Supporting Information

Title

Ultrahigh Photosensitive Organic Phototransistors by Photoelectric Dual Control

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Supplementary Figures

Figure S1. Optical extinction spectra of devices doped with different PC$_{61}$BM ratios with Quartz/OTS/FBT-Th$_{4}$(1,4):PC$_{61}$BM (D/A ratio) structure.
**Figure S2.** The transfer characteristic curves of organic phototransistor in dark and under light. (a) FBT-Th$_d$(1,4):PC$_{61}$BM (D/A ratio = 5:1) (180 nm) /Au electrodes), (b) FBT-Th$_d$(1,4) device (Si /SiO$_2$ /OTS /FBT-Th$_d$(1,4):PC$_{61}$BM (D/A ratio = 5:1) (190 nm) /Au electrodes). Here, the weak light were provided by diode pumped crystal laser with a wavelength of 405 nm.

**Figure S3.** (a) the contrastive output characteristic curves of organic phototransistor with Si /SiO$_2$ /OTS /FBT-Th$_d$(1,4) (190 nm) /Au electrodes structure (logogram as the FBT-Th$_d$(1,4) device) in the dark and under weak photo-irradiation (0.0031 mW/cm$^2$ ), (b) the transfer $I-V$ characteristic curves of the FBT-Th$_d$(1,4) device in dark and under different light intensity. The different light intensities were provided by diode pumped crystal laser with a wavelength of 405 nm.
Figure S4. The photodetector parameters of OPT Si/SiO$_2$/OTS/FBT-Th$_4$(1,4)/Au electrodes structure (FBT-Th$_4$(1,4) control device): (a) the responsivity dependent on light intensity under $V_{g} = 0$ V and $V_{d} = -30$ V at 405 nm; (b) the responsivity dependent on gate voltage under 0.0031 mW/cm$^2$; (c) the dependence of the gain and specific detectivity on gate voltage under 0.0031 mW/cm$^2$. Here, the different light intensities were provided by diode pumped crystal laser with a wavelength of 405 nm.
Figure S5. (a) Current-time characteristics for device initialization operation processes (erasing and reading (off-state)) based on $V_d = -30 \, V$, the gate voltages for different steps as marked in figures; (b) the transfer $I-V$ characteristic curves of the FBT-Th$_4$(1,4):PC$_{61}$BM device in dark and under different wavelength light source (0.55 $\mu$W/cm$^2$). (c) the dependence of the responsivity on the wavelength of OPT at $V_g = 0 \, V$ and $V_d = -30 \, V$ under 0.55 $\mu$W/cm$^2$. Here, the different light wavelength was provided by a continuous spectrum light source at 20 Hz (Opolette 355 LD). Before test the transfer $I-V$ characteristic curves under different wavelength light, the current-time characteristics for device initialization operation processes (erasing and reading (off-state)) based on $V_d = -30 \, V$ should be executed as shown in Figure S4a.
Figure S6. Normalized time-current curve of FBT-Th4(1,4):PC61BM device at constant source drain voltage \( V_d = -30 \, V \) under light excitation \((0.0031 \, \text{mW/cm}^2)\). (a) on-state gate voltage (OSGV) \( V_g = -30 \, V \) and off-state gate voltage \( V_g = 30 \, V \); (b) on-state gate voltage (OSGV) \( V_g = 10 \, V \) and off-state gate voltage \( V_g = 30 \, V \). Here, the weak light were provided by diode pumped crystal laser with a wavelength of 405 nm. The on-state-light \((II)\) means the device work in light with \( V_g = 0 \, V \) and \( V_d = -30 \, V \); The off-state-dark \((I)\) means the device work in the dark with \( V_g = 30 \, V \) (or \( 10 \, V \)) and \( V_d = -30 \, V \).

Figure S7. (a) normalized time-current curve and (b) current-time curve of FBT-Th4(1,4) control device at on-state gate voltage (OSGV) \( V_g = -30 \, V \) and off-state gate voltage \( V_g = 30 \, V \) under light excitation \((0.0031 \, \text{mW/cm}^2)\). Here, the weak light were
provided by diode pumped crystal laser with a wavelength of 405 nm. $I$ represents the off-state, $II$ represents the on-state. Synchronous optical programming and gate voltage programming were shown in upper part in Figure S7a,b. The source-drain voltage is maintained at $V_d = -30\ V$ in both $I$ and $II$ process throughout the test.