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

Supplementary Information:

Transfer-printing of patterned PEDOT:PSS structures for bendable, stretchable and biodegradable electronics

Carla Volkert[1*], Renan Colucci[1], Rüdiger Berger[2], Pol Besenius[3], Paul W. M. Blom[4], Ulrike Kraft[1*]

[1]Organic Bioelectronics Research Group, Max Planck Institute for Polymer Research, 55128 Mainz, Germany
[2]Department of Physics of Interfaces, Max Planck Institute for Polymer Research, Mainz, Germany
[3]Department of Chemistry, Johannes Gutenberg Universität Mainz, 55128 Mainz, Germany
[4]Department of Molecular Electronics, Max Planck Institute for Polymer Research, 55128 Mainz, Germany

Email: volkertc@mpip-mainz.mpg.de, kraftu@mpip-mainz.mpg.de

1) Literature overview

2) Electrical characterization

3) Transmission measurements

4) Mask layout and detailed margins of patterned and transfer-printed PEDOT:PSS thin films

Additional material: Video demonstrating the lift-off process.

1. Literature overview

Table S1: Comparative overview of different transfer methods onto flexible and stretchable substrates, including details on the donating substrate, required treatment, receiving substrate, limitations on PEDOT:PSS formulation, and, if applicable, the dimensions of structured PEDOT:PSS that can be transferred.

reference	donating substrate	required treatment		receiving substrate	PEDOT:PSS formulation limited?	structures transferred?	conductivity maintained after transfer?
		decrease adhesion from donating substrate	increase adhesion to receiving substrate				
2	glass	acid soaking or dipping treatments		PDMS	yes	no	almost identical
14	glass	acid treatment	PEDOT:PSS/ d-sorbitol layer on top of PET	PET	yes	no	not explicitly given
16	glass		chemically tailored PDMS	APTES-PDMS	unknown	yes; no exact margins given, approx. mm-scale	increased
17	glass	acid treatment		PDMS	yes	yes; margins not given	almost identical
20	glass	surfactant DBSA		poly (lactic) acid	yes	yes; 500 μm	decrease
this work	glass	none	none	PVA: glycerol	no	yes ≥ 50 μm	almost identical/ increase

2 X. Fan, B. Xu, S. Liu, C. Cui, J. Wang and F. Yan, *ACS Appl. Mater. Interfaces*, 2016, 8, 14029–14036.

14 X. Fan, W. Song, T. Lei, B. Xu, F. Yan, N. Wang, H. Cui and Z. Ge, *Mater. Chem. Front.*, 2019, 3, 901–908.

16 Z. Rao, A. Thukral, P. Yang, Y. Lu, H. Shim, W. Wu, A. Karim and C. Yu, *Adv. Funct. Mater.*, 2022, 32, 2111232.

17 N. Kim, H. Kang, J. H. Lee, S. Kee, S. H. Lee and K. Lee, *Adv. Mater.*, 2015, 27, 2317–2323.

20 S. Zhang, H. Ling, Y. Chen, Q. Cui, J. Ni, X. Wang, M. C. Hartel, X. Meng, K. J. Lee, J. Lee, W. Sun, H. Lin, S. Emaminejad, S. Ahadian, N. Ashammakhi, M. R. Dokmeci and A. Khademhosseini, *Adv. Funct. Mater.*, 2020, 30, 1906016.

2. Electrical characterization

Table S2: Film thickness, resistance and conductivity values for variously treated PEDOT:PSS thin films before and after transfer-printing and O_2-plasma etching, respectively. All films were spin-coated speed at 1000 rpm for 60 s.

Please note that all resistance values were recorded for the exact same thin film before and after printing or O_2-plasma etching, respectively.

