Supplementary Information

One-step assembly of multi-layered structures with orthogonally oriented stripe-like patterns on the surface of capillary tube

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Experimental Section

Materials: Regioregular P3HT (M_w = 45 kDa, PDI = 1.8, RR = 98%) was purchased from Rieke Metals Inc and PLA (M_w = 100 kDa, PDI = 1.5) was purchased from Polymer Source Inc. Different diameters of glass capillary tubes were purchased from Kimble Chase and were cleaned with *Piranha solution* (H_2SO_4:H_2O_2=7:3) heating at 100°C for 2 h to remove the stains on the surface (*Caution! Piranha solution reacts violently with organic materials.*), then washed thoroughly with deionized water for three times and dried under nitrogen flow.

Sample fabrication: Two horizontal concentrically aligned glass capillary tubes with (outer diameters 3.5 mm and 1.5 mm, thickness 0.35 mm and 0.1 mm, length 2.2 cm and 3 cm) were first placed on a horizontal bench. Then glass slides (0.5 cm×0.5 cm in square and 1 mm in height) were used to pad up the inner tubes to make them concentric and coaxial and fixed the inner tube on the glass slides. Take 0.1 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA solution for example, P3HT blending with PLA solutions

were trapped within the inner tube (34 μL) and the gap (58 μL) between the two tubes using syringe quickly due to the capillary force. After drying process, the chloroform evaporaed (at room temperature 20 ± 2°C and 20 ~ 30% humidity) for 4 hours, stripe patterns were readily produced in one step on the inside surface and the outer surface of the inner capillary tubes simultaneously. After carefully removed the outer tube, the inner tube was used to analyze and do the following cells alignment experiments. The temperature and humidity were monitored by a temperature-hygrometer (Hygrometer Testo 608-H1, Germany). Different diameters of annular tubes were also tried as the same fabrication method as mentioned above. Different concentration of P3HT&PLA solution systerms were also examined following the above procedures. As the evaporation rate vary along the length of tube, resulting in the change of distance between adjacent stripes (**Figure S1**). Considering the solution at the edge can well reflect the assembly behavior of the bulk solution, therefore the stripes formed at the edges were chosen to study.

Cell experiments: Smooth muscle cells of rats (A7r5 cells) were cultured in Dulbecco's modified Eagle's medium with high glucose (DMEM) containing 10% fetal bovine serum (FBS) from Gibco, penicillin (100 U mL^{-1}) and streptomycin (100 μg mL^{-1}) at 37°C in a 5% CO_2 humidified atmosphere. Once after a confluent cell sheet is formed, the cells were detached by trypsin, re-suspended into culture medium in at a concentration of 1×10^5 cells mL^{-1}. Cells were also cultured in and on the tubes at the same time. Later, live cells were stained with FDA (2.5 μg mL^{-1}) for 5 min before confocal fluorescence observation. Samples were examined on a laser confocal scanning microscope (LSM 700, Carl Zeiss Microscopy) with the laser excitation wavelength at 555 nm. SEM images of cells were first fixed using 4% paraformaldehyde solutions, then dehydrated twice by gradient ethanol for 15 min respectively. After that, the samples were dried in vacuum oven.

Characterization: Optical microscopy measurements were carried out using a Carl Zeiss A1m microscope with a charge-coupled device camera. AFM characterization was obtained on an Agilent 5500 AFM by tapping mode in an ambient atmosphere. CLSM images were characterized by a LSM 700 with a Zeiss microscopy. The SEM

images were obtained from the Phenon scanning electron microscope Pro-x PW-100-011(part nr), 800-07333 (model nr) system (PHENON WORLD) at a 10 kV voltage. Raman orientation spectra were obtained with LabRam HR800 spectrometer (Horiba Jobin Yvon) equipped with an Olympus BX41 microscope in the backscattering geometry. A 632.8 nm He-Ne laser was focused on the sample with a 50 X objective lens. Stripes were aligned along the *Z* direction (perpendicular to the direction of tube long-axis) and polarized spectra were recorded in the order: *ZZ*, *XX*, ratios were obtained by measuring the intensity ten different points in one stripe at different positions in the tubes. We define *Z* direction as that parallel to the long axis of the stripe and *X* perpendicular to the stripe long axis in the sample plane. For the measurements with polarized light, we use two configurations, *ZZ* and *XX*, using the notation "incident polarization analyzed polarization".

