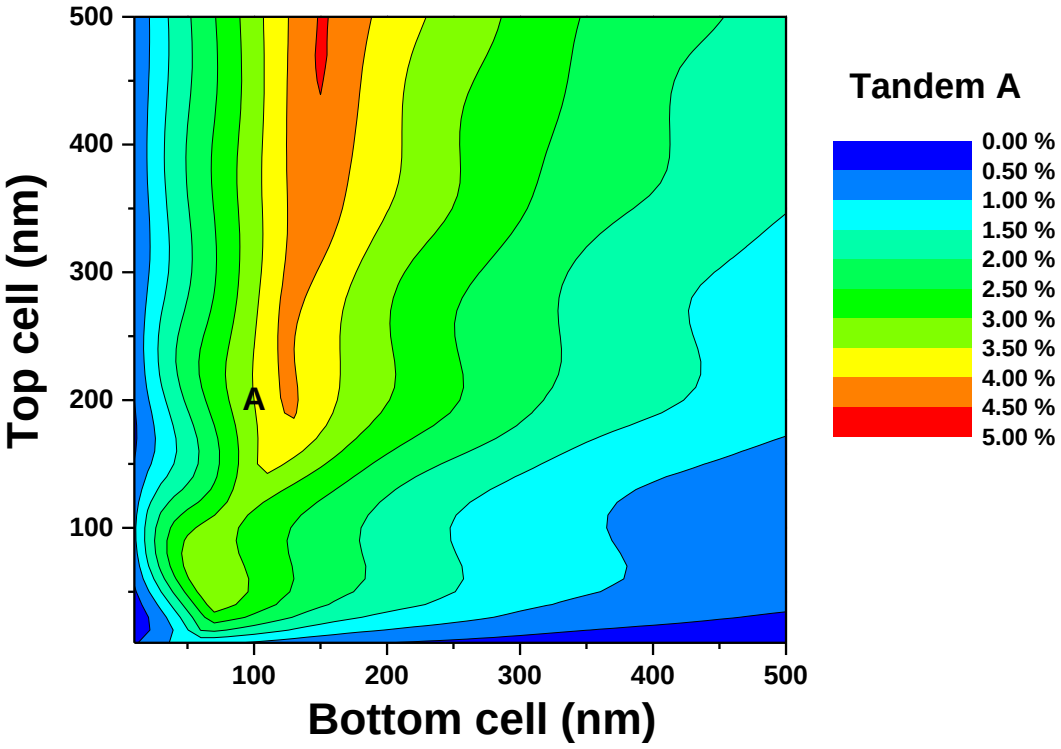

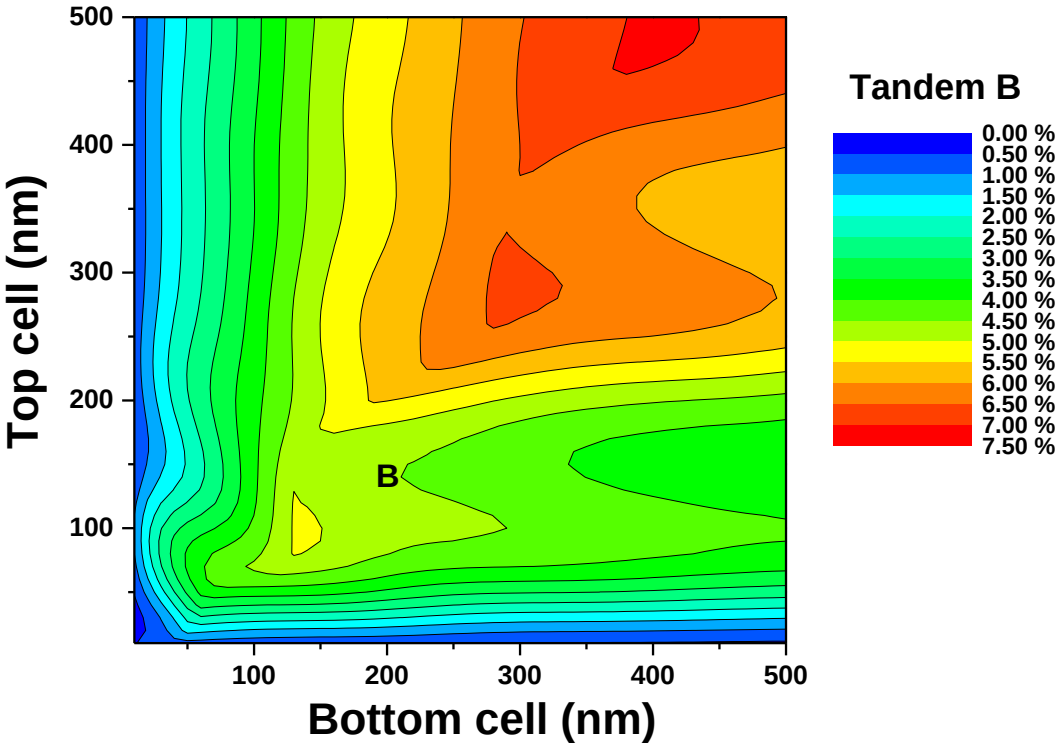

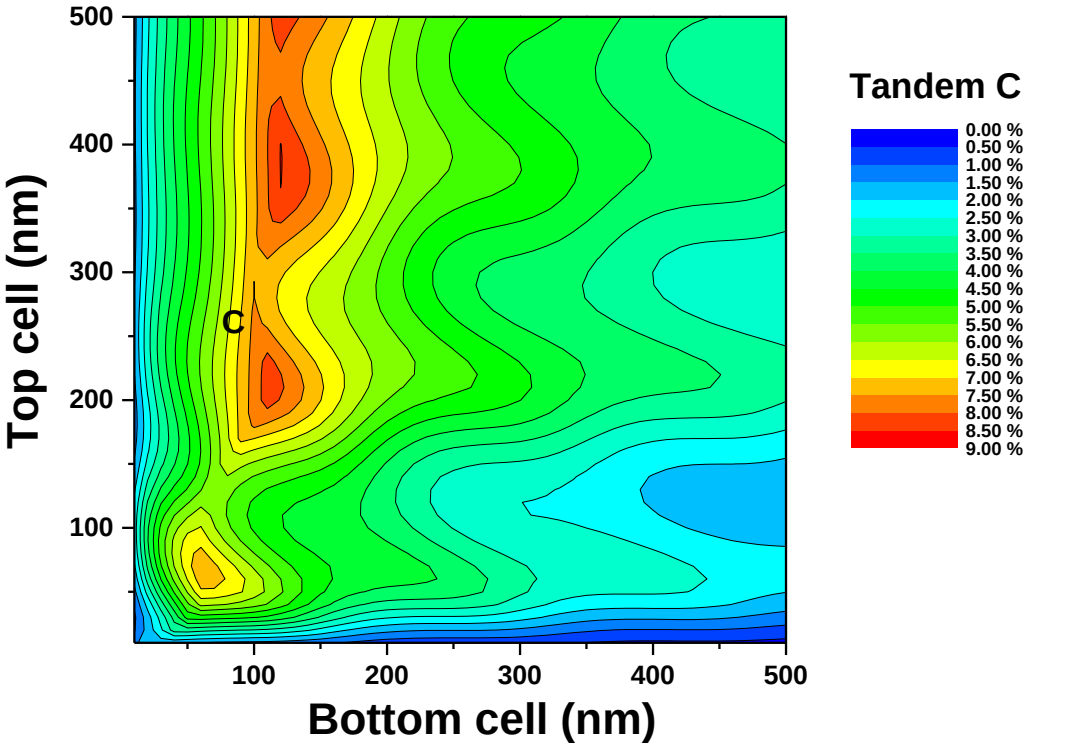

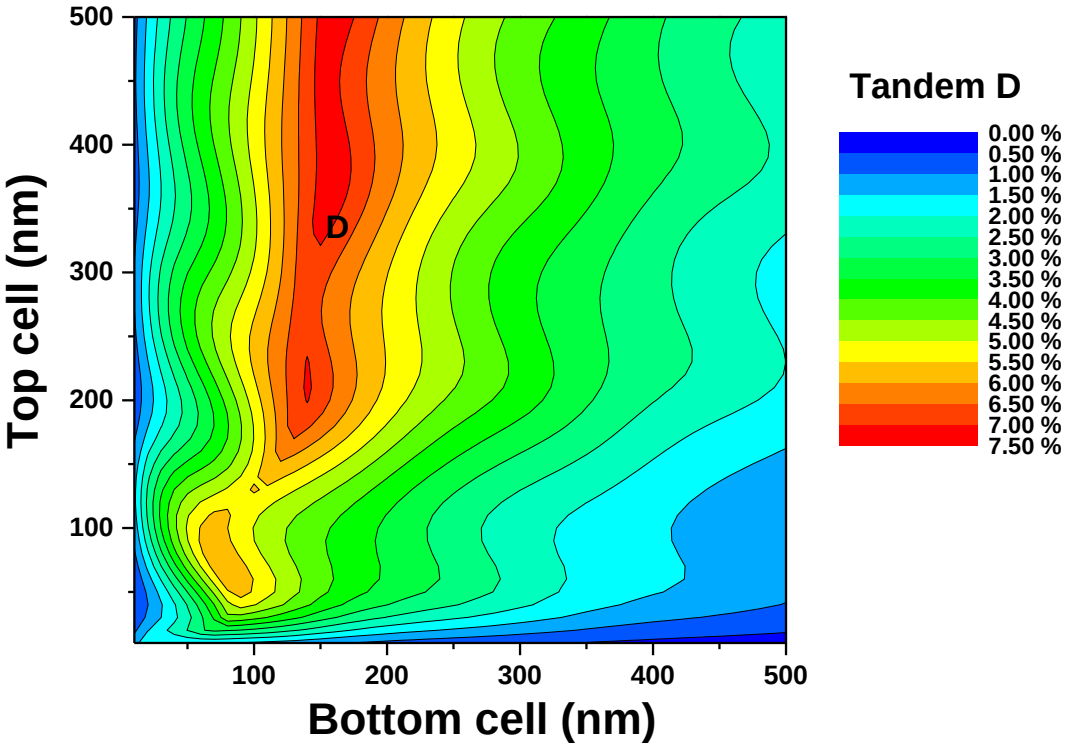

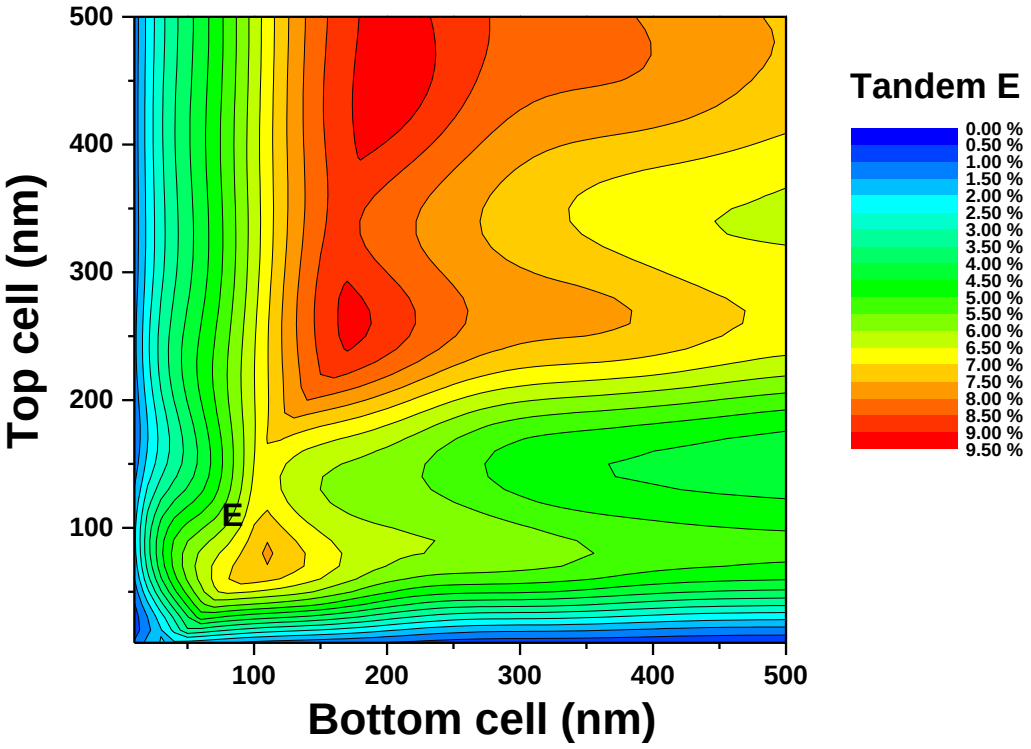

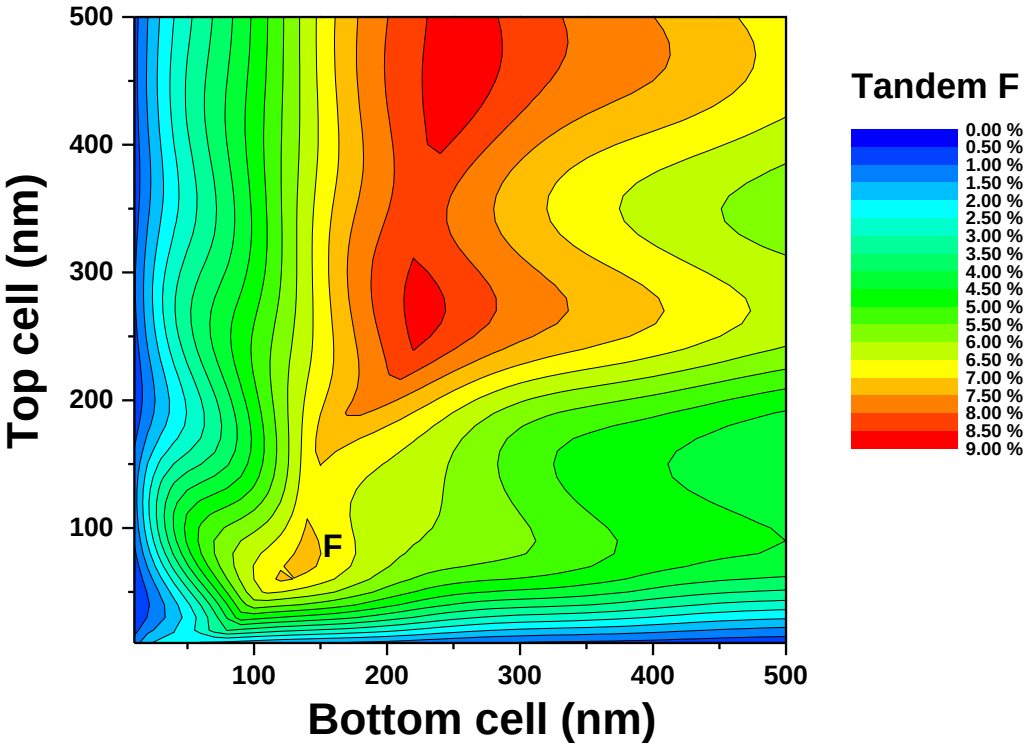

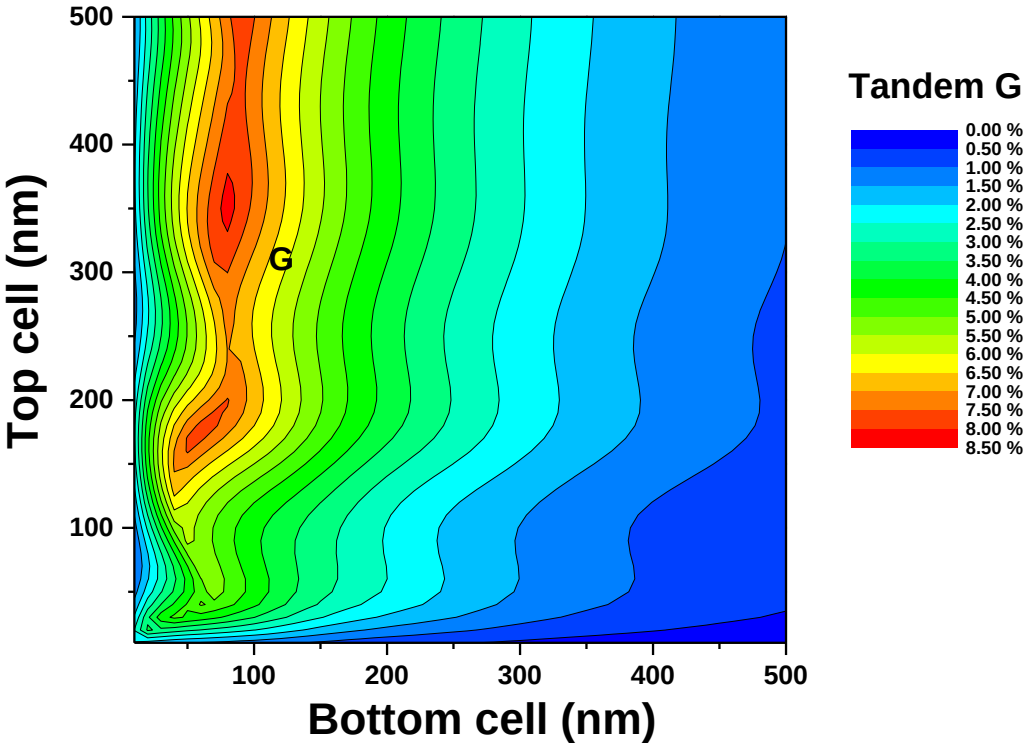

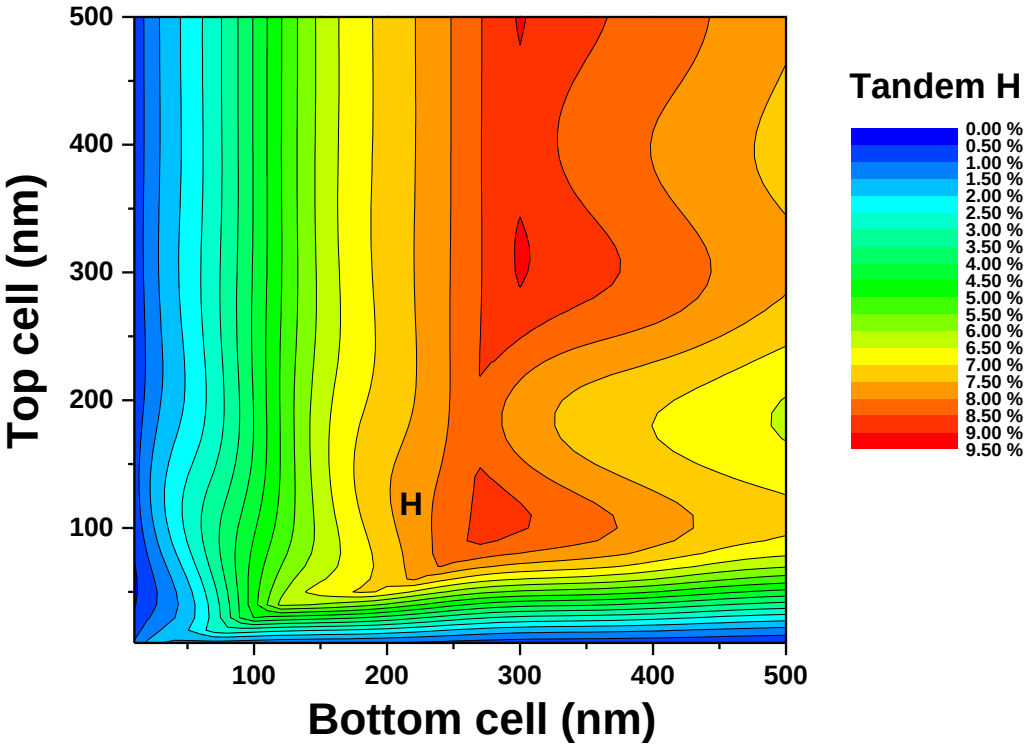

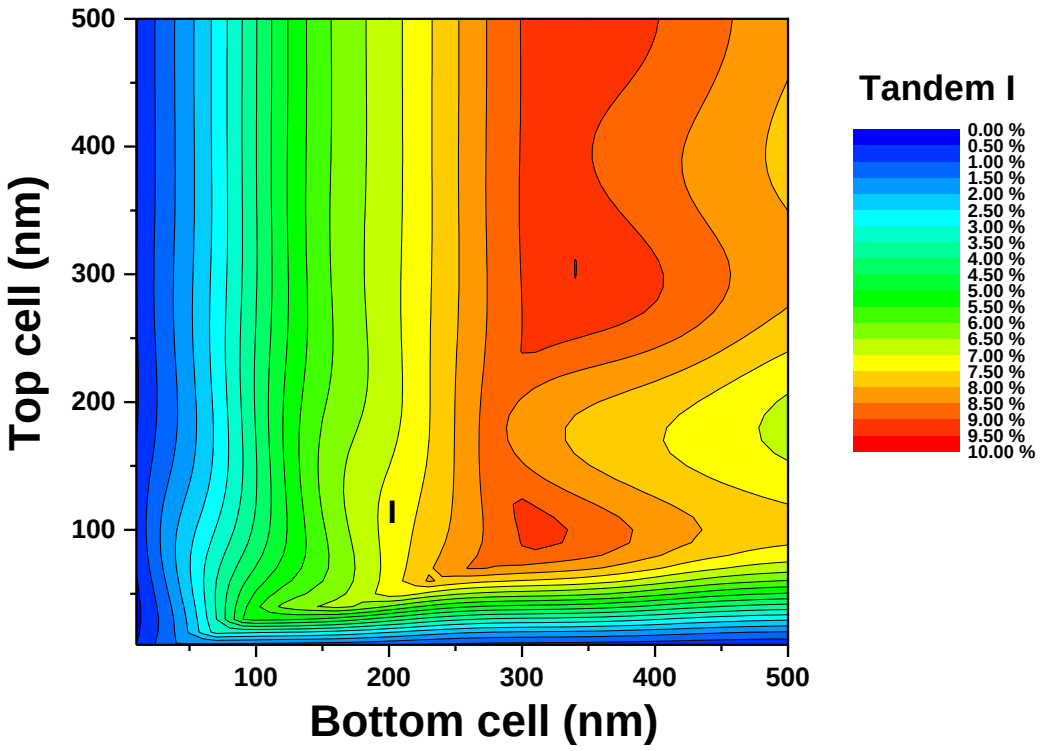

Figure S1 Efficiency prediction of organic tandem solar cells based on commercially available materials in combination with PCBM. The