



Highly-Ordered Cyclodextrin-Frameworks for Next Generation PFAS Absorption

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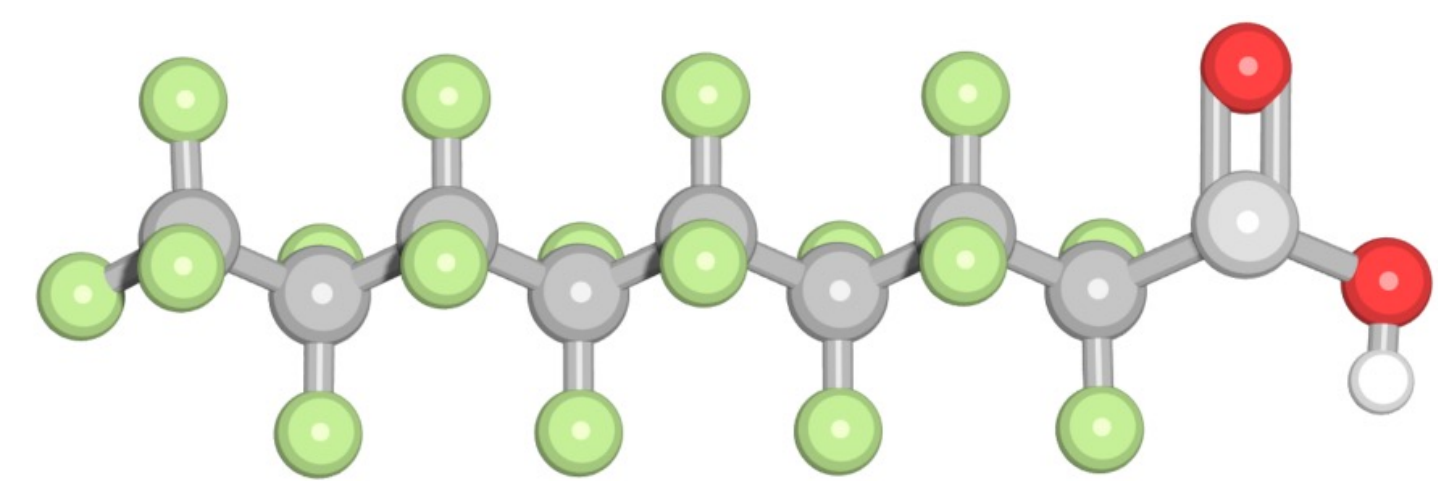


F.E.M

Introduction

What Is PFAS?

PFAS: Perfluoroalkyl substances are persistent environmental contaminants. Often referred to as 'forever chemicals' due to their half-life of 2-15 years. Utilized for hydrophobic enhancement, PFAS forms strong carbon-fluorine bonds, rendering them highly resistant to degradation in water. The EPA links PFAS to increased risks of cancer, infertility, and other dangerous health effects; the full scope of which are still unknown.¹ Current PFAS removal systems are time consuming and expensive creating a demand for a new class of sorbent.



