Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Water-Based, Heat-Assisted Preparation of Water-Repellent Cotton Fabrics Using Graft Copolymers

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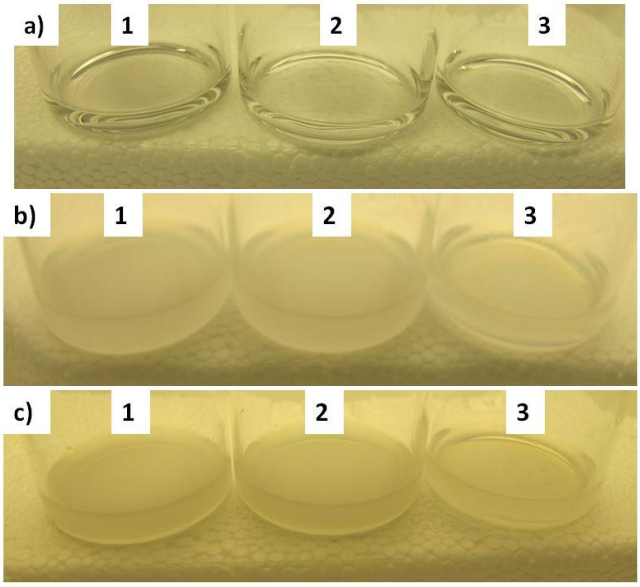

Figure S1. Photographs of polymers (1) P1-*g*-PDMS$_{27\%}$, (2) P1-*g*-PDMS$_{66\%}$, and (3) P2-*g*-PDMS$_{41\%}$ in (a) acetone, (b) acetone/water mixture (0.6/1), and (c) water.

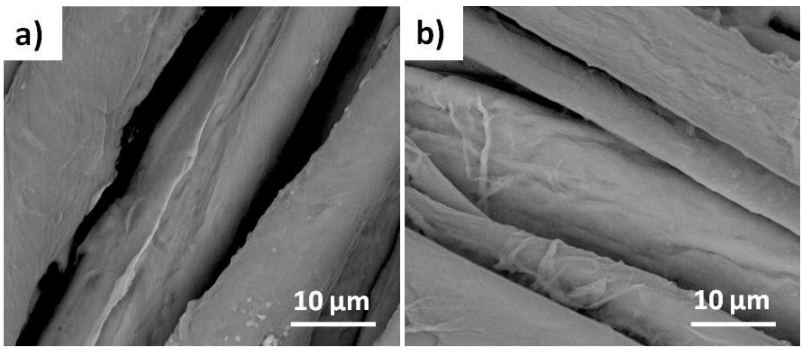

Figure S2. SEM images of (a) cotton coated with P1-*g*-PDMS$_{66\%}$, and (b) cotton coated with P2-*g*-PDMS$_{41\%}$.

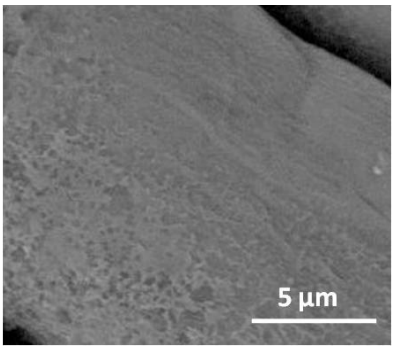

Figure S3. Additional SEM image of cotton coated with P1-*g*-PDMS$_{27\%}$

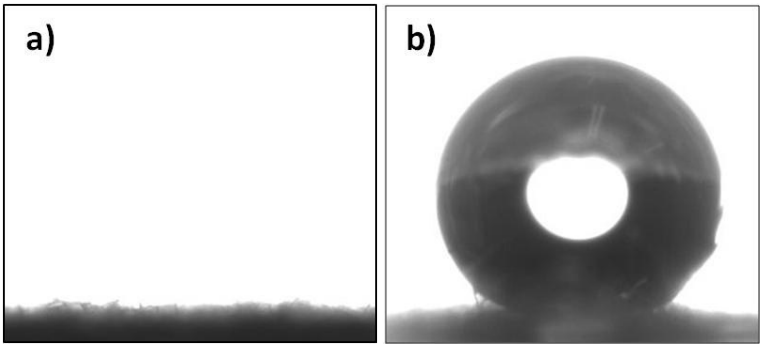

Figure S4. Photographs of 5.0 µL water droplets on (a) uncoated cotton, and (b) coated cotton with P1-*g*-PDMS$_{27\%}$.

