

Supporting information for

## **Tuning the electrical memory characteristics from WORM to flash by $\alpha$ - and $\beta$ -substitution of the electron-donating naphthylamine moieties in functional polyimides**

*Lei Shi, Hebo Ye, Wenlu Liu, Guofeng Tian, Shengli Qi\*, and Dezhen Wu*

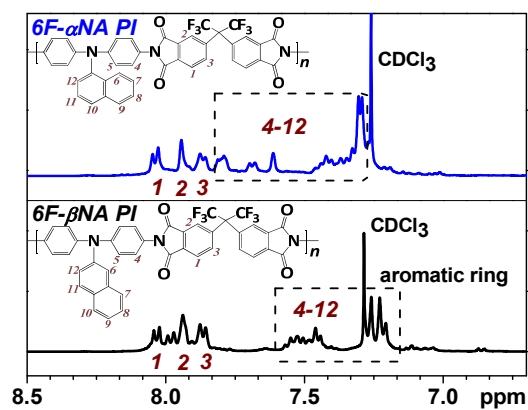
[\*] Dr. Shengli Qi

State Key Laboratory of Chemical Resource Engineering, Beijing University of Chemical  
Technology, Beijing 100029 (China).

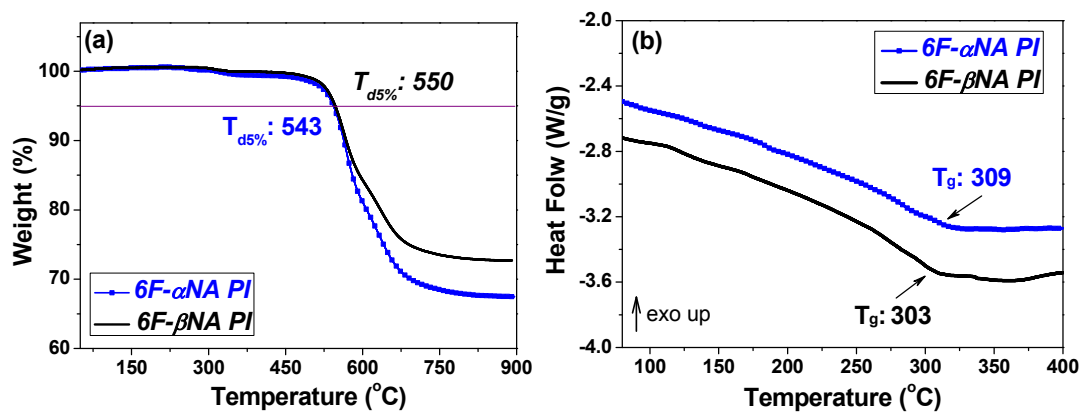
E-mail: [qisl@mail.buct.edu.cn](mailto:qisl@mail.buct.edu.cn)

