# Supporting Information

## High-density polyethylene — an inert additive with stabilizing effects on organic field-effect transistors

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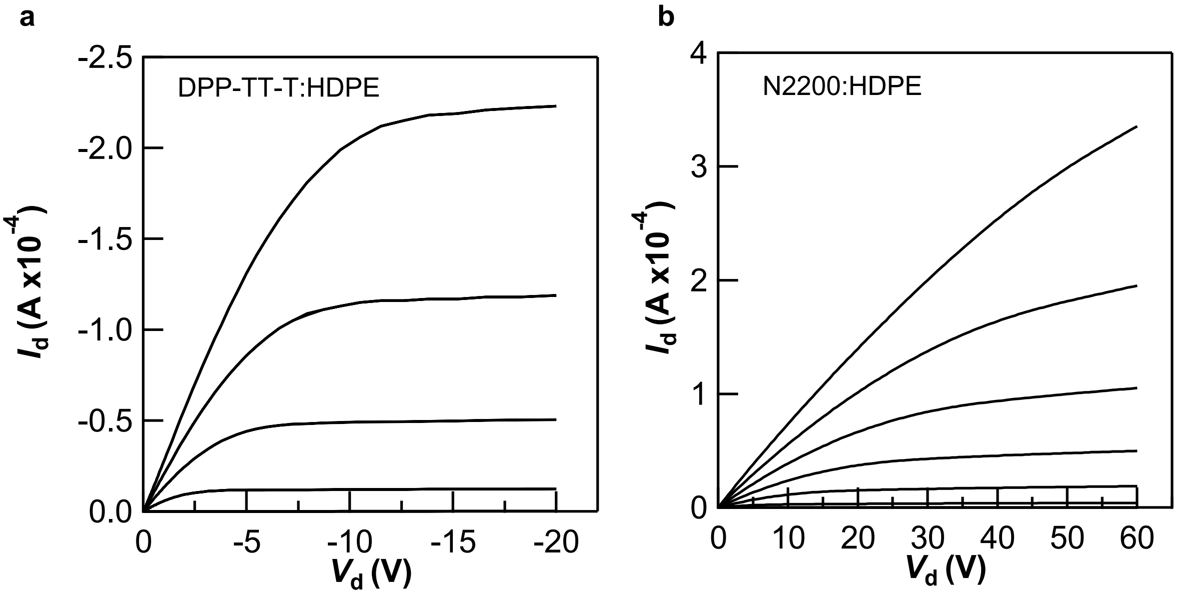

Figure S 1. Representative output characteristics of a) an 1:1 DPP-TT-T:HDPE bottom-gate/bottom-contact device with a $SiO_2$ dielectric (thickness = 90 nm) and b) an 1:1 N2200:HDPE top-gate/bottom-contact device with a PMMA dielectric (thickness = 600 nm).

