Microscopy TODAY

Coming Events

Due to COVID-19, please check to see if the listed events have been postponed or cancelled.

2021

Microscopy & Microanalysis 2021
August 1–5, 2021
Virtual
www.microscopy.org/events/future.cfm

MC 2021 Joint Meeting of Dreiländertagung & Multinational Congress on Microscopy
August 22–26, 2021
Virtual
www.microscopy-conference.de

IMAT 2021 International Materials, Applications & Technologies (ASM International Annual Meeting)
September 13–16, 2021
St. Louis, MO
https://www.asminternational.org/web/imat-2021/event-info

2021 Gordon Research Conference on Three-Dimensional Electron Microscopy
October 31–November 5, 2021
Newry, ME
www.grc.org/three-dimensional-electron-microscopy-conference/2021

Neuroscience 2021
November 13–17, 2021
Chicago, IL
http://www.sfn.org/meetings/neuroscience-2021

2021 MRS Fall Meeting & Exhibit
November 28–December 3, 2021
Boston, MA and virtual
https://www.mrs.org/meetings-events/fall-meetings-exhibits/2021-mrs-fall-meeting

Cell Bio 2021
December 1–10, 2021
Virtual
https://www.ascb.org/cellbio2021

2022

Microscopy & Microanalysis 2022
July 31–August 4, 2022
Portland, OR
www.microscopy.org/events/future.cfm

2023

Microscopy & Microanalysis 2023
July 24–28, 2023
Minneapolis, MN
www.microscopy.org/events/future.cfm

2024

Microscopy & Microanalysis 2024
July 28–August 1, 2024
Cleveland, OH
www.microscopy.org/events/future.cfm

Carmichael's Concise Review

Earthworms Inspire the Creation of Fabrics that Aggressively Repel Water

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Fabrics that aggressively repel water have attracted considerable attention for their potential applications in functional sportswear, among other uses. Recently, Liyun Xu, Lili Yang, Dengteng Ge, Ying Guo, and others were inspired by the excellent robustness of the wrinkled skin of the earthworm to withstand the abrasiveness of soil. This led them to develop a fabric that not only repels water (superhydrophobic), but also can hold up after more than 800 laundry cycles (ultradurable) [1]. A superhydrophobic fabric is achieved by coating materials that have low surface tension with polysiloxane, fluorinated polymers, fluorinated nanoparticles, or something similar. The key challenge is the ability of the coating to survive repeated harsh laundering cycles. In addition, fluorinated oligomers may present safety risks.

Whereas wrinkled surfaces are common, the periodically wrinkled skin of the earthworm greatly reduces soil resistance, mainly owing to the lubrication of mucus and reversibly deformable wrinkled surface features. Conventionally, wrinkles form when a bilayer film with a thin stiff layer on a thick soft substrate undergoes mechanical stretching or swelling, followed by compression. Based on this stiff-soft two-layer model, previous researchers attempted to generate wrinkles on a single fiber of poly(dimethylsiloxane) (PDMS) among other fibers, but they were not able to create wrinkles that were useful for a woven fabric. Recently, a three-layer model consisting of a stiff top layer, a compliant middle layer, and a rigid support layer has shown that under certain circumstances PDMS sheets can spontaneously form wrinkles after plasma and UV light treatment, but this, too, was never exploited on entire woven fabrics. Xu et al. created PDMS wrinkles on a

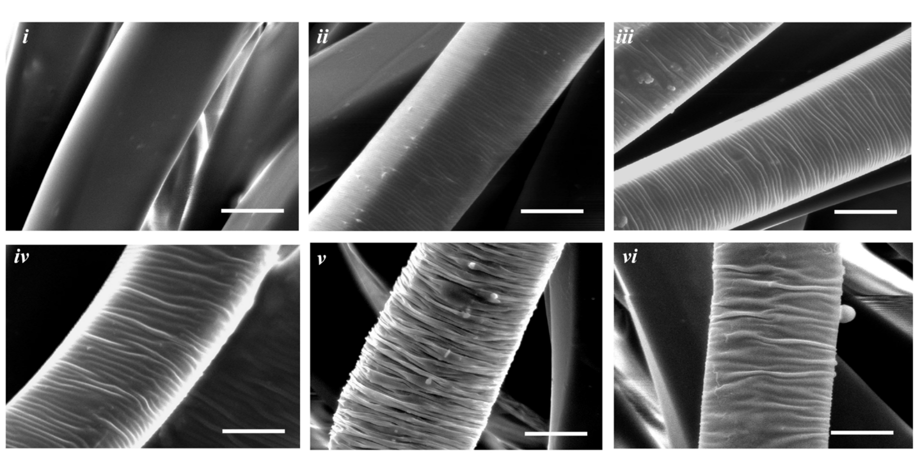

Figure 1: SEM images of PET fabric fibers with different Ar treatment times: (i) 0 s, (ii) 20 s, (iii) 40 s, (iv) 60 s, (v) 80 s, and (vi) 120 s. Scale bars, 10 µm.

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poly(ethylene terephthalate) (PET) fabric by forming a cross-linking gradient of PDMS fibers via argon (Ar) plasma treatment.

Specifically, Xu et al. developed a two-step process that involved dip-coating a PDMS precursor without a cross-linking agent, and then exposing it to Ar plasma. A low-viscosity PDMS precursor with terminal methyl groups was chosen because it is environmentally friendly, biocompatible, and has low surface energy. During exposure to the Ar plasma, ions penetrate into the polymer and initiate the self-diffusion of polymer chains as well as subsequent cross-linking. These processes are greatly affected by the chamber pressure, radiofrequency discharge power, exposure time, etc. Since the operator can manipulate these parameters, the process can be carefully controlled. When the process was optimized, treated PDMS fibers showed constant hardness, as determined by nanoindentation and X-ray photoelectron spectroscopy. Scanning electron microscopy showed that significant wrinkles appeared in less than 40 seconds and increased considerably during the next minute or so, when the fiber closely resembled a soft earthworm that is wrapped by periodically wrinkled skin (Figure 1).

The treated PET fabric displayed excellent water repellency, even showing resistance to water penetration under hydrostatic pressure. Surprisingly, the treated PET fabric maintained almost the same fabric style and vapor permeability as the pristine PET fabric because of the thin and soft PDMS coating but was softer than those treated with commercial waterproofing agents. Importantly, the multilayered PET fabric can be generated in a single-step plasma processing so both surfaces strongly repel water. Therefore, fabric products do not need to be treated on both sides.

Benefitting from the wrinkled surface topography and the interfacial viscoelastic layer, the treated fabrics exhibit ultradurability to laundering and rubbing. Moreover, this superhydrophobic fabric is capable of self-healing with another treatment of heat and Ar plasma. Xu et al. believe that their scalable-friendly approach to forming ordered wrinkled skin on fabric fibers is of great importance for the practical applications of durable functional fabrics, as well as further exploitation of wrinkled topography. And to think this technological breakthrough that has the potential to revolutionize the textile industry was inspired by the earthworm!

References

[1] Xu et al., *ACS Appl Mater Interfaces* 13 (2021) https://dx.doi.org/10.1021/acsami.0c18528.

[2] The author gratefully acknowledges Drs. Dengteng Ge, Lili Yang, and Ying Guo for reviewing this article.

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