Fluorine Carbon Oxygen
PFAS Structure

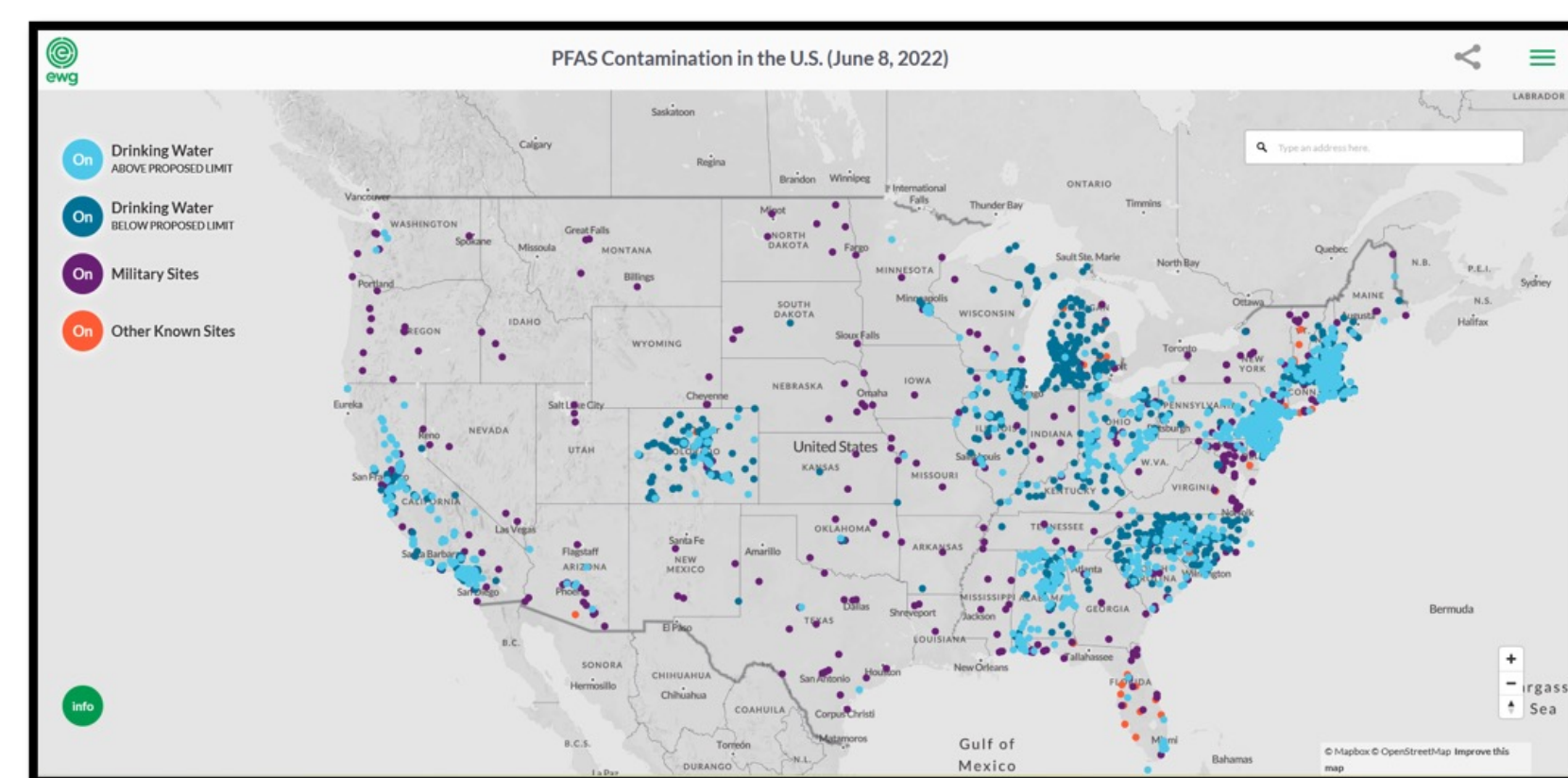
