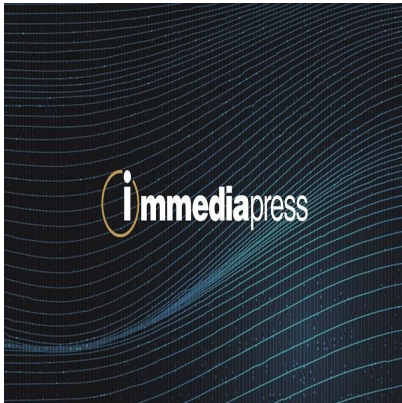




New Membrane Design Advances Carbon Capture

Descrizione

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TIANJIN, China, Oct. 14, 2026 /PRNewswire/ • A research team at Tianjin University has developed a new type of all-organic mixed-matrix membrane that could offer a more efficient and scalable approach to carbon capture by combining high separation performance with long-term stability and large-scale processability.

The study was published online in Nature Energy on Oct. 7 under the title "All-organic mixed-matrix membranes with single-crystal covalent organic frameworks for carbon capture."

Membrane separation has attracted growing attention for carbon capture because of its potential advantages in energy efficiency and environmental performance. However, separating CO₂ from industrial flue gas remains challenging, requiring membranes that can transport CO₂ rapidly while effectively separating other gases and maintaining stable performance over time.

Mixed-matrix membranes combine the processability of polymers with the efficient molecular transport properties of porous fillers, but their development has long been limited by compatibility problems between the two components. Porous particles can aggregate or settle within polymers, while overly strong filler-polymer interactions may restrict polymer movement or block transport pathways.

To address the problem, the Tianjin University team, led by professors Jiang Zhongyi and He Guangwei, proposed a "weak-interaction inlaying" strategy. Instead of simply strengthening filler-polymer interactions, the researchers balanced interactions between the filler and polymer with those among filler particles.

Using single-crystal covalent organic frameworks, or COFs, as porous fillers, the team achieved uniform incorporation at high loading within a polymer matrix. The resulting membrane retained the flexibility and solution processability of the polymer, while the ordered pores of the COF crystals provided efficient pathways for CO₂ transport.

Tests using simulated flue gas showed an order-of-magnitude increase in CO2 permeability, setting a new record. It also showed strong long-term stability, with performance remaining consistent during extended operation and under conditions containing water vapor, sulfur oxides and nitrogen oxides.

A preliminary techno-economic analysis estimated a carbon capture cost of about 38 U.S. dollars per tonne of CO2 under the assumptions used in the study.

The researchers said this work could open up a new direction for mixed-matrix membrane molecular separations and support future applications in carbon capture from power generation, cement and steel production.

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