Chemistry with Baker Research at the University of Missouri

Arren Mallott (right) (‘21)

I conducted my internship with the Baker Group in the Department of Chemistry at the University of Missouri. The Baker Group had already worked with the EEE Internship program before and agreed to let me work in their lab after I met with Dr. Gary Baker, the principal investigator of the group, and Nathaniel Larm (pictured on the left in the photo), the graduate student that I was going to work under. I originally went to the lab on Wednesdays and Saturdays from 9 am to noon, but I later went on weekdays from the same times starting in January when I had more room in my schedule.

Research in the Baker Group is centered around polyionic nanoclays, or PINCs. These new substances are made of a magnesium and oxygen backbone with a silane bonded to the oxygen. For the nanoclay to be polyionic, the silane must be an ionic liquid, which is another area of research in the Baker Group. Ionic liquids are ionic compounds (like salts) that are in the liquid phase at room temperature (unlike typical salts). The useful properties of the PINCs come from which functional group (or even multiple groups) is attached to the silane, and the wide variety of possible functional groups means that the PINCs have great potential. The applications of

PINCs that I worked with included making metallic nanoparticles, stabilizing porous nanostructures, and dye absorbance.

Most of my time at the Baker Group involved using PINCs to make metallic nanoparticles that are extremely effective catalysts. For example, gold is a catalyst for the reduction of 4-nitrophenol into 4-aminophenol by sodium borohydride, a reaction that does not take place at an observable rate without a catalyst. The reduction of nitro groups into amines is important in the manufacture of pharmaceuticals and is beneficial for the environment since nitrophenols are poisonous. This reaction is easy to perform in the lab because sodium borohydride is also used in the formation of metallic nanoparticles. Additionally, the rate of this reaction is easy to measure since a solution of 4-nitrophenol and sodium borohydride is bright yellow, but turns colorless when the reaction is complete. We used a UV-vis spectrophotometer to measure a sample's absorbance at a wavelength of 400 nanometers over time in order to quantify the efficiency of our catalysts. When their efficiency as catalysts for the reduction of 4-nitrophenol is measured, nanoparticles prepared using PINCs consistently perform significantly better than all previous catalysts. Learning how to make and use all of the required materials and equipment for this reaction was the first thing that I did with the Baker Group, a process that spanned several months.

Once I had learned how to perform all of the standard procedures for research in the Baker Group, I had the opportunity to conduct my own research. The topic that I chose was to investigate the effects of using PINCs to stabilize dealloyed nanoparticles. Dealloying is the process of removing one metal from an alloy of two metals; in this case, I removed silver from a gold-silver alloy. Theoretically, this process

would make porous gold nanoparticles that would have more surface area than their alloyed counterparts and therefore would be more effective catalysts. Through the process of conducting my own research, I learned many practical skills that will greatly assist me in the future, especially regarding the processing of data and how to professionally display it. In addition to the programs used to run the instruments that collect the data, having my own data to work up let me expand my familiarity with programs that I had used before, such as Microsoft Excel, and learn new ones, such as SigmaPlot. While my chemistry classes taught me the explanations behind what I did, working on my own experiment in a lab allowed me to experience how to actually *do* chemistry and allowed me to fully understand why certain experimental procedures were in place in a way that the classroom could not.

I am very grateful for the opportunity to work with the Baker Group and I have learned so much from working with them. I now have hands-on experience working with chemicals and the equipment used to measure them that will be extremely beneficial to me in college and beyond. My internship has also let me become familiar with computer programs used to collect, analyze, and display data, such as Cary WinUV, Microsoft Excel, and SigmaPlot. I would like to thank Nate Larm for personally directing and assisting me throughout the more than 200 hours I have spent working with the Baker Group so far, as well as Dr. Gary Baker for graciously allowing me to work in his lab.