

Patrick Cappillino, Ph.D.

Chemistry and Biochemistry Department
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Academic/Research Positions:

- 2020-present **Associate Professor**, Chemistry and Biochemistry Department, University of Massachusetts Dartmouth, North Dartmouth, MA, USA
- **CAS Faculty Director of Research and Scholarship** (2024 – present)
 - **Director of Graduate Programs** (2021 – present)
 - Inorganic and materials chemistry research
 - Nanostructured catalyst development
 - Redox flow battery active-material development
 - Graduate and undergraduate research mentor
 - Instructor for Advanced and Descriptive Inorganic and Bioinorganic Chemistry
- 2014-2020 **Assistant Professor**, Chemistry and Biochemistry Department, University of Massachusetts Dartmouth, North Dartmouth, MA, USA
- 2010-2014 **Postdoctoral Appointee**, Energy Nanomaterials, Sandia National Laboratories, Livermore, CA, USA
- Synthesis of nanoporous and nanostructured palladium and palladium alloys
 - Hydrogen storage research
 - Redox flow battery research
- 2009-2010 **Visiting Assistant Professor**, Department of Chemistry and Biochemistry, Worcester Polytechnic Institute, Worcester, MA USA

Education:

- 2010 **Ph.D., Chemistry**, Department of Chemistry, Boston University, Boston, MA, USA
Advisor: Professor John P. Caradonna
Dissertation: *Modeling the structure and reactivity of mono- and binuclear nonheme iron oxygenase enzymes*
- 1997 **B.A., Biology**, State University of New York at Albany, Albany, NY, USA

Extramural Funding:

- 2024 – 2027 **NSF – Electrochemical Systems (\$331k), PI**
“Collaborative Research: Designing Solid Boosters and Electrolytes for Redox-Targeting Flow Batteries”
- 2023 – 2024 **MassVentures – Acorn Innovation Grant Award (\$35k), co-PI**
“Mushroom-Inspired Vanadium Extraction.”
- 2023 – 2025 **Office of Naval Research – University of Massachusetts Lowell (\$80k), Subaward**
“High Energy Density Redox Flow Batteries with Solid Boosters for Naval Installations.”
- 2022 – 2023 **Massachusetts Clean Energy Center Catalyst Award (\$65k), co-PI**
“Extraction of Critical Minerals for Battery Applications.”
- 2021 – 2024 **U.S. Office of Naval Research, UMass Dartmouth Marine & Undersea Research (\$298k), co-PI**
“Durability and Performance of Flow Batteries for Applications in Marine and Undersea Technology.”
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- 2021 **U.S. Department of Defense, STTR – Triton Systems (\$50k), Subaward**
“Chemical Sensors for Toxic Industrial Chemicals.”
- 2020 **U.S. Department of Energy, SBIR – Triton Systems (\$25k), Subaward**
“Swelling-Resistant Membranes for Nonaqueous Redox Flow Batteries.”
- 2019 – 2021 **U.S. Office of Naval Research, UMass Dartmouth Marine & Undersea Research (\$172k), co-PI**
“Toward High-Power/High-Energy Flow Batteries for Applications in Unmanned Undersea Vehicles: Overcoming Fundamental Obstacles with a Bio-Inspired Active-Material Scaffold”
- 2019 **UMass OTCV Tech Dev Award (\$25k), co-PI**
“Valorization of Low-Grade Vanadium for Flow Battery Applications”
- 2017 – 2018 **Massachusetts Clean Energy Center Catalyst Award (\$65k), co-PI**
“Bio-inspired Electrolytes for High-Performance Non-Aqueous Redox Flow Batteries”
- 2017 – 2018 **UMass OTCV Tech Dev Award (\$25k), co-PI**
“High-performance redox flow batteries with bio-inspired electrolytes for grid-scale energy storage”
- 2016 – 2017 **Army Research Office, Short-Term Innovative Research Grant (\$50k), single-PI**
“Multifunctional, Bimetallic Nanomaterials Prepared by Atomic Layer Electroless Deposition”
- 2015 – 2016 **ECS/Toyota Young Investigator Fellowship (\$50k), single-PI**
“Energy Storage in Mushroom-derived Natural Products”

Publications/Patents: (* = corresponding author)

