Synthesis of a Hydrophobic/Hydrophilic Nano-Patterned Metal-Organic Framework Material

Daniel Pivaral

Synthesis of a Hydrophobic/Hydrophillic Nano-Patterned Metal-Organic Framework Material

Daniel Pivaral, Kanchana Samarakoon, Tendai Gadzikwa Ph.D.
Department of Chemistry, Kansas State University

Objective

- The main objective of this research is to demonstrate that an MOF material with two different channels can be functionalized with two incompatible chemical groups resulting in the groups self-sorting into different channels.

Background Info

- Metal-organic framework (MOF) materials are formed from a reaction between an organic linker with multiple binding sites and a metal node, creating a porous 3D grid-like structure.

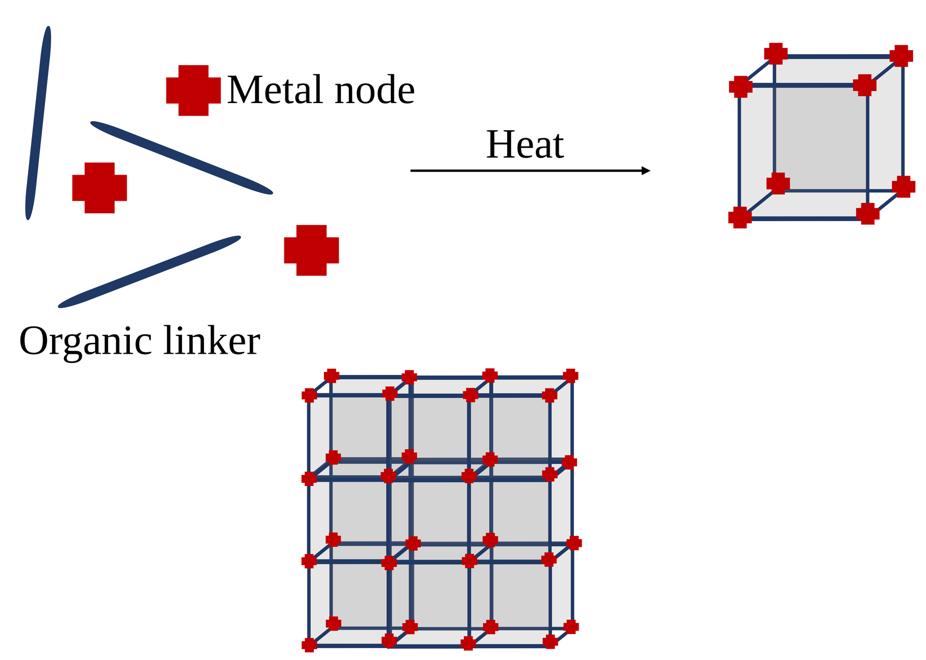
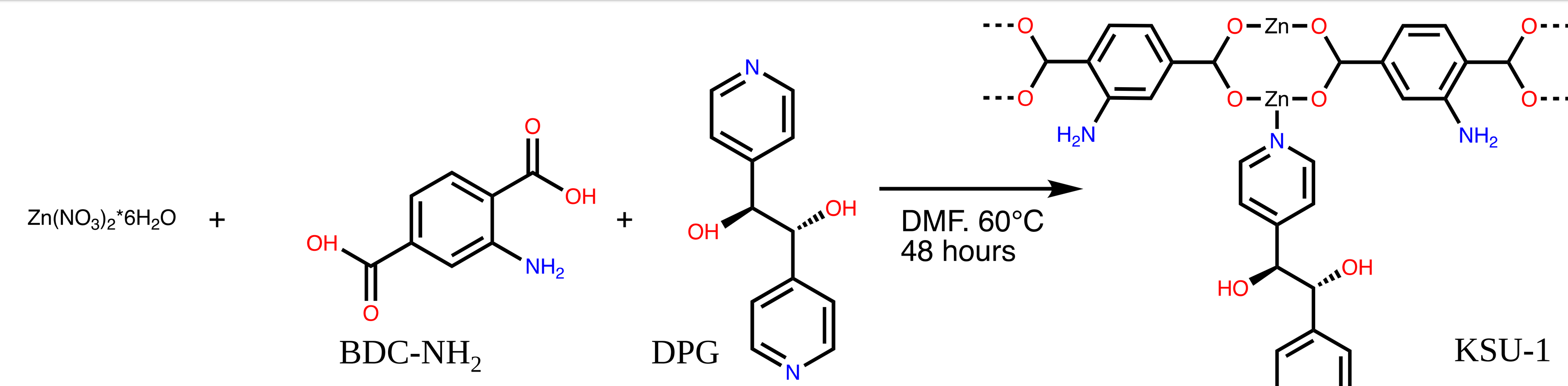