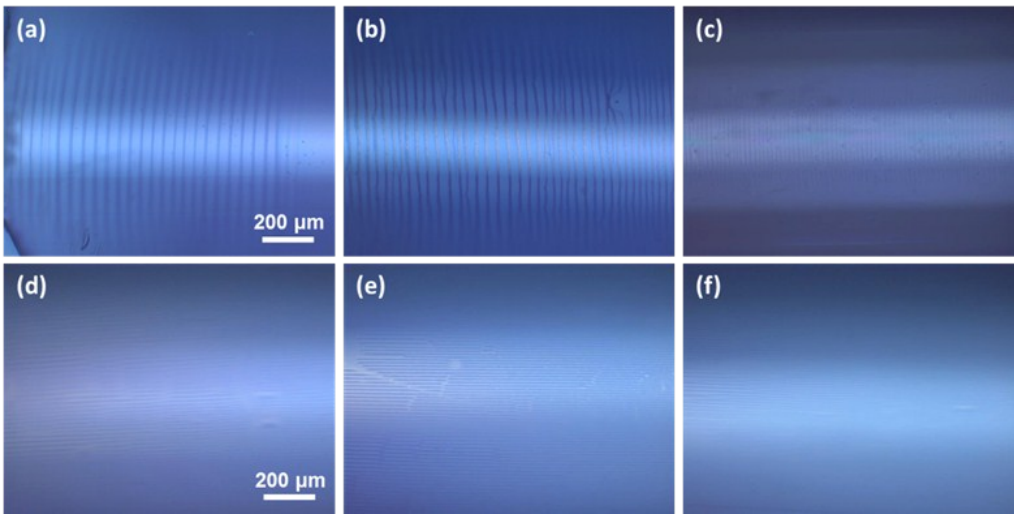

Figure S1. Optical images of inside surfaces (a-c) and outside surfaces (d-f) self-assembled from 0.1 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA solutions at different positions from outer to the center of the capillary tube.

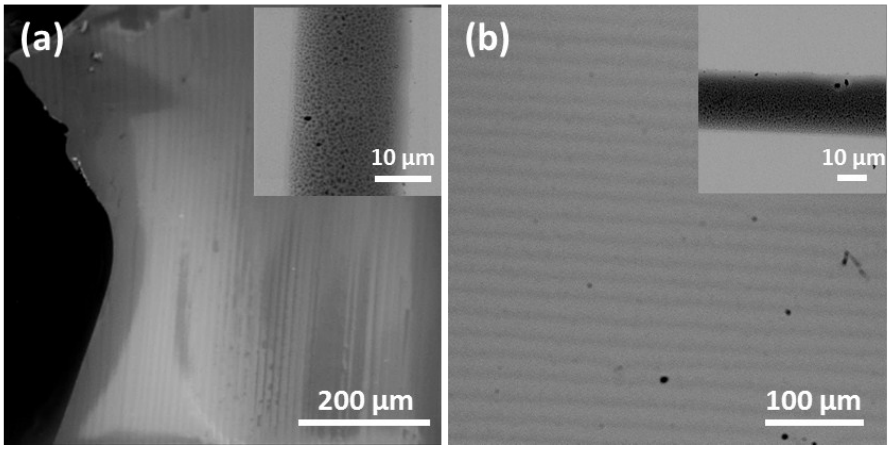

Figure S2. Typical SEM image of the stripe pattern on the inside surface (a) and on the outside surface (b) of the capillary tube.

