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

Supporting Information

Pentacene/non-fullerene acceptor heterojunction type phototransistors for broadened spectral photoresponsivity and ultralow level light detection

Keli Shi,*[a] Risheng Jin,[a] Shihua Huang,*[a] Hongwei Lei,[d] Pei Dai,[d] Dan Chi,[a] Weifeng Zhang,*[b] and Gui Yu*[b,c]

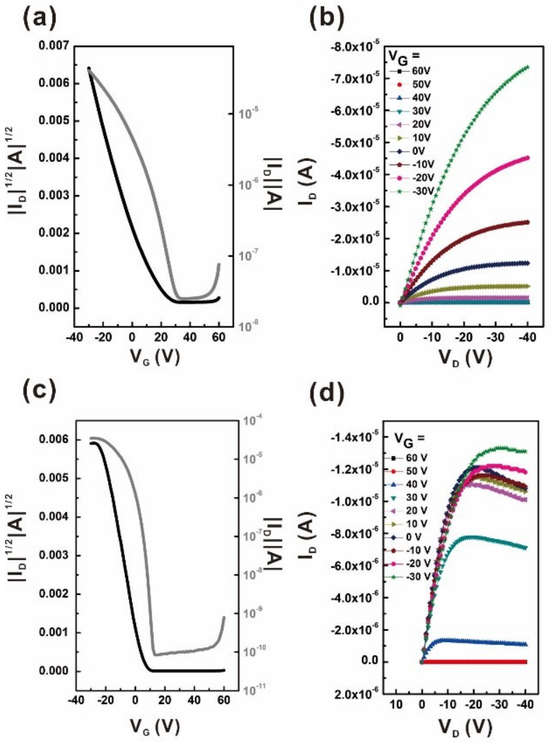

Fig. S1 Typical transfer and output characteristics of the two OFETs (a, b) based on pure pentacene film and (c, d) based on ITIC/pentacene heterojunction.

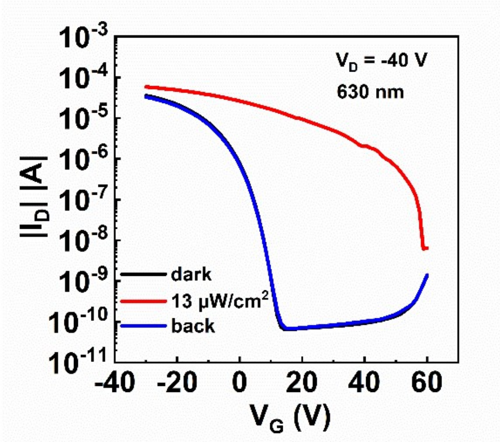

Fig. S2 Transfer characteristic curves of the ITIC/pentacene-based phototransistors in dark, under illumination and back in the dark after illumination.

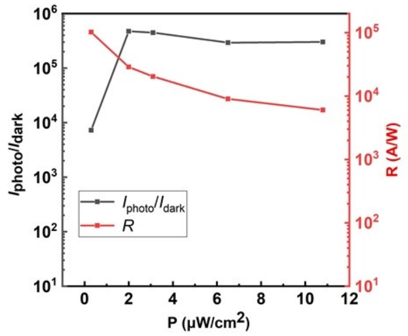

Fig. S3 I_{photo}/I_{dark} ratio (Vg = 13.2 V) and R (Vg = -9.6 V) of the phototransistors based on ITIC/pentacene heterojunction under various illumination power intensities at 630 nm.

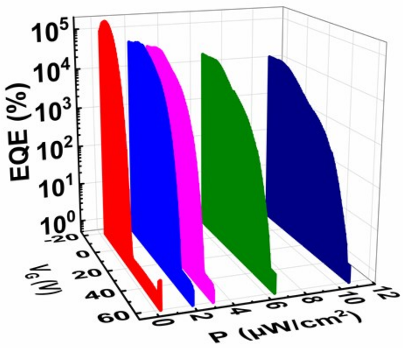

Fig. S4 *EQE* of the phototransistors based on ITIC/pentacene heterojunction as a function of V_G under different illumination intensities at 630 nm.

