Bio-Inspired, Smart, Multiscale Interfacial Materials with Super-Wettability

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Learning from nature and starting from the superhydrophobic lotus leaves, we revealed that a super-hydrophobic surface needs the cooperation of micro- and nanostructures. Further studies have proved that the arrangement of micro/nano structure can directly affect the wettability and water movements. Recently, we found that hydrophilic compositions together with micro/nano structures endow the fish scale with superoleophobicity underwater. Inspired by this, artificial fish scales with robust mechanical strength have been fabricated.

Based on the micro/nano structured interfaces with special wettability, kinds of basic chemical reactions could be done within a small water drop. Crystal arrays could also been prepared, and also small molecule, polymer, silver NPs and microspheres can be arrayed in one direction.

Under certain circumstances, a surface wettability can switch between superhydrophilicity and superhydrophobicity. Besides the 2D interface, we recently extended the cooperation concept into 1D system. Artificial ion channels with smart gating properties have been fabricated by integrating smart molecules into the single nanochannels. These intelligent nanochannels could be used in energy-conversion system. The other one dimensional system is the artificial spider's silk. The periodic spindle knots on the spider's silk can drive liquid drops in a specific direction that can collect water from moist air. Further, we prepared artificial spider's silk and droplets of water on the artificial spider's silk behaved similarly to those on its biological counterparts. Most recently, inspired by the cactus surviving in the most drought desert, we probed into the relationship of the structure-function of cactus and found that the cactus had evolved a multi-structural and multi-functional integrated continuous fog collection system.

Learning from nature, the constructed smart multiscale interfacial materials system not only presents new knowledge, but also has great applications in various fields, such as self-cleaning glasses, water/oil separation, anti-biofouling interfaces, and water collection system.

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