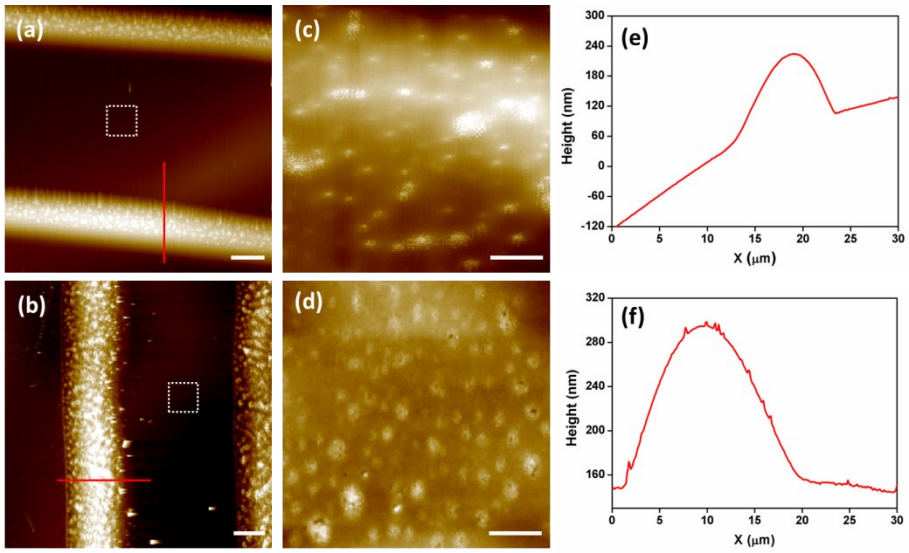

Figure S3. AFM images of the stripes (a, b) and spacing area between the stripes (c, d) self-assembly from 0.1 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA solution formed on the inner capillary tube: on the outside surface (a, c) and on the inside surface (b, d). c and d are enlarged view of white dashed squares in a and b, respectively. (e, f) Height profiles of single stripe in a and b, respectively. Scale bars are all 10 µm.

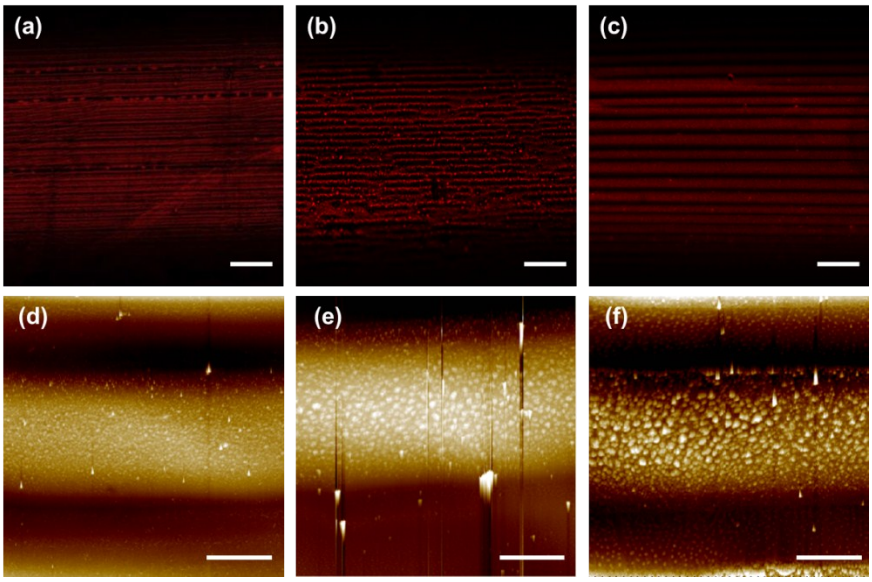

Figure S4. (a-f) Fluorescence (a-c) and AFM (d-f) images of P3HT & PLA solutions self-assembled on the outside surface of the capillary tubes. (a, d) 0.05 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA, (b, e) 0.1 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA, (c, f) 0.2 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA. Scale bars are 100 μm for a-c and 20 μm for d-f.

