

Lucy Metzroth

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Materials scientist interested in expanding renewable energy usage opportunities through energy storage systems. Strives for a deeper fundamental mechanistic understanding of solid-state battery and hydrogen storage materials. Results driven; works well independently and in collaborative environments.

EDUCATION

Colorado School of Mines, Golden, Colorado
Major: Materials Science; GPA: 4.0

Doctorate of Philosophy
2021 – Current

Metropolitan State University of Denver, Denver, Colorado
Major: Chemistry; GPA: 3.89

Bachelors of Science
2016 – 2020

University of Colorado, Boulder, Colorado
Major: International Affairs; GPA: 3.36

Bachelors of Arts and Science
2006 – 2010

L'Institut d'Etudes Politiques de Paris (Sciences Po) Institute of Political Studies of Paris, France
International Exchange Program

2008 – 2009

RESEARCH EXPERIENCE

Research Assistantship

Colorado School of Mines/National Renewable Energy Laboratory September 2021 – current

Mentors: Dr. Steve Christensen, Dr. Tom Gennett, Dr. Shubham Vyas

Examination of fuel additives for solid hydrogen carriers including characterization, mechanistic understanding, and electrochemical regeneration.

- Characterization of species formed using cyclic voltammetry, temperature programmed desorption, and spectroscopic techniques.
- Computational analysis of electronic structure to understand mechanisms and predict reaction pathways
- Determine possible regeneration techniques including electrochemical regeneration and ball-milling.
- Attend meetings with industry partners (Honeywell).

Chemistry and Nanosciences Research Technician

National Renewable Energy Laboratory (NREL) August 2020 – September 2021

Mentors: Dr. Mike Carroll and Dr. Tom Gennett

Assisting staff scientists with research on catalytic materials for CO₂ reduction and hydrogen storage materials both experimentally and computationally.

- Optimized a gas chromatograph mass spectrometer (GC/MS) and differential electrochemical mass spectrometer (DEMS) for CO₂ reduction product detection.

- Collected and analyzed data from the GC/MS, DEMS, and electrochemical experiments.
- Published two papers on our electrocatalytic work with palladium nanocubes as first author.
- Optimized low temperature diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS) technique.
- Collected temperature program desorption (TPD) data, surface area measurements, and DRIFTS data for staff scientists.
- Contributed computational research using density functional theory on covalent organic frameworks regarding the energetics of hydrogen release mechanisms.

Solar Fuels Undergraduate Internship

NREL

August 2019 – August 2020

Mentor: Dr. Elisa Miller

Developing photocatalytic systems with transition metal dichalcogenides (TMDCs) for solar fuel production via CO₂ reduction reaction, N₂ reduction reaction, and hydrogen evolution reaction.

- Thin-film transfer methods, electrode fabrication, electrochemical analysis of samples via a potentiostat, set up and maintenance of optics used for sample excitation, gas chromatography, confocal Raman/photoluminescence spectroscopy, TMDC exfoliation by probe sonication, fluorimeter operation, and establishing controls for ammonia generation.
- Participate in biweekly 2D TMDC and Thrust 3 meetings
- Hours per week in lab: 20

Computational Chemistry Research Experience

Metropolitan State University of Denver (MSU)

December 2019 – August 2020

Mentor: Dr. Joshua Martin

An in-depth computational examination of the electronic properties of cyanophenylalanine isomers using ab initio methods to determine minimum energy geometries. Insight into these chromophores' photophysical behaviors promote their use as participants in Förster Resonance Energy Transfer (FRET) and protein folding studies.

- Building molecules in Gauss View and running calculations through Gaussian
- Using calculation methods such as Hartree-Fock (HF), Density Functional Theory (DFT/B3LYP), Moller-Plesset Perturbation (MP2), Couple Clustered Single Double (CCSD), and Complete Active Space Self-Consistent Field (CASSCF)
- Presented at MSU Undergraduate Research Conference
- Hours per week: 5

Department of Energy (DOE) Science Undergraduate Laboratory Internship (SULI)

NREL

June 2019 – August 2019

Mentor: Dr. Jeremy Dunklin

Investigated the photocatalytic reduction of ferricyanide by gold decorated TMDCs. Observing a one electron reduction process gave insight into the effect of both the TMDC and the

plasmonic metal as charge generators and separators. This combination has the potential to improve reduction processes for solar fuels.

- Bulk exfoliation techniques such as probe sonication and ion intercalation, thin film transfer processes, UV- vis and confocal Raman spectroscopy
- Presented at the SULI poster session and wrote a research paper detailing methods and results of experiments.
- Hours per week in lab: 40

Analytical Biomass Analysis Internship

NREL

February 2018 – May 2019

Optimization of a total organic carbon analysis method to track carbon distribution in live algae cultures using a Shimadzu total organic carbon (TOC) analyzer. (Mentor: Bonnie Panczak)

- Set up, maintenance, and installation of TOC analyzer and optimization of TOC analyzer methods for total carbon, inorganic carbon, total organic carbon, and non-purgeable organic carbon analyses as well as their flow paths for live algal cultures. Improved analytical techniques such as calibration curve development, precision dilution and pipetting, sample care, and sample homogenization.

A comparison of the accuracy of handheld Near Infrared (NIR) scanning devices with tabletop NIR spectrophotometers using established statistical models of terrestrial feedstocks. (Mentor: Courtney Payne)

- Experimental design and method development for handheld devices and knowledge of several different spectrophotometer software programs.

Design and implementation of sampling processes for the Feedstock Conversion Interface Consortium pilot plant runs to determine the feasibility of a scalable process for terrestrial feedstock conversion to biofuels. (Mentor: Dr. Ed Wolfrum)

- Prepared sampling schedule, prepared and labeled sampling containers and supplies for 9 separate sampling stations, implemented proper sample recording, and learned the importance of a rigorous and consistent sampling method in experimentation.
- Assisted in sample analyses including fraction insoluble solids, ash free dry weight, percent solids, and other mass closure techniques.

