

# Meng Cai

E-mail: [mcai@vt.edu](mailto:mcai@vt.edu)

Phone: 540-728-3321

1165 Orange Leaf, Ct  
Christiansburg, VA 24073

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## CAREER HIGHLIGHTS

- Experienced materials scientist & engineer with a strong background in materials chemistry, surface/interface science, materials processing, analytical chemistry, photochemistry, and electrochemistry.
- Extensive expertise in materials characterization using optic microscopy; hands-on experience and in-depth knowledge of chemical synthesis and separation, thin film/coating preparation, structural characterization, thermal treatment, electrochemistry, catalysis, and spectroscopy.
- Strong background in laboratory equipment installation, maintenance, and laboratory safety.
- Highly-collaborative team worker and active member of the materials/inorganic chemistry communities.

## EDUCATION

**Ph.D. in Chemistry**, Virginia Tech, Blacksburg, VA, USA August 2015–May 2020

Supervised by Prof. Amanda J. Morris

**M.S. in Metallurgical Engineering**, Central South University, Changsha, China August 2013–June 2015

Supervised by Prof. Chuanfu Zhang and Prof. Jing Zhan

**B.S. in Metallurgical Engineering**, Central South University, Changsha, China August 2008–June 2013

Supervised by Prof. Jing Zhan

## INSTRUMENTAL TECHNIQUES

- Chemical synthesis and separation: Schlenk line, glove box, HPLC
- Film/coating preparation: solvothermal method, electrodeposition, chemical vapor deposition (CVD)
- Material characterization: NMR, PXRD, TGA, FT-IR, surface area measurement (BET)
- Optic microscopy: SEM, TEM, AFM, confocal microscopy.
- Electrochemical analysis: CV, CA, CPE & Electrochemical Impedance spectroscopy (EIS)
- Optical spectroscopic techniques: UV-Visible spectroscopy (UV-Vis), photoluminescence spectroscopy

## PROFESSIONAL EXPERIENCE

**Doctoral Research** (Virginia Tech, Blacksburg, VA, USA) August 2015–present

Related coursework: Advanced Inorganic Chemistry, Methods and Applications of Inorganic Chemistry, Advanced Electrochemistry, Analytical Spectroscopy.

Research focus 1: Fabrication and optimization of ruthenium(II)-polypyridyl doped metal-organic framework (MOF) films for solid-state electrochemiluminescence (ECL) – *Funded Project by National Science Foundation, USA*

- Fabricated and characterized the structural, physical, and electrochemical properties of UiO-67-Ru films.
- Optimized MOF films by a systematic study of synthetic conditions based on structure-property relationships.
- Investigated *in-situ* ECL of UiO-67-Ru films using confocal microscopy.
- Successfully applied UiO-67-Ru thin films as ECL indicator for practical dopamine detection.

Research focus 2: Design rules for efficient charge transfer in MOF films (manuscript in preparation) – *Funded Project by National Science Foundation, USA*

- Prepared three ferrocene-doped MOF thin films with different MOF pore sizes by electrodeposition.
- Analyzed electron and ion diffusion processes in three MOFs by applying a computational model.
- Revealed the relationship between MOF structure and diffusion rates that can guide future MOF design.

Research focus 3: Electrochemical oxidation of hydroxymethylfurfural (HMF) to 2,5-furandicarboxylic acid (FDCA) over a nickel-modified covalent organic framework (COF) (manuscript in preparation) – *Funded Project by Department of Energy, USA*

- Synthesized covalent organic framework TpBpy films by a template-free method of interfacial polymerization.
- Achieved high catalytic reactivity of nickel-modified TpBpy for electrochemical oxidation of HMF.
- Quantitatively analyzed HMF oxidation products by high-performance liquid chromatography (HPLC).

Thesis: Synthesis of mesoporous fibrous NiCo<sub>2</sub>O<sub>4</sub>, NiO, Co<sub>3</sub>O<sub>4</sub>, and Ni-Co alloy and their electrocatalytic activity as electrode material for direct ethanol fuel cells – *Funded Project by Natural Science Foundation of Hunan Province of China*

- Synthesized mesoporous metal oxide and alloy fibers via a coprecipitation-thermal decomposition method.
- Characterized prepared fibers and optimized synthetic conditions to achieve high aspect ratio.
- Improved the electrocatalytic activity of mesoporous fibers for ethanol oxidation in alkaline media.