V_{oc} values are adopted from experimental data. The FF values are assumed to be of 65 %. The optical constants of the materials used for the interlayers and active layers were measured by spectroscopic ellipsometry and verified by transmission measurements. The letters in the efficiency maps represent the tandem solar cells that constructed with the corresponding active layer thicknesses. The J-V characteristics and photovoltaic parameters of these solar cells are shown in **Figure 4a** and **Table 3**, respectively.

Tandem cell	Bottom cell	Top cell	Device structure	V_{oc}[a] [V]	J_{sc}[a] [mA/cm^2]	FF[a] [%]	IQE-Bottom [%]	IQE-Top [%]	J_{sc}[c] [mA/cm^2]	FF[b] [%]	PCE[c] [%]
Tandem A	P3HT: [60]PCBM	P3HT: [60]PCBM	Inverted	1.12	4.7	64	80[1]	80	6.32	65	5.0
Tandem B	P3HT: [60]PCBM	Si-PCPDTBT: [60]PCBM	Inverted	1.11	7.68	57	80	60[2]	9.90	65	7.5
Tandem C	PCDTBT: [70]PCBM	GEN-2: [60]PCBM	Inverted	1.64	6.53	56	90[3]	80	8.01	65	9.0
Tandem D	GEN-2: [60]PCBM	GEN-2: [60]PCBM	Inverted	1.48	7.19	57	80	80	7.73	65	7.5
