Electronic Supplementary Information

Effect of Donor Units in Methylated DPP-Based Polymers on Performance of Organic Field-Effect Transistors

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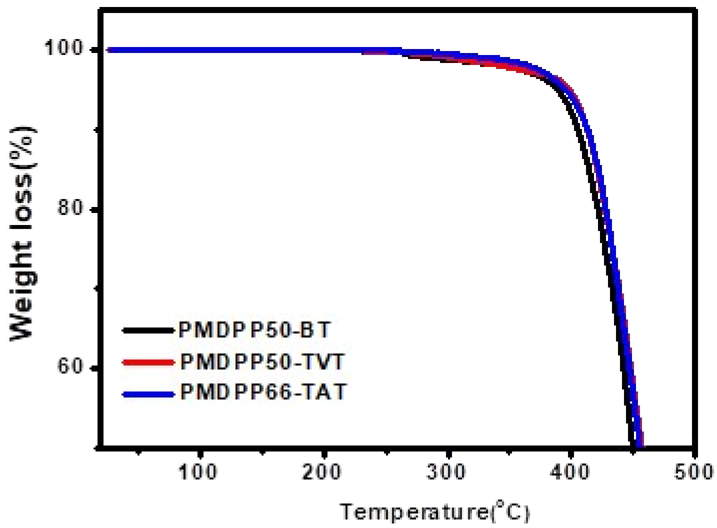


Fig. S1 The TGA of the synthesized polymers.

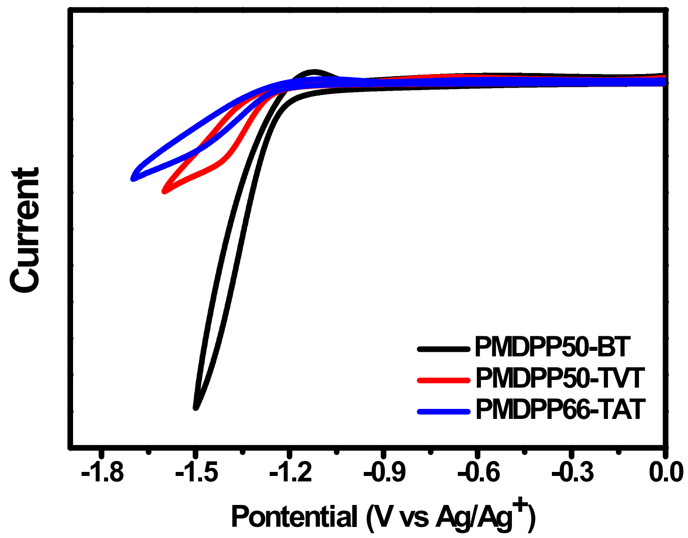


Fig. S2 Cyclic voltammograms of the polymers (reduction part).

