Supplementary Information

Polymer Ferroelectric Field-Effect Memory Device with SnO Channel Layer Exhibits Record Hole Mobility

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Table S1. State of the art on small molecule p-type ferroelectric field effect transistors.

Author	Paper Title	Journal and Year	Dielectric	Semiconductor	Mobility ($cm^2V^{-1}s^{-1}$)
Seok Ju Kang et. al.	Non-volatile Ferroelectric Poly(vinylidenefluoride-co-trifluoroethylene) Memory Based on a Single-Crystalline Tri isopropylsilylethynyl Pentacene Field-Effect Transistor	Adv. Funct. Mater. 2009, 19, 1609–1616	P(VDF-TrFE) with PVP interlayer	Single crystal TIPS pentacene	0.29
C.A. Nguyen et. al.	Enhanced organic ferroelectric field effect transistor characteristics with strained poly(vinylidene fluoride-trifluoroethylene) dielectric	Organic Electronics 9 (2008) 1087–1092	P(VDF-TrFE)-Strained	Pentacene	0.12
Kwang H. Lee et. al.	High-Mobility Nonvolatile Memory Thin-Film Transistors with a Ferroelectric Polymer Interfacing ZnO and Pentacene Channels	Adv. Mater. 2009, 21, 4287–4291	P(VDF-TrFE)-Quenched	Pentacene	0.12
M.A. Khan et. al.	High-Performance Non-Volatile Organic Ferroelectric Memory on Banknotes	Adv. Mater. 2012, 24, 2165–2170	P(VDF-TrFE)	Pentacene	0.12
R.C.G. Naber et. al.	High-performance solution-processed polymer ferroelectric field-effect transistors	Nature Materials, VOL 4, 2005	P(VDF-TrFE)	MEH-PPV	$1.3x10^{-3}$
R.C.G. Naber et. al.	Low-voltage polymer field-effect transistors for nonvolatile memories	Appl. Phys. Lett. 87, 203509 2005	P(VDF-TrFE)	rr-P3HT	$8X10^{-3}$

P-E characteristics of the P(VDF-TrFE) film.

The ferroelectric properties of P(VDF-TrFE) were characterized by measuring a capacitor with similar thickness of the film used in the FeFETs with Au (bottom) and Al (top) electrodes, as used for the source/drain and gate electrodes in our FeFETs respectively. The films were annealed at 130 ˚C for 2 hours identical to our FeFETs. The remnant polarization was measured to be ~ 7.1 μCcm^{-2} and with coercive fields ~ 55 MVm^{-1}.

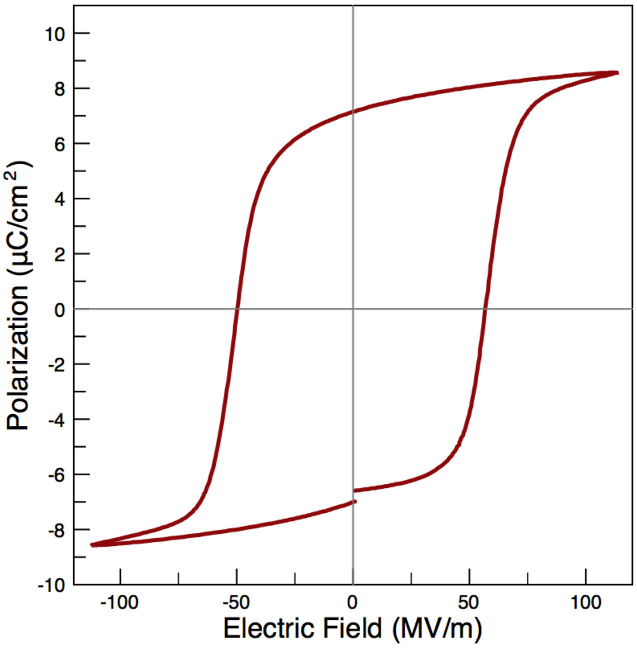


Figure S1. Properties of the P(VDF-TrFE) film.

Endurance characterization

Our ferroelectric capacitors were fatigued at 100 Hz and 100 MV/m. The polarization dropped to ~40% of its initial value after 10^5 cycles which is comparable to reports in literature.[1,2,3] Read/write endurance of FeFETs was manually characterized up to 128 cycles. The initial I_{ON}/I_{OFF} of ~2×10^2 decreases to ~ 0.8×10^2 after 40 cycles and remains stable up to 128 cycles, showing that there is significant drain-current hysteresis after 128 cycles.