1. Visayas, B.; Pahari, S.; Poudel, T.; Golen, J.; **Cappillino, P.J.**, Mayes, M.* “Designing Alkylammonium Cations for Enhanced Solubility of Anionic Active Materials in Redox Flow Batteries: The Role of Bulk and Chain Length,” *ChemPhysChem* (2024), <https://doi.org/10.1002/cphc.202400517>.
2. Pahari, S.; Gokoglan, T.; Chaurasia, S.; Bolibok, J.; Golen, J., Agar, E.*; **Cappillino, P.J.***, “Toward high-performance non-aqueous redox flow batteries, through electrolyte design,” *ACS Applied Energy Materials* (2023), 6, (14), p. 7521.
3. Hoene, H.; Gokoglan, T.; Pahari, S.; Liu, F.; Agar, E.; **Cappillino, P.J.**; Jin, X., “Parametric Study of a Bio-Inspired Non-Aqueous Redox Flow Battery Model” *Journal of the Electrochemical Society* (2023) 170 (2) p. 020522.
4. Egitto, J.; Gokoglan, T. ; Pahari, S.; Aravamuthan, Sundar R.; Liu, F.; Jin, X.; **Cappillino, P.J.**; Agar, E.* “Toward High Energy Density Redox Targeting Flow Batteries with a Mushroom-Derived Electrolyte.” *Journal of Electrochemical Energy Conversion and Storage* (2022) 19(4), p. 041005
5. **Cappillino, P.J.**; Agar, E.; Huang, "Flow Battery and Components Thereof," US 20210139516 A1, *United States Patent and Trademark Office*, 2021.
6. Visayas B., Pahari S., Gokoglan T., Golen J., Agar E., **Cappillino P.J.**,* Mayes M.L.* “Computational and Experimental Investigation of the Effect of Cation Structure on the Solubility of Anionic Flow Battery Active-Materials.” *Chemical Science* (2021) 12, 15892 - 15097.
7. Pahari S., Gokoglan T., Visayas B., Woehl J., Golen J., Howland R., Mayes M., Agar E., **Cappillino, P.J.*** “Designing high energy density flow batteries by tuning active-material thermodynamics.” *RSC Advances* (2021) 11(10), 5432-5443.
8. Gurung, S.; Robinson, D.B.; **Cappillino, P.J.***. “Palladium-Coated Platinum Powders with Tunable, Nanostructured Surfaces for Applications in Catalysis,” *ACS Applied Nano Materials* (2020) 3 (1), 530-537
9. Gokoglan, T.C.; Pahari, S.K.; Hamel, A.; Howland,R.; **Cappillino, P.J.***; Agar, E.*. “Operando Spectroelectrochemical Characterization of a Highly Stable Bioinspired Redox Flow Battery Active Material,” *Journal of the Electrochemical Society* (2019) 166 (10), A1745-A1751.