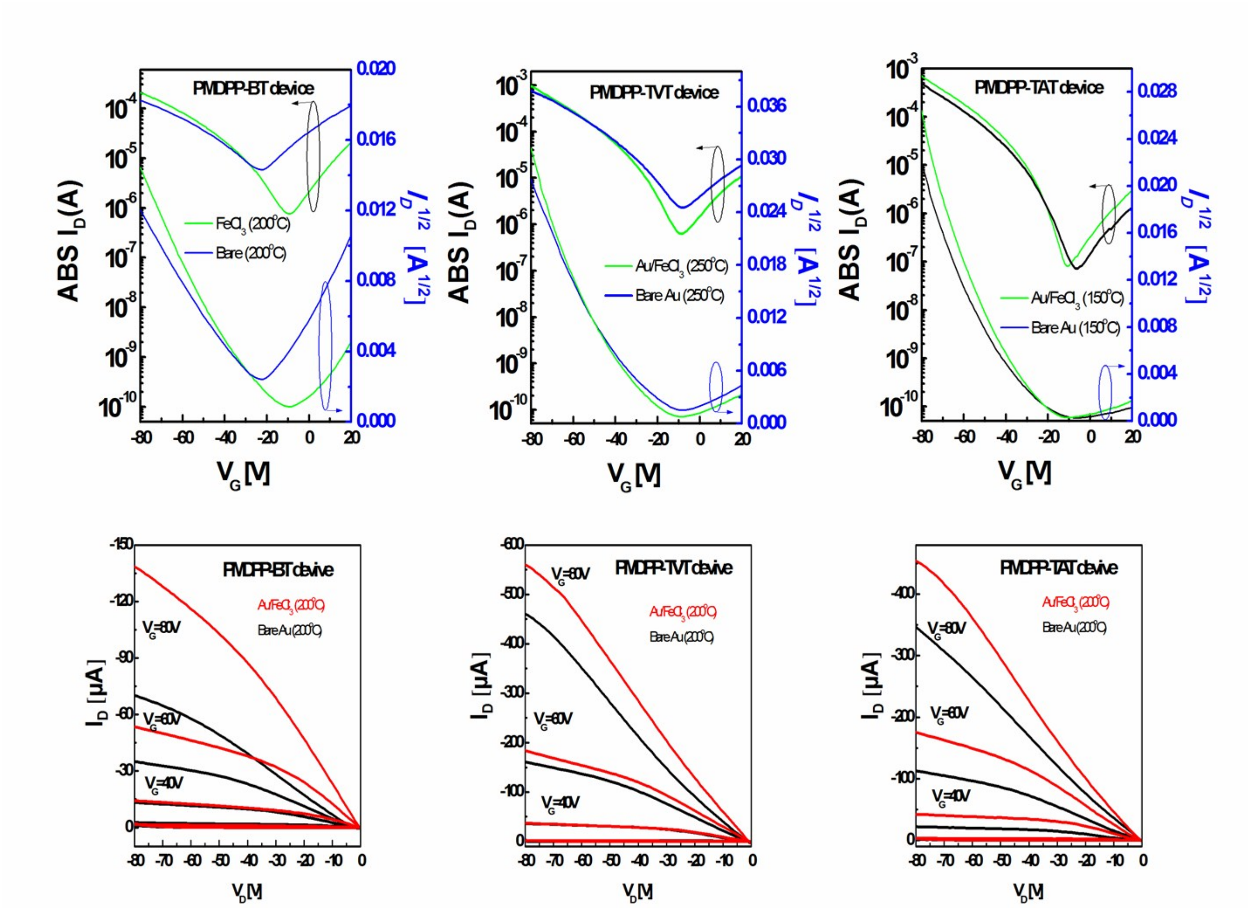


Fig. S3 The transfer and output characteristics of the OFETs based on PMDPP- BT, PMDPP-TVT, and PMDPP-TAT with and without the $FeCl_3$ interlayer at their optimized thermal annealing temperatures.

Table S1 Solid-state packing parameters for the polymer thin films.

Polymer	Annealing Temperature (°C)	Lamellar Stacking		π-π Stacking		FWHM (°)
		q ($Å^{-1}$)	d (Å)	q (Å)	d (Å)	
PMDPP50-BT	200	0.2413	26.03	1.689	3.72	30
PMDPP50-TVT	250	0.2591	24.25	1.759	3.57	17.4
PMDPP66-TAT	150	0.2254	27.87	1.740	3.61	17.4

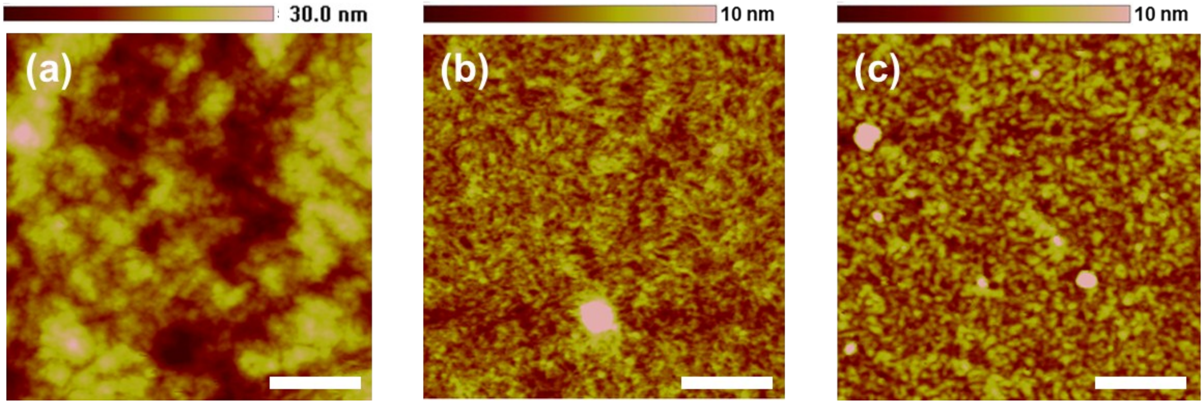


Fig. S4 AFM height images of the (a) PMDPP50-BT, (b) PMDPP50-TVT, and c) PMDPP66-TAT films deposited at their optimal annealing temperatures. The scale bar is 500 nm.

