Bio-Inspired Synthesis of Composite Materials - A View from the Interface

Prof. Lara Estroff  
Department of Materials Science and Engineering  
Thursday, June 6th 12pm, 700 Clark Hall  

Biomineralization, the study of how organisms form minerals such as bones, teeth, and shells, provides examples of strategies for controlling the growth of crystalline materials patterned at the nanoscale. In particular, the concept of crystal growth in confinement has led to many interesting synthetic structures. In this presentation, I will focus on our recent efforts to use confinement within track-etched membranes to force the incorporation of a secondary phase with single crystals and the use of block copolymers to template the surface confined precipitation of crystalline transition metal oxides with periodicities on the order of 50 nm. I will also discuss recent fluid cell Atomic Force Microscopy (AFM) studies of calcite growth in the presence of polymeric micelles with varying surface chemistries. These results have the potential to lead to design criteria for polymer-reinforced crystalline materials with unique structure-property relationships. In addition, insights provided by this work may help to elucidate the formation mechanism(s) and properties of biogenic single crystals with incorporated organic material.

Seeing with Electrons: From Single Atoms to Cells  
Prof. Lena Kourkoutis  
Department of Applied and Engineering Physics  
Thursday, June 20th 12pm, 120 PSB  

The smallest element in an electronic device such as your cell phone is a layer just a few atoms across, 10,000 times smaller than the average diameter of a human hair. If the structure of that layer is not precisely controlled your device will fail. With powerful microscopes, which use electrons instead of light, we can see the fine details of the layer and understand materials atom-by-atom. Today, electron microscopes are among the most important tools in the physical and biological sciences to understand the structure of matter. Even the inner workings of a cell can be studied using these instruments. In this talk I will demonstrate the power of this technique by showing you what we can see with electrons.

Biochar as an Adsorbent in Water Purification Applications and as a Soil Amendment  
Prof. Matthew Reid  
Department of Civil and Environmental Engineering  
Thursday, June 27th 12pm, 226 Weill Hall  

Biochar is the residue of organic materials that are heated to temperatures between 300 – 700°C in the absence of oxygen. This process, called pyrolysis, produces a material with a high surface area, internal microporosity, and a combination of polar and hydrophobic surface sites. Biochar can be produced from a wide range of agricultural and other organic wastes as feedstock, and is therefore widely available and relatively inexpensive to produce. These
properties have made biochar an increasingly popular adsorbent material for removing pollutants from contaminated water and soil. This first part of this talk will provide a brief introduction and overview of the production and properties of biochar. The second part of this talk will discuss the application of biochar as a low-cost adsorbent for removing organic and inorganic contaminants from soil and water. This part of the talk will include a case study of the problem of naturally-occurring arsenic in groundwater used as drinking water sources in South Asia and East Africa, and the potential for an iron-impregnated form of biochar to act as a low-cost and locally-available filter material in these settings.

**Cooperative Adsorbents Enable Energy-Efficient Carbon Dioxide Capture from Fossil Fuel-Fired Power Plants**

*Prof. Phillip Milner  
Department of Chemistry and Chemical Biology  
Thursday, July 11th 12pm, 226 Weill Hall*

Global atmospheric levels of carbon dioxide recently surpassed an unprecedented level of 410 ppm. Carbon capture and sequestration (CCS), in which the carbon dioxide emitted from point sources such as coal- and natural gas-fired power plants is captured from flue gas streams and sequestered underground instead of being released, has been proposed as a necessary strategy to reduce anthropogenic CO$_2$ emissions. However, current CO$_2$ capture technologies such as aqueous amine scrubbers would lead to a $>30\%$ increase in the levelized cost of electricity if implemented on large scale. Therefore, the design of new, energy-efficient materials capable of selectively (ad)sorbing CO$_2$ over N$_2$, O$_2$, and H$_2$O, would greatly reduce the penalty of CCS and enable its implementation world-wide. Metal-organic frameworks are a relatively new class of porous, crystalline materials that self-assemble from organic “linkers” and inorganic “secondary building units.” Here, we demonstrate that diamine-appended variants of the metal-organic framework Mg$_2$(dobpdc) ($\text{dobpdc}^4- = 4,4’$-dioxidobiphenyl-3,3’-dicarboxylate) possess unique “step-shaped” CO$_2$ adsorption profiles, enabling higher working capacities to be achieved with lower temperature swings than conventional materials. Key to this unique behavior is the cooperative formation of ammonium carbamate chains along the pores of the framework. We show that the CO$_2$ adsorption properties of the materials can be rationally tuned simply by changing the structure of the post-synthetically appended diamine, enabling the design of promising adsorbents for CO$_2$ capture from both coal and natural gas fired power plants.

**Cell Sized Robots**

*Prof. Itai Cohen  
Department of Physics  
Thursday, July 18th 12pm, 226 Weill Hall*

What would we be able to do if we could build cell-scale machines that sense, interact, and control their micro environment? Here I will describe a new platform we are developing for the construction of micron sized origami machines can sense their environments, respond, and perform useful functions on time and length scales comparable to microscale biological organisms. With the incorporation of electronic, photonic, and chemical payloads, these basic elements will become a powerful platform for robotics at the micron scale. As such, I will close by offering a few forward looking proposals to use these machines as basic programmable
elements for the assembly of multifunctional materials and surfaces with tunable mechanical, optical, hydrophilic properties.

**Scientific Presentation Skills by Prof. Melissa Hines, Thursday, July 25th at 12pm, 226 Weill Hall**

All students will attend an [interactive workshop on public speaking and scientific presentation](#). Topics covered include: how to improve your communication skills, how to give a presentation that effectively illustrates the focus of your research, and how to avoid common pitfalls.  
[Presentation PDF]

**Graduate School: A View from the Trenches**

Current Cornell graduate students and faculty will present a forum on graduate school. Topics of discussion will include:

- Is graduate school for you?
- Career possibilities in materials
- Tips and tricks for graduate school admissions

**Ethics Presentation by Prof. Paul McEuen, Thursday, June 13th at 12pm, 700 Clark Hall**

Starting from a case study of scientific misconduct uncovered by McEuen, the Hendrik Schön case at Bell Labs, the human and intellectual cost of scientific misconduct will be discussed in a group setting. The workshop will also discuss how scientists can give back to society—issues ranging from choosing research that is meaningful to conveying science to the government and society at large.