Supplementary Information

Water Responsive Fabrics with Artificial Leaf Stomata

Lihong Lao[a†], Hedan Bai[b‡], and Jintu Fan[a,c*]

[a] Department of Fiber Science & Apparel Design, Cornell University, Ithaca, NY 14853, USA

[b] Sibley School of Mechanical and Aerospace Engineering, Cornell University, Ithaca, NY 14853, USA

[c] School of Fashion and Textiles, Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, 999077, China

[†]Present address: Department of Materials Science and Engineering, University of Illinois Urbana-Champaign, Urbana, IL 61801, USA

[‡]Present address: Querrey Simpson Institute for Bioelectronics, Northwestern University, Evanston, IL 60208, USA

Corresponding Author: [*] jin-tu.fan@polyu.edu.hk

Water behavior of two polyacrylamide (PAAm) hydrogels with different cross-linker loadings

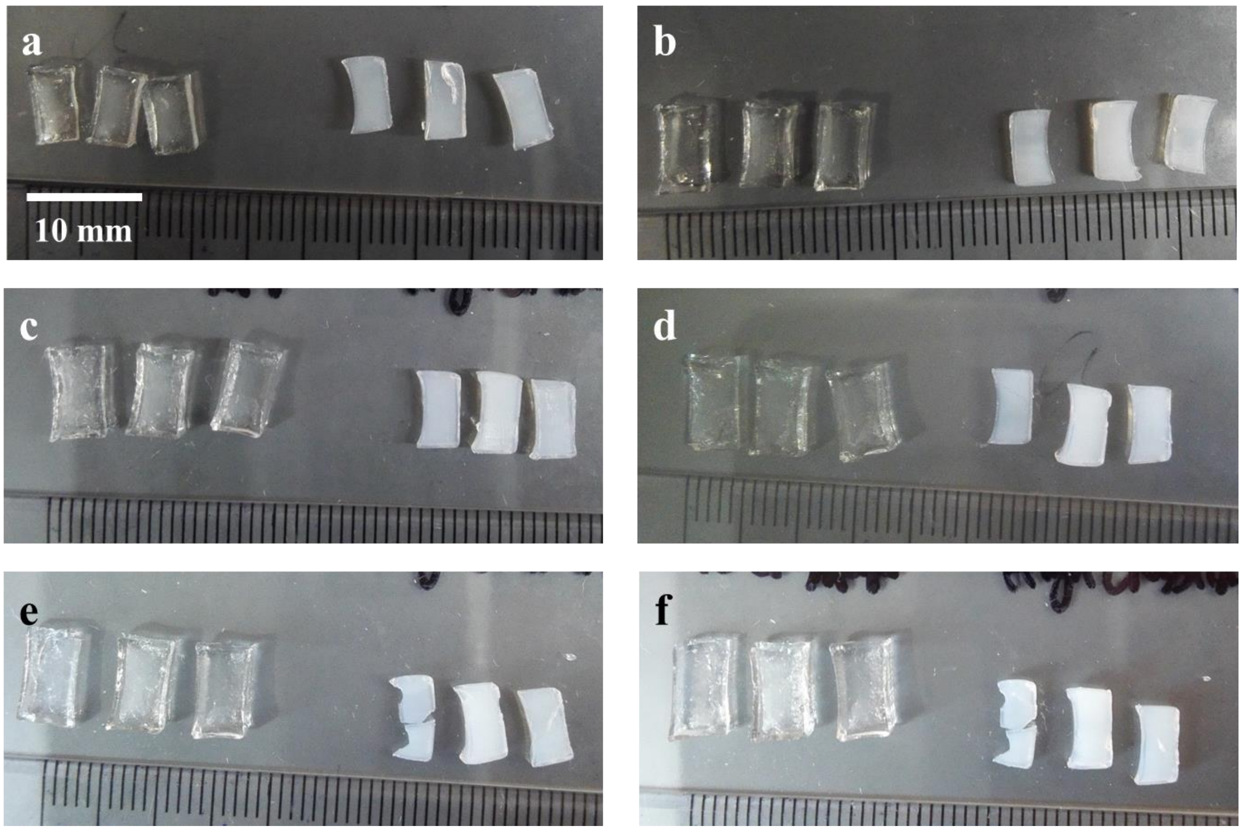

Fig. S1. Images of three parallel samples of less cross-linked (left) and highly cross-linked (right) PAAm hydrogels after water uptake for (a) 0 min, (b) 10 min, (b) 20 min, (d) 40 min, (e) 60 min and (f) 120 min, respectively.

Mechanical properties of two PAAm hydrogels before and after water swelling

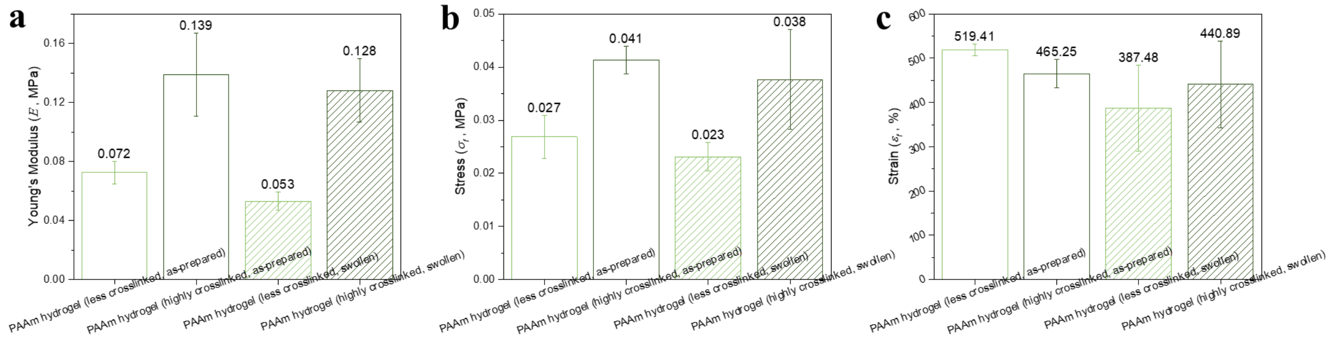

Fig. S2. Mechanical properties of the less cross-linked (LC) and highly cross-linked (HC) PAAm hydrogels before and after water swelling. (a) Young's Modulus (*E*, at 2.5% strain), (b) Fracture stress (σ_f) and (c) Fracture strain (ε_f), respectively.