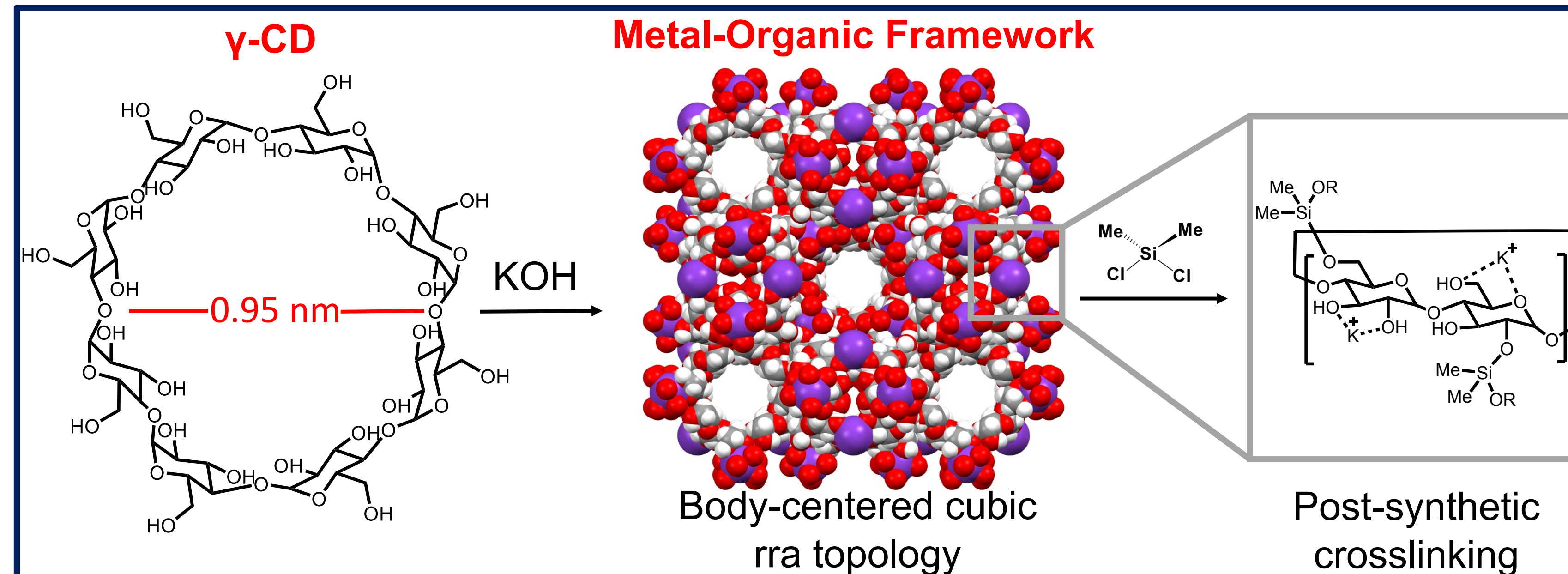


