In-situ Observation of Organic Single Micro-crystal Fabrication by Solvent Vapor Annealing

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Experimental section

Chlorobenzene was purchased from Sigma-Aldrich and used without further purification. (2,6-diphenylanthracene-9,10-diyl)bis(ethyne-2,1-diyl)bis(triethylsilane) (TES-DPA) was synthesised by the procedure steps reported in our previous work[35]. Si (100) substrates with 300 nm thermally grown oxide layer were purchased from Sunson Electronics. Au patterns were fabricated through EBL technique, and the poly (methyl methacrylate) (PMMA) resist was cleaned by acetone, ethanol and water for 30 minutes each.

The substrate with Au patterns was brought into a home-made vacuum chamber for the deposition of organic molecules. Without additional instructions, the substrate temperature was set to 160 ℃. Organic molecules were placed in a quartz crucible, and the evaporation rate is controlled by the temperature of organic evaporator. During the deposition process, the film thickness was monitored by a quartz microbalance. The samples were cooled down to room temperature and taken out of the vacuum chamber after the deposition of TES-DPA for the further treatment and characterization.

The morphology and topography of the samples were characterized by SEM, AFM and optical microscope. The UV-VIS adsorption and PL spectrums were characterized by Shimadzu UV-3600 and Edinburgh instruments FS5, respectively. The in-situ SVA were performed by placing the sample in the chamber with a container filled of chlorobenzene solution inside. And then, the chamber was sealed by a transparent cover, and the morphology evolution of the sample was recorded by a digital camera through a long work distance microscope. The SVA process was carried out at room temperature. The container filled with chlorobenzene solvent was put into the annealing chamber for at least one hour to fill the chamber with chlorobenzene vapor. Then the samples were put onto the sample holder as quick as possible to reach the saturation state of chlorobenzene vapor the chamber. The AFM images were analysed by WSxM software. XRD measurements were performed in a θ-2θ configuration with a Siemens D5000 X-ray diffractometer. The SAED measurements were carried out on a FEI Talos F200 transmission electron microscope operated at 200kV. With the heavily doped silicon wafer and the 300 nm oxide layer serving as gate and insulator respectively, field-effect characteristic measurements were performed with a Keithley

4200 in air at room temperature.

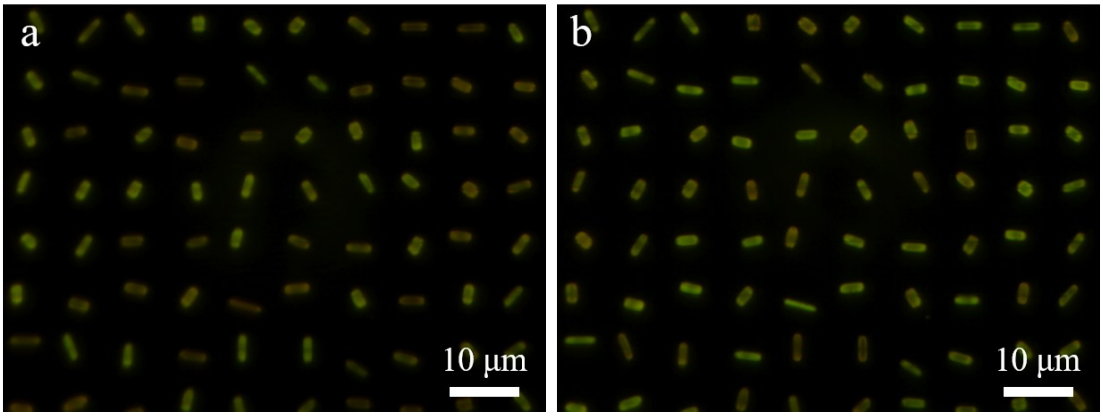

Figure S1. Fluorescence microscope images of TES-DPA single crystals located on Au pairs illuminated under polarized light with angles of (a) 0° and (b) 180°, respectively.

