

Supporting Information for

Conjugated polymer composite artificial muscle with solvent-induced anisotropic mechanical actuation

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Supporting Movies

Movie S1. Real-time video for the bending process of an aligned MWCNT/PTP composite film at 78 °C.

Movie S2. Slow-motion video for the opening process of an aligned MWCNT/PTP composite flower upon exposure to ethanol. The video is replayed at 0.077X real-time speed, from high-speed footage recorded at a rate of 400 frames per second.

Movie S3. Real-time video for the closing process of an aligned MWCNT/PTP composite flower upon evaporation of ethanol.

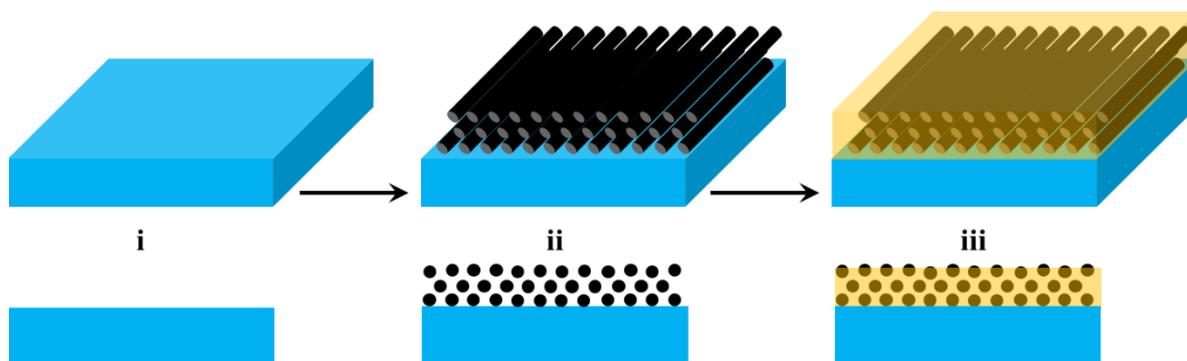


Figure S1. Schematic illustration to the preparation of the aligned MWCNT/PTP composite film by top and side views: i, poly(dimethylsiloxane) substrate; ii, paving aligned MWCNT sheets; iii, spin-coating PTP solution onto aligned MWCNT sheets.

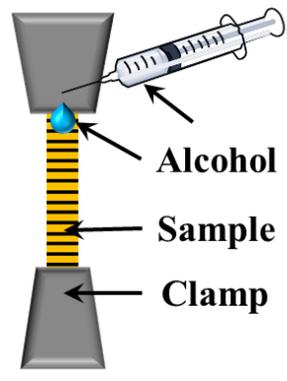


Figure S2. Schematic illustration to the measurement of the force generated by the aligned MWCNT/PTP composite film.