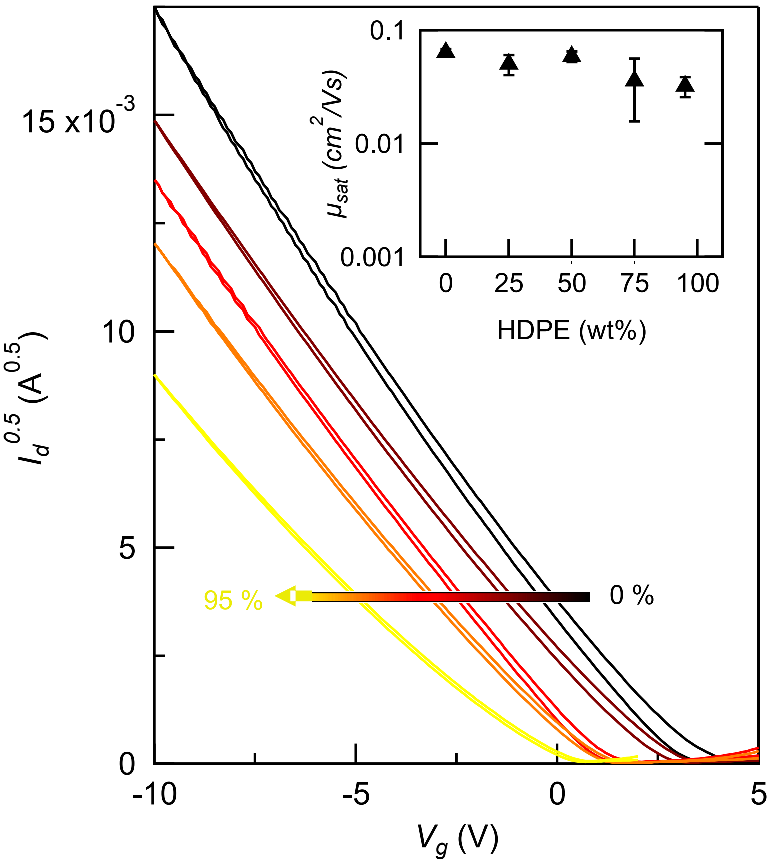

Figure S 2: Square root of the current as a function of $V_g$ for DPP-TT-T:HDPE blend devices. The HDPE content (0 wt%, 25 wt%, 50 wt%, 75 wt%, 95 wt%) is indicated with an arrow and a colour scale. Corresponding hole mobility (extracted in saturation regime) as a function of HDPE content is shown in the inset.

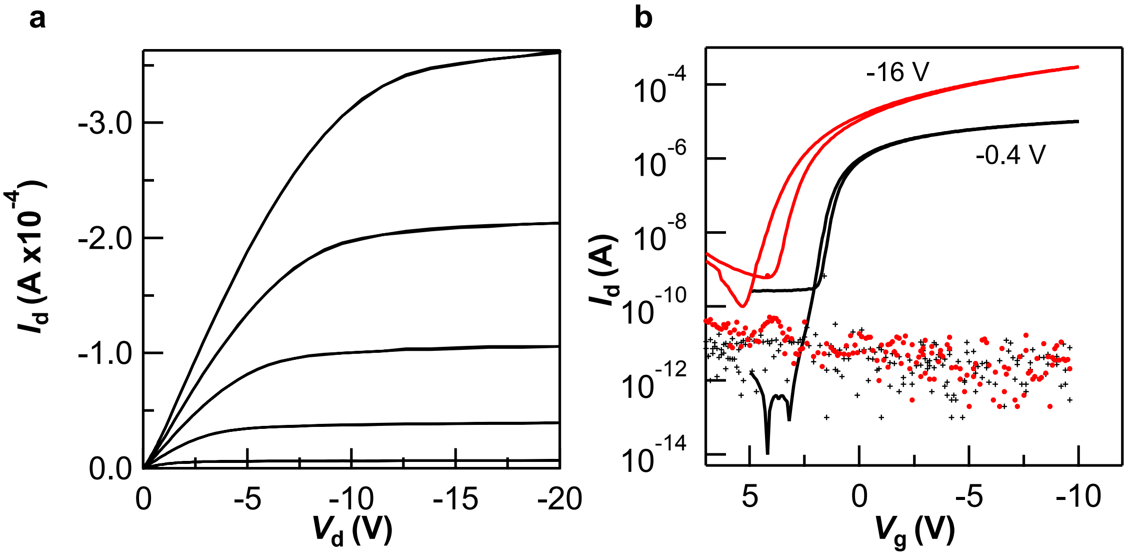

Figure S 3. Representative a) output and b) transfer characteristics of a neat DPP-TT-T bottom-gate/bottom-contact device with a $SiO_2$ dielectric (thickness = 90 nm, channel length $L$ = 5 µm, channel width $W$ = 1000 µm). The $V_g$ applied in the output characteristics ranges from +1 to -11 V with a $\Delta V_g$ = 3V. The $V_d$ applied in the transfer scan is -0.4 V in the linear and -16 V in the saturation regime.

