BIOINSPIRED MECHANICALLY DURABLE 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]. 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 hierarchical –structured surfaces with re-entrant geometry and surface chemistry that provide multifunctional properties including superliquiphilicity/phobicity, self-cleaning/low biofouling, and/or low drag. Four different techniques have been developed[2]. A multilayered nanoparticle/binder composite coating has been developed to repel oil and surfactants with self-cleaning properties[3]. A layer-by-layer technique has been developed that provides surfaces with varying surface chemistry to result in coatings that are hydrophilic/oleophilic, hydrophilic/oleophobic, hydrophobic/oleophilic, or hydrophobic/oleophobic[4]. Nanoparticle-encapsulated[5] and liquid impregnation[6] techniques have been developed to create surfaces which repel oil and surfactants. Etched Al surfaces with fluorosilane treatment result in a superoleophobic surface[7]. Some of the nanostructured surfaces have been found to be anti-bacterial[8]. These various techniques provide the basis to fabricate surfaces for a range of applications including self-cleaning, anti-fouling, anti-smudge, anti-fogging, anti-icing, low drag, water purification, and oil–water separation. The coatings have been found to be mechanically durable and some optically transparent.

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