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

Supplementary Information

Manipulating the ambipolar characteristics of pentacene-based field-effect transistors

Liang-Yun Chiu,[a] Horng-Long Cheng,*[a] Hsin-Yuan Wan,[a] Wei-Yang Chou[a] and Fu-Ching Tang[b]

[a] *Department of Photonics, Advanced Optoelectronic Technology Center, National Cheng Kung University, Tainan 701, Taiwan*

[b] *Department of Physics, National Cheng Kung University, Tainan 701, Taiwan*

Corresponding Author

*E-mail: shlcheng@mail.ncku.edu.tw

1. Surface properties of gate dielectrics

Table S1. Properties of polymer buffer layers on silicon dioxide (SiO_2) gate dielectric and the corresponding interfacial tension (R_{12})

Gate dielectric or buffer	Thickness (nm)	Surface energy γ^{da} (mJ/m^2)	Surface energy γ^{pa} (mJ/m^2)	Surface energy γ (mJ/m^2)	Surface roughness (Å)	R_{12} (mJ/m^2)
SiO_2	400	23.0	32.6	55.6	17.0	21.66
PVDF	42	30.4	15.7	46.1	19.1	6.16
PVNP	49	40.9	9.0	49.9	3.4	2.03
h-PMMA	426	33.3	8.1	41.4	2.7	1.80
PS	55	42.3	0.3	42.6	4.9	1.17
t-PMMA	188	33.7	6.1	39.7	3.8	0.95
d-PMMA	52	35.6	5.8	41.4	5.4	0.72
ls-PMMA	113	36.2	5.6	41.8	3.8	0.65
hs-PMMA	44	36.3	4.4	40.7	6.7	0.31
s-PMMA	63	36.8	3.7	40.5	4.0	0.14

[a] γ^d and γ^p denoted as the dispersion and polar force components of surface free energy, respectively.

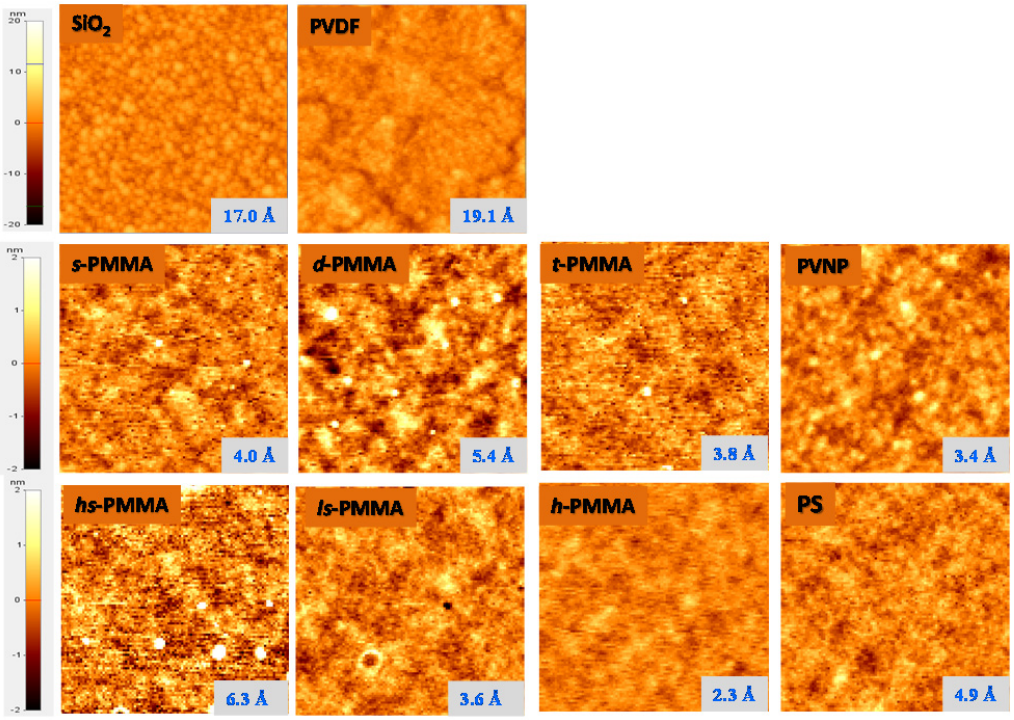

Fig. S1 AFM images (2 μm x 2 μm) of SiO_2 and various polymer buffer layers. The root-mean-square roughness is also shown.

2. XRD and AFM analysis of other pentacene films

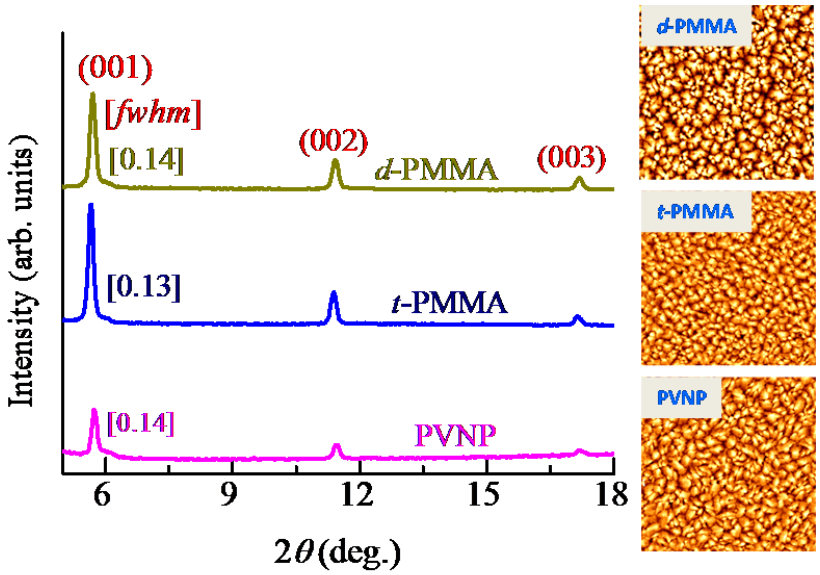

Fig. S2 XRD pattern of the pentacene films (thickness of ca. 60 nm) on various surface-modified dielectrics. Note: the full width at half maximum (FWHM) of the (001) diffraction peak was also indicated. Inset: AFM images (5 μm x 5μm) of the pentacene films with a thickness of ca. 10 nm.

