SUPPORTING INFORMATION

Water-based Superhydrophobic Coatings for Nonwoven and Cellulosic Substrates

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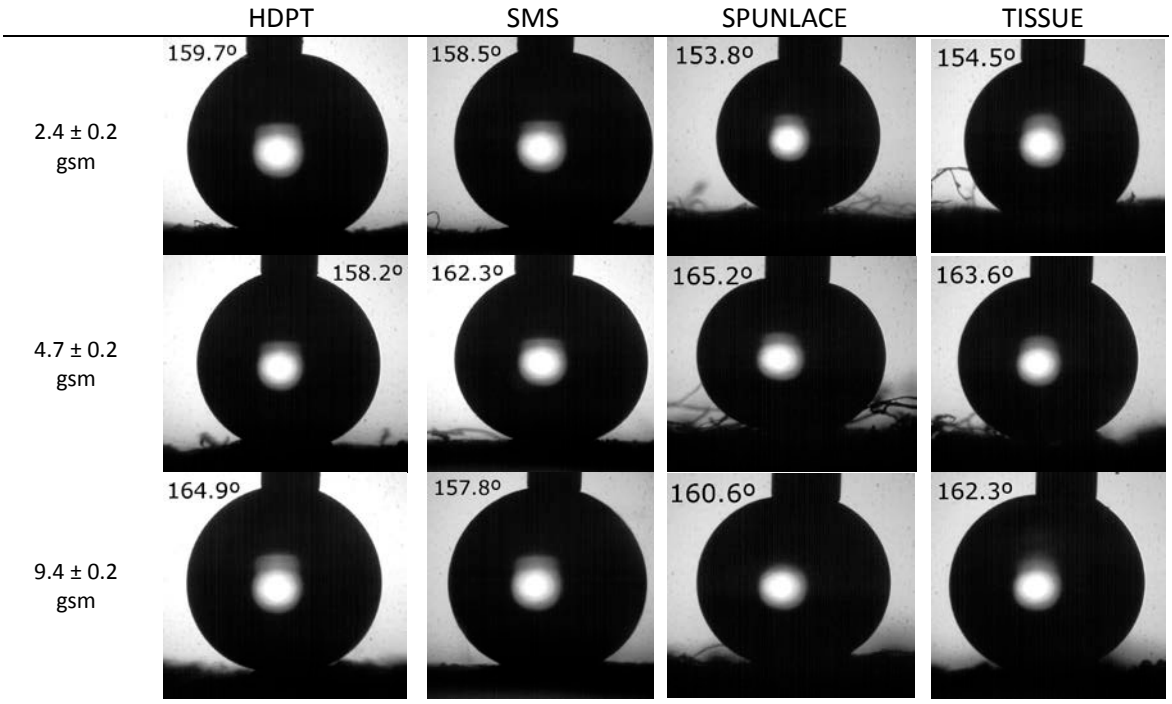
Contact Angle Measurements

In determining contact angles (CA), the irregularities in surface topography of the substrates made it difficult to obtain accurate and consistent measurements. This is due to the surface features having nearly the same length scale as the test droplet size, as well as some of the substrates possessing fibers that extended through the surface treatment, thus obscuring the contact line between droplet and substrate.

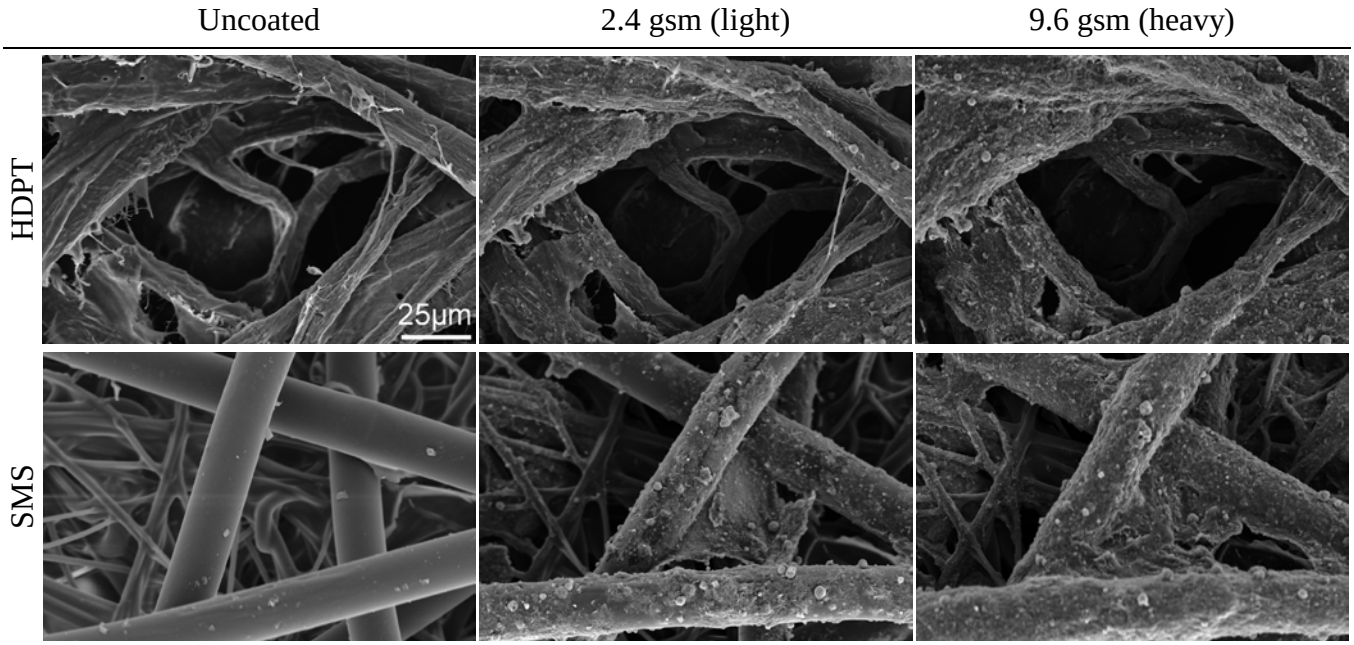
Figure S1. Typical images captured during CA measurements for all four samples at three coating add-on levels. The rough nature of the surface topography makes it difficult to obtain accurate and consistent CA measurements. All measurements were taken using a horizontal side view and the corresponding CA's are listed above left of each droplet measured. All of the shown coating levels achieve superhydrophobicity (CA > 150^{o}) on all substrates. CA measurements for similar coating levels were obtained on glass slides for comparison with these rough samples. The needle diameter in all images is 1mm, implying an average droplet diameter between 3 and 4mm.