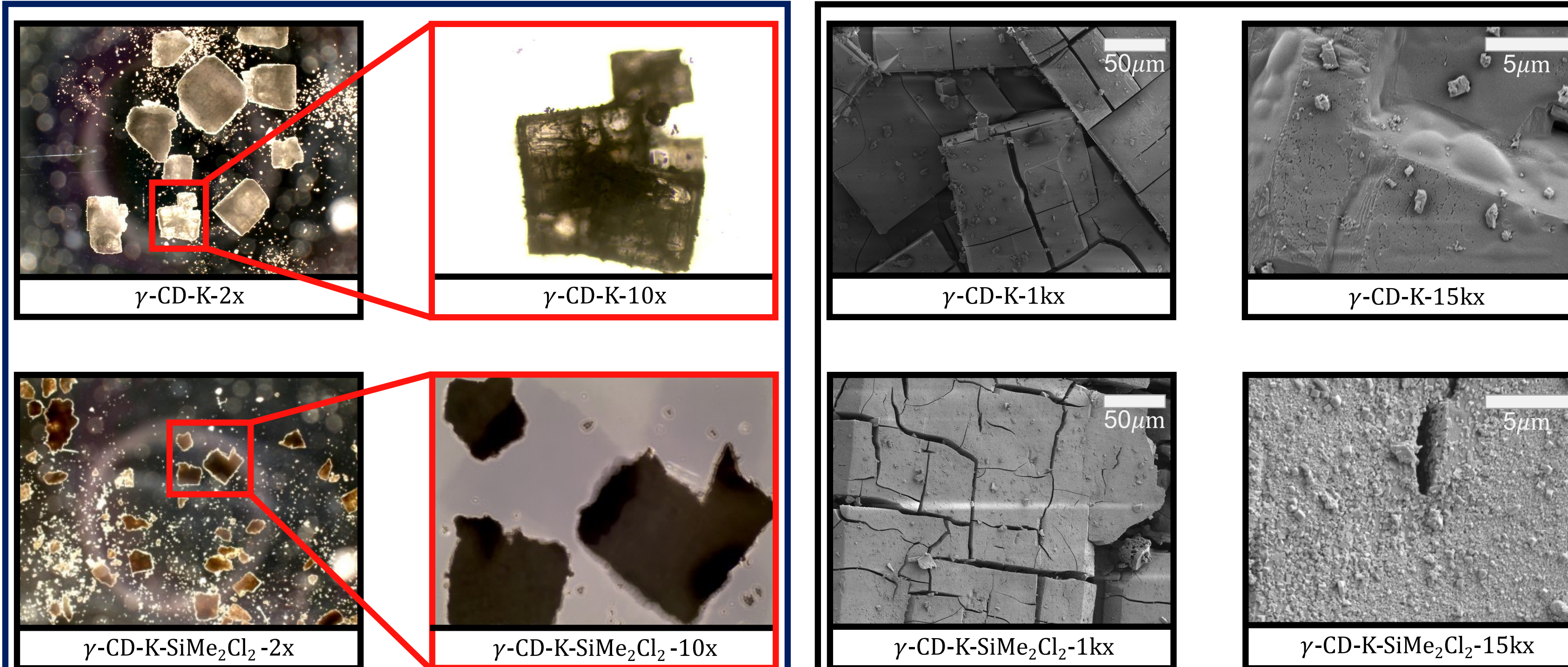
Figure 1. PFAS Contamination in the U.S. ⁽²⁾

