High-Performance Multilevel Nonvolatile Organic Field-Effect Transistor Memory Based on Multilayer Organic Semiconductor Heterostructures

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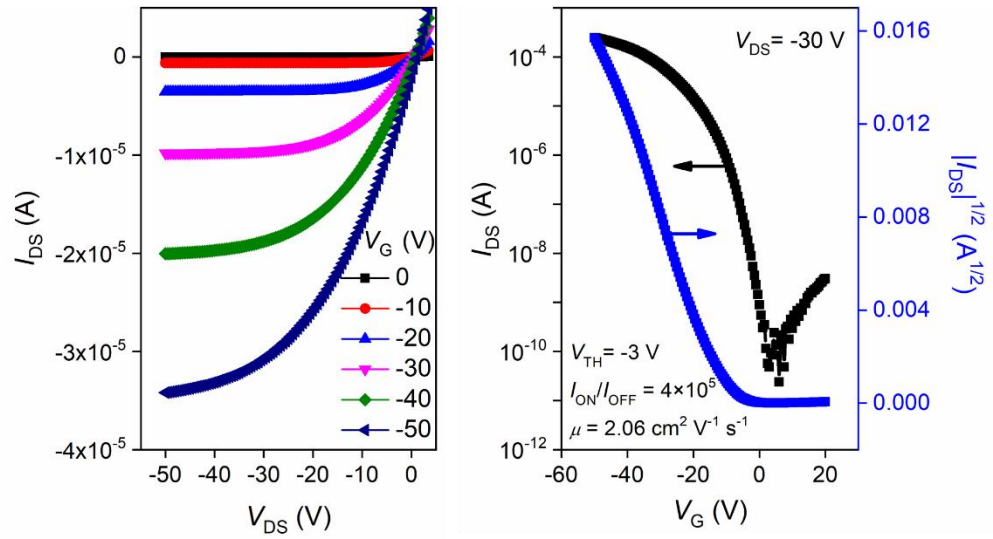

Fig. S1 Transfer and output characteristics of the OHTM.

