The Five Whys (and one H) of Super Hydrophobic Surfaces in Medicine

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Super hydrophobic surfaces (SHSs) are typically artificial, micro- or nano- fabricated surfaces, with a texture given by a regular periodic lattice of cylindrical pillars. The top of pillars may be conveniently modified via either chemical or physical processes, and thus the geometry and surface chemistry would combine to yield substrates that are clearly water repellent. A drop of water, positioned upon such a surface, would maintain a quasi spherical shape, with a contact angle at the air-solid interface that can be theoretically predicted with excellent accuracy. In the celebrated model of Cassie and Baxter the wetting behaviour of the surface is lumped in the sole parameter ϕ, that is the ratio of the solid to the total projected area. When ϕ tends to zero, at the interface with the substrate, the liquid mostly `senses` air and the droplet would resemble a perfect sphere. The most practical property of our SHSs is their reduced friction coefficient and, on account of this, they can be conveniently used to manipulate diluted solutions of biological or medical interest.

Here, we show how these surfaces can be integrated to other technologies for the positioning, identification and detection of a single molecule.

In particular, we will discuss the simultaneous use of SHSs and nano geometry based photonic devices, whereby the former serve as vehicles to concentrate diluted solutions into a small area, and the latter would measure the solute with unprecedented accuracy. We will explain how SHSs can be utilized for the organization of single cells into three dimensional architectures, and proteins sensing. We will describe how SHSs and nanoporous silicon matrices can be combined to yield devices with the capability of concentrating and harvesting small molecules, where the cut-off size can be adequately controlled. Finally, we will provide the mathematical foundation of SHSs, on the basis of which these surfaces can be conveniently designed and fabricated.

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