

Supporting Information

Bio-inspired Hybrid Carbon Nanotube Muscles

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Supplementary Movies

Movie S1. Real-time tracing of the contraction and relaxation of a single myotube.

Movie S2. Contraction of hornworm-like hybrid muscle.

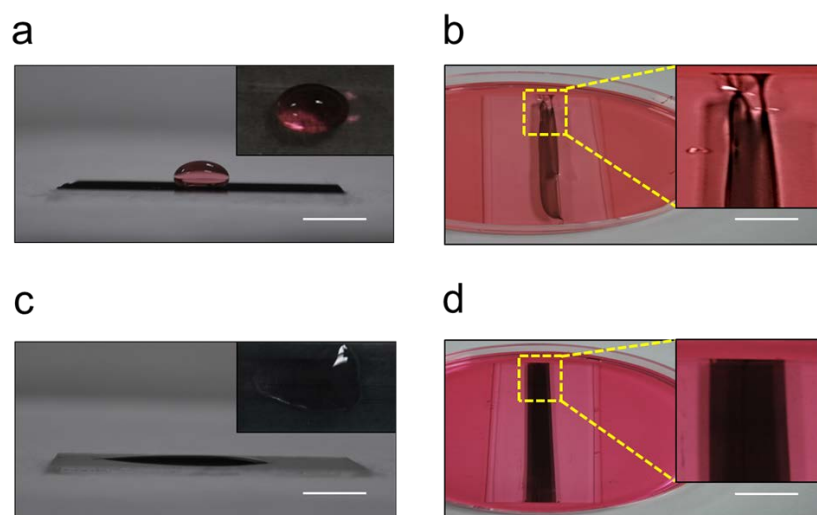


Figure S1. Comparison of the hydrophilicity of a bare MWCNT and a PEDOT-coated MWCNT sheets. (a) When cell culture medium (DMEM) is dropped on a bare MWCNT, the drop on it maintains a higher contact angle (Scale bar: 1 cm). (b) Fully-sunk bare MWCNT sheet with partially damaged structure in culture medium (Scale bar: 2 cm). (c) While, the drops on a PEDOT/MWCNT sheet, spread widely, indicating its hydrophilicity (Scale bar: 1 cm). (d) Fully-sunk PEDOT/MWCNT sheet showing the shape-maintenance property in culture medium (Scale bar: 2 cm)

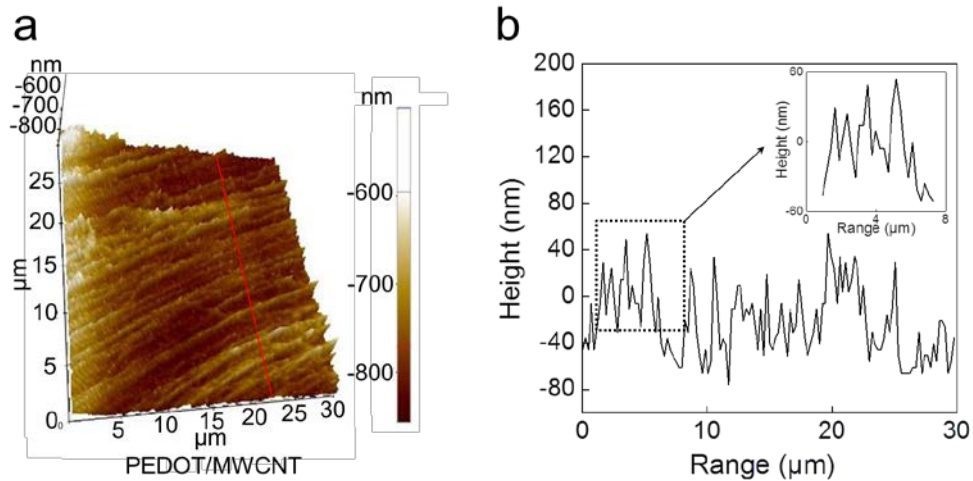


Figure S2. SICM image of the PEDOT/MWCNT sheet surface. The manufactured PEDOT/MWCNT sheet is prepared on a slide glass and placed in PBS buffer solution, and then a SICM image of the surface is obtained. **(a)** A three-dimensional SICM image of a PEDOT/MWCNT sheet surface. Scan size: $30 \times 30 \mu\text{m}$. **(b)** Graph of the SICM image. The inset shows an enlarged line profile from the dashed box.

