SLATT UNDERGRADUATE RESEARCH FELLOWSHIP
FINAL REPORT

SCHOLAR NAME:	Kimberly Riordan
FACULTY ADVISOR:	Dr. Emily Tsui
PROJECT PERIOD:	August 2020 – Ongoing
PROJECT TITLE:	Thiol-Amine Solubility in Water and Hydrogen Sulfide Quantification
CONNECTION TO ONE OR MORE ENERGY-RELATED RESEARCH AREAS (CHECK ALL THAT APPLY):	**(X) Energy Conversion and Efficiency** **( ) Sustainable and Secure Nuclear** **(X) Smart Storage and Distribution** **( ) Transformation Solar** **( ) Sustainable Bio/Fossil Fuels** **( ) Transformative Wind**

MAJOR GOALS AND ACCOMPLISHMENTS

Summarize your research goals and provide a brief statement of your accomplishments (no more than 1-2 sentences). Indicate whether you were able to accomplish your goals by estimating the percentage completed for each one. Use the next page for your written report.

RESEARCH GOALS	ACTUAL PERFORMANCE AND ACCOMPLISHMENTS	% OF GOAL COMPLETED
Product elucidation	The reaction between cysteamine and elemental sulfur forms a soluble compound which we sought to determine the structure of to understand its solubility. Various NMR methods (proton, carbon, variable temperature, and diffusion ordered spectroscopy) along with mass spectrometry and control reactions have been used.	75
Hydrogen sulfide quantification	We have been able to confirm hydrogen sulfide production through a qualitative reaction with lead acetate to precipitate lead sulfide. We are looking to quantify the amount of hydrogen sulfide formed in order to help with product elucidation as well as help us determine if we can controllably form hydrogen sulfide.	60
Electrochemical analysis of compounds	It is important to understand the electrochemical capabilities of our final product(s) in order to assess their potential for battery applications. This can be accomplished with the use of cyclic voltammetry and other electrochemistry techniques.	20

RESEARCH OUTPUT

Please provide any output that may have resulted from your research project. You may leave any and all categories blank or check with your faculty advisor if you are unsure how to respond.

CATEGORY	INFORMATION
EXTERNAL PROPOSALS SUBMITTED	n/a
EXTERNAL AWARDS RECEIVED	n/a
JOURNAL ARTICLES IN PROCESS OR PUBLISHED	Expecting to write a manuscript during the Spring 2021 semester
BOOKS AND CHAPTERS RELATED TO YOUR RESEARCH	n/a
PUBLIC PRESENTATIONS YOU MADE ABOUT YOUR RESEARCH	(Scientia Talk Science Lecture, Synthesis of a Trigonal Pyramidal Sulfur Radical and Exploration of Sulfur Solubility, Oct. 15, 2020, University of Notre Dame)
AWARDS OR RECOGNITIONS YOU RECEIVED FOR YOUR RESEARCH PROJECT	n/a
INTERNAL COLLABORATIONS FOSTERED	n/a
EXTERNAL COLLABORATIONS FOSTERED	n/a
WEBSITE(S) FEATURING RESEARCH PROJECT	n/a
OTHER PRODUCTS AND SERVICES (e.g., media reports, databases, software, models,	Research from this project will be used and published in my senior thesis for the Glynn Family Honors Program and the Chemistry Honors program.

curricula, instruments, education programs, outreach for ND Energy and other groups)	

RESEARCH EXPERIENCE

Please let us know what you thought of your research experience: Did this experience meet your expectations? Were lab personnel helpful and responsive to your needs? What else could have been done to improve your experience or achieve additional results?

I have greatly enjoyed my research experience with the Tsui group through the funding of the Slatt Fellowship. The funding from the Slatt family has granted me the opportunity to spend a summer doing full time research at the University of Notre Dame which helped me discern my career path and my desire to pursue a PhD in chemistry. Although I was not able to spend the summer of 2020 continuing my research, I appreciate the ability to use my funding from the Slatt Fellowship during my work during the semester. I plan on continuing my research through the spring 2021 semester with the aid of the Slatt family.

FINAL WRITTEN REPORT

(Please use the space below to describe your research project and objectives, any findings and results you can share, and graphs, charts, and other visuals to help us understand what you achieved as a result of this research experience.)

This project was undertaken in spring 2020 and was halted due to COVID-19 over the summer. During fall 2020 it was resumed and will be continued through my graduation in spring 2021. This project looked at the reaction of cysteamine with elemental sulfur and base in water. By inspection, the reaction turns yellow and it appears the sulfur goes into solution. The figures below are nuclear magnetic resonance (NMR) spectra of this reaction and control substrates. Cyclic voltammetry (CV) runs comparing cysteamine and sulfur with cysteamine alone show redox activity for the sulfur reaction. This activity is important for our compound to have applications in lithium-ion batteries with energy implications. We are interested in learning more about the electrochemical properties of this reaction and how this could influence the energy sector.

