

# Molly McDonough

508.579.2641 || mrm6464@psu.edu || linkedin.com/in/mollyrmdonough

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## EDUCATION

### **Pennsylvania State University**

Ph.D. Materials Science and Engineering

August 2022 - Present

### **Suffolk University**

Bachelor's of Science, Physics, Cum Laude  
Minor: Pure Mathematics

Conferred: December 2020

## RESEARCH INTERESTS

- *III-V Semiconductor Synthesis*: Utilizing Molecular Beam Epitaxy (MBE) to synthesize thin film semiconductors to improve quality, understand fundamental properties, and develop new technologies.
- *Optoelectronic Materials*: Developing materials for applications in infrared sensing at frequencies that cannot be achieved with conventional sensing technology.

## TECHNICAL SKILLS, TRAINING & CERTIFICATIONS

- **Material Synthesis**: Molecular beam epitaxy (MBE), chemical vapor deposition (CVD), heterostructure fabrication
- **Material Characterization**: X-ray Diffraction/ Refraction (XRD/XRR), Physical Property Measurement System (PPMS), Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Energy Dispersive X-ray spectroscopy (EDX/EDS), Raman spectroscopy, Diamond Anvil Cell (DAC), ellipsometry
- **Data Analysis & Modeling**: MATLAB, Python, Origin, iGor, C/C++, C#, Java
- **Experimental Design & Machining**: AutoCAD, Solidworks, Fusion360, Milling, Lathe, CNC

### *Certifications:*

Security Clearance, Level: Secret, Issued by United States Department of Defense (activatable until July 2024)

Department of Defense: Digital Engineering Credential

Acquisition Management, Level 1, Defense Acquisition University

CRLA International TUTOR Training Program Certification (ITTPC) Level

## RESEARCH EXPERIENCE

### **Graduate Research Assistant**

May 2023 - Present

Pennsylvania State University, Department of Materials Science & Engineering

*Project*: Growth of Bismide Thin-Films via Molecular Beam Epitaxy (MBE)

*Principle Investigator*: Dr. Stephanie Law

*Description*: Using molecular beam epitaxy (MBE) to synthesize III-Bi compounds and study their synthesis-structure-property relationships.

*Relevant Skills*: Molecular beam epitaxy (MBE), X-Ray diffraction and refraction (XRD/XRR), atomic force microscopy (AFM), and electronic transport.

### **Graduate Research Assistant**

January 2023 - July 2023

Pennsylvania State University, Department of Physics

*Project 1*: Use of 2DCC Data as a Testbed for Materials Data Integration

*Principle Investigator*: Dr. Nitin Samarth

*Description*: Implemented data analysis tools in Python to parse and characterize 2DCC materials data.

Developed a pipeline to use analyzed materials characterization for machine learning.

*Relevant Skills*: Python, data analysis, REST-APIs

*Project 2*: Study of Superconductivity in Fe-chalcogenide thin films

*Principle Investigator*: Dr. Nitin Samarth

*Description*: Synthesized Fe-chalcogenide thin films via Molecular Beam Epitaxy (MBE). Studied the electronic and magnetic properties of these thin films via low-temperature transport.

*Relevant Skills*: Molecular beam epitaxy (MBE), X-Ray diffraction and refraction (XRD/XRR), atomic force microscopy (AFM), and low-temperature transport.

**Research Assistant**

January 2020 - January 2021

Massachusetts Institute of Technology, Department of Physics

*Project 1:* Pressure and Strain Studies of 2D Magnetic Materials*Principle Investigator:* Dr. Riccardo Comin*Description:* Used Raman spectroscopy, MOKE, cryo-strain cells, and diamond anvil cells (DAC) to measure and analyze properties of 2D magnetic materials and heterostructures grown via molecular chemical vapor deposition (MOCVD). Study phonon interactions in monolayer MoS<sub>2</sub> and WS<sub>2</sub>.*Relevant Skills:* Raman spectroscopy, MOKE, mechanical exfoliation, heterostructure fabrication*Project 2:* Predictions of Phase Transitions in 2D Materials via Monte Carlo*Principal Investigator:* Dr. Riccardo Comin*Description:* Designed a Monte Carlo Metropolis algorithm in MATLAB to predict phase transitions and states of 2D magnetic and ferromagnetic materials.*Relevant Skills:* Monte Carlo, MATLAB, materials modeling, and simulation**SMART Scholar**

