SLATT UNDERGRADUATE RESEARCH FELLOWSHIP
FINAL REPORT

SCHOLAR NAME:	William Cheong
FACULTY ADVISOR:	Dr. Emily Tsui
PROJECT PERIOD:	June 2022 – August 2022
PROJECT TITLE:	1,3,5 Trithiane as a Sulfur Source in Metal Sulfide Nanoparticle Synthesis
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
Determine role of H_2S in phase selectivity	The rate of H_2S release from various sulfur precursors have been quantified. However, the direct influence of H_2S on phase selectivity is still unknown.	25

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	(Sponsor, Project Title, PIs, Submission Date, Proposal Amount)
EXTERNAL AWARDS RECEIVED	(Sponsor, Project Title, PIs, Award Date, Award Amount)
JOURNAL ARTICLES IN PROCESS OR PUBLISHED	(Journal Name, Title, Authors, Submission Date, Publication Date, Volume #, Page #s)
BOOKS AND CHAPTERS RELATED TO YOUR RESEARCH	(Book Title, Chapter Title, Authors, Submission Date, Publication Date, Volume #, Page #s)
PUBLIC PRESENTATIONS YOU MADE ABOUT YOUR RESEARCH	(Event, Presentation Title, Presentation Date, Location)
AWARDS OR RECOGNITIONS YOU RECEIVED FOR YOUR RESEARCH PROJECT	(Purpose, Title, Date Received)
INTERNAL COLLABORATIONS FOSTERED	(Name, Organization, Purpose of Affiliation, and Frequency of Interactions)
EXTERNAL COLLABORATIONS FOSTERED	(Name, Organization, Purpose of Affiliation, and Frequency of Interactions)
WEBSITE(S) FEATURING RESEARCH PROJECT	(URL)
OTHER PRODUCTS AND SERVICES (e.g., media reports, databases, software, models, curricula, instruments, education programs, outreach for ND Energy and other groups)	(Please describe each item in detail)

RESEARCH EXPERIENCE

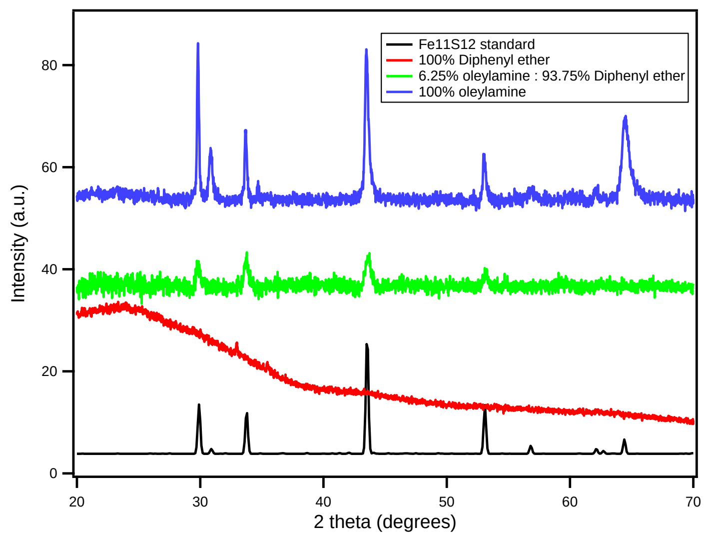
Please let us know what you thought of your research experience: Did this experience meet your expectations? Were lab personnel helpful and responsive to your needs? What else could have been done to improve your experience or achieve additional results?

FINAL WRITTEN REPORT

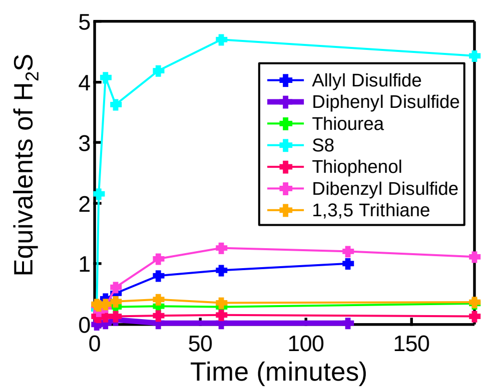
(Please use the space below to describe your research project and objectives, any findings and results you can share, and graphs, charts, and other visuals to help us understand what you achieved as a result of this research experience.)

My research focuses on the mechanism of formation of iron sulfide nanoparticles. Iron sulfide is present in several phases, with unique chemical compositions and properties. They have been theorized to be useful in catalysis, biosensors, batteries, and other applications. However, the current literature fails to provide a comprehensive and selective understanding of metal sulfide formations. More specifically, the reactivity of the sulfur precursor needs to be investigated further. As a result, there is a lack of information on what factors affect phase selectivity of iron sulfide.

My project focuses on the role of the sulfur source in iron sulfide phase selectivity. Last summer, I showed that the presence of an amine is necessary for the formation of crystalline iron sulfide nanoparticles. This has been shown before as the amine is necessary for the release of reactive sulfur species from the sulfur precursors. In the case of my sulfur precursor, 1,3,5 trithiane, previous literature has shown that aryl amines can substitute into the heterocycle and release H_2S gas. H_2S gas is a well-documented sulfur precursor. This led us to probe this reactivity. We initially hypothesized that the rate and quantity of H_2S release contributed to phase selectivity in iron sulfide. This led to a series of H_2S quantification experiments.



I initially began my H_2S quantification experiments by reacting 1,3,5 trithiane with oleylamine to release H_2S gas. The released H_2S was bubbled into a flask containing $Pb(NO_3)_2$ to form PbS which precipitates out as a black solid. The percent yield can be determined after weighing the product. However, this method presented several issues. PbS would form at the outlet of the teflon tubing, blocking the flow of H_2S gas. Furthermore, it was not possible to track the rate of the reaction over time. My PI was in contact with Mike Pluth from the University of Oregon and we adopted a method of H_2S quantification that he uses. N,N-dimethyl-p-phenylene diamine reacts with H_2S to form a blue compound, methylene blue. The formation of this compound was tracked over time using UV-vis. This procedure was performed using various sulfur precursors.



We drew two primary conclusions. It appears that H_2S formation is not a significant reactive sulfur species for several precursors. It is not formed to any appreciable amount which means other sulfur species are responsible for the formation of metal sulfide nanoparticles. Second, allyl and benzyl disulfide release H_2S at slower rates. This result has been corroborated previously by Huang Group from the National University of Singapore. In the future, we hope to further investigate the reactive sulfur species that do form and how it leads to phase selectivity in iron sulfide nanoparticles.