Pore Size

Pore sizes for the same substrate varied as a function of coating level and initial fiber spacing, as shown in Figure S2. The light coating (2.4 gsm, middle column) generates a thin conformal film around the surface fibers and leaves most of the larger pores intact. This coating level essentially has a sealing effect on those substrates that are hydrophilic initially without a noticeable reduction in pore size. For the smaller pores, the light coating is able to bridge these gaps and thus completely seal some of the finer pore sizes, such as those seen in the middle meltblown layer of SMS. The heaviest coating level (9.6 gsm, right column) is seen to eliminate much of the original surface features of the fibers and has smoothed out all but the largest pores. These large pores still remain in the sample and designate the hydrohead limit. The coating required to fully clog these pores (and raise the hydrohead even further) will affect coating breathability and cost, thus making such coating add-on levels undesirable for industrial applications.

Figure S2. Pore size as a function of add-on coating level for two representative substrates: hydrophilic HDPT (top row), hydrophobic SMS (bottom row). The left column displays images of uncoated pores, the middle column is at the lightest coating level of 2.4 gsm, and the right column is at the heaviest coating level of 9.6 gsm. It can be clearly seen for the larger pore sizes on HDPT, the coating has a negligible effect on reducing pore size as they are too large for the polymer to bridge and seal. In contrast, the much smaller pore sizes of SMS are greatly reduced by the coating. The scale bar in the top left SEM micrograph applies to all images.



Hydrohead Measurement Apparatus

Figure S3 shows the apparatus used to determine resistance to external water pressure, as based on ASTM standard F1670-08. A 2.5cm-diameter acrylic tube measuring 1.4m in length was used as a graduated column of water for measuring hydrostatic pressure in centimeters (hydrohead). The water flow was driven by an aquarium pump (Lifegard Aquatics QuietOne 2200). For a given test, 2.5cm circles of test material were cut and placed at the bottom of the tube, where a nitrile rubber gasket was screwed on top to ensure proper seal. Water was then pumped at a rate below 1.5×10^{-2} lt/s to avoid inertial effects through flow disturbances introduced in the rising liquid column. An optical mirror on a swivel mount was placed directly beneath the column of water to enable a direct view of the sample (via a CCD camera) as hydrostatic pressure was gradually increased. Water breakthrough appeared as a bright spot of light at the point of first penetration, as shown in the inset on Fig. S3. The height of the water column at breakthrough designated the maximum hydrohead that a sample could tolerate reliably. This process was repeated at least 5 times for a given test sample, and the pressures were then averaged to determine the final resistance pressure and the accompanying standard deviation.

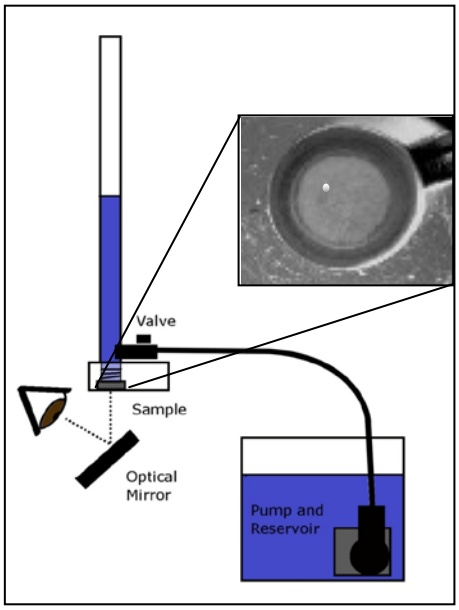


Figure S3. Schematic of hydrohead apparatus consisting of pump reservoir, viewing mirror and column. The water column is filled slowly until breakthrough is seen (shown as a white spot in the inset).