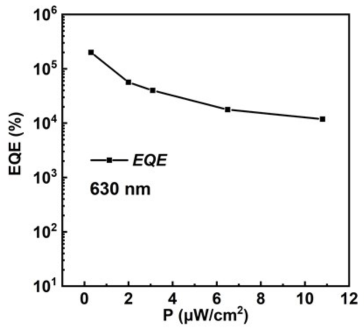

Fig. S5 *EQE* of the phototransistors based on ITIC/pentacene heterojunction under various illumination power intensities at 630 nm.

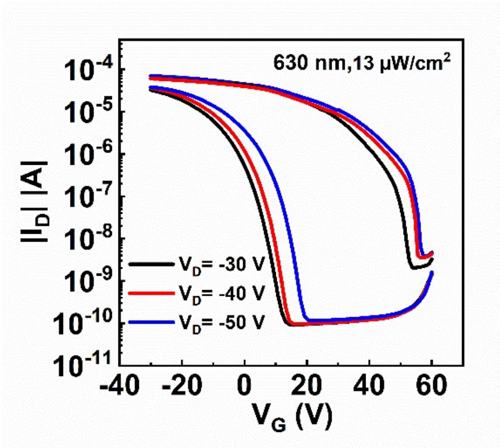

Fig. S6 Transfer characteristics of the phototransistors based on ITIC/pentacene heterojunction under different drain voltage.

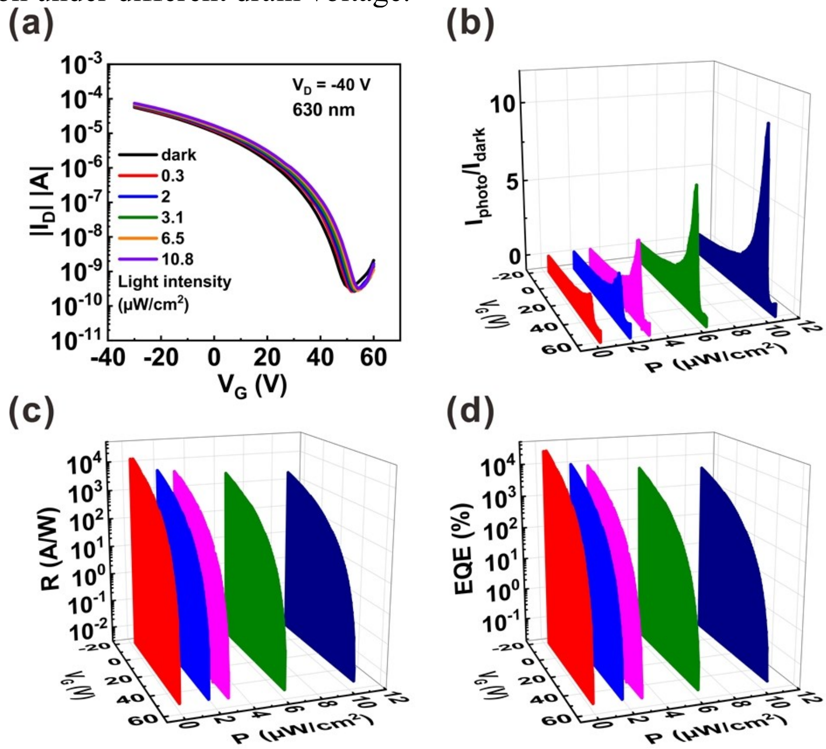

Fig. S7 (a) Transfer characteristics of the phototransistors based on pentacene under different illumination intensities at 630 nm. (b) I_{photo}/I_{dark} ratio, (c) R and (d) EQE of the phototransistors based on pentacene under different illumination intensities at 630 nm at different gate voltages.

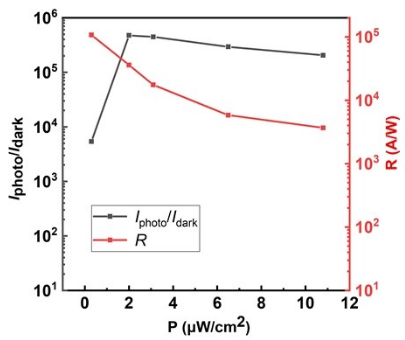

Fig. S8 I_{photo}/I_{dark} ratio (Vg = 13.2 V) and R (Vg = −9.6 V) of the phototransistors based on ITIC/pentacene heterojunction under various illumination power intensities at 750 nm.