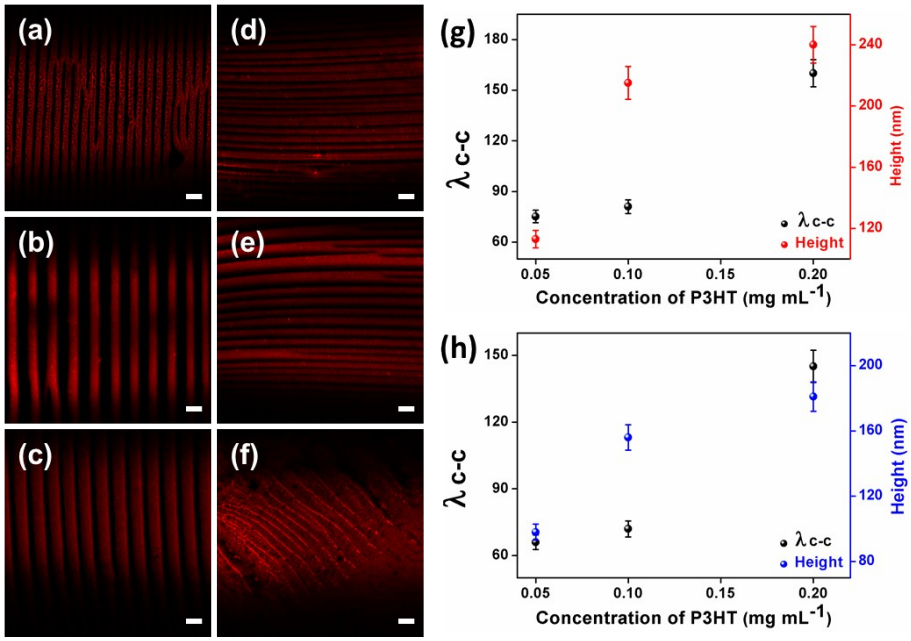

Figure S5. Fluorescence images (a-f) of P3HT & PLA solutions self-assembled structures on the capillary tubes. (a, d) 0.05 mg mL^{-1} P3HT & 0.5 mg mL^{-1} PLA, (b, e) 0.1 mg mL^{-1} P3HT & 0.5 mg mL^{-1} PLA, (c, f) 0.2 mg mL^{-1} P3HT & 0.5 mg mL^{-1} PLA. Scale bar: 50 μm for a-f. Height and distance between adjacent stripes of inside surface (g) and outside surface (h).

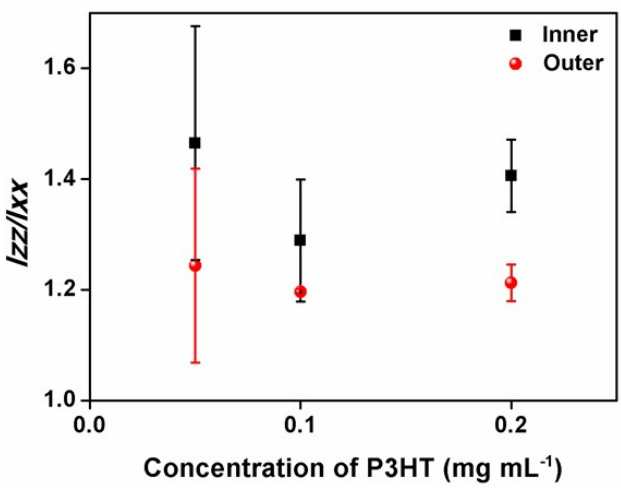

Figure S6. Raman anisotropy of individual stripe in different patterns including the inside surface and the outside surface with the concentration of PLA is 0.5 mg mL^{-1}.

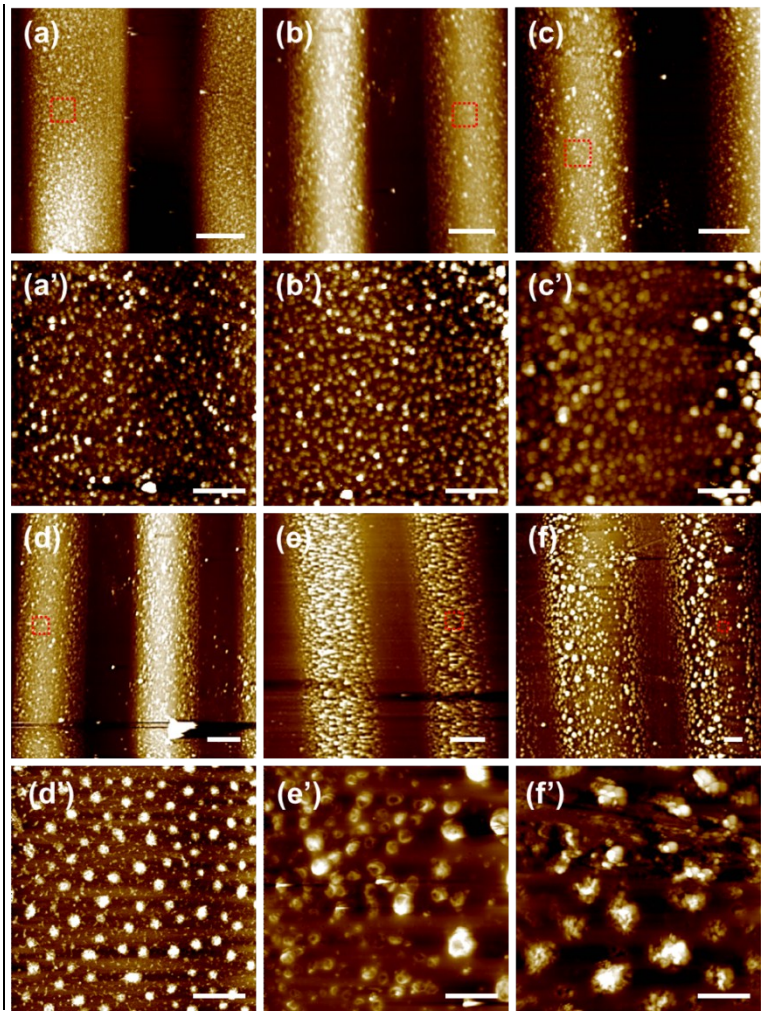

Figure S7. AFM images of morphology of stripes on inside surfaces of the capillary tube. (a, a') 0.05 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA, (b, b') 0.1 mg mL^{-1} P3HT &

