Synthesis of Nanoparticles of Hybrid Frameworks Using Hydrothermal and Emulsion Methods

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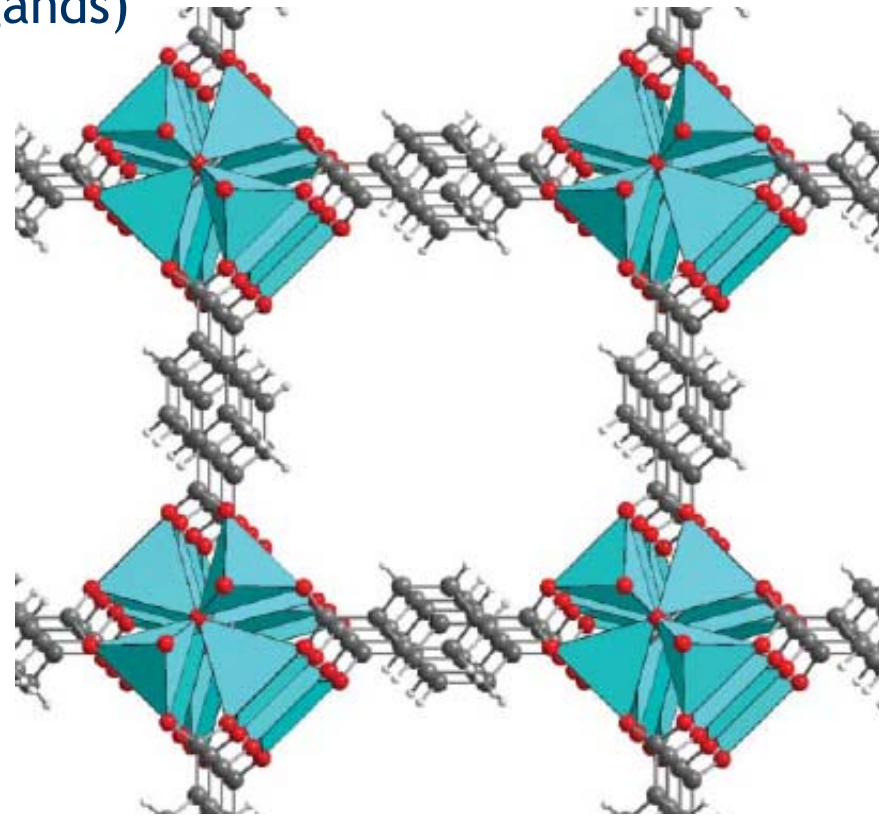
Nanoparticles of Hybrid Frameworks

Hybrid Framework Structures

- Metal centers with organic linkers (ligands)
- Low density, high porosity materials



Applications

- Separations
- Catalysis
- Hydrogen storage

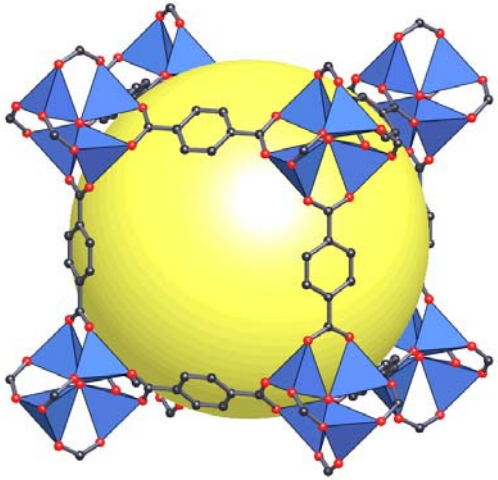
Nanoscale

- New properties emerge
- Very few examples of nanoscale hybrid frameworks

Li, H.; Eddaoudi, M.; O'Keeffe, M.; Yaghi, O.M. *Nature* **1999**, *402*, 276.

