Researcher shows method for controlled growth of porous crystalline materials

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Porous crystals called metal-organic frameworks (MOFs) consist of metallic intersections with organic molecules as connecting elements. Thanks to their high porosity, MOFs have an extremely large surface area. A teaspoonful of MOFs has the same surface area as a football pitch. These countless pores situated in an extremely small space offer room for "guests" and can, for example, be used for gas storage or as "molecular gate" for separation of chemicals.

But MOFs have a much greater potential and it is what Paolo Falcaro from TU Graz's Institute of Physical and Theoretical Chemistry (PTC) wants to unlock. "MOFs are prepared by self-organisation. We don't have to do anything other than mix the components, and the crystals will grow by themselves. However, crystals grow with random orientation and position, and thus their pores. Now, we can control this growth, and new properties of MOFs will be explored for multifunctional use in microelectronics, optics, sensors and biotechnology."

In the current issue of *Nature Materials*, a research activity lead by Paolo Falcaro and Masahide Takahashi (Osaka Prefecture University - Japan) together with Australian colleagues at the University of Adelaide, Monash University and The Commonwealth Scientific and Industrial Research Organisation (CSIRO) describes a method of growing MOFs on a comparatively large surface area of one square centimetre rapidly achieving an unprecedented controlled orientation and alignment of the crystals.

Directionally dependent properties

The big advantage of precisely oriented crystals in MOFs makes every materials scientist excited. Functional materials can be infiltrated in the pores of the crystals to generate anisotropic materials; in other words, materials with directionally dependent properties. In the journal *Nature Materials*, the research team shows how the controlled synthesis of a MOF film behaves in the presence of fluorescent dye. Just by rotating the film, the fluorescent signal is turned "on" or "off" and an optically active switch has been created.

Paolo Falcaro: "This has many conceivable applications and we're going to try many of them with a variety of different functionalities. One and the same material can show different properties through different orientations and alignments. Intentional growth of MOFs on this scale opens up a whole range of promising applications which we're going to explore step by step."

Protecting enzymes

A major aim of Paolo Falcaro and his team at TU Graz is the development of MOFs for biotechnological applications: "We are trying to encapsulate enzymes, proteins and even DNA in MOFs and to immunise their activity against fluctuations in temperature. The crystalline structure surrounding the "guest" in the pore has a protective effect, like a tough jacket. We want to check out the possibilities more accurately," explains Falcaro.

More information: Paolo Falcaro et al. Centimetre-scale micropore alignment in oriented polycrystalline metal–organic framework films via heteroepitaxial growth, *Nature Materials* (2016). DOI: 10.1038/nmat4815

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