

TIANYU ZHU

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Personal Summary

Materials Scientist and Engineer with experience in the synthesis and processing of polymers and ceramics for energy related applications. My research interests lie at the interface of functional polymers and energy materials. (Keywords: polymers, ceramics, composites, batteries)

Professional Appointments

- Assistant Professor** | Clemson University, SC *Aug 2023 – Present*
- Synthesis of robust ion-exchange polymers for energy storage and energy conversion devices.
 - Scalable ceramic fabrication process using selective laser sintering (SLS) technique for battery applications.
- Senior Research Engineer** | QuantumScape, CA *Aug 2022 - Aug 2023*
- Formulation and roll-to-roll coating process for ceramic separators for solid-state Li metal batteries.
 - Continuous fast sintering process for manufacturing ceramic electrolytes.
 - Quality analysis and defect reduction for EV-battery separators through advanced imaging and input material optimization.
- Postdoctoral Researcher** | Lawrence Berkeley National Lab, CA *Oct 2020 - July 2022*
- Developed synthetic pathways for organometallic catalysts, conductive polymers and polyelectrolytes.
 - Lab-based research on electrode fabrication and surface coatings for battery industry.
 - Partnered with Berkeley Lab and Applied Materials to license and commercialize inventions on polymer coating, electrode fabrication and slurry processing.
- Postdoctoral Fellow** | University of South Carolina, SC *Jan 2020 - Sept 2020*
- Developed synthetic strategies to prepare polyolefin grafted nanoparticles with precise molecular weight and graft density control.
 - Designed a class of polymer electrolytes with polyethylene backbones for alkaline fuel cells and rechargeable batteries.
 - Explored quantitative analysis of the chemical and mechanical degradation of polymer membranes and synthetic organics.

Education History

- Ph.D. in Chemistry | University of South Carolina *July 2015-Dec 2019*
Thesis: Cationic Cobaltocene Derivatives and Polyelectrolyte Membranes for Energy Storage Applications.
- B.S. in Chemistry | Nanjing University *Sept 2011-May 2015*

Awards and Achievements

1. ACS PMSE Future Faculty Scholar - ACS Chicago, 2022
2. Excellence in Graduate Polymer Research Symposium - ACS Philadelphia, 2020
3. ACS POLY/PMSE Student Chapter Officer, 2018~2019
4. Departmental and Graduate School Travel Award (USC), 2017

Patents

1. Tang, C.; **Zhu, T.**, Preparation of metallocene containing cationic polymers for anion exchange applications. US11738311B2, [Link](#).
2. Liu, G.; **Zhu, T.**, Conductive polymers and electrode processing useful for lithium batteries. [Patent Licensed](#).
3. Herle, S.; Liu, G.; Guan, J.; Cushing, J.; Joshi, A.; **Zhu, T.**; Fang, C.; Tran, T., Thermally stable polymer binders for lithium-ion battery anodes. US20220336813A1, [Link](#).
4. Liu, G.; **Zhu, T.**, Mixed solid-state ionic-electronic polymer conductors for electrochemical devices. US App No: 63/369,182. [Patent Licensed](#).
5. Liu, G.; Scown, C.; Hubble, D.; Nordahl, S.; **Zhu, T.**; Baral, N., Solvent-assisted poly(lactic acid) upcycling under mild conditions. [Patent Pending](#).

Teaching, Mentorship and Relevant Skills

- NSF RET Program, Faculty Research Mentors for “Ion-conducting oxide ceramics for better battery electrolytes”

- Lecture courses and laboratory courses – Materials Processing (MSE 3190), Organic Chemistry I & II (Chem 33X), General Chemistry Lab, Essentials of Organic Chemistry Lab, comprehensive Organic Chemistry Lab (Chem 33XL)
- Research mentor for graduate student – Yujin Cha (2017-2020, University of South Carolina)
Dr. Yujin Cha co-authored 2 papers with me: *JACS* 2021, *143*, 11871; *ACS Macro Lett.* 2019, *8*, 835.
- Research mentor for undergraduate students - Alex Cushing (2020, Berkeley Lab), Emily Miao (2022, University of California, Berkeley) Alex published 1 research paper under my supervision.
- Research mentor for high school student – Samuel Hankinson (2018, in ACS Project Seed Program)
Samuel co-authored 1 paper with me: *Polymer* 2019, *174*, 170.
- *Materials Processing and Characterization*: atomic force microscopy (AFM), thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), gas chromatography (GC), gel permeation chromatography (GPC), dynamic light scattering (DLS), tensile testing; scanning and transmission electron microscopy (SEM and TEM), X-ray absorption spectroscopy (XAS); battery and fuel cell assembly and testing. *Structural Analysis*: nuclear magnetic resonance (NMR), FT-IR and UV-vis spectroscopy, X-ray diffraction and Rietveld refinement. *Organic and Polymer Synthesis*: controlled polymerization, column chromatography, thermal evaporation, surface modification of nanoparticles. *Computation and Data Analysis*: DFT calculations for structures, orbitals, bonding and reaction pathways, statistical and failure analysis, JMP.