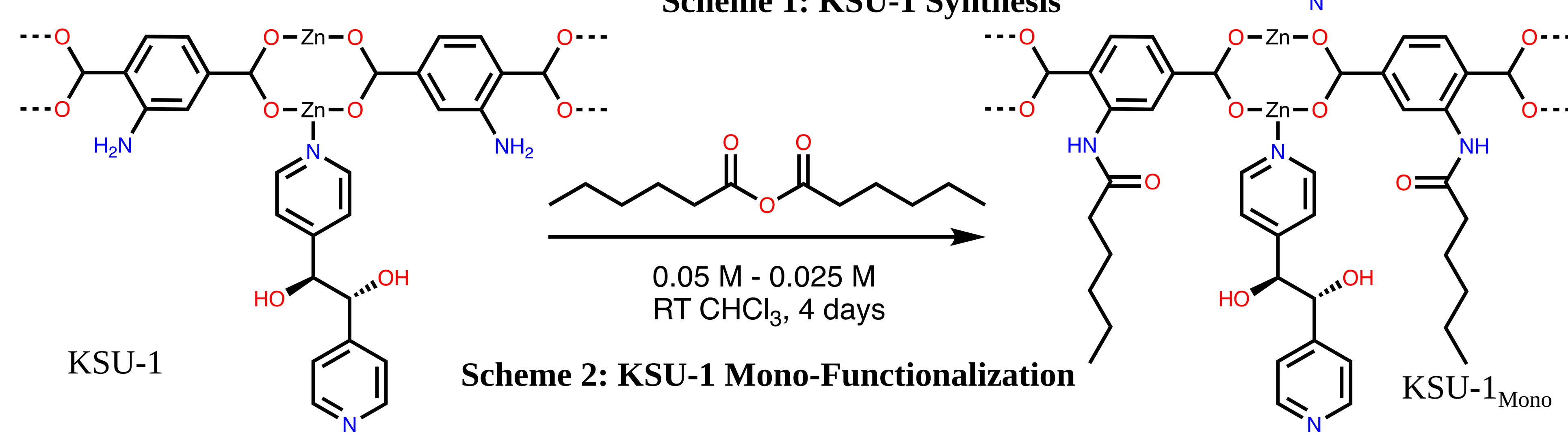
Figure 1: How Metal-Organic Frameworks are made

- MOF materials can be utilized in catalysis, gas storage, and filtration.
- MOF crystal structures affect their functionality, so structure manipulation is key for certain applications.
- Post-synthetic modification (PSM) is a process where an assembled MOF is chemically altered while keeping the crystal structure intact.
- In this project two PSMs are going to be performed onto a synthesized MOF to get hydrophobic and hydrophilic properties.

