# DECLAN P. MCCARTHY

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## RESEARCH INTERESTS

**Materials Chemistry** · **Sustainability & Clean Energy** · **High-Throughput Workflows** · **EUV Lithography** · **Perovskite Optoelectronics** · **Polymer Science**

**Research Focus:** Cross-Facility Materials Discovery for Sustainability, Clean Energy, and Microelectronics—Integrating Heterogeneous Data and Automated Experimental Pipelines (robotic solution handling, spin-coating, rapid downselection metrology, high-throughput synchrotron characterization, and multimodal data analysis and modeling) to accelerate materials for renewable energy conversion, polymer sustainability, and microelectronics.

## EDUCATION

**University of Colorado Boulder** *2023*
Ph.D., Chemistry, Concentration: Organic
*Note: Transferred from Georgia Institute of Technology with advisor in Fall 2021*

**University of Virginia** *2016*
B.Sc., Chemistry, Specialization in Environmental Chemistry
ACS Certified, Distinguished Major with High Distinction

## RESEARCH EXPERIENCE

**Lawrence Berkeley National Laboratory** Spring 2024 – Present
*Postdoctoral Fellow, Helms Group (Materials Sciences Division)* *Berkeley, CA*

- Designed and synthesized novel hybrid organic–inorganic metal halide photoresists with tunable dimensionality and ligand chemistry for high-precision patterning using extreme ultraviolet (EUV) lithography within the DOE Center for High Precision Patterning Science (CHiPPS EFRC).
- Grew high-quality single crystals of hybrid metal halide complexes via vapor diffusion and slow evaporation for synchrotron single-crystal X-ray diffraction (SC-XRD at ALS Beamline 12.2.1), establishing atomic-level structure–property relationships across 0D, 1D, and 2D coordination motifs (*ChemRxiv* **2026**).
- Built cross-facility experimental workflows linking solution formulation and spin-coating with rapid optical and spectroscopic downselection and high-throughput synchrotron metrology at the Advanced Light Source (ALS) and Molecular Foundry (GIWAXS, SC-XRD, XPS, EUV photoemission/TEY, residual gas analysis, FTIR, ellipsometry, and AFM), integrating heterogeneous datasets to elucidate low-energy electron-triggered reaction cascades.
- Contributed thin-film and surface characterization to a collaborative study on the selective, catalytic oxidation of polyethylene surfaces (*Nature* **2026**).
- Selected for leadership roles as the CHiPPS EFRC Seminar Chair and the center's representative for the DOE Basic Energy Sciences (BES) Early Career Network (ECN).

**University of Colorado Boulder** Fall 2021 – Fall 2023
*Doctoral Candidate, Marder Group (DOE SCGSR Fellow at NREL, 2021–2022)* *Boulder, CO*

- Thesis Title: *Understanding and Reducing Interfacial Losses in Perovskite Solar Cells*.
- Designed, synthesized, and characterized small molecules, conjugated redox-active polymers, and hybrid organic–inorganic materials (including single-crystal growth of low-dimensional perovskite and ammonium salt phases) for single-junction and silicon–perovskite tandem optoelectronic applications.
- Synthesized and characterized a naphthalene diimide (NDI) side-chain homopolymer and an analogous copolymer with cinnamate photo-crosslinking groups, demonstrating high optical transparency, thermal stability, solvent resistance, photo-crosslinking, and n-doping in perovskite solar cells (*Chem. Mater.* **2024**; *Chem. Commun.* **2024**).

- Conducted a large-scale, high-throughput photoluminescence-based downselection screening of passivation materials across diverse metal halide perovskite compositions, combining combinatorial solution processing and spin-coating with downstream statistical and manifold data analysis to identify passivators that reduced hysteresis, improved reverse-bias stability, and achieved PCEs >19% in MA-free absorbers (*J. Am. Chem. Soc.* **2024**; *Nat. Energy* **2024**).
- Explored the chemical reactivity of amines, diamines, and ammoniums with formamidinium (FA) salts, leading to the synthesis and implementation of additives and surface treatments for controlling FA-containing perovskite crystallization and suppressing phase instabilities (*ACS Appl. Mater. Interfaces* **2025**; *ACS Energy Lett.* **2022**).

**Georgia Institute of Technology** Fall 2018 – Summer 2021
*Doctoral Candidate, Marder Group* *Atlanta, GA*

- Conducted doctoral research prior to group transfer to the University of Colorado Boulder; synthesized and characterized NDI side-chain electron-extraction polymers and hybrid perovskite thin films for photocarrier dynamics and solar cell stability studies (*Mater. Chem. Front.* **2021**; *J. Mater. Chem. C* **2021**).

**Centers for Disease Control and Prevention** June 2016 – June 2018
*ORISE Fellow / Chemist* *Atlanta, GA*

- Chemistry Lab Analyst, Tobacco and Volatiles Branch, Division of Laboratory Sciences, National Center for Environmental Health.
- Developed and executed high-throughput UPLC-ESI-MS/MS methods and Hamilton robotic liquid-handling automation for the quantification of volatile organic compound (VOC) exposure in urine specimens; performed routine analysis and statistical data workup for a CLIA-certified panel of 28 biomarkers (*J. Chromatogr. B* **2019**; *J. Am. Soc. Mass Spectrom.* **2019**).
- Assisted in conducting large-scale population biomonitoring studies including the Population Assessment of Tobacco and Health (PATH) and the National Health and Nutrition Examination Survey (NHANES).

