

JOSEPH M. MARRETT

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Montreal, QC

EDUCATION

McGill University

PhD Student (ongoing)

Chemistry (Materials)

2022 -

McGill University

M.Sc.

Chemistry (Materials)

Thesis Title: "Molecular Self-Assembly of Reactive Organic and Metal-Organic Solids"

2021

McGill University

B.Sc.

Honors Chemistry

Thesis Title: "ZIF Synthesis in Supercritical Carbon Dioxide"

2018

RESEARCH EXPERIENCE

Graduate Researcher, McGill University

Supervised by Prof. T. Friščić, Department of Chemistry

Montreal, Canada

2018-2021

- Designed and synthesized functional and reactive crystalline materials
- Relied heavily on powder and single-crystal XRD structural analysis
- Gained extensive experience in inorganic, organic, and materials synthesis

Undergraduate Researcher, McGill University

Supervised by Prof. T. Friščić and Prof. C. J. Li, Department of Chemistry

Montreal, Canada

2016-2018

- Investigated alternative syntheses for the greener production of metal-organic frameworks
- Used mechanochemical methods for solvent-free synthesis
- Designed reaction methodologies using supercritical carbon dioxide as a reaction medium

SKILLS

X-Ray Diffraction and Crystallography

- Powder X-Ray diffraction data collection and analysis
- Single crystal X-Ray diffraction data collection and refinement

Materials Characterization

- Common materials characterization methods including thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), Fourier-transform infrared spectroscopy (FTIR), solution and solid-state nuclear magnetic resonance spectroscopy (NMR), scanning electron microscopy (SEM), hot stage optical microscopy, and mass spectroscopy (MS)

Chemical Synthesis

- Experience in the synthesis of metal-organic and organic materials by solution and by solid-state (mechanochemical) methodologies

- Well-versed in common experimental methodologies including air- and moisture-free synthesis, solvothermal synthesis, column chromatography, thin-layer chromatography, preparative thin-layer chromatography, and distillation

Computational Chemistry

- Limited experience in gas-phase density functional theory (DFT) calculations of electrostatic surface potentials (ESPs) and nuclear magnetic resonance (NMR) chemical shifts and J -couplings

Software

- Crystallographic software (APEX3, OLEX2, ShelXle, CCDC Software, PLATON), Python for data analysis (matplotlib, pandas, numpy, seaborn), Gaussian 16, image manipulation Software (Inkscape, Illustrator), MS Office, OriginLab, and LaTeX

Teaching and Mentoring

- 2 years of experience as a teaching assistant for an upper level synthesis laboratory course for undergraduate students. Mentored an undergraduate student on multiple projects related to the synthesis of metal-organic frameworks

PATENTS

1. Hypergolic Metal Organic Frameworks

US 16/570,307, Pending

This patent describes the synthesis and function of the first hypergolic metal-organic frameworks (MOFs). These are solid materials which ignite on contact with a liquid oxidizing species (*i.e.* nitric acid) and have potential for use as fuels or fuel-additives in aerospace propulsion.

PUBLICATIONS

7. Olivier Jobin, Cristina Mottillo, Hatem M. Titi, Joseph M. Marrett, Mihails Arhangeliskis, Robin D. Rogers, Tomislav Friščić, and Étienne Robert, **Metal–Organic Frameworks as Hypergolic Additives for Hybrid Rockets**, *Chemical Science* **2022**, *13*, 3424-3436.
6. Filip Topić, Joseph M. Marrett, Tristan H. Borchers, Hatem M. Titi, Christopher Barrett, and Tomislav Friščić, **After 200 Years: The Structure of Bleach and Characterization of Hypohalite Ions by Single-Crystal X-Ray Diffraction**, *Angewandte Chemie International Edition* **2021**, *60*, 24400-24405.
5. Novendra Novendra, Joseph M. Marrett, Athanassios D. Katsenis, Hatem M. Titi, Mihails Arhangeliskis, Tomislav Friščić, and Alexandra Navrotsky, **Linker Substituents Control the Thermodynamic Stability in Metal-Organic Frameworks**, *Journal of the American Chemical Society* **2020** *142*, 21720-21729.
4. James P. Darby, Mihails Arhangeliskis, Athanassios D. Katsenis, Joseph M. Marrett, Tomislav Friščić, and Andrew J. Morris, ***Ab Initio* Prediction of Metal-Organic Framework Structures**, *Chemistry of Materials* **2020**, *31*, 5835-5844.
3. Mihails Arhangeliskis, Athanassios D. Katsenis, Novendra Novendra, Zamirbek Akimbekov, Gandrath Dayaker, Joseph M. Marrett, Ghada Ayoub, Andrew J. Morris, Omar K. Farha, Tomislav Friščić, and Alexandra Navrotsky, **Theoretical Prediction and Experimental Evaluation of Topological Landscape and Thermodynamic Stability of a Fluorinated Zeolitic Imidazolate Framework**, *Chemistry of Materials* **2019**, *31*, 3777-3783.
2. Hatem M. Titi, Joseph M. Marrett, Gandrath Dayaker, Mihails Arhangeliskis, Cristina Mottillo, Andrew J. Morris, Giovanni P. Rachiero, Tomislav Friščić, and Robin D. Rogers, **Hypergolic Zeolitic Imidazolate Frameworks (ZIFs) as next-generation solid fuels: Unlocking the latent energetic behavior of ZIFs**, *Science Advances* **2019**, *5*, eaav9044.

