

Electronic Supplementary Information

Low surface energy interface-derived low-temperature recrystallization behavior of organic thin film for boosting carrier mobility

Shuya Wang, Zhan Wei, Yahan Yang, Xiaoli Zhao,* Qingxin Tang,* Yanhong Tong,*
Yichun Liu

Center for Advanced Optoelectronic Functional Materials Research, and Key Laboratory of
UV-Emitting Materials and Technology of Ministry of Education, Northeast Normal
University, 5268 Renmin Street, Changchun 130024, China.

*E-mail: tangqx@nenu.edu.cn, zhaoxl326@nenu.edu.cn, tongyh@nenu.edu.cn

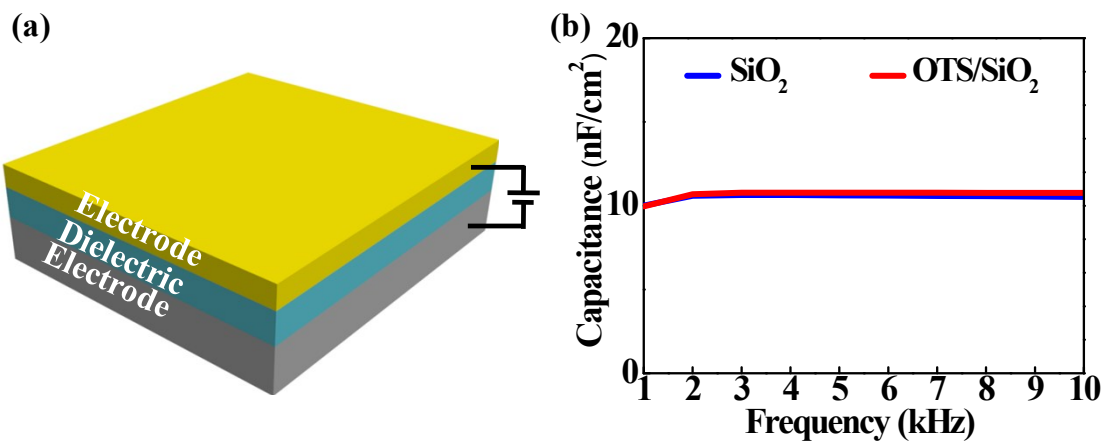


Fig. S1 (a) Schematic diagram of capacitance measurement. (b) Capacitance-frequency curve (C - F) for the dielectric. Capacitances of SiO₂ and OTS/SiO₂ are approximately 10 nF cm⁻².

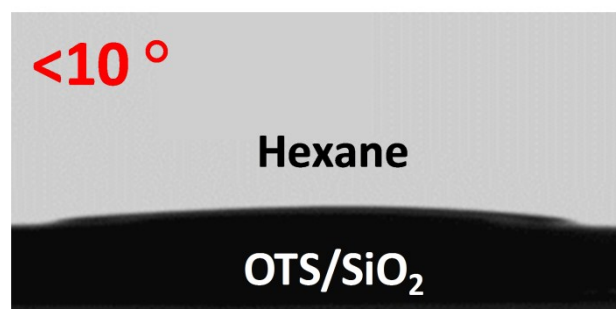


Fig. S2 Contact angle of hexane on the OTS/SiO₂ dielectric layer.

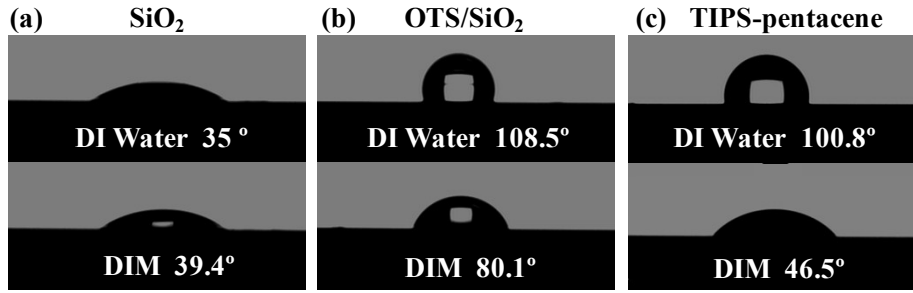


Fig. S3 Contact angle of deionized (DI) water and diiodomethane (DIM) on different dielectrics and TIPS-pentacene thin film. (a) SiO₂; (b) OTS/SiO₂; (c) TIPS-pentacene thin film.

The polar component (γ^p) and dispersive component (γ^d) of surface energy were counted to solve two simultaneous equations. The total surface energy (γ^S) was counted from the sum of these components.^{S1}

$$1 + \cos \theta = \frac{2\sqrt{\gamma^d}\sqrt{\gamma_{lv}^d}}{\gamma_{lv}} + \frac{2\sqrt{\gamma^p}\sqrt{\gamma_{lv}^p}}{\gamma_{lv}} \quad (1)$$

Diiodomethane (DIM) and deionized (DI) water were used as test liquids. Measurement results of the surface energy of dielectrics and TIPS-pentacene thin film are shown in Table S1.