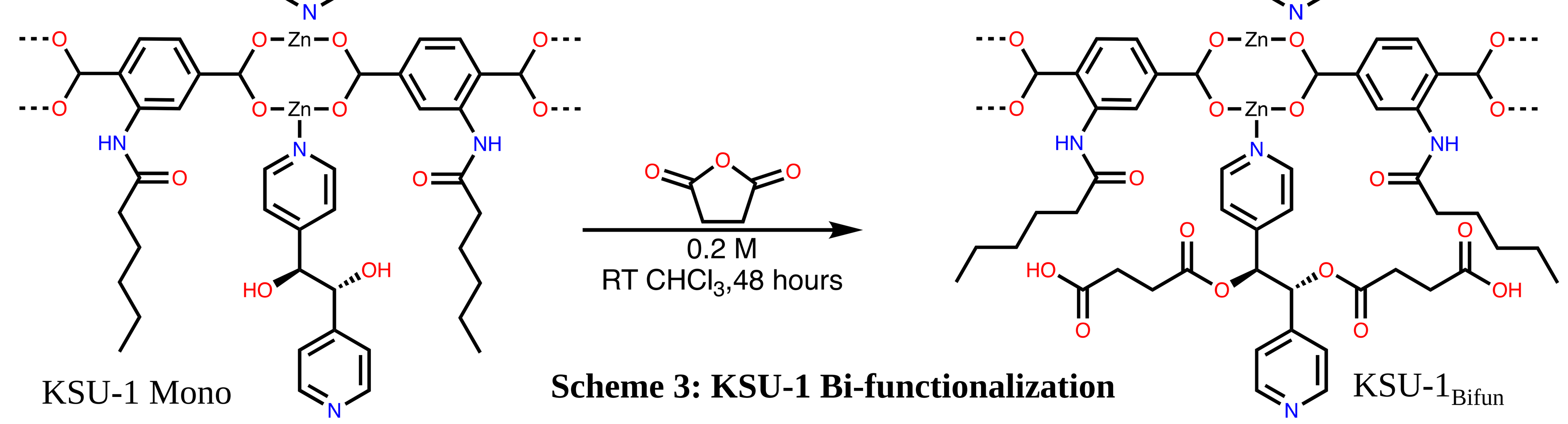
Reactions



Scheme 1: KSU-1 Synthesis



Scheme 2: KSU-1 Mono-Functionalization



Scheme 3: KSU-1 Bi-functionalization

Data/Results

