Supporting Information

Investigation and control of charge transport anisotropy in highly oriented friction transferred polythiophene thin films

Nikita Kumari[†], Manish Pandey[‡], Shuichi Nagamatsu[⊥], Masakazu Nakamura[‡], Shyam S. Pandey[†*]*

[†]Graduate School of Life Science and Systems Engineering, Kyushu Institute of Technology, 2-4 Hibikino, Wakamatsu, Kitakyushu, 8080196 Japan

[‡] Laboratory for Organic Electronics, Division of Materials Science, Nara Institute of Science and Technology, 8916-5 Takayama-cho, Ikoma, Nara 630-0192, Japan

[⊥]Department of Computer Science and Electronics, Kyushu Institute of Technology, 80-4 Kawazu, Iizuka, 820-8502 Japan

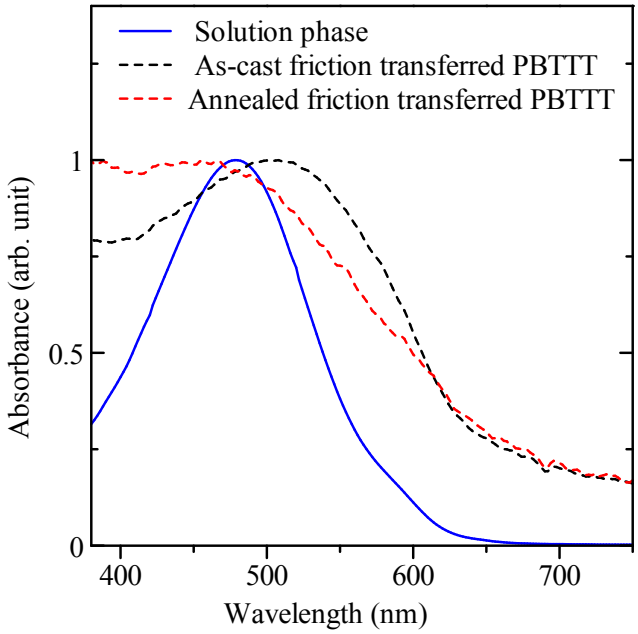

Figure S1. Normalized absorption spectra of different PBTTT samples, solution phase (dissolved in chlorobenzene) and friction transferred thin films as-cast and annealed at 180 °C. The spectra of solution-phase was measured with un-polarized light source and that of thin film was measured with orthogonally polarized light source.

Table S1. Some of the high optical anisotropy obtained for PBTTT through different casting techniques.

Casting technique	DR	Reference
Mechanical rubbing	13	[1]
Compression on ionic liquid	15.6	[2]
Strain alignment	~ 9	[3]

Floating film transfer	up to 13	[4]
Friction transfer	27.62 ± 2.46	this work

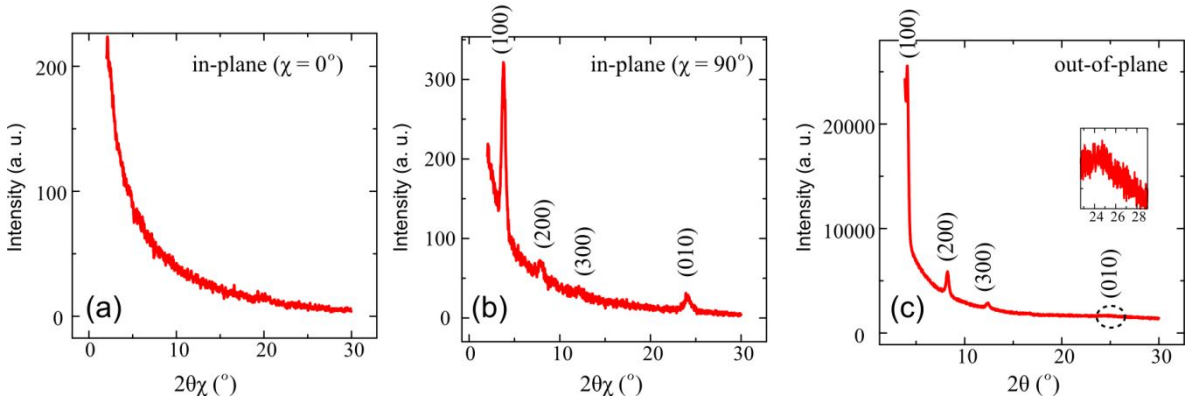

Figure S2. In-plane GIXD profile of friction transferred PBTTT film on bare oxide substrate and annealed at 200 ℃ for 10 minutes with incident X-ray beam parallel (a) and orthogonal to the drawing direction (b). Out-of-plane XRD pattern of the same film. Inset of (c) represents the magnified part of the graph circled with broken line. The scheme of measurement are shown in Figure 2 (a and b).

