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SUMMARY

I aspire to build an inclusive and diverse team dedicated to next-generation materials for environmental challenges. My research focuses on using experiments to understand the stimuli-responsive assembly of bio-based materials in the environment. I apply this understanding to engineer advanced, biodegradable nanomaterials for controlled environmental delivery and resource capture technologies. The over-arching aim is to enhance the efficiency of the food, water, and energy nexus while minimizing environmental impact.

EDUCATION AND TRAINING

Postdoc	Civil and Environmental Engineering	**Massachusetts Institute of Technology (MIT)**, Cambridge, MA	2020 - Now
Ph.D.	Chemistry	**Brown University**, Providence, RI	2020
M.E.	Materials Engineering	**Beihang University**, Beijing, China	2015
B.E.	Materials Science and Engineering	**Beihang University**, Beijing, China	2012

GRANT WRITING

Contributed to the drafting of a pending grant application with **Department of Energy (DOE) – Office of Energy Efficiency and Renewable Energy (EERE)** 2023 - Now

Contributed to the drafting of a pending grant application with **Office of Naval Research (ONR) – Defense University Research Instrumentation Program (DURIP)** 2023 - Now

Contributed to proposal drafting and secured over *$540,000* from **ONR** 2021-2024

Contributed to proposal drafting and secured over *$360,000* from **BASF SE** 2021-2023

HONORS

Rising Stars, Carnegie Mellon University's Civil and Environmental Engineering, Pittsburgh, PA 2022

Special Mention, *Carbon* Journal Prize, awarded by the journal *Carbon* and *Elsevier* 2021

Best Presentation Award, Materials Research Society (MRS) Fall Meeting, Boston, MA 2019

Finalist, *Science as Art Competition*, MRS Fall Meeting, Boston, MA 2019 & 2022

William R. Potter Conference Travel Grants, Brown University, Providence, RI 2018

National Graduate Scholarship, Beihang University, Beijing, China 2013

RESEARCH EXPERIENCE

MIT, Cambridge, MA — Advisor: Prof. Benedetto Marelli — 2020 - Now

Postdoctoral Associate

- Designing biopolymer-based nano- and microarchitectures for efficient payload delivery.
- Developing biodegradable silk-based microcapsules to replace microplastics in agriculture and cosmetics adopting existing industrial equipment.

Brown University, Providence, RI — Advisor: Prof. Robert H. Hurt — 2015 - 2020

PhD student (thesis)

Thesis: "2D nanochannels in textured graphene films – intercalated templating, nanofluidic transport and controlled release (link)." Committee members: Shouheng Sun, Vicki L. Colvin, Robert H. Hurt

- Established 2D intercalated templating principles by colloidally engineering the surface charge and 2D space filling. These rules enabled the transformation of non-layered ceramic materials into stretchable magnetic and bio-textured 2D films.
- Transformed conventional graphene nanochannels from a horizontal orientation to a vertical or complex configuration using a thermal-responsive technique. This design allowed for the development of an ultrafast nanofiltration membrane and a controlled-release virucide coating.
- Uncovered molecules transport rules within graphene-based films based on molecular polarity and size exclusion. This insight facilitated the design of smart protective barriers for insects and toxicants.
- Demonstrated environmental stability and chemical fate of MoS_2 and $MoSe_2$ nanosheets for assessing nanotoxicity.

Beihang University, Beijing, China — Advisor: Prof. Yan Zhao — 2012-2015
Master's student (thesis)
Thesis: "Microwave-assisted solution synthesis of graphene loaded with $LiFePO_4$-C nanoplatelets for lithium-ion batteries."
- Developed graphene/$LiFePO_4$/C composites with high electrochemical performance by a mild nanofabrication method.

Beihang University; Institute of Chemistry, Chinese Academy of Sciences, Beijing, China — Advisor: Prof. Yan Zhao; Co-advisor: Prof. Tong Zhao — 2012
Undergraduate student (thesis)
Thesis: "A study of amino-modified graphene and its composite."
- Enhanced the mechanical properties of bismaleimide composites by incorporating aniline modified-graphene nanosheets.

TEACHING

Institute at Brown for Environment and Society (IBES) – Leadership Alliance Summer Research – Early Identification Program (SR-EIP) – Instructor, Brown University — 2020
- Prepared online presentations and delivered 16 lectures for a national research program for underrepresented students.
- Hosted group studies for 6 undergraduates, mentored their research projects, and helped them with national symposium presentations.

CHEM0330 Equilibrium, Rate, and Structure – Graduate teaching assistant, Brown University — 2015 - 2016
- Facilitated problem sessions, hosted office hours and graded assignments and tests.

