POROUS MATERIALS

MOFs go fungal

Metal–organic frameworks (MOFs) can be assembled on yeast cell walls to yield microcapsules with size-selective porosity, report Guoliang Zhang and colleagues in *Angewandte Chemie*. These defect-free, biotemplated microcapsules hold particular promise as substrates for catalytic reactions and as containers for therapeutic agents.

MOFs — porous crystalline materials comprising metal ions or clusters coordinated to organic linkers — continue to garner tremendous interest for a suite of applications, extending from gas capture, storage and separation, to catalysis and drug delivery. To date, some tens of thousands of different MOFs have been reported with a multitude of structures. Hollow MOF microcapsules are one type of structure that has received attention owing to the possibilities such materials offer for the encapsulation and release of small molecules and as catalytic microreactors. To realize the size-selectivity required for these applications, it is necessary for the capsules to be defect-free, and to have uniform and easily tuned molecular-scale porosity. As Zhang explains, "few people have fabricated MOF capsules with size-selective permeability. Moreover, the synthesis of controllable MOF capsules via a facile and scalable route remains a challenge."

To overcome these issues, the authors took inspiration from nature. "We have previously synthesized continuous MOF membranes on polymer hollow fibres that possess excellent size-selective permeability for gas separation," says Zhang. "Moreover, we have engaged in biological engineering for many years. Therefore, we had the idea to combine cell walls and MOFs." Zhang and colleagues used pure cell walls derived from yeast cells — following the removal of the cytoplasm — as a support material for MOF assembly. This assembly was achieved by impregnating the cells with metal ions and then immersing them in the linker solution. As a result of an interfacial crystallization process, continuous MOF layers crystallize at the cell surface: the metal ions on the inside of the cell and organic linkers on the outside. A crucial feature of this strategy is that crystallization occurs preferentially at the cell wall owing to the high number of polar groups. This allows lower precursor concentrations to be used compared with conventional interfacial syntheses and thereby suppresses bulk nucleation, which would lead to a discontinuous framework and poor control over the release kinetics.

Importantly, this means of separating the metal ions and linkers conveys certain advantages: "Our method can be applied under mild conditions without the requirement for two immiscible solvents and special equipment," explains Zhang. Aside from satisfying both the chemical and structural criteria, the biomaterial scaffolds are easily harvested in large quantities and are inexpensive. Moreover, the method is applicable to a broad range of MOFs and cell walls from various organisms. This imbues the system with size-selective permeability because different MOFs have different pore sizes. The continuity and size-selectivity of the materials were verified by loading and monitoring the release of several small molecules from microcapsules formed from different MOFs.

According to Zhang, "the most important aspect of this work is the new concept of combining a biological cell wall and MOFs, as this takes the advantages of both the diverse structures of biomaterials available and the uniform microporous nature of MOFs." Looking forward, the authors plan to extend this strategy to other structured materials, such as films and sponges with different functions in separation, catalysis, adsorption, drug delivery, encapsulation and sensor technologies.

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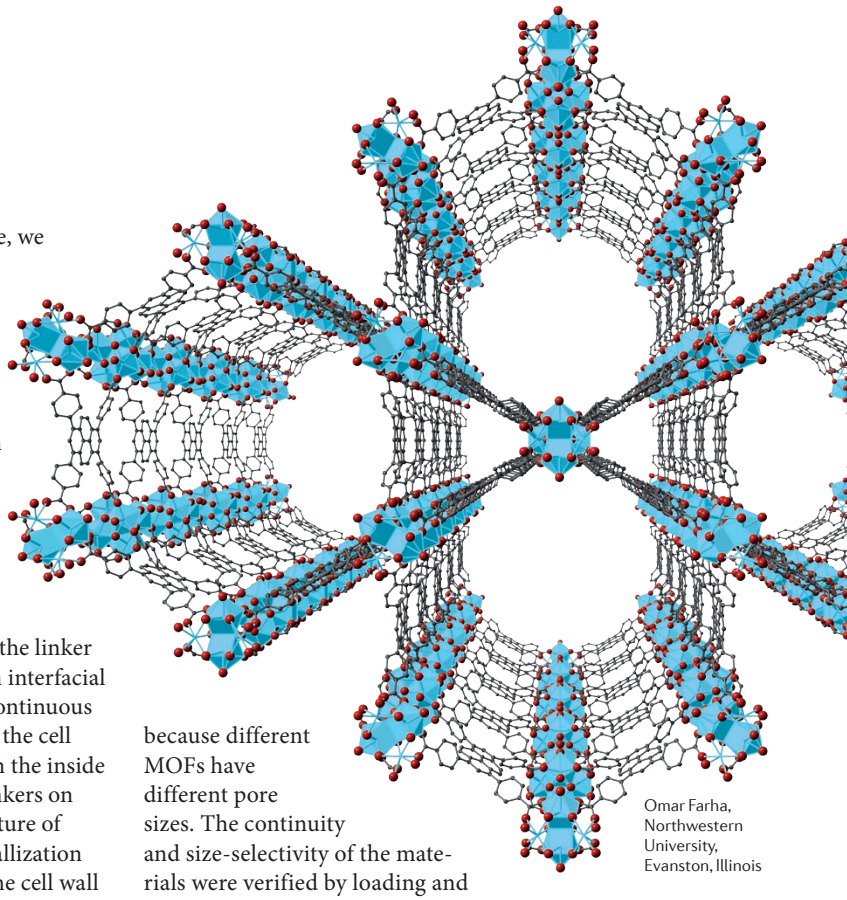

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