Presentations

1. Division Seminar at University of South Carolina, Sept 2023 (Invited: Processing Functional Polymers for High Energy Density Lithium Batteries)
2. John Newman Fellowship at LBNL Energy Technology Area, Apr 2023 (High Voltage Tolerant Polymer-Based Electrolytes for Solid State Cathodes)
3. Laboratory Directed Research & Development (LDRD) at LBNL Energy Technology Area, Nov 2022 (Molecular design and chemical recycling of polyolefins for a circular polymer economy)
4. Microscopy and Microanalysis, Aug 2022. (4D-STEM characterization of low q scattering in conductive polymers used for Li-ion battery anodes)
5. American Chemical Society National Meeting & Exposition, Aug 2022. (Invited Oral Presentation: Synthetic polymers for advanced electrochemical systems)
6. American Chemical Society National Meeting & Exposition, Mar 2022. (Oral: Conductive polymers for alloy anodes)
7. Molecular Foundry User Meeting, Aug. 2021. (Poster: Metallopolymer electrolytes for rechargeable batteries and fuel cells)
8. American Chemical Society National Meeting & Exposition, Aug 2020. (Invited Oral Presentation: Metallopolymer electrolytes for energy storage)
9. 2019 Southeast Regional Meeting (SERMACS), Oct 2019. (Oral: Robust metallo-polyelectrolyte membranes towards energy storage applications)
10. American Chemical Society National Meeting & Exposition, Aug 2019. (Oral: Facile ring-opening metathesis polymerization toward bioplastics and ionomer membranes)
11. 10th US-Japan Hybrid Materials Workshop, Jun 2018. (Poster: Metallo-polyelectrolyte membranes for alkaline fuel cells)
12. American Chemical Society National Meeting & Exposition, Aug 2017. (Oral: Synthetic methodologies toward cationic metallocene derivatives and polymers)
13. 2016 Southeast Regional Meeting (SERMACS), Oct 2016. (Poster: Rational design and preparation of thiophene polymers for dielectric energy storage)

Professional Service

Guest Editor for *Polymers*.

Referee for 1) journal articles: *Macromolecules*, *Composites Part B*, *Polymer Degradation and Stability*, *Journal of Applied Polymer Science*, *International Journal of Molecular Sciences*, *Polymer*, *Polymers*, *Applied Sciences*, *High Performance Polymers*, *Gels*, *International Journal of Environmental Research and Public Health*; 2) research proposals: *U.S. Army Research Office*.

Publications (After Joining Clemson)

‡ Denotes equal contribution * Denotes corresponding author

1. Nan, J.; Sun, Y.; Yang, F.; Zhang, Y.; Li, Y.; Wang, Z.; Wang, C.; Wang, D.; Chu, F.; Wang, C.*; **Zhu, T.***; and Jiang, J.*, Coupling of Adhesion and Anti-Freezing Properties in Hydrogel Electrolytes for Low-Temperature Aqueous-Based Hybrid Capacitors. *Nano-Micro Letters* **2024**, *16*, 22.

Selected Publications (Before Joining Clemson)

