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Nature Inspired Surface Coatings

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Materials Scientists more and more are looking to nature for clues on how to create highly functional surface coatings with exceptional properties. The fog harvesting capabilities of the Namib Desert beetle, the beautiful iridescent colors of the hummingbird, and the super water repellent abilities of the Lotus leaf are but a few examples of the amazing properties developed over many years in the natural world. Nature also makes extensive use of the pH-dependent behavior of weak functional groups such as carboxylic acid and amine functional groups. This presentation will explore synthetic mimics to the nano- and microstructures responsible for these fascinating properties. For example, we have demonstrated a pH-induced porosity transition that can be used to create porous films with pore sizes that are tunable from the nanometer scale to the multiple micron scale. The pores of these films, either nano- or micropores, can be reversibly opened and closed by changes in solution pH. The ability to engineer pH-gated porosity transitions in heterostructured thin films has led to the demonstration of broadband anti-reflection coatings that mimic the anti-reflection properties of the moth eye and pH-tunable Bragg reflectors with a structure and function similar to that found in hummingbird wings and the Longhorn beetle. In addition, the highly textured honeycomb-like surfaces created by the formation of micron-scale pores are ideally suited for the creation of superhydrophobic surfaces that mimic the behavior of the self-cleaning lotus leaf. The development of synthetic “backbacks” on immune system cells that may one day ferry drugs to disease sites will also be discussed.