Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Smart Moisture Management and Thermoregulation Properties of Stimuli-Responsive Cotton Modified With Polymer Brushes

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Experimental Section:

Materials. Cotton fabrics used in the experiments were pretreated by singeing, desizing, scouring, bleaching and mercerizing. Subsequently, they were cleaned with water, ethanol, and toluene to remove any possible impurities before use, and finally dried at room temperature and cured at 105 ^{o}C for 24 h in an oven. N-Isopropylacrylamide (NIPAM), N,N,N,N,N-pentamethyldiethylenetrimine (PMDETA), copper(I) bromide (CuBr), and methanol were purchased from Sigma-Aldrich. NIPAM was recrystallized in n-hexane to remove the inhibitors. CuBr was purified by stirring in glacial acetic acid for 5 h, was washed with absolute ethanol and anhydrous diethyl ether, was dried under vacuum for 12 h at room temperature, and was stored under dry nitrogen. The monomer was used as received. Silane initiator was synthesized by our lab, the synthesis detail is described in reference [1]

Surface Graft Initiator Monolayers.

The purified cotton fabrics were placed in dried toluene that contained triethyamine (2%, w/v). Then, the surface initiator, silane initiator was added drop wise. The mixture was left for 1 h at room temperature for 12 h. Finally, the cotton fabrics were cleaned with acetone and toluene and were dried under a nitrogen flow.

Fabrication of PNIPAM Brushes.

Preparation of PNIPAM brushes was achieved by immersing the substrates with the initiator grafted onto the cotton fabrics. For a 3.9 M NIPAM solution, NIPAM (3.79 g, 33 mmol) was dissolved in a 7:3 mixture of MeOH/H_2O (3.75 mL) and subjected to three freeze−pump−thaw cycles. Inside a glovebox, CuBr (48 mg, 0.33 mmol) and PMDETA (0.174 g, 210 μL, 1.0 mmol) were weighed into a jar with screw-top lid, dissolved in the MeOH/H_2O mixture containing NIPAM.The polymerization was allowed to proceed for 30 min at room temperature, after which the substrates were removed from the reaction flask and were then rinsed with MeOH and H_2O and dried under a stream of nitrogen.

Moisture Regain Measurements.

Cotton fabrics were conditioned at 20 ± 1°C &95 ± 2% RH and 40 ± 1°C &95 ± 2% RH for a period of 8 hours respectively before the weight measurement for moisture regain test. The measured cotton fabrics were then oven-dried at 105 ± 2°C for a period of 12 hours according to ASTM D 2495-01: Standard Test Method for Moisture in Cotton by Oven-Drying. The cotton fabrics were reweighed after oven-drying. The drying, cooling, and weighing processes were repeated until the change in mass between two successive weights was less than 0.1% of the sample mass. The difference between the original mass and the oven-dry mass was calculated in percentage, as moisture content and moisture regain according to these equations:

$$M = G - C$$

where M is mass of specimen as received, g; G is gross mass, specimen, and container, g; and C is mass of empty container, g.

$$D = B - T$$

where D is oven-dry mass of specimen, g; B is mass of specimen and basket or weighting bottle, g; and T is mass of empty weighting container, g.

$$\text{Moisture content}(\%) = [(M - D)/M)] \times 100$$

$$\text{Moisture regain}(\%) = [(M - D)/D)] \times 100$$

The surface of the cotton fabric structure was characterized using JSM-6335F (Tokyo, Japan) Field Emission Scanning Electron Microscope (SEM). The scanning electron

micrograph of the surface was taken at the magnification of 10000. The fibres were gold coated before being inspected.

Contact Angle Measurements.

The water contact angle on the PNIPAM brushes modified fabrics was measured with a Ramè-Hart goniometer (Model 100-00). The fabrics were straightened with certain tension. A small droplet of distilled water (50 uL) was placed on the fabrics with a syringe. The contact angles were measured for each water droplet at temperatures ranging from 25°C to 40 °C in a temperature-controlled chamber. Three measurements at three different spots were taken with each substrate, and the average of these values was determined. A video camera recorded process of the placement of the water droplet and the contact angle immediately after the water droplet landed on the fabrics was calculated with SCA 20 software.

AFM Morphology of Polymer Brushes

Atomic force microscopy (AFM) was performed with XE-100 (Park Systems) in non-contact mode to characterize the surface morphology of PNIPAM brushes on cotton surface. The result showed that the surface roughness of grafted polymer brushes on the cotton surface was ≈5nm. The polymer brushes homogeneously covered the cotton surface and processed a fine domain surface texture.

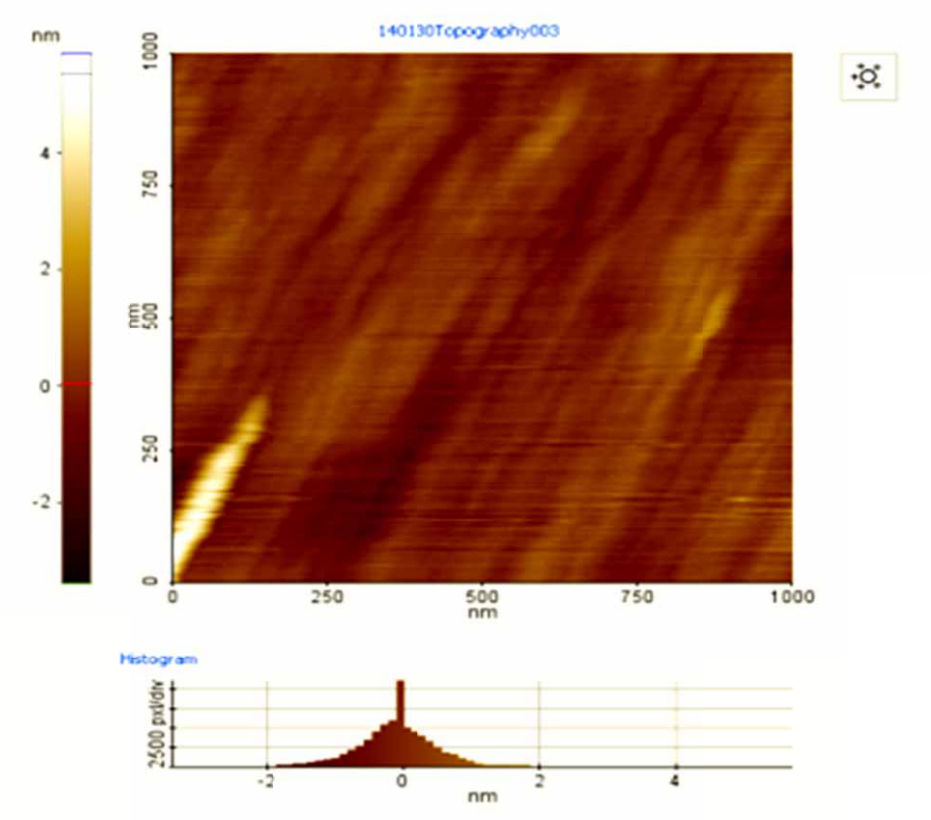

Figure SI 1. Noncontact-molded AFM image of grafted polymer brushes on the surface of cotton (1000 nm×1000nm).

Reference

[1] Formation of Polymer Brushes on Cotton Fabric by SI-ATRP: the Effect of Initiator, Liu, X. Q.; Li, Y.; Shen, Y. D.; et al. Textile Bioengineering and Informatics Symposium Proceedings, Vols 1-3 Pages: 406-409 Published: 2010.