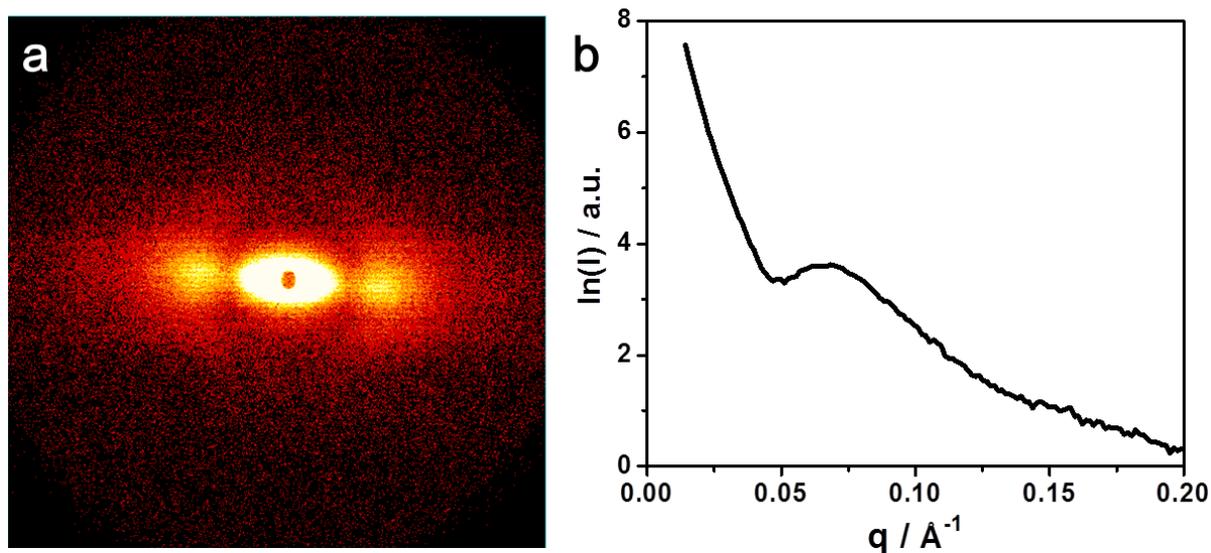


Figure S3. Two-dimensional small-angle X-ray scattering pattern (a) and linear scattering profile (b) of aligned MWCNTs. The sample was attached to the sample holder with the MWCNTs being aligned in the vertical direction. A pair of dense reflection areas in the horizontal direction in (a) indicates the alignment of MWCNTs and the reflection peak in (b) corresponds to the diameter of MWCNTs.

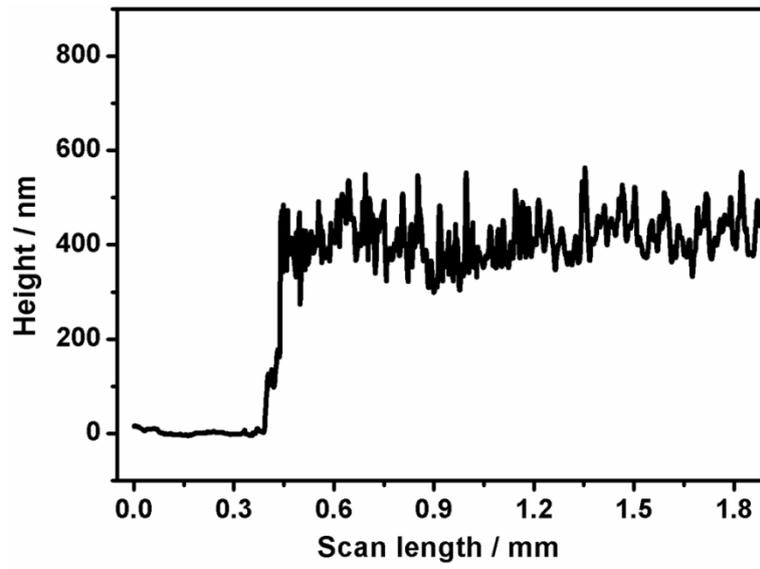


Figure S4. Thickness of the aligned MWCNT/PTP composite film measured with a Dektak 150 surface profilometer.

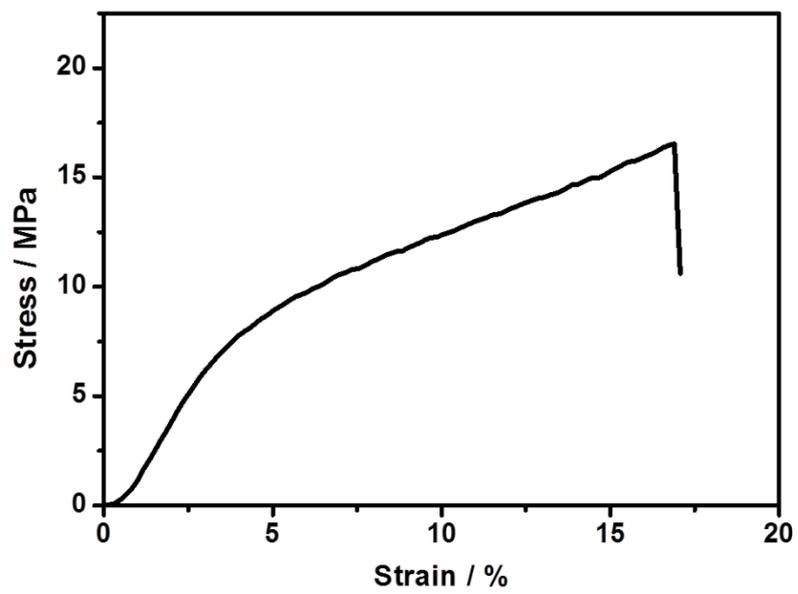


Figure S5. Stress-strain curve of a bare PTP film.

