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Meredith received his B.S. from Georgia Tech and Ph.D. from University of Texas-Austin, both in chemical engineering. He spent two years as an NRC postdoctoral associate in NIST’s Polymers Division and then joined the faculty in the School of Chemical & Biomolecular Engineering at Georgia Tech in 2000. Meredith’s research focuses on advanced materials characterization, with an emphasis on polymer-metal, polymer-inorganic, and polymer-biological interfaces. Projects span applications including development of zeolite-polymer nanocomposite membranes for gas separations, highly-scattering polymer-metal nanoparticle beads for biomedical imaging, and probing the adhesion of biological particles like pollen with indoor material surfaces. His work has been featured on the covers of Macromolecules, Macromolecular Chemistry and Physics, and the Materials Research Bulletin. Meredith also serves on the Agenda 2020 Forest Product Nanotechnology panel of the American Forest and Paper Products Association.

“Particle Adhesion to Surfaces: Implications in Nanotechnology and the Environment”

Adhesive forces that bind micro- and nanoparticles to surfaces play a key role in nanotechnology and the environment. Yet in many applications, the ability to predict such interactions remains limited. This talk will highlight recent measurements of interaction forces between biological and synthetic particles with various organic and inorganic surfaces. Two applications are outlined: (1) accumulation of particles indoors and its effect on air quality and (2) polymer-zeolite nanocomposites for separations. (1) For indoor air quality there is limited understanding of the mechanism and magnitude bioparticle interactions (pollen) with other surfaces in air. A central question is whether bioparticles accumulate as contaminants on indoor surfaces (e.g., carpet) at higher levels than occur outdoors. Such bioparticles have a profound impact on health, given the tens of millions of asthma and allergy sufferers in the U.S. alone. (2) Polymer-zeolite nanocomposites are of interest due to their applications in energy efficient membrane separations. Yet, the presence of defects between the polymer and zeolite particle eliminates any gains in selectivity due to the zeolite. Understanding adhesion between particle and polymer both of these cases can provide important design guidelines. The measurements presented here, made with atomic force microscopy, are the first of their kind for pollen and zeolites. Using models, we illuminate the governing mechanisms driving these adhesive interactions. The adhesion of ragweed pollen is governed by van der Waals forces, which are relatively weak, but the total adhesive magnitude is enhanced by the ‘spiky’ outer-surface protrusions. This is contrasted to zeolite (all-silica MFI), for which adhesion is governed primarily by acid-base interactions in which adsorbed surface water plays a key role. Models for these adhesion mechanisms are presented and compared as well. In particular, we find that adhesion can be correlated strongly with known surface tension values if measurements with a variety of solvents (protic and aprotic, polar and non-polar) are available.