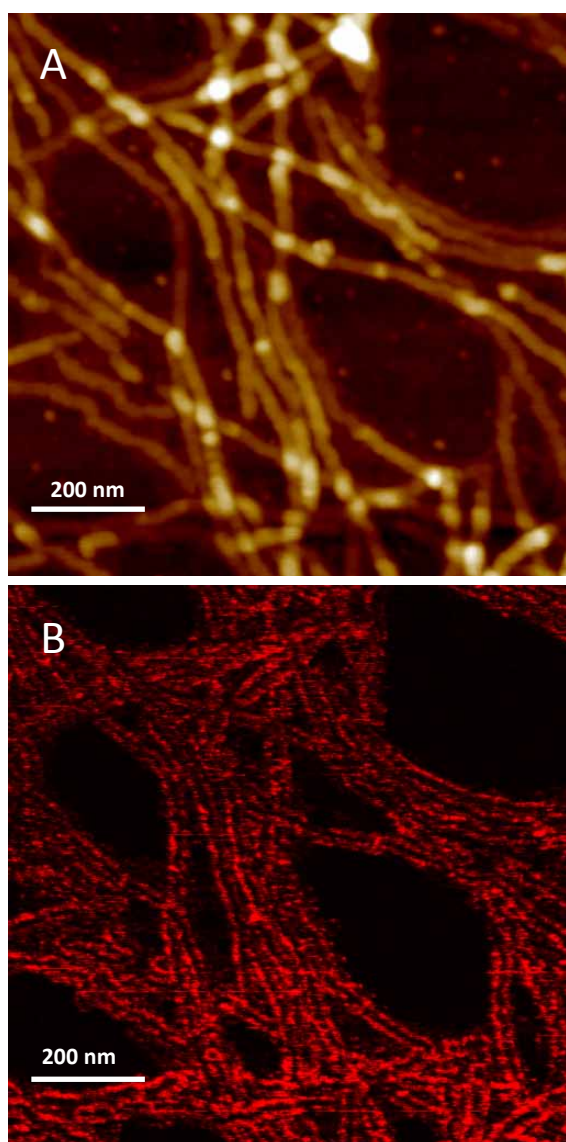


## Supporting Information :



**Figure SI.1:**  $1 \times 1 \mu\text{m}^2$  height (A) and contact current (B) CSFS-AFM images of a P3HT:CNT blend on a glass/ITO substrate. Force applied = 50 pN – DC sample bias = -1 V. The vertical color code is 20 nm for image A and 10 pA for image B

### Synthesis of the polymer

1.34 mL of isopropylmagnesium chloride (2 M solution in THF) were added to a solution of 2-bromo-3-hexyl-5-iodothiophene (1 g, 2.68 mmol) in 15 mL of dry THF at  $0^\circ\text{C}$ . The mixture was stirred 30 minutes at  $0^\circ\text{C}$  then transferred onto a suspension of  $\text{Ni}(\text{dppp})\text{Cl}_2$  (24 mg, 1.7 mol %) in 15 mL of dry THF cooled at  $0^\circ\text{C}$ . The resulting mixture was stirred at room temperature overnight. 10 mL of a 5 M HCl solution were added, and the mixture was stirred for 30 minutes. The reaction was poured into 500 mL of cold methanol. The purple precipitate was filtrated, washed with methanol and dried under vacuum at  $40^\circ\text{C}$  for 2 hours, to give 304 mg of a purple solid. Yield 68%.

**Table 1:** Molecular, optical and thermal characterizations of the polymer. GPC and UV-vis are recorded in chloroform. \* regioregularity.

GPC		UV-vis	DSC	TGA ( $^\circ\text{C}$ )		
$M_n$ ( $\text{g}\cdot\text{mol}^{-1}$ )	$\bar{D}$	$\lambda_{\text{max}}$ (nm)	$T_m$ ( $^\circ\text{C}$ )	$T_{\text{d1}}$	$T_{\text{d2}}$ (5% w.loss)	rr*
11 000	1.1	451	220	247	451	98

### Polymer characterization

Gel Permeation Chromatography (GPC) was performed in  $\text{CHCl}_3$  at  $30^\circ\text{C}$  using a Agilent Technologies 1200 chromatograph equipped with a degasser, an isocratic HPLC pump (flow rate = 1 mL/min), a autosampler, a RI refractive index detector at  $30^\circ\text{C}$  and three columns: a PL gel  $5 \mu\text{m}$  guard column and two PL gel Mixed-D  $5 \mu\text{m}$  columns. Molecular weights and molecular weight distributions were calculated with reference to polystyrene standards. UV-vis absorption spectra were recorded with a Cary-Win UV50 spectrophotometer from 320 to 900 nm. Thermogravimetric analysis (TGA) was performed at a heating rate of  $20^\circ\text{C}/\text{min}$  from room temperature to  $800^\circ\text{C}$  by using a Hi-ResTGA 5000 device from TA Instruments. Thermodegradation was determined on approx. 15 mg samples with a platinum sample pan in a  $74 \text{ cm}^3/\text{min}$  nitrogen flow. A DSC Q2000 from TA Instrument was used for Differential Scanning Calorimetry (DSC) analysis. The sample was sealed in an aluminum DSC pan and placed in the DSC cell. The DSC was calibrated with indium. The sample was heated from  $-50^\circ\text{C}$  to  $200^\circ\text{C}$  with a heating rate of  $10^\circ\text{C}/\text{min}$ .

