UNIVERSITY OF NOTRE DAME
NDnano
CENTER FOR NANO SCIENCE AND TECHNOLOGY

1) Student name: **Kassandra Knapper**
2) Faculty mentor name: **Zachary Schultz**
3) Project title: **Generating Hotspots: Experiments and Modeling of Surface Enhanced Raman Detection**

4) Briefly describe any new skills you acquired during your summer research: **This summer, I learned a lot about working with instrumentation that I have never had the opportunity to use. I learned how to align lasers, and all of the components that are required for directing a laser into a Raman microscope. I also learned how to used dark field microscopy. I also acquired skills in working with various analytical computer software programs.**

5) Please briefly share a practical application/end use of your research: **The end goal of my research is to be able to explain differences in the intensity of surface enhanced Raman scattering (SERS) spectra based on the variation of the electric field by looking at the localized surface plasmon resonances at spots where enhancement occurs. This will provide new insights in SERS spectroscopy. It also has implications for new developments in tip enhanced Raman scattering (TERS) experiments.**

Begin two-paragraph project summary here: **Raman scattering is a highly specific and label free analytical technique. However, because Raman scattering is a rare phenomenon and results in signals that are often difficult to distinguish from noise. Surface enhanced Raman scattering (SERS) increases the scattering by putting the molecule in close proximity to a metal structure that has an enhanced electric field. Increased understanding of SERS indicates the electric fields associated with localized surface plasmon resonances (LSPR) can generate enhancements as great as 10^{11} in Raman scattering. The size and shape of nanoparticles influences the LSPR, modulating the observed Raman enhancement. Additionally, the polarization of the incident laser beam has a strong impact on the observed enhancement in nanoparticle aggregates.**

This summer, I analyzed samples of gold nanoparticles of various diameters (90nm, 72 nm, 52 nm, and 36 nm) that were adsorbed to a monolayer of 4-aminothiophenol on a smooth gold surface (Fig. 1). We modeled the scattered electric field of each particle size at different polarizations to predict how the enhancement at the gap between the gold film and the nanoparticles would vary with particle size and polarization direction. I conducted SERS experiments and compared the experimental data to the models. The experimental results and the model agree that 72 nm particles result in the greatest signal enhancement. Additionally, nanoparticle aggregates were observed in the experimental data that resulted in additional enhancements, not accounted for in the model. In addition to these results, we obtained dark field spectra associate with the plasmons at spots where signal enhancement occurs. This will allow for a better understanding of the origin of the enhancement. Further evaluation of the system using atomic force microscopy (AFM) and tip enhanced Raman scattering (TERS) will provide more conclusive results on the origin of the signal enhancement.

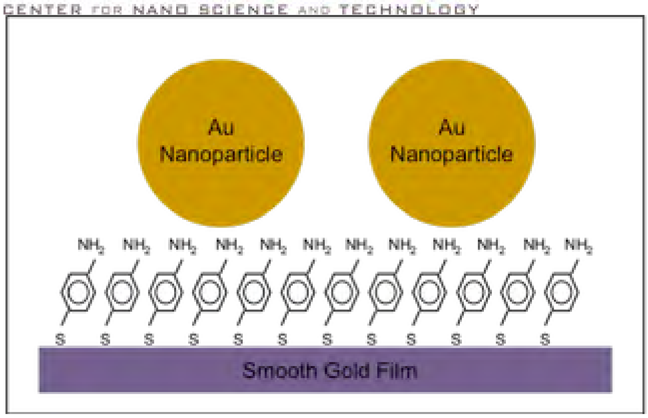

Figure 1: A schematic representation of the monolayer sample design.

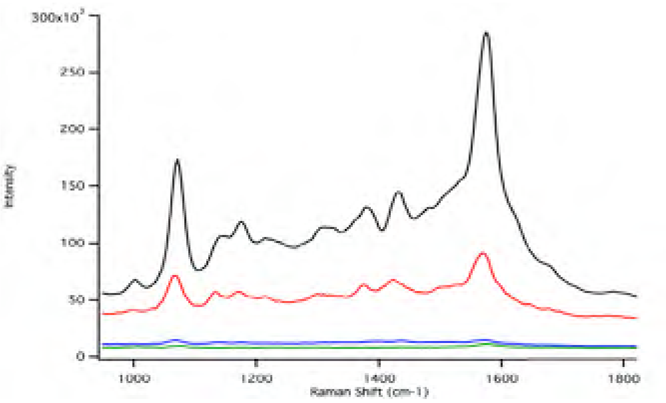

Figure 2: A comparison of SERS spectra from samples with different sized nanoparticles. Green: 90nm, blue: 52 nm, black: 72 nm, red: 36 nm.

Publications (papers/posters/presentations): **Poster presentation: "Generating Hotspots: Experiments and Modeling of Surface Enhanced Raman Detection" by Kassandra Knapper, Hao Wang, Zachary Schultz delivered at 2012 URSS at University of Notre Dame**