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Internship Summary

My internship was centered around the synthesizing and characterizing of compounds that followed a chemical formula that resembled $(R_2NH_2)_2MCl_4$. The M represents the place of different metals used, including Cobalt, Copper, Manganese, Zinc, and Nickel. Most of these metals were in the form of salts. The R group represents the different amines used, ranging from Di-n-butylamine, with four carbon atoms and nine hydrogen atoms, to Dodecylamine, with 12 carbon atoms and 25 hydrogen atoms. Five different R groups were used, with each one having two more carbon atoms than the previous R group (Butylamine, Hexylamine, Octylamine, Decylamine, and Dodecylamine).

The first few weeks of the internship were spent working closely with Dr. Bachman so that I could become familiar with different methods of synthesizing and characterizing the compounds. As I became comfortable with using the lab equipment, I was able to work more independently. I spent most of my time repeating reactions and comparing data.

In order to synthesize compounds with the $(R_2NH_2)_2MCl_4$ formula, three separate reactions were set up:

$R_2NH + HCl\ (g) \rightarrow R_2NH_2Cl\ (s)$ (solvent: Et_2O)

$2R_2NH_2Cl + MCl_2 \rightarrow 2R_2NH_2^{+} + MCl_4^{2-}$ (solvent: CH_2Cl_2 or $CHCl_3$)

evaporate $CH_2Cl_2 \rightarrow (R_2NH_2)_2MCl_4$

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I initially made four different R_2NH_2Cl solids, a process that took two day and included pipetting HCl gas into a solution containing one of the four salts and filtering out the precipitates that were believed to be the R_2NH_2Cl solids. The solids differed based on the R group used, either Di-n-butylamine, Di-n-octylamine, Didecylamine, or Didodecylamine.

The chemical makeup of these mostly white substances was unclear to the naked eye. I highly doubted that I had timed all the procedures and reaction times to anywhere near perfection. So the first extremely expensive machine that Dr. Bachman taught me to use and befriend was the infrared spectroscopy contraption. Every time I used that beautiful piece of technology I thought "I just smeared substance on a little diamond." I eventually learned a little bit about reading the infrared spectroscopy scans and understanding what was really happening in that little white and blue box that housed the mechanics of the "IR scans."

I took so many scans. Some days I would stand there, going back and forth between a new batch of 5-10 substances, taking scans and then examining, saving, comparing, cleaning, and finally repeating. I did a lot of repeating. Cleaning was always my favorite part: a little squirt of 100% ethanol, and a quick rub with a paper-based laboratory tissue. This often took hours. If the reactions weren't quite complete and I needed to evaporate excess solute, then I would be running between three or four different stations doing four totally different things for about 5-10 unique little infant samples of salt substances. Although I'm not a huge fan of personifying inanimate

objects, I became very attached to each special sample of approximately 0.2 grams of salty, colorful, powdery solids.

I had around 68 little glass vials sitting around atop the black work area. Some of them were considered failures for the time being, but I still kept them around, especially if they looked a little odd. One reason for my personal attachment to the contents of those little glass vials was that it was uncommon for the solids to be a white. Bright colors make me happy. I've very sensitive about colors, so the fact that 80% of the things I focused on were bright yellows, blues, greens, oranges, browns, even some pinks and subtle purples. Turns out that the pinks and purples meant that oxidation occurred, signifying impurities. We later found one solution for that, but it happened in a slightly odd way.

I suppose my fondness for 100% ethanol sprouted during those first few days while learning about Infrared spectroscopy. Adding the solvent to solutions with undissolved salts appeared to speed up the reaction. Upon later discovery of an earlier stoichiometric error, it was discovered that there were excess salts to begin with, so the addition of 100% ethanol resulted in leaving impurities.

Chemistry was very new and exciting for me at that point. I was fascinated by everything. The microscope became my favorite, especially when melting the substance on a special hot plate. The patterns I saw while melting and cooling some samples were beautiful. The unsymmetrical patterns of clovers and alternating sequences were quick to come and go, especially if the hot plate was set to heat at a higher rate. Luckily the

camera attached could take digital pictures, and if the focus was just right and the lighting looked acceptable, I could attempt to capture some of the pretty pictures.

After a few weeks or so, I gained some confidence in the few tasks I repeated in order to have a reliable process. After a number of glass vials had been filled with different combinations of slightly different reactants, I began to run out of the first batch of salts that I had synthesized on the first few days. So, it was decided I would make some more of those salts. The ventilated hood I used for pipetting HCl gas was in a different lab down the hall. So while handling a few different flasks, I had made the mistake of leaving the pipet connected to the rubber tube connected to the canister of HCl gas. After tightening the valve for the canister of gas, a slow suction had clogged the rubber tube with the thick solution of precipitate and solvent.

Opening the valve a few minutes later was not a good idea, thanks to pressure laws that I probably should have learned in my previous chemistry class. Those posters of safety goggle and drawings of blind people are not to be laughed at. Thanks to the science of safety goggles that I didn't get a slew of inorganic, pretty toxic liquids and solids in my eyes. I happened to break some glass, drench my face, and make a mess which managed to go a few meters past me, all over the lab. I also attempted to use those eye washing stations at a nearby sink, but I was too twitchy to operate such complicated creatures.

So my confidence was shot that day, but perhaps it needed to be. I still learned a few things about pressure, and I eventually went back and learned how to use one of those fancy eye wash stations. The skin on my face had a slight tickling feeling for a few

days, but I didn't mind that. Luckily none of those substances ate holes through my clothes. Also, mistakes happen to everyone. I had to keep that in mind to ease the pain.

The rest of the time I spent doing those same things, except not exploding anymore glass. I dropped a lot of glass, yes, but it was all minor. Of course, a few times I ended up bleeding, but I've never been very precise with sharp objects. As the days and weeks went on, I continued attempting to characterizing the substances. Dr. Bachman would teach me how to use a new instrument for analyzing the compounds every few weeks. Eventually I managed to narrow down which metals expressed a noticeable change as the carbon chains got longer in the amine reactants. Some metals had more drastic colors changes than others.

Particularly Copper and Cobalt were the most expressive, and prettiest, in my opinion. The last few weeks were spent synthesizing, examining, scanning, and comparing Copper compounds and Cobalt compounds. I found a new companion, the DSC machine. My last few days of summer internship were spent staring at the computer screen as the DSC scanned compounds tucked away in a nitrogen chamber in a metal pellet of a bed.

Working in a Chemistry Research Lab was an amazing opportunity for me to learn new things everyday from Dr. Bachman and from the chemistry involved with the substances I was examining. I gained insight into the tediousness of research and the importance of trial and error. I had mostly errors, but each error gave a clue as to what to do next, and perhaps that's an important life lesson as well. Although I don't see myself dedicating a career to Chemistry research or even switching my major, I still enjoyed my

time in the lab and was constantly amazed at what I learned in the lab. I certainly appreciate my time in the lab and I've grown very fond of those salts I spent so much time handling over the summer.