Coating of three-layer hydrogel on slit areas of the fabric

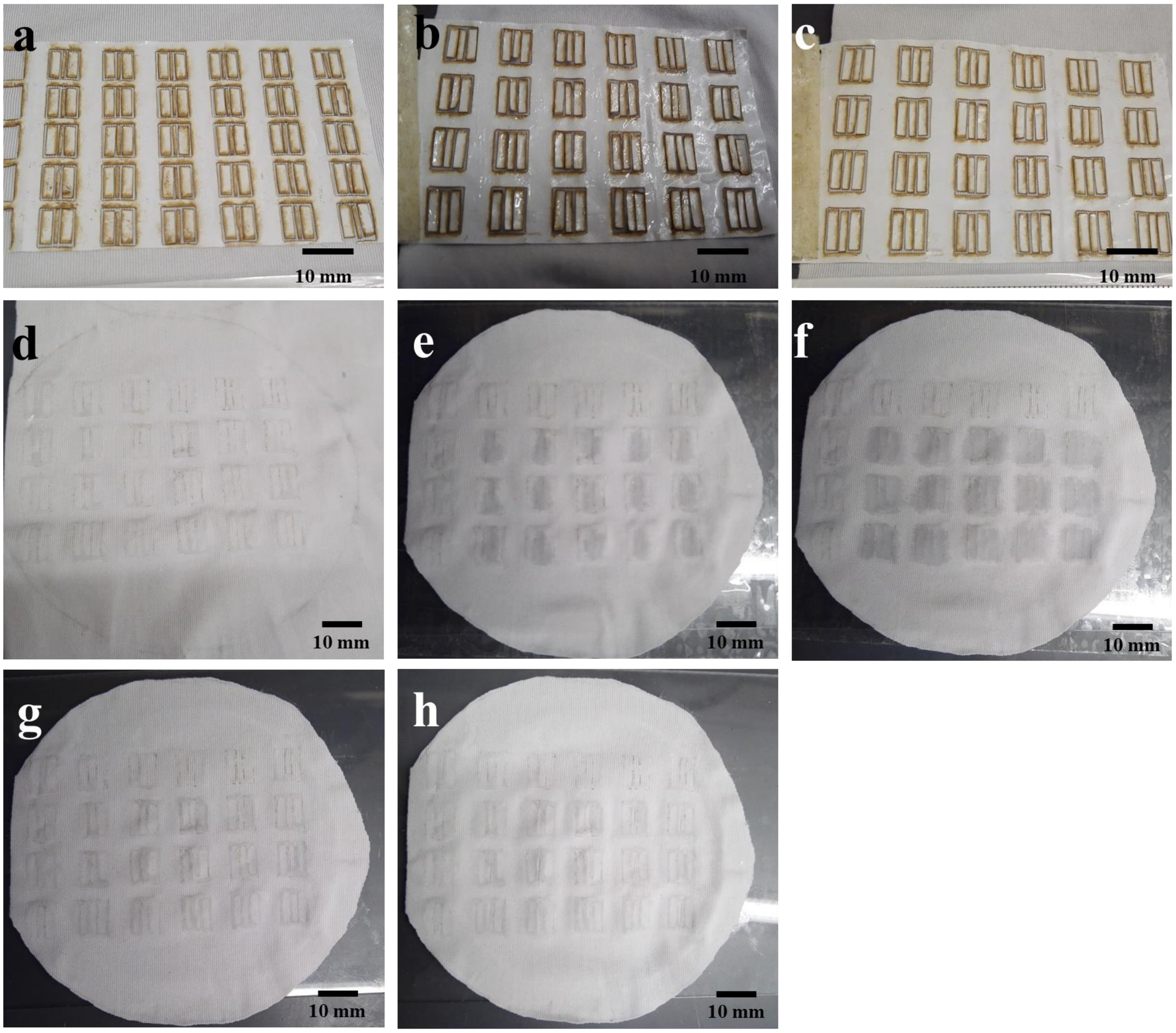

Fig. S3. Fabrication process to create knitted nylon fabrics with the slit areas coated by three-layer PAAm hydrogels as artificial leaf stomata. (a) Cover nylon fabric with a laser-cut tape mask with patterned window structure. (b) Extrude a glue resist into the grooves of the window patterns. (c) Solidify the glue in air. (d) Form the glue template with patterned windows after peeling off the mask. (e) Inject and cure the HC hydrogel solution in the inner window of the glue window templates. (f) Inject and cure the LC hydrogel in the two outer windows of the glue window templates. (g) Form the three-layer hydrogel coated windows after hydrogel being completely cured. (h) Cut slits in the middle of the inner HC hydrogel layer to form leaf stomata-mimicking pores.