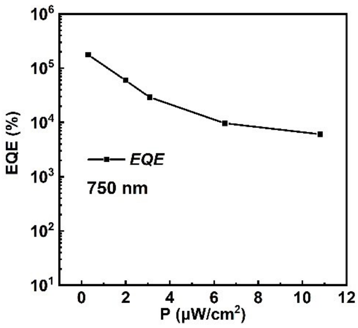

Fig. S9 *EQE* of the phototransistors based on ITIC/pentacene heterojunction under various illumination power intensities at 750 nm.

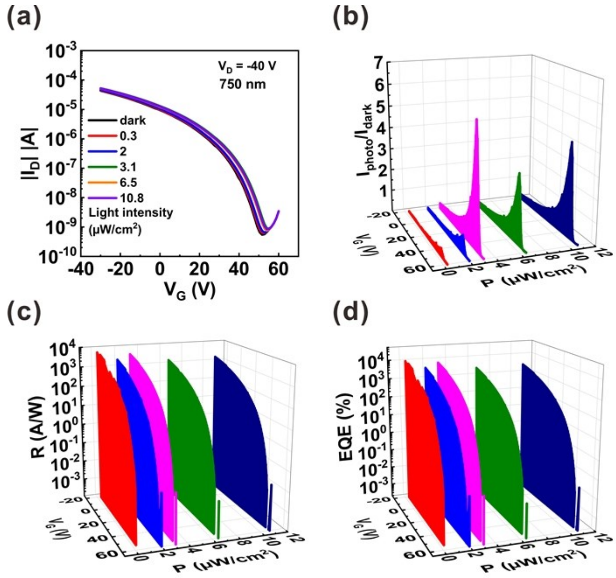

Fig. S10 (a) Transfer characteristics of the phototransistors based on pentacene under different illumination intensities at 750 nm. (b) I_{photo}/I_{dark} ratio, (c) R and (d) *EQE* of the phototransistors based on pentacene under different illumination intensities at 750 nm at different gate voltages.

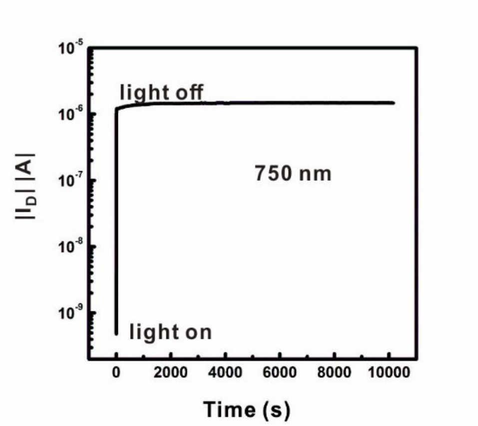

Fig. S11 Retention test of the phototransistor based on ITIC/pentacene bi-layer heterojunction under light illumination of 750 nm (light intensity = 6.5 μW cm^{-2}).