## SKILLS

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| **Data Science & Modeling** | Python, MATLAB, JMP, OriginLab, Dimensionality Reduction & Manifold Learning (UMAP, PCA), Multimodal Data Integration, Sciex Analyst & MultiQuant |
| **Automation & Workflows** | Hamilton Robotic Solution Handling, Combinatorial Spin-Coating, High-Throughput PL/Optical Downselection, Automated 96-Well SPE, High-Throughput Synchrotron Characterization |
| **X-ray & EUV Metrology** | Grazing Incidence Wide-Angle X-ray Scattering (GIWAXS), Single-Crystal & Powder XRD (SC-XRD, XRD), X-ray Photoelectron Spectroscopy (XPS), EUV Photoemission/TEY, Residual Gas Analysis (RGA) |
| **Spectroscopy** | Nuclear Magnetic Resonance (NMR), UV-Visible-NIR (UV-Vis), Steady-State & Time-Resolved Photoluminescence (PL), Fourier-Transform Infrared (FTIR) |
| **Microscopy & Surface** | Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Spectroscopic Ellipsometry, Profilometry, Contact Angle Goniometry |
| **Chromatography & MS** | UPLC-ESI-MS/MS, High-Performance Liquid Chromatography (HPLC/UHPLC), Gas Chromatography–MS (GC-MS), Gel Permeation Chromatography (GPC) |
| **Thermal & Electrochem.** | Thermogravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), Cyclic Voltammetry |
| **Synthesis & Crystal Growth** | Single-Crystal Growth (Vapor Diffusion, Slow Evaporation, Antisolvent Crystallization), Glovebox/Air-Free/Schlenk Synthesis, Hybrid Metal Halides, Functional Polymers, EUV Photoresist Formulation, Spin-Coating, Flash Chromatography, Soxhlet Extraction, Train Sublimation |

## TEACHING EXPERIENCE

**Georgia Institute of Technology** — *Atlanta, GA*

*Teaching Assistant for Organic Chemistry II* — Fall 2020 Academic Year

*Teaching Assistant for Synthesis Laboratory I* — Spring 2020 Academic Year

*Teaching Assistant for Synthesis Laboratory I* — 2018–2019 Academic Year

**University of Virginia** — *Charlottesville, VA*

*Lead Student Teaching Assistant for Organic Chemistry* — 2015–2016 Academic Year

*Student Teaching Assistant for Organic Chemistry* — 2014–2015 Academic Year

## HONORS, AWARDS, AND LEADERSHIP

CHiPPS EFRC Seminar Chair & DOE BES Early Career Network Representative — *2024–Present*

Best Poster Award, Excited State Processes Conference, Santa Fe, NM — *2023*

DOE Office of Science Graduate Student Research (SCGSR) Fellowship, NREL — *2021–2022*

Graduate Assistance in Areas of National Need (GAANN) Fellowship — *2019–2021*

Graduate Student Forum (GSF) Seminar Chair, Georgia Institute of Technology — *2019–2021*

NSF Graduate Research Fellowship Program (GRFP) Honorable Mention — *2020*

Hugh Miller Spencer Scholarship Award, University of Virginia — *2016*

Double 'Hoo Research Grant, University of Virginia — *2015*

Phi Beta Kappa — *2015*

## PUBLICATIONS

*($^{\ddagger}$ denotes equal first-author contribution)*

1. Woroch, C. P.; Klivansky, L.; **McCarthy, D. P.**; Miao, H.; Fink, Z.; Zuo, X.; Guthrie, C.; Wang, C.; Helms, B. A.; Hartwig, J. F. Selective, Catalytic Oxidation of Polyethylene Surfaces. *Nature* **2026**. DOI: 10.1038/s41586-026-11255-3.

2. **McCarthy, D. P.**; Im, H.; Lloyd, M.; Coda, K.; Wang, Y.; Moral, R. F.; Sutter-Fella, C. M.; Ober, C. K.; Segalman, R. A.; Ruiz, R.; Teat, S. J.; Zhu, C.; Zhang, J.; Kostko, O.; Helms, B. A. Extreme Ultraviolet Light-Triggered Reaction Cascades in Hybrid Metal Halide Photoresists. *ChemRxiv* **2026** (Preprint). DOI: 10.26434/chemrxiv.15003505/v1.

3. Taddei, M.; Contreras, H.; Doan, H.-N.; **McCarthy, D. P.**; Seo, S.; Westbrook, R. J. E.; Graham, D. J.; Datta, K.; Carroy, P.; Muñoz, D.; Correa-Baena, J.-P.; Barlow, S.; Marder, S. R.; Smith, J. A.; Snaith, H. J.; Ginger, D. S. Diamine Surface Passivation and Postannealing Enhance the Performance of Silicon–Perovskite Tandem Solar Cells. *ACS Appl. Mater. Interfaces* **2025**, *17*, 38754–38762.