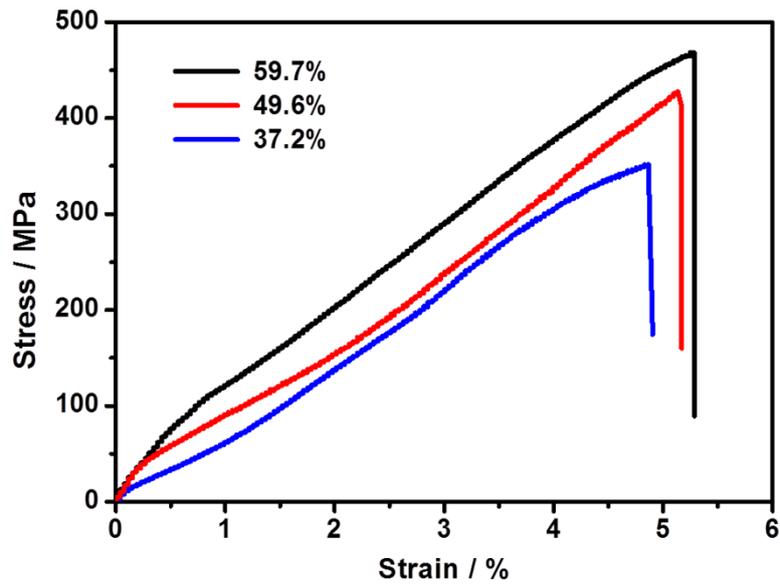


Figure S6. Stress-strain curves of aligned MWCNT/PTP composite films with different weight percentages of MWCNT. They showed strengths of ~470, ~420 and ~350 MPa with MWCNT percentages of 59.7%, 49.6% and 37.2% respectively.

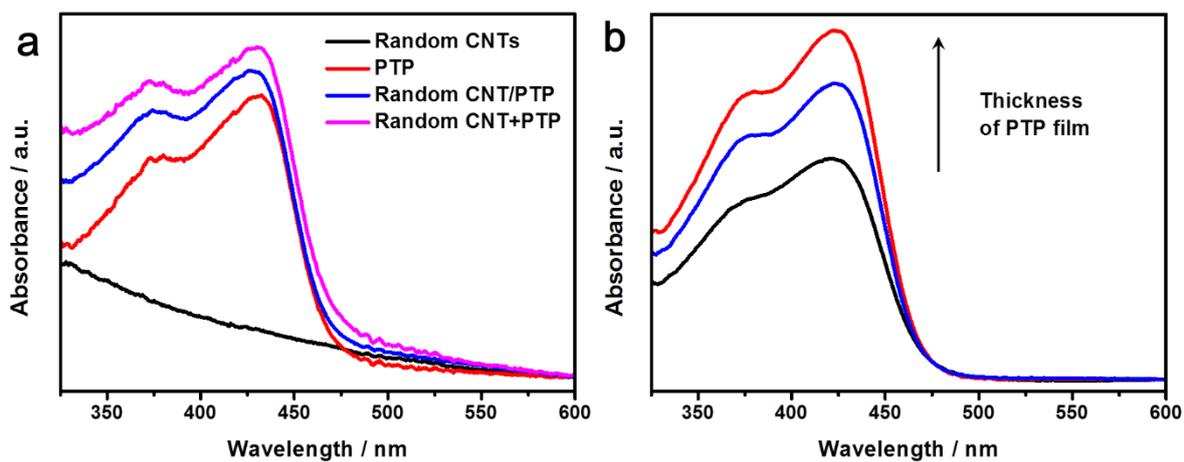


Figure S7. (a) UV-vis spectra of the bare PTP, random MWCNTs, random MWCNT/PTP composite and the stacked film with one random MWCNT layer and one PTP layer. (b) UV-vis spectra of the bare PTP films with increasing thicknesses.