1. Joseph M. Marrett, Cristina Mottillo, Simon Girard, Christopher W. Nickels, Jean-Louis Do, Gandrath Dayaker, Luzia S. Germann, Robert E. Dinnebier, Ashlee J. Howarth, Omar K. Farha, Tomislav Frišćić, and Chao-Jun Li, **Supercritical Carbon Dioxide Enables Rapid, Clean, and Scalable Conversion of a Metal Oxide into Zeolitic Metal-Organic Frameworks**, *Crystal Growth & Design* **2018**, 18, 3222-3228.

PREPRINTS

2. Hatem M. Titi, Joseph M. Marrett, Olivier Jobin, Cristina Mottillo, Blaine G. Fiss, Audrey H. Moores, Étienne Robert, Robin D. Rogers, and Tomislav Frišćić, **Metal-Organic Frameworks Induce Hypergolic Ignition of Bulk Materials**, *in preprint on ChemRxiv*, **2021**.
1. Joseph M. Marrett, Hatem M. Titi, and Tomislav Frišćić, **Wittig Olefination “Baking Powder”: a Hexameric Halogen-Bonded Phosphonium Salt Cage for Encapsulation and Mechanochemical Transformation of Small-Molecule Carbonyl Compounds**, *in preprint on ChemRxiv*, **2021**.

ORAL PRESENTATIONS

2. Joseph M. Marrett, Hatem M. Titi, Cristina Mottillo, Gandrath Dayaker, Mihails Arhangelskis, Chao-Jun Li, Robin D. Rogers, and Tomislav Frišćić, **New Methods for the Discovery and Synthesis of Functional Metal-Organic Frameworks**, *102nd Canadian Chemistry Conference and Exhibition, Quebec City*, **2019**.
1. Joseph M. Marrett, Hatem M. Titi, Gandrath Dayaker, Igor Huskić, and Tomislav Frišćić, **Azolate Frameworks Involving Unusual Metal Nodes**, *256th ACS National Meeting & Exposition, Boston*, **2018**.

POSTER PRESENTATIONS

6. Joseph M. Marrett, Hatem M. Titi, Mihails Arhangelskis, Cristina Mottillo, Gandrath Dayaker, Robin D. Rogers, and Tomislav Frišćić, **Metal-Organic Frameworks as Highly Tuneable Fuels**, *Crystal Engineering and Emerging Materials Workshop of Ontario and Quebec 6.5, Virtual*, **2020**.
5. Joseph M. Marrett, Hatem M. Titi, Mihails Arhangelskis, Gandrath Dayaker, Robin D. Rogers, and Tomislav Frišćić, **Modulation of Hypergolic Behavior in MOFs via Changes in Solid-State Structure**, *6th Crystal Engineering and Emerging Materials Workshop of Ontario and Quebec, Montreal*, **2019**.
4. Joseph M. Marrett, Hatem M. Titi, Mihails Arhangelskis, Gandrath Dayaker, Robin D. Rogers, and Tomislav Frišćić, **Modulation of Hypergolic Behavior in MOFs via Changes in Solid-State Structure**, *24th International Conference on the Chemistry of the Organic Solid State, New York*, **2019**.
3. Joseph M. Marrett, Cristina Mottillo, Christopher W. Nickels, Jean-Louis Do, Gandrath Dayaker, Luzia S. Germann, Robert E. Dinnebier, Ashlee J. Howarth, Omar K. Farha, Tomislav Frišćić, and Chao-Jun Li, **Supercritical Carbon Dioxide Enables Rapid, Clean, and Scalable Conversion of a Metal Oxide into Zeolitic Metal-Organic Frameworks**, *5th Crystal Engineering and Emerging Materials Workshop of Ontario and Quebec, Montreal*, **2018**.
2. Joseph M. Marrett, Cristina Mottillo, and Tomislav Frišćić, **Synthesis of Porous Zeolitic Imidazolate Frameworks From a Metal-Oxide in Supercritical Carbon Dioxide**, *4th Crystal Engineering and Emerging Materials Workshop of Ontario and Quebec, Waterloo*, **2017**.
1. Joseph M. Marrett, Athanassios D. Katsenis, Mihails Arhangelskis, Ghada Ayoub, Ashlee J. Howarth, Omar K. Farha, and Tomislav Frišćić, **Solid-state Studies of the Effect of Molecular Functionalities on Topological Preferences of Metal-Organic Frameworks**, *100th Canadian Chemistry Conference and Exhibition, Toronto*, **2017**.

AWARDS

2. **Hidden Isochema Graduate Student Travel Poster Prize (\$500)**, *Crystal Engineering and Emerging Materials Workshop of Ontario and Quebec 6.5, Virtual, 2019*.
1. **Rubin Gruber Science Undergraduate Research Award (\$3000)**.