Research Objectives

- Synthesize hybrid frameworks using hydrothermal methods
- Use emulsion method to make nanomaterials
- Combine both methods to synthesize nanoparticles of hybrid frameworks

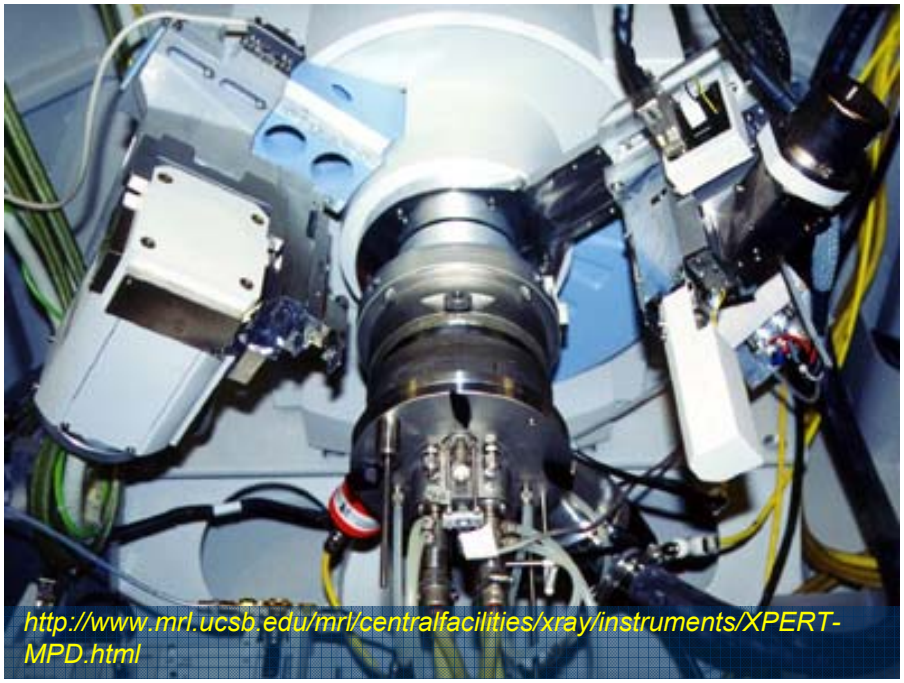


Rowsell, J. L. C.; Yaghi, O. M. *Angew. Chem. Int. Ed.* **2005**, *44*, 4670-4679.

Tools for Analysis

- **SEM** – Scanning electron microscopy
- **XRD** – X-ray diffraction: powder and single crystal

