Crystalline Nanoporous Metal Organic Frameworks

(Material Research Laboratory)

Major: Biochemistry

Antoin Douglawi

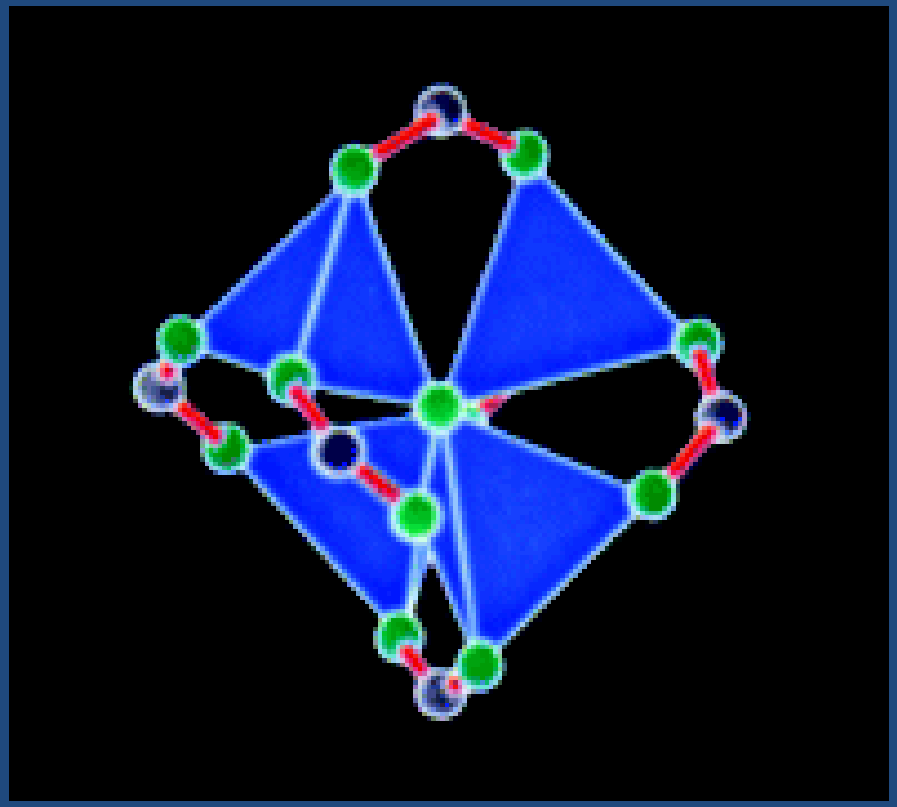
Mentor: Prashant Jain

Advisor: Anthony K. Cheetham