PUBLICATIONS

- Lucy J.T. Metzroth, Elisa M. Miller, Gregory F. Pach, Andrew G. Norman, and Gerard Michael Carroll. "Insights into the Dynamic Interfacial and Bulk Composition of Copper-Modified, Hydrogen-Alloyed, Palladium Nanocubes under Electrocatalytic Conditions" *Journal of Physical Chemistry C*, 125, 15487–15495 (2021).
DOI 10.1021/acs.jpcc.1c02186

- Lucy J.T. Metzroth, Elisa M. Miller, Andrew G. Norman, Sadegh Yazdi, and Gerard Michael Carroll. “Accelerating Electrochemical Hydrogen Absorption Rates in Cubic Palladium Nanocubes with a Simple Surface Modification” *Nano Lett.* 2021, 21, 9131–9137
DOI 10.1021/acs.nanolett.1c02903
- Pre-accepted for 2022 “Synchrotron-Based Techniques for Characterizing Water-Splitting Materials” *Frontiers in Energy Research.*

TEACHING EXPERIENCE

August 2021 – December 2021 Teaching Assistant for Physical Chemistry at Colorado School of Mines. Lead recitations and lab sessions.

AWARDS

2022 – National Science Foundation Graduate Research Fellowship: awards tuition and stipend for three years.

2021 – Colorado School of Mines Chemistry Department Outstanding New Graduate Student Fellowship

2019 – Summer DOE SULI position at NREL: covers 10-week stipend

PRESENTATIONS and CONFERENCE CONTRIBUTIONS

2021 – Martin, J.P.; Melendrez Zerwekh, A.; Martinez, R. J.; Metzroth, L.; Haider, A. J. “Photophysical and Forster Resonance Energy Transfer Studies of 2-Cyanophenylalanine” In *261st National Meeting of American Chemical Society*, April 5-16, 2021.

2020 – Metzroth, L. J.T.; Martin, J.P. “Computational Examination of the Electronic Properties of 2-Cyanophenylalanine, 3-Cyanophenylalanine, and 4-Cyanophenylalanine” In MSU Undergraduate Research Conference.

2019 – Metzroth, L. J.T.; Dunklin, J. “Photocatalytic reduction on gold-decorated transition metal dichalcogenides” In DOE SULI Poster Presentation.

VOLUNTEER AND COMMUNITY ORGANIZATIONS

CSM Women in Science, Engineering, and Mathematics (WISEM) member 2021 – current

- Participate in social activities and volunteer for outreach events like Girls Lead the Way.

Post Docs and Graduate Students Network (PDAGS) at NREL 2020 – current

- Participate in networking and social activities. Take advantage of career development and volunteer opportunities

Member of the Women’s Network at NREL 2018 – Current

- Attend monthly meetings around mentoring, networking, diversity in leadership, community outreach, and workforce development

Vice President of the MSU Women in Science and Engineering (WiSE) 2017 – 2020

- Coordinated STEM school nights at elementary schools, led a Girl Scout science badge workshop, arranged career development workshops for MSU students, and arranged tours at NREL for MSU students.

INSTRUMENT, TECHNIQUE, AND SOFTWARE EXPERIENCE

Extensive Knowledge

- Differential Electrochemical Mass Spectroscopy
- UV-vis spectroscopy
- NIR spectroscopy
- TOC analyzer
- Gas Chromatography
- Diffuse Reflectance Infrared Fourier Transform Spectroscopy
- Thin film transfer (blade coating, spin coating, vacuum filtration, self-assembly, and drop casting)
- Cyclic voltammetry
- Gaussian 09 and Gauss View
- JDFTx (computational software)
- Microsoft Office (Word, Excel, PowerPoint, Outlook)

Educational Knowledge

- Confocal Raman Spectroscopy
- Impedance Spectroscopy
- Fourier Transform Infrared spectroscopy
- Nuclear Magnetic Resonance Spectroscopy
- Schlenck glassware
- Bomb and solution calorimetry
- Python
- Igor (data analysis and graphing software)
- Quantum Espresso (computational software)

OTHER WORK EXPERIENCE

Solutions Sales Associate, Tech Data AVT, Broomfield, CO **2014 – 2017**

- Assisted technology resellers to find appropriate software solutions for their end users.
- Excellent data entry and computer skills were needed in order to best serve customers.

Production Manager and Baker, Kim and Jake's Cakes, Boulder, CO **2013 – 2014**

- Used baking skills like measuring, weighing, and mixing to ensure a delicious and timely product.
- Contributed to the creation of a gluten free bread recipe and mastered production technique.
- Organized and tested a production assembly line for cookies and bread using industrial sized machinery and equipment.

Baker and Pastry Chef, Frasca Food and Wine, Boulder, CO **2012 – 2013**

- Bread production for Frasca and dessert and pastry production for Pizzeria Locale.
- Learned to effectively sanitize and set up a workstation for food according to food service standards.

Sales Representative, Showroom Event Manager, and Reception, BSH Home Appliances, Singapore, Singapore **2011 – 2012**

- Greeted customers and used excellent customer service protocol.
- Explained and demonstrated functions of all appliances including energy needs, maintenance expectations, and installation methods.
- Coordinated showroom events to display appliance capabilities and entertain potential customers.

Manager and Sales Representative, Origins, Boulder, CO **2010 – 2011**

- Opened and closed store independently ensuring security and operation of the business including cash deposits and daily Back Office updates.
- Provided excellent customer service and knowledge of store products.
- Encouraged other sales associates and helped achieve high sales awards nearly every month working there.