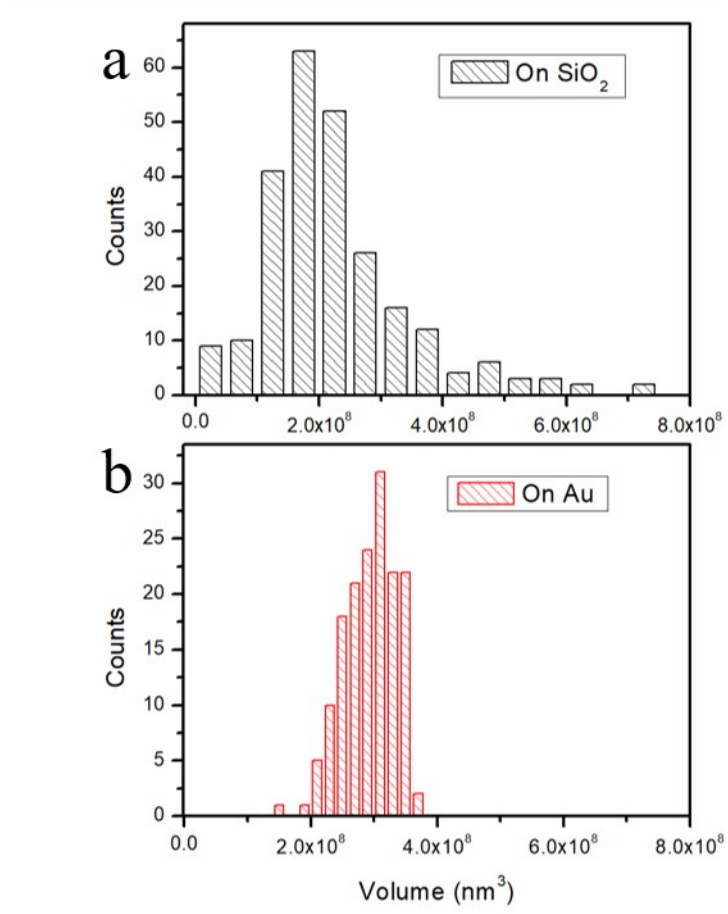

Figure S2. Volume distributions of TES-DPA crystals obtained by deposition of 10 nm TES-DPA and subsequent SVA for 4 hours on (a) bare SiO_2 substrate and (b) Au electrode pair patterned SiO_2. The Au electrode pairs were fabricated on SiO_2 substrate with Au length of 5 μm, width of 2.3 μm and the gap between the two neighboring electrodes of 0.4 μm, respectively.

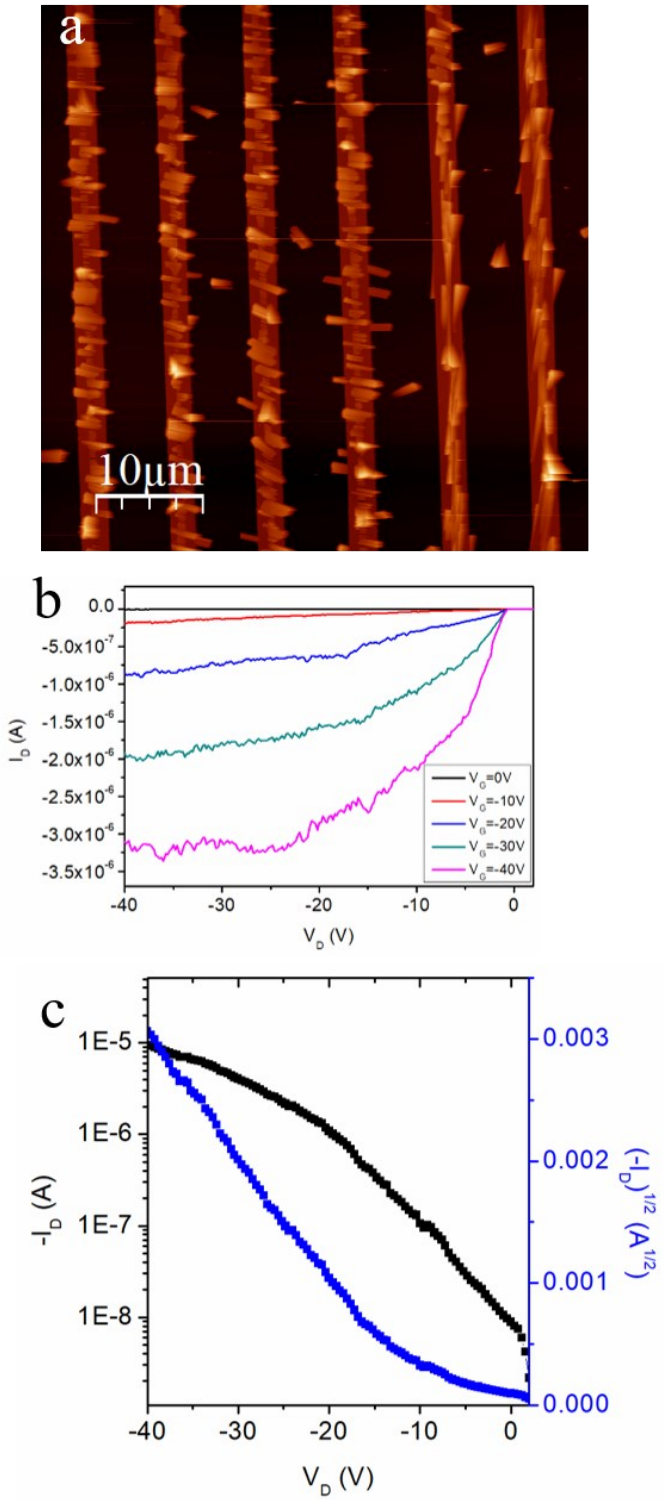

Figure S3. (a) AFM image of 10 nm TES-DPA deposited on Au interdigital electrodes with subsequent SVA by chlorobenzene for 4 hours. Corresponding (b) output and (c) transfer curves of the sample containing 30 pairs of interdigital with the channel length of 1 μm, and channel width of 80μm, respectively.