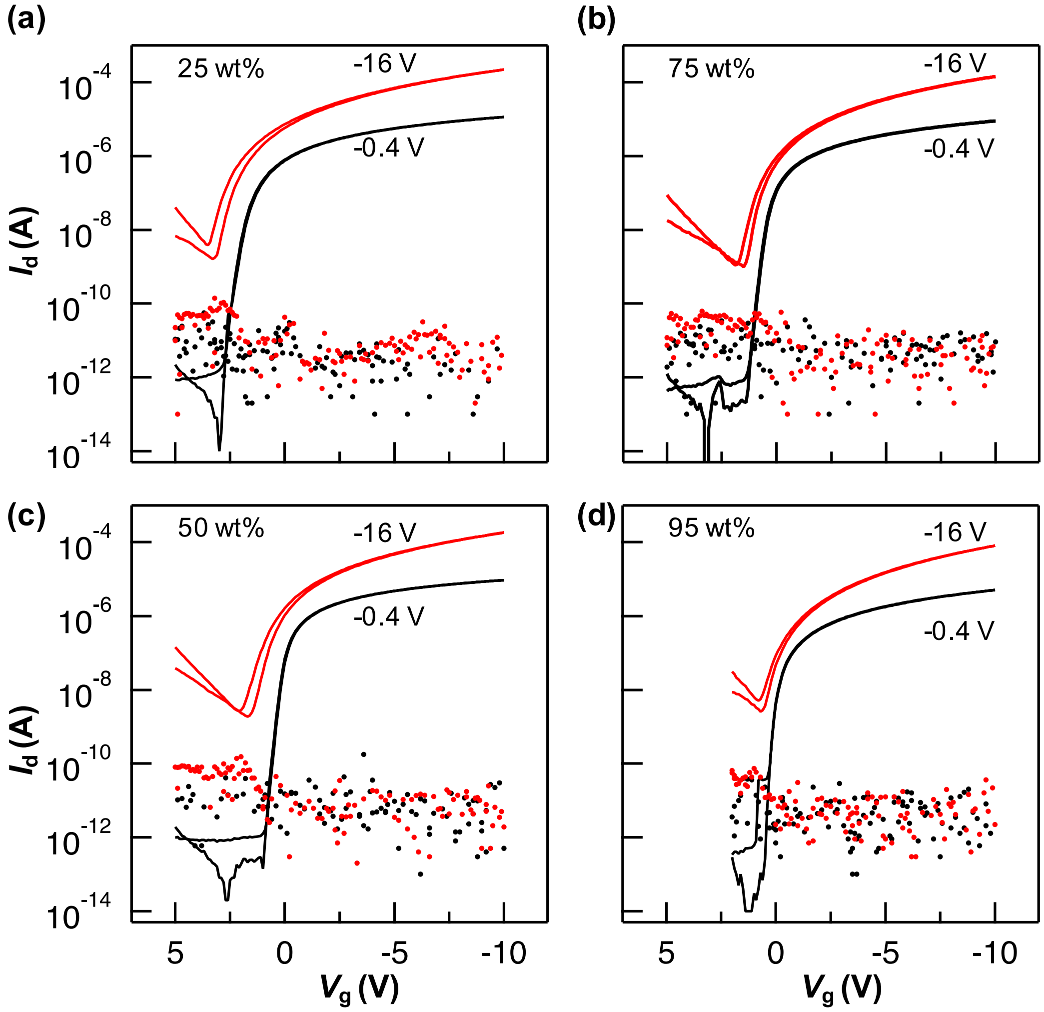

Figure S 4. Representative transfer characteristics of a bottom-gate/bottom-contact device made with a 1:1 DPP-TT-T:HDPE blend with $SiO_2$ dielectric (thickness = 90 nm, channel length $L$ = 5 µm, channel width $W$ = 1000 µm). The HDPE content (weight fraction) is indicated in the top left of each panel. The $V_d$ applied in the transfer scan is -0.4 V in the linear and -16 V in the saturation regime. The dotted lines show the gate current.