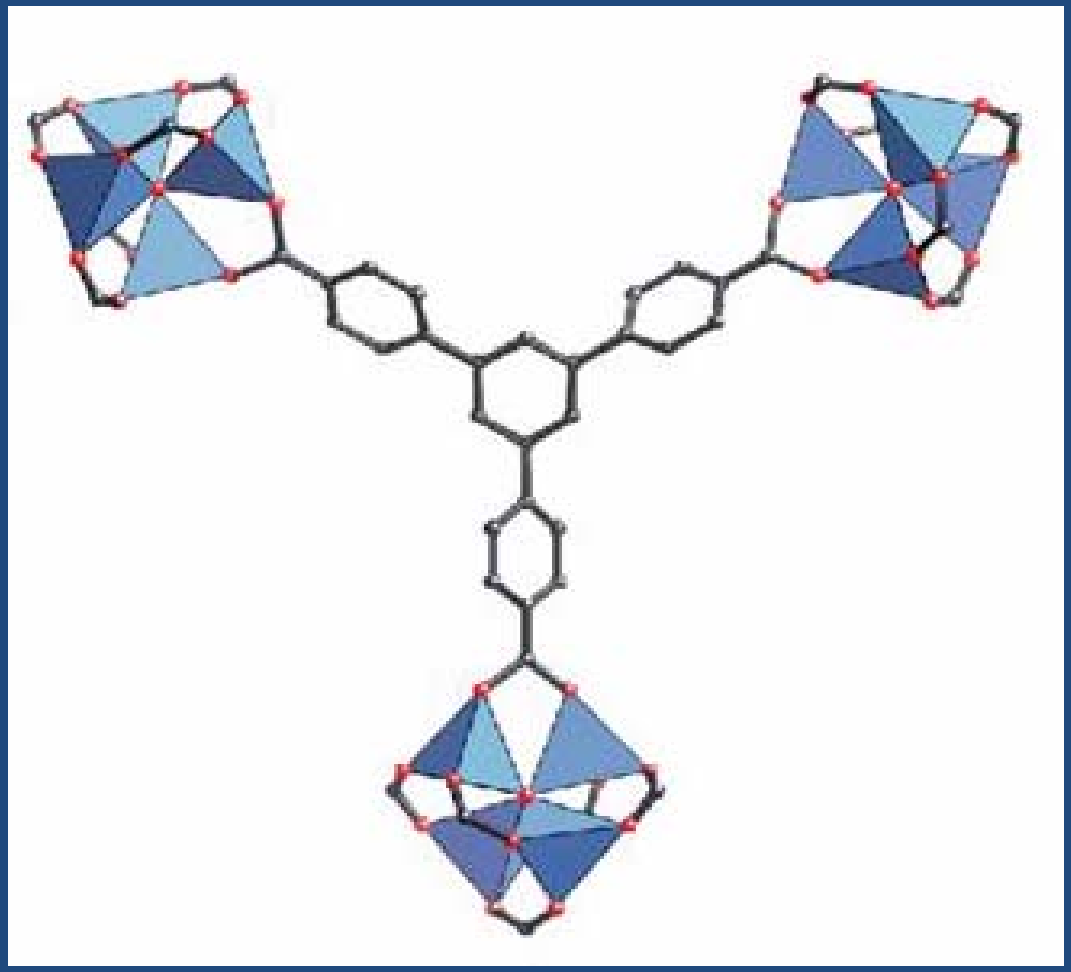
Industrial Funding
by
Uniliver

Coordination Polymers

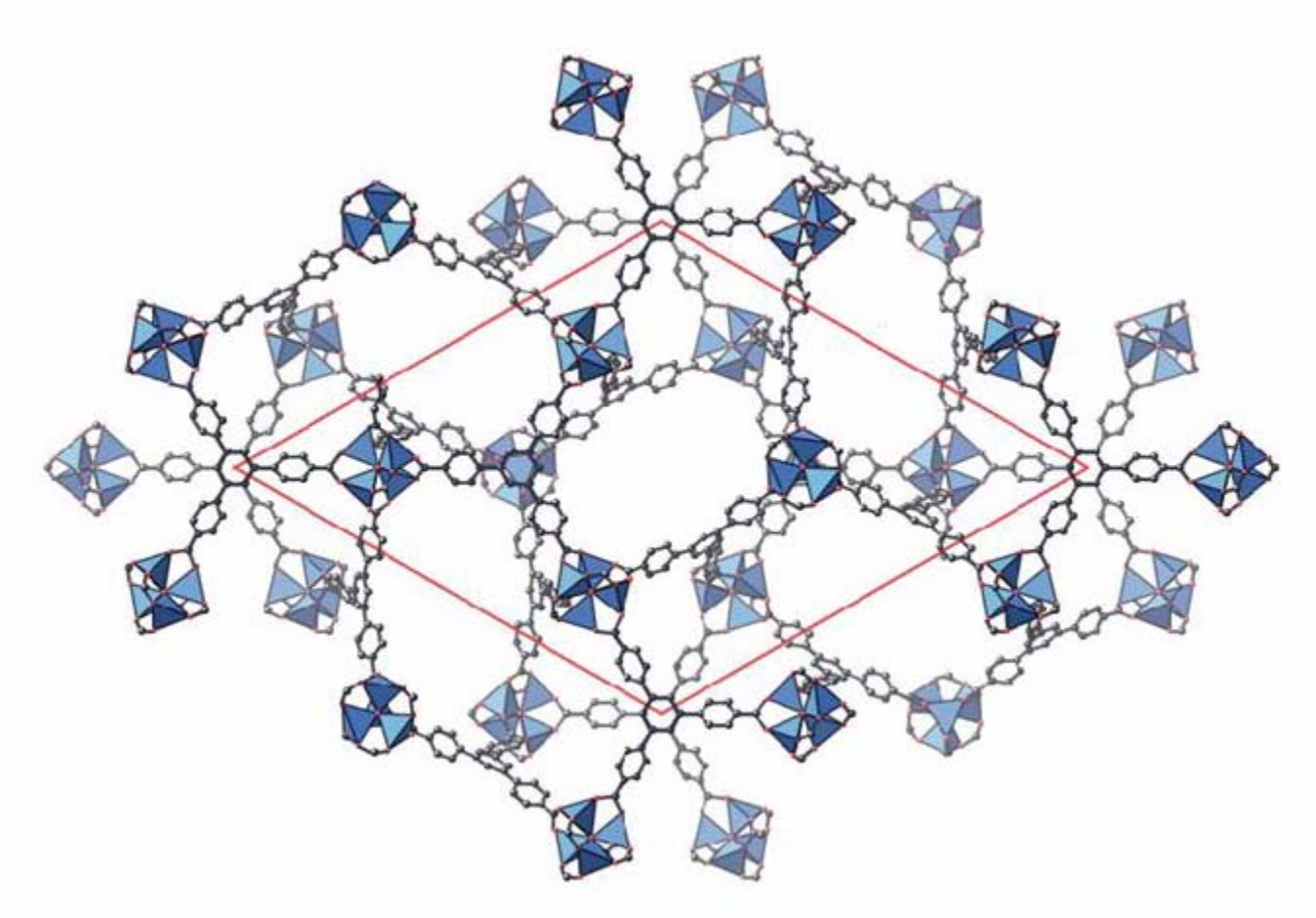
- Extended Crystalline Organic-Inorganic Materials
- 1D, 2D, or 3D