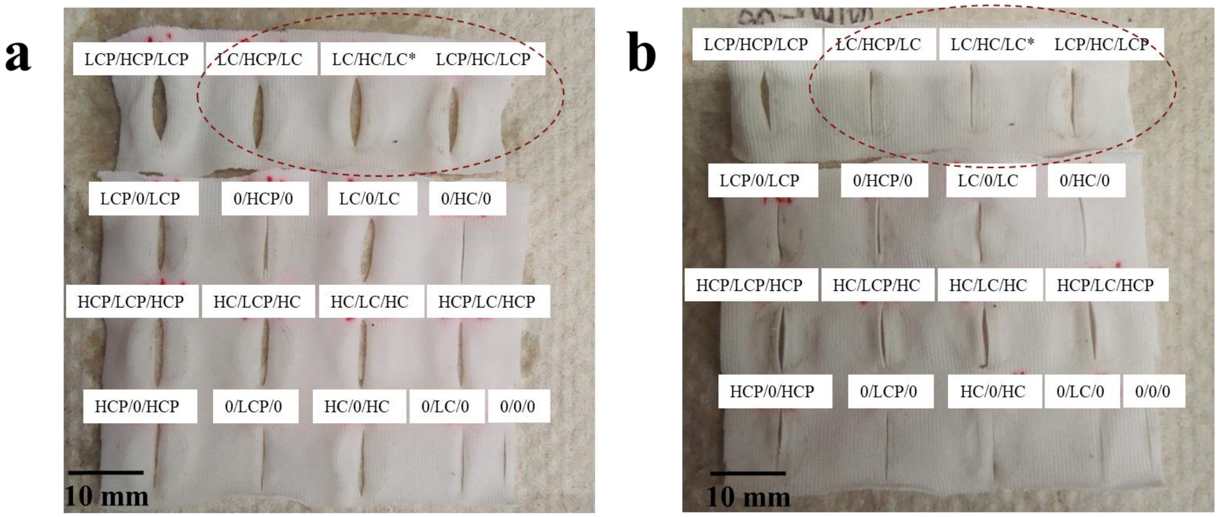

Fig. S4. Water response of the slit windows coated by different combinations of no hydrogel (0), less cross-linked hydrogel (LC), highly cross-linked hydrogel (HC), less cross-linked hydrogel plus PAAm polymer (LCP) and highly cross-linked hydrogel plus PAAm polymer (HCP) under (a) wet and (b) dry conditions, respectively. Red circles showed good combinations for slit open and close behaviors. * represents the hydrogel combination used in the following experiments.

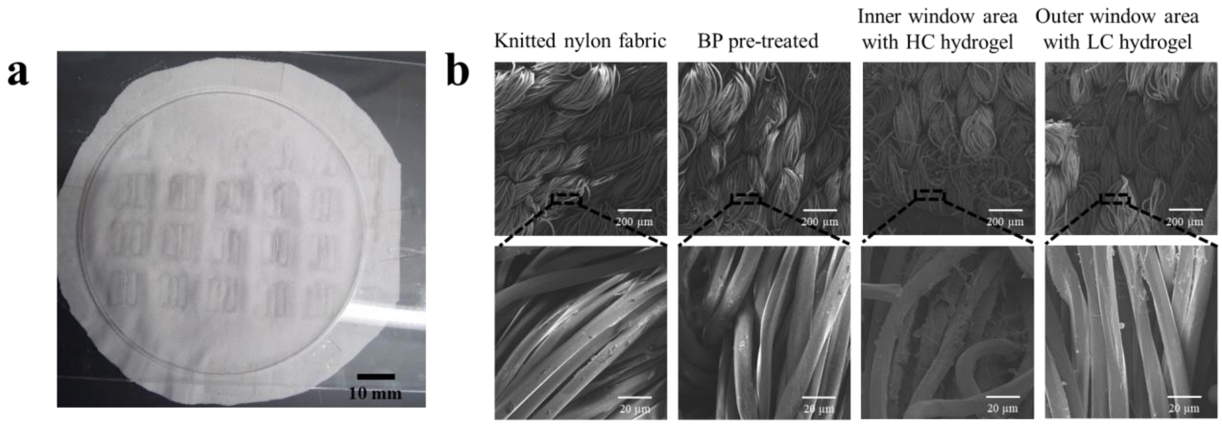

Fig. S5. Morphology of back side of knitted nylon fabrics under different treatment conditions. (a) An image of back side of a typical knitted nylon fabric with three-layer LC/HC/LC hydrogel coated slit structures. (b) SEM images of back side of the neat nylon fabric, BP pre-tread fabric, the inner and outer window areas of the three-layer hydrogel coated slits on the fabrics.