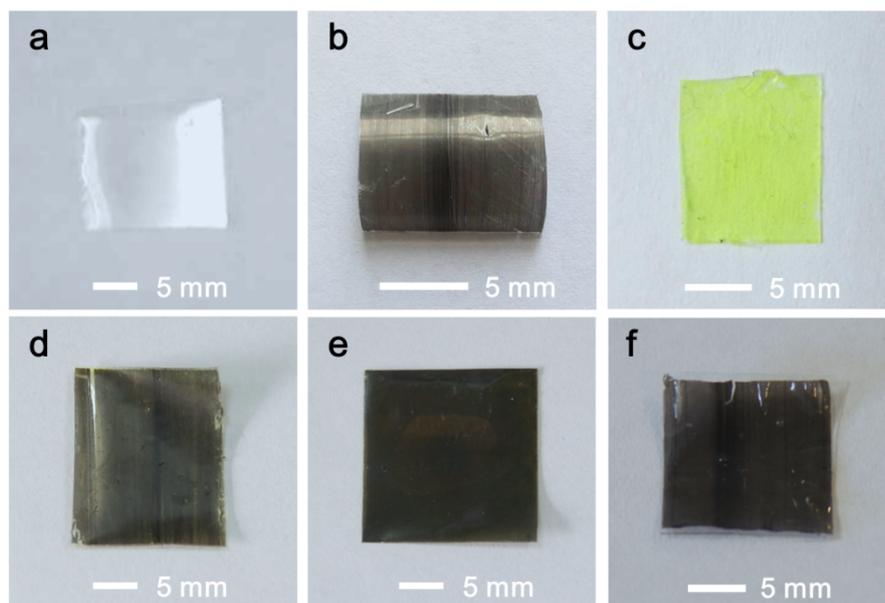


Figure S8. Photographs of different films after evaporation of ethanol. (a) A bare poly(dimethylsiloxane) film. (b) A bare aligned MWCNT sheet on poly(dimethylsiloxane) substrate. (c) A PTP film on poly(dimethylsiloxane) substrate. (d) A PTP film and an aligned MWCNT sheet being sequentially attached onto the poly(dimethylsiloxane) substrate. The PTP was first spun-coated on the substrate, followed by paving the aligned MWCNTs on the top of the PTP film. (e) A randomly dispersed MWCNT/PTP composite film on the poly(dimethylsiloxane) substrate. (f) A polymethyl methacrylate film coated on the aligned MWCNT/poly(dimethylsiloxane) substrate. The MWCNTs were aligned along the vertical direction in (b), (d) and (f).

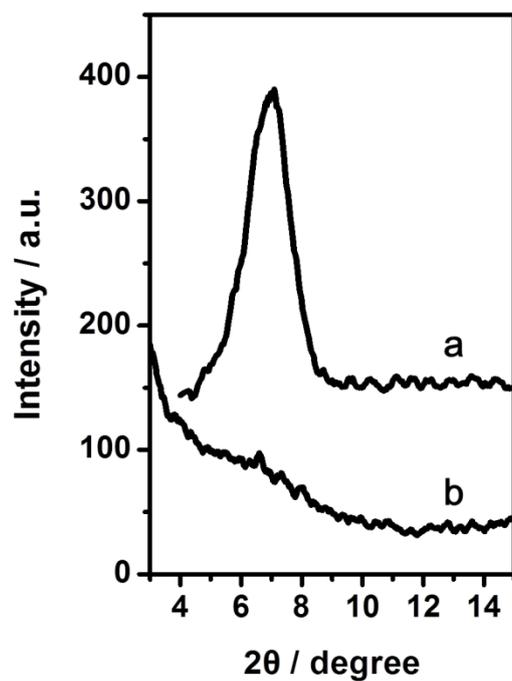


Figure S9. X-ray diffraction patterns of an aligned MWCNT/PTP composite film. (a) After evaporation of solvent. (b) After exposure to solvent.

