PORES GALORE

MATERIALS: Lengthening organic section of hybrid materials gives compounds with record-breaking properties

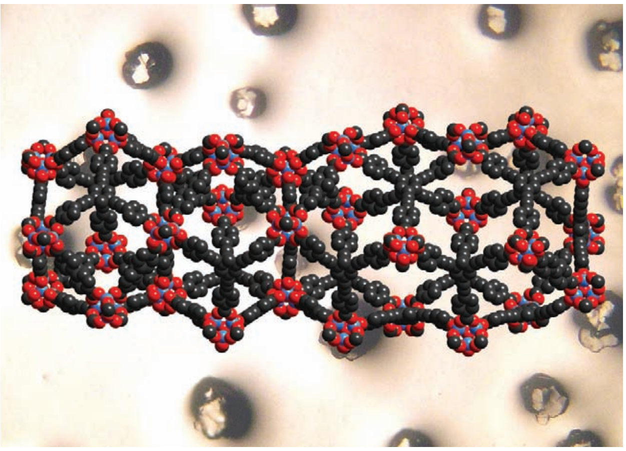
BY EXTENDING the organic segments that position metal clusters in the lattices of highly porous compounds, researchers in the U.S. and South Korea have synthesized new materials with higher porosity and surface area than ever before (*Science,* DOI: 10.1126/science.1192160). The new metal organic framework (MOF) compounds also exhibit a propensity to take up exceptional quantities of gas. Those properties may pave the way to commercial applications, including gas storage and separation.

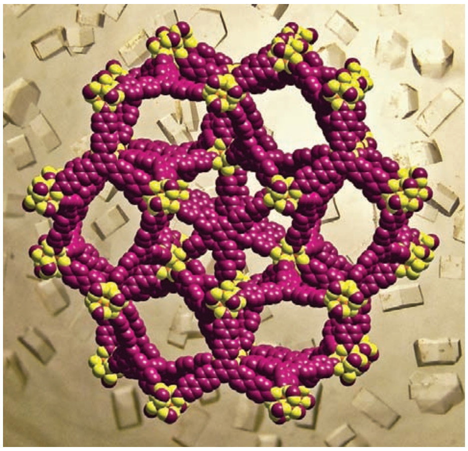
MOF compounds are crystalline materials composed of metal ions or clusters that are connected by organic linkers. Several research teams have demonstrated that that harbor two crystal lattices growing in an interpenetrating geometry, thereby reducing porosity.

Now, UCLA chemistry professor Omar M. Yaghi and postdoc Hiroyasu Furukawa; Jaheon Kim of Soongsil University, in Seoul; and coworkers have demonstrated that new record-setting MOFs can be synthesized by lengthening the organic linkers in previous record setters and by using combinations of linkers.

For example, by replacing the benzenetribenzoate units in MOF-177 with structurally related but extended linkers, or with a combination of such linkers, the team prepared MOF-200 and MOF-210, respectively. These compounds' uptake of CO_2 and N_2 (roughly 2,400 cm^3/g) significantly exceeds previously reported values. And MOF-210's surface area (6,240 m^2/g) and pore volume also set new records.

"MOFs have been popular for some time now due to their very high surface areas," says UC San Diego chemistry professor Seth M. Cohen. But the present study "takes this to the extreme, producing MOFs of exceptionally high surface areas," he says. In a nod to the current World





HIROYASU FURUKAWA/UCLA

NEW CHAMPS Made from a combination of zinc clusters and organic linkers, these materials set new records for surface area and gas uptake. MOF-210 (left): C is black, O is red, and Zn is blue. MOF-200 (right): C is purple, O is yellow, and Zn is not visible.

their large pores, internal openness, and high surface area—which far outstrip values for activated carbons and zeolites—make MOFs well suited for use in gas storage and purification, as well as in catalysis, chemical sensing, and biotechnology. In just the past few years, interest in MOF research has soared, thanks in part to some well-publicized demonstrations and efforts to expand the variety and quantity of MOFs produced commercially (C&EN, Aug. 25, 2008, page 13).

Increasing their porosity and gas uptake beyond the high values that have already been achieved could boost MOFs to the next level of commercialization. But efforts to do so often lead to materials that are fragile and cannot support repeated gas uptake and release or Cup, Cohen points out that a single gram of MOF-210 has roughly 90% of the surface area of an official soccer field.

In another just-published MOF study, Peking University chemists Zhe-Ming Wang and Song Gao report that a zinc-formate MOF undergoes a change in electronic character known as a paraelectric-ferroelectric transition as a result of temperature-controlled structural changes—specifically an order-disorder transition of NH_4^+ ions within the structure (*J. Am. Chem. Soc.,* DOI: 10.1021/ja104263m). The discovery of this uncharacteristic MOF property may lead to new applications of ferroelectric compounds, which are used in some types of infrared cameras, vibration sensors, and ultrasound equipment, the researchers say.—MITCH JACOBY