Performance of the fabric with three-layer hydrogel coated slits

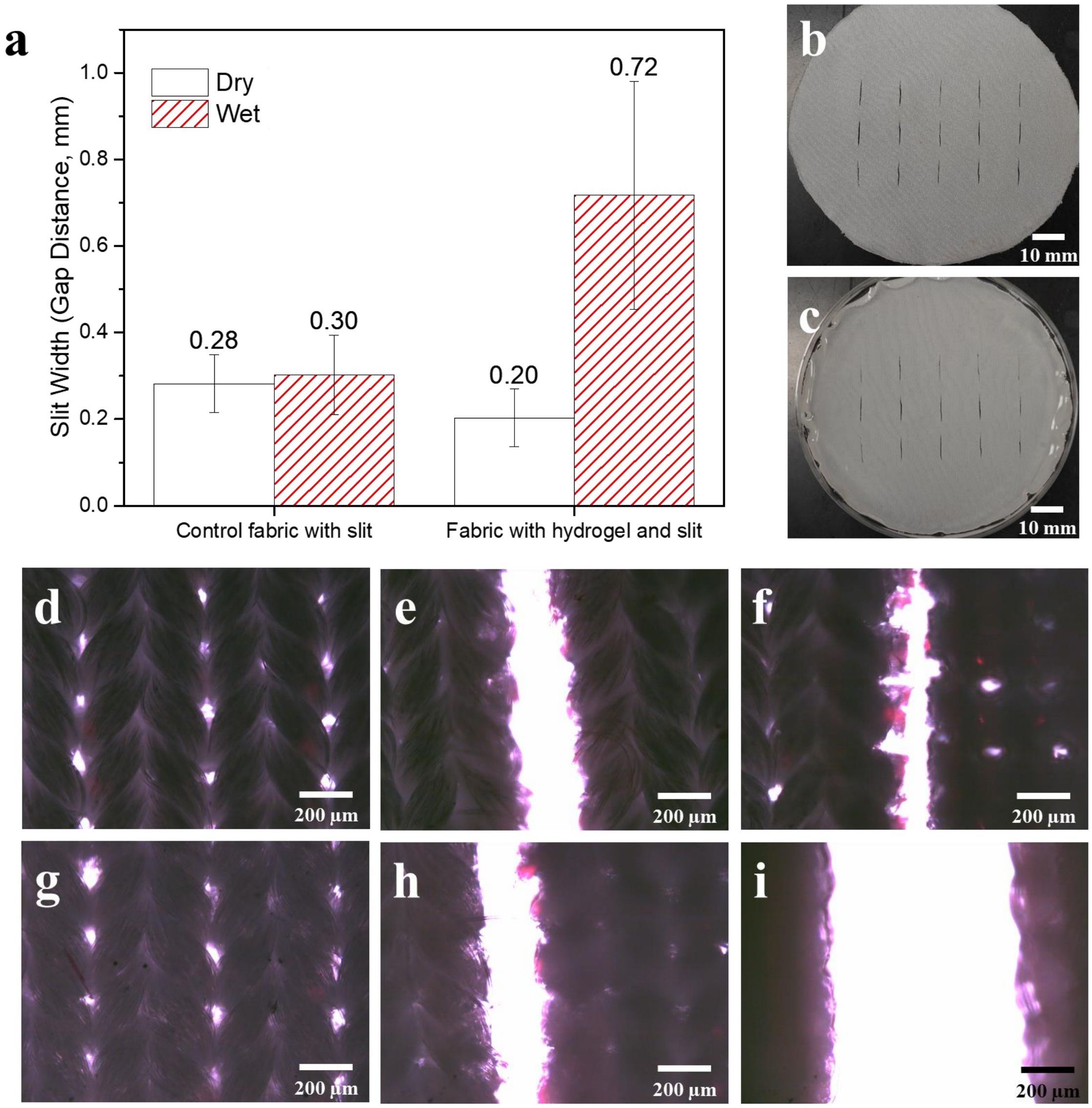

Fig. S6. Water response of control knitted nylon fabric, control fabric with slits and fabric with slits coated with three-layer hydrogels. (a) Slit width (gap distance) of control fabric with slits, and fabric with slit areas coated with three-layer hydrogels under both dry and wet conditions, calculated from optical microscopy. (b, c) Images of control fabric with slits under (b) dry and (c) wet conditions, respectively. (d-i) Representative optical images of the