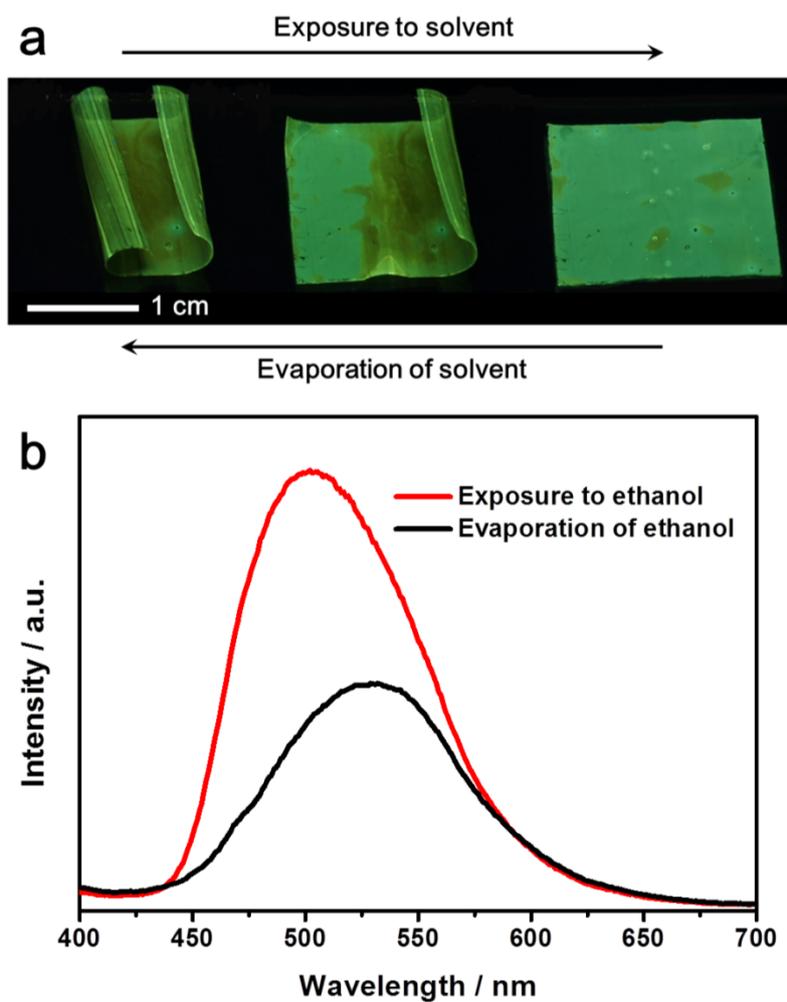


Figure S10. (a) Fluorescence micrographs of a bilayer composite film between exposure to and evaporation of ethanol (excited by UV light with a wavelength of 254 nm). (b) Fluorescent spectra of the aligned MWCNT/PTP composite film upon exposure to and after evaporation of ethanol.

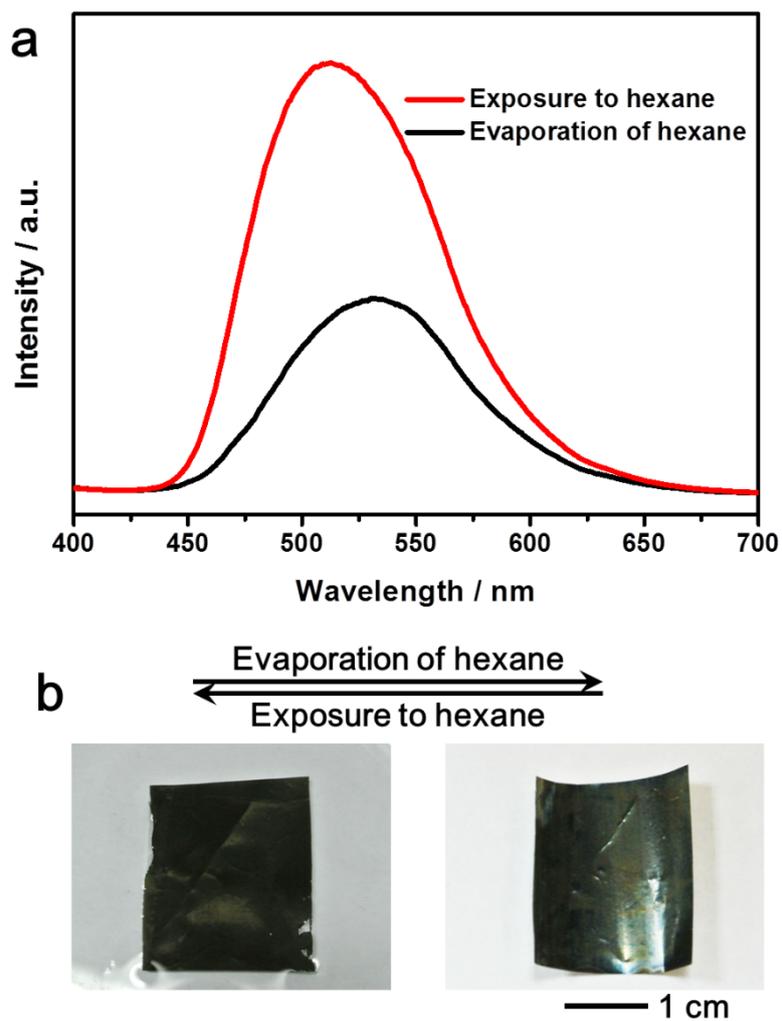


Figure S11. (a) Fluorescent spectra and (b) photographs of the aligned MWCNT/PTP composite film on poly(ethylene terephthalate) substrate upon exposure to and evaporation of n-hexane. Here poly(ethylene terephthalate) was used instead of poly (dimethylsiloxane) to avoid the swelling of the substrate by n-hexane.