http://www.mrl.ucsb.edu/mrl/centralfacilities/microscopy/index.html#sem



http://www.mrl.ucsb.edu/mrl/centralfacilities/xray/instruments/XPERT-MPD.html

http://www.dur.ac.uk/crystallography.group/images/smart6k.jpg

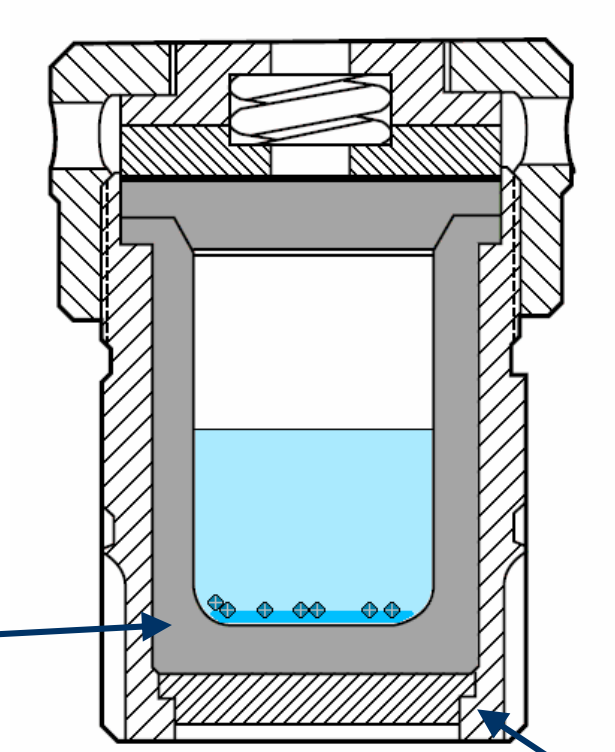
Hydrothermal Method

Purpose

- Increased pressure and temperature

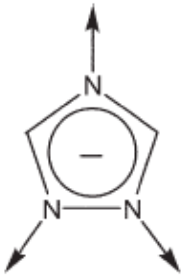
Variables

- Time
- Temperature