slit responses of (d, g) control fabric, (e, h) control fabric with slits and (f, i) fabric with hydrogel and slits under (d-f) dry and (g-i) wet conditions, respectively. Wet condition refers to the fabrics being immersed in water for 10 min.

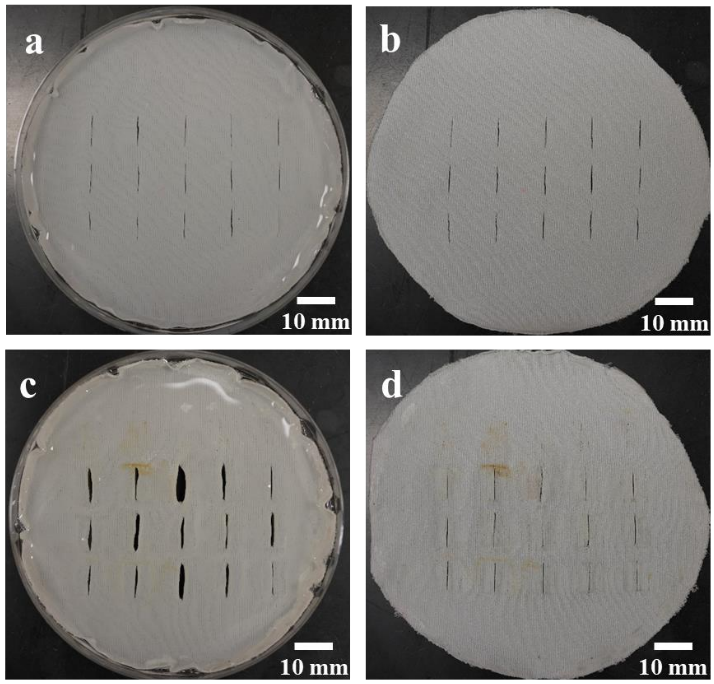

Fig. S7. Slit response on (a, b) Control fabrics with slits and (c, d) Fabric with slit areas coated with three-layer hydrogels in artificial sweat under (a, c) wet and (b, d) dry conditions, respectively. Wet condition refers to the fabrics being immersed in artificial sweat for 10 min.