### List of Contents for Supplementary Material:

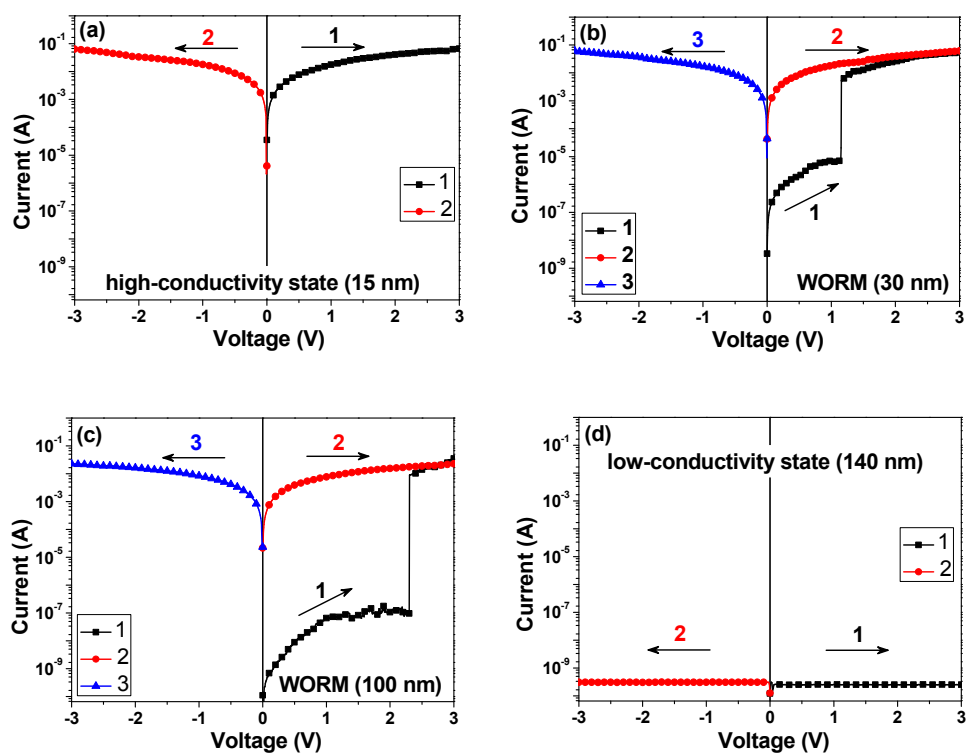
- Figure S1.**  $^1\text{H}$  NMR spectra of the synthesized 6F- $\alpha$ NA and 6F- $\beta$ NA polyimides measured in  $\text{CDCl}_3$ .
- Figure S2.** (a) TGA curves of the synthesized 6F- $\alpha$ NA and 6F- $\beta$ NA polyimides measured in nitrogen atmospheres at a heating rate of  $10\text{ }^\circ\text{C min}^{-1}$ ; (b) DSC curves of the synthesized 6F- $\alpha$ NA and 6F- $\beta$ NA polyimides undertaken at a heating rate of  $20\text{ }^\circ\text{C min}^{-1}$  in nitrogen atmospheres.
- Figure S3.** Current-voltage (I-V) characteristics of the ITO | Thin 6F- $\alpha$ NA PI Layer | Au sandwich devices with different film thickness. The sequence and direction of each sweep are indicated by the respective number and arrow: (a) 15 nm; (b) 30 nm; (c) 100 nm; (d) 140 nm.
- Figure S4.** Current-voltage (I-V) characteristics of the ITO | Thin 6F- $\beta$ NA Layer | Au sandwich devices with different film thicknesses. The sequence and direction of each sweep are indicated by the respective number and arrow: (a) 30 nm; (b) 100 nm; (c) 140 nm.
- Figure S5.** (a) Current-voltage (I-V) characteristics of the ITO | Thin 6F- $\alpha$ NA PI Layer | Al sandwich device with an initial positive voltage sweep. The sequence and direction of each sweep are indicated by the respective number and arrow. (b) Current-voltage (I-V) characteristics of the ITO | Thin 6F- $\alpha$ NA PI Layer | Al sandwich device with an initial negative voltage sweep.
- Figure S6.** Current-voltage (I-V) characteristics of the ITO | Thin 6F- $\beta$ NA PI Layer | Al sandwich device with an initial positive voltage sweep. The sequence and direction of each sweep are indicated by the respective number and arrow.
- Table S1.** Molecular simulation results for the components of the 6F- $\alpha$ NA PI and 6F- $\beta$ NA PI based on B3PW91/6-31G(d) model chemistry.