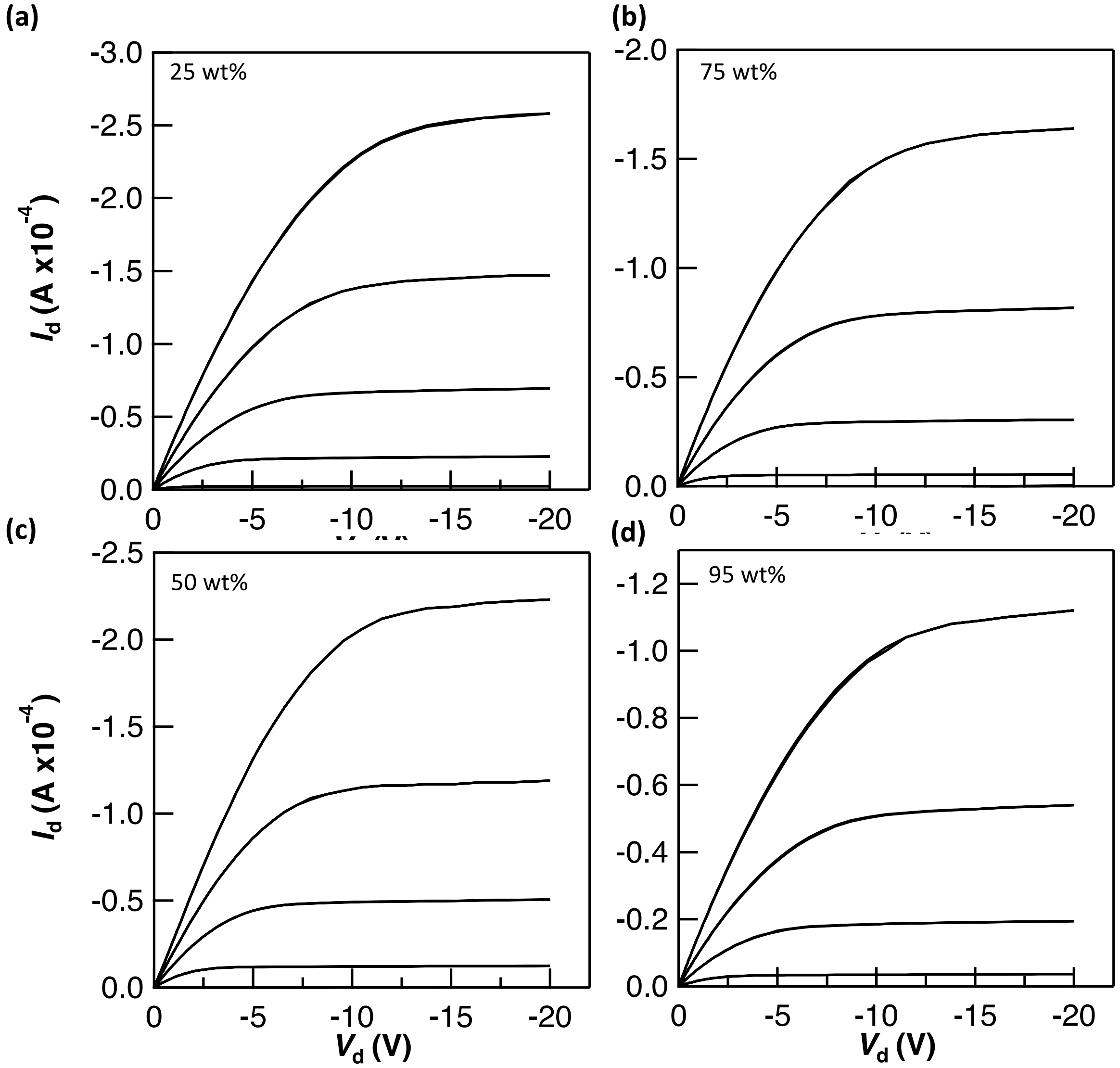

Figure S 5. Representative output characteristics of a bottom gate/bottom-contact device made with a 1:1 DPP-TT-T:HDPE blend with a SiO$_2$ dielectric (thickness = 90 nm, channel length $L$ = 5 µm, channel width $W$ = 1000 µm). The HDPE content (weight fraction) is indicated in the top left of each panel. The $V_g$ applied in the output scan ranges from +1 to -11 V with a $\Delta V_g$ = 3V.

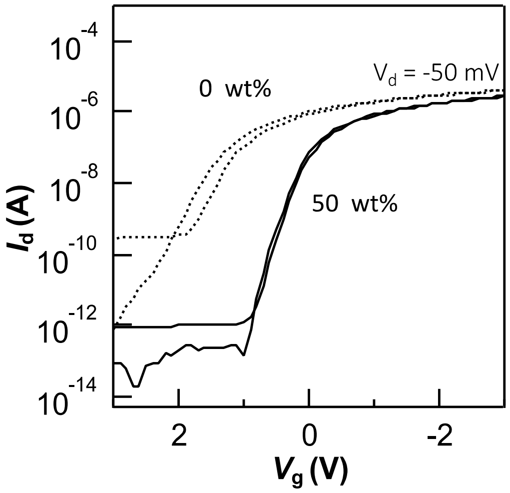

Figure S 6: Representative transfer characteristics of a bottom-gate/bottom-contact devices made with, respectively, neat DPP-TT-T (dashed line) and a 1:1 DPP-TT-T:HDPE blend (solid line), with a $SiO_2$ dielectric (thickness = 90 nm, channel length $L$ = 5 µm, channel width $W$ = 1000 µm) operated at a $V_d$ = -50 mV with a $V_g$ sweep between 2.5 and -2.5 V.