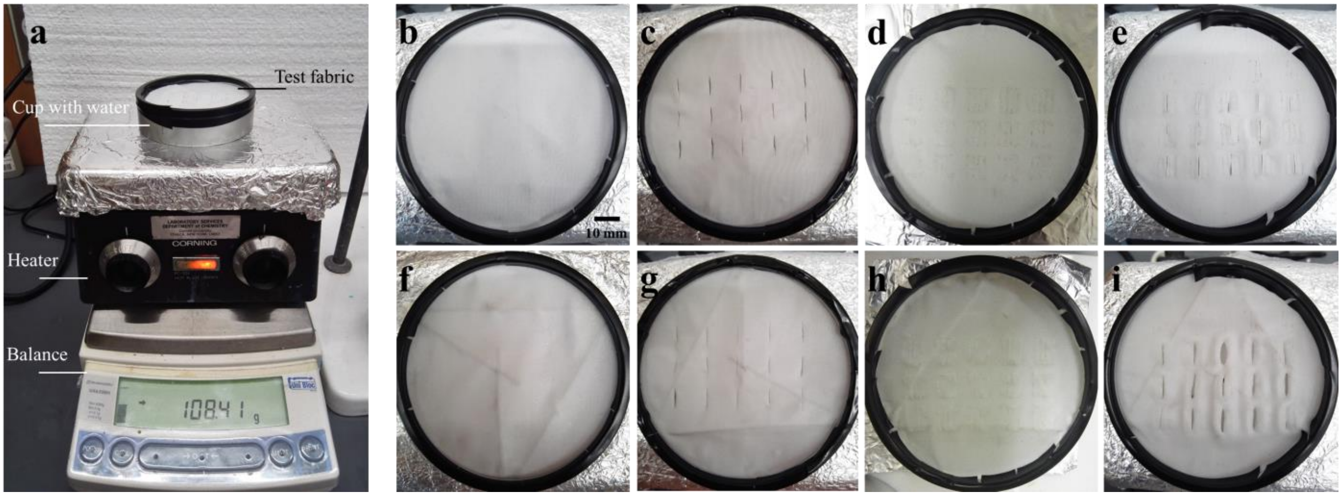

Fig. S8. Cup method to measure water vapor transmission rate (WVTR) of the fabrics. (a) Experimental set-up with a heater to elevate the temperature to 35 ^oC. (b-i) The fabrics were covered on the cups for tests under (b-e) dry and (f-i) wet conditions, respectively. (b, f) Control knitted nylon fabric, (c, g) Control fabric with slits, (d, h) Fabric coated with three-layer hydrogels but without slits, and (e, i) Fabric coated with three-layer hydrogels and with slits.