		PRINTING				O_2-PLASMA			
		before on glass		after on PVA: glycerol (25 wt%)		before on glass		after on glass	
	d [nm]	*R* [Ohm]	σ [S/cm]	*R* [Ohm]	σ [S/cm]	*R* [Ohm]	σ [S/cm]	*R* [Ohm]	σ [S/cm]
pristine	74	338 k	0.5	205k	0.8	459 k	0.3	757 k	0.2
DMSO	55	130	1600	125	1655	138	1500	169	1225
H_2SO_4	28	147	2808	139	2976	2.6	1496	284	1453
DBSA/ EG	60	239	797	206	927	257	742	556	342
$MeSO_3H$	63	136	1348	98	1860	78	1939	99	1527

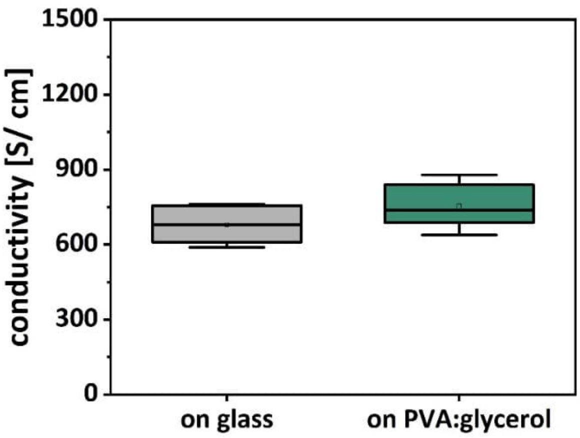

Figure S1: Conductivity values for multiple DBSA/EG treated PEDOT:PSS thin films before (on glass) and after transfer-printing (on PVA:glycerol).

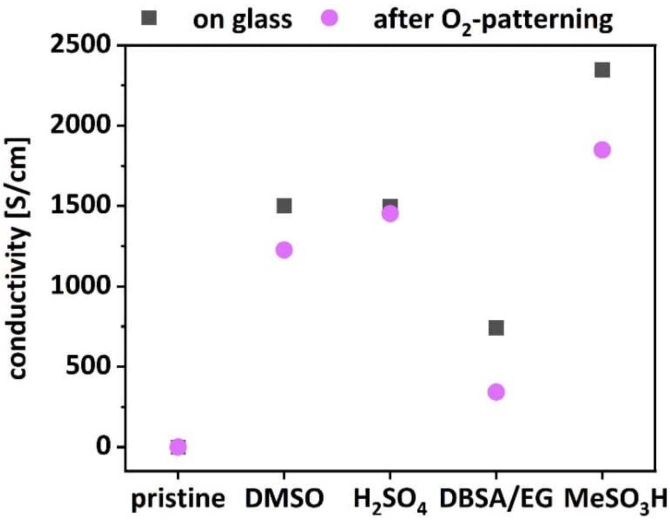

Figure S2: Effect of O_2-patterning on the conductivity of PEDOT:PSS films.

3. Transmission measurements

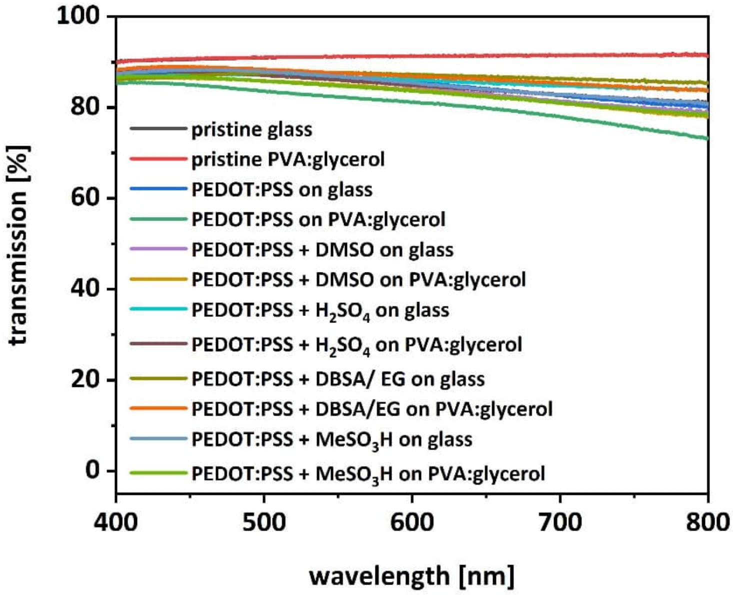

Figure S3: Transmission spectra of pristine glass and PVA/glycerol (25 wt%) substrates, as well as variously treated PEDOT:PSS films on glass or transfer-printed on PVA substrates, respectively.