Molecular Design



Schematic 1. MOF synthesis of γ -CD-K and crosslinked structure with SiMe_2Cl_2 .

Optical and Selective Electron Microscopy



Results and Future Work

Based on preliminary results, a hydrophobic γ -cyclodextrin-potassium MOF crosslinked with SiMe_2Cl_2 has been synthesized while maintaining crystallinity. Next, contact angle measurements of the crosslinked cyclodextrin will be taken to confirm it's hydrophobic material. Further testing is required to investigate porosity and thermal stability. Then, PFAS adsorption isotherms will be done using Liquid Chromatography-Mass Spectrometry (LC-MS). Our group is also interested in developing non-toxic, reusable cyclodextrin based hydrogels and assess their effectiveness at PFAS removal.

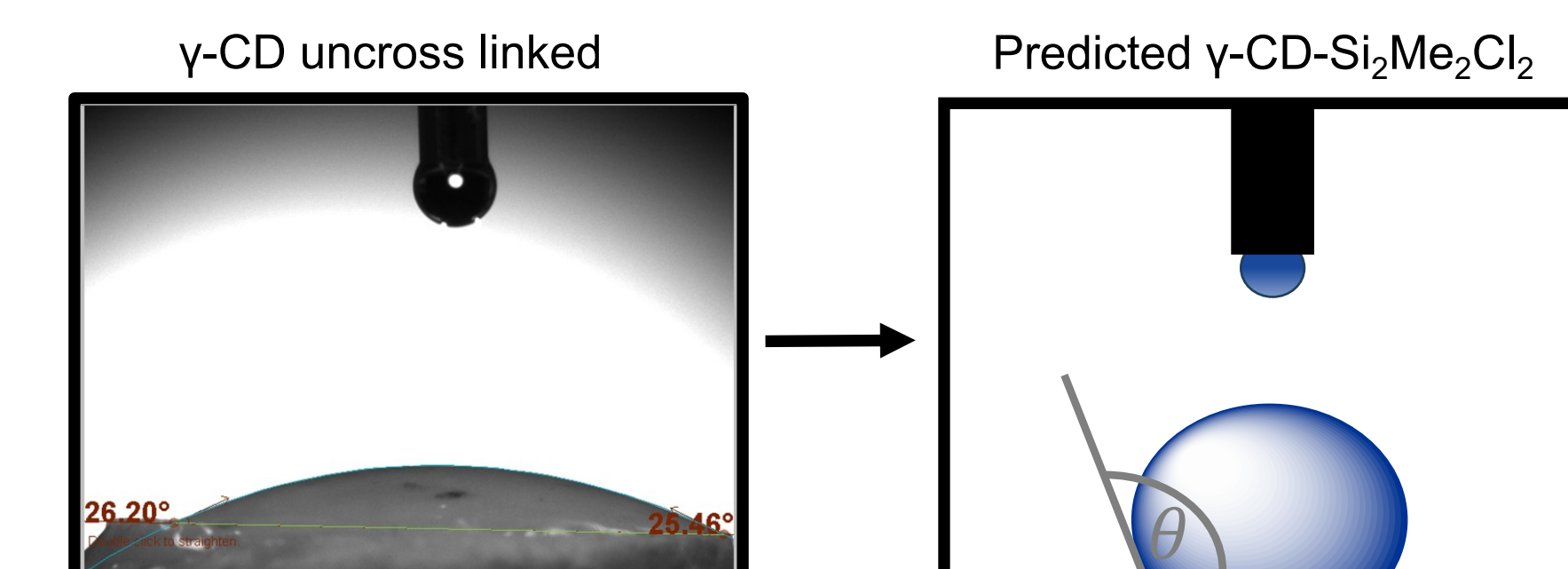


Figure 4. Contact angle of γ -Cyclodextrin-potassium MOF and predicted γ -Cyclodextrin-potassium crosslinked with SiMe_2Cl_2 .

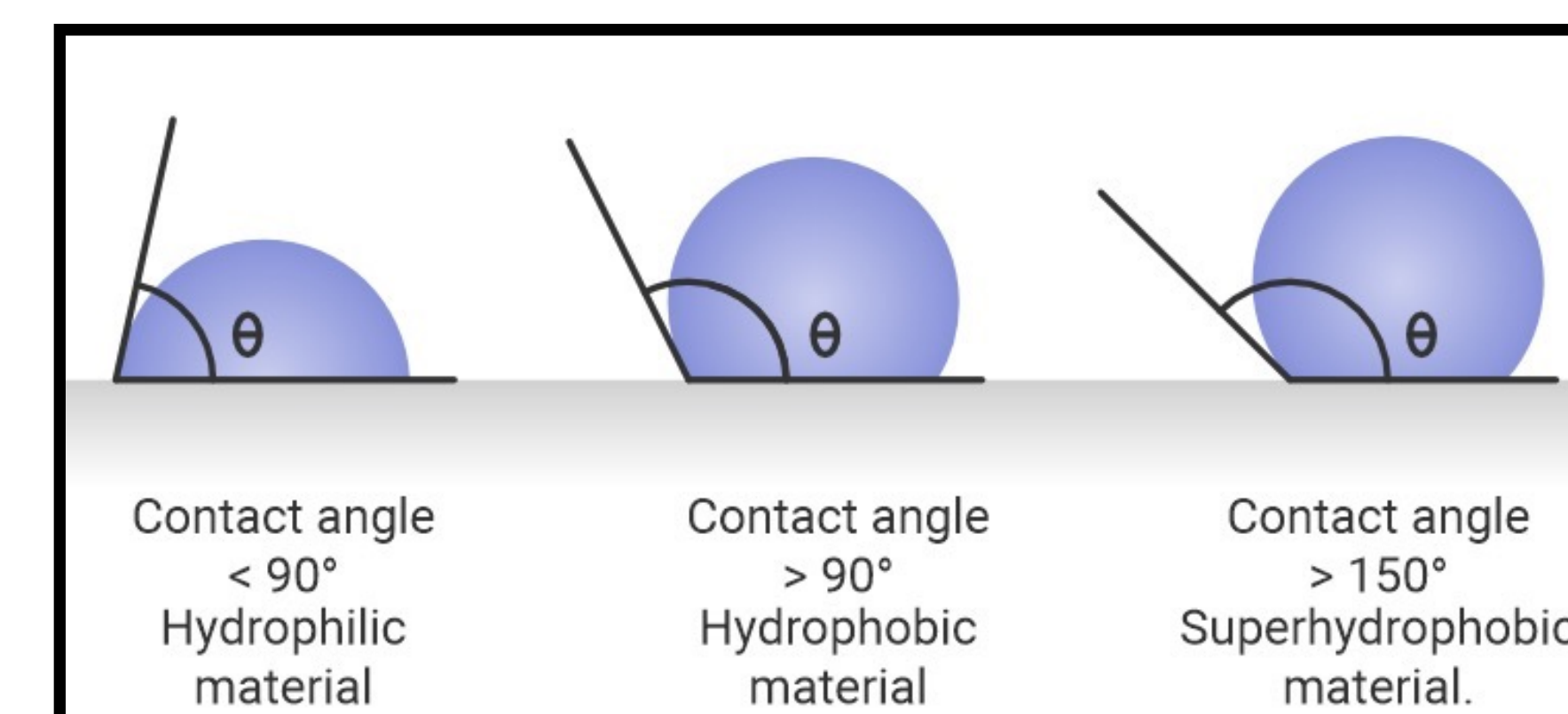
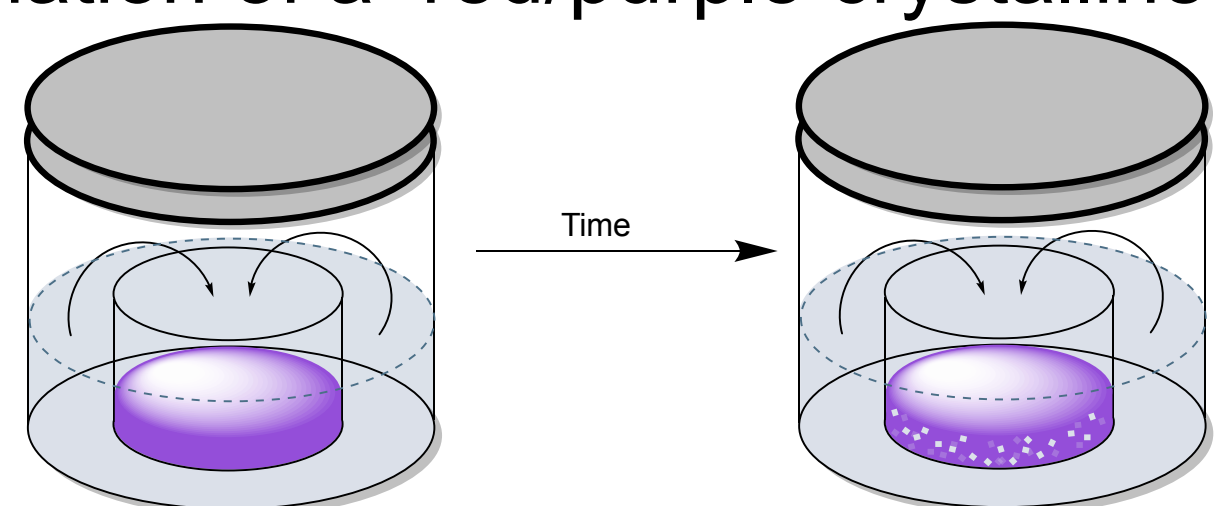