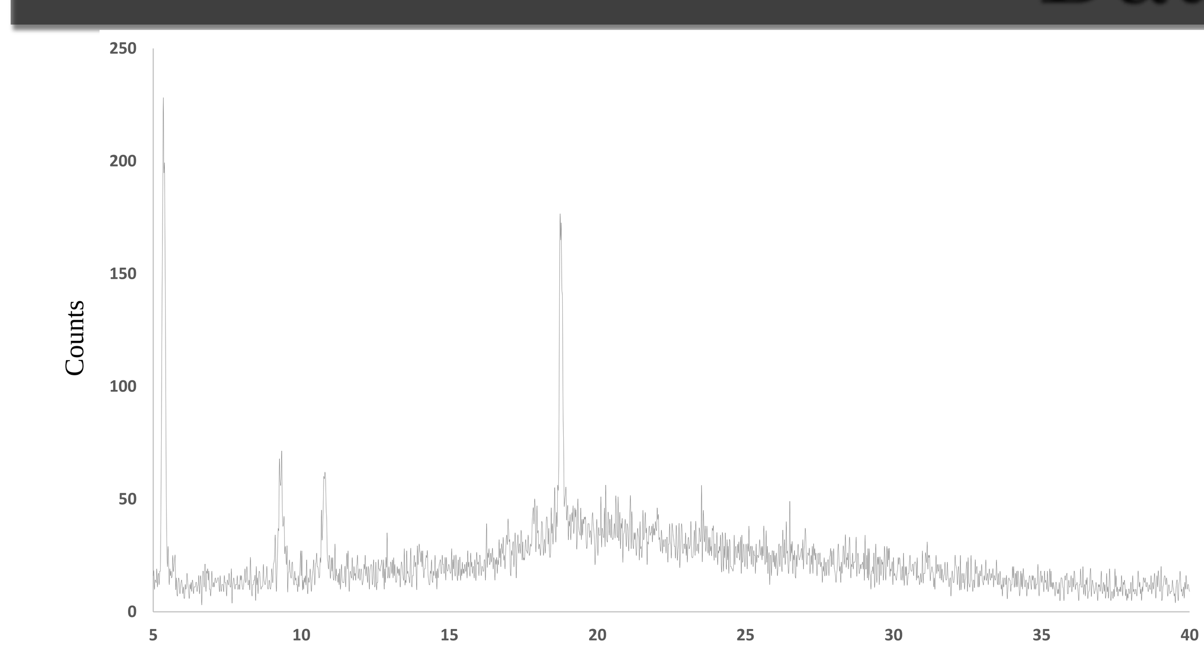


Figure 2: KSU-1_{Mono} Powder X-Ray Diffraction Spectrum

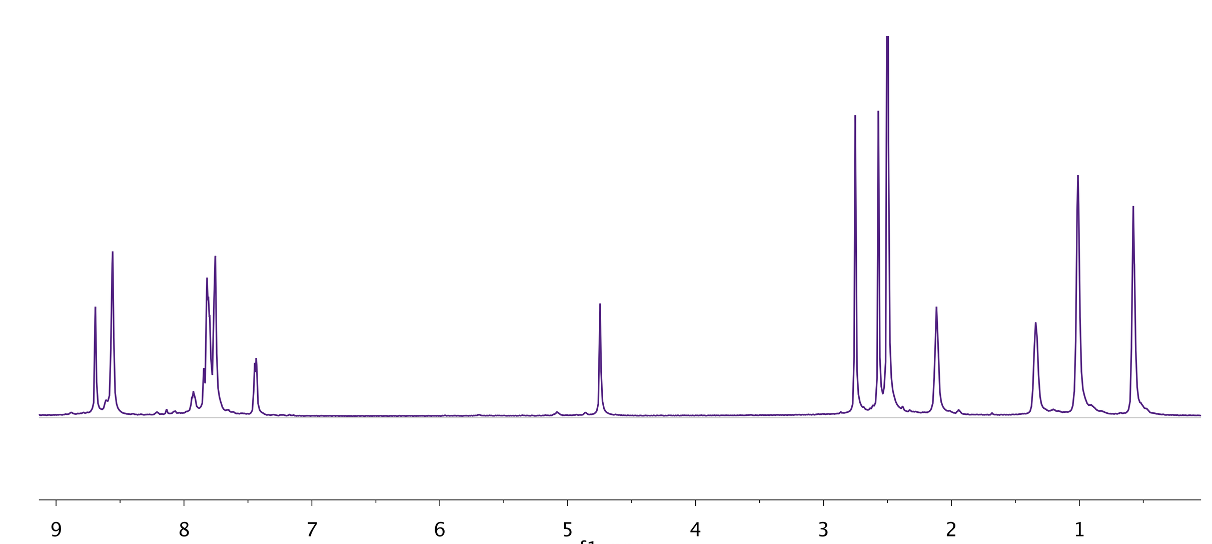


Figure 4: KSU-1_{Mono} ^{1}H-NMR Spectrum (d$_6$-DMSO/D_2SO_4)