CHEM0100 Introductory Chemistry – Graduate teaching assistant, Brown University — 2015 - 2016
- Facilitated problem sessions, hosted office hours and graded assignments and tests.

MENTORING

Mentee, Grace Harrington – MIT Capstone Projects — 2023 - Now

Mentee, Emily Wang – MIT Undergraduate Research Opportunities Program — 2023 - Now

Mentee, Alexis Meservey – Brown Leadership Alliance SR-EIP — 2020
Curr. Pos.: Ph.D. student, Chemical and Environmental Engineering, Brown University

Mentee, Siri Neerchal – Brown Leadership Alliance SR-EIP — 2020
Curr. Pos.: Ph.D. student, Sociology and Social Policy, Harvard University

Mentee, Keren Herrán – Brown Leadership Alliance SR-EIP — 2020
Curr. Pos.: Ph.D. student, Health Promotion, Education, and Behavior, University of South Carolina

Mentee, Chantaly Villalona – Brown Leadership Alliance SR-EIP — 2020
Curr. Pos.: Master's student, Civil Engineering, Virginia Tech

Mentee, Alexis Brooks – Brown Leadership Alliance SR-EIP — 2020
Curr. Pos.: Master's student, Sustainability Management, Columbia University

Mentee, Alan Green – Brown undergraduate thesis research project — 2018 - 2020
Curr. Pos.: M.D. Candidate, Medicine, Stanford University

Mentee, Ayisha Jackson – Brown undergraduate research project — 2017 - 2018
Curr. Pos.: Master's student, Mechanical Engineering, Stanford University

Mentee, Mengke Zhang – Brown master's thesis research project — 2015 - 2017
Curr. Pos.: Senior Research Engineer, Spectrum Dynamic Research Corp

PROFESSIONAL SERVICES

Member, *Carbon*'s Extended Advisory Board — 2021 - Now

Active reviewer, *Carbon*, *Carbon Trends*, *iScience, Nanoscale Advances*

Session chair, Smart Functions of Stimuli-Responsive Materials, MRS Fall Meeting — 2022

Session chair, Division of Polymeric Materials Science and Engineering, American Chemical Society (ACS) Fall Meeting — 2022

	Session chair, Micro and Nano Fabrication of Biomaterials for Sensing and Delivery, MRS Fall Meeting	2021

OUTREACH

Member, MIT Committee on Race and Diversity, Cambridge, MA	2021 - Now
Invited Presenter, Cambridge Science Festival, Cambridge, MA	2022 - 2023
Invited Presenter, Brookline Adult and Community Education, The Public Schools of Brookline, MA	2023
Online Consultant, High School Students' Research Project, Polytechnic School in Pasadena, CA	2022
Volunteer, Per- and polyfluoroalkyl substances (PFAS) Drinking Water Sampling in Rhode Island	2019
Member, Graduate Student Leadership Committee, Brown University, Providence, RI	2018 - 2020

CERTIFICATES

Predictive Multiscale Materials Design, MIT Professional Education Certificate	2023
MIT Leadership and Professional Strategies and Skills Certificate Program	2022
MIT Kaufman Teaching Certificate Program	2020

PATENTS

1. B Marelli, M Liu, P-E Millard, H Urch, O Zeyons, R Konradi, B Oschmann. PCT Patent Application No. PCT/US2022/080497. Tunable structure of biodegradable silk-based microcapsules for soluble and insoluble payload delivery. Filed date: 2022-11-28. Assigned to Massachusetts Institute of Technology.
2. Y Zhao, YX Duan, M Liu, Y Wang, YQ Su. CN Patent Application No. CN103408934B. A kind of modified graphene/bismaleimide resin composite material and preparation method thereof. Publication date: 2015-09-16. Assigned to Beihang University.
3. Y Zhao, YX Duan, X Li, JM Sun, Y Wang, XG Shen, Q Dong, M Liu. CN Patent Application No. CN102634779A. Electromagnetic shielding material with chemically plated iron modified carbon nano-tubes and method for preparing same. Publication date: 2013-09-18. Assigned to Beihang University.

PUBLICATION LIST

Citation Summary (08/24/2023): Citations: 745; h-index: 13; i10-index: 13

(*indicates co-corresponding author)