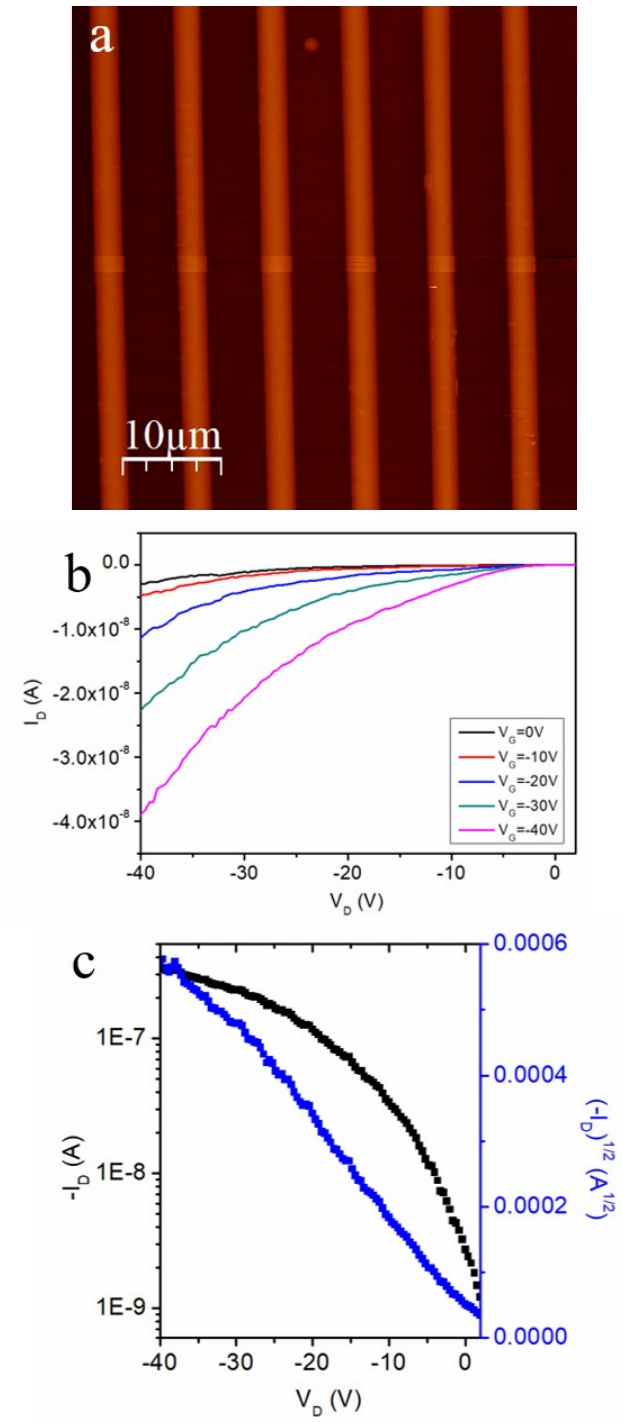

Figure S4. (a) AFM image of 10 nm TES-DPA deposited on Au interdigital electrodes. Corresponding (b) output and (c) transfer curves of the sample containing 30 pairs of interdigital with the channel length of 1 μm, and channel width of 80μm, respectively.

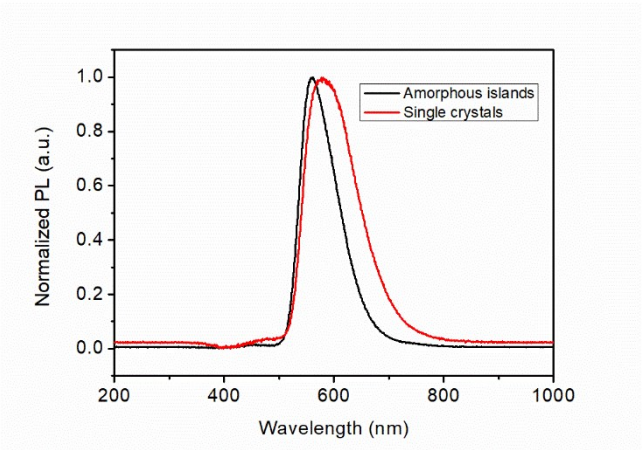

Figure S5. PL spectrum of TES-DPA amorphous islands and single crystals on SiO_2 surface. An obverse red shift was observed after crystallization, in comparison to that of amorphous islands. It's worth noting that the full width at half maximum (FWHM) of crystals is larger than that of amorphous islands, which is attributed to the wide size distribution of those obtained crystals via SVA methods on SiO2 surface[1, 2].

References

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2 S.-H. Chin, J. W. Choi, H. C. Woo, J. H. Kim, H. S. Lee and C.-L. Lee, Nanoscale, 2019, 11, 5861-5867.