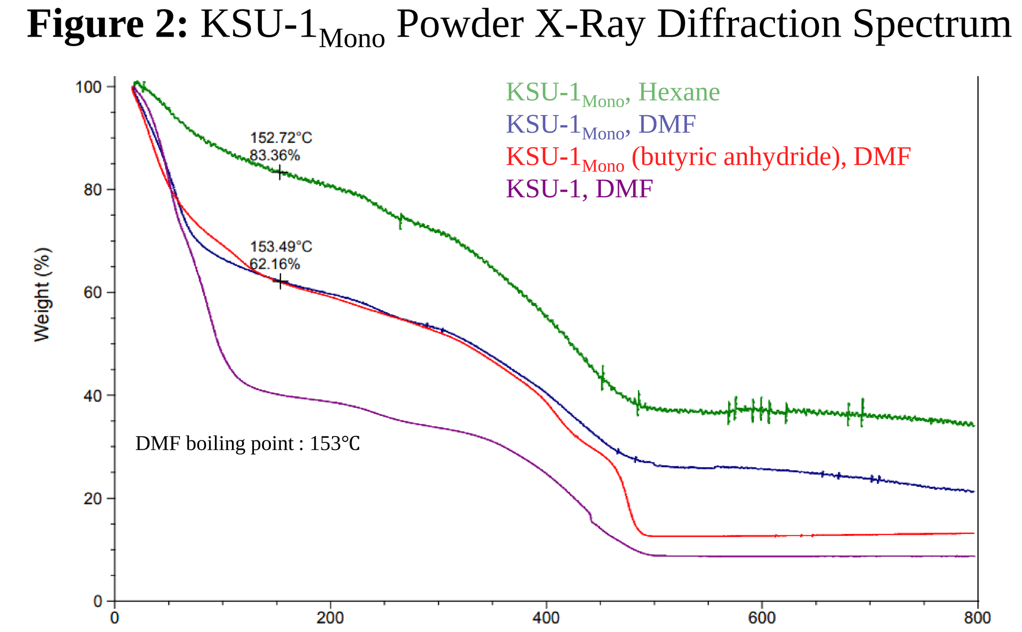


Figure 3: Thermogravimetric Analysis of KSU-1 and KSU-1_{Mono}

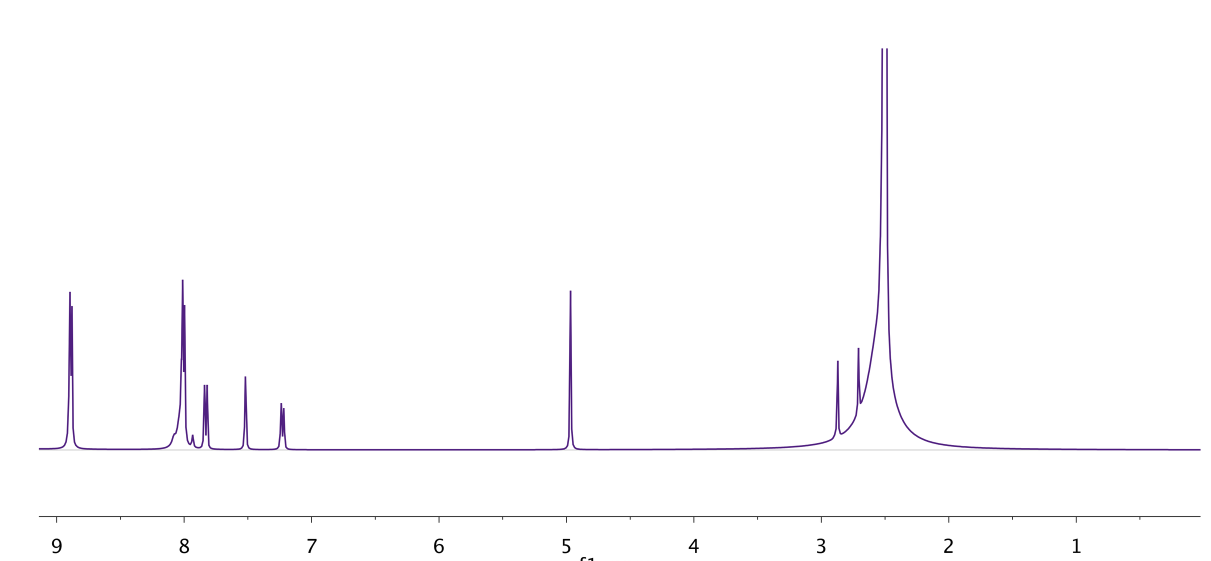


Figure 5: KSU-1 ^{1}H-NMR Spectrum (d$_6$-DMSO/D_2SO_4)

Conclusions

- The first PSM of KSU-1 successfully modified the amine group to an amide group.
- The mono-functionalized KSU-1 retained its solvent absorption capabilities.
- Mono-functionalized KSU-1 retained crystallinity.

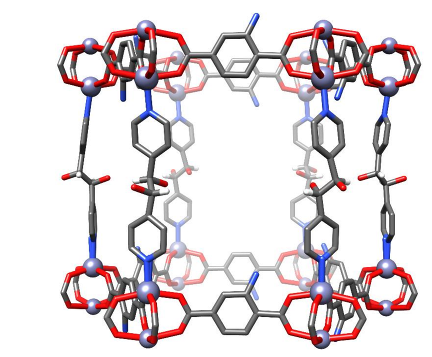


Figure 6: KSU-1 Crystal Structure

Future Research

- In future studies, the second PSM will be done on KSU-1 along with spectroscopy to characterize it.
- Bi-functionalized KSU-1 will be tested with various polar and non-polar solvents to observe hydrophobic and hydrophilic qualities.
- Spectroscopy is needed to help identify where the PSMs are occurring.

References

- Rubio-Martinez, M.; Avci-Camur, C.; Thornton, A. W.; Imaz, I.; Maspoch, D.; Hill, M. R. New synthetic routes towards MOF production at scale. **2017**, *46*, 3453-348.
- Cohen, S. M. Postsynthetic methods for the functionalization of metal-organic frameworks. *Chem. Rev.* **2012**, *112*, 970.

Acknowledgements

- This research was funded by Kansas State University.
- Thank you to the Gadzikwa Lab for the great work environment.
- Thank you to the Bridges to the Future Program.