- Concentration
- pH
- Metal salt
- Solvent

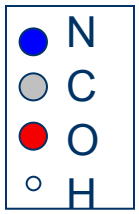


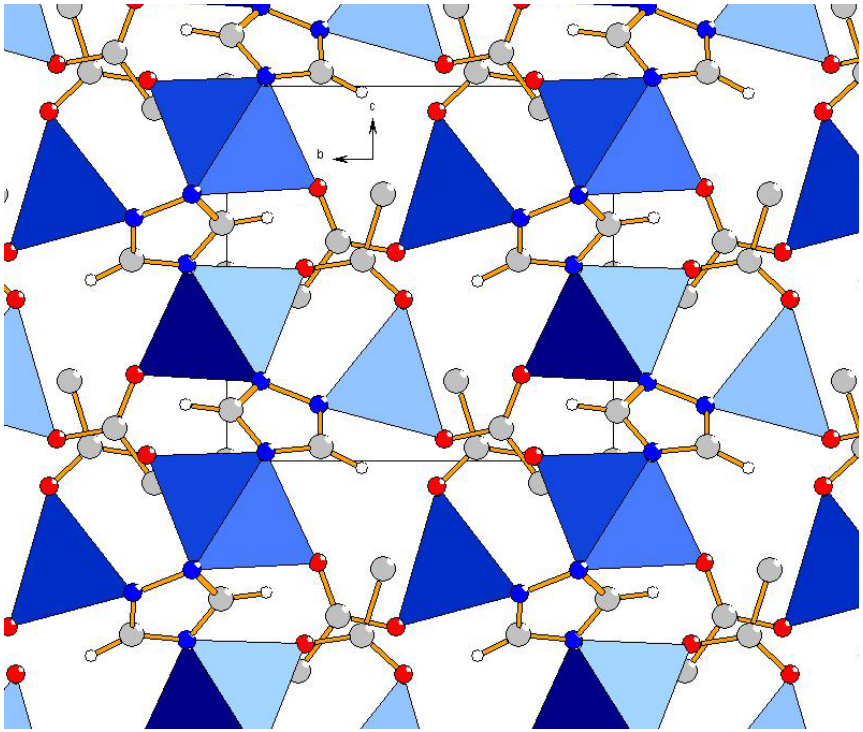
Hydrothermal Results

•Focused on 1,2,4-triazole

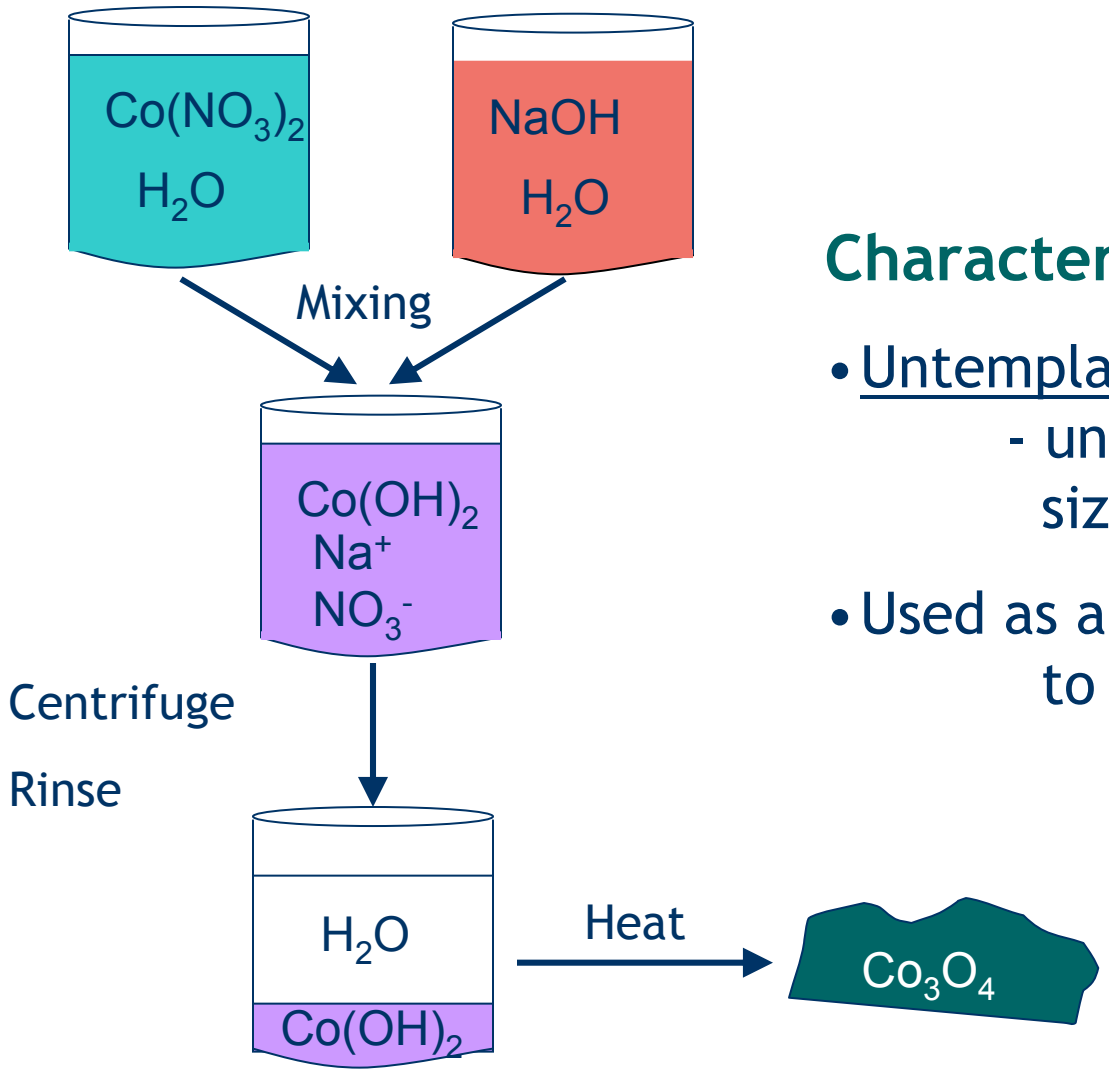


- Synthesized single crystals of $Zn(C_2N_3H_2)(CH_3COO)$
- ZnO_2N_4 octahedra and ZnO_2N_2 tetrahedra connected by triazolate and acetate ions
- Investigating possible porosity





