SLATT UNDERGRADUATE STUDENT FELLOWSHIP PROGRESS REPORT

SLATT SCHOLAR:	Seancarlos Gonzalez
FACULTY ADVISOR:	Jennifer L. Schaefer
REPORT PERIOD:	06/03/2019 - 07/30/2019
PROJECT TITLE:	'Improving the longevity of lithium metal batteries' and 'Using nanoscale carbon as a cathode for magnesium-sulfur batteries'
CONNECTION TO ND ENERGY'S RESEARCH AREAS (CHECK ALL THAT APPLY):	**( ) 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:
List your major research goals and provide a brief description of your accomplishments (1-2 sentences). Indicate the percentage completed for each goal. Please use a separate sheet to share additional details, technical results, charts, and graphics.

MAJOR RESEARCH GOALS	ACTUAL PERFORMANCE AND ACCOMPLISHMENTS	% OF GOAL COMPLETED
Form nanoscale graphene carbon to use as a cathode	I was able to find an effective procedure to form nanoscale mesoporous carbon and it functioned very well as a cathode for Mg-S batteries.	100%*
Prevent dendrites in lithium metal batteries	I observed lithium cells that failed due to dendrites and was able to correct this behavior through a PEGDA coated separator.	100%*
	*Although I reached my goals for this summer, both my projects have future work to be done during the school year	

RESEARCH OUTPUT:
Please provide detailed information below regarding any output resulting from your research project. Please check with your faculty advisor if you are unsure how to respond.

CATEGORY	INFORMATION
EXTERNAL PROPOSALS	
EXTERNAL AWARDS	
JOURNAL ARTICLES	
BOOKS AND CHAPTERS	
PUBLIC PRESENTATIONS, SEMINARS, LECTURES	I presented at Notre Dame's Undergraduate Research Symposium on 07/24/19 and my presentation was titled 'Improving the Longevity of Lithium Metal Batteries.'
AWARDS, PRIZES, RECOGNITIONS	
INTERNAL COLLABORATIONS FOSTERED	
EXTERNAL COLLABORATIONS FOSTERED	
WEBSITE(S) FEATURING RESEARCH PROJECT	
OTHER PRODUCTS AND SERVICES (e.g., media reports, databases, software, models, 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? Was there something else that could have been done to improve your research experience? Were lab personnel helpful and responsive to your needs? What could have been done differently, if anything, to achieve additional research results?

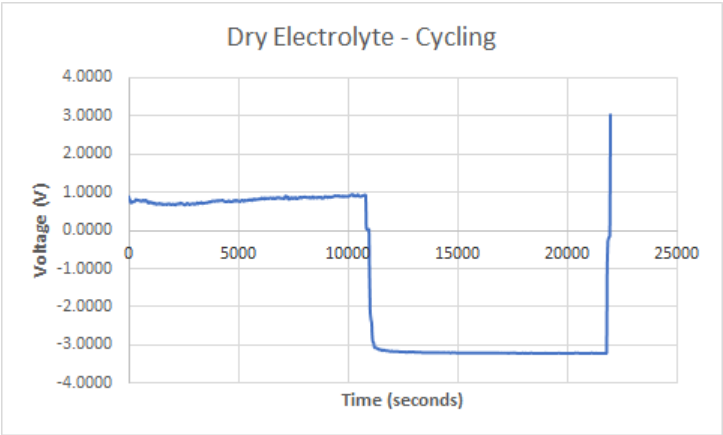
I am very pleased with my research experience. I learned a lot about the day-to-day of working in a lab, how to manage and move forward on my projects, the conceptual basis behind my work, and learning to present my findings. My faculty advisor and my graduate

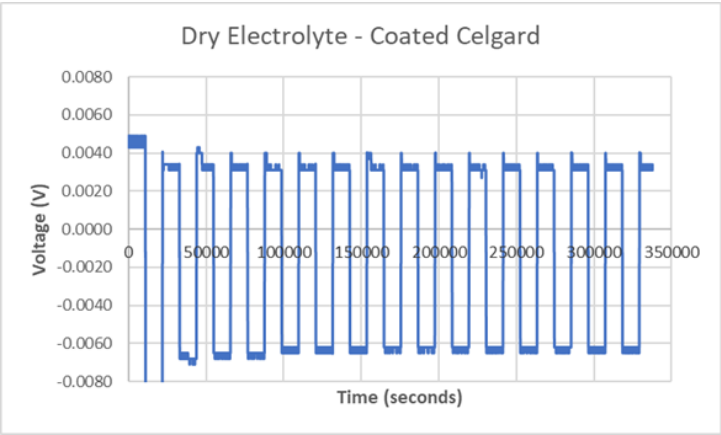
mentors (Hunter Ford, Peng He) were all extremely helpful in guiding me in my projects. I am content with my results so far and I am eager to continue to work on them throughout the school year.

