Supporting Information

Universal Electrode for Ambipolar Charge Injection in Organic Electronic Devices

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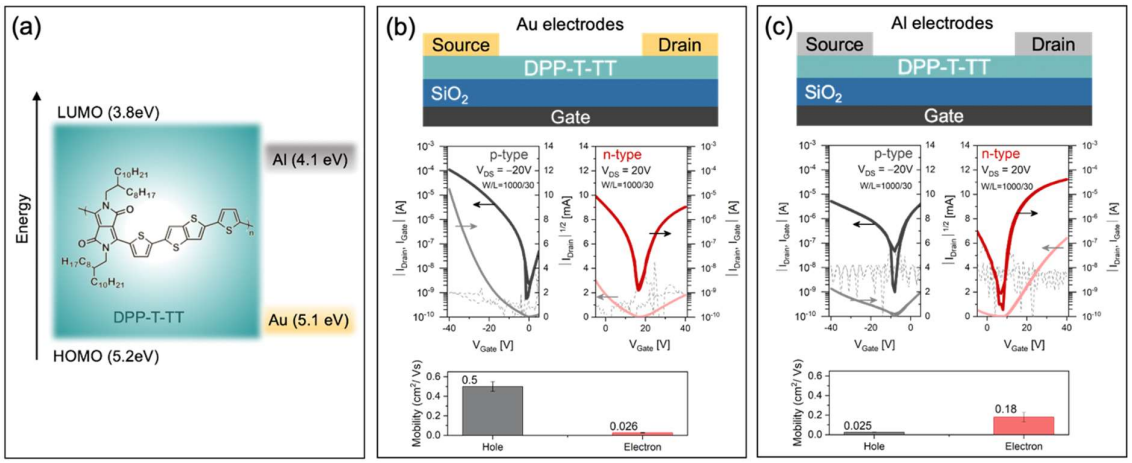

Figure S 1: DPP-T-TT polymer and top-contact bottom-gate OFET performances with Au and Al electrodes. The chemical structure of DPP-T-TT polymer is shown in (a) with the HOMO and LUMO levels compared to the work functions of gold and aluminum. (b) OFET device structure with Au source & drain electrodes, n- and p-type transfer characteristics and extracted mobility values. (c) OFET device structure with Al source & drain electrodes, n- and p-type transfer characteristics and extracted mobility values.

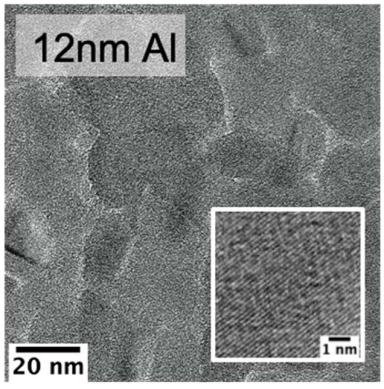

Figure S 2: TEM image of continues 12nm Al layer on DPP-T-TT polymer surface. Inset shows the lattice image of deposited Al. The roughness is due to the polymer film topography.

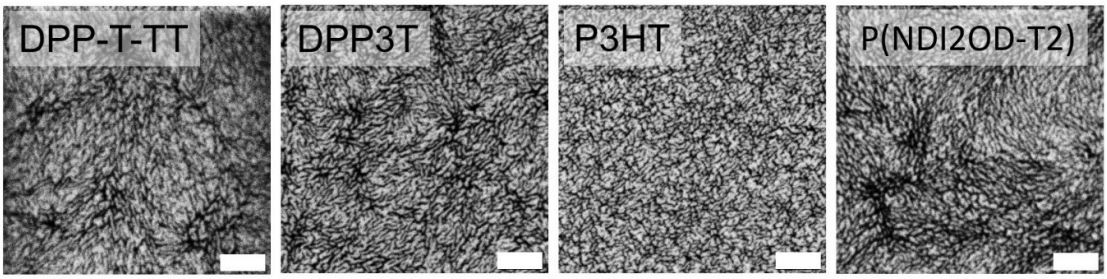

Figure S 3: Top view SEM images of Au islands on DPP-T-TT, DPP3T, P3HT and P(NDI2OD-T2) polymer surface (nominal Au thickness 5nm). The length scale for all images is 100nm.

