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Supplementary Information

Evaluating the Resilience of Superhydrophobic Materials using the Slip-length Concept

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Materials

All reagents were used as supplied from Sigma-Aldrich or Alfa Aesar, without further purification. All water used was deionized (>15 MΩ cm) and reactions performed at room temperature (RT) (~20°C) unless otherwise noted. Exceptions to the above suppliers include; Smooth PTFE sheets (Direct Plastics Limited), stainless steel meshes (The Mesh Company), and 3M '77' spray adhesive (Premier Farnell UK).

Experimental Detail

Manufacture of superhydrophobic xPTFE surface

Superhydrophobicity is created via a combination of micro/nano-scale surface structures and a low surface free energy material, PTFE. In this work, a simple and inexpensive method to create superhydrophobicity on a PTFE surface is utilized. This method is based on the transference of structures from very fine stainless-steel meshes onto the PTFE sheets. PTFE was chosen due to its low surface free energies, low coefficient of friction, and flexibility. Microscale diameter stainless-steel meshes were used to emboss the PTFE sheets. Firstly, the PTFE sheet was sanded by sandpaper (180 grit) to soften the surface sufficiently for the embossing process. Then the mesh (400 wires per inch with a wire diameter of 30 μm) was placed onto the PTFE sheet and sandwiched in between two 12mm thick stainless-steel plates. To achieve uniformity of the PTFE sheet embossing process, several G-clamps tightened by a torque wrench were used to hold the mesh and PTFE sheet between two stainless steel gauge plates. The sample was then heated in an oven at 350°C for 3 hours. Finally the surface was allowed to cool naturally to avoid any unbalanced thermal expansion. For additional sample preparation (30040/50025 xPTFE), the steel meshes were changed to 300 wires per inch with a wire diameter of 40 μm, and 500 wires per inch with a wire diameter of 25 μm respectively.

Manufacture of superhydrophobic TiO_2 Surface

Acrylic Perspex substrates (thickness - 3mm), were initially treated with a hydrophobic adhesive (3M - 77 spray adhesive). To ensure a conformal coating, the adhesive was mixed with hexane (1:5, adhesive:hexane w/v ratio), this liquid was applied to the Perspex whilst lying horizontally, and the substrate was stood vertically. The coated substrate was allowed to dry for five minutes at room temperature before application of the superhydrophobic coating. The superhydrophobic precursor suspension was prepared by firstly dissolving 0.5 g of 1H, 1H, 2H, 2H-perfluorooctyltriethoxysilane into 49.5 g of absolute ethanol, and ensuring the mixture was stirred for one hour. Titanium dioxide nanoparticles (a mixture of; 3 g of powdered TiO_2 [Ø ~ 100 nm], and 3 g of P25 [Ø ~ 25 nm]) were added to the solution, and stirred vigorously for five minutes. The suspension was loaded into a spray coater (FoxHunter KMS Airbrush Kit, AS186), and applied to the adhesive coated acrylic Perspex using an air pressure of 200 kPa (2 bar). The suspension was applied to the substrate with a coverage of ~ 0.3 mL/cm^2, and was allowed to dry for five minutes prior to any testing