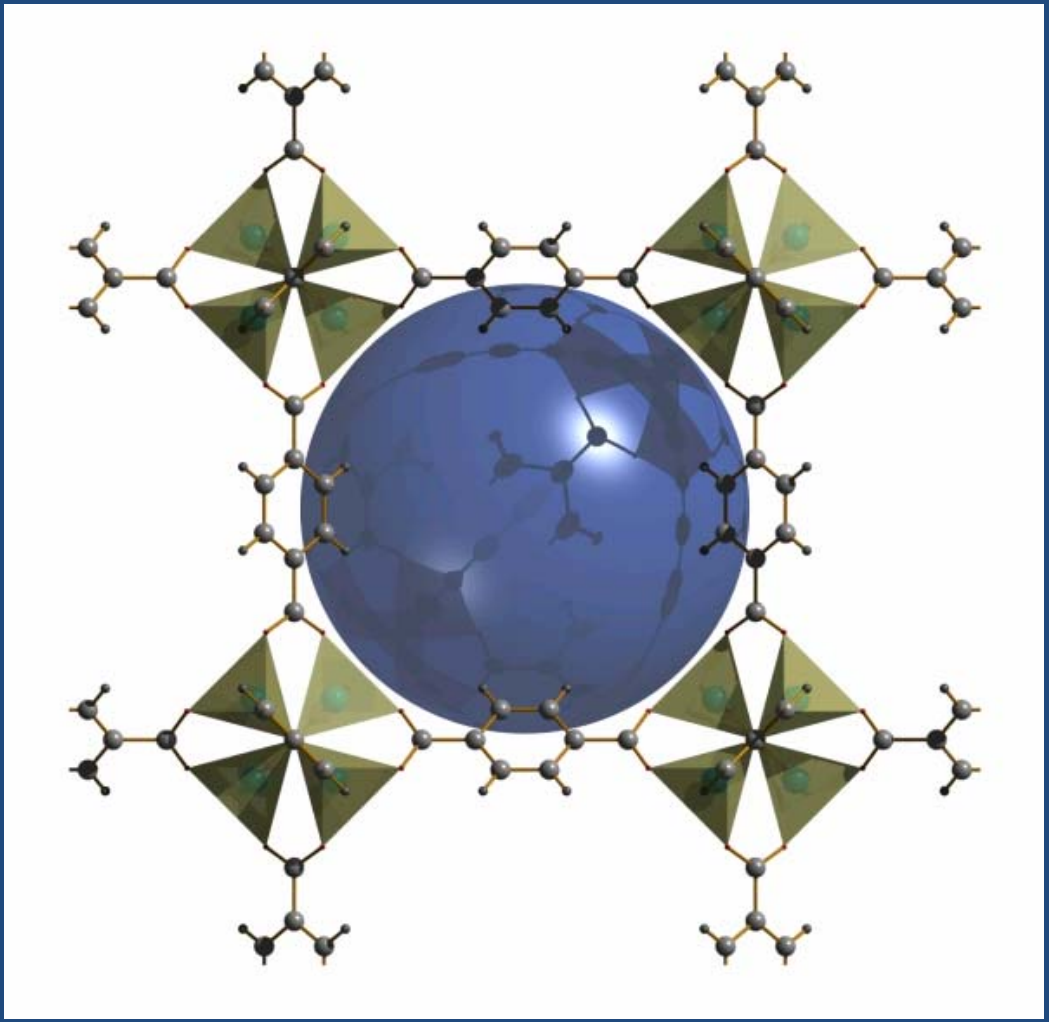
2D Frame



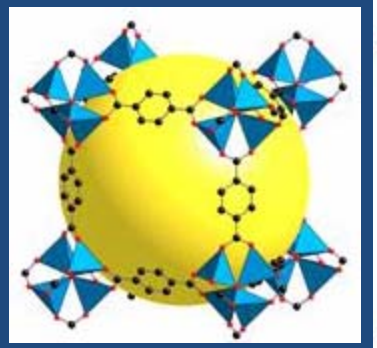
3D Frame

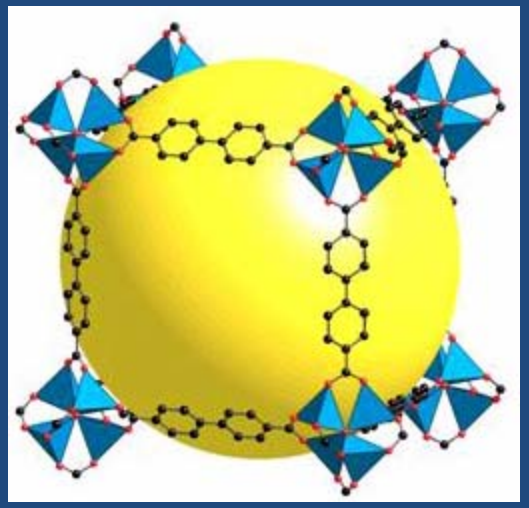


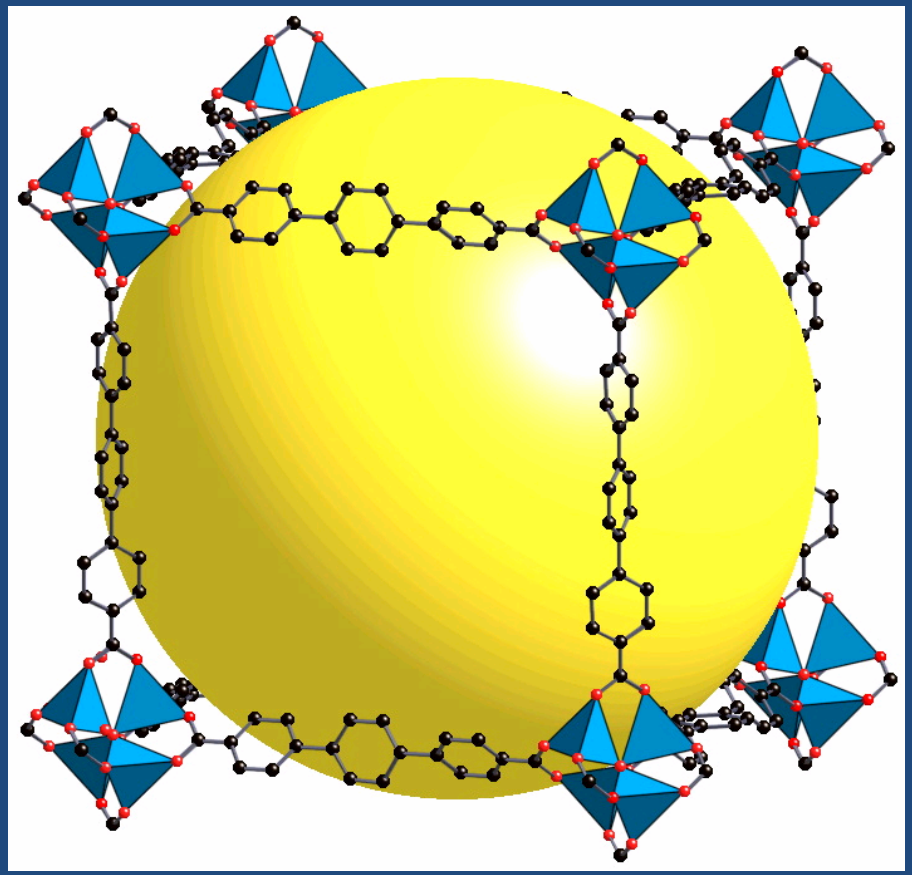
Porous Structures



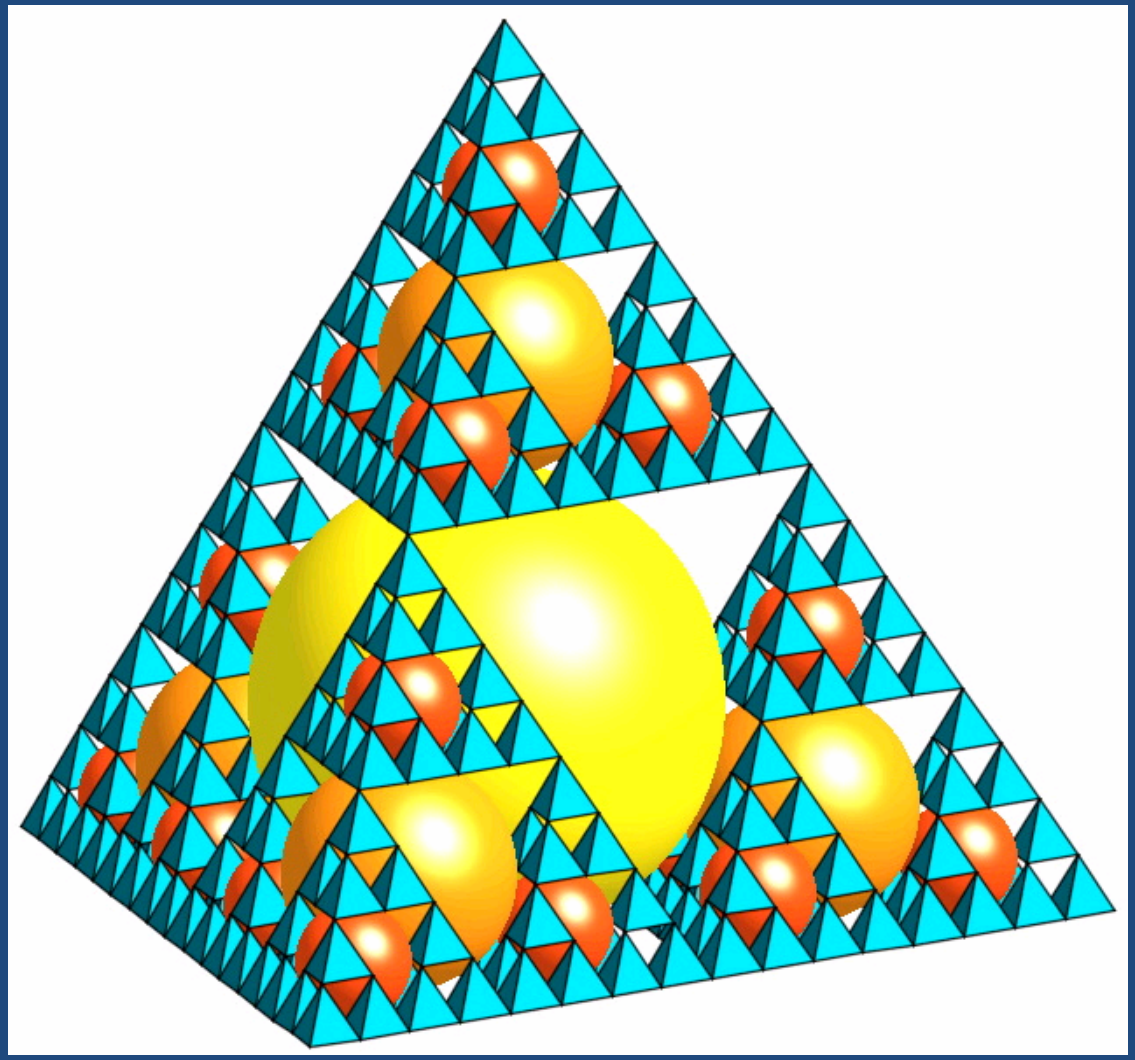
Size of Pores Can Be Varied



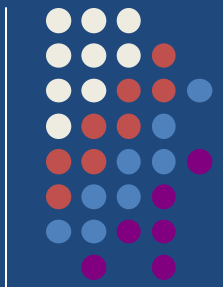




Multiple Pore Sizes

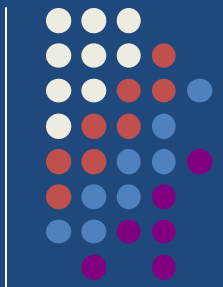


Applications