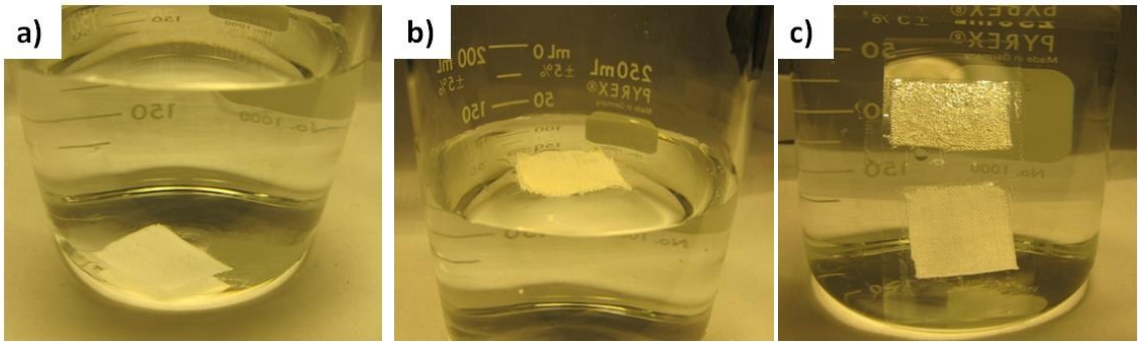

Figure S5. Photographs of (a) uncoated cotton, and (b) coated cotton with P1-*g*-PDMS$_{27\%}$ in a vial with water, and (c) same coated cotton piece forcibly submerged into the water attached to the top of the slide and uncoated cotton attached to the bottom of the slide. The coated cotton shows a plastron layer.

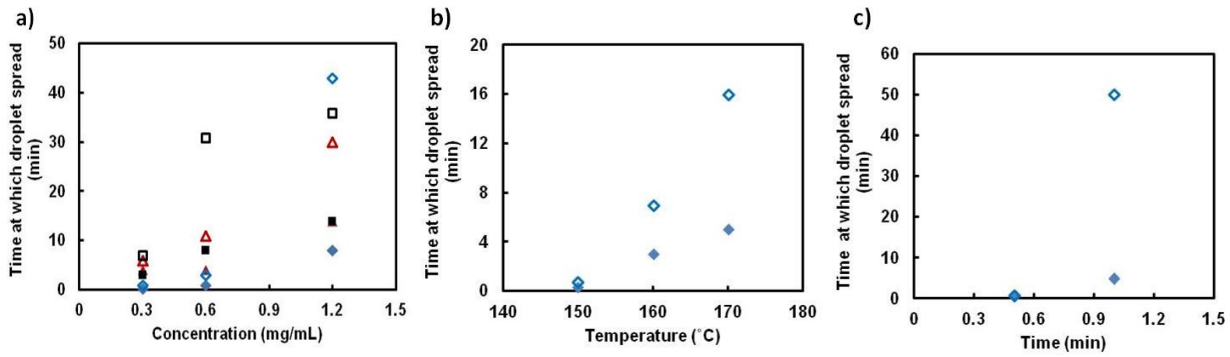

Figure S6. Time at which the first water droplet (filled symbol) and the fifth (last) water droplet (open symbol) spread on the unstable P1-*g*-PDMS$_{27\%}$ cotton coatings prepared as a function of (a) concentration, (b) temperature, and (c) time.

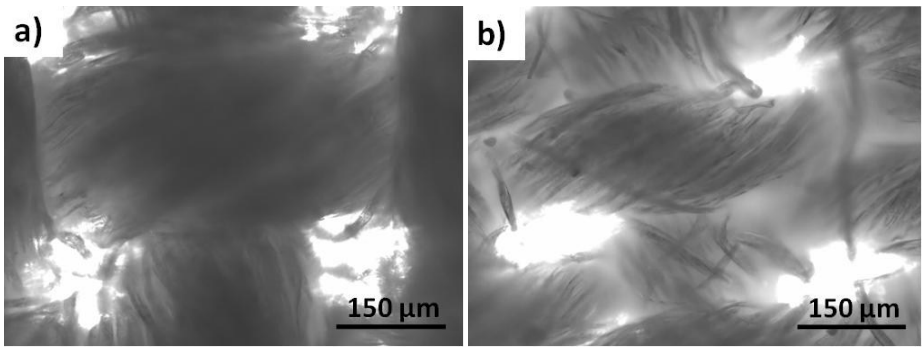

Figure S7. Optical microscopy images of (a) cotton swatch used in this study, and (b) additional new cotton swatch.