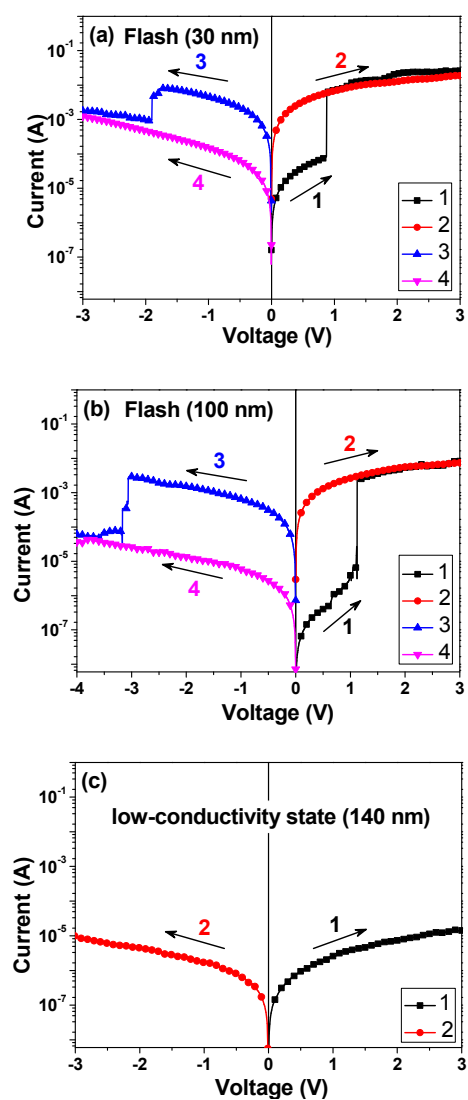
**Figure S1.** <sup>1</sup>H NMR spectra of the synthesized 6F- $\alpha$ NA and 6F- $\beta$ NA polyimides measured in CDCl<sub>3</sub>.



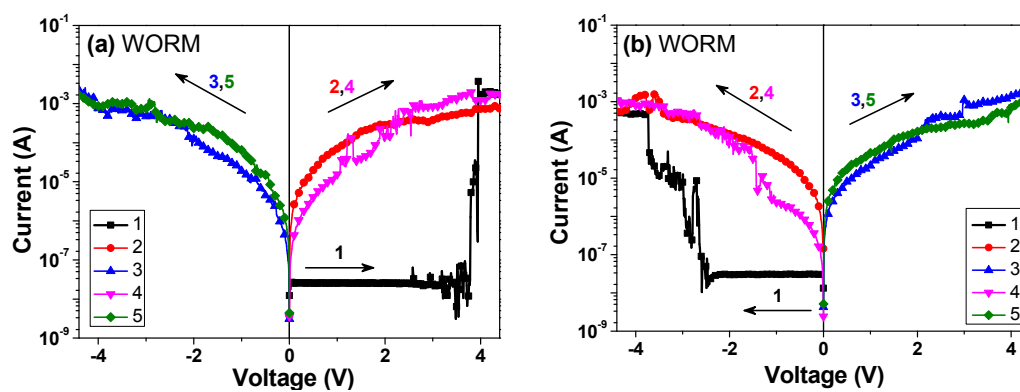
**Figure S2.** (a) TGA curves of the synthesized 6F- $\alpha$ NA and 6F- $\beta$ NA polyimides measured in nitrogen atmospheres at a heating rate of 10 °C min<sup>-1</sup>; (b) DSC curves of the synthesized 6F- $\alpha$ NA and 6F- $\beta$ NA polyimides undertaken at a heating rate of 20 °C min<sup>-1</sup> in nitrogen atmospheres.



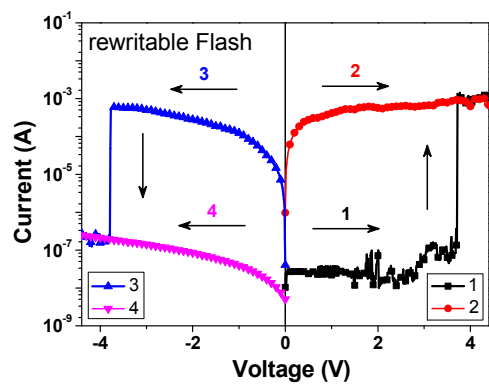
**Figure S3.** Current-voltage (I-V) characteristics of the ITO | Thin 6F- $\alpha$ NA PI Layer | Au sandwich devices with different film thicknesses. The sequence and direction of each sweep are indicated by the respective number and arrow: (a) 15 nm; (b) 30 nm; (c) 100 nm; (d) 140 nm.