### Sample preparation for AFM measurements

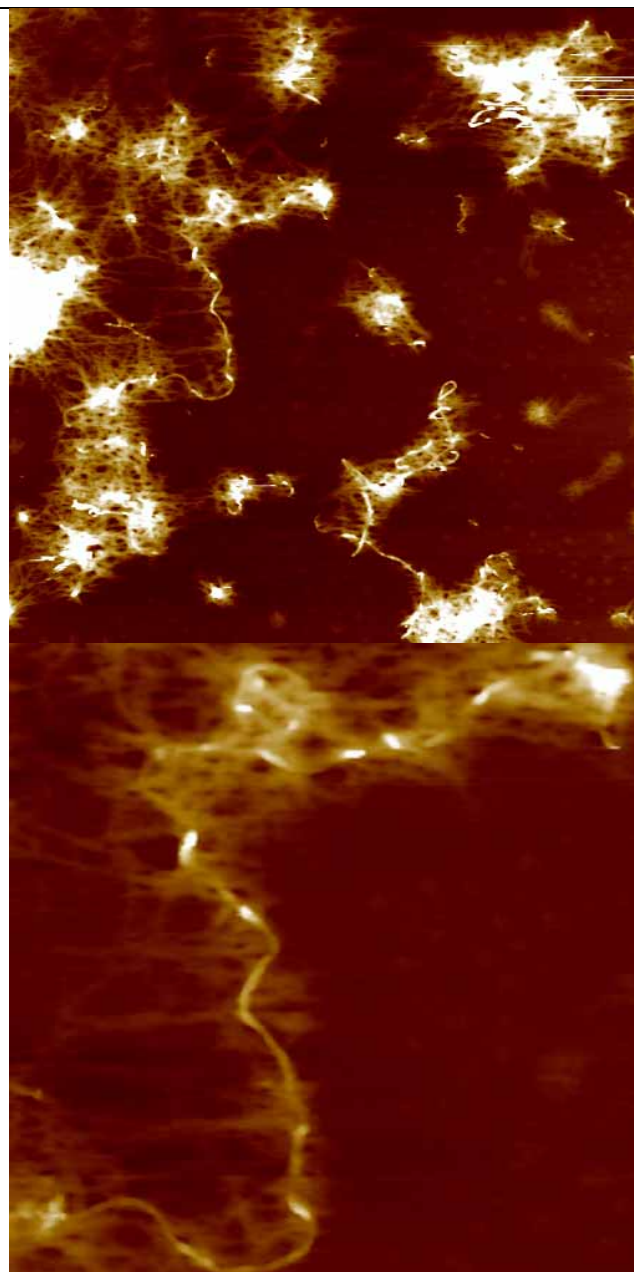
Regio-regular P3HT is solubilized in chlorobenzene with a typical concentration of 0.25 mg/mL. The solution is stirred and heated up to  $70^\circ\text{C}$  for 20 minutes in order to totally solubilize the polymer, and then cooled down to room temperature before deposition. The solubilisation of the nanotubes (Nanocyl, NT7000) is done as follows: 1 mg of P3HT and 1 mg of nanotubes are placed in the same flask, and 1 mL of chlorobenzene (Aldrich) is then added. This solution is placed in an ultrasonic bath for 20 minutes in order to separate the nanotubes and maximize their solubilization. The correct amount of this solution is then added to a 1 mg/mL P3HT solution to achieve the desired proportion of nanotubes (in most cases  $10 \mu\text{L}$  of the P3HT/nanotubes solution is added to a 1 mL P3HT solution, giving a content in nanotubes of 1% in weight). Glass substrates with 100 nm-thick ITO patterns are used. Those substrates are cleaned with a RBS solution and abundantly rinsed with distilled water and then dried under a nitrogen flow.  $10$  to  $20 \mu\text{L}$  of solution are drop-cast on the substrate so that the final solid P3HT:CNT film covers the largest part of the substrate. The deposition is carried out under a solvent saturated atmosphere in order to slow down the solvent evaporation. This “solvent annealing” process is expected to bring the system towards the

most ordered configuration.

### AFM measurements

Morphological and electrical AFM measurements are performed using a Dimension Icon microscope equipped with a Nanoscope V controller from Bruker-Nano. Electrical measurements (TUNA and Peak Force TUNA) are carried out using appropriate modules equipped with current amplifier electronics yielding similar sensitivity (below 100 fA). All images are recorded under ambient conditions. In Intermittent Contact AFM (tapping-mode) mode, Si cantilevers with a resonance frequency in the 150-300 kHz range are used. In Conductive AFM (TUNA mode), Pt/Ir coated probes with a spring constant around 0.5 N/m are used for very soft contact between the tip and the sample. In Current Sensing Force Spectroscopy AFM mode (also known as the trade mark Peak Force TUNA at Bruker-Nano AXS, see **Error! Reference source not found.**), **Error! Reference source not found.** Pt/Ir coated probes with a spring constant around 2.0 N/m are used.

For the electrical measurements, the samples are connected to the sample holder with silver paint, so that the ITO electrode is directly wired to the sample holder (see schematic representation of the samples in **Error! Reference source not found.**).



**Figure SI 2** A.  $10 \times 10 \mu\text{m}^2$  C-AFM topographic image of a P3HT:CNT blend on a glass/ITO substrate illustrating the good dispersion of CNT in a fibrillate P3HT matrix. The CNTs appear bright in the image. B. Zoom ( $3 \times 3 \mu\text{m}^2$ ) of the Figure SI 2A corresponding to the current image (see Figure 4A).