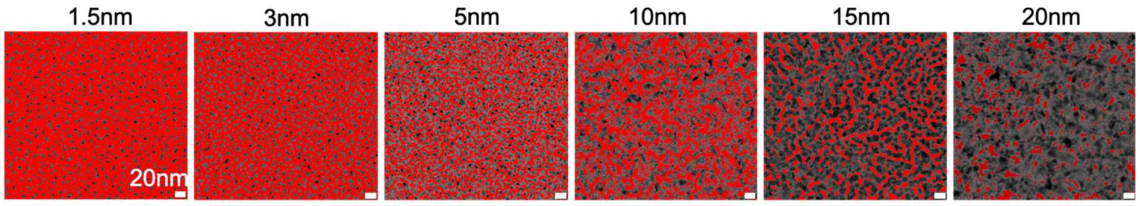

Figure S 4: TEM images of a DPP-T-TT film after thermal evaporation of Au with nominal thicknesses ranging between 1.5-20 nm, followed by a 12 nm Al layer. For these measurements a DPP-TT-T solution in 1,2-dichlorobenzene was spun onto a carbon coated TEM copper grid followed by Au and Al deposition. The acquired bright field TEM image (by FEI Tecnai T20 LaB6 TEM) showed dark Au regions (heavy metal) and bright Al regions (here in red). Using Olympus "Stream Essentials" software the surface coverage of the bright (Al) and dark (Au) areas were calculated.

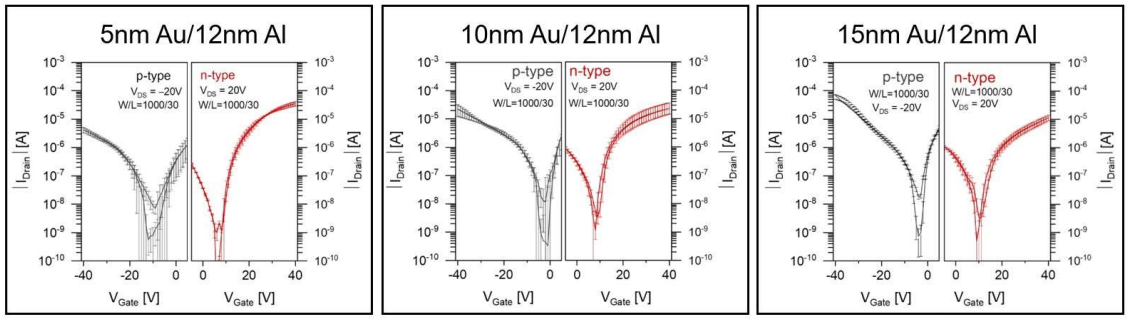

Figure S 5: The data from Figure 2 of the manuscript replotted with the standard deviation calculated over more than 10 devices for each Au-Al thickness ratio.

Table-S1: Parameters of n-type and p-type DPP-T-TT OFETs with different electrodes: Au, Al and bi-metallic mosaics

Polymer	No. Of devices	Type of electrodes	Threshold Voltage [V]		Mobility (cm^2/Vs) (@ $V_{Gate} = \pm 40V$)		ON/OFF (@$V_{Drain} = \pm 20V$)	
			p-type	n-type	μ_h	μ_e	p-type	n-type
DPP-T-TT	10	Only Au	-11	18	0.5 (±0.03)	0.026 (±0.005)	10^5	10^4
	8	Only Al	-11.8	10.5	0.025 (±0.003)	0.18 (±0.05)	10^3	10^5
	7	5nm Au:12 Al: 30nm Au	-12.5	10.5	0.02 (±0.006)	0.15 (±0.03)	10^3	10^5
	8	10nm Au:12 Al: 30nm Au	-5	8	0.1 (±0.03)	0.095 (±0.02)	10^4	10^4
	4	15nm Au:12 Al: 30nm Au	-13	10.4	0.27 (±0.04)	0.04 (±0.013)	10^5	10^4

Equation S1: The OFET mobility calculated from the following equation:

$$I_{Drain} = \frac{1}{2}\frac{W}{L} C \mu_{FET} (V_{Gate} - V_{Threshold})^2$$

Where, I_{Drain} is drain current, V_{Gate} is Gate voltage, $V_{Threshold}$ is threshold voltage, C is capacitance of the gate dielectric, μ_{FET} is the mobility, W and L is the channel width and length of the OFET. According to this equation OFET mobility (μ_{FET}) is proportional to the drain current (I_{Drain}).