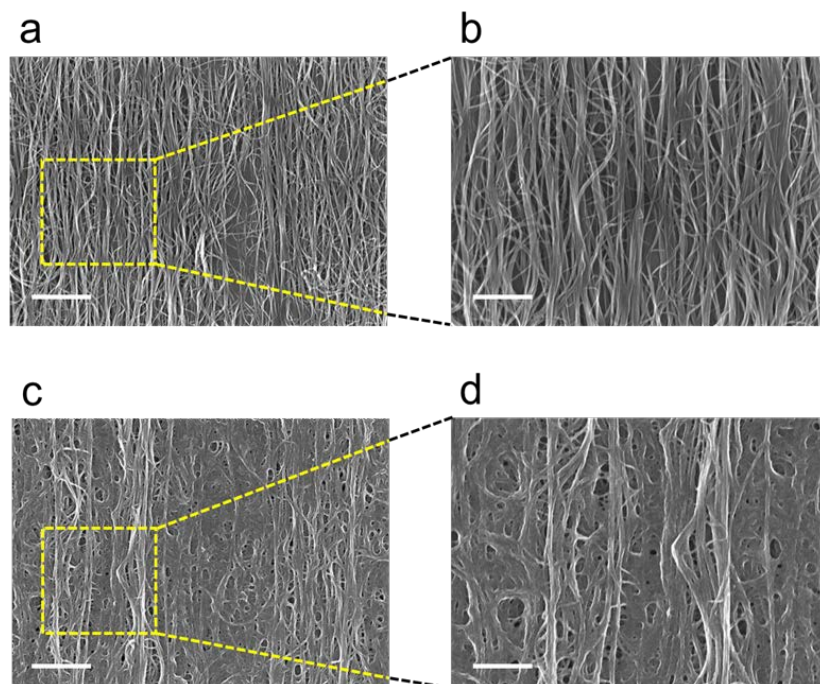


Figure S3. Comparison of each surface of a bare MWCNT sheet and a PEDOT-coated MWCNT sheet. **(a)** The surface image of a bare MWCNT sheet. Each carbon nanotube is well-aligned with an axial direction (Scale bar: 1 μm) and **(b)** is a close-up SEM image of Fig. S3a (Scale bar: 250 nm). **(c)** The surface image of a PEDOT-coated MWCNT sheet. Compared to a bare MWCNT sheet, CNT bundles are densely placed with coating PEDOT polymer, and still kept the alignment from the bare MWCNT sheet (Scale bar: 1 μm). **(d)** a close-up SEM image of Fig. S3c (Scale bar: 250 nm).

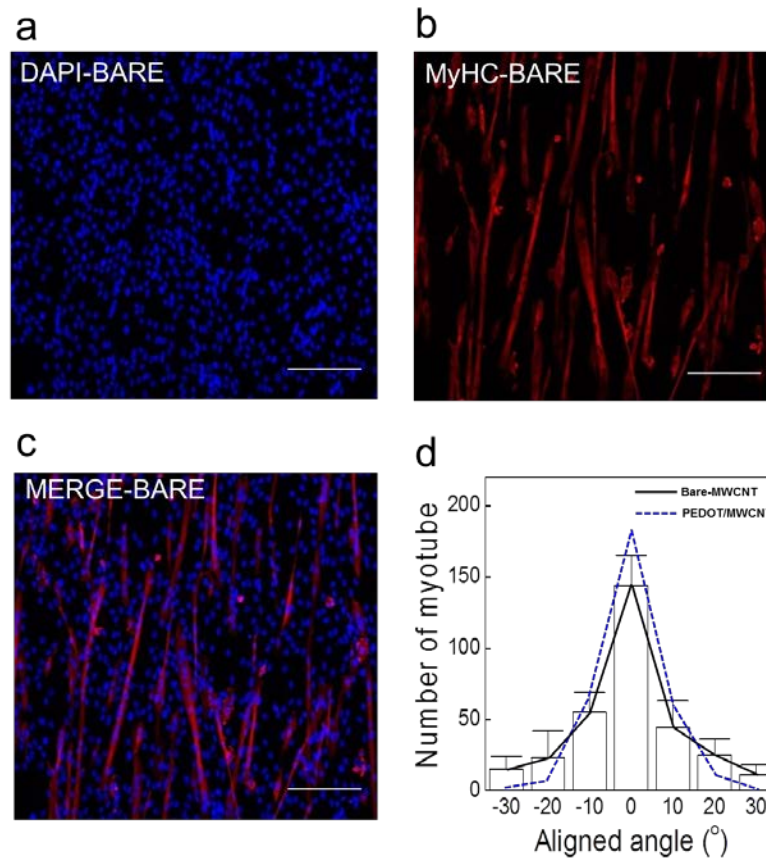


Figure S4. MyHC⁺ C2C12 myotubes differentiated on bare MWCNT sheet. The degree of differentiation and cell alignment on the bare MWCNT sheet is lower than that on the PEDOT/MWCNT sheet. (a) Nuclear staining with DAPI. (b) MyHC immunocytochemistry of the myotubes. (c) Merged image of DAPI and MyHC (Scale bars: 100 μ m). (d) Myotube alignment ratio analyzed by constructed angular spread distribution histogram. About 46 % of the myotubes are aligned with the direction of alignment of the bare MWCNT sheet (0° aligned angle, n = 70).

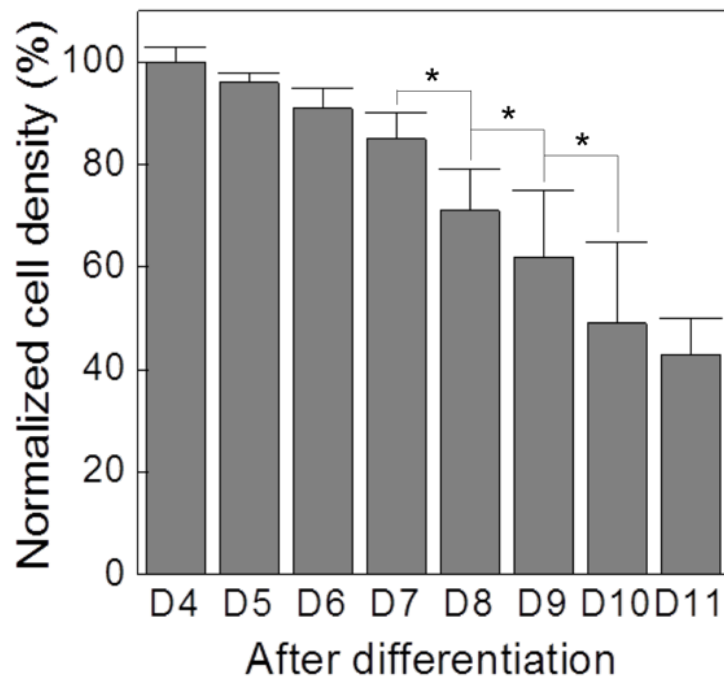


Figure S5. The plot of the normalized cell densities according to the time (after differentiation) (* $p < 0.05$, $n = 5$).