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Engineering Extreme Hydrophobic and Super Slippery Water Shedding Surfaces

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The intrinsic water repellency of a material is fundamentally determined by its surface chemistry, but alone this does not determine the ability of a surface to shed water. Physical factors such as the surface texture/topography, rigidity/flexibility, granularity/porosity combined with the intrinsic wetting properties of the liquid with the surface and whether it is infused by a lubricating liquid are equally important. In this talk I will outline fundamental, but simple, ideas on the topographic enhancement of surface chemistry to create superhydrophobicity, the adhesion of particles to liquid-air interfaces to create liquid marbles, elastocapillarity to create droplet wrapping, and lubricant impregnated surfaces to create completely mobile droplets [1-3]. I will discuss how these ideas have their origins in natural systems and surfaces, such as Lotus leaves, galling aphids and the Nepenthes pitcher plant. I will show how we have applied these concepts to study the wetting of granular systems, such as sand, to understand extreme soil water repellency. I will argue that relaxing the assumption that a solid substrate is fixed in shape and arrangement, can lead to the formation of liquid marbles, whereby a droplet self-coats in a hydrophobic powder/grains. I will show that the concepts of wetting and porosity blur as liquids penetrate into a porous or granular substrate. I will also discuss how lubricant impregnated super slippery surfaces can be used to study a pure constant contact angle mode of droplet evaporation [4]. Finally, I will show dewetting of a surface is not simply a video reversal of wetting [5], and I will give an example of the use of perfect hydrophobicity using the Leidenfrost effect to create a new type of low friction mechanical and hear engine [6].

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