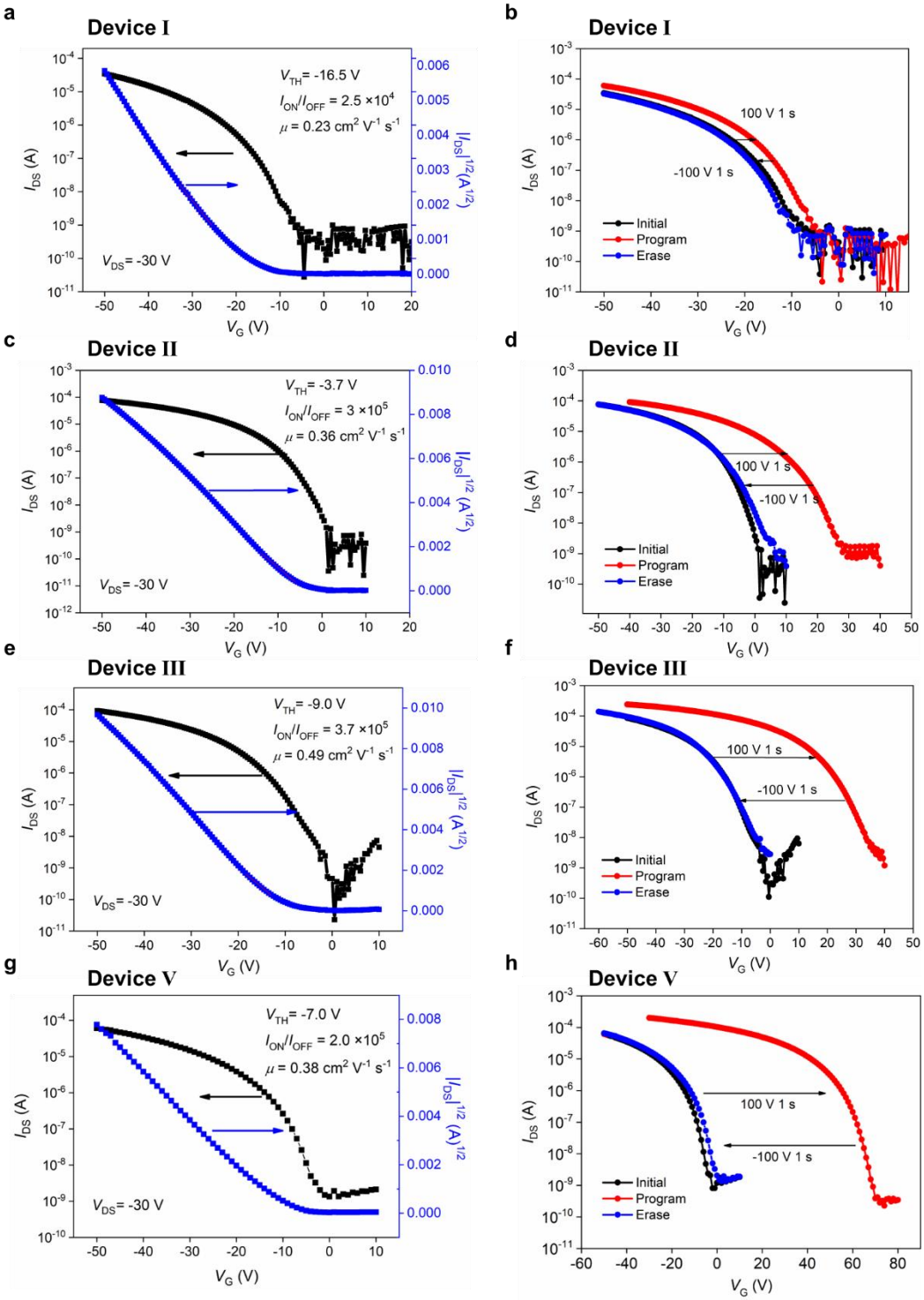

Fig. S2 Transfer characteristics (a) and memory window (b) of Device I: Pentacene (30 nm); transfer characteristics (c) and memory window (d) of Device II: Pentacene (30 nm)/ P13 (3 nm)/ Pentacene (20 nm); transfer characteristics (e) and memory window (f) of Device III: Pentacene (30 nm)/ P13 (6 nm)/ Pentacene (20 nm); transfer characteristics (g) and memory window (h) of Device V: Pentacene (30 nm)/ P13 (3 nm)/ Pentacene (3 nm) / P13 (3 nm)/ Pentacene (3 nm) / P13 (3 nm)/ Pentacene (20 nm).