10. **Cappillino, P.J.**; Robinson, D.B., “Porous Metals from Sintering of Nanoparticles,” US 9981313 B1., *US Patent and Trademark Office*, 2018.
11. Howland, R; **Cappillino, P.J.***; “Scalable, Versatile Synthesis of Bio-Inspired Vanadium Compounds for High Stability, High Solubility Flow Battery Active Materials,” *The Nucleus* (2018) 96 (6), p 6.
12. Huang, H. B.; Howland, R.; Agar, E.; Nourani, M.; Golen, J. A.; **Cappillino, P. J.***, "Bioinspired, high-stability, nonaqueous redox flow battery electrolytes," *Journal of Materials Chemistry A* (2017) 5 (23), 11586-11591.
13. Benson, D. M.; Tsang, C. F.; Sugar, J. D.; Jagannathan, K.; Robinson, D. B.; El Gabaly, F.; **Cappillino, P. J.**; Stickney, J. L., "Enhanced Kinetics of Electrochemical Hydrogen Uptake and Release by Palladium Powders Modified by Electrochemical Atomic Layer Deposition," *ACS Applied Materials and Interfaces* (2017) 9 (21), 18338-18345.
14. Robinson, D.B.; **Cappillino, P.J.**; Sheridan, L.B.;Stickney, J.L. "Electroless Atomic Layer Deposition," US 9803285 B1, *US Patent and Trademark Office*, 2017.
15. Vitale, S.; Sugar, J.D.; **Cappillino, P.J.**; Giannuzzi, L.A.; Robinson, D.B. “Site Specific Preparation of Powders for High-Resolution Analytical Electron Microscopy Using Ga⁺ Focused Ion Beam.” *Microscopy and Microanalysis* (2016), Volume 22 (S3) pp. 180 – 181
16. Homer, M.; **Cappillino, P.J.**; El Gabaly, F.; Gnaegi, H.; Robinson, D.B.; Sugar, J. “Preparation of Electron and X-Ray Transparent Inorganic Particles for Analytical Microscopy Using the Ultramicrotome” *Microscopy and Microanalysis* (2015), Volume 21 (S3) pp. 1815 – 1816
17. Sugar, J.D.; Homer, M.; Kotula, P.G.; **Cappillino, P.J.**; Ong, M.; Robinson, D.B. “Quantitative EDS of Surface Modified Pd Powders for Hydrogen Storage” *Microscopy and Microanalysis* (2015), Volume 21 (S3) pp. 1083 – 108
18. McCracken, J.; **Cappillino, P.J.**; McNally, J.S.; Kryzaniak, M.D.; Tarves, P.C.; Cardonna, J.P. “Characterization of Water Coordination to Ferrous Nitrosyl Complexes with *fac*-N₂O, *cis*-N₂O₂, and N₂O₃ Donor Ligands” *Inorganic Chemistry* (2015), 54 (13), 6486 – 6497
19. Yang, N.Y.; Yee, J.K.; Zhang, Z.; Kurmaneva, L.; **Cappillino, P.J.**; Stavila, V.; Lavernia, E.J.; San Marchi, C. “Hydrogen sorption characteristics of nanostructured Pd–10Rh processed by cryomilling” *Acta Materialia* (2015), 82, 41-50.
20. **Cappillino, P.J.**; Pratt, H. D.; Hudak, N. S.; Tomson, N. C.; Anderson, T. M.; Anstey, M. R., “Application of Redox Non-Innocent Ligands to Non-aqueous Flow Battery Electrolytes.” *Advanced Energy Materials* (2014), 4, 1300566.
21. **Cappillino, P.J.**; Sugar, J.D.; El Gabaly, F.; Cai, T.Y.; Liu, Z.; Stickney, J.L.; Robinson, D.B. “Atomic-Layer Electroless Deposition: A Scalable Approach to Surface-Modified Metal Powders.” *Langmuir* (2014), 30, 4820-4829.
22. Parent, L.; Robinson, D.B.; **Cappillino, P.J.**; Hartnett, R.J.; Abellan, P.; Evans, J.; Browning, N.; Arslan, I., “In Situ Observation of Directed Nanoparticle Aggregation During the Synthesis of Ordered Nanoporous Metal in Soft Templates”, *Chemistry of Materials* (2014), 26 (3), 1426 – 1433.
23. **Cappillino, P.J.**; Lavernia, E.J.;Ong, M.D.;Wolfer, W.G.;Yang, N.Y., “Plastic Deformation and Hysteresis for H₂ Storage in Pd-Rh Alloys,” *Journal of Alloys and Compounds* (2014), 586, 59-65.
24. Jones, C.G.; **Cappillino, P.J.**; Stavila, V.;Robinson, D.B., “Control of both particle and pore size in nanoporous palladium alloy powders” *Powder Technology* (2014), 267, 95-102
25. **Cappillino, P.J.**; Robinson, D.B., “Porous Metals from Sintering of Nanoparticles,” US Patent No. 9,981,313, *US Pat. and Trademark Office*, Washington D.C.
26. **Cappillino, P. J.**; Harnett, R.J.; Hekmaty, M.A.; Jacobs, B.W.;Hattar, K.M.;Clark,B.G.; Robinson, D.B., “Synthesis of mesoporous palladium with tunable porosity and demonstration of its thermal stability by *in situ* heating and environmental transmission electron microscopy.” *Journal of Materials Chemistry A* (2013), 1, 602-610.
27. **Cappillino, P.J.**; Sugar, J.D.; Hekmaty, M.A.; Jacobs, B.W.; Stavila, V.; Chames, J.; Yang, N.Y.; Robinson, D.B., “Nanoporous Pd alloys with compositionally tunable hydrogen storage properties prepared by nanoparticle consolidation,” *Journal of Materials Chemistry*, (2012), 22, 14013-14022.
28. Ong, M.D.; Jacobs, B.W.; Sugar, J.D.; Grass, M.E.; Liu, Z.; Buffleben, G.M.; Clift, W. M.; Langham, M.E.; **Cappillino, P. J.**; Robinson, D.B., “Effect of rhodium distribution on thermal stability of nanoporous palladium-rhodium powders”, *Chemistry of Materials*, (2012), 24(6), 996-1004.

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29. **Cappillino, P. J.**; Miecznikowski, J. R.; Tyler, L. A.; Lo, W.; Krzyaniak, M. D.; McCracken, John L.; Armstrong, W. H.; Caradonna, John P., " Studies of iron (II) and iron(III) complexes with fac-N₂O, cis-N₂O₂ and N₂O₃ donor ligands: models for the 2-His 1-carboxylate motif of non-heme iron monooxygenases", *Dalton Transactions*, (2012), 41, 5662-5677.
 30. **Cappillino, P. J.**; McNally, Joshua S.; Wang, F.; Caradonna, J. P., "The effect of varying carboxylate ligation on the electronic environment of N₂O_x (x = 1-3) nonheme iron: A DFT analysis", *Dalton Transactions*, (2012), 41, 464-483.
 31. **Cappillino, P. J.**; Tarves, P. C.; Rowe, G. T.; Lewis, A. J.; Harvey, M.; Rogge, C.; Stassinopoulos, A.; Lo, W.; Armstrong, W. H.; Caradonna, J. P., "Synthesis and characterization of a family of binuclear non-heme iron monooxygenase model compounds: evidence for a "phenolate/amide carbonyl (PAC) shift" upon oxidation", *Inorganica Chimica Acta* (2009), 369, 2136-2150.
 32. Meyer, J.; Brown, S.; Kleiman, R.; Hill, J.; **Cappillino, P. J.**; Koritala, R., "A novel presentation of nonionic PEG surfactants' characteristics", *Cosmetics & Toiletries* (2004), 119(4), 61-64, 66, 68.
 33. **Cappillino, P. J.**; Kleiman, R.; Botti, C., "Composition of Chilean jojoba seeds", *Industrial Crops and Products* (2003), 17(3), 177-182.