### SELECTED PUBLICATIONS (cited by 116 on Google Scholar)

- **Cai, M.**; Loague, Q.; Zhu J.; Lin, S.; Usov, P. M.; Morris, A. J., "Ruthenium(II)-polypyridyl Doped Zirconium(IV) Metal-organic Frameworks for Solid-state Electrochemiluminescence", *Dalton Trans.* **2018**, 47, 16807-16812.
- Celis-Salazar, P. J.; **Cai, M.**; Cucinell, C. A.; Ahrenholtz, S. R.; Epley, C. C.; Usov, P. M.; Morris, A. J., "Independent Quantification of Electron and Ion Diffusion in Metal-locene-doped Metal-Organic Frameworks Thin Films", *J. Am. Chem. Soc.* **2019**, 41 (30), 11947-11953.
- Zhan, J.; **Cai, M.**; Zhang, C.; Wang, C., "Synthesis of Mesoporous NiCo<sub>2</sub>O<sub>4</sub> Fibers and Their Electrocatalytic Activity on Direct Oxidation of Ethanol in Alkaline Media", *Electrochim. Acta* **2015**, 154, 70-76.
- (*Patent*) Zhan, J.; Zhang, C.; Li, C.; **Cai, M.**; Wang, C.; Wang, C., "Preparation method of mesoporous nickel cobaltate fiber and application thereof", CN103318978B
- Shaikh, S.; Usov, P. M.; Zhu, J.; **Cai, M.**; Altatis, J.; Morris, A. J., "Synthesis and Defect Characterization of Phase-Pure Zr-MOFs Based on Meso-tetracarboxyphenylporphyrin", *Inorg. Chem.* **2019**, 58 (8), 5145-5153.
- Shaikh, S.; Chakraborty, A.; Alatis, J.; **Cai, M.**; Danilov, E.; Morris, A. J., "Light Harvesting and Energy Transfer in a Porphyrin-based Metal Organic Framework", *Faraday Discuss.* **2018**, DOI: 10.1039/C8FD00194D.
- Zhu, J.; Liu, J.; Machain, Y.; Bonnett, B.; Lin, S.; **Cai, M.**; Kessinger, M.C.; Usov, P.M.; Xu, W.; Senanayake, S.D.; Troya, D.; Esker, A.R.; Morris, A. J. "Insights into CO<sub>2</sub> Adsorption and Chemical Fixation Properties of VPI-100 Metal-Organic Frameworks", *J. Mater. Chem. A* **2018**, 6, 22195-22203.
- Zhu, J.; Usov, P. M.; Xu, W.; Celis-Salazar, P. J.; Lin, S.; Kessinger, M. C.; Landaverde-Alvarado, C.; **Cai, M.**; May, A. M.; Slobodnick, C., "A New Class of Metal-Cyclam-Based Zirconium Metal-Organic Frameworks for CO<sub>2</sub> Adsorption and Chemical Fixation", *J. Am. Chem. Soc.* **2018**, 140 (3), 993-1003.
- Lin, S.; Ravari, A. K.; Zhu, J.; Usov, P. M.; **Cai, M.**; Ahrenholtz, S. R.; Pushkar, Y.; Morris, A. J., "Insight into Metal-Organic Framework Reactivity: Chemical Water Oxidation Catalyzed by a [Ru(tpy)(dcbpy)(OH<sub>2</sub>)]<sup>2+</sup> Modified UiO-67", *ChemSusChem* **2018**, 11 (2), 464-471.

### HONORS & AWARDS

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|--|------|
| • Graduate School Doctoral Assistantship (GSDA) Award – Virginia Tech            | 2019 |
| • Outstanding Master's Thesis Award – Central South University                   | 2015 |
| • Distinguished Research Award – Central South University                        | 2014 |
| • Outstanding Undergraduate Thesis Award – Central South University              | 2013 |
| • National Scholarship – Ministry of Education of China (Award percentage: 0.2%) | 2009 |

### SERVICE & LEADERSHIP

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|---|---------------------------|
| • Teaching Assistant for General Chemistry Lab<br>(Instructed over 300 undergraduate students in general chemistry experiments) | August 2015–December 2017 |
| • Undergraduate students' project leader (advised 7 undergraduate researchers)  | June 2014–present         |
| • Laboratory Inventory Supervisor   | January 2017–present      |
| • Laboratory Scanning Electron Microscopy (SEM) Director  | January 2017–present      |
| • Laboratory Chemical Hygiene Officer   | sOctober 2015–July 2016   |

### PRESENTATIONS

- American Chemical Society (ACS) National Meeting – Washington DC. – August 20, 2017 (*Poster; among most exceptional posters selected for Sci-Mix session*)
- Materials Innovations and Instrumentation Expo – Blacksburg, VA – May 7, 2019 (*Poster*)
- ACS Southeastern Regional Meeting (SERMACS) – Savannah, GA – Expected October 20, 2019 (*Oral*)