0.1 mg mL^{-1} PLA, (c, c') 0.2 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA, (d, d') 0.05 mg mL^{-1} P3HT & 0.5 mg mL^{-1} PLA, (e, e') 0.1 mg mL^{-1} P3HT & 0.5 mg mL^{-1} PLA, (f, f') 0.2 mg mL^{-1} P3HT & 0.5 mg mL^{-1} PLA. a'-f' are enlarged views of red dashed squares in a-f, respectively. Scale bars are 20 μm for a-f and 2 μm for a'-f'.

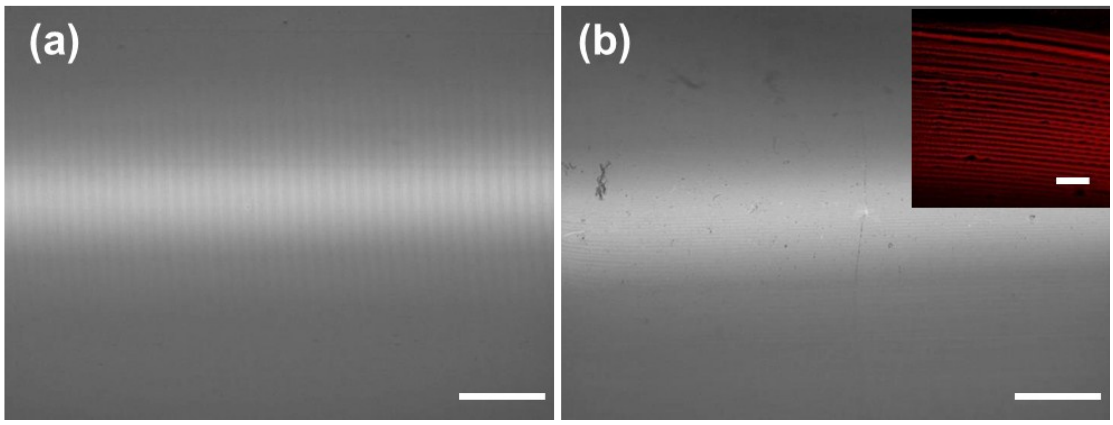

Figure S8. Optical images of patterns formed by 0.1 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA solutions with different diameters of concentrically aligned glass capillary tubes system. (a, b) 1.5 mm-0.4 mm. Scale bars: 200 μm for a-b. Inset of b is the fluorescence image. Scale bar is 30 μm.

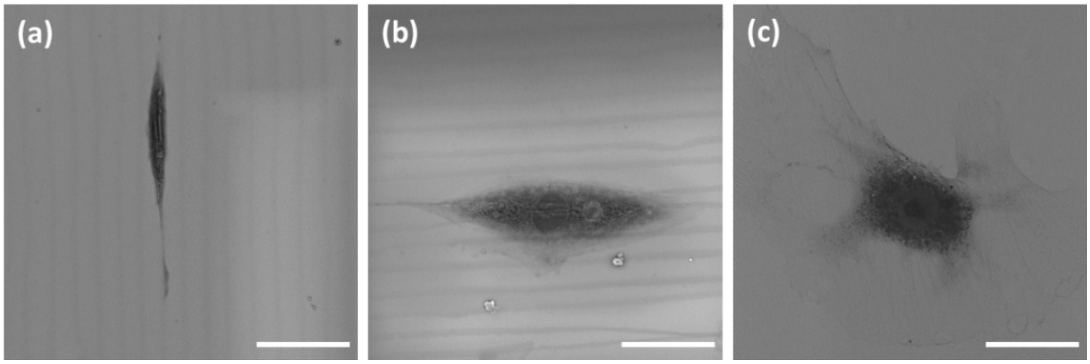

Figure S9. SEM images of smooth muscle cells (SMCs) cultured on the patterns of the tube: (a) on the inside surface, (b) outside surface and (c) control studies within non-coated blank tube. Scale bars are all 30 μm.

