Supporting information for

Moisture-Sensitive Torsional Cotton Artificial Muscle and Textile

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This supporting information contains:

1. Calculation details for torque
2. Supplementary Figures and Figure captions (Fig. S1 to S3)
3. Supplementary Movie and Movie caption (Movie S1)

1. Calculation details for torque

The helical bias angle (α) of a cotton yarn can be calculated using the equation:

$$\tan\alpha = \pi dT \quad (S1)$$

the d is the cotton yarn diameter (in meters), and T is the inserted twist density (in turns m^{-1}). The cotton yarn diameter and the helical angle were obtained from SEM measurements.

For torsional muscle characterization, a high-speed camera recorded the paddle's rotation. The paddle was considered as a semicircular ring, R is the outer radius, and R_0 is the inner radius of the semicircular ring. The R and R_0 were measured as 3.92 and 2.97 mm, respectively. In the torsional actuation experiments, the moment of inertia (I) of the paddle having a weight (M) of 200 mg is calculated as

$$I = M\,(R^2 + R_0{}^2)/4 \quad (S2)$$

and therefore the maximum torque (τ) can be calculated as

$$\tau = I\alpha \quad (S3)$$

2. Supplementary Figures

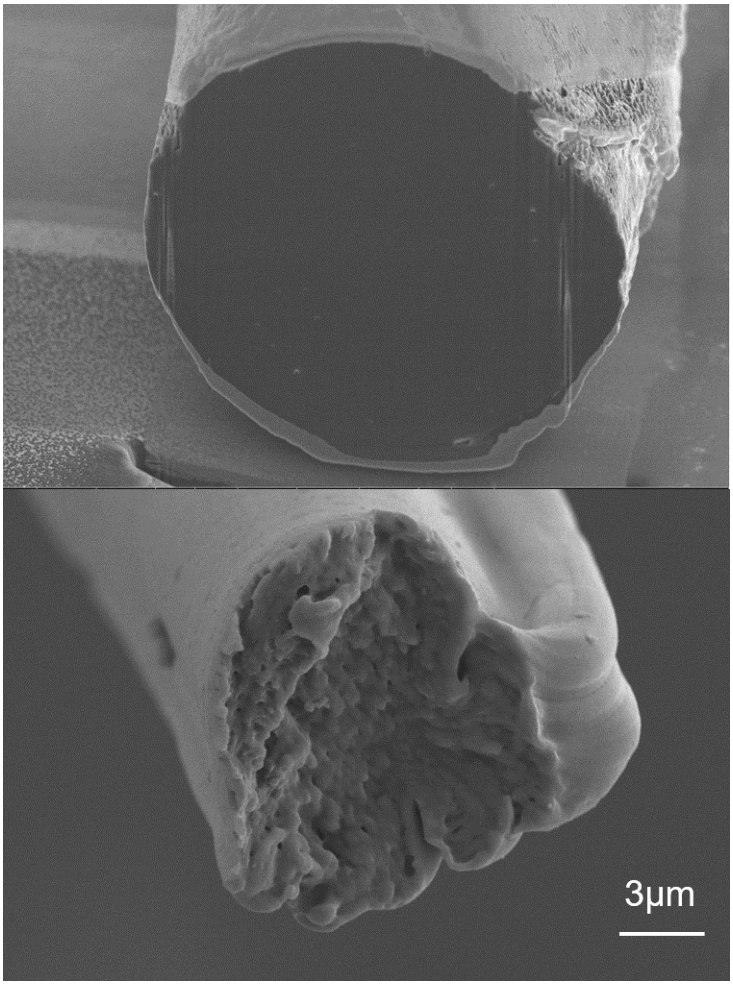

Figure S1. SEM images of the cross-section of a cotton fiber (**a**) using focused ion beam and (**b**) cut in liquid N_2.

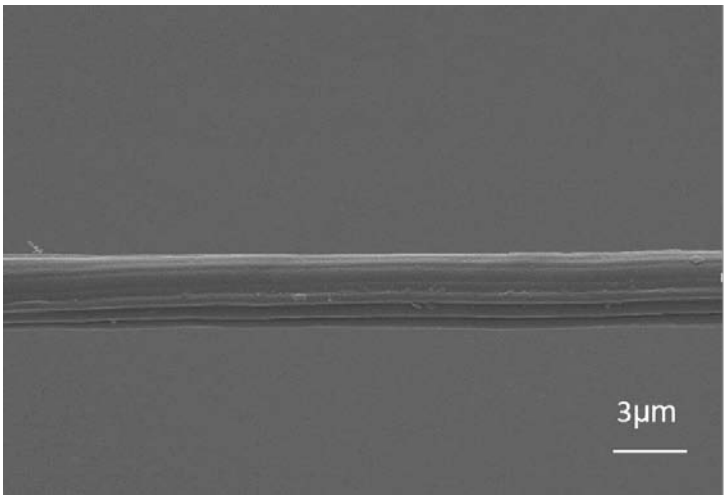

Figure S2. SEM image of a cotton fiber showing the surface morphology.

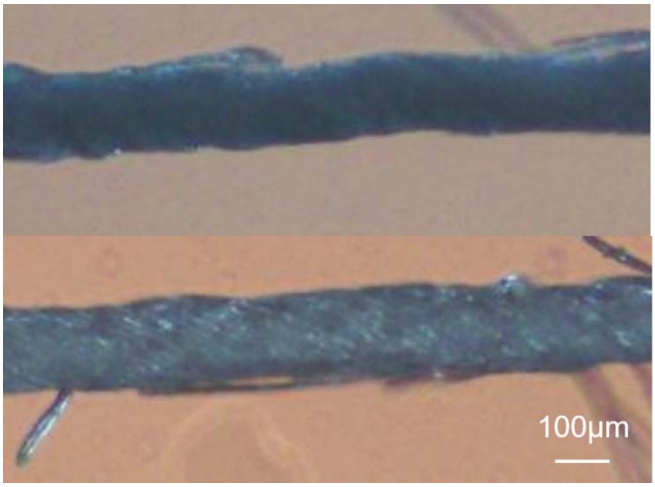

Figure S3. Photographs of a cotton fiber (taken using an OLYMPUS BX53 metalloscope) before (**a**) and after (**b**) absorption of water fog at room temperature. The fiber diameter increases by about 7% after water absorption. The twist density of the cotton yarn was 1200 turns m^{-1}. The water fog flux is 0.25 g s^{-1} m^{-2}.

3. Supplementary Movie

Movie S1. A moisture sensitive window made of cotton yarn artificial muscle closes on exposure to water fog, and opens again when it is dried. The window is made by knitting a 5-cm-long, self-balanced, 2-ply, single filament cotton yarn muscle (with yarn diameter of 140 μm and weight of 2.5 mg) through the center of a 5-cm-long, 2-cm-wide textile (weight of 0.14 g).