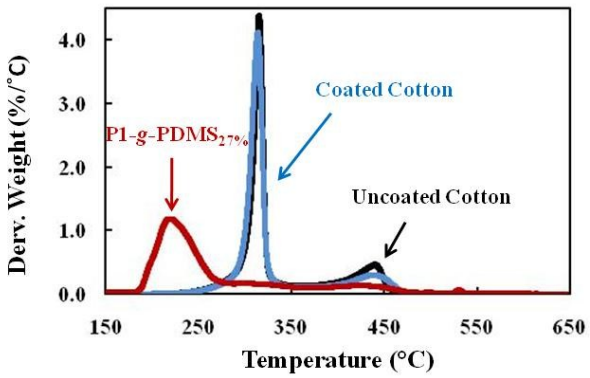

Figure S8. DTGA traces of uncoated cotton, cotton coated with P1-*g*-PDMS$_{27\%}$, and P1-*g*-PDMS$_{27\%}$.

Estimation of the Thickness of the Copolymer Layer on the Cotton Swatch

The thickness of the P1-*g*-PDMS$_{27\%}$ copolymer layer on the cotton swatch was estimated using a previously reported procedure.[1] We assume the cotton fabric was covered by a single layer of fibres at a density (ρ) of 1.55 g/cm^3. Thus, the volume of an individual cotton fibre (V) in a 65 mg cotton fabric (m) was:

$$V = \frac{m}{\rho} = \frac{(6.5 \times 10^{-2})\ g}{1.55\ g/cm^3} = (4.2 \times 10^{-2})\ cm^3 \quad (1)$$

From SEM characterization, the diameter of a single fibre was (14 ± 4) μm, which corresponds to a fibre radius (r) of 7 μm. Thus, the length of a single fibre (L) was:

$$L = \frac{V}{\pi \times r^2} = \frac{(4.2 \times 10^{-2})\ cm^3}{\pi \times ((7.0 \times 10^{-4})\ cm)^2} = (2.7 \times 10^4)\ cm \quad (2)$$

We further assume that the surface of the fibres was smooth. The total surface area of the fibres (S) was:

$$S = 2 \times \pi \times r \times L = 2 \times \pi \times ((7.0 \times 10^{-4})\ cm) \times ((2.7 \times 10^4)\ cm) = 120\ cm^2 \quad (3)$$

From TGA characterization, we determined a (3.0 ± 0.5) wt% of grafted P1-*g*-PDMS$_{27\%}$ copolymer onto a cotton swatch, which corresponds to a weight (m_p) of 2.0 mg. We assume the copolymer density was 1.2 g/cm^3. The volume of the copolymer (V_p) grafted onto the cotton swatch was:

$$V_p = \frac{m}{\rho} = \frac{(2.0 \times 10^{-3})\ g}{1.2\ g/cm^3} = (1.7 \times 10^{-3})\ cm^3 \quad (4)$$

Finally, the thickness of the copolymer layer (h) was:

$$h = \frac{V_p}{S} = \frac{(1.7 \times 10^{-3})cm^3}{120\ cm^2} = 140\ nm \quad (5)$$

This calculation suggests a 140 nm polymer layer. However, this thickness is an overestimation. The real surface area of the cotton fibres is much larger than our estimation due to their roughness.

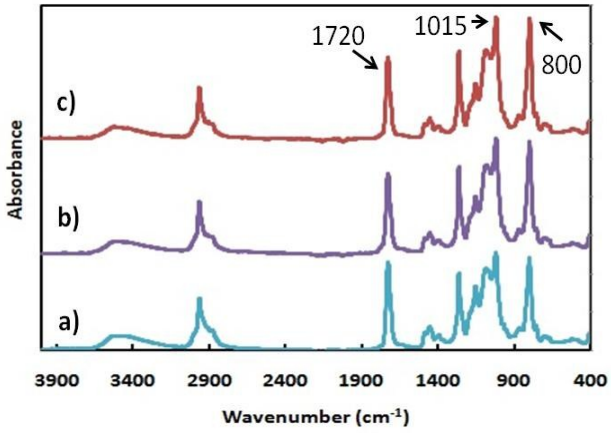

Figure S9. ATR-IR spectra of (a) P1-*g*-PDMS$_{27\%}$, (b) P1-*g*-PDMS$_{66\%}$, and (c) P2-*g*-PDMS$_{41\%}$.

