

(Supporting Information)

The carbon nanotubes-elastomer actuator driven electrothermally by low-voltage

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actuator

Experimental

Materials

The silicone rubber Ecoflex 00-50 (Smooth-On, USA) and methanol (Sigma Aldrich, USA) were used in this work. Spinnable MWCNT forests were purchased from Lintec of America Inc (United States).

Preparation of silicone-methanol composite: A highly elastomeric silicone (Ecoflex 00-50, component A and B, 1:1 by weight) as the polymer matrix and methanol as the active phase change material was used. To start with, the methanol was poured on the component A and B, respectively, and mixed by hand. Then, each solution was mixed and stirred for 2 minute through the homogenizer.

Fabrication of hybrid yarn artificial muscle: The MWCNT sheets with width and length of 2 and 10 cm was pulled from a MWCNT forest. The sheet stacks were twisted into a low density yarn in order to provide a high porosity in the yarn. By using a low-inserted twist yarn, the amount of silicone resin was easily infiltrated into the yarn. The silicone and methanol was mixed through the homogenizer for 1 min. After that, a mixture of silicone and methanol composite (3:1 by weight) was poured on the above low-inserted twist yarn in order to infiltrate the homogeneous solution to the twist yarn. After curing for 24 hrs at room temperature, the low-inserted twist yarn was withdrawn from silicone-methanol composite and then reattached at the end to a motor to twist until it was completely coiled. To observe the morphology of the hybrid coiled yarn muscle, the scanning electron microscope (SEM, Hitachi S-4800) was conducted after and before infiltration.

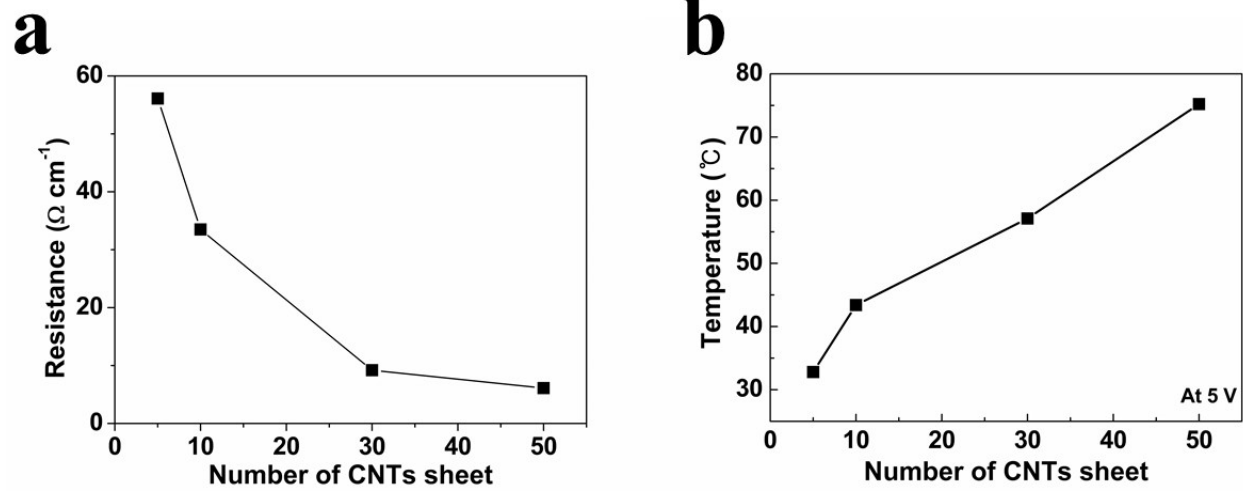


Figure S1. The different of number of CNTs sheets dependence of (a) resistance and (b) temperature

