Porous polymers show remarkable stability at high pressure

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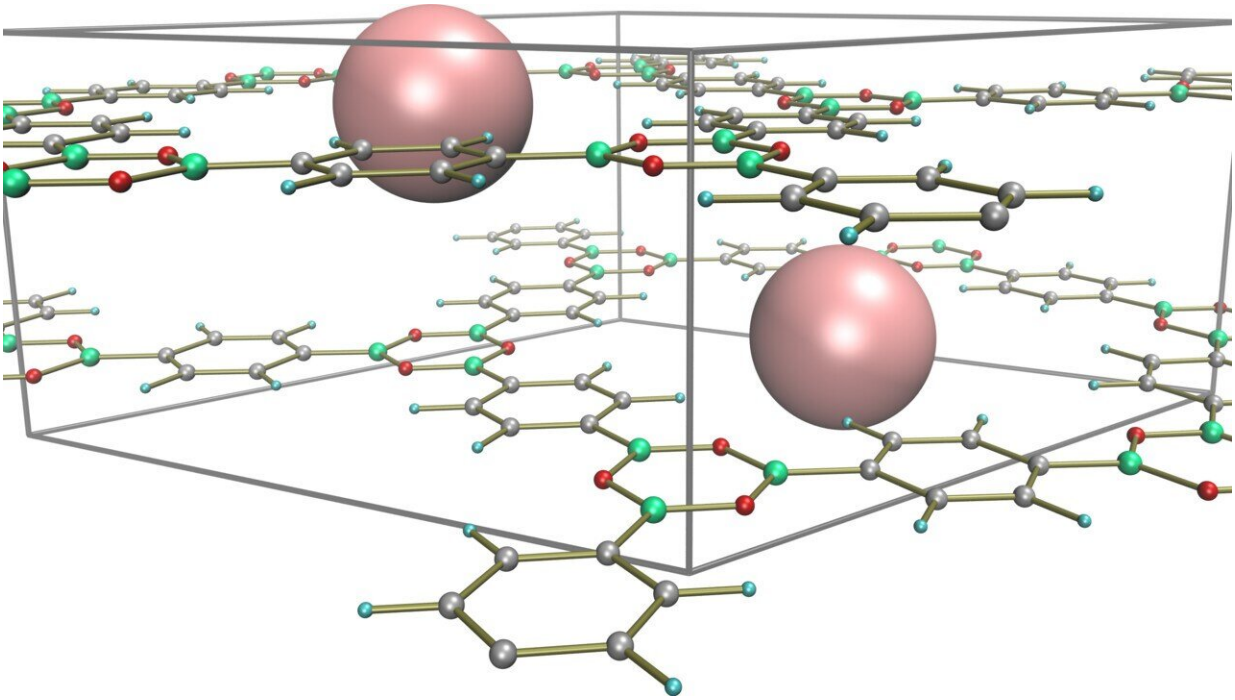

Porous nano material called COFs (covalent organic frameworks). Credit: Alexandr Talyzin

Umeå physicists in collaboration with the Technical University of Dresden and Chalmers University are the first to show high stability of the porous nanomaterial COF-1. The study is published in *Angewandte Chemie*, Int. Ed.

Covalent organic frameworks (COFs) is a broad family of polymeric materials composed only by light elements. The absence of metal atoms in their structure makes COFs distinctly different compared to their relatives, Metal Organic Framework materials (MOFs).

The first COF structure was discovered in 2005 (named COF-1) and consists of benzene rings linked by B_3O_3 into hexagon-shaped 2-D sheets which are stacked into a layered structure, resembling in this respect the structure of graphite composed by graphene layers. By analogy with graphene the single layer of COF material could be named as COFene since it represents a true 2-D material composed by carbon, hydrogen, boron and oxygen.

Unlike graphite, COF-1 is porous material with relatively high surface area which makes it promising for various applications, e.g. for energy storage devices, as a sorbents for gas storage or for membranes. There is also general fundamental scientific interest in single COF-1 layers, which are true 2-D materials.

However, little was known about the mechanical properties of COFs or single layered COFenes except for a few theoretical estimations. Unlike graphite or MOFs, no high pressure studies were available for COFs.

The researchers used synchrotron X-ray diffraction and Raman spectroscopy to evaluate what happen with the structure of this material at pressures up to 30 GPa. It was found that the ambient pressure structure of COF-1 can is unexpectedly stable and preserves even after compression up to 10^{-15} GPa. At higher pressure, the structure collapses irreversibly.

"We saw remarkable stability at high pressures for such a porous structure as COF is. This was surprising because porous MOF structures collapse at lower pressure," says Alexandr Talyzin, senior lecturer at the

Department of Physics at Umeå University. Combination of experimental and theoretical approaches provides insight into stiffness and mechanical properties of the COF-1 structure, which can be considered as typical representative for the whole family of COF materials.

More information: Jinhua Sun et al. Covalent Organic Framework (COF-1) under High Pressure, *Angewandte Chemie International Edition* (2019). DOI: 10.1002/anie.201907689

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