May 2020 - December 2020

Air Force Research Laboratory, LiDAR Technology Branch

*Project:* Modeling of Linear Mode Avalanche Photodiodes (LM-APDs)*Principle Investigator:* Dr. Maureen Szymanski*Description:* Developed a Monte Carlo algorithm to calculate gain and excess-noise factors from first principles for linear mode avalanche photodiodes. This work has been applied to reduce risk and advance optoelectronic technology for the Air Force and its contractors.*Relevant Skills:* Monte Carlo, MATLAB, sensors development, modeling, and simulation.**Research Assistant**

September 2017 - December 2020

Suffolk University, Department of Physics &amp; Massachusetts General Hospital

*Project:* Neutron Distributions around a Medical Linear Accelerator*Principle Investigator:* Dr. Walter Johnson*Description:* Designed and executed studies to determine and map the neutron flux around a medical linear accelerator (LINAC) and a neutron AmBe source to help medical professionals provide more accurate dosing for cancer treatments.*Relevant Skills:* Data analysis, experimental design, and neutron scattering.**Undergraduate Research Assistant**

September 2019 - December 2019

Suffolk University, Department of Chemistry

*Project:* Modeling of Linear Polyynes using 1D PIB and Simulations of UV-Vis Spectra*Principle Investigator:* Dr. Kelsey Stocker*Description:* Developed simulation techniques to apply particle in a box theory, perturbation theory, and simulated UV-Vis spectra to explore linear polyynes with both hydrogen and non-hydrogen end groups.*Relevant Skills:* Data analysis, experimental design, and neutron scattering.**NSF Research Experience for Undergraduates (REU) Participant**

May 2019 - August 2019

Pennsylvania State University, Department of Physics

*Project:* In-situ Ellipsometry of epitaxially grown Bismuth Antimony Telluride*Principal Investigator:* Dr. Nitin Samarth*Description:* Synthesized bismuth antimony telluride thin films via molecular beam epitaxy (MBE) and characterized them via ellipsometry, AFM, and XRD. Developed ellipsometry models to study the thickness of thin films during growth without needing to expose the materials to air.*Relevant Skills:* Molecular beam epitaxy (MBE), X-Ray diffraction and refraction (XRD/XRR), atomic force microscopy (AFM), and ellipsometry.**Research Scholar**

September 2018 - May 2019

Suffolk University, Center for Learning and Academic Success

*Project:* Increasing Retention in STEM through Using New Technologies in Peer Tutoring and Pedagogy

*Principal Investigators:* Jamie Bondar & Dr. Walter Johnson

*Description:* Developed virtual reality applications to display medical particle accelerators and give users a guided tour of experimental setups for ongoing research.

*Relevant Skills:* Virtual reality, C#, Unity, pedagogy, and science communication.

**Research Assistant**

September 2018 - October 2019

Suffolk University, Department of Physics

*Project:* Using Virtual Reality to Demonstrate Particle Physics

*Principle Investigator:* Dr. Walter Johnson

*Description:* Carried out a year-long study to determine the effectiveness of virtual reality as a teaching tool. Developed surveys and virtual reality applications and carried out testing in Physics classrooms.

*Relevant Skills:* Virtual reality, C#, Unity, 3D design, and science communication.

**PROFESSIONAL EXPERIENCE**

**Engineering & Business Development Graduate Intern**

July 2022 - August 2022

Ubiccept

- Assisted in creating technical direction plans for upcoming camera and computer vision products
- Wrote and submitted proposals for government-funded research programs (SBIR/STTR)
- Contributed to product development by conducting product-market-fit (PMF) research

**Associate Research Physicist**

February 2021 - July 2022

Air Force Research Laboratory, LiDAR Technology Branch

- Developed a Full-Band Monte Carlo algorithm as well as a technology computer-aided design (TCAD) program in MATLAB to simulate impact ionization and simulate electrostatic conditions to model performance parameters of Avalanche Photodiodes (APDs) and use for risk-reduction in ongoing programs
- Served as a subject matter expert (SME) on a portfolio valued up to \$20 million for research programs related to Avalanche Photodiodes (APDs), and read-out integrated circuits (ROICs)
- Responsible for electrostatic characterization of epitaxial growth, fabricated devices, and packaged arrays for deployment in LiDAR camera systems
- Reviewed grant applications from various funding streams, including SBIR/STTR programs

**Project Lead**

September 2021 - July 2022

Air Force Research Laboratory, Transformational Capabilities Office (TCO)

- Managed collaborative project between AFRL and AFWERX to acquire high-speed vertical take-off and landing (VTOL) state-of-the-art aircraft valued at up to \$1.2 million.
- Utilized waterfall methodology from initial estimate to closeout to optimize delivery and increase communication on all projects.
- Facilitated weekly meetings with contractors, ensuring teams remained on schedule and within budget and deliverables met stakeholder success criteria.
- Reviewed milestone reports ensuring the project remained on track and within the program's scope.
- Hand-selected by a team of senior leaders for this matrixed career-broadening experience.