Supplementary Figures

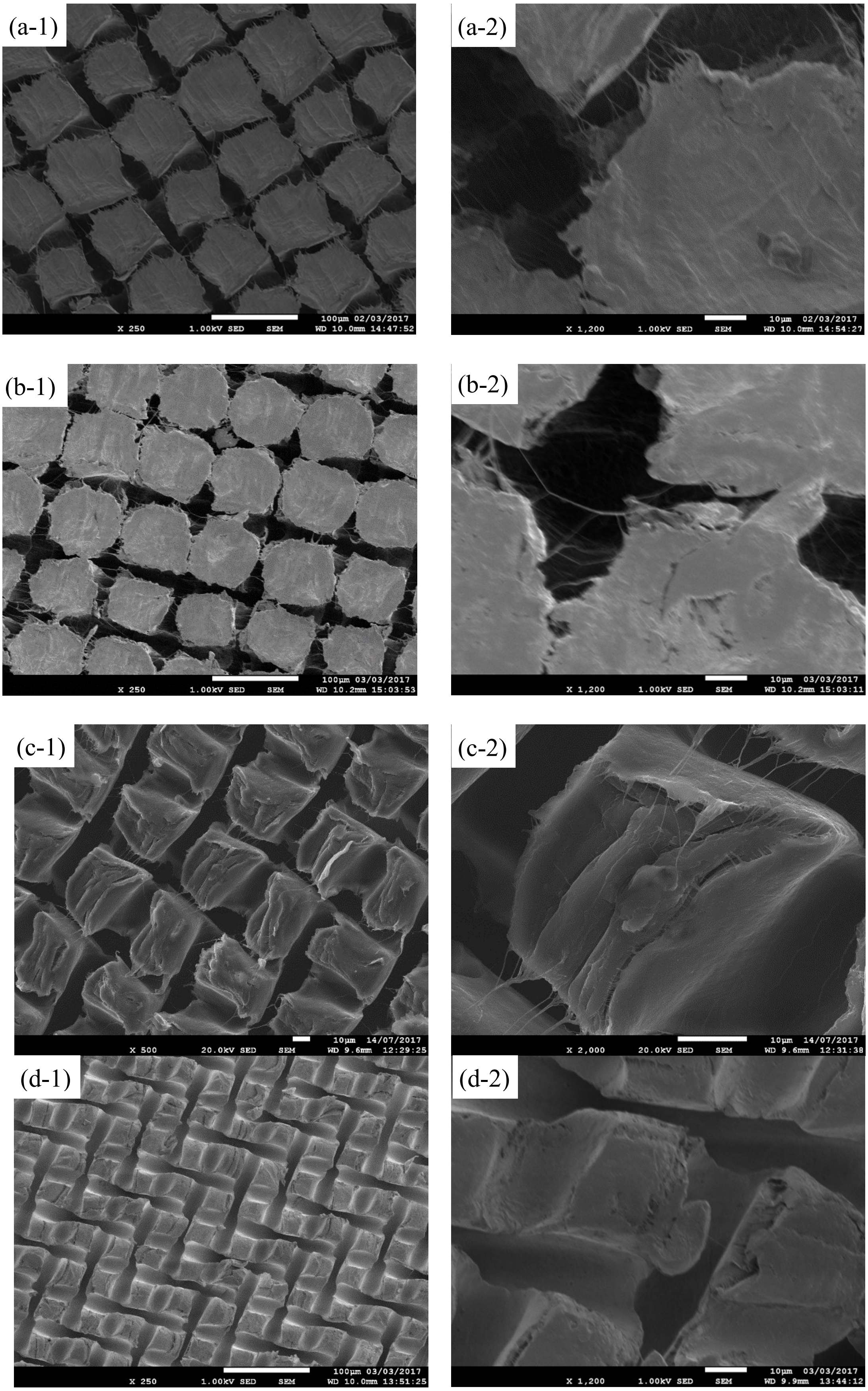
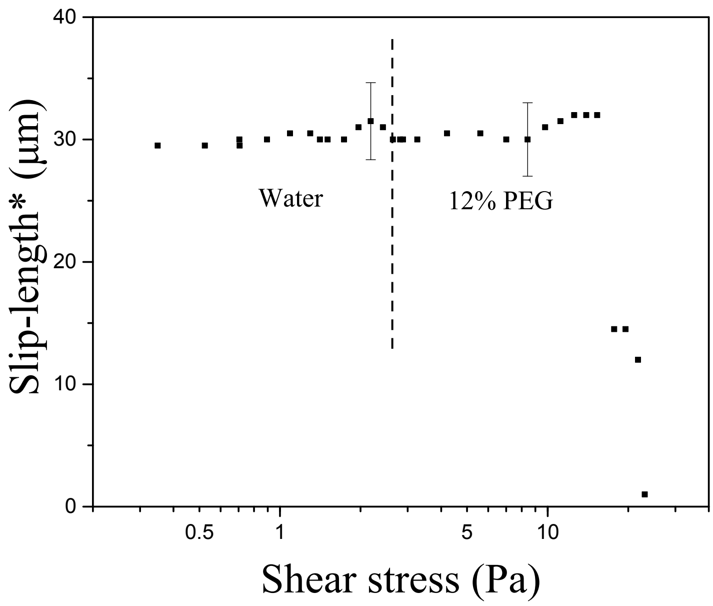