The method to evaluate OFET parameters: field-effect mobility, μ, and threshold voltage, V_{th}, is the classical metal-oxide–semiconductor field-effect transistor (MOSFET) model. This method is described for the two extreme modes of operation above threshold, $|V_{GS}|>V_{th}|$, in equations (1) and (2). For linear mode, $|V_{DS}|<|V_{GS}-V_{th}|$,

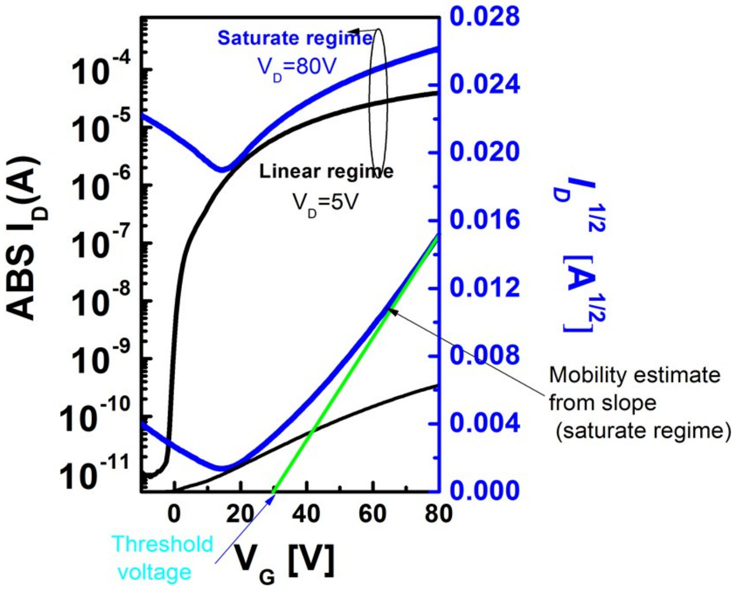
$$I_D = \mu_{lin} c_{ox} \frac{W}{L} \left[(V_{GS} - V_{th}) V_{DS} - \frac{V_{DS}^2}{2} \right], \qquad (1)$$

and for saturation mode $|V_{DS}|>|V_{GS}-V_{th}|$,

$$I_D = \mu_{sat} c_{ox} \frac{W}{2L} (V_{GS} - V_{th})^2, \qquad (2)$$

where V_{GS} is the gate voltage, V_{th} is the threshold voltage, I_D is the drain current, V_{DS} is the drain voltage, μ_{lin} and μ_{sat} are the linear and saturation mobility, respectively, W and L are the width and length of the transistor channel and c_{ox} is the capacitance per unit area.

I_D shows an abrupt change in slope as a function of V_{GS}, I_D ($I_D^{1/2}$) is linear with V_{GS} in the linear (saturation) regime as defined in equations (1) and (2). This slope is used to calculate mobility and extrapolate the threshold voltage.



Y-function method (YFM): Y-function method (YFM) is considered as a fast and precise alternative method for obtaining Rc comparing with the traditional transmission line method (TLM). From the transfer characteristics of the OFETs, I_d in the linear regime can be described as in following equation:

$$I_d = \frac{W}{L} C_i (V_g - V_{Th}) \frac{\mu_0}{1+\theta(V_g - V_{Th})} \times V_d \tag{1}$$

where C_i is the dielectric capacitance per unit area, and μ_o is the low-field mobility. θ is the mobility attenuation factor, which consists of the extrinsic factors caused by the surface roughness and phonon scattering (θ_o) and contact resistance [$\theta^* = (W/L)\mu_o C_i R_c$]. Assuming a constant R_c, the transconductance (g_m) can be expressed as

$$g_m = \frac{\delta I_d}{\delta V_g} = \frac{W}{L} C_i \frac{\mu_0}{[1+\theta(V_g - V_{Th})]^2} \times V_d \tag{2}$$

θ can be obtained by plotting $1/g_m^{1/2}$ versus V_g at a strong charge accumulation, where a linear behavior is obtained. Assuming that θ_o is negligible, R_c can be calculated, as summarized in Table. Note that the negative value of θ, is presumably due to the gate-field enhanced mobility, which is compensated for by the conventional mobility attenuation.