The Radke Lab
Professor Clayton J. Radke
Ali Boushehri, Tom Dursch, Colin Cerretani, Sam Maurer, Tatiana Svtova, Victoria Tran and Christoph Walowski

Who works in Radke Lab?
Current Graduate Student Research
Wangling Barriers to Tear Film Evaporation
CF Cerretani

Who else hangs out there?

What is the Radke Lab?
Surface and colloid science and technology

Research in the Radke Lab focuses on combining principles of surface and colloid science towards engineering technologies where phase boundaries dictate system behavior. We employ modern spectroscopic tools along with molecular theory and simulation, and continuum transport and reaction engineering to provide quantitative description of interfacial behavior important to technology development.

- Biofuels and catalysis
- Bacterial adhesion on contact lenses
- Cleaning of silicon wafers
- Diblock copolymer surface properties
- Composition and evaporation of the human tear film
- Thermodynamic simulation of the air/water interface

Current Graduate Student Research

Bacterial Adhesion of Pseudomonas Aeruginosa
VB Tran

While P. aeruginosa adhesion to contact lenses has been studied, the published literature at times is confusing and contradictory. Bacterial gene expression is regulated in response to prevailing environmental conditions. Thus, this study tests the hypothesis that bacteria express multiple phenotypes when interacting with the surface of a contact lens, possibly relating to the confusion in this field. Swimming motility is required for efficient adhesion to contact lenses, but the presence of flagella (aggregates that mediate swimming) is not sufficient. Neither pilA, nor specific LPS O-antigens are needed. Swimming motility was required for the tethering phenotype. Mechanisms for the involvement of swimming are to be elucidated, but may include promoting access to the lens surface, a direct role in adhesion, or a role in regulating the expression of unidentified adhesion factors.

Pseudomonas aeruginosa attachment is an important precursor to tissue colonization and biofilm formation on medical devices. Both pilA and flagella have been previously shown to be involved in attachment to a variety of surfaces; however, studies to date have yet to delineate the relative roles of these appendages in this process. Here we used quantitative video microscopy to investigate the surface association dynamics of wild-type P. aeruginosa strain PAK to hydrophilic contact lenses using a flow-chamber. Rates of surface association and the phenotypes observed with wild-type bacteria were compared with those of isogenic mutants in pilA (pilA), flagellin (flgK) and genes impactin g pilus or flagellin function (pilU and motAB respectively). Wild-type PAK surface associated at a rate ~40 times faster than that of the pilA or motA mutants. Wild-type and pilA bacteria associated at the same rate each being 4 times faster than the pilU mutant. On association with the surface, wild-type PAK attached and showed multiple phenotypes which included static, lateral-surface movement and rotational. Bacteria also detached from the surface. In contrast, pilA and motAB did not exhibit the rotational phenotype while the pilU and pilA mutants lacked the lateral-surface movement phenotype.

Surface Kinetic Mechanisms of Enzymatic Cellulose Deconstruction
SA Maurer

The rate-determining step in the biological decomposition of lignocellulosic feedstocks is the enzymatic cleavage of lignocellulose found in plant cell walls to simple sugars. Currently, this process is accomplished through the reaction of solid lignocellulose crystals suspended in an aqueous solution containing various enzymes and cellulose-producing bacteria. The rate of this lignocellulose deconstruction is governed by surface interactions between crystalline lignocellulose and aqueous cellulase.

Rate data currently available on cellulose deconstruction kinetics have been obtained through batch studies; little is known about the molecular events that trigger the release of cellulose from the surface of crystalline lignocellulose. We seek to quantify these surface interactions through flow ellipsometry, quartz crystal microbalance, and atomic force microscopy. Thus far we have utilized flow ellipsometry to quantify not only cellulase adsorption, but also cellulase adsorption on a model cellulose surface. Continuous, rather than discrete, measurements were taken, offering a complete picture of the adsorption behavior of various isolated cellulases. Through our unique methods of studying the cellulase surface, we seek to develop a surface kinetic model for the mechanism of enzymatic cellulose deconstruction and investigate hypothesized causes of the kinetic slowdown of cellulases on cellulose.

Water Transport Through Soft Contact Lenses Determined in a Fan Evaporation Cell
A Boushehri and KJ Shieh

On-eye movement of commercial soft contact lenses (SCL) is crucial to the health of the cornea. Comfort and safety of a SCL lens depends on both the water content of and the water flux through the lens membrane. Unfortunately, the permeability of commercial soft contact lenses is unavailable. To acquire SCL water-permeability data, a newly designed fan evaporation cell (FEC) is constructed. The fan evaporation cell employs a much simpler design compared to the previously used vacuum evaporation cell for flat membranes and accommodates both commercial SCLs and flat-sheet membranes. After correction for membrane thickness, measured water fluxes in the simple fan evaporation cell agree with those obtained in the vacuum evaporation cell (VEC). For the first time, gradient-driven water flux is reported for seven commercial SCLs encompassing both HEMA and silicone-hydrogel types. For relative humidities less than about 75%, effective Fickian diffusivities of water in the polymer gel are about 1.5 x 10^-7 cm^2/s rather independent of lens material and saturated water content. The proposed explanation is formation of a glassy skin due to low water content at the evaporating surface.

Freezing Point Depressions in Porous Media
TF Dursch

One of the limitations of current fuel cell technology is the mechanical damage and hysteresis to porous media within the fuel cell stacks when they are exposed to low temperatures for extended periods of time. One of the primary goals is to better understand the mechanism for frost heave in porous media, in order to eventually prevent frost heave in fuel cell stacks.

Aside from this, current water transport models in fuel cells rely heavily on soil literature for some of the needed equations. We are interested in determining empirical equations for predicting water transport media including kinetic parameters and rate expressions for ice formation. Experimentally, this can be accomplished through the use of differential scanning calorimetry (DSC). Also through the use of DSC, we hope to be able to determine the bound water content and freezing point depressions in various porous media.