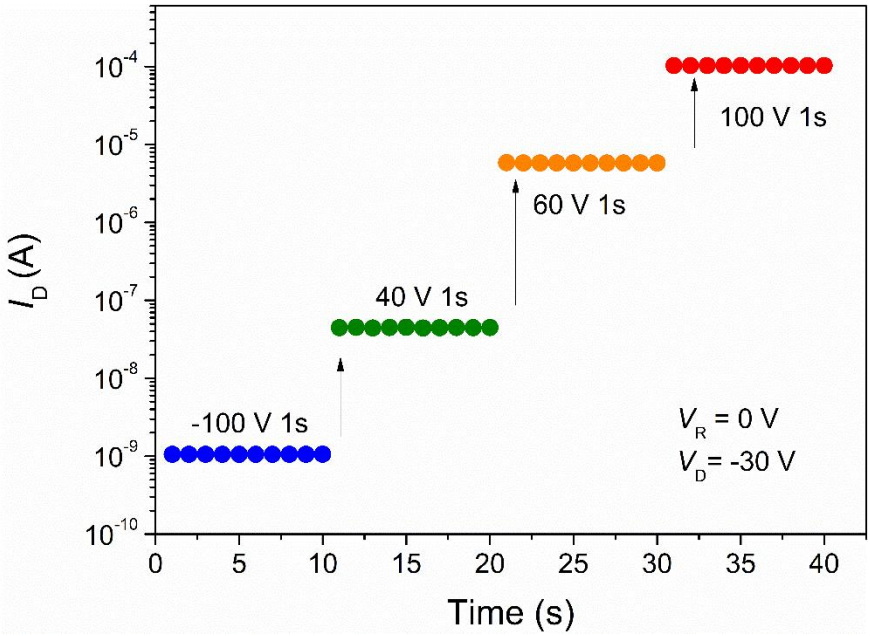

Fig. S3 Corresponding drain current levels of the OHTMs at different programming voltages (40, 60, 100, -100 V) which is read at V_R = 0 V, V_{DS} = -30 V.

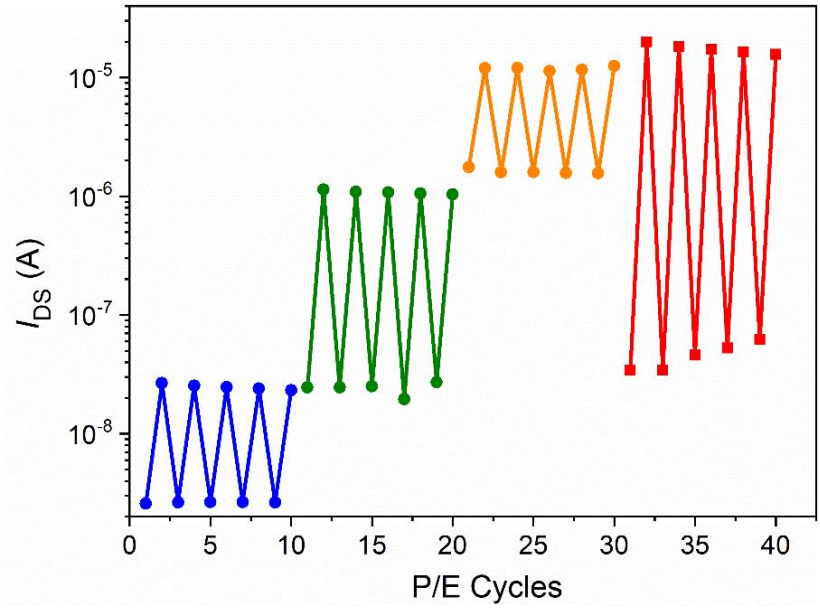

Fig. S4 The dynamic behavior of I_{DS} switching between two states of the OHTMs.