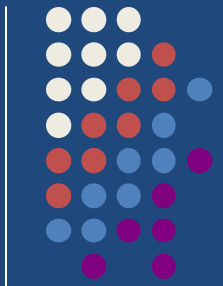


- **Gas storage and separation**
  - **Hydrogen storage**
- **Optical applications**
  - Photoluminescence for sensors and displays
- **Electronic applications**
  - Computer memory
- **Magnetic Materials**
  - Single molecular magnets

Multiferroics

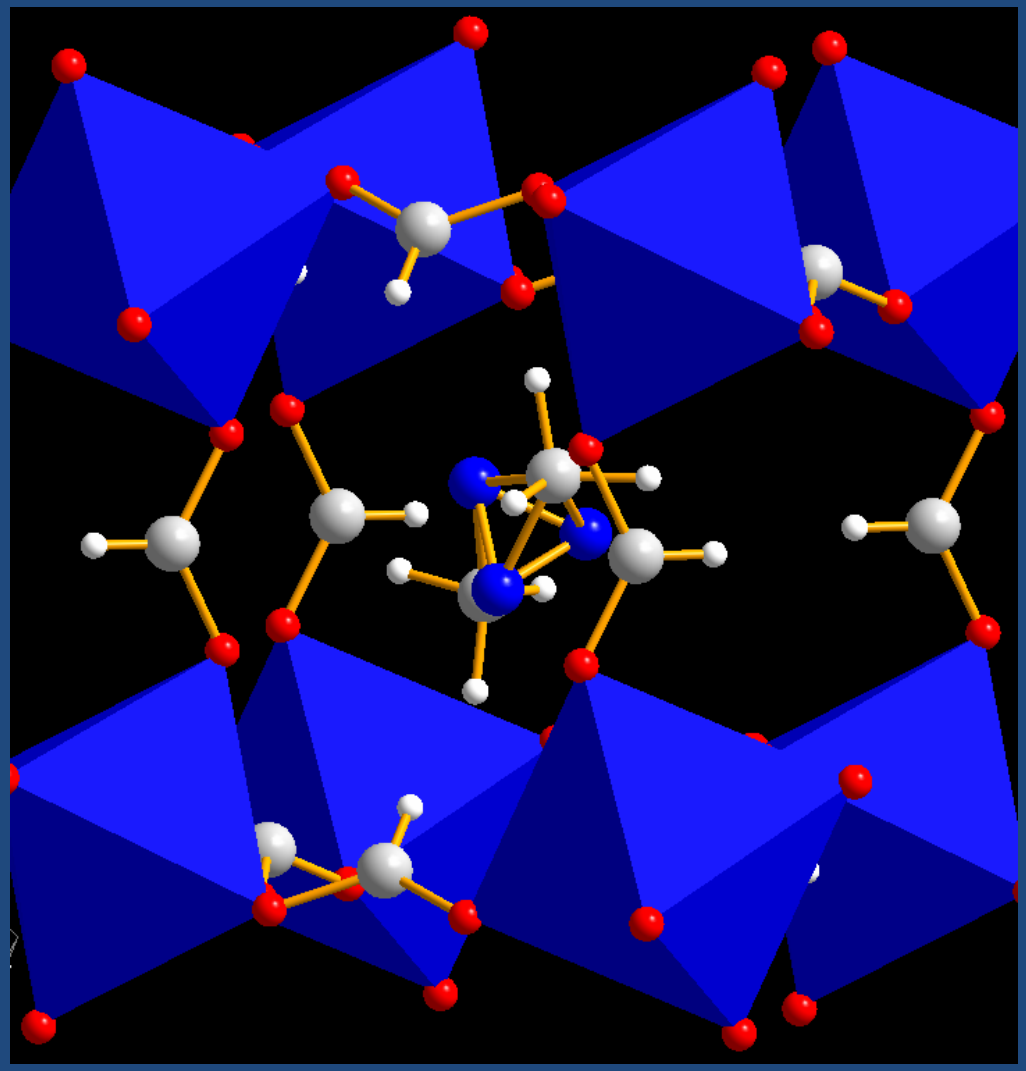


- Electric and Magnetic Phases Coexist.
- Magnetoelectric (ME) Effect.

