SLATT UNDERGRADUATE RESEARCH FELLOWSHIP
FINAL REPORT

SCHOLAR NAME:	Gavin W. Ealey
FACULTY ADVISOR:	Prashant V. Kamat
PROJECT PERIOD:	May 31-August 12th (?)
PROJECT TITLE:	Charge transfer processes with $AgInS_2$ loaded in Bipolar membrane (BPM)
CONNECTION TO ONE OR MORE ENERGY-RELATED RESEARCH AREAS (CHECK ALL THAT APPLY):	**(X) Energy Conversion and Efficiency ( ) Sustainable and Secure Nuclear ( ) Smart Storage and Distribution (X) Transformation Solar (X) 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
Work Independently and Collaboratively with other Researchers	Successfully performed experiments on my own as well as learned how to use analytical equipment in and out of my own lab.	100%
Use ND Resources to get a broad spectrum of Research knowledge	I learned how to use all of our labs in house equipment as well as how to use resources in Stinson Remick and Stepan	100%
Write a research paper	I created and presented my research findings and hope to start a paper soon	~10%
Present my research in house to my lab	I successfully presented my work at a group meeting to display my work and received useful critiques for future directions	100%

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	N/A
BOOKS AND CHAPTERS RELATED TO YOUR RESEARCH	N/A
PUBLIC PRESENTATIONS YOU MADE ABOUT YOUR RESEARCH	Notre Dame Summer Symposium, Jordan Hall of Science
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, curricula, instruments, education programs, outreach for ND Energy and other groups)	N/A

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?

This experience did meet my expectations. I got the work that I set out to do finished and I now hope to build on it when I come back to lab for the coming semester. My lab's fellow researchers were beyond encouraging and helpful. I couldn't be happier with the environment here at the Rad Lab. The only thing that might have been helpful would be some sample posters or resources to apply or try for the above mentioned presentations or research experiences.

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.)

Throughout this project, the main goal was to create a photocatalytic membrane that harnesses light energy and turns it into chemical energy. To do this, a semiconductor that harvests light was placed into Nafion, a transparent membrane that would allow the semiconductor to be between two liquid species. This effort was successful.

The ternary semiconductor, $AgInS_2$ (Silver Indium Sulfide) was placed into the Nafion membrane through simple aqueous ion exchange and deposition. First, Indium, In^{3+}, was placed into the membrane via the submersion of a Nafion sample in .5M In^{3+} solution for 2 hours. After this, a .5M TAA solution was used as the sulfur source, forming In_2S_3, an easily identifiable compound. This submersion required 70C for 2 hours. Finally, a .01M Ag^+ solution was used to create the ternary structure. This submersion only took between 30-150 seconds. This timeframe is a clear indication that despite lower charge, and lower attraction therefore as Nafion is slightly negatively charged, silver ions enter Nafion much quicker via aqueous deposition.

With the semiconductor supposedly/hopefully in place, we went about confirming that we had made the correct species. This was done via X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF), Scanning Electron Microscope (SEM) imaging and UV-Vis Absorbance. With these sets of data, our species was both confirmed and partially characterized.

Further characterization was done via Transient Absorption Spectroscopy (TAS), Photoluminescence (PL) and PL Excitation (PLE). Here, we were able to find a lifetime and study the nature of the excited semiconductor while its inside the film.

With this data, it was time to measure the photocatalytic abilities of the film. In simple terms, could it actually absorb light and then turn it to chemical energy? To test this, 4-nitrophenol, a yellow-colored alkaline species, was placed in one half of an H-Cell with the $AgInS_2$ Nafion film in the center. 4-nitrophenol (4NP) when reduced turns to 4-aminophenol (4AP), a species with a very different absorbance peak than 4NP.

This was how the reduction would be trackable. After exposure of the H-Cell/$AgInS_2$ to light, the 4AP began to form and was measured on a UV-Vis spectrometer. A photocatalytic membrane had been formed.

As of now, we are currently working on ligands paced upon the film as a means of passivating defects to increase efficiency. Additionally, we are looking at deposition of Pd Nanoparticles that have shown to be channels for energy release that can increase efficiency.