Research proposes a modular customization strategy for defect-free MOF separation membranes

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A modular customization strategy was applied for efficient MOF membrane fabrication. MOF material screening, defect-free membrane output, membrane physicochemical property regulation and separation applications can be rapidly realized by separately designing and modifying the MOF module within the membrane. High separation performance is easily achieved, which can meet diverse separation requirements. Credit: *Angewandte Chemie International Edition* (2023). DOI: 10.1002/anie.202315057

Membrane separation technology offers great potential due to its low energy consumption and continuous operation. Metal-organic frameworks (MOFs) are ideal membrane candidates due to their abundant species, high porosity, and precise regulation of pore architectures.

Recently, a research group led by Prof. Yang Weishen and Assoc. Prof.

Peng Yuan from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) has proposed a new strategy of modular customization and non-destructive regulation of MOFs for efficient membrane separations.

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The researchers proposed a strategy to modularize custom defect-free MOF separation membranes. The membrane structure consisted of two parallel modules. One was a discrete MOF module based on the characteristics of heterogeneous mutually reinforcing nuclei, which led to the implementation of molecular mass transfer and separation by exploiting the intrinsic pore structure.

The other was the highly cross-linked, ultra-low permeability polyamide module formed by the confined interface polymerization operation, which was responsible for the comprehensive blockade of defects between MOF modules.

Guided by this strategy, the MOF module could be randomly replaced to customize the corresponding MOF separation membrane, and high-performance MOF separation membranes could be rapidly produced. With the modified post-synthesis strategy, the MOF module skeleton in the membrane was controlled without loss and the separation accuracy was doubled.

The researchers selected four MOFs with different pore/channel sizes and functionalities for batch fabrication of defect-free MOF membranes. Each membrane fully displayed the separation potential according to the MOF pore size.

Among them, the NH_2-Zn_2Bim_4 membrane exhibited a high H_2/CO_2

mixture separation factor of 1656 and H_2 permeability of 964 gas permeation unit. Taking advantage of this strategy, the membrane performance could be further enhanced via application-oriented post-synthetic ligand exchange. The H_2/CO_2 selectivity of the regulated membrane was approximately 200% higher than that of the original membrane.

"This strategy provides a tractable route to customize a myriad of high-performance membranes to meet different separation requirements," said Prof. Yang.

More information: Lun Shu et al, Modular Customization and Regulation of Metal–Organic Frameworks for Efficient Membrane Separations, *Angewandte Chemie International Edition* (2023). DOI: 10.1002/anie.202315057

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