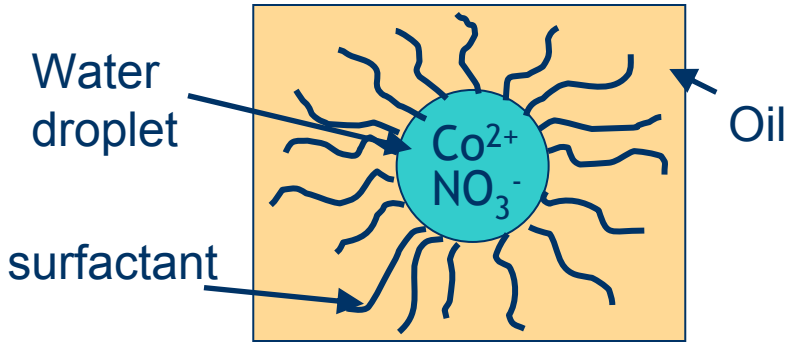
Precipitation Method

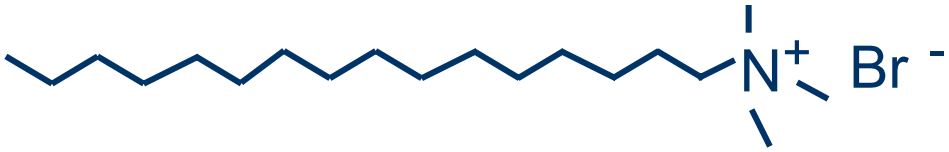


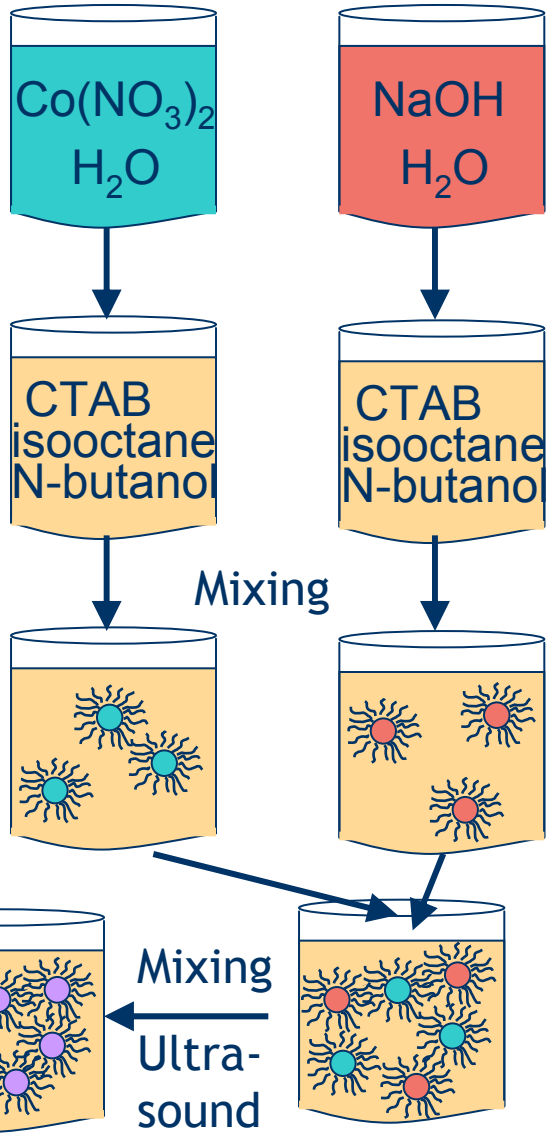
Characteristics

- Untemplated method
  - uncontrolled particle size and shape
- Used as a control for comparison to the emulsion sample