3. Electrical characteristics of pentacene FETs and its complementary-like inverter

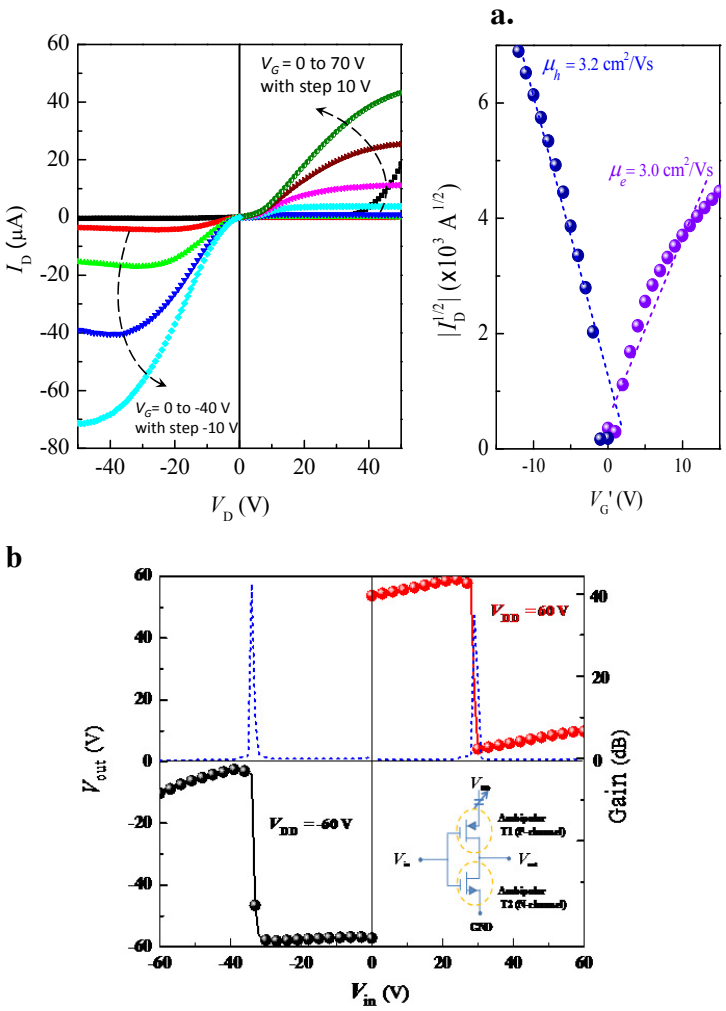

Fig. S3 (a) *p*-Channel and *n*-channel electrical characteristics of pentacene FETs with *s*-PMMA surface-modified gate dielectrics. Left panel: output characteristics; Right panel: transfer characteristics. I_D: drain current, V_D: source-to-drain bias, V_G: gate bias, and V_G': effective gate bias. (b) Transfer characteristics of complementary-like inverters based on two identical ambipolar pentacene FETs with *s*-PMMA surface modification. Depending on the polarity of the supply voltage V_{DD}, the inverter works in the first or the third quadrant. Top left and right (dashed lines): the corresponding signal gains. Inset bottom right: Schematic circuit configuration of a complementary-like inverter.

4. Raman spectra

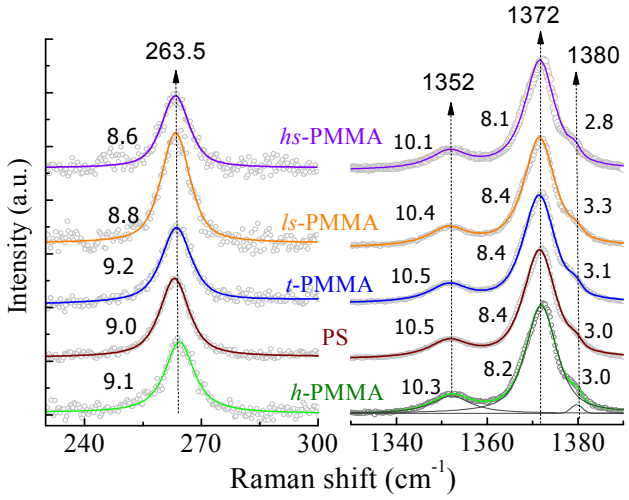

Fig. S4 Raman spectra (λ_{exc} = 633 nm) of the pentacene films (thickness of ca. 10 nm) grown on various dielectric surfaces. The spectra were normalized to the intensity of the 1371 cm^{-1} band. The intensities of all spectra in left panel were enlarged ten times. The Gaussian/Lorentzian functions used for the deconvolution are presented by a thin solid line. The thick solid lines represent the overall fit, while the open cycles to the experimental data. The dashed lines serve as guidelines. Full width at half maximum (*fwhm*) of the selected bands are also shown.