

Single-phase covalent organic frameworks membranes make CO₂-selective separation possible

July 29 2021, by Li Yuan

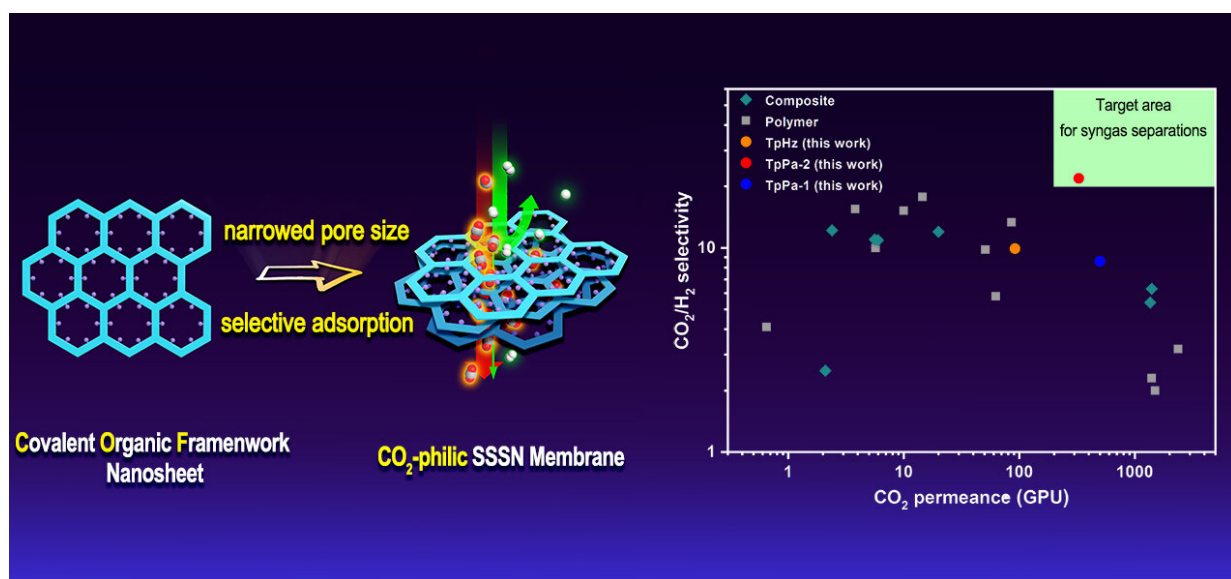


Illustration of superior CO₂-selective COF nanosheet membrane for high-performance CO₂/H₂ separation. Credit: Peng Yuan

A research group led by Prof. Yang Weishen and Dr. Peng Yuan from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) developed a novel strategy to fabricate single-phase CO₂-selective covalent organic frameworks (COFs) nanosheet membranes featured with both high CO₂/H₂ separation factors

and high CO₂ permeance.

This study was published in *Angewandte Chemie International Edition* on July 20.

Two-dimensional (2D) COFs, a class of crystalline organic skeletons possessing permanent one-dimensional pores, are promising to serve as high-quality membrane materials in CO₂ capture field. However, their inherent pore sizes (>0.8 nm) are too large to provide desired molecular sieve capability for gas separations currently.

The researchers exfoliated three kinds of 2D COFs, that is, TpPa-1, TpPa-2 and TpHz, with an average particle size of 3 μm and different pore sizes into 2 nm-thick nanosheets. Intact crystallinities and functionalities were well-retained after exfoliation treatment.

They found that even the TpHz with relatively smallest inherent pore size could not exhibit desired gas separation performance in a form of conventional bulk membrane. With ultrathin nanosheets served as membrane building units, they developed novel COF nanosheet membranes exhibiting distinctive staggered stacking micro-structures.

"Just like the [fishing net](#), you can irregularly pile up several nets to catch tiny fish," said Dr. Peng.

The intriguing membrane structures in collaboration with inherent CO₂-selective adsorption capacities of COF frameworks endowed the COF nanosheet membranes with permeation priority of large CO₂ molecules from mixed CO₂/H₂ gas based on a surface diffusion mechanism.

Among the membranes, TpPa-2 nanosheet membranes with medium pore size showed the highest CO₂/H₂ separation factor and CO₂ permeance, which reached the target with commercial feasibility for syngas separations.

The researchers identified that the TpPa-2 [nanosheet](#) membranes exhibited proper narrowed pores derived from the staggered stacking patterns, which allowed exactly two columns of CO₂ molecules to pass through and maximized the blocking effect for H₂ passage.

This study provides a new pore engineering strategy for the design and manufacture of high-performance COF membranes in gas separation realm.

"Taking full advantage of this pore-engineering strategy, different categories of COFs with diversified [pore](#) structures can enable specified [membrane](#)-based gas separations," said Prof. Yang.

More information: Pengyuan Wang et al, Single-Phase Covalent Organic Framework Staggered Stacking Nanosheet Membrane for CO₂-Selective Separation, *Angewandte Chemie International Edition* (2021). [DOI: 10.1002/anie.202106346](https://doi.org/10.1002/anie.202106346)

Provided by Chinese Academy of Sciences

Citation: Single-phase covalent organic frameworks membranes make CO₂-selective separation possible (2021, July 29) retrieved 25 April 2024 from <https://phys.org/news/2021-07-single-phase-covalent-frameworks-membranes-co2-selective.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.