**Web Development Intern**

September 2017 - February 2018

The ADK Group

- Assisted with SEO campaign analytics reporting and working with project managers to review and test websites and applications.
- Created marketing campaigns and designs using Adobe InDesign, Photoshop, Lightroom, and Premiere.

**RESEARCH PUBLICATIONS**

- M. Yu, J. Wang, S. A. Iddawela, **M. McDonough**, J. L. Thompson, S. B. Sinnott, D. Reifsnyder Hickey, S. Law. *Treatment and Aging Studies of GaAs(111)B Substrates for van der Waals Chalcogenide Film*

*Growth*. Journal of Vacuum Science and Technology B, **accepted**. (2024). ArXiv pre-print: 10.48550/arXiv.2401.10425

- D. Barbagallo, B. Bolduc, B. Hassett; W. Johnson, K. Koumba, Ally Leeming, P. Mach, J. McCormack, **M. McDonough**, J. Nyamwanda, *Neutron Attenuation in Polyethylene Using an AmBe Source*. Journal of Undergraduate Reports in Physics (JURP). JURP, **30**, 1000001, (2020). DOI:10.1063/10.0002041.

### **OTHER PUBLICATIONS**

- **McDonough, M.** *Symposium X—MRS/The Kavli Foundation Frontiers of Materials*. MRS Meeting Science. April 2024.
- **McDonough, M.** *2024 MRS Communications Lecture*. MRS Meeting Science. April 2024.
- **McDonough, M.** *Unlocking Topological Phase Transitions in HfTe5 through Strain*. MRS Bulletin: Materials News. Materials Research Society. April 2024. DOI: 10.1557/s43577-024-00712-x.
- **McDonough, M.** *Selecting the Right Ph.D. Advisor for You*. Society of Physics Students Observer. Fall 2023.
- **McDonough, M.** *Kicking A\*\* at Physics*. Society of Physics Students Observer. Fall 2021.
- **McDonough, M.**, Perov, P., Johnson, W., Radojev, S. *Data Processing & Analysis for Atomic Force Microscopy (AFM)*. Digital Collections @ Suffolk. Fall 2021.
- **McDonough, M.**, A. Kuchera, N. Gugliucci. *How to Virtually Maintain a Healthy SPS Chapter*. SPS Observer. Fall 2020.
- **McDonough, M.** *Solving for Inclusivity in Physics*. Radiations. Fall 2020.
- **McDonough, M.** *Enacting Change as a Physicist*. Society of Physics Students Observer. Spring 2020.
- **McDonough, M.**, Nolan, J., Thomas, J. *Mapping the Neutron Flux Distribution Near a Medical LINAC*. Society of Physics Students Observer. May 2018.

### **ORAL PRESENTATIONS**

- “The joys, trials, and tribulations of grad school” *invited seminar* at Juniata College, Department of Physics. November 2023. Juniata, PA.
- “In situ ellipsometry of epitaxially grown bismuth antimony telluride on sapphire” *presented* at the Interdisciplinary Physics and Materials NSF REU Symposium at Penn State. August 2019. State College, PA.
- “Increasing Retention in STEM through Using New Technologies in Peer Tutoring and Pedagogy” *presented* at McNair-Ballotti Undergraduate Research Symposium (MBURS). April 2019. Boston, MA.

### **POSTER PRESENTATIONS**

- “Growth and Characterization of III-V Semiconductors” *presented* at Penn State Materials Day Conference. October 2023. State College, PA.
- “Bridging the Gap: Synthesis-Structure-Property Relationships in Novel III-Bi Topological Materials” *presented* at the College of Earth and Mineral Sciences NSF GRFP Poster Competition. October 2023. State College, PA.
- “Energy Dependent Neutron Absorption Coefficients in Polyethylene” *presented* at the American Physical Society (APS) March Meeting. March 2023. Las Vegas, NV.
- “Neutron Energy Distribution of an AmBe Source at the MGH Proton Center” *presented* at the American Physical Society (APS) March Meeting. April 2022. New York, NY.
- “Data Processing & Analysis for Atomic Force Microscopy (AFM)” *presented* at the Suffolk University College of Arts and Sciences Honors Symposium. December 2020. Boston, MA.
- “Neutron Energy Distribution of an AmBe Source at the MGH Proton Center” *presented* at the American Physical Society (APS) April Meeting. April 2020. Virtual.
- “In situ ellipsometry of epitaxially grown bismuth antimony telluride on sapphire” *presented* at the American Physical Society (APS) March Meeting. March 2020. Virtual.

