Lessons from Nature:
Bioinspired Mechanically Durable and Self-healing Superliquiphilic/phobic Surfaces

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Living nature, through some 3 billion years of evolution, has developed materials, objects, and processes that function from the nanoscale to the macroscale. The understanding of the functions provided by species and processes found in living nature can guide us to design and produce bioinspired surfaces for various applications[1,2]. There are a large number of flora and fauna with properties of commercial interest. Nature provides many examples of surfaces that repel (hydrophobic) or attract (hydrophilic) water. The most famous is the lotus leaf. Its surface contains a hierarchical structure that, combined with specific surface chemistry, results in a water repellant surface that is self-cleaning, as water droplets collect contaminants as they roll off. Some plant leaves, such as fagus leaves, are hydrophilic, allowing water to rapidly spread into a thin layer, increasing evaporation, leading to a dry and self-cleaning surface. By taking inspiration from nature, it is possible to create hierarchically–structured surfaces with re-entrant geometry and surface chemistry that provide multifunctional properties including superliquiphilicity/phobicity, self-cleaning/low biofouling, and/or low drag.

A facile, substrate-independent, multilayered nanoparticle/binder composite coating technique has been developed to produce various combinations of water and oil repellency and affinity with self-cleaning properties[3]. These coatings having a so-called re-entrant geometry can also repel surfactant-containing liquids. Some of the nanostructured surfaces have been found to be anti-bacterial[4]. These coatings provide the basis to fabricate surfaces for a range of applications including self-cleaning, anti-fouling, anti-smudge, optical transparency, anti-fogging, anti-icing, low drag, water purification, and oil–water separation[1,3-7]. The coatings have been found to be mechanically durable and self-healing[3,5].

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