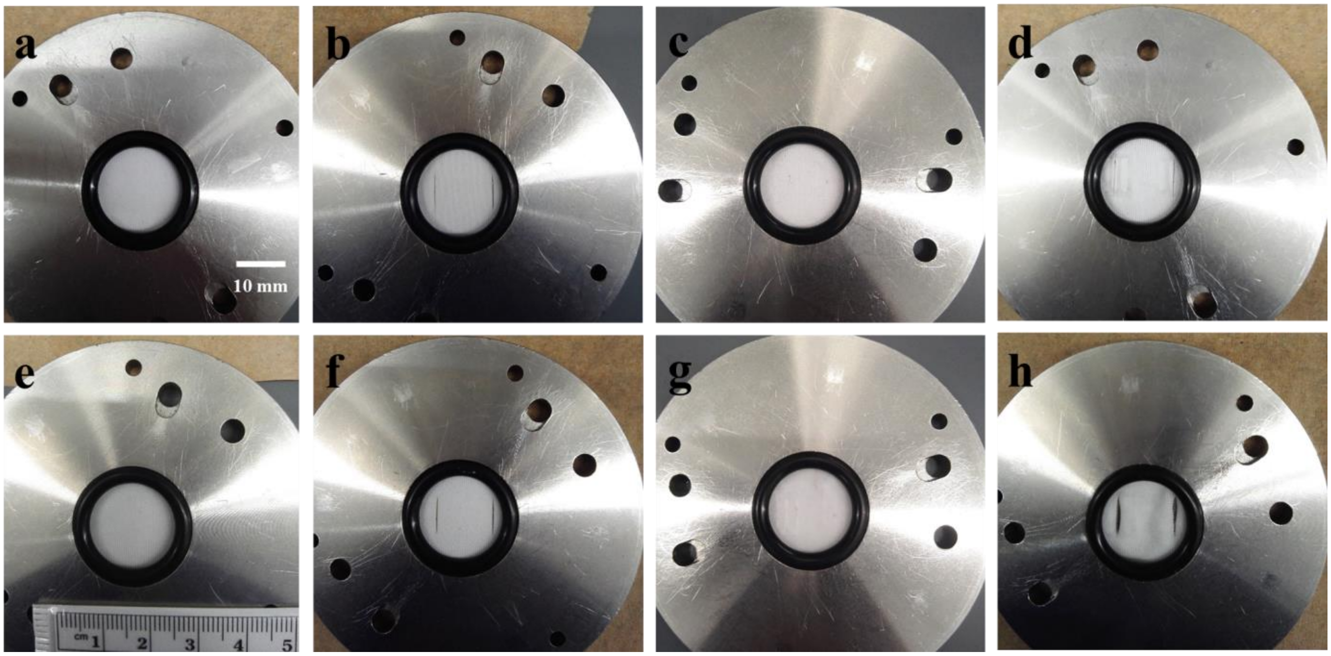

Fig. S9. Fabric samples fixed in the capillary flow porometer chambers for air permeability test under (a-d) dry and (e-h) wet conditions, respectively. (a, e) Control knitted nylon fabric, (b, f) Control fabric with slits, (c, g) Fabric coated with three-layer hydrogels but without slits, and (d, h) Fabric coated with three-layer hydrogels and with slits.

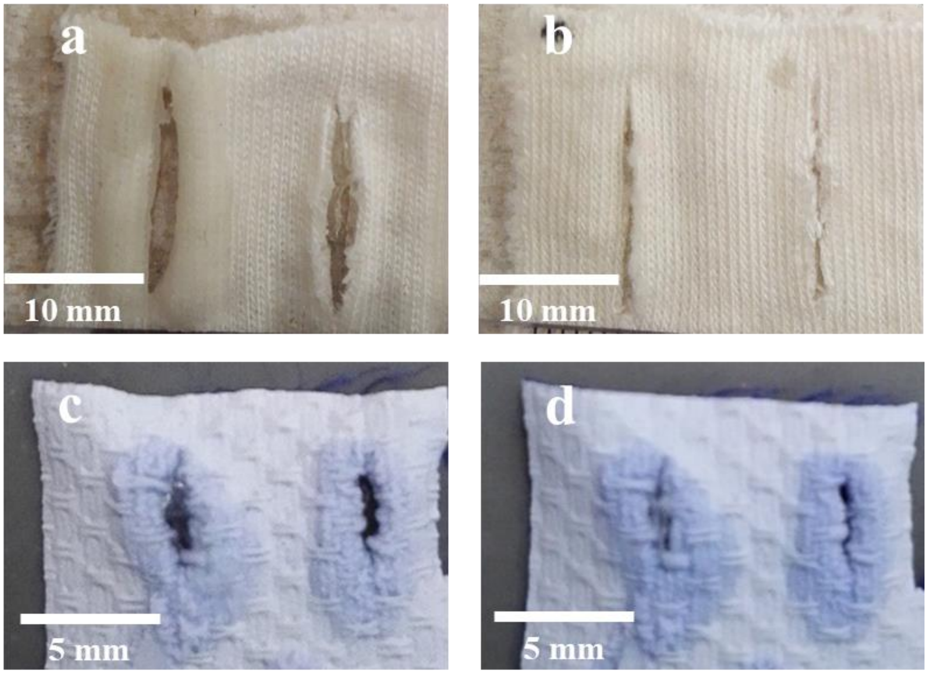

Fig. S10. Slit response on other fabrics with slit areas coated with three-layer hydrogels. (a, b) Cotton fabric and (c, d) Polyurethane fabric under (a, c) wet and (b, d) dry conditions, respectively. Wet condition refers to the fabrics being immersed in water for 10 min.

Movie S1. Slit response of **control fabric with slits only** when contacting with artificial sweat for 10 min. In the first 5 min, the fabric was naturally floating in the liquid, and afterward it was immersed completely into the liquid.

Movie S2. Slit response of **fabric with slit areas coated with three-layer hydrogels** when contacting with artificial sweat for 10 min. In the first 5 min, the fabric was naturally floating in the liquid, and afterward it was immersed completely into the liquid.