1. M Liu, Y Cao, Z Li, RJ Ram, B Marelli. Synergistic nanostructuring of mm-scale micronetworks and echinate microspheres. *Submitted.*
2. Z Shepard, Z Saleeba, M Liu, RH Hurt, V Craver. Effect of bacterial growth stage on the response to two-dimensional nanomaterials. ***Environ. Sci. Nano*** 2023, 10, 178 (link).
3. M Liu, PE Millard, H Urch, O Zeyons, D Findley, R Konradi, B Marelli. Microencapsulation of high-content actives using biodegradable silk materials. ***Small*** 2022, 18, 2201487. (link)
4. AT Zvinavashe, Z Barghouti, Y Cao, H Sun, D Kim, M Liu, EJ Lim, B Marelli. Degradation of regenerated silk fibroin in soil and marine environments. ***ACS Sustainable Chem. Eng.*** 2022, 10, 34, 11088. (link)
5. M Liu*, DCC Fernandes, ZSSL Saleeba, RH Hurt. Controlled release of molecular intercalants from two-dimensional nanosheet films. ***ACS Nano***, 2021, 15, 20105. (link)
6. M Liu, PJ Weston, RH Hurt. Controlling nanochannel orientation and dimensions in graphene-based nanofluidic membranes. ***Nat. Commun.*** 2021, 12, 507. (link)
7. M Liu*, L Qian, C Yu, G Xiao, RH Hurt. Stretching, bending and magnetic properties of cobalt ferrite wrinkled films. ***Nanoscale Adv.*** 2021, 3, 800. (link)
8. Y Kwon, M Liu, CJ Castilho, Z Saleeba, R Hurt, I Külaots. Controlling pore structure and conductivity in graphene nanosheet films through partial thermal exfoliation. ***Carbon*** 2021, 174, 227. (link)
9. EP Gray, CL Browning, CA Vaslet, KD Gion, A Green, M Liu, AB Kane, RH Hurt. Chemical and colloidal dynamics of MnO_2 nanosheets in biological media relevant for nanosafety assessment. ***Small*** 2020, 2000303. (link)
10. CJ Castilho, D Li, M Liu, Y Liu, H Gao, RH Hurt. Mosquito bite prevention through graphene barrier layers. ***Proc.***

Natl. Acad. Sci. 2019, 116, 18304. (link)

11. TM Valentin, AK Landauer, LC Morales, EM DuBois, S Shukla, M Liu, et al. Alginate-graphene oxide hydrogels with enhanced ionic tunability and chemomechanical stability for light-directed 3D printing. ***Carbon*** 2019, 143, 447. (link)
12. M Liu, PY Chen, RH Hurt. Graphene inks as versatile templates for printing tiled metal oxide crystalline films. ***Adv. Mater.*** 2018, 30, 1705080. (link)
13. M Liu, CJ Castilho, RH Hurt. New material architectures through graphene nanosheet assembly. ***Adv. Mater. Lett.*** 2018, 9, 843. (link)
14. PY Chen, M Zhang, M Liu, IY Wong, RH Hurt. Ultrastretchable graphene-based molecular barriers for chemical protection, detection, and actuation. ***ACS Nano*** 2017, 12, 234. (link)
15. PY Chen, M Liu, Z Wang, RH Hurt, IY Wong. From flatland to spaceland: higher dimensional patterning with two-dimensional materials. ***Adv. Mater.*** 2017, 29, 1605096. (link)
16. Z Wang, YJ Zhang, M Liu, A Peterson, RH Hurt. Oxidation suppression during hydrothermal phase reversion allows synthesis of monolayer semiconducting MoS_2 in stable aqueous suspension. ***Nanoscale*** 2017, 9, 5398. (link)
17. PY Chen, M Liu, TM Valentin, Z Wang, RS Steinberg, J Sodhi, IY Wong, RH Hurt. Hierarchical metal oxide topographies replicated from highly textured graphene oxide by intercalation templating. ***ACS Nano*** 2016, 10, 10869. (link)
18. M Liu, Y Zhao, S Gao, Y Wang, Y Duan, X Han, Q Dong. Mild solution synthesis of graphene loaded with $LiFePO_4$-C nanoplatelets for high performance lithium ion batteries. ***New J. Chem.*** 2015, 39, 1094. (link)
19. Y Wang, Y Zhao, X Han, M Liu. Epoxy nanocomposites with two-dimensional tungsten disulfide additives. *2015 ICCM International Conferences on Composite Materials*, 2015. (link)
20. M Liu, Y Duan, Y Wang, Y Zhao. Diazonium functionalization of graphene nanosheets and impact response of aniline modified graphene/bismaleimide nanocomposites. ***Mater. Des.*** 2014, 53, 466. (link)
21. Y Wang, Y Zhao, J Yin, M Liu, Q Dong, Y Su. Synthesis and electrocatalytic alcohol oxidation performance of Pd-Co bimetallic nanoparticles supported on graphene. ***Int. J. Hydrog. Energy*** 2014, 39, 1325. (link)
22. Q Dong, Y Zhao, X Han, Y Wang, M Liu, Y Li. Pd/Cu bimetallic nanoparticles supported on graphene nanosheets: Facile synthesis and application as novel electrocatalyst for ethanol oxidation in alkaline media. ***Int. J. Hydrog. Energy*** 2014, 39, 14669. (link)
23. M Liu, Y Duan, Y Zhao, M Ge, S Yang. Study on mechanical properties of modified graphene/epoxy nanocomposites. *2013 ICCM International Conferences on Composite Materials*, 2013, 3857. (link)

