

Undergraduate Research Seminar  
Wednesday, March 11<sup>th</sup>, 2015 5:30 p.m.  
Leigh 309

### **Sadra Hamedzadeh**

“A Novel Methodology in Synthesis of Cyclic Dipeptides”

Diketopiperazines are a unique class of compounds with diverse structural characteristics that have captured the attention of scientists since their discovery. In particular, it has been shown that 2,5-diketopiperazines (2,5-DKPs), which are cyclic dipeptides, have significant biological activities. They have a wide range of applications including: antibiotic, insecticidal, antimitotic, chemosensitizing, anti-HIV, and so forth. All these properties make 2,5-DKPs substantial building blocks for the discovery of new leads and therapeutic agents. Despite the considerable exploration to date, there is still a need for further development of alternative, flexible, and cost-effective synthetic strategies. Our longstanding involvement in benzotriazole (Bt)-mediated oligopeptide chemistry prompted us to design a new, versatile, and flexible strategy able to provide 2,5-DKPs and bis-2,5-DKPs starting from inexpensive 1,1-dipeptidoyl benzotriazoles. We have developed a novel, widely applicable, and flexible triethylamine-promoted strategy for the synthesis of 2,5-DKPs and bis-2,5-DKPs from open chain peptidoyl benzotriazole sequences. The methodology was successfully demonstrated on the syntheses of novel 2,5-DKPs and symmetrical bis-2,5-DKPs, in moderate to good yields. Proline and hydroxy-proline have been utilized to introduce reverse turns to achieve short end-to-end distance in peptide chains in order to facilitate the intra-molecular lactamizations.

### **Alan Roberts**

“Morphology-Dependent Electronic Properties of CeO<sub>2</sub> Nanoparticles, Cubes, and Octahedrons”

Photocatalytic degradation of methylene blue dye was investigated in gold-loaded cerium dioxide under visible light ( $\lambda > 435$  nm). Our study illustrates the role of semiconductor morphology on its corresponding band structure through variations in photocatalytic efficiency. The arrangement of atoms in the crystal lattice dictates the width of the band gap, and so directly affects the activity of the crystal. This is exemplified in the expressed surface facets of the study's morphologies and their corresponding photocatalytic efficiencies. Nanoparticles have been observed to express a variety of surface facets, but primarily {100} and {111}. Cubes primarily express {100} surface facets, and octahedrons express primarily {111} facets on their surface. The {111} facets correspond to a face centered cubic orientation, and should theoretically be the lowest energy atomic arrangement of those studied. Nano ceria is not excitable by visible wavelengths, so gold must be incorporated to facilitate catalysis. Gold particle size and shape was held constant during deposition, as both of these factors would further alter the observed activity and distort the contribution from the cerium dioxide support.

## **Alex Touchton**

“Synthesis and Characterization of Tungsten Nitrido Complexes as Precursors for the Chemical Vapor Deposition of  $WN_xCy$  Thin Film Diffusion Barriers”

With semiconductor components growing increasingly smaller and with a migration to copper interconnections, one must ensure that the copper metal does not diffuse into the underlying silicon layer, something that could lead to a series of problems with the circuit. To prevent this, a thin amorphous film is deposited atop the silicon wafer as a diffusion barrier. With the nanoscale contours of the silicon surface, one must deposit a highly conformational thin film. Instead of just sputtering the film directly onto the silicon, one deposits the film chemically at the surface. A precursor that will attach to the silicon layer and then decompose above a certain temperature and pressure to grow the film, ensuring good coverage of sharp features and pits on at the silicon surface. Our group has been researching single source precursors that can be pumped into the deposition chamber as aerosols and will decompose at relatively low temperatures (180–350 °C in comparison to the 300+ °C of other  $WN_xCy$  precursors). We have synthesized a series of tungsten nitride complexes that can sublime and be aerosolized, that decompose at relatively low temperatures, and that grow amorphous tungsten nitride thin films. Through the design, synthesis, and characterization of these precursors with a variety of analytical techniques, our research has proposed several strong novel precursors for the chemical vapor deposition  $WN_xCy$ .