Table S3: Transmission at λ = 550 nm of pristine glass and PVA:glycerol (25 wt%) substrates, as well as variously treated PEDOT:PSS on top of glass or transfer-printed, respectively.

	transmission [%]				
pristine glass	91.3				
pristine pva:glycerol (25 wt%)	91.3				
PEDOT:PSS	pristine	DMSO	H_2SO_4	DBSA/ EG	$MeSO_3H$
on glass	85.1	86.4	86.8	87.6	86.9
on pva:glycerol (25 wt%)	86.3	85	86	87.6	84.7

4. Mask layout and detailed margins of patterned and transfer-printed PEDOT:PSS thin films

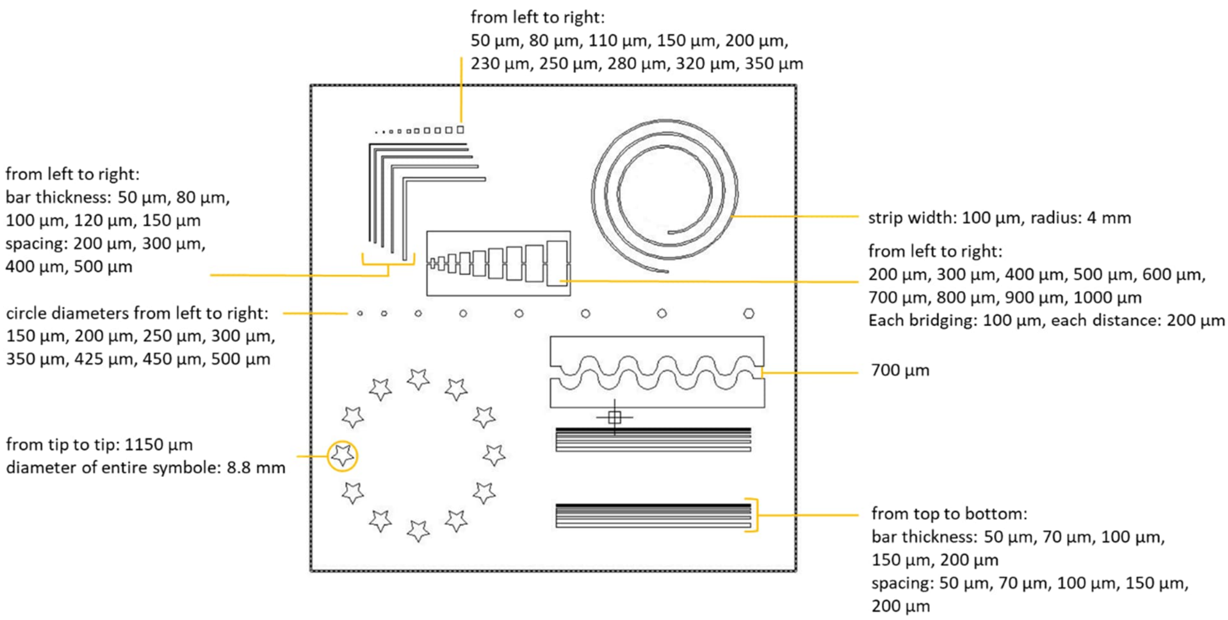

Figure S4: Mask layout for patterning PEDOT:PSS, including all margins.