Device parameters were extracted within the gradual channel approximation. In saturation regime the current voltage relationship is described by equation 1:

$$I_{Dsat} = \frac{WC_{diel}\mu_{sat}}{2L}(V_G - V_{th})^2 \quad (1)$$

Where $W$ is the channel width, $L$ is the channel length, $C_{diel}$ is the dielectric capacitance.

The saturation mobility can consequently be deduced from equation 2.

$$\mu_{sat} = \frac{2L}{WC_{diel}} \frac{\partial^2 I_d}{\partial V_g^2} \quad (2)$$

The saturation mobility can be extracted from the slope of $I_d^{0.5}$ ($V_g$), while $V_{th}$ can be extracted from the intercept of the current with $V_g$. The model predicts a linear dependency of the square root of $I_d$ with $V_g$, in saturation regime, hence no ambiguity for parameters extraction occurs for perfectly ideal devices. On the other hand, in most organic based transistors there is a deviation from linearity of $I_d$. In our N2200 devices, the slope of $I_d^{0.5}$ ($V_g$) tends to increase supralinearly. Therefore, the $\mu_{sat}$ is not constant upon increasing the gate voltage, but it will increase upon increasing $V_g$. Similarly, the extracted value for $V_{th}$ depends on the $V_g$ interval over which the fit is performed. The values reported for our N2200 and N2200:HDPE devices are extracted at high gate voltage, between 55 and 60 V. Blend devices show a higher charge transport anisotropy that is accompanied by a stronger $V_g$ dependence of $I_d^{0.5}$, which renders the extraction of fit parameters less accurate.