Figure S1. SEM images of (a) fresh surfaces and (b) after 8 hours of 1Pa fluid shear-stress for 30040 xPTFE at (1) 250 x and (2) 1200 x magnifications, and (c) fresh surfaces and at (1) 500 x and (2) 2000 x magnifications; (d) after 8 hours if 1Pa fluid shear-stress for 50025 xPTFE at (1) 250 x and (2) 1200 x magnifications. The static contact angles for 30040 surfaces were measured as 134°±5° on fresh surfaces and decreased to 112°±8° after 8 hours exposure to a 1 Pa fluid shear-stress. The static contact angles for 50025 were measured as 143°±5° for the fresh surfaces and decreased to 126°±8° after 8 hours of wear.

(a)



(b)

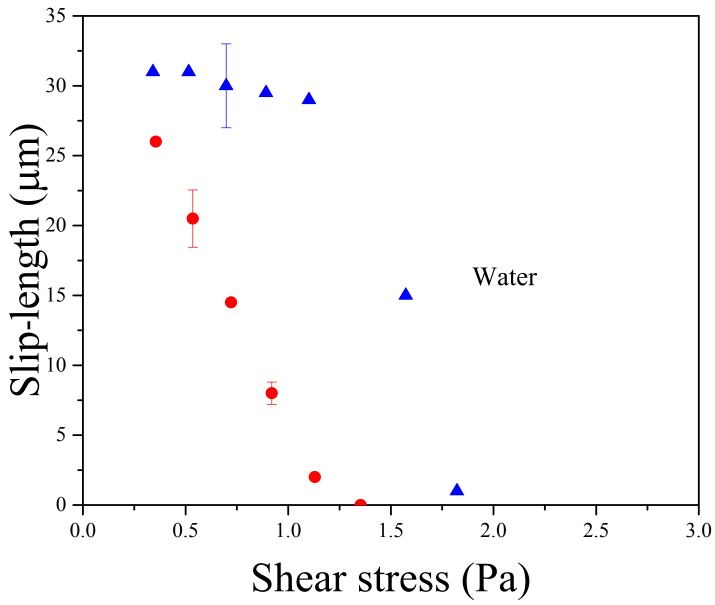


Figure S2. Fluid shear-stress creep experiments for xPTFE surfaces (a) Principal xPTFE (■), (b) 30040 (●) and 50025 (▲) xPTFE using water and 12% PEG8000 solution in a cone-and-plate geometry (α_c = 1°, R = 3cm). The error bars represent the variation of repeats.

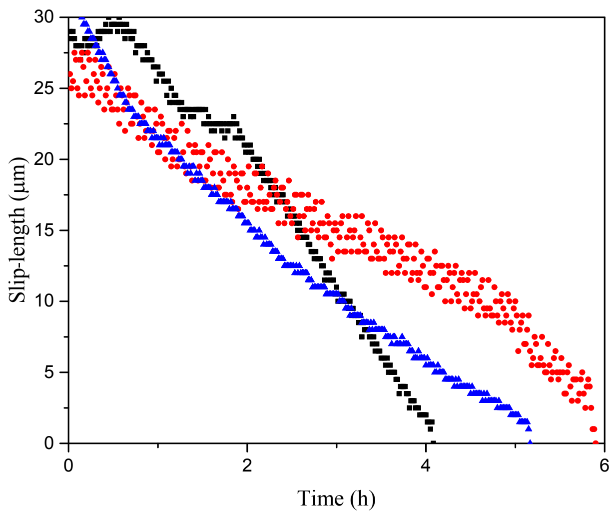


Figure S3. Time endurance of xPTFE surfaces; ■ Principal xPTFE, and ▲ 30040 / ● 50025 xPTFE surfaces under a 1 Pa fluid shear-stress