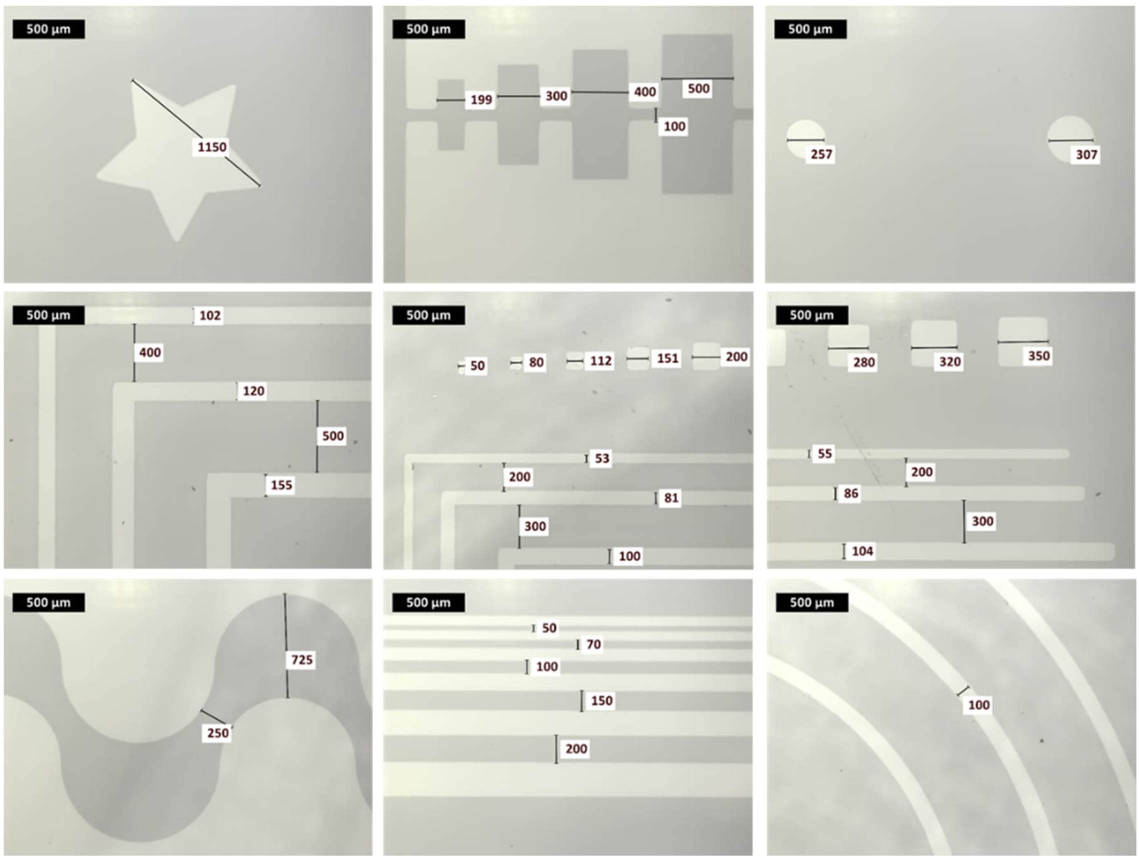

Figure S5: Detailed margins of O_2-patterned PEDOT:PSS.