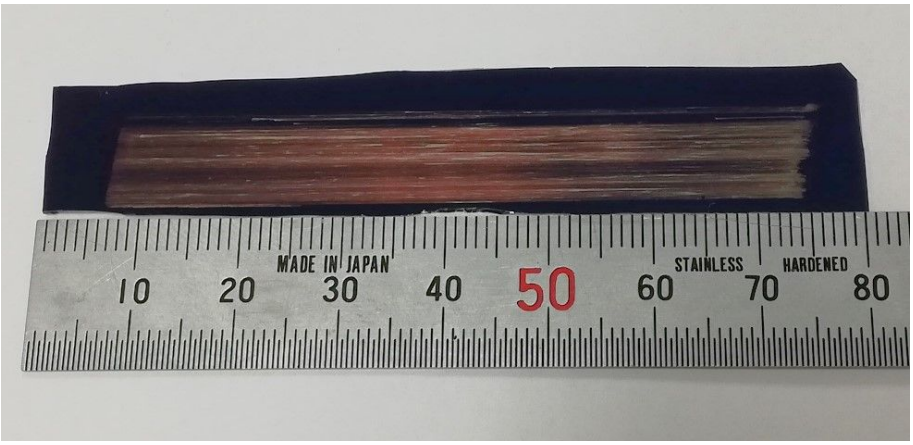

Figure S3. Digital image of the friction transferred PBTTT film on Si/SiO_2 substrate, to fabricate multiple OFETs on the same substrate.

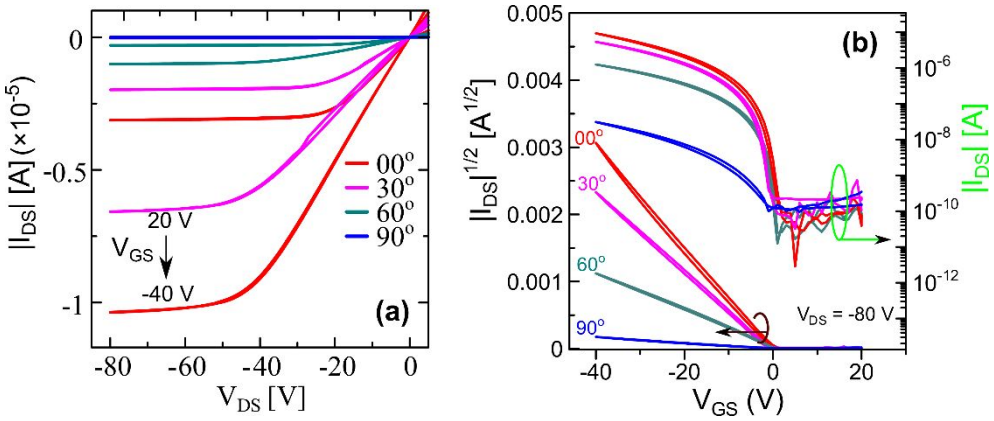

Figure S4. Output and (a) transfer (b) characteristics for the OFETs with varying channel direction with respect to the polymer back-bone orientation, the OFETs were fabricated with the friction transferred PBTTT on bare oxide surface films and annealed to 180 ℃.

AUTHOR INFORMATION

Corresponding Author

Tel.: +81-93-695-6230. Fax: +81-93-695-6000

*Shyam S. Pandey- Email: shyam@life.kyutech.ac.jp

*Manish Pandey- Email: manish.iitp12@gmail.com

Reference:

(1) Biniek, L.; Leclerc, N.; Heiser, T.; Bechara, R.; Brinkmann, M. Large Scale Alignment and Charge Transport Anisotropy of PBTTT Films Oriented by High Temperature Rubbing. *Macromolecules* **2013**, *46* (10), 4014–4023.

(2) Soeda, J.; Matsui, H.; Okamoto, T.; Osaka, I.; Takimiya, K.; Takeya, J. Highly Oriented Polymer Semiconductor Films Compressed at the Surface of Ionic Liquids for High-Performance Polymeric Organic Field-Effect Transistors. *Adv. Mater.* **2014**, *26* (37), 6430–6435.

(3) Xue, X.; Chandler, G.; Zhang, X.; Kline, R. J.; Fei, Z.; Heeney, M.; Diemer, P. J.; Jurchescu, O. D.; O'connor, B. T. Oriented Liquid Crystalline Polymer Semiconductor Films with Large Ordered Domains. *ACS Appl. Mater. Interfaces* **2015**, *7* (48), 26726–26734.

(4) Pandey, M.; Gowda, A.; Nagamatsu, S.; Kumar, S.; Takashima, W.; Hayase, S.; Pandey, S. S. Rapid Formation and Macroscopic Self-Assembly of Liquid-Crystalline, High-Mobility, Semiconducting Thienothiophene. *Adv. Mater. Interfaces* **2018**, *5* (6), 1700875.