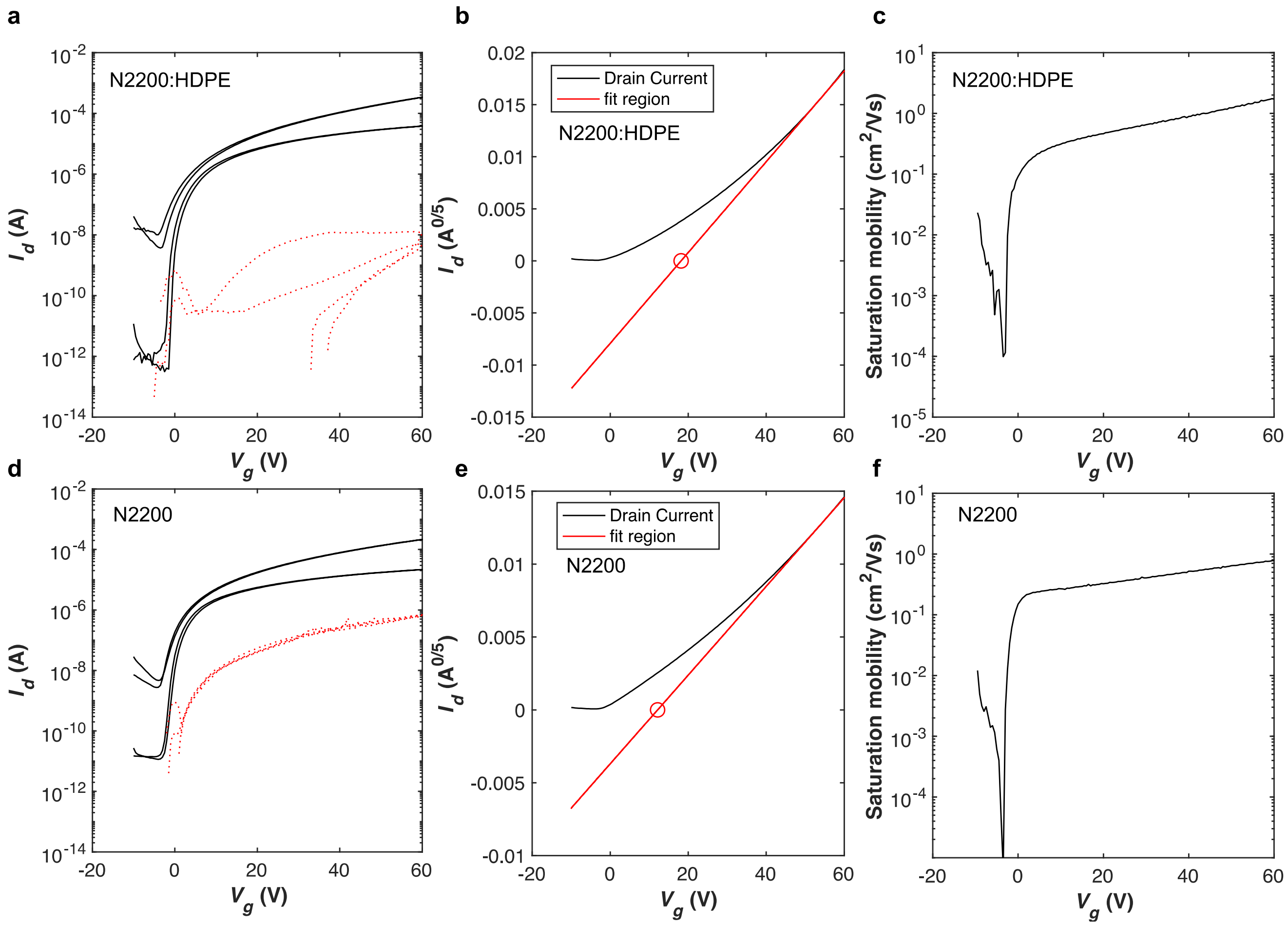

Figure S 7: (a,d), Top-gate bottom-contact transfer characteristics measured for an 1:1 N2200:HDPE blend and neat N2200 devices. (b,e) Square root of $I_d$ as a function of $V_g$, showing also the fit used for the $V_{th}$ extraction, represented with a red circle. (c,f) Saturation mobility as a function of $V_g$ as measured for the two systems (neat *vs.* blend).

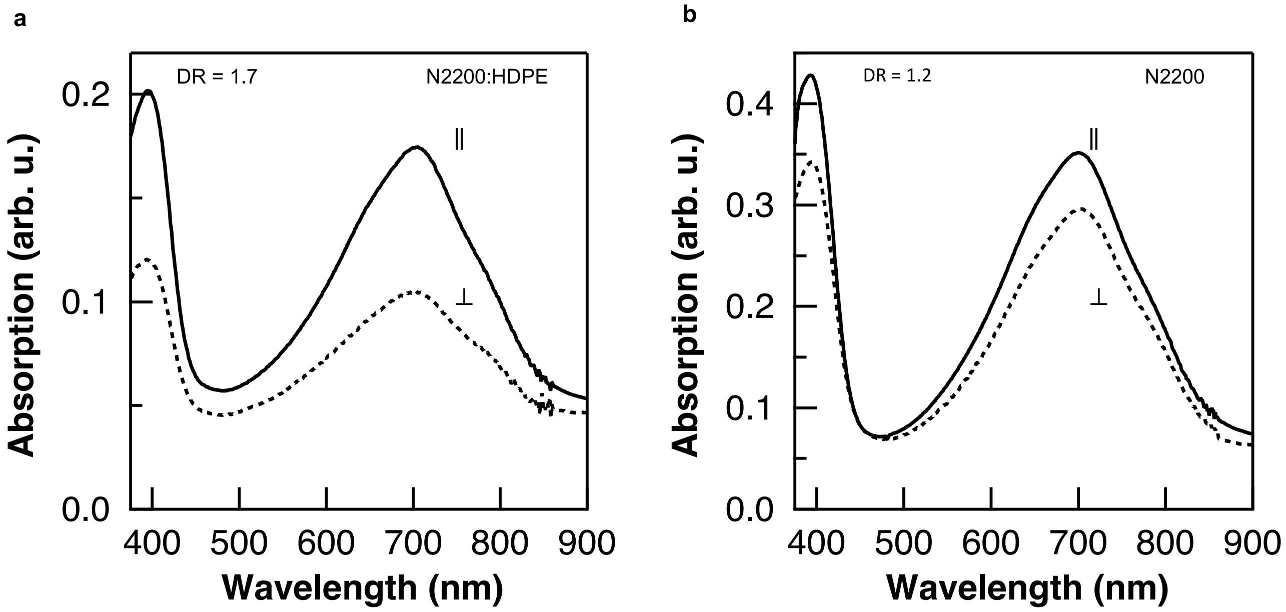

Figure S 8: Polarized absorption spectra of a) 1:1 N2200:HDPE and b) N2200 thin films measured with polarization perpendicular (dashed) and parallel (solid line) to the coating direction.