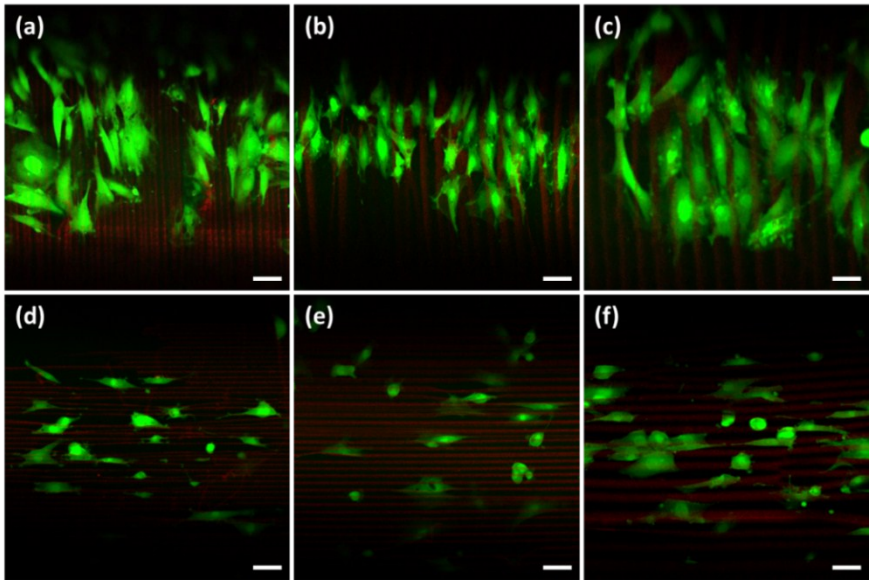

Figure S10. Fluorescence images of FDA staining of living smooth muscle cells (SMCs) cultured on the patterns of the tube: (a-c) on the inside surface, (d-f) outside surface. (a, d) 0.05 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA, (b, e) 0.1 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA, (c, f) 0.2 mg mL^{-1} P3HT & 0.1 mg mL^{-1} PLA. Scale bars are all 50 μm.

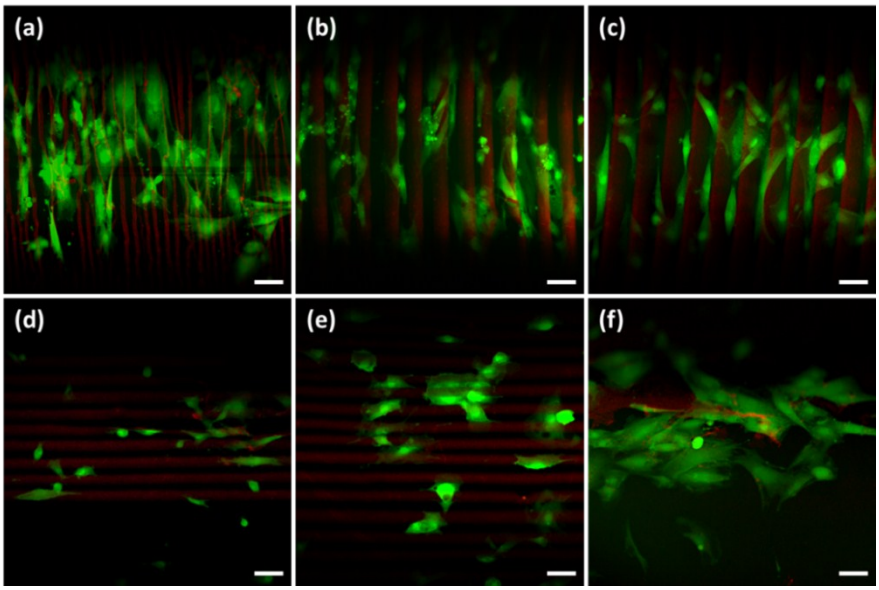

Figure S11. Fluorescence images of FDA staining of living smooth muscle cells (SMCs) cultured on the patterns of the tube: (a-c) on the inside surface, (d-f) outside surface. (a, d) 0.05 mg mL^{-1} P3HT & 0.5 mg mL^{-1} PLA, (b, e) 0.1 mg mL^{-1} P3HT & 0.5 mg mL^{-1} PLA, (c, f) 0.2 mg mL^{-1} P3HT & 0.5 mg mL^{-1} PLA. Scale bars are all 50 μm.