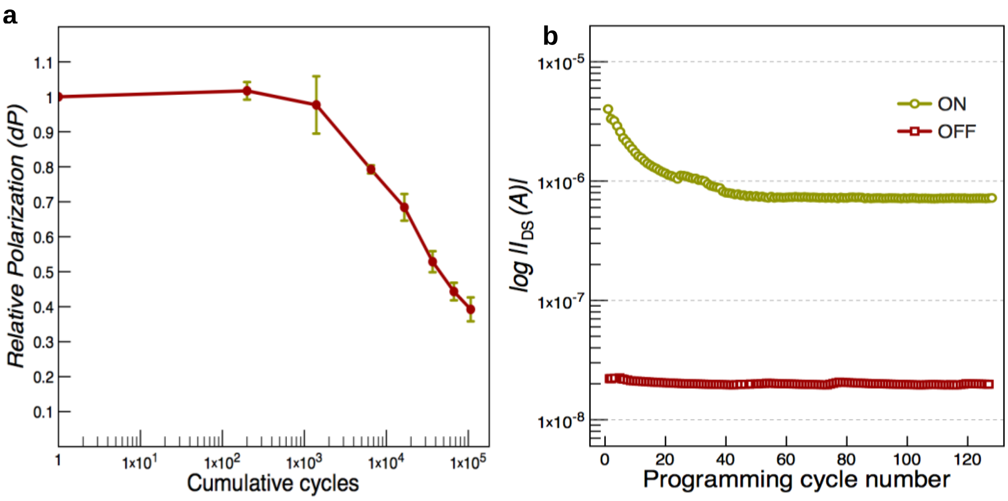
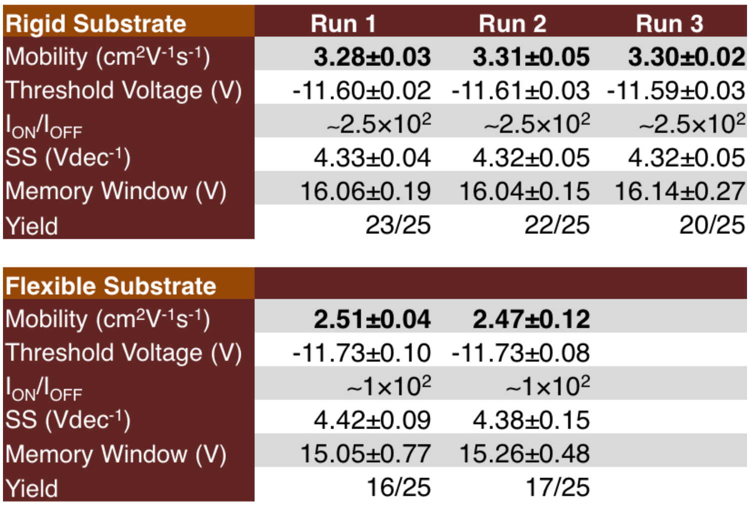


Figure S2. Endurance properties. **a,** Fatigue properties of the ferroelectric capacitor. **b,** The ON and OFF state drain current at zero gate bias as a function of the number of applied gate voltage sweeps (V_{GS} ± 25V)

1) G. Zhu, Y. Gu, H. Yu, S. Fu, and Y. Jiang, J. Appl. Phys. 110, 024109 (2011).
2) G.-D. Zhu, X.-Y. Luo, J.-H. Zhang, and Y. Gu, IEEE Trans. Dielectr. Electr. Insul. 17, 1172 (2010).
3) S. Z. Yuan, X. J. Meng, J. L. Sun, Y. F. Cui, J. L. Wang, L. Tian, and J. H.Chu, Phys. Lett. A 375, 1612 (2011).

Statistical Analysis

Results of the statistical analysis are shown in Table S2 for FeFETs with W/L ratios of 1,2,5,10 and 20 and channel widths of 50, 100, 200, 500 and 1000 μm giving a total of 25 devices per run. Very consistent results are observed in all the measured devices.



Rigid Substrate	**Run 1**	**Run 2**	**Run 3**
Mobility ($cm^2V^{-1}s^{-1}$)	**3.28±0.03**	**3.31±0.05**	**3.30±0.02**
Threshold Voltage (V)	-11.60±0.02	-11.61±0.03	-11.59±0.03
I_{ON}/I_{OFF}	~2.5x10^2	~2.5x10^2	~2.5x10^2
SS ($Vdec^{-1}$)	4.33±0.04	4.32±0.05	4.32±0.05
Memory Window (V)	16.06±0.19	16.04±0.15	16.14±0.27
Yield	23/25	22/25	20/25

Flexible Substrate		
Mobility ($cm^2V^{-1}s^{-1}$)	**2.51±0.04**	**2.47±0.12**
Threshold Voltage (V)	-11.73±0.10	-11.73±0.08
I_{ON}/I_{OFF}	~1x10^2	~1x10^2
SS ($Vdec^{-1}$)	4.42±0.09	4.38±0.15
Memory Window (V)	15.05±0.77	15.26±0.48
Yield	16/25	17/25

Table R1. Statistical analysis of FeFETs. Important device characteristics were obtained at operating voltages (V_{GS}) from -30 V to 30 V at V_{DS}=-1 V for all the devices characterized in this study.

Device resistance to mechanical deformation

Flexible sample has been bent for 200 cycles with an approximate bending radius of 10 mm. No significant degradation of the FeFET has been observed up to 100 cycles and around 20% decrease in the mobility after 200 cycles, as shown in the transfer curves of Fig. S3.

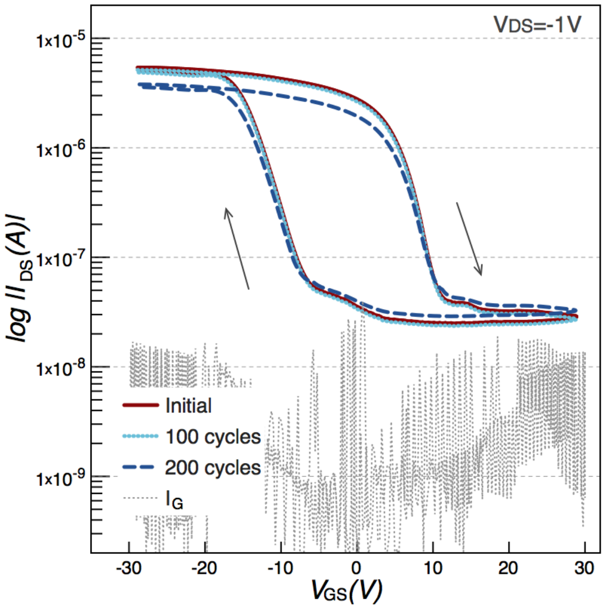


Figure S3. Transfer characteristics showing device resistance to mechanical deformation with an approximate bending radius of 10 mm before and after 200 bending cycles.