- “Neutron Distributions Surrounding a Medical Linear Accelerator” *presented* at the American Physical Society (APS) April Meeting. April 2019. Denver, CO.
- “Neutron Distributions Surrounding a Medical Linear Accelerator” *presented* at the American Physical Society (APS) April Meeting. April 2018. Columbus, OH.

## TEACHING & PEDAGOGY

### **Graduate Teaching Assistant**

August 2022 - May 2023

Pennsylvania State University, Department of Physics

*Teaching Assistant for General Physics: Mechanics (PHYS-211)*

- Assisted teaching faculty in facilitating undergraduate physics laboratory instruction, including laboratory set-up and grading
- Employed evidence-based pedagogy practices in the classroom to enhance student learning and increase retention
- Served as a mentor for first-year undergraduate women in STEM

### **Academic Tutor**

September 2018 - May 2019

Suffolk University

*Tutor for Precalculus, Calculus I, Calculus II, Calculus III, Statistics, Chemistry I, Chemistry II, University Physics I, University Physics II, University Physics III, and Writing*

- Provided tutoring by appointment and drop-in for all math classes through Integral Calculus, first-year physics, general science courses, Computer Science, and Applied Statistics.
- Worked with students and faculty based on needs to make sure students with various learning styles could achieve their full potential.
- Completed training, support, and mentoring for CRLA Tutor Certification.

### **Teaching Assistant**

September 2018 - May 2019

Suffolk University

*Teaching Assistant for Strategies for Success (CAS-101)*

- Provided a peer's perspective on success at Suffolk University.
- Graded homework & presentations and assisted the professor with course planning.
- Held office hours to meet individually or in small groups with students to answer any questions.

## HONORS & AWARDS

### **Materials Science and Engineering Travel Award**

December 2023

*Department of Materials Science & Engineering, Pennsylvania State University*

### **EMS NSF GRFP Poster Competition Winner**

October 2023

*College of Earth and Mineral Science, Pennsylvania State University*

### **Materials Science & Engineering Endowed Fellowship**

August 2023

*Department of Materials Science & Engineering, Pennsylvania State University*

### **Special Acts and Service Award (SASA)**

April 2022

*Sensors Directorate, Air Force Research Lab*

### **Science, Mathematics, and Research for Transformation (SMART) Scholarship**

2019 - 2021

*Department of Defense*

### **Sigma Pi Sigma Inductee**

September 2020

*Sigma Pi Sigma, National Physics Honors Society*

### **Geno A. Balloti Research Scholar**

2018 - 2019

*Suffolk University*

### **Chapter Research Award**

2018 & 2019 & 2020

*Society of Physics Students*

## **LEADERSHIP & COMMUNITY INVOLVEMENT**

|   |                                |
|---|--------------------------------|
| Membership Commitment Leader (Region 10), Alpha Sigma Alpha                       | July 2022 - Present            |
| Co-Chair, 2025 Congress Executive Planning Committee, Society of Physics Students | January 2021 - Present         |
| Co-Chair, Young Women in Science (YWiS) Events Committee                          | April 2023 - October 2023      |
| Panhellenic Liaison (Region 4), Alpha Sigma Alpha                                 | April 2021 - July 2022         |
| Board Member, Association of Chelmsford Theatre (ACT)                             | July 2020 - August 2021        |
| Associate Zone Councilor Representative, Society of Physics Students              | November 2019 - September 2020 |
| Vice President, Suffolk University Honors Council                                 | May 2019 - May 2020            |
| Associate Zone Councilor, Zone 1, Society of Physics Students                     | June 2018 - June 2020          |

## **PROFESSIONAL MEMBERSHIPS**

**MRS** - Materials Research Society  
**APS** - American Physical Society  
**AAAS** - American Association for the Advancement of Science  
**NASW** - National Association of Science Writers  
**SWE** - Society of Women Engineers  
**GWIS** - Graduate Women in Science  
**SPS** - Sigma Pi Sigma, National Physics Honors Society  
**ASA** - Alpha Sigma Alpha  
**PMI** - Project Management Institute