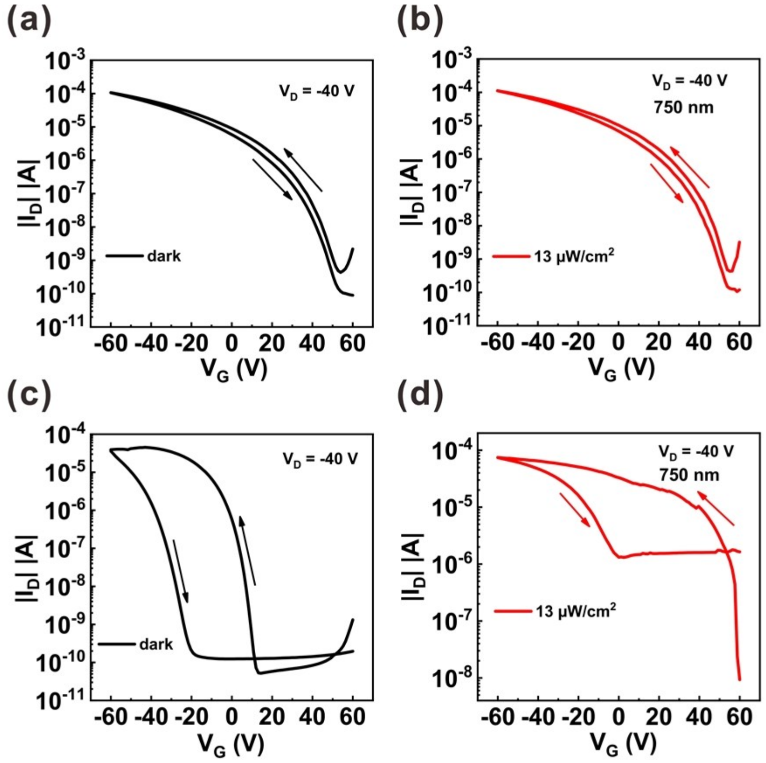

Fig. S12 Double-sweep characteristics for pentacene- (a, b) and pentacene/ITIC-based (c, d) OFETs in the dark and under light illumination of 750 nm.

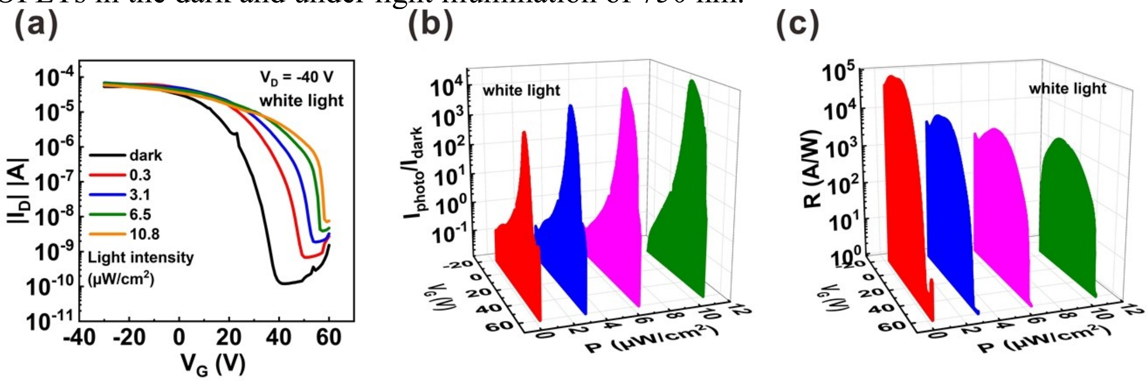

Fig. S13 (a) Transfer characteristics of the phototransistor based on ITIC/pentacene heterojunction under different illumination intensities of white light. (b) $I_{\mathrm{photo}}/I_{\mathrm{dark}}$ ratio and (c) R of the phototransistor based on ITIC/pentacene heterojunction under different illumination intensities at different gate voltages.

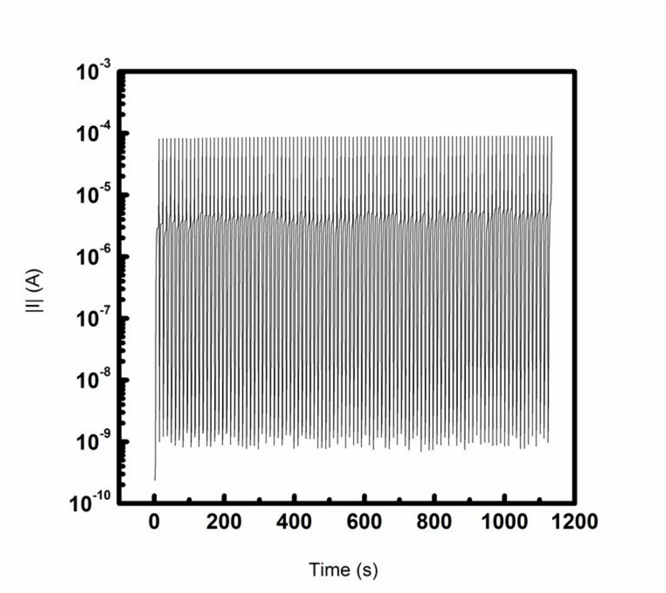

Fig. S14 Photoswitching characteristic of the phototransistor based on ITIC/pentacene heterojunction under alternating ON/OFF cycles under white light illumination (10.8 μW cm^{-2}).