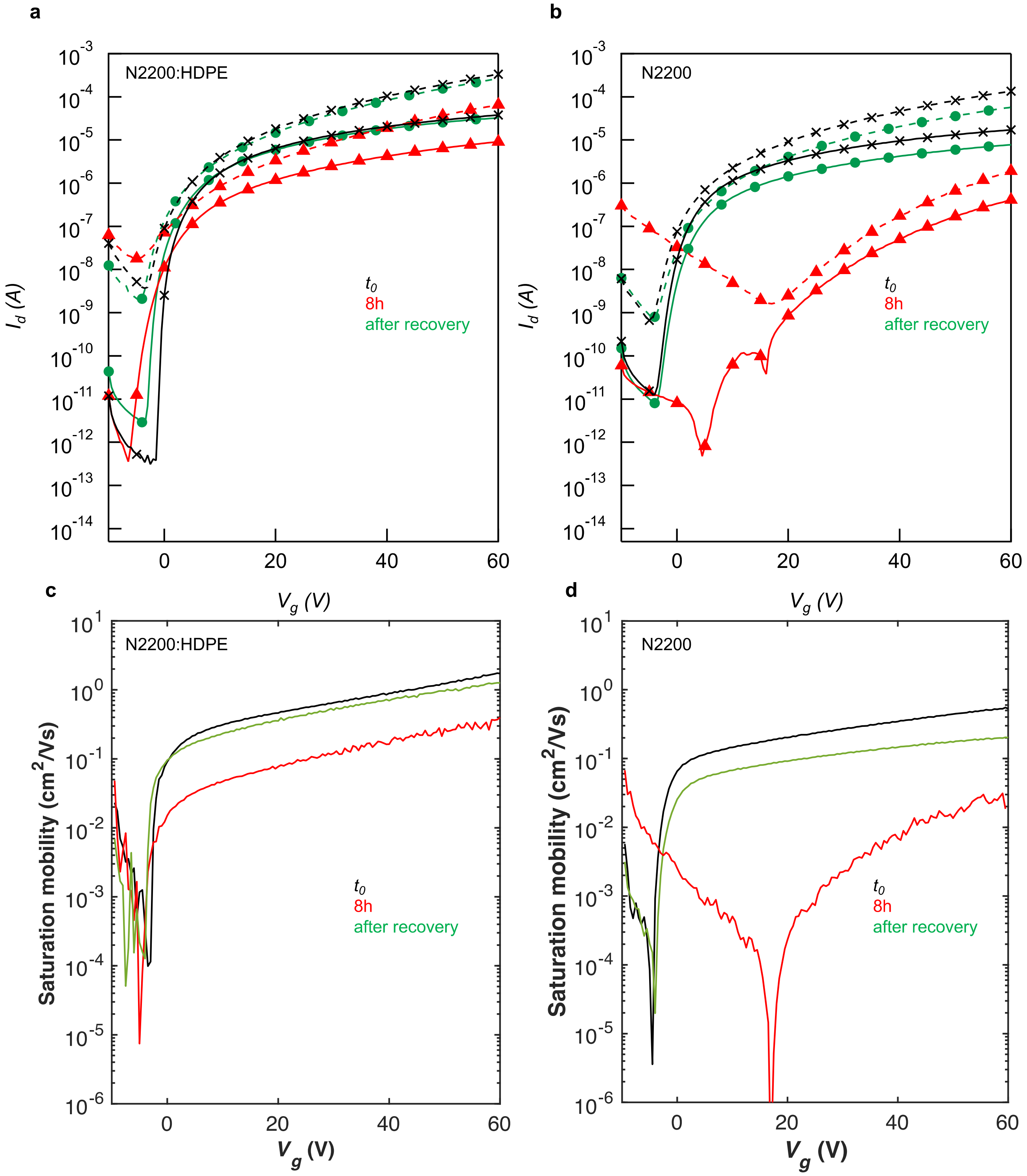

Figure S 9: Transfer characteristics of OTFTs made with a) an 1:1 N2200:HDPE blend and b) neat N2200 upon exposure to ambient conditions. $V_d$ = -5 V (linear regime) is shown with a solid line; $V_d$ = -60 V (saturation regime) is shown with a dashed line. The initial measurement, labelled as $t_0$, is shown using black crosses; the final measurement after 8 h of exposures is shown with red, square symbols. The