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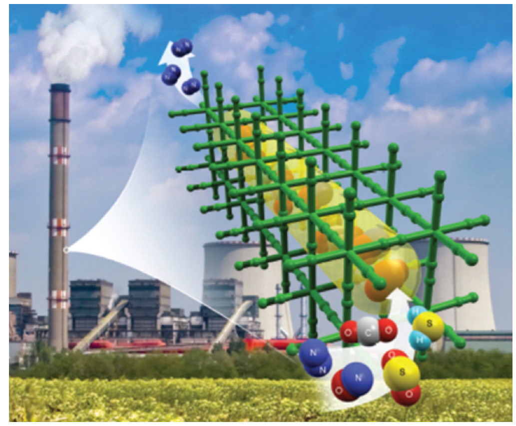
Molecularly Organized Nanomaterials for Carbon Dioxide Capture

One of the most significant problems in the carbon capture and storage (CCS) industry is how to separate harmful greenhouse gases (GHG) before those GHGs are distributed to the atmosphere. Researchers at Pacific Northwest National Laboratory have developed a new material that captures CO_2 efficiently, selectively, and most importantly, economically.



Capture and separation of CO_2 and other gases using PNNL's MOF nanocrystals.

NEW MATERIAL CAPTURES TWICE AS MUCH CO_2

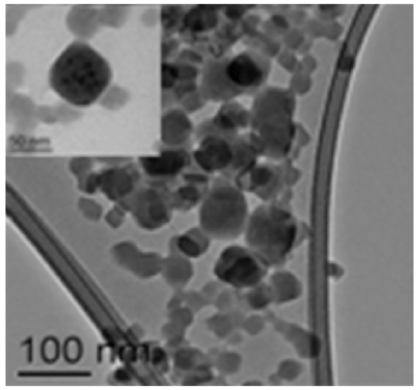
PNNL's team has created a new series of materials based on metal-organic frameworks (MOFs), that has tiny "cages"—trapping CO_2 before it reaches the atmosphere. The cages themselves consist of metal ions linked together with organic ligands forming a porous network that trap gas molecules. The team combined "off the shelf" chemicals—zinc nitrate and organic building blocks that serve as the foundation for the new materials. The unique molecules have two to three times the capacity for carbon dioxide uptake as conventional solvents, and appears to have an extremely high preference for carbon dioxide over other gases. The team did comprehensive testing using the U.S. Department of Energy's Environmental Molecular Sciences Laboratory (EMSL), to determine size and shape of the crystal. The researchers created square and hexagonal (not shown here) shaped crystal cages connected in a lattice permeable to CO_2 where it binds to the cage frame as a physical reaction. The CO_2 can then be released by pulling a slight vacuum, as opposed to current technologies, which bind the gas to the materials chemically and then need to be heated to release the trapped gas. The crystals actually have a diameter of about 35 nanometers, and a wall thickness of approximately 40 nanometers. The surface area of just one gram, however, is equivalent to about a football field, according to researchers.

After the CO_2 release, the gases can be pumped deep in the Earth where it becomes trapped and forms stable carbonate minerals, or used to produce byproducts, such as methanol.

U.S. DEPARTMENT OF ENERGY

FACILITIES

Researchers used leading-edge experimental and computational resources at the Environmental Molecular Sciences Laboratory, a U.S. Department of Energy national scientific user facility at PNNL. Additional resources exist in the Applied Materials Science group within the Energy and Environment Directorate of PNNL.



TEM micrographs of PNNL's MOF nanocrystals with 40 nm in size. The homogeneous distribution of nanopores within the MOF nanocrystal is also shown here.

ABOUT PNNL

Pacific Northwest National Laboratory, a U.S. Department of Energy Office of Science laboratory, solves complex problems in energy, the environment, and national security by advancing the understanding of science. PNNL employs more than 4,900 staff, has a business volume exceeding $1.1 billion, and has been managed by Ohio-based Battelle since the Lab's inception in 1965.

SELECTED PUBLICATIONS

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