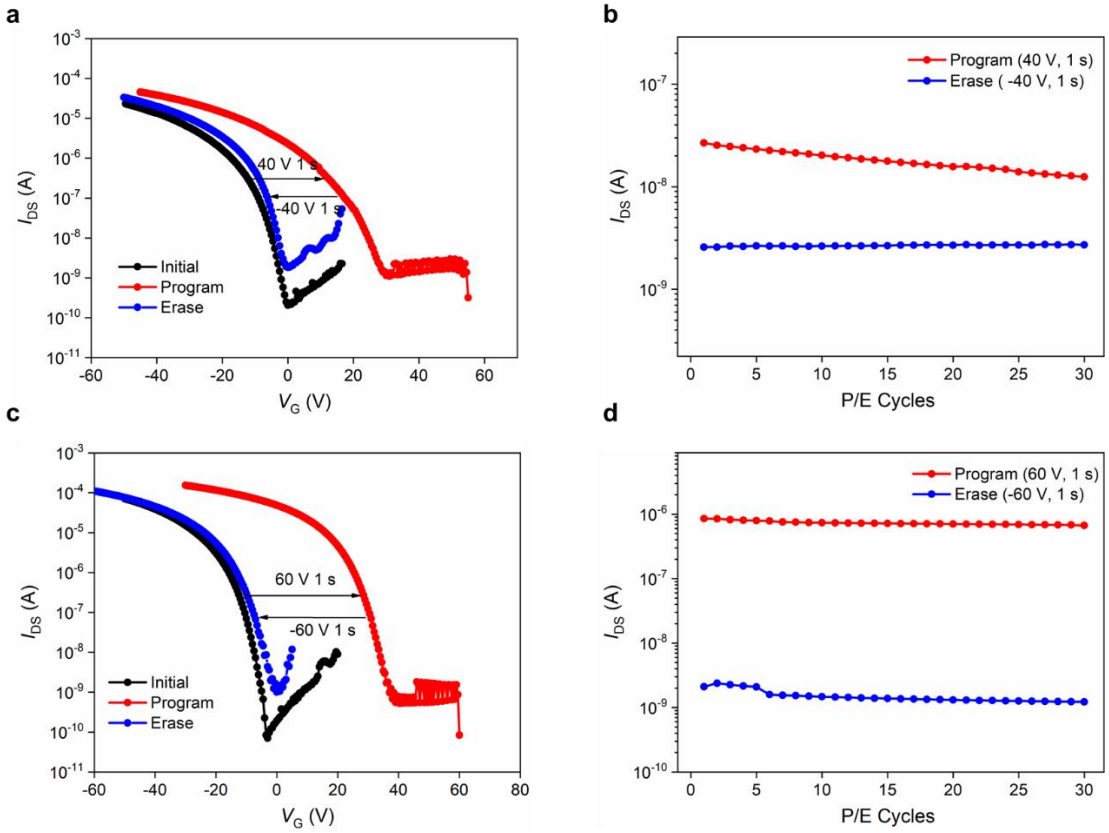

Fig. S5 Transfer characteristics (a) and switching endurance (b) at repeatable V_P/V_E operations (±40 V); transfer characteristics (c) and switching endurance (d) at repeatable V_P/V_E operations (±60 V).

Table S1. Summary of key characteristics of OFET memory in this paper compared with those reported in the literature.

Substrate /Dielectric Type	Organic Semiconductor Material	Proposed Mechanism Type	Charge Storage Elements	Mobility [$cm^2 V^{-1} s^{-1}$]	V_P/V_E [V]	t_P/t_E [s]	Memory Window [V]	Charge Trapping Density [$\times 10^{12}$]	Memory Ratio	P/R/E Cycles	Retention Time	Level	REF
Si/90 nm SiO_2	pen	PE	N2200/PVN	0.14	30/-18	1	30	\	10^5	10^3	10^4	2	[1]
Si/200 nm SiO_2	P(NDI2OD-T2)	FG	PS/P3HT	8.20	±50	5×10^{-3}	9.6	0.6	10^2	500	5×10^3	4	[2]
Glass/CYTOP	DPP-DTT	FG	PS/TIPS-Pentacene	0.3	60/-70	1	13	\	10^5	\	10^5	4	[3]
PEN/PAA:PEG	PCDTFBT	PE	PS	6.78	\	\	\	\	2×10^4	\	\	2	[4]
Al/Al_2O_3	Br_2PTCDI-C_{18}	PE	PVA/PMMA	1.2	±3	sweep	3	\	10^2	\	\	2	[5]
ITO/HfO_2	pen	FG	CuPc/N-C_{60}	1.25×10^{-2}	±5	sweep	4.4	1.8	8.3×10^3	500	10^4	2	[6]
Si/300 nm SiO_2	Rubrene	FG	hBN	15	±4	sweep	\	\	10^7	\	\	2	[7]
PEN/ P(VDFTrFE) /PVT	DNTT	FE	P(VDF-TrFE)	0.07	±200	sweep	190	\	10^3	100	5×10^3	2	[8]
Si/300 nm SiO_2	pen/P13/pen	PE	P13/PVP	0.23	±120	1	63.5	4.36	10^4	3×10^3	10^4	4	[9]
Si/300 nm SiO_2	pen/P13/pen /P13/ pen	PE	P13/PS	2.06	±100	1	80	5.48	10^4	100	10^5	4	This work

Pen represents pentacene.

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