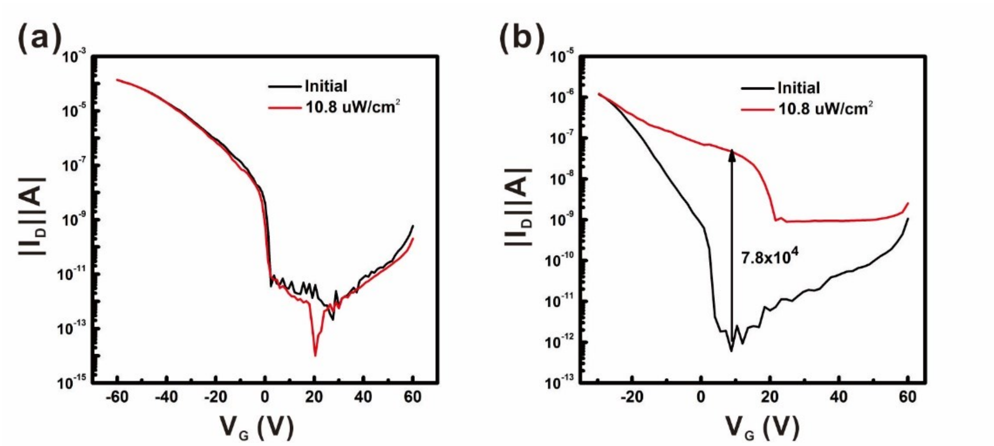

Fig. S15 Photoresponse properties for transistors based on C8-BTBT (a) without (b) and with ITIC under illumination power intensity of 10.8 μm cm^{-2} at a fixed wavelength of 750 nm.

Table S1 Comparison of current work with representative phototransistors based on all-organic heterojunction thin-film phototransistors

Active layer	R_{max} (A/W)	EQE_{max} (%)	$(I_{photo}/I_{dark})_{max}$	Spectral range	Reference
(C8-BTBT: $PC_{61}BM$) BHJ	2.9×10^3	-	9.2×10^4	365 nm	[1]
(P3HT: PCBM) BHJ	0.047	-	-	White light	[2]
(MDMO-PPV: $PC_{61}BM$) BHJ Dual-gate phototransistor	40	~9000	-	543 nm	[3]
(DPP-DTT: PCBM) BHJ	8×10^5	-	1.6×10^4	NIR	[4]
(P3HT: F8BT) BHJ	4.3	-	-	470 nm	[5]
(DPP-DTT: PCBM) BHJ	3.5×10^5	-	-	NIR	[6]
(P3HT: PDPPTTT) BHJ	4.29	-	-	450,555, 795 nm	[7]
(PDPP2T: $PC_{61}BM$) BHJ	1.5×10^3	-	7.5×10^5	808	[8]
C_{60}/AlClPc bi-layer heterojunction	94.4	26066	10^4	450, 650, 808 nm	[9]
CuPc/p-6P bi-layer heterojunction	4.3×10^2	-	2.2×10^4	365 nm	[10]
ITIC/pentacene bi-layer heterojunction	**$\sim 1.0 \times 10^5$**	**$\sim 2 \times 10^5$**	**$\sim 4.7 \times 10^5$**	**365−750 nm**	**In this work**

Table S2 Comparison of the maximum I_{photo}/I_{dark}, R, and EQE values between the ITIC-pentacene-based hybrid phototransistors and the pentacene-based ones under light illumination of 630 nm

Active layer	R_{max} (A/W)	EQE_{max} (%)	$(I_{photo}/I_{dark})_{max}$
ITIC/pentacene bi-layer heterojunction	$\sim 1.0 \times 10^5$	$\sim 2 \times 10^5$	$\sim 4.7 \times 10^5$
pentacene	$\sim 2.3 \times 10^4$	$\sim 4.6 \times 10^4$	~10

Notes and references

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