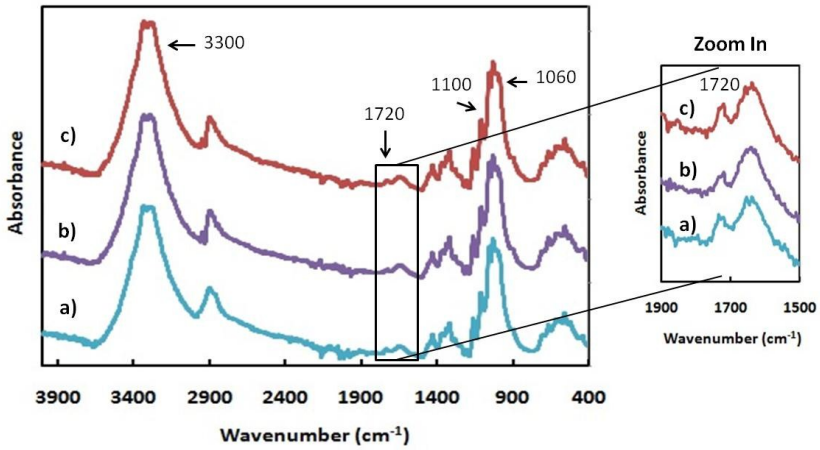

Figure S10. ATR-IR spectra of coated cotton with (a) P1-*g*-PDMS$_{27\%}$, (b) P1-*g*-PDMS$_{66\%}$, and (c) P2-*g*-PDMS$_{41\%}$. Left side is a zoom in of the 1500-1900 cm^{-1} range.

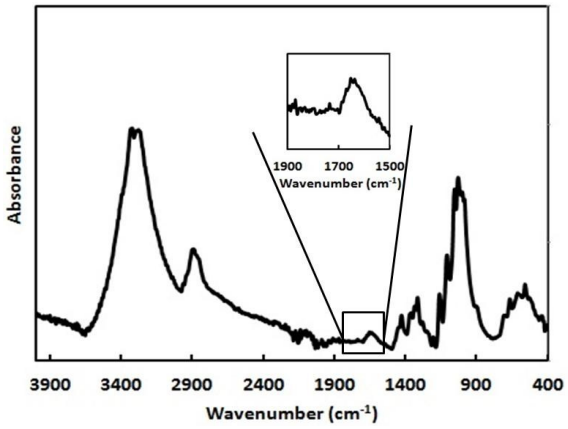

Figure S11. ATR-IR spectra of cotton coated with P1-*g*-PDMS$_{27\%}$ after 0.5 h oven annealing. Inset is a zoom in the 1500-1900 cm^{-1} range.

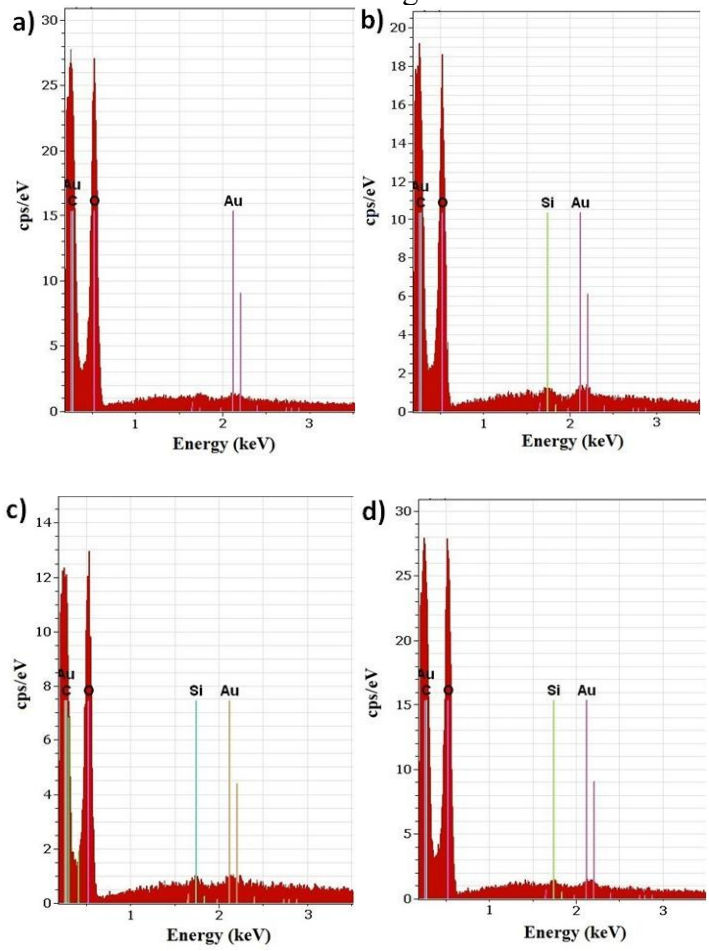

Figure S12. EDS spectra of (a) uncoated cotton, (b) cotton coated with P1-*g*-PDMS$_{27\%}$, (c) cotton coated with P1-*g*-PDMS$_{66\%}$, and (d) cotton coated with P2-*g*-PDMS$_{41\%}$.

References

1. H. Zou, S. Lin, Y. Tu, G. Liu, J. Hu, F. Li, L. Miao, G. Zhang, H. Luo, F. Liu, C. Hou and M. Hu, *J. Mater. Chem. A*, 2013, **1**, 11246-11260.