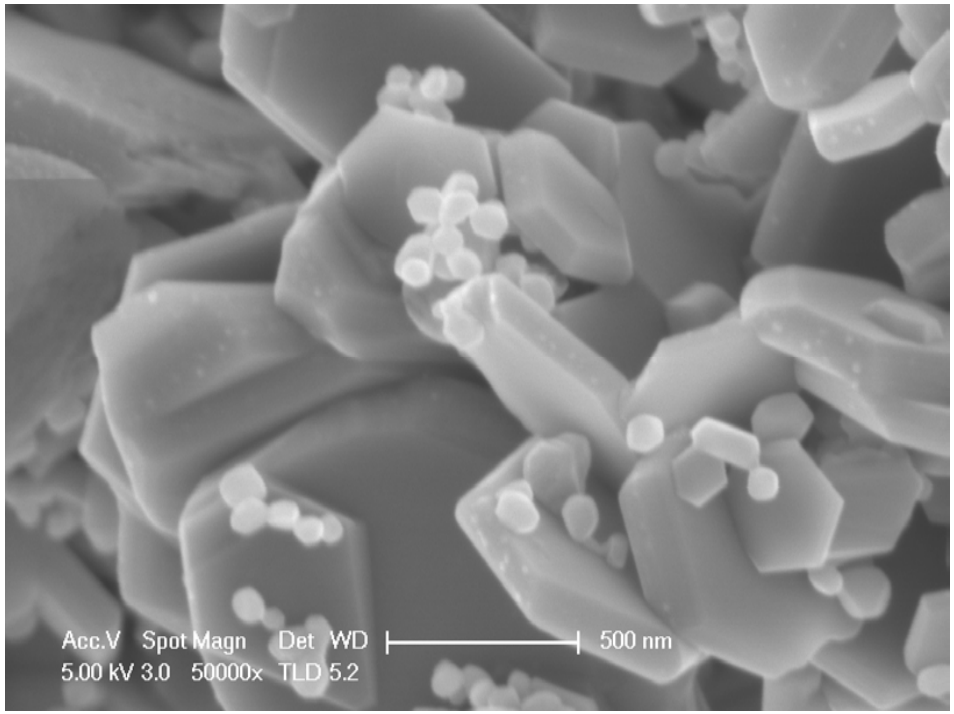
Emulsion Method



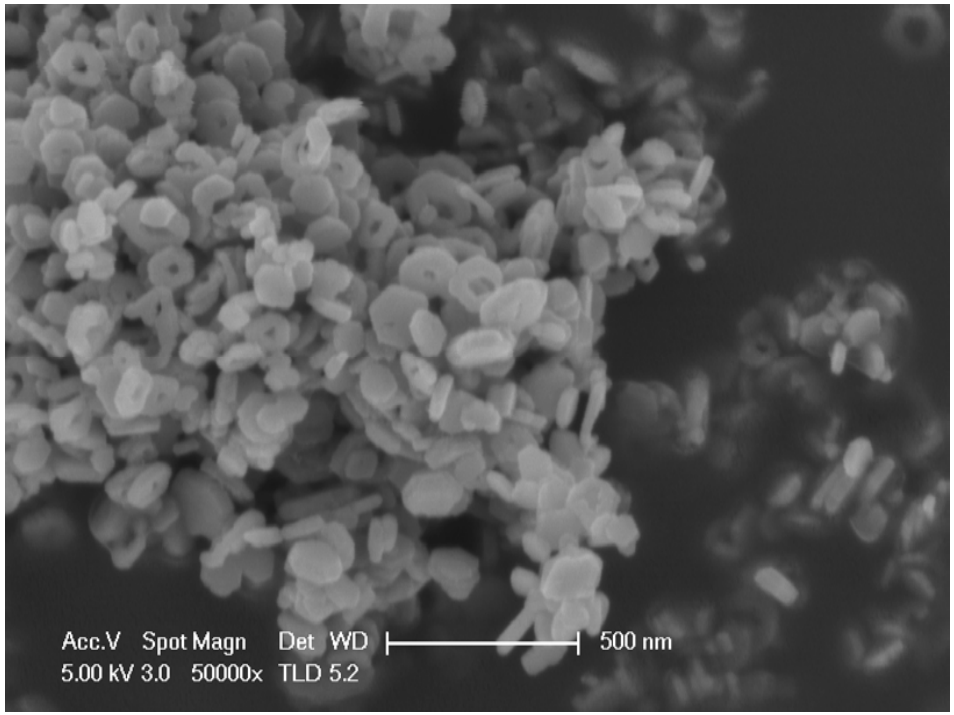




Precipitation vs. Emulsion SEM Images

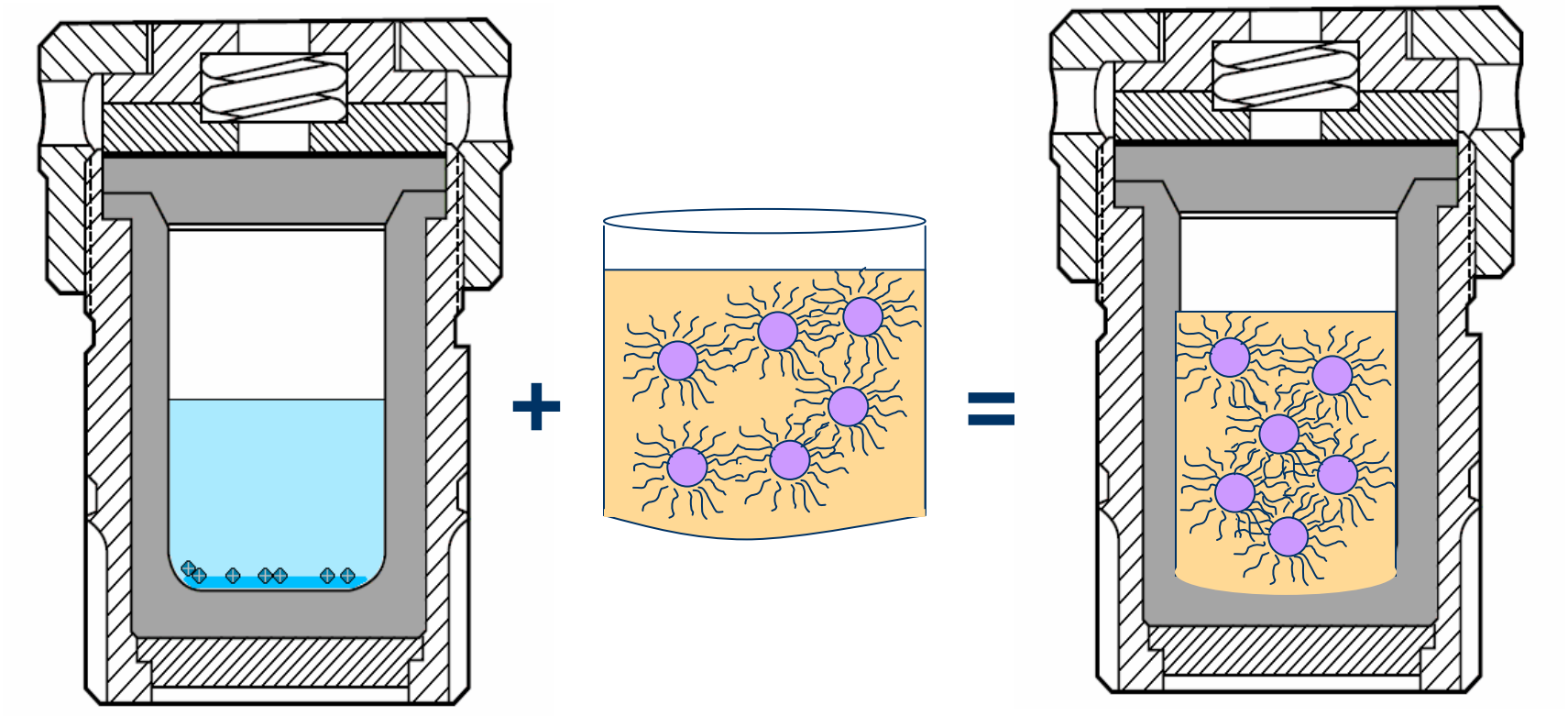


Precipitation sample of Co_3O_4



Emulsion sample of Co_3O_4

Combination of the Emulsion and Hydrothermal Methods



Conclusions

Accomplishments

- Synthesized a new hybrid framework
- Emulsion reactions reduced particle size and increased uniformity

Future work

- Continue work on combining the emulsion and the hydrothermal methods

Acknowledgements

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Thank you for your time!

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