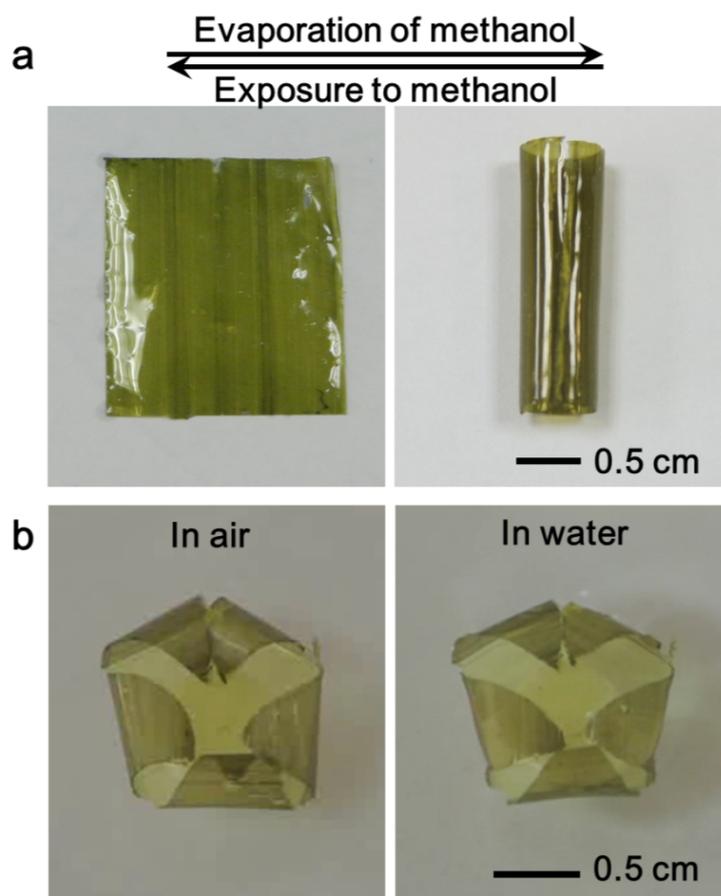


Figure S12. (a) Photographs of a bilayer composite film upon absorption and evaporation of methanol. (b) Photographs of an artificial flower based on the bilayer composite film before and after exposure to water.

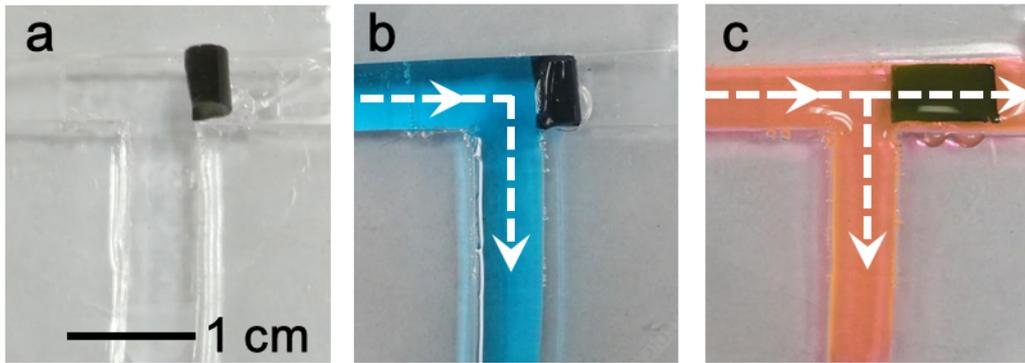


Figure S13. Photographs of a micro-valve based on the aligned MWCNT/PTP composite film used in a T-shape channel. (a) The channel without fluid. (b) Blue liquid flowing in the channel and being blocked by the right valve. (c) Orange liquid flowing to the right through the valve by unbending the film to the flat format. The white arrows indicate the flow directions.