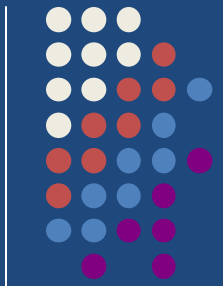


Previous Work

ABX_3 - $[(CH_3)_2NH_2]\ Zn(HCOO)_3$

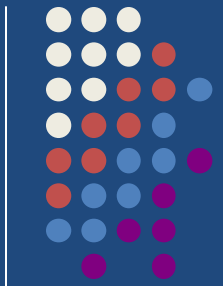


Project Goals



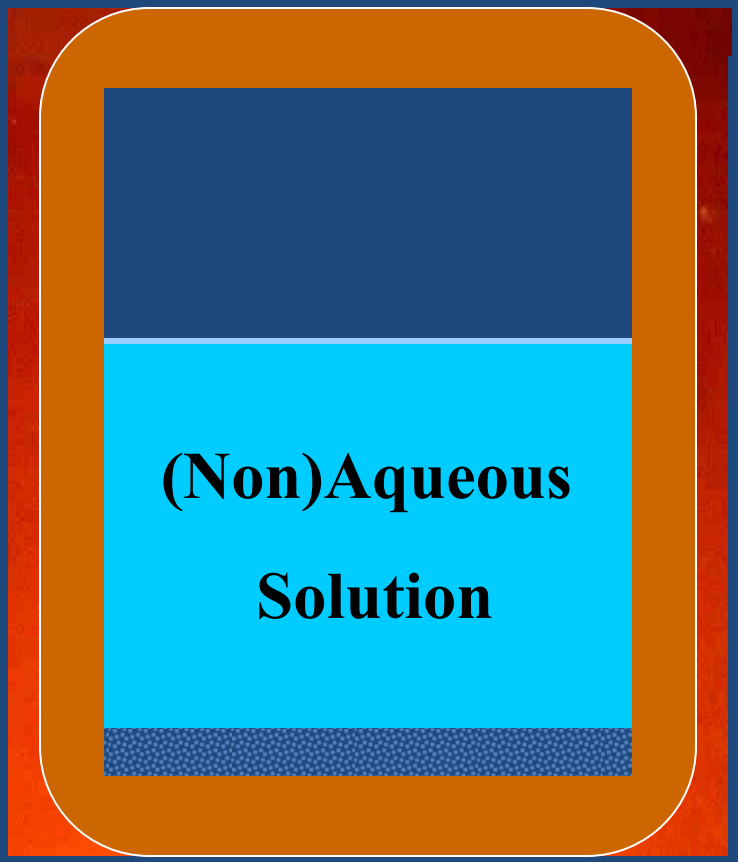
- Synthesize New Multiferroic Metal Organic Frameworks (MOFs)
- Observe Effects of Different Central Cations on Multiferroic Properties
- Create New Multivalence MOFs

Our Approach



- Trying Different Cations:
  - Trimethylamine
  - N-ethyl N-methyl amine
- Mixed Valence Iron Formates

Hydrothermal Synthesis

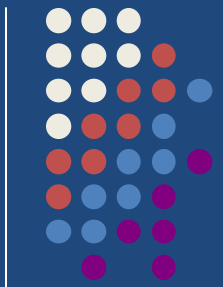


Hydrothermal Bomb

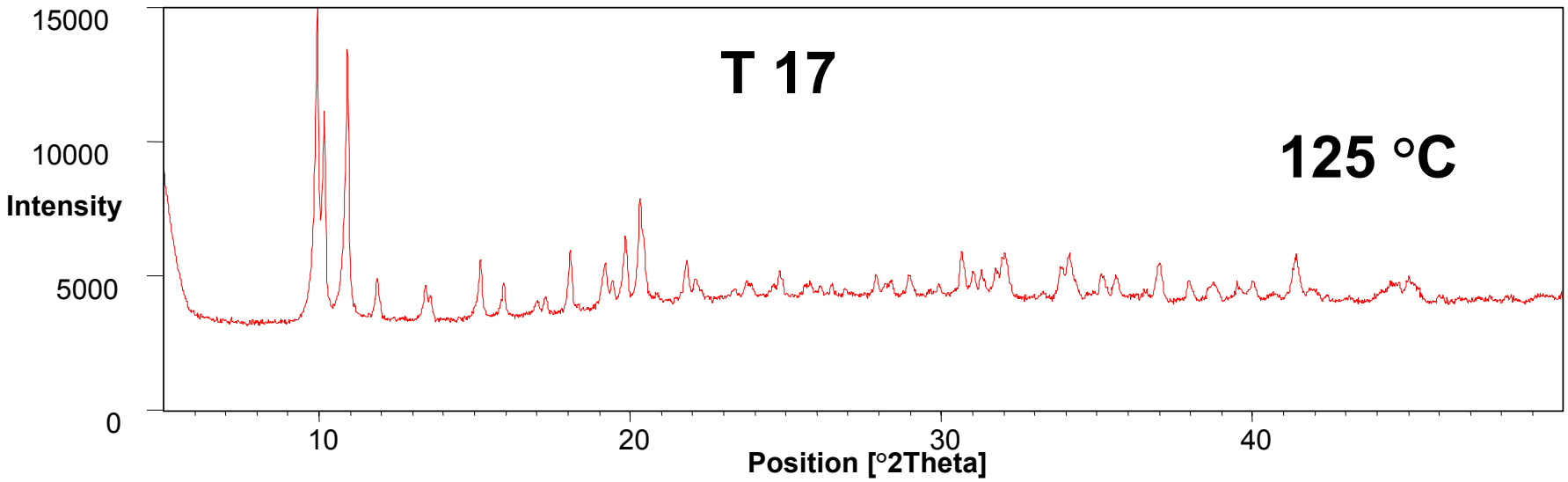
Temperatures range from 125 – 200^{o}C

- **Metal salt** (Zn, Ni, Mn, Fe, Cu, Co)
- **Ammonium Cation** (Trimethylamine, Dimethylamine, N-ethyl N-methyl amine)
- **Ligand** (Formic acid, Acetic acid, Carbodiimide acid)
- **Organic Solvent** (Dimethylformamide, Diethyleformamide, water)