Tandem E	PCDTBT: [70]PCBM	Si-PCPDTBT: [70]PCBM	Inverted	1.41	8.06	52	90	60	10.32	65	9.5
Tandem F	GEN-2: [60]PCBM	Si-PCPDTBT: [70]PCBM	Inverted	1.39	6.95	57	80	60	9.85	65	9.0
Tandem G	pDPP5T-2: [60]PCBM	GEN-2: [60]PCBM	Inverted	1.40	5.76	58	65[4]	80	9.05	65	8.5
Tandem H	GEN-2: [60]PCBM	pDPP5T-2: [70]PCBM	Regular	1.30	6.98	68	80	65	10.75	65	9.5
Tandem I	OPV12: [60]PCBM	pDPP5T-2: [70]PCBM	Regular	1.35	7.46	66	80	65	10.83	65	10

a) Experimental values; b) FF values used for optical simulation; c) Maximum J_{sc} and PCE values estimated by optical simulations.

Table S1 The PCE prediction of the solution-processed organic tandem solar cells based on commercially available donor materials in combination with PCBM. The V_{oc} values are adopted from experimental data, while the FF values of 65 % were used in previous prediction [5].

[1] G. Dennler, K. Forberich, M. C. Scharber, C. J. Brabec, I. Tomis, K. Hingerl, T. Fromherz, *J Appl Phys*, 2007, **102**, 054516.

[2] H. Azimi, M. Morana, T. Ameri, B. Dastmalchi, M. Scharber, K. Hingerl, C. J. Brabec, *Sol Energ Mat Sol C*, 2011, **95**, 3093-3098.

[3] S. H. Park, A. Roy, S. Beaupre, S. Cho, N. Coates, J. S. Moon, D. Moses, M. Leclerc, K. Lee, A. J. Heeger, *Nature Photonics*, 2009, **3**, 297.

[4] N. Li, D. Baran, K. Forberich, M. Turbiez, T. Ameri, F.C. Krebs, C.J. Brabec, *Advanced Energy Materials*, doi:10.1002/aenm.201300372.

[5] G. Dennler, M. C. Scharber, T. Ameri, P. Denk, K. Forberich, C. Waldauf, C. J. Brabec, *Advanced Materials*, 2008, **20**, 579-583.