‡ Denotes equal contribution * Denotes corresponding author

- Zhu, T.**; Sternlicht, H.; Ha, Y.; Fang, C.; Liu, D.; Savitzky, B.; Zhao, X.; Lu, Y.; Fu, Y.; Ophus, C.; Zhu, C.; Yang, W.; Minor, A.; Liu, G.*; Formation of Hierarchically Ordered Structures in Conductive Polymers to Enhance the Performances of Lithium-Ion Batteries. *Nat. Energy* **2023**, *8*, 129.
Research Highlight: Heating up the binder. *Nat. Energy* **2023**, *8*, 133.
- Zhu, T.**; Tran, T.; Fang, C.; Liu, D.; Herle, S.; Guan, J.; Gopal, G.; Joshi, A.; Chshing, J.; Minor, A.; Liu, G.*; Lithium Substituted Poly(amic acid) As a Water-Soluble Anode Binder for High-Temperature Pre-Lithiation. *J. Power Sources* **2022**, *521*, 230889.
- Zhu, T.**; Lu, Y.; Huang, K.*; Tang, C.*; Metallopolymer as a Solid Electrolyte for Rechargeable Zn-Metal Alkaline Batteries. *ACS Mater. Lett.* **2021**, *3*, 799.
- Zhu, T.**; Liu, G.*; Functional Conductive Polymer Binder for Practical Si-Based Electrodes. *J. Electrochem. Soc.* **2021**, *168*, 050533.
- Zhu, T.**; Sha, Y.; Adabi, H.; Peng, X.; Cha, Y.; Dissanayake, D. M. M. M.; Smith, M. D.; Vannucci, A. K.; Mustain, W. E.; Tang, C.*; Rational Synthesis of Metallo-Cations Toward Redox- and Alkaline-Stable Metallo-Polyelectrolytes. *J. Am. Chem. Soc.* **2020**, *142*, 1083.
- Zhu, T.**; Rahman, M. A.; Benicewicz, B.*; Synthesis of Well-Defined Polyolefin Grafted SiO₂ Nanoparticles with Molecular Weight and Graft Density Control. *ACS Macro Lett.* **2020**, *9*, 1255. (Highlighted as Supplementary Cover)
- Zhu, T.**; Zhang, J.*; Tang, C.*; Metallo-Polyelectrolytes: Correlating Macromolecular Architectures with Properties and Applications. *Trends Chem.* **2020**, *2*, 227.
- Zhu, T.**; Tang, C.*; Crosslinked Metallo-Polyelectrolytes with Enhanced Flexibility and Dimensional Stability for Anion-Exchange Membranes. *Polym. Chem.* **2020**, *11*, 4542.
- Zhu, T.**; Xu, S.; Rahman, M. A.; Dogdibegovic, E.; Yang, P.; Pageni, P.; Kabir, M. P.; Zhou, X.; Tang, C.*; Cationic Metallo-Polyelectrolytes for Robust Alkaline Anion-Exchange Membranes. *Angew. Chem. Int. Ed.* **2018**, *57*, 2388. (Highlighted as Hot Paper and Inside Back Cover)
- Zhu, T.**; Sha, Y.; Yan, J.; Pageni, P.; Rahman, M. A.; Yan, Y.*; Tang, C.*; Metallo-Polyelectrolytes as A Class of Ionic Macromolecules for Functional Materials. *Nat. Commun.* **2018**, *9*, 4329.
- Song, L.; **Zhu, T.**; Yuan, L.; Zhou, J.; Zhang, Y.; Wang, Z.*; Tang, C.*; Ultra-Strong Long-Chain Polyamide Elastomers with Programmable Supramolecular Interactions and Oriented Crystalline Microstructures. *Nat. Commun.* **2019**, *10*, 1315.
- Hubble, D.; Nordahl, S.; **Zhu, T.**; Baral, N.; Scown C.*; Liu, G.*; Solvent-Assisted Poly (lactic acid) Upcycling under Mild Conditions. *ACS Sustain. Chem. Eng.* **2023**, *11*, 8208.
- Lu, Y.; **Zhu, T.**; McShane, E.; McCloskey, B.; Chen, G.*; Single-Crystal LiNi_xMn_yCo_{1-x-y}O₂ Cathodes for Extreme Fast Charging. *Small*, **2022**, *18*, 2105833. (Research Highlighted in 2022 R&D100)
- Cha, Y.; **Zhu, T.**; Sha, Y.; Lin, H.; Hwang, J.; Seraydarian, M.; Craig, S.; Tang, C.*; Mechanochemistry of Cationic Cobaltocenium Mechanophore. *J. Am. Chem. Soc.* **2021**, *143*, 11871.
- Lu, Y.; **Zhu, T.**; Bergh, W.; Stefik, M.; Huang, K.*; A High Performing Zn-ion Battery Cathode Enabled by in-situ Transformation of V₂O₅ Atomic Layers. *Angew. Chem. Int. Ed.* **2020**, *59*, 2.
- Nan, J.; Zhang, G.; **Zhu, T.**; Wang, Z.; Wang, L.; Wang, H.; Chu, F.; Wang, C.*; Tang, C.*; A Highly Elastic and Fatigue-Resistant Natural Protein-Reinforced Hydrogel Electrolyte for Reversible-Compressible Quasi-Solid-State Supercapacitors. *Adv. Sci.* **2020**, 2000587.
- Lu, Y.; Wen, Y.; Huang, F.; Zhu, T.; Benicewicz, B.; Huang, K.*; Rational Design and Demonstration of a High-Performance Flexible Zn/V₂O₅ Battery with Thin-Film Electrodes and Para-Polybenzimidazole Electrolyte Membrane. *Energy Storage Mater.* **2020**, *27*, 418.
- Sha, Y.; Rahman, M. A.; **Zhu, T.**; Cha, Y.; McAlister, W.; Tang, C.*; ROMPI-CDSA: Ring-Opening Metathesis Polymerization-Induced Crystallization-Driven Self-Assembly of Metallo-Block Copolymers. *Chem. Sci.* **2019**, *10*, 9782.
- Cha, Y.; Jarrett-Wilkins, C.; Rahman, M. A.; **Zhu, T.**; Sha, Y.; Ian, M.; Tang, C.*; Crystallization-Driven Self-Assembly of Metallo-Polyelectrolyte Block Copolymers with a Polycaprolactone Core-Forming Segment. *ACS Macro Lett.* **2019**, *8*, 835.
- Qiao, Y.; Yin, X.; **Zhu, T.**; Li, H.; Tang, C.*; Dielectric Polymers with Novel Chemistry, Compositions and Architectures. *Prog. Polym. Sci.* **2018**, *80*, 153.
- Sha, Y.; Zhang, Y.; **Zhu, T.**; Tan, S.; Cha, Y.; Craig, S. L.; Tang C.*; Ring-Closing Metathesis and Ring-Opening Metathesis Polymerization Toward Main-Chain Ferrocene-Containing Polymers. *Macromolecules* **2018**, *51*, 9131.