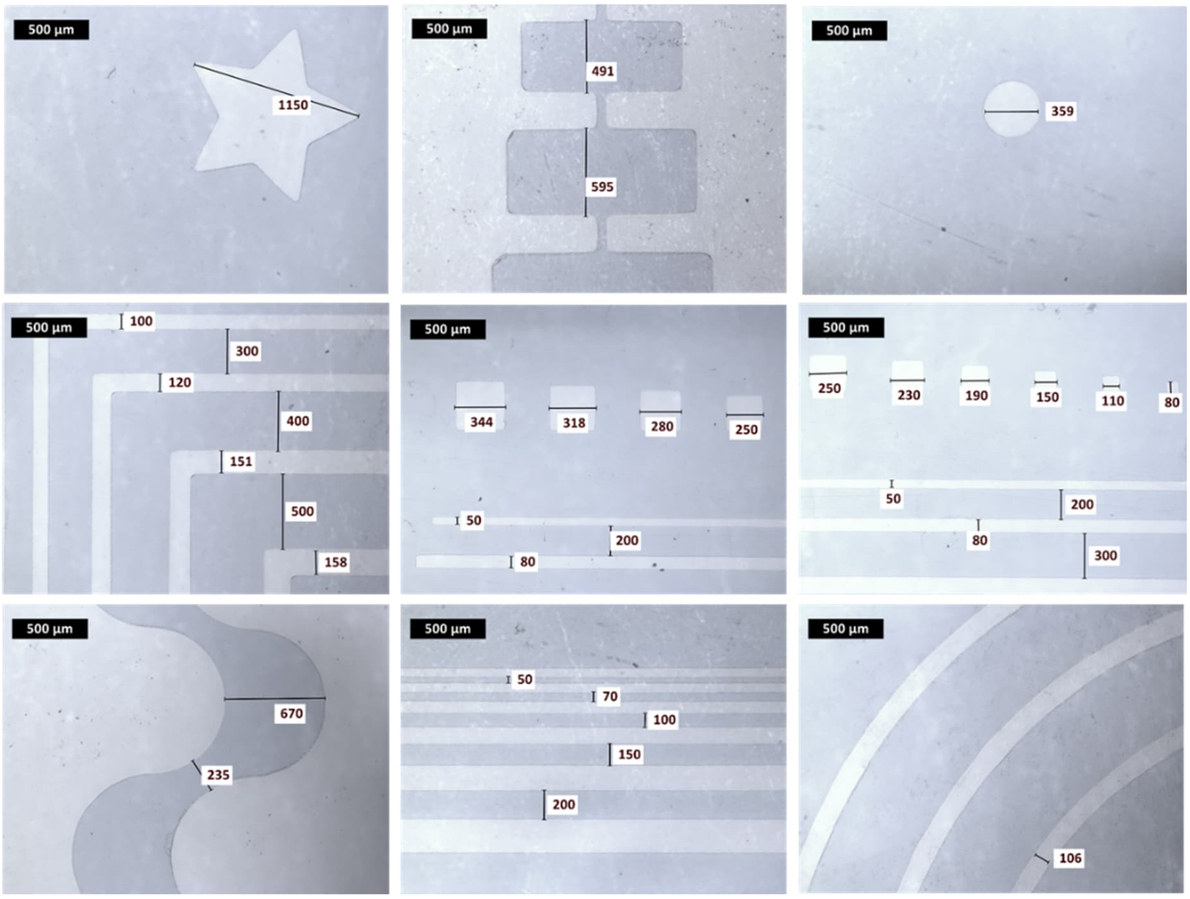

Figure S6: Detailed margins of O_2-patterned and subsequently transfer-printed PEDOT:PSS on PVA:glycerol (25 wt%) substrates.

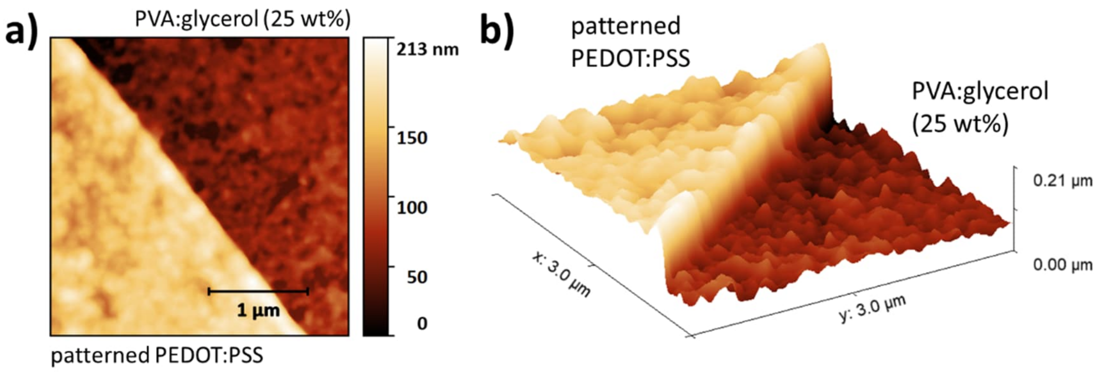

Figure S7: Scanning Force Microscopy recordings (3 µm x 3 µm) of patterned and transfer-printed PEDOT:PSS o PVA:glycerol (25 wt%). a) Topography image and b) 3D representation.