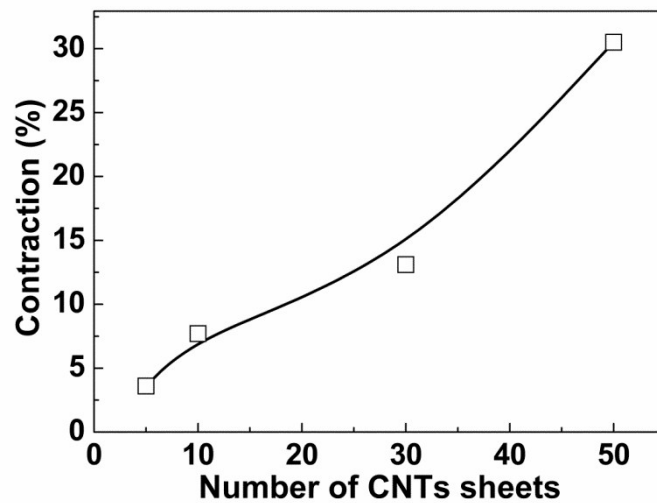


Figure S2. The different of number of CNTs sheets dependence of the contraction of the HCYM driven by DC voltage of 5 V.

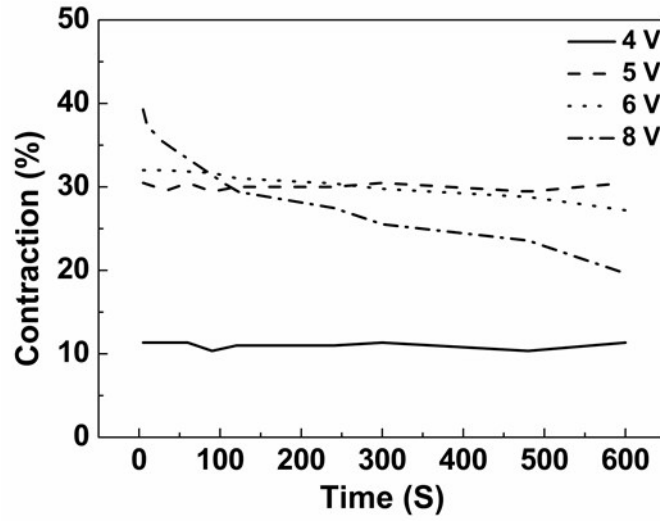


Figure S3. The contraction as a function of time for 600 s after applied different voltages.

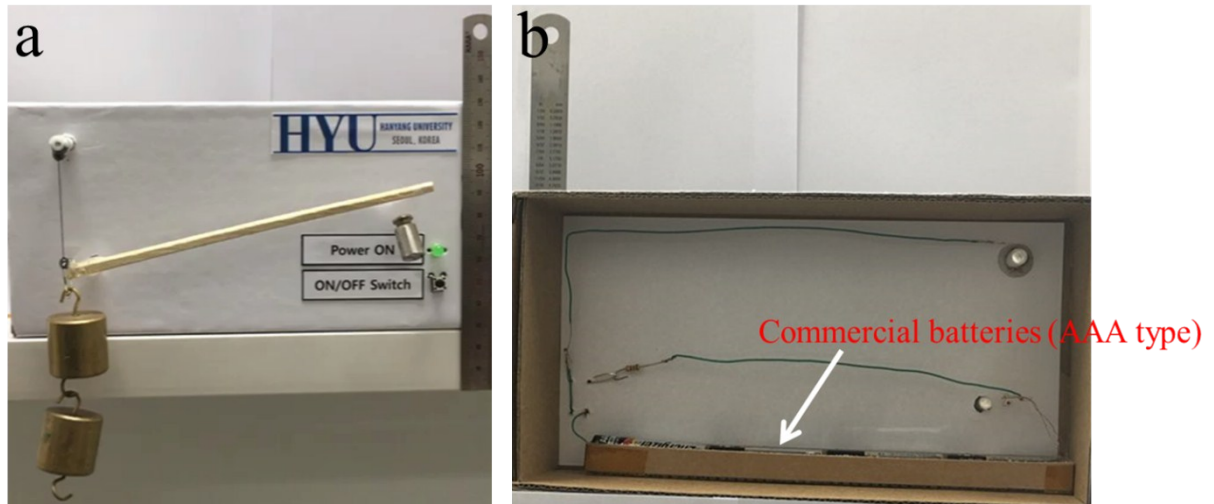


Figure S4. The photographs show the (a) front part and (b) backside of application of the HCYM actuator at 6 V using the commercial batteries (AAA type).