MAJOR GOALS AND ACCOMPLISHMENTS

(Additional Details, Technical Results, Charts and Graphics)

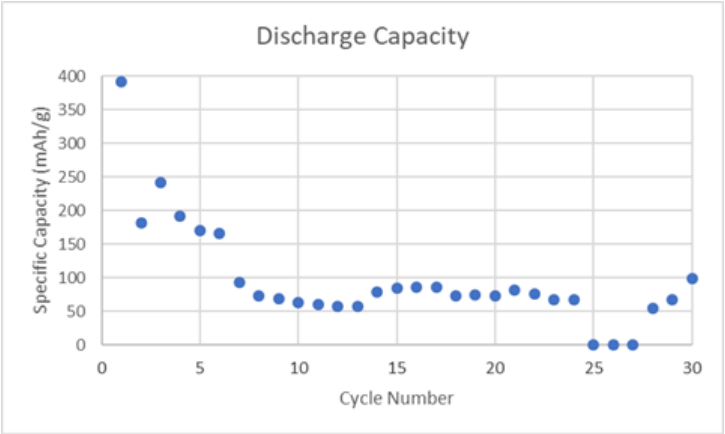
IMPROVING THE LONGEVITY OF LITHIUM METAL BATTERIES

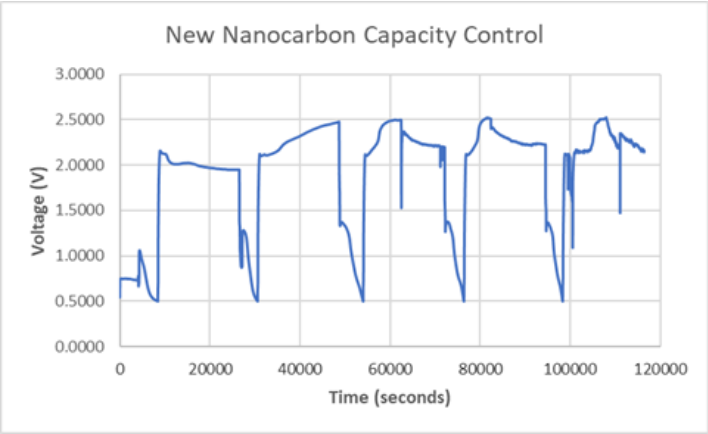




On the left is a lithium symmetric cell formed with a dried electrolyte that is set to charge and discharge at 5mA/cm^2. The cell goes through one cycle at very high voltages and then breaks down, showing that the cell breaks down due to the electrolyte forming a poor solid electrolyte interphase (SEI) causing the cell to deposit non-uniformly and fail to cycle. On the right is a cell formed and tested under the exact same conditions, but with a coating on the separator designed to serve as an artificial SEI. This cell actually cycles consistently, has lasted a long time, and displays a low voltage which is excellent for a symmetric cell. The coating seems to greatly improve the longevity of the lithium metal batteries and will be continued to be researched.

USING NANOSCALE CARBON AS A CATHODE FOR MAGNESIUM-SULFUR BATTERIES





In the past, different types of carbon cathodes have failed to cycle well for more than one cycle. Above is the data for a coin cell synthesized using nanocarbon that I myself have made in the lab under certain reaction conditions. On the left, the discharge capacity over different cycles shows that the cell lasts for about six solid cycles in which the capacities add up to come close to sulfur's theoretical capacity (1675 mAh/g). The voltage profile on the right shows that the cells have no issue charging and discharging with the discharges maintaining a consistent shape through five cycles. This nanocarbon has shown itself to be much more consistent, reproducible, and effective than other types of carbon in the lab.