same device after annealing in a glovebox at 100 ˚C is given with green, circle symbols and is labelled as “after recovery”. Corresponding saturation mobilities as a function of $V_g$ for c) 1:1 N2200:HDPE and d) N2200 devices.

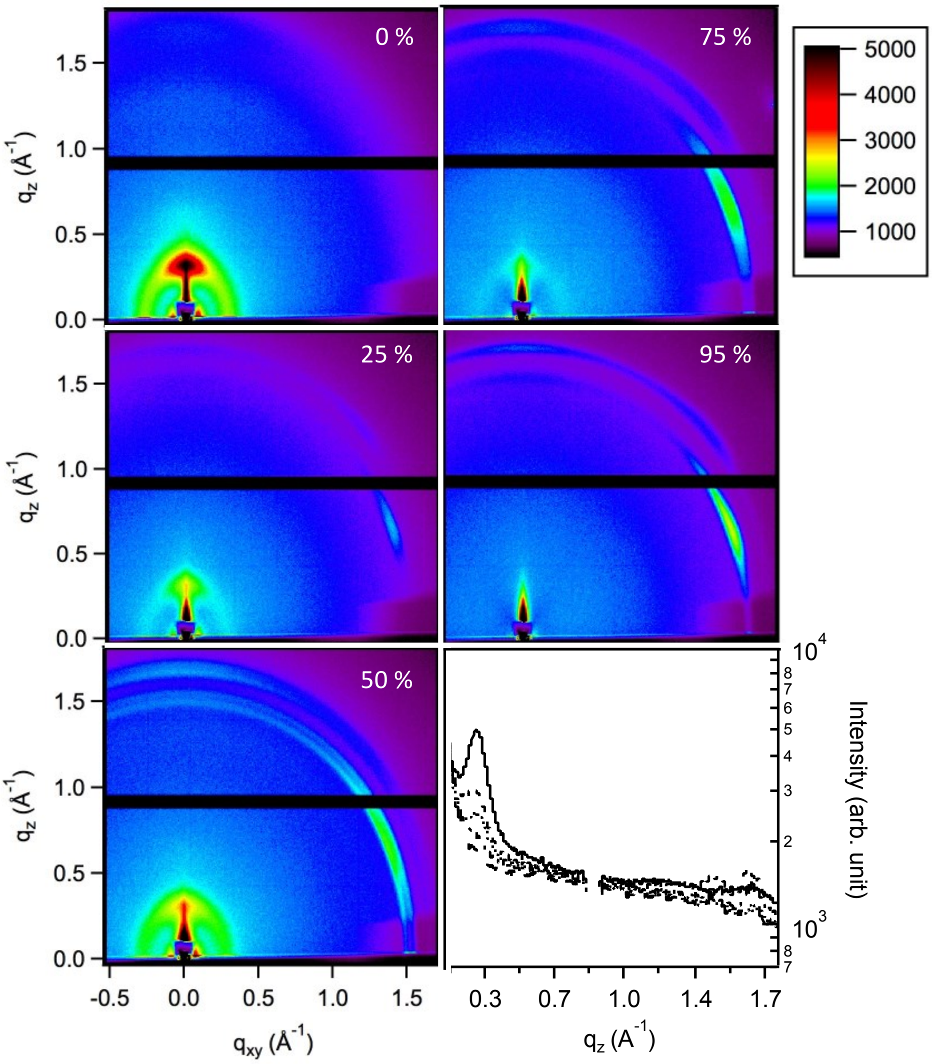

Figure S 10: Two-dimensional GIWAXS of DPP-TT-T:HDPE blends. The polyethylene content is indicated in the top right. Out-of-plane scattering integration is displayed in the bottom right panel.