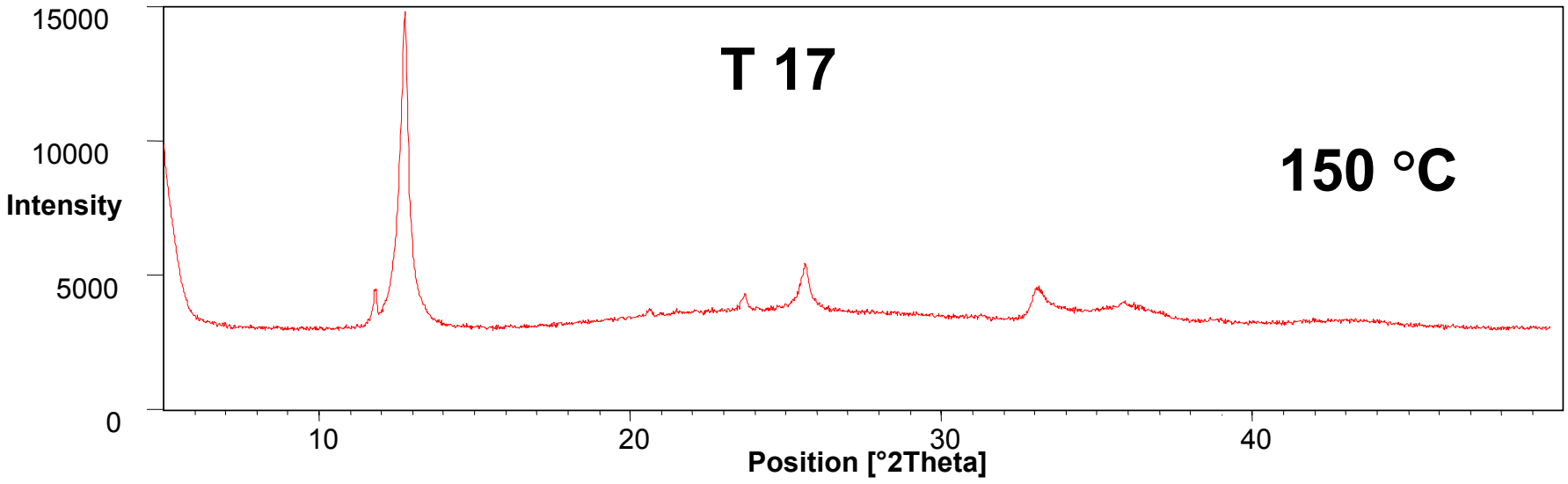
Compounds Created



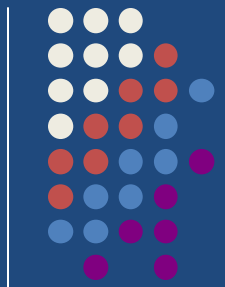
- New compound synthesized using:
  - Nickel
  - Trimethylamine $(CH_3)_3N$
  - Formic Acid (HCOOH)
  - Dimethylformamide DMF
- Does not match any compound in the database
- Multiphase compound: Phases vary as temperatures change



X-ray Diffraction Data

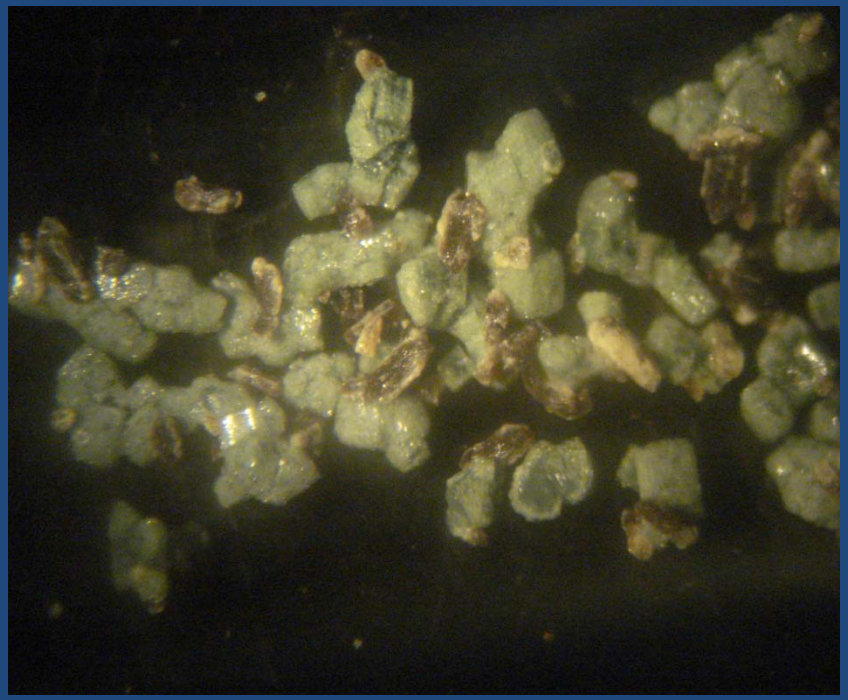


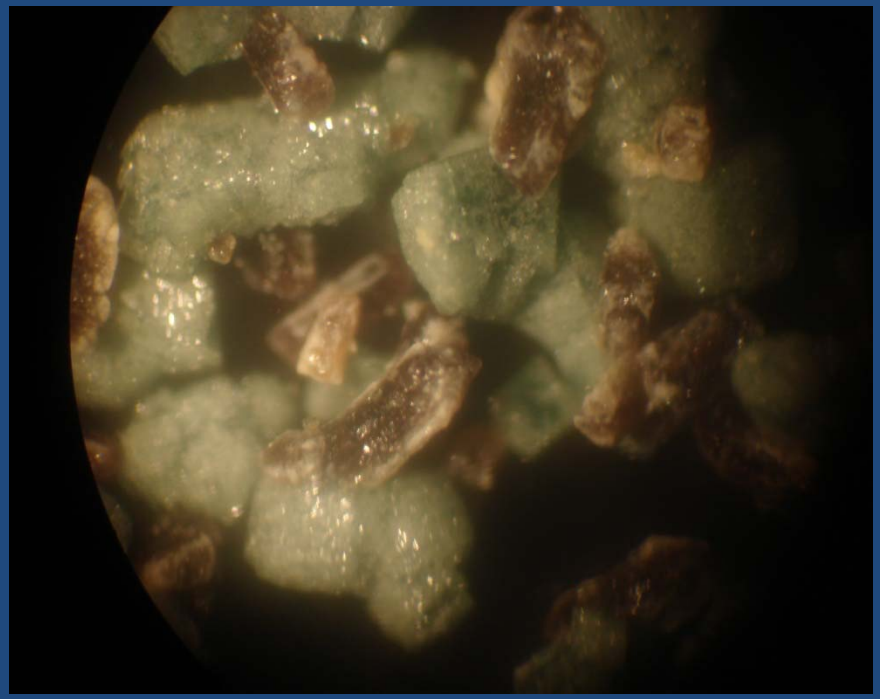
Crystals Synthesized



- MOF synthesized using:
  - Iron (III)
  - Copper (II)
  - Dimethylamine $(CH_3)_2N$
  - Formic Acid (HCOOH)
- Two crystals
- Green crystals
  - CO_2 templated Fe (III) formate
- Black crystals
  - Unknown. Possibility of mixed valance iron compound