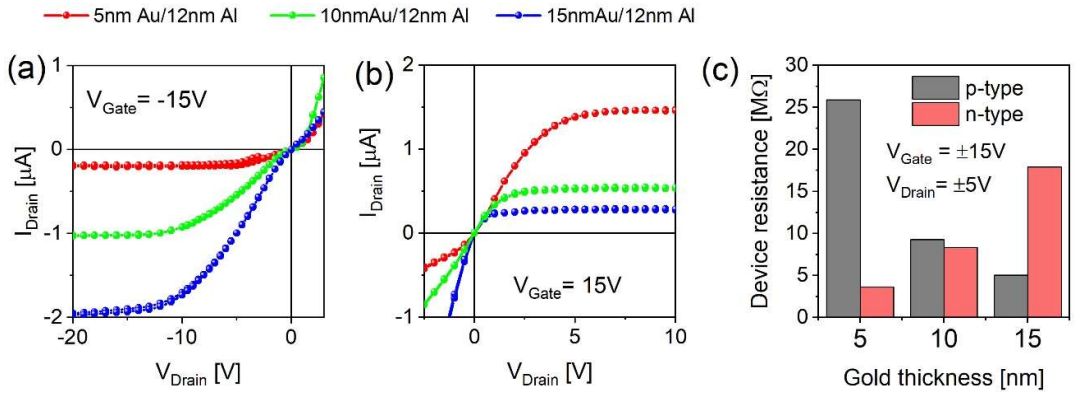

Figure S 6: (a) The p-type and (b) n-type output characteristics (for V_{Gate}= ±15V) of OFETs with different Au-Al ratios. (c) Device resistance values are calculated from the corresponding output characteristics, plotted with respect to the Au "thickness".

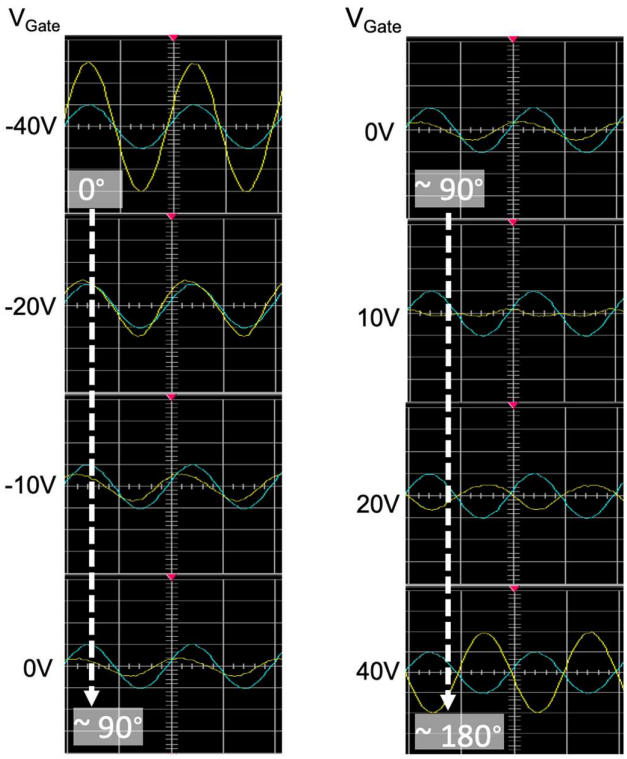

Figure S 7: Performance of an analogue phase shifter based on a single ambipolar OFET and a 100KΩ resistor as shown in figure 3-b-i of the manuscript. The biasing voltage was swept from negative to positive 40V so the phase difference was tuned from zero to 180° through intermediate. The input and output signals have a similar frequency of 100Hz.

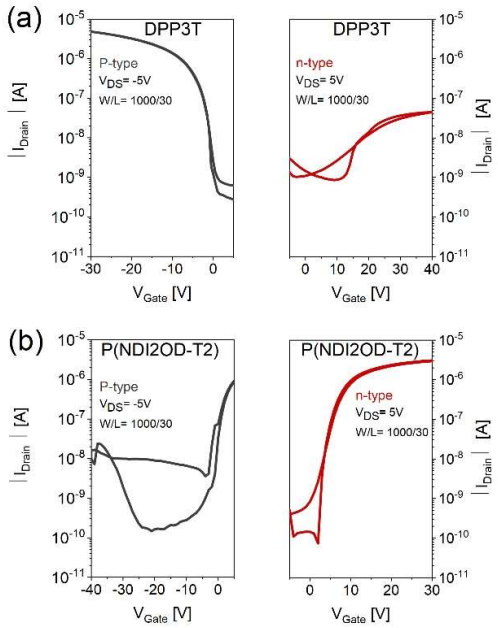

Figure S 8: (a) Transfer characteristics of pristine DPP3T OFETs (left: p-type, right: n-type) and (b) Transfer characteristics of pristine P(NDI2OD-T2) OFETs (left: p-type, right: n-type) with 10nm Au/12nm Al electrode.

