ND*nano* Undergraduate Research Fellowship (NURF)
2012 Project Summary

1) Student name: Adelia Tuse
2) Faculty mentor name: Zachary Schultz
3) Project title: Protein Detection in Solution using Surface Enhanced Raman Scattering

4) Briefly describe any new skills you acquired during your summer research:

During my summer research, I learned various instrumental skills and laboratory technique. I learned how to properly calibrate various parts of the microscope and align the laser in order to achieve better Raman spectra. In the lab, I learned proper safety and disposal of hazardous compounds. In addition, I also learned how to operate laboratory equipment, such as the plasma cleaner, and evaporate gold in the Stinson-Remick Hall clean room.

5) Please briefly share a practical application/end use of your research:

Using my research, Raman spectra of various compounds can be quickly and easily taken using the flow cell setup designed this summer. Eventually, my research can act as a reference or database of amino acid and protein Raman spectra.

Begin two-paragraph project summary here:

Raman spectroscopy is a spectroscopic technique that uses the scattering of light. Being an extremely weak signal, photons emitted when laser light passes through the sample almost always scatter at the same frequency as the laser itself. However, very rarely, light scattered from the sample is emitted at a different frequency than the laser. This is known as Raman scattering. In order to overcome the weak Raman signal, surface enhanced Raman spectroscopy (SERS) is used. Surface enhanced Raman spectroscopy is a technique increasingly used for high sensitivity detection. Molecules that come in close (~ 2 nm) proximity to a nanostructure in resonance with the excitation laser give rise to substantial Raman signals. The Raman spectrum observed is dominated by the residues that are closest to the nanostructure, creating differences in the SERS and conventional Raman spectrum. The goal of my project this summer was to characterize the SERS spectrum of the known amino acids to facilitate protein detection and analysis by SERS.

This summer, we developed methodology to reproducibly obtain the Raman signal of biological samples, such as amino acids and proteins in solution. A flow cell setup was designed that used a SERS substrate, produced either by the evaporation of gold or electroless deposition of silver onto an anodized aluminum oxide filter, attached to a self-supportive, biocompatible polystyrene slide. The polystyrene slide was fabricated by melting solid polystyrene powder in a self-assembled mold until it formed a clear, glass-like slide. After the slide was cooled, it was removed from the mold and sanded until smooth. Two pinholes were drilled on opposite ends of the slide to allow it to be securely inserted into the flow cell. SERS substrates created by the evaporation of gold were created in the Stinson-Remick Hall clean room. Gold was evaporated

onto an anodized aluminum oxide (AAO) filter, and the filter was removed with 0.1 M NaOH. Electroless deposition of silver onto AAO filters was attempted but was not yet achieved due to problems with the laboratory gas tank and air-sensitive silver plating solution. After a SERS substrate was adhered to a polystyrene slide, the filter was removed, leaving only gold on the slide. When the slide is inserted into the flow cell, the solution flows across the slide and over the substrate without leaking. Raman spectra taken using the SERS substrate shows excellent signal.

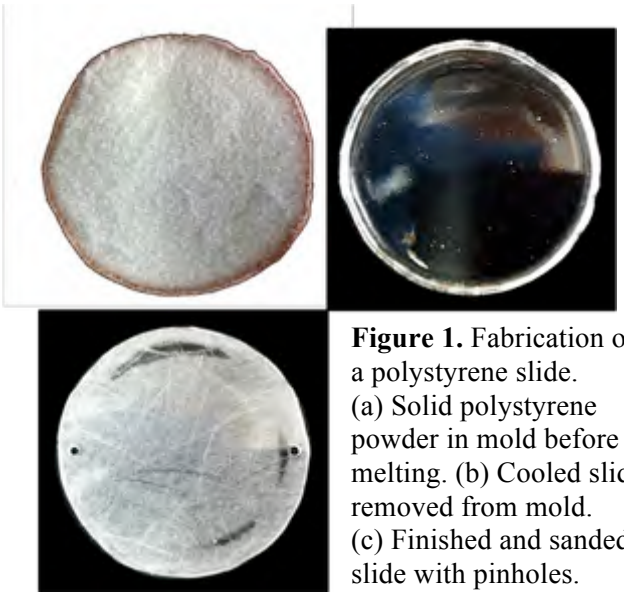

Figure 1. Fabrication of a polystyrene slide. (a) Solid polystyrene powder in mold before melting. (b) Cooled slide removed from mold. (c) Finished and sanded slide with pinholes.

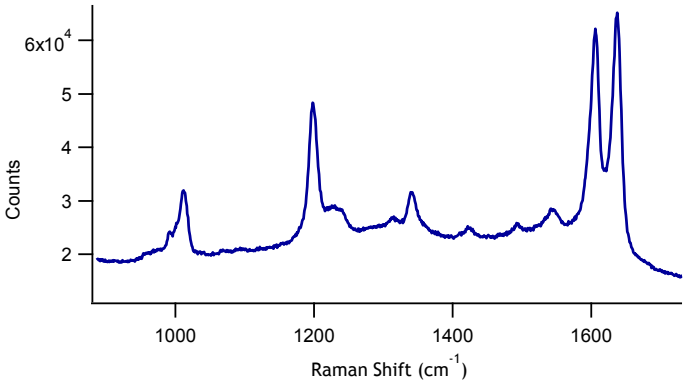

Figure 2. Raman spectrum of 1,2-di-(4-pyridyl)-ethylene using SERS substrate on polystyrene slide.

Publications (papers/posters/presentations): Poster Presentation: “Protein Detection in Solution using Surface enhanced Raman Spectroscopy” by Adelia L. Tuse, Steven Asiala, and Zachary D. Schultz.