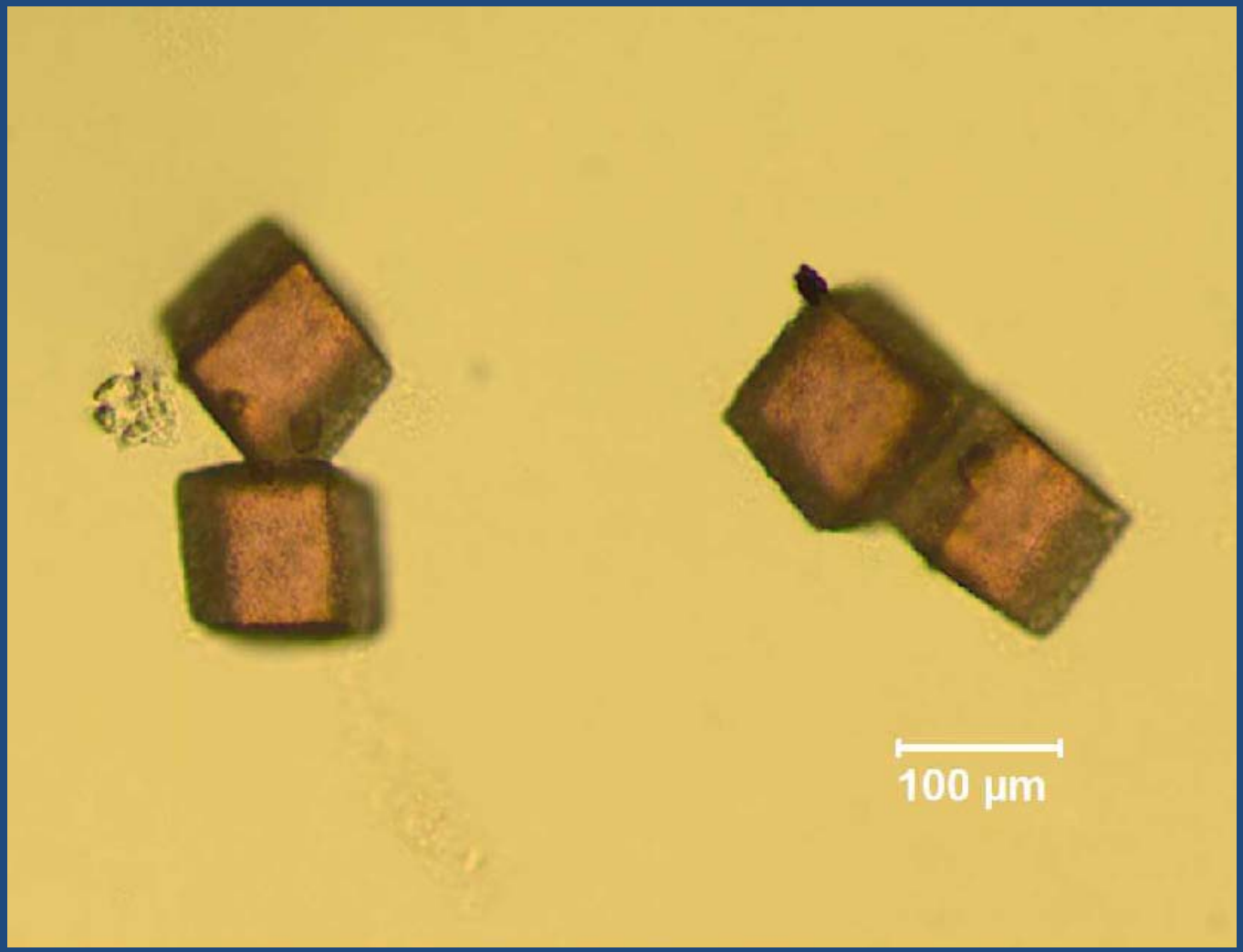
T36 Crystals



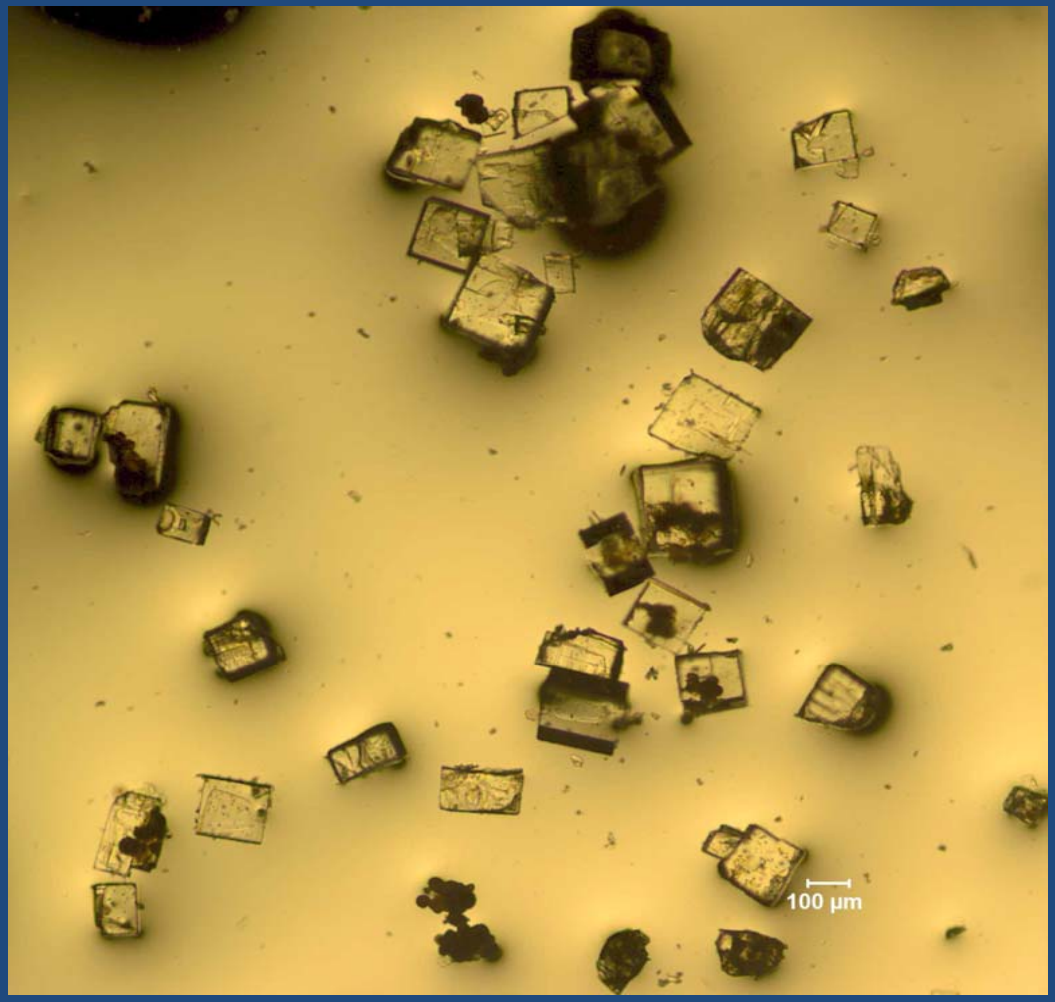


N-Ethyl N-Methyl Amine

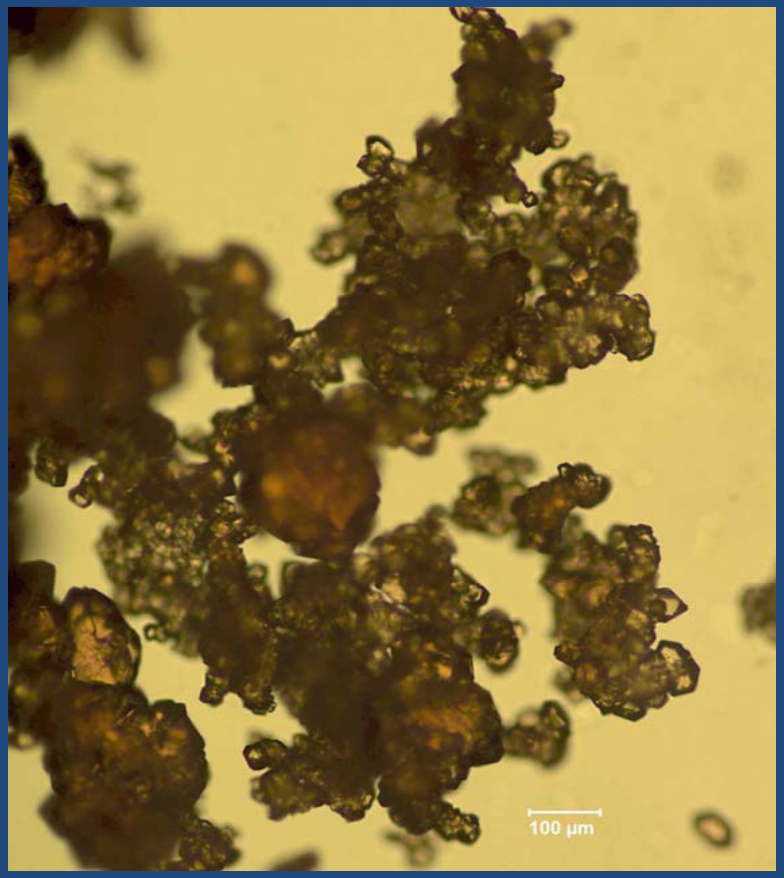
Cobalt (Co^{2+})



Trimethylamine (TMA)
Iron (Fe^{2+})



Trimethylamine (TMA)
Cobalt (Co^{2+})