The primary focus has been on product elucidation through various spectroscopy methods and through analyzing the formation of hydrogen sulfide. We have conducted proton, carbon, variable temperature, and diffusion ordered NMR. We have also used mass spectrometry, UV-visible spectroscopy, and electrochemical analysis on this reaction.

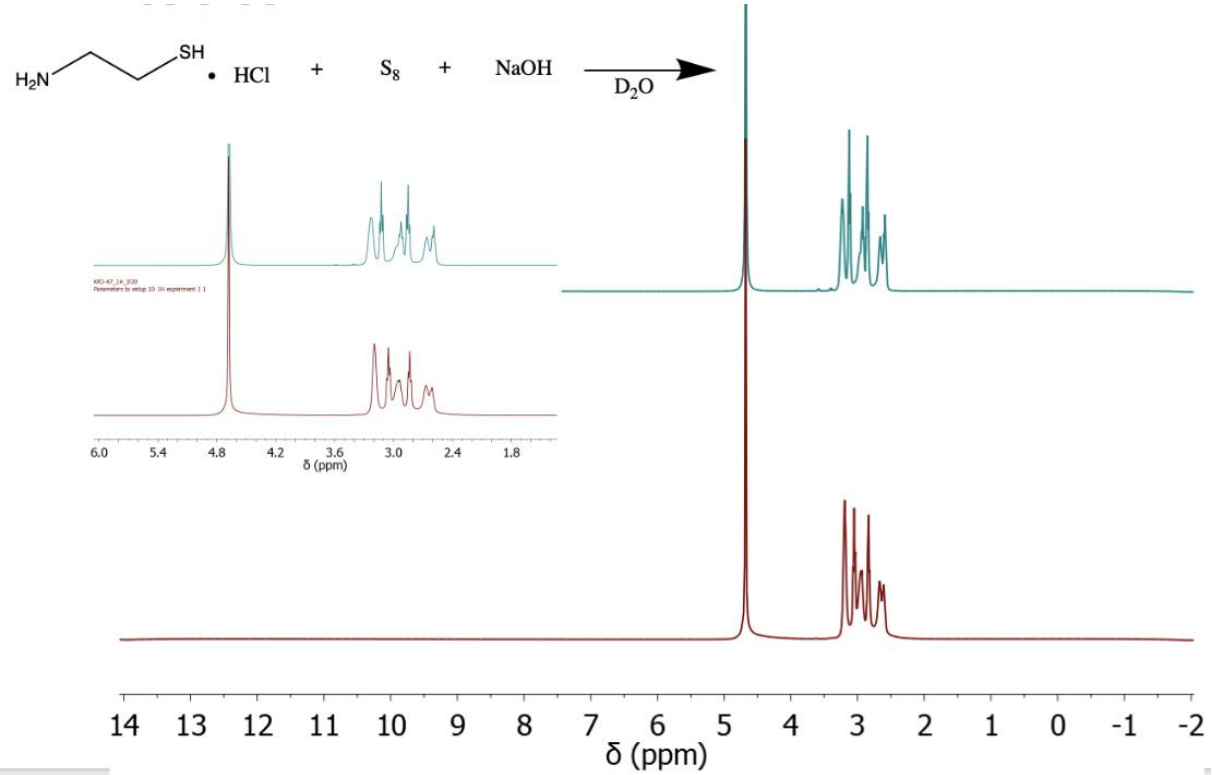

Figure 1: Reaction of cysteamine with elemental sulfur and base in water. The NMR spectra are for the same reaction repeated on different days to determine if the reaction decomposes over time.