Invited Talks

1. "Inroads and Challenges in the Design of Robust, High-Performance Flow Battery Electrolytes" **Fall, 2022 MRS Conference** in Boston, MA, Symposium: EN01: Redox Flow Batteries—Materials, Methods and Devices, November 28, 2022
2. "Toward High-Performance Nonaqueous Flow Battery Active-Materials, from a Bio-inspired Scaffold," **Joint Center for Energy Storage Research, Redoxmer Workshop**, Massachusetts Institute of Technology, Endicott House, May 21-22, 2019
3. "Delivering Robust, High-Performance Flow Battery Active Materials Using Bioinspired Design Principles" **University of Massachusetts Amherst** Chemistry Department, April 26, 2019.
4. "Engineering Stability and High-performance in Nonaqueous Flow Batteries with a Bioinspired Approach" Invited talk, given at the **Spring, 2019 ACS Conference** in Orlando, FL., Symposium: Materials & Techniques to Advance Redox Flow Batteries.
5. "Natural Selection as a Molecular Design Toolkit: Bio-Inspired Flow Battery Active Materials" Invited talk given at **AI23 Battery Systems**, Waltham, MA, August 23, 2018.
6. "Natural Selection as a Molecular Design Toolkit: Bio-Inspired Flow Battery Active Materials" Invited talk given at the **University of Massachusetts Boston** Department of Chemistry, Boston, MA, April 4, 2018.
7. "Natural Selection as a Molecular Toolbox: Bio-Inspired Design of Battery Materials for Grid Applications" Invited talk given at the **Fairfield University** Department of Chemistry, Fairfield, CT, October 27, 2017.
8. "Mushroom-Derived Flow Battery Electrolytes" Invited talk given at the **Bridgewater State University** Department of Chemical Sciences, Bridgewater, MA, October 14, 2016.
9. "Mushroom-Derived Flow Battery Electrolytes" Invited talk given at **Toyota Motor Engineering & Manufacturing**, Ann Arbor, MI, August 18, 2016.
10. "Designing Coordination Compounds for Grid Energy Storage: Some Lessons from Nature" Invited talk given at the 39th **Boston Regional Inorganic Colloquium**, Clark University, Worcester, MA, February, 27, 2016.

Affiliations

- Electrochemical Society (2014 – present)
- Materials Research Society (2010 – present)
- American Chemical Society, Inorganic Section (2004 – present)
- Northeastern Section Younger Chemists Committee (Executive Committee, Webmaster, 2008)

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- Boston University Younger Chemists Committee (Vice-president, 2007)

Awards

- University of Massachusetts Dartmouth, Chemistry and Biochemistry Department, Chemistry Educator of Year Award (2021)
- Emerging Investigators, Journal of Materials Chemistry A (2017)
- ECS Toyota Young Investigator Fellowship (2015/16)
- NSYCC/NESACS German Exchange Program Awardee (2008)
- 3rd prize for best oral presentation, 10th Frühjahrssymposium of the GDCh Younger Chemists' Forum., (2008)
- Boston University Department of Chemistry Outstanding Teaching Fellow (2006/7)

Additional Synergistic Activities

2023 – 2024	DoE Advanced Materials & Manufacturing Technologies Office Battery Lab Call Proposal Review
2024	Oak Ridge Affiliated Universities, Ralph E Powe Junior Faculty Enhancement Awards 2024, Physical Sciences Panel
2023	DOE Office of Science, Basic Energy Sciences, Energy Earth Shot Proposal Review
2021	National Science Foundation, Math & Physical Sciences Directorate, Chemistry Division, Chemical Synthesis, Ad-hoc
2020	National Science Foundation, Engineering Directorate, CBET Division, Electrochemical Systems, Review Panel Member
2017 – 2019	Technical Reviewer for Department of Energy's Technology Commercialization Fund (TCF)
2014 – 2019	Ph.D., M.S. thesis research mentor, undergraduate research mentor
2018	South Shore Regional Science Fair Judge
2017	Dartmouth Highschool Summer Research Mentor
2011 – 2014	Principal Investigator of Sandia-funded, Campus Executive Fellowship
2011	Bay Area Regional Science Bowl Judge