4. Zhou, S.; Gallant, B. M.; Zhang, J.; Shi, Y.; Smith, J.; Drysdale, J. N.; Therdkatanyuphong, P.; Taddei, M.; **McCarthy, D. P.**; Barlow, S.; Kilbride, R. C.; Dasgupta, A.; Marshall, A. R.; Wang, J.; Kubicki, D. J.; Ginger, D. S.; Marder, S. R.; Snaith, H. J. Reactive Passivation of Wide-Bandgap Organic–Inorganic Perovskites with Benzylamine. *J. Am. Chem. Soc.* **2024**, *146*, 27405–27416.

5. Jiang, F.; Shi, Y.; Rana, T. R.; Morales, D.; Gould, I. E.; **McCarthy, D. P.**; Smith, J. A.; Christoforo, M. G.; Yaman, M. Y.; Mandani, F.; Terlier, T.; Contreras, H.; Barlow, S.; Mohite, A. D.; Snaith, H. J.; Marder, S. R.; MacKenzie, J. D.; McGehee, M. D.; Ginger, D. S. Improved Reverse Bias Stability in p–i–n Perovskite Solar Cells with Optimized Hole Transport Materials and Less Reactive Electrodes. *Nat. Energy* **2024**, *9*, 1275–1284.

6. Mohapatra, A. A.; Yual, W. K.; Zhang, Y.; Samoylov, A. A.; Thurston, J.; Davis, C. M.; **McCarthy, D. P.**; Printz, A. D.; Toney, M. F.; Ratcliff, E. L.; Armstrong, N. R.; Greenaway, A. L.; Barlow, S.; Marder, S. R. Reducing Delamination of an Electron-Transporting Polymer from a Metal Oxide for Electrochemical Applications. *Chem. Commun.* **2024**, *60*, 988–991.

7. Shi, Y.[‡]; **McCarthy, D. P.**[‡]; Lungwitz, D.; Jiang, F.; Taddei, M.; Contreras, H.; Lin, Y.; Mohapatra, A. A.; Tang, K.; Zhang, Y.; Barlow, S.; Kahn, A.; Marder, S. R.; Ginger, D. S. Photo-Crosslinkable Naphthalene Diimide Polymer for Solution-Processed n–i–p Perovskite Solar Cells. *Chem. Mater.* **2024**, *36*, 795–802.

8. Taddei, M.; Smith, J. A.; Gallant, B. M.; Zhou, S.; Westbrook, R. J. E.; Shi, Y.; Wang, J.; Drysdale, J. N.; **McCarthy, D. P.**; Barlow, S.; Marder, S. R.; Snaith, H. J.; Ginger, D. S. Ethylenediamine Addition Improves Performance and Suppresses Phase Instabilities in Mixed-Halide Perovskites. *ACS Energy Lett.* **2022**, *7*, 4265–4273.

9. Valverde-Chávez, D. A.; Rojas-Gatjens, E.; Williamson, J.; Jariwala, S.; Shi, Y.; **McCarthy, D. P.**; Barlow, S.; Marder, S. R.; Ginger, D. S.; Silva-Acuña, C. Nonlinear Photocarrier Dynamics and the Role of Shallow Traps in Mixed-Halide Mixed-Cation Hybrid Perovskites. *J. Mater. Chem. C* **2021**, *9*, 8204–8212.

10. Al Kurdi, K.; **McCarthy, D. P.**; McMeekin, D. P.; Furer, S. O.; Tremblay, M.-H.; Barlow, S.; Bach, U.; Marder, S. R. A Naphthalene Diimide Side-Chain Polymer as an Electron-Extraction Layer for Stable Perovskite Solar Cells. *Mater. Chem. Front.* **2021**, *5*, 450–457.

11. Bhandari, D.; **McCarthy, D. P.**; Biren, C.; Movassaghi, C. S.; Blount, B. C.; De Jesús, V. R. Development of a UPLC-ESI-MS/MS Method to Measure Urinary Metabolites of Selected VOCs: Benzene, Cyanide, Furfural, Furfuryl Alcohol, 5-Hydroxymethylfurfural, and *N*-Methyl-2-pyrrolidone. *J. Chromatogr. B* **2019**, *1126–1127*, 121746.

12. Movassaghi, C. S.; **McCarthy, D. P.**; Bhandari, D.; Blount, B. C.; De Jesús, V. R. Multiple Ion Transition Summation of Isotopologues for Improved Mass Spectrometric Detection of *N*-Acetyl-*S*-(1,2-dichlorovinyl)-L-cysteine. *J. Am. Soc. Mass Spectrom.* **2019**, *30*, 1213–1219.

## PEER REVIEW ACTIVITY

*Journal of Micro/Nanopatterning, Materials, and Metrology* (JM3; 1 article) *2026*

*Journal of the American Chemical Society* (JACS; 1 article) *2024*