Figure 5. Diagram of various contact angle measurements.⁽⁴⁾

Experimental Methods

Crystal Generation: Gamma-cyclodextrin and potassium hydroxide is dissolved in water and placed in a vapor diffusion chamber. The chamber contains methanol, a volatile solvent, that slowly diffuses into solution over a week. Gradual diffusion decreases the solubility of the sample, creating white crystalline solid. Resulting crystals are removed and allowed to dry under ambient conditions.

Crosslinking: The dried crystals are transferred to a new vapor diffusion chamber, where dichlorodimethylsilane is the volatile diffusing agent. Over a week diffusion occurs, resulting in the formation of a red/purple crystalline solid.



Powder X-Ray Diffraction

PXRD Results

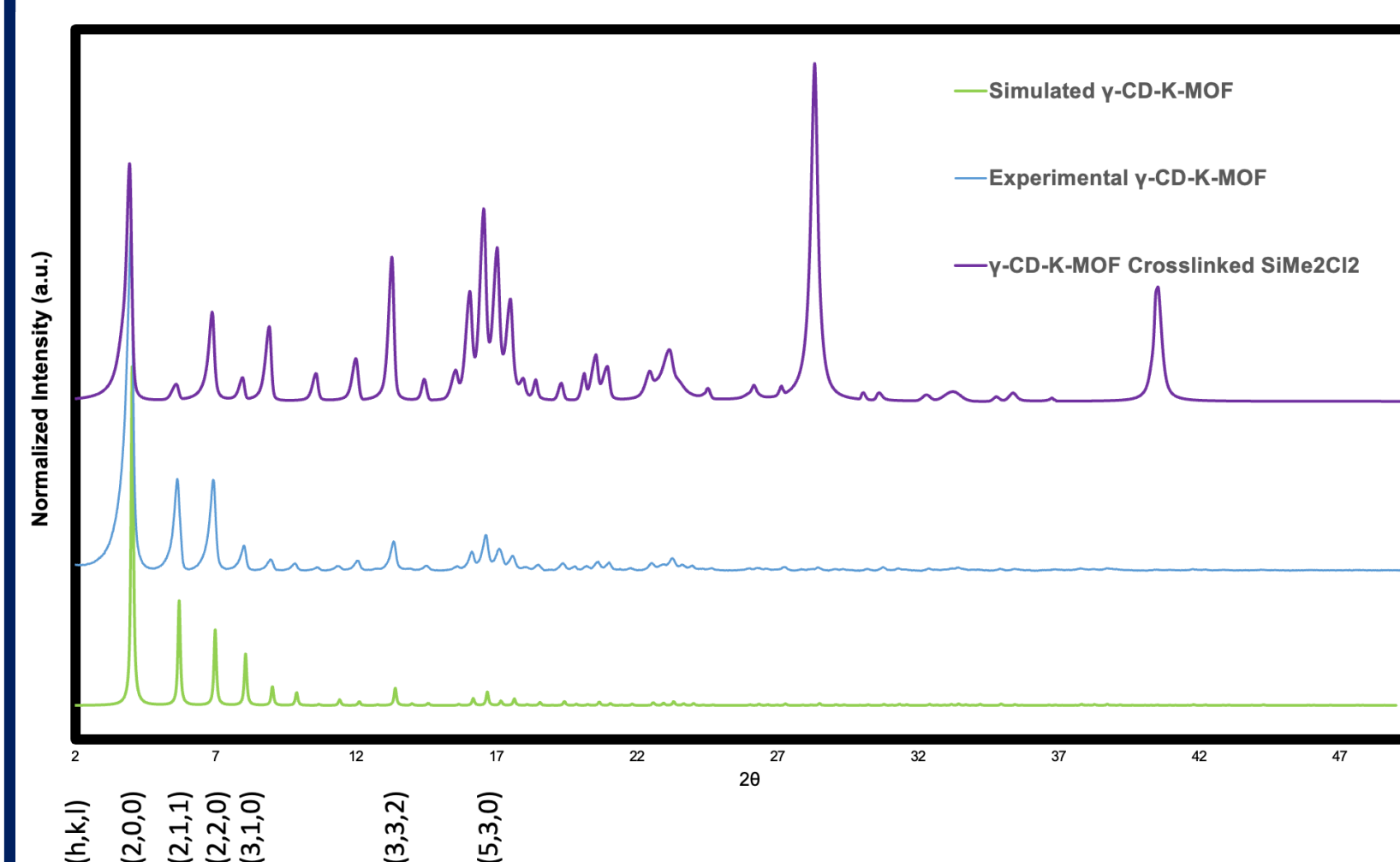


Figure 2. γ -Cyclodextrin-potassium MOF and crosslinked with SiMe_2Cl_2 . (March 26, 2025)

