Synthesis and Characterization of Metal-Organic Frameworks for Multifunctional Applications

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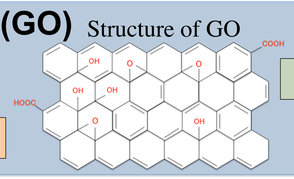
Introduction

Graphene Oxide (GO)

Structure of GO



High porosity

Eco-friendliness

Mechanical stiffness

Flexibility

Metal-Organic Frameworks (MOFs)

- Crystalline materials consisting of coordination bonds between metal ions and organic ligands
- Have an open framework structure that can be porous
- Can be used for gas storage, purification and separation, as well catalysis and sensing applications

- Growing demand for multifunctional composite materials
- Concerns about water environmental destruction

Objective

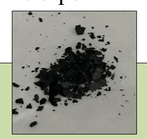
To synthesize highly porous Metal Organic Framework composites with tunable properties for multifunctional applications

Methods

GO powder + Distilled water

1. Sonication

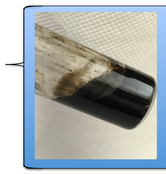
GO powder



- Keep sonicating to get homogeneous solution

GO solution

2. Mix reagent



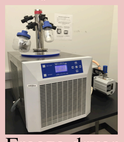
Add
- Triethylamine (TEA, $N(CH_2CH_3)_3$)
- Copper sulfate ($CuSO_4 \cdot 5H_2O$)

Gels

3. Freeze-dry

- Freeze-dry by liquid nitrogen
- Keep inside of the freeze dryer at low pressure

Freeze dry



Freeze dryer

MOFs

Analysis

Composite sponge

Results

Scanning Electron Microscopy (SEM)

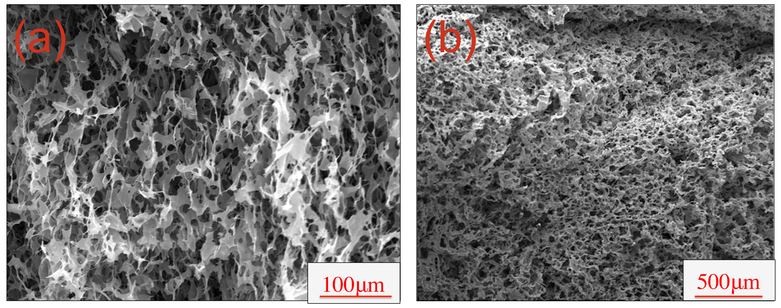


Figure 1 (a) SEM image of Pure GO showing a sheath-like appearance with a inconsistent connectivity and porosity; (b) Select GO-MOF composite sponge showing interconnected porosity

X-ray Diffraction (XRD)

(a)

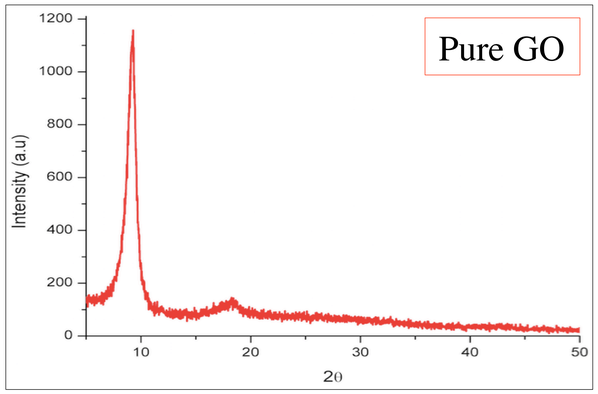


Figure 2 (a) XRD spectrum of pure GO sponge. Sharp peak was observed at 2θ = 9.3°

(b)

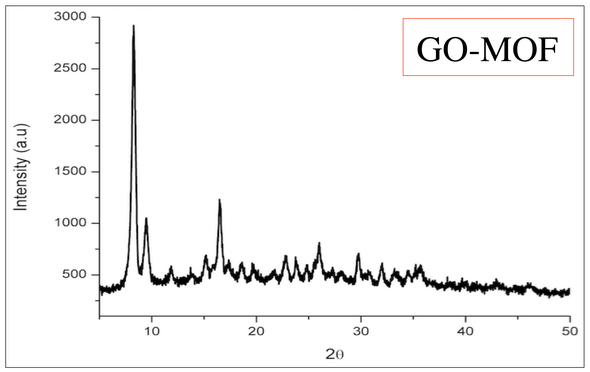


Figure 2 (b) XRD spectrum of select GO-MOF composite. Several peaks were observed, the sharp peak around 2θ =9.3° corresponds to GO and other peaks corresponds to metal salts.

Discussion

SEM: Higher porosity of GO-MOF composites

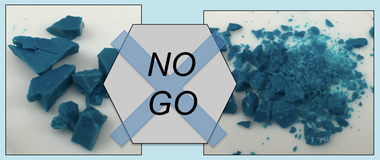
- The developed GO-MOF composite materials were found to be highly porous when compared to the pure GO sponge. The addition of TEA and metal salts were found to assist in pore size expansion, along with interconnectivity.

XRD: Distinctive patterns between GO and GO-MOF

- The Pure GO sponge exhibited a single sharp peak at around 2θ = 9.3°, whereas one of the developed GO-MOF composite sponge displayed several peaks including the peak at 2θ = 9.3°. This suggests the possible homogenous mixing of GO with the metal salt. Further studies on this analysis were yet to be done.

Other MOFs for Environmental Studies

We also synthesized a few other MOFs for different applications



Trimesic acid, TEA, Copper salt

Here we synthesized mechanically stable MOFs since, the GO based MOFs were not mechanically stable. These MOFs were expected to find suitable application in different fields where the mechanical stability is expected to be an important criteria.

Conclusion

- ✓ MOFs synthesized using GO exhibited unique characters such as high porosity and interconnected junctions.
- ✓ The formed composite sponges were characterized using different techniques to confirm the homogenous mixing and to evaluate their properties.
- ✓ The presence of interconnected porosity is expected to play a vital role in applications related to oil and dye absorption.

Future Work

The developed composite sponges will be additionally characterized using different analytical techniques and their oil and dye absorption properties will be further explored

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