INVITED TALKS

The AIChE Annual Meeting, Phoenix, AZ	2022
MIT, Department of Chemical Engineering	2020
Harvard University, Center for Nanotechnology and Nanotoxicology	2020

CONFERENCE TALKS

1. "Synergistic Assembly of Hierarchical Biomaterials for Sustainable Technologies," the American Institute of Chemical Engineers (AIChE) Annual Meeting, Orlando, FL, 2023
2. "Robust Spines of Biopolymer Microspheres for Enhanced Adhesion," MRS Fall Meeting, Boston, MA, 2022.
3. "Biodegradable Microcapsule Designer Using Silk Fibroin Technology," Cells, Organs, and Labs on a Chip Session, the AIChE Annual Meeting, Phoenix, AZ, 2022
4. "Design and Assembly of Biodegradable Engineered Micro- and Nanomaterials from Biopolymers," the AIChE Annual Meeting, Phoenix, AZ, 2022
5. "Tunable structure of biodegradable silk-based microcapsules for soluble and insoluble payload delivery," the

264th ACS Fall National Meeting, Chicago, IL, 2022.

6. "Manufacturing structural biopolymers as technical materials to boost food security," the 264th ACS Fall National Meeting, Chicago, IL, 2022.
7. "Growing structural proteins into advanced materials for food security," the 26th Annual Green Chemistry & Engineering Conference, Reston, VA, 2022.
8. "Tunable structure of biodegradable silk-based microcapsules for soluble and insoluble payload delivery," MRS Fall National Meeting, Boston, MA, 2021.
9. "Realigning nanochannels in conventional graphene oxide films to achieve enhanced permeability and controlled release," MRS Fall National Meeting, Boston, MA, 2019.
10. "Tessellated platelet-crystal metal oxide topographies by graphene ink templating," The World Carbon Conference, Melbourne, Australia, 2017.
11. "Graphene inks as versatile templates for printing tiled metal oxide crystalline films," MRS Fall National Meeting, Boston, MA, 2017.
12. "Ultrastretchable graphene-based molecular barriers for chemical protection, detection, and actuation," NIEHS Superfund Research Program Annual Meeting, Philadelphia, PA, 2017.
13. "Mild solution synthesis of graphene wrapped $LiFePO_4$/C disc-shaped nanoparticles for lithium ion batteries," The Fifteenth International Conference on the Science and Application of Nanotubes (NT14), Los Angeles, CA, 2014.
14. Study on mechanical properties of modified graphene/epoxy nanocomposites," the 19th International Conference on Composite Materials, Montréal, Canada, 2013.

CONFERENCE POSTERS

1. "Programming Hierarchical Architectures in Biodegradable Microcapsules for Advanced Functions," MRS Fall National Meeting, Boston, MA, 2023
2. "Hierarchical Structuring of Biopolymers for Environmental Nanotechnologies," the AIChE Annual Meeting, Orlando, FL, 2023
3. "Programming Hierarchical Architectures in Biodegradable Microcapsules for Advanced Functions," Gordon Research Conference, Nanotechnology for a More Sustainable World, Newry, ME, 2023.
4. "Engineered Multiscale Materials from Biopolymers for Sustainable Agriculture and Manufacturing," the AIChE Annual Meeting, Phoenix, AZ, 2022
5. "Biodegradable Microcapsule Designer Using Silk Fibroin Technology," the AIChE Meeting, Phoenix, AZ, 2022
6. "Realigning nanochannels in conventional graphene oxide films to achieve enhanced permeability and controlled release," Sustainable Nanotechnology Organization Conference, San Diego, CA, 2019.
7. "Graphene inks as versatile templates for printing tiled metal oxide crystalline films," 256th ACS Fall National Meeting, Boston, MA, 2018.

MEDIA COVERAGE

Scientific American, Silkworms Spin a Potential Microplastics Substitute	2022
World Economic Forum, Microplastics in products? Silk offers a biodegradable alternative	2022
MIT News Cover story*,* Silk offers an alternative to some microplastics	2022
MIT Postdoc Spotlight, Muchun Liu: Postdoctoral Spotlight	2022
Salon, Could silk take a bite out of humanity's microplastic problem?	2022
The American Society of Mechanical Engineers, Silk Delivers at the Small Scale	2022
Nature Communications, Editors' Highlights section	2021
Nano Today's featured story*,* Rotated graphene stacks up for better membranes	2021