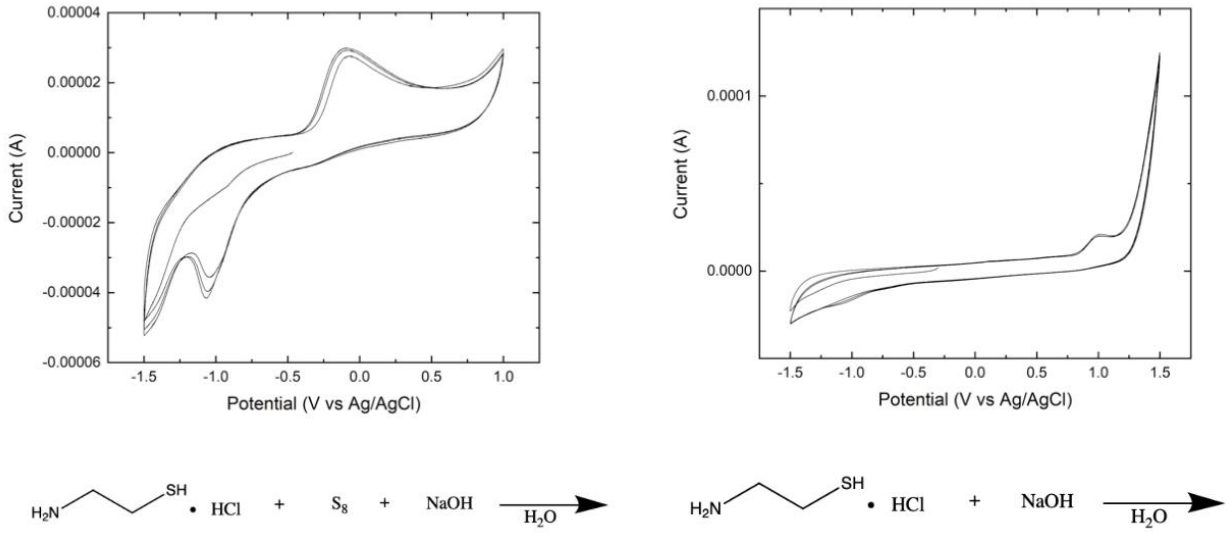

Figure 2: Cyclic voltammetry experiment for cysteamine and base with or without sulfur.

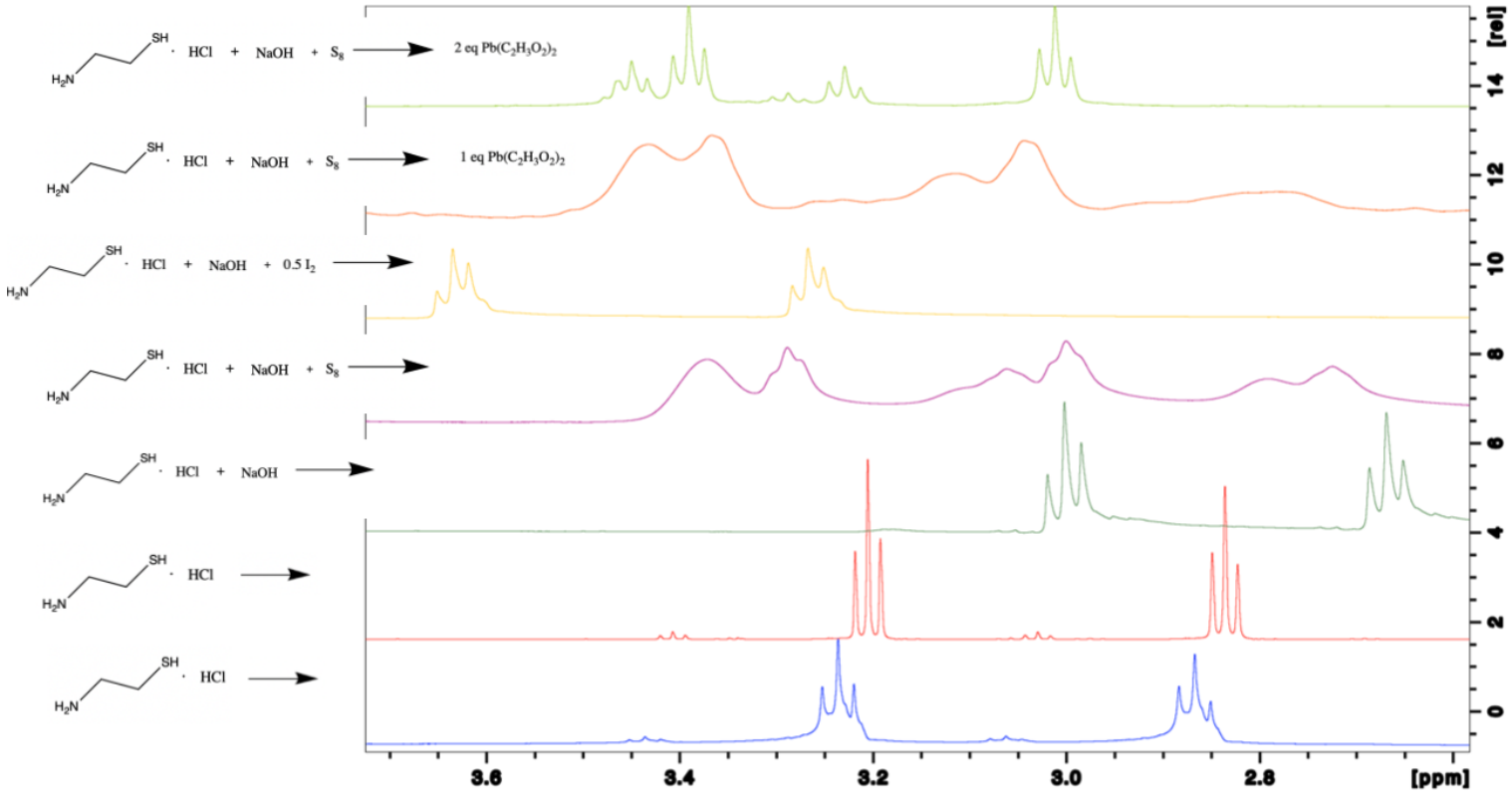

Figure 3: Cysteamine reaction with an oxidizing agent (I_2) and lead acetate used to help with product elucidation.