Designing Smarter Surfaces: Lessons from Nature at the Nanoscale

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Bioinspired surface nanopatterning can impart antireflectivity, the ability to repel water (rain/fog), oils, and bacteria, as well as to prevent or delay ice formation. Such capabilities open unparalleled opportunities for engineering new multifunctional substrates and achieving otherwise difficult combinations of material properties.

In this talk, I will provide an overview of various fabrication techniques we have developed to create these patterns — and beyond — in silicon, glass, and polymers (including thermoplastics, thermosets, and natural or synthetic hydrogels). I will then outline the properties we have characterized and the applications we have explored: from antireflective surfaces and enhanced light extraction in luminescent solar concentrators to self-cleaning, antifogging, antibacterial activity, and improved capture and retention of mammalian cells under flow conditions.

Finally, I will highlight our recent advances, including the universal antifogging capabilities of nanoscale cone structures, capillary-force-enhanced mechano-bactericidal activity, and the antimicrobial potential of vanadium-oxide coatings.