**Figure S4.** Current-voltage (I-V) characteristics of the ITO | Thin 6F- $\beta$ NA Layer | Au sandwich devices with different film thicknesses. The sequence and direction of each sweep are indicated by the respective number and arrow: **(a)** 30 nm; **(b)** 100 nm; **(c)** 140 nm.

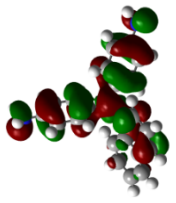
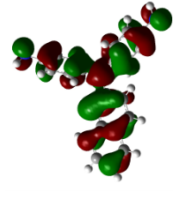
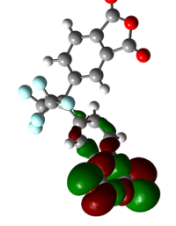
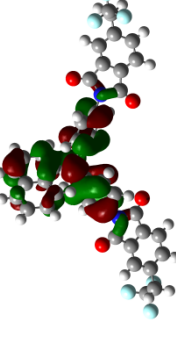
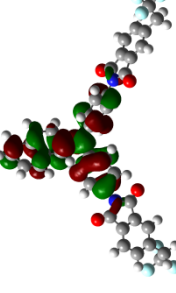
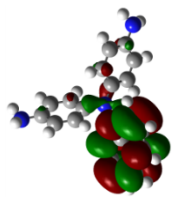
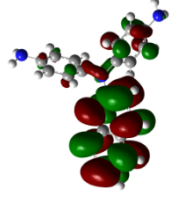
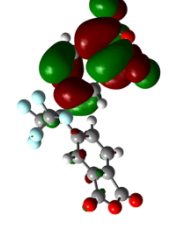
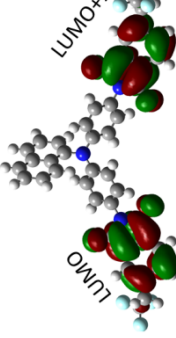
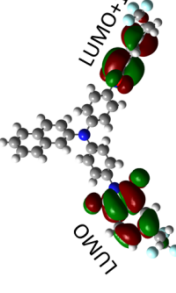


**Figure S5.** (a) Current-voltage (I-V) characteristics of the ITO | Thin 6F- $\alpha$ NA PI Layer | Al sandwich device with an initial positive voltage sweep. The sequence and direction of each sweep are indicated by the respective number and arrow. (b) Current-voltage (I-V) characteristics of the ITO | Thin 6F- $\alpha$ NA PI Layer | Al sandwich device with an initial negative voltage sweep.



**Figure S6.** Current-voltage (I-V) characteristics of the ITO | Thin 6F- $\beta$ NA PI Layer | Al sandwich device with an initial positive voltage sweep. The sequence and direction of each sweep are indicated by the respective number and arrow.

**Table S1.** Molecular simulation results for the components of the 6F- $\alpha$ NA PI and 6F- $\beta$ NA PI based on B3PW91/6-31G(d) model chemistry.

Components	DAP $\alpha$ NA	DAP $\beta$ NA	6FDA	6F- $\alpha$ NA PI (model compound 1)	6F- $\beta$ NA PI (model compound 2)
HOMO level	 -4.55 eV	 -4.59 eV	 -8.28 eV	 -5.37 eV	 -5.27 eV
LUMO level	 -0.79 eV	 -0.65 eV	 -2.98 eV	 -2.22 eV	 -2.24 eV
Energy gap	3.76 eV	3.94 eV	5.30 eV	3.15 eV	3.03 eV