Acknowledgements

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Inset Director: Samantha Freeman

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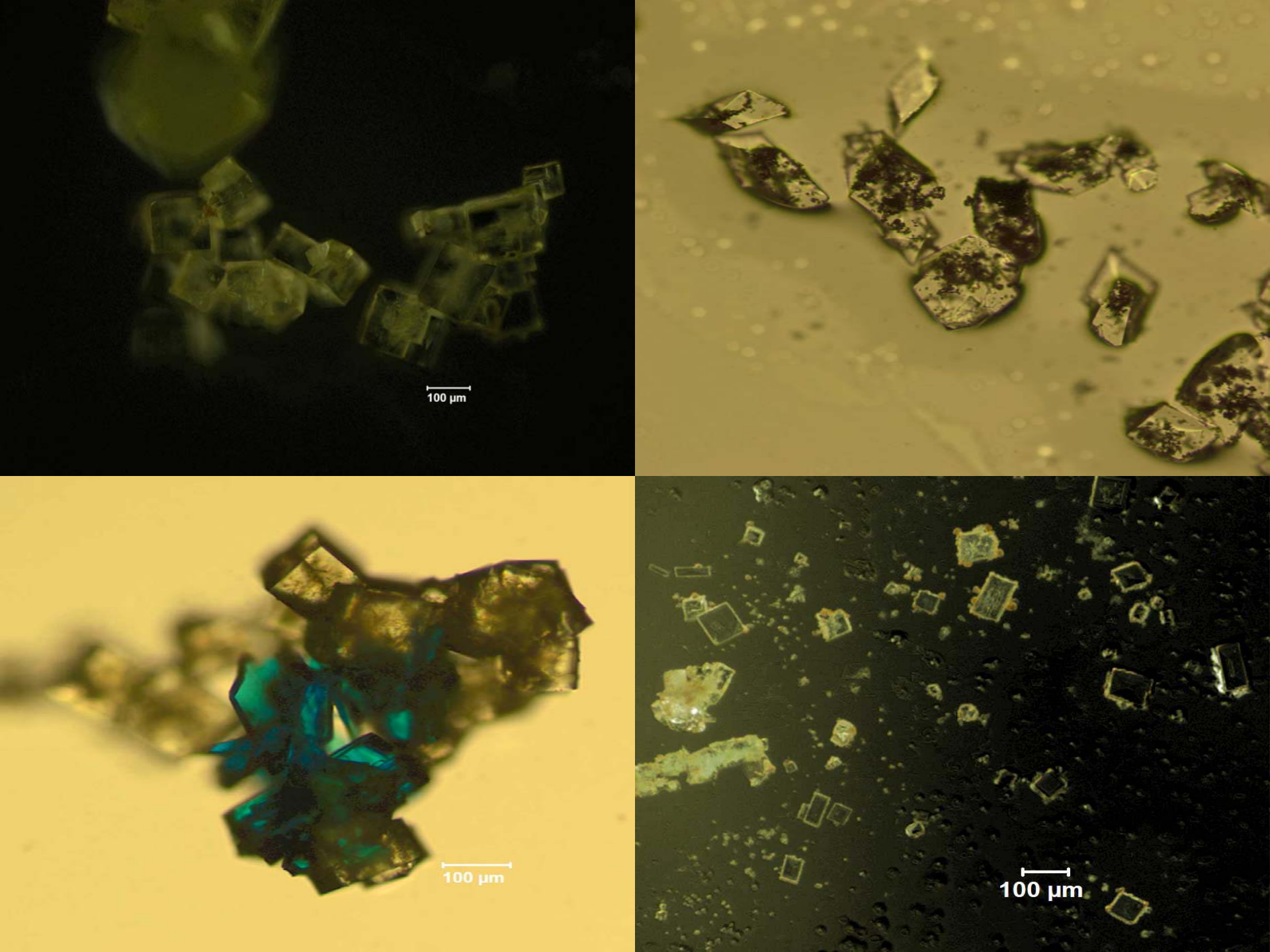
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