142bi Quantification of Bioparticulate Adhesion on Polymeric Surfaces Using Atomic Force Microscopy

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In this talk, we present the adaptation of Atomic Force Microscopy (AFM) to the measurement of adhesion forces between indoor-air-pollution bioparticulates and synthetic carpet fiber materials. In recent years, media reports and journal articles have labeled interior carpeting and rugs as significant contributors to indoor air “pollution”. The central issue is that biological particles, including bacteria, mold, dust mites, pet dander and pollen can be trapped in carpet fiber and released during cleaning or foot traffic. There is a growing trend of lawsuits and insurance claims related to carpet mold growth and exposure to so-called “mold toxins”. A growing literature counters previous claims that carpet is the cause of indoor air pollution (in particular toxic mold). There is also solid evidence that biological particles do induce allergies and asthma.

While numerous statistical (correlative) studies exist both in support and denial of this hypothesis, there is little fundamental understanding of the microscopic-level interactions between carpet and bioparticles. A comprehensive database of particle affinities with carpet fiber would help to dispel incorrect notions, develop meaningful cleaning procedures, and address true problems with allergens in a rational and productive manner.

No previous known work has investigated cell or bioparticle adhesion with a surface as complex as that of a typical Nylon fiber encountered in carpeting. Thus prior to embarking on investigations of cells with Nylon, we investigate the interaction of three model micro-organisms: *Escherichia coli* (common intestinal bacteria), *Ambrosia artemisiifloia* (common ragweed) and *Aspergillus niger* (common black-mold) with model cleaved silicon wafer surfaces and wafer substrates coated with thin nylon and polystyrene films. Careful statistical analysis of at least 25 independent force measurements for each surface type is performed and comparisons are made using ANOVA to determine the significance level at which the measurement sets are statistically independent.

We attempt to model the relationship of the adhesional forces between the series of bio-particles and polymer film surfaces using Israelachvili's simplification of the Lifshitz theory and the Johnson-Kendall-Roberts (JKR) theory. Hamaker constants were derived from the Lifshitz theory and the work of adhesion and the AFM tip radii could be calculated from the JKR theory. This is a novel attempt to assign Hamaker constants to complex micro-organisms and bulk polymers from their adhesional force interactions. Being able to determine the contact radii would also help to provide science-based practical knowledge to industry to allow them to design new carpeting materials that break the particle trapping and accumulation cycle.