A Glimpse Into the World of Reticular Chemistry and Periodic Frameworks
Omar Yaghi Lab

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The magnitude of chemistry research being conducted at UC Berkeley is staggering, with every subdiscipline of chemistry under the sun receiving focus and attention in one lab or another on campus. Of these many amazing research groups, one belongs to Professor Omar M. Yaghi, whose contributions to the scientific world so far have been phenomenal. Professor Yaghi is credited with the creation of an entire subfield of chemistry, which has colloquially been termed “reticular chemistry.” Reticular chemistry describes the study and design of open crystalline frameworks that are essentially molecular “building blocks” linked together by strong bonds to create permanently porous materials with exceptionally high surface areas.

Metal-Organic Frameworks (MOFs) encapsulate a large portion of this field, although there are other kinds of frameworks that are also a subset of reticular chemistry such as COFs and ZIFs. MOFs consist of a network of ordered metal atoms connected by organic linkers to generate an open, porous structure. The high surface area and seemingly infinite tunability of MOFs have put them on the radar of chemists from all walks of life. The internal surface area of a MOF named NU-110 is so large, that if one gram was spread out in an atomically thin layer, it would cover one and a half football fields. This incredibly high surface area is attributed to MOFs porous nature. Pore size in these materials can be optimized specifically for many small molecules, such as hydrogen, carbon dioxide, and even water. This allows MOFs to selectively bind many molecules in a way that previous materials have simply been unable to.

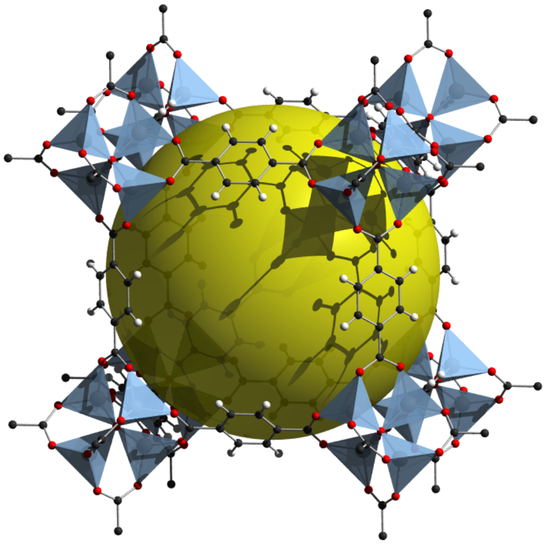

Figure 1: ***3D Structure of MOF-5’s Pore Size (Yellow Sphere)***

One example of MOF’s extremely selective and impressive ability to bind targeted substrates is an experiment that was conducted by Yaghi’s group, which involved taking one kilogram of a MOF titled MOF-801 into the Arizona desert, and letting it sit out in the open for 24 hours. After this time, the MOF had collected over 100 mL of pure water free of contamination. Even in the arid conditions of the desert, and without any external energy sources, this MOF was able to selectively soak up what little water was present in the atmosphere and capture it, allowing other gases such as nitrogen and carbon dioxide to flow right through. They also tested an aluminum based MOF-303, and found it to capture double the amount of water that MOF-801 did.

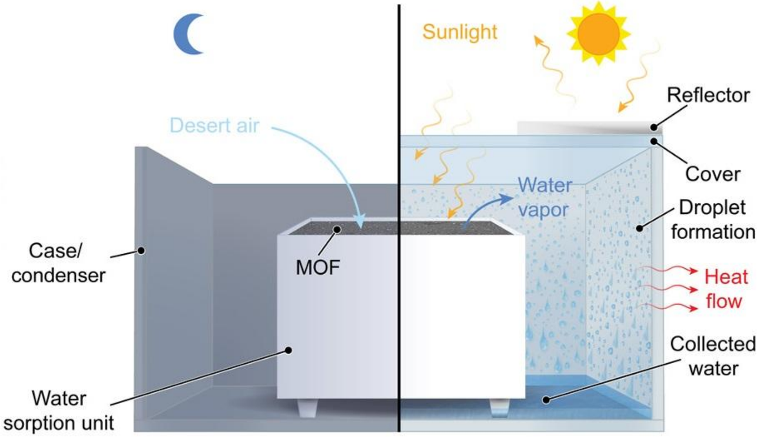

Figure 2: ***MOF Desert Air Extraction Setup***

The applications for this variety of molecules are limitless. From eliminating the shortages of clean drinking water around the world, to capturing carbon dioxide out of the atmosphere as a tool to combat anthropogenic climate change, to storing hydrogen in a dense and efficient manner to revolutionize the type of fuel our cars run on, MOFs seem to be a promising potential tool for humanity to develop and investigate further. Since Professor Yaghi reported the first MOF in 1999, his research group has synthesized over 1,000 unique MOFs, making him truly one of the world leaders in this exciting emergent field.

References:

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