Table S1 Contact angle and surface energy data for different dielectrics and TIPS-pentacene thin film.

Dielectrics and semiconductor	Contact angles (degree) avg. \pm avg. dev		Surface energy (mJ m ⁻²) avg. \pm avg. dev		
	DI Water	DIM	γ^p	γ^d	γ^S
SiO ₂	35.5 \pm 0.7	39.4 \pm 0.3	26.2 \pm 0.3	39.9 \pm 0.1	66.1 \pm 0.4
OTS/SiO ₂	108.5 \pm 0.4	80.3 \pm 0.6	0.6 \pm 0.07	17.3 \pm 0.3	17.9 \pm 0.2
TIPS-pentacene	100.9 \pm 0.4	46.0 \pm 0.8	0.04 \pm 0.01	36.46 \pm 0.4	36.5 \pm 0.4

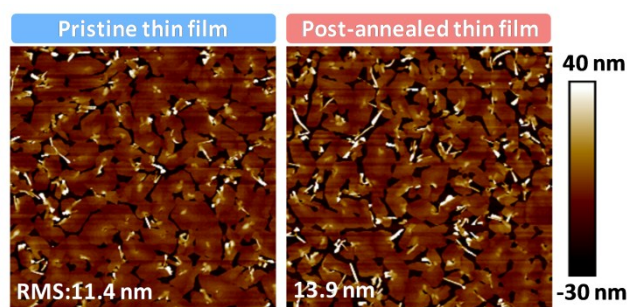


Fig. S4 AFM images ($20\ \mu\text{m} \times 20\ \mu\text{m}$) of vacuum-deposited TIPS-pentacene thin films on a low surface energy OTS/SiO₂ dielectric layer before and after post-annealing treatment.

Fig. S4 shows AFM images of vacuum-deposited TIPS-pentacene thin films on a low surface energy OTS/SiO₂ dielectric layer before and after post-annealing treatment. 20 nm TIPS-pentacene thin films was deposited directly on the OTS/SiO₂ dielectric layer by vacuum thermal evaporation at a rate of ca. $0.1\ \text{\AA}\ \text{s}^{-1}$ at a substrate temperature of $70\ ^\circ\text{C}$. The post-annealing condition is fixed at $40\ ^\circ\text{C}$ for 15 min. It can be obviously observed that the morphology of the TIPS-pentacene thin film is almost no change after the post-annealing treatment. It can be ascribed that the morphology of vacuum-deposited TIPS-pentacene thin film is stable, while the morphology of solution-processed TIPS-pentacene thin film is metastable.^{S2,S3}

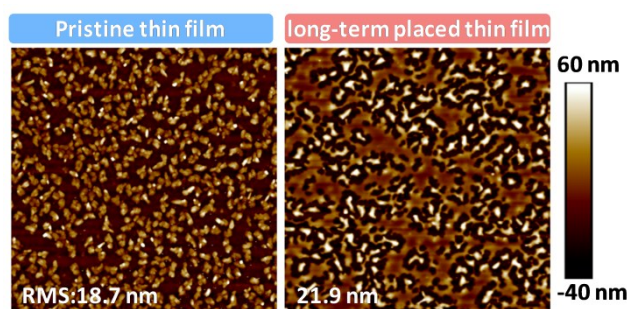


Fig. S5 AFM images ($20\ \mu\text{m} \times 20\ \mu\text{m}$) of solution-processed TIPS-pentacene thin films on a low surface energy OTS/SiO₂ dielectric before and after long-term placement.

Fig. S5 shows AFM images of spin-coated TIPS-pentacene thin films on a low surface energy OTS/SiO₂ dielectric layer before and after long-term placement. It can be observed that TIPS-pentacene thin films before and after long-term placement present rather different morphology, while the morphology after long-term placement is not improved. The RMS of TIPS-pentacene thin films after long-term placement increases to 21.9 nm. Therefore, after long-term placement, TIPS-pentacene thin film on the OTS/SiO₂ dielectric layer can recrystallize, but does not become smooth. It can be attributed to the fact that TIPS-pentacene molecules can move at room temperature,^{S4} but the small kinetic energy can not move TIPS-pentacene molecules to the appropriate distance, thus failing to form the smooth TIPS-pentacene thin film.

REFERENCES

- S1 D. K. Owens and R. C. Wendt, *Journal of Applied Polymer Science*, 1969, 13, 1741-1747.
- S2 Y. Yuan, G. Giri, A. L. Ayzner, A. P. Zoombelt, S. C. B. Mannsfeld, J. Chen, D. Nordlund, M. F. Toney, J. Huang and Z. Bao, *Nat. Commun.*, 2014, 5, 3005.
- S3 E. Treossi, A. Liscio, X. Feng, V. Palermo, K. Mullen and P. Samori, *Small*, 2009, 5, 112-119.
- S4 A. Troisi, G. Orlandi and J. E. Anthony, *Chem. Mater.*, 2005, 17, 5024-5031.