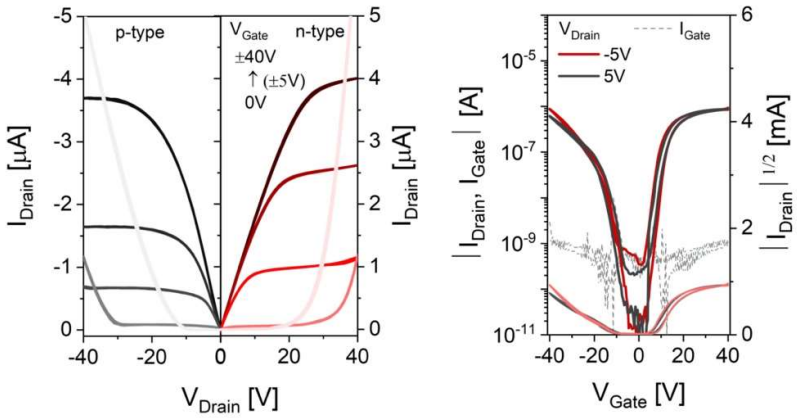

Figure S 9: Output (left) and transfer (right) characteristics of a BHJ-based OFET device with bi-metallic mosaic electrodes. The BHJ is composed of a 1:1 wt% p-type DPP3T and n-type PNDI(2OD)T2 polymer blend.

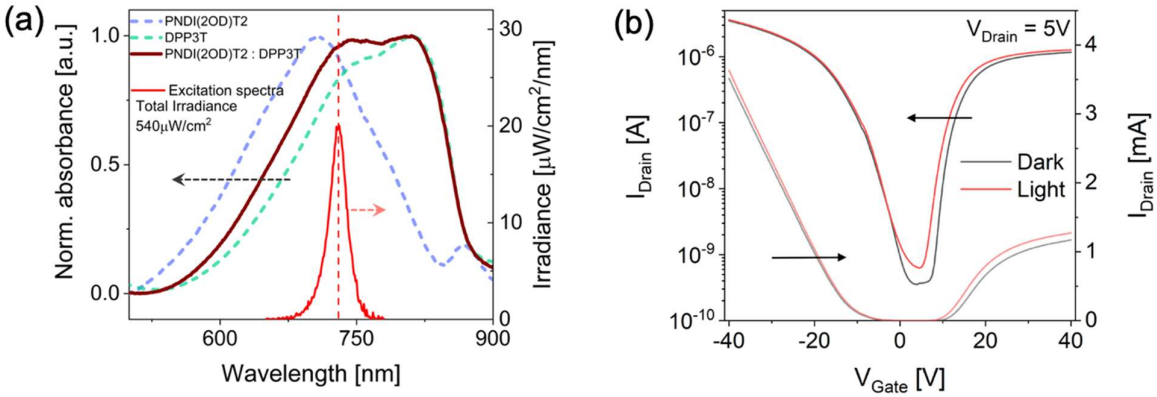

Figure S 10: (a) Absorbance (left y-axis) of p-type DPP3T and n-type P(NDI2OD-T2) and their 1:1 wt% blend. The irradiance (right y-axis) of a 730 nm commercial LED. (b) The transfer characteristics of the BHJ-based OFET with bi-metallic electrodes in dark and under illumination of the 540 µW/cm^2 730 nm LED.

Equation S2: Photoresponsivity (R) typically defined by the following equation:

$$R = \frac{I_i - I_d}{E^{tot}\, LW}$$

Where, I_i is the drain current under illumination, I_d is the drain current in the dark, E^{tot} is the total irradiance measured at the device; L and W are the channel length and width, respectively.

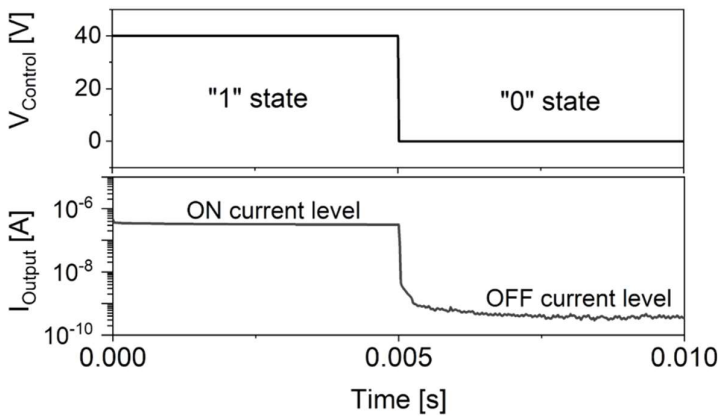

Figure S 11: The current level measurement at the 'ON' ("1") and 'OFF' ("0") state of the BHJ-based ambipolar transistor during transmission gate operation.