How Powder X-Ray Diffraction Works

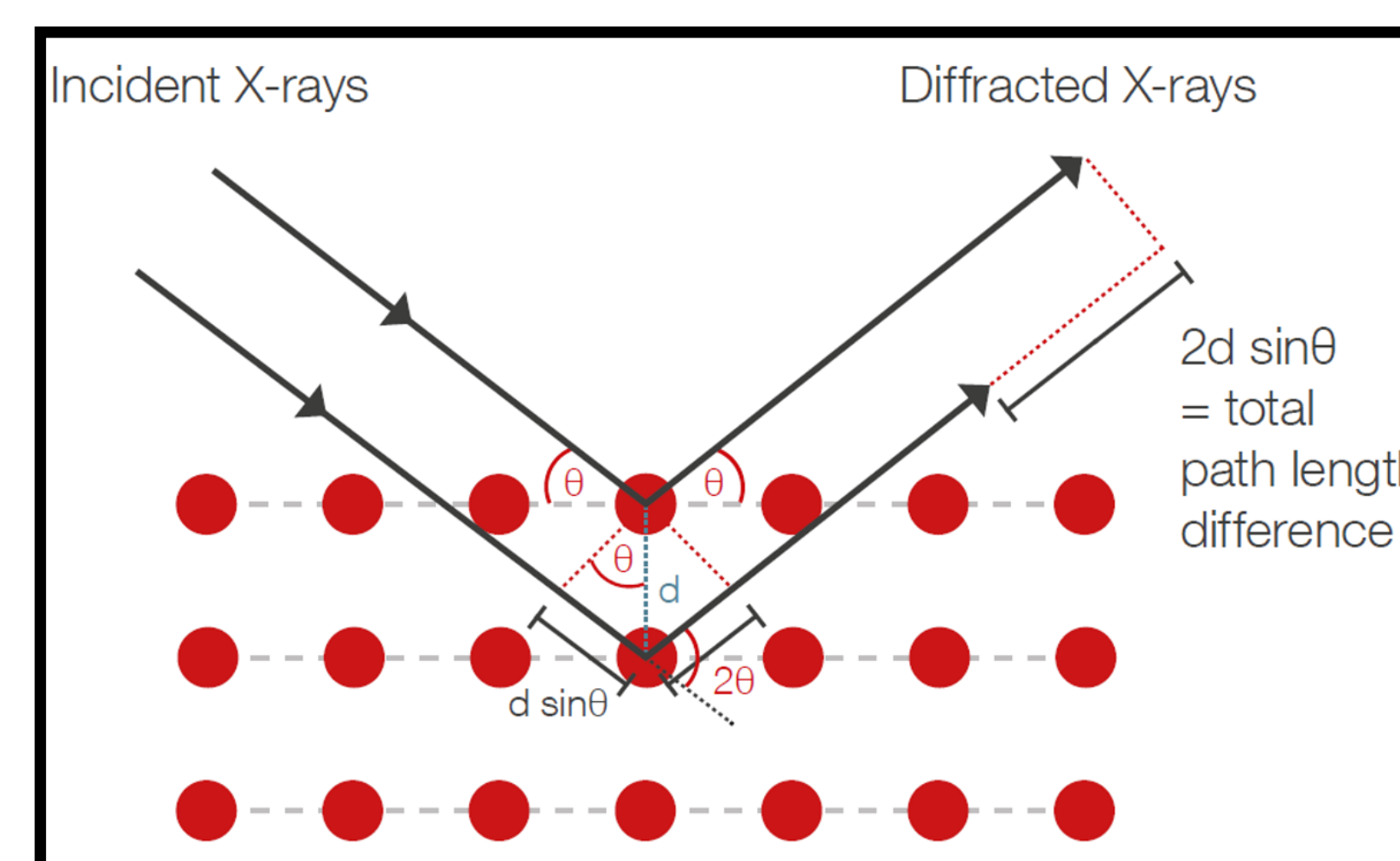


Figure 3. Incident x-rays interacting with powder crystalline surface producing a diffraction pattern that reveals interplanar spacing by Bragg's Law.⁽³⁾

Acknowledgements

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References

- (1) United States Environmental Protection Agency. "Our Current Understanding of the Human Health and Environmental Risks of PFAS." www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas, 26 Nov. 2024.
- (2) Environmental Working Group. "Interactive Map: PFAS Contamination Crisis: New Data Show 2,230 Sites in 49 States." www.ewg.org/interactive-maps/pfas-contamination/map/, 8 June 2022.
- (3) "X-Ray Diffraction (XRD)." Anton Paar Wiki, 2019, wiki.anton-paar.com/en/x-ray-diffraction-xrd/.
- (4) Measurlabs. *Contact Angle Measurement* | Measurlabs. [Measurlabs.com](https://measurlabs.com/methods/contact-angle-measurement/).