NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Nanyang Environment and Water Research Institute

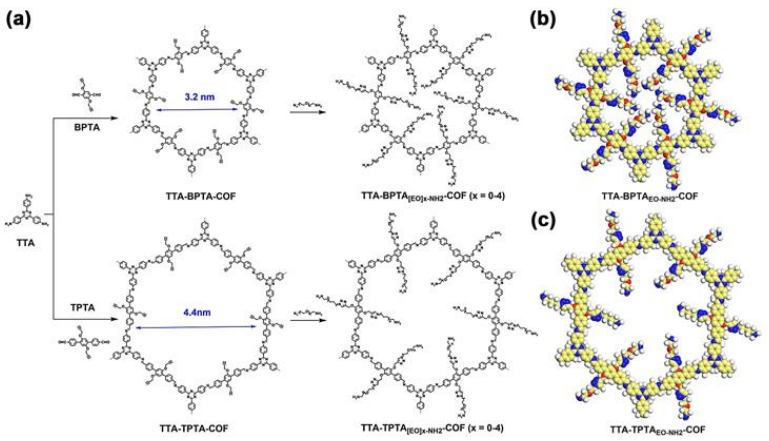
COF-BASED HOLLOW FIBER MEMBRANES FOR VERSATILE CO_2-SELECTIVE SEPARATION

Abstract:

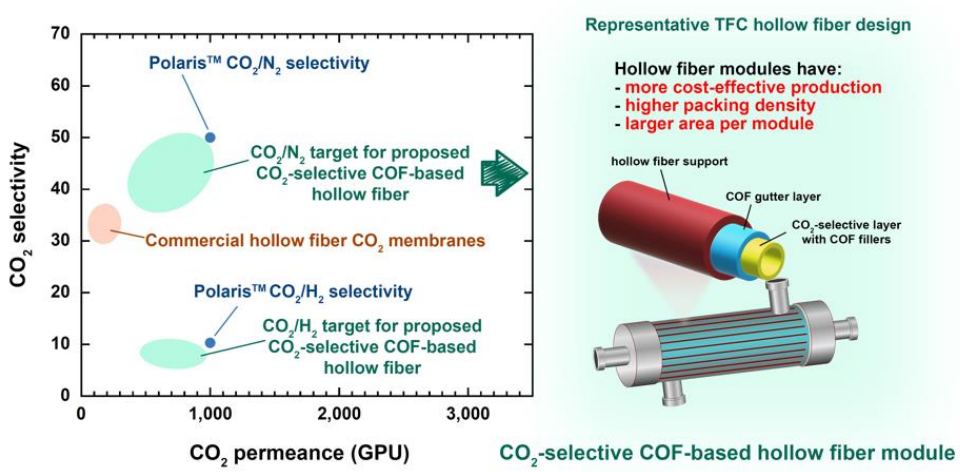
This project aims to design two-dimensional covalent organic frameworks (COFs) to develop a new class of COF-based CO_2-selective membranes for enabling competitive CO_2 capture. Potential applications are targeted at decarbonization efforts of Singapore's power sector, which include flue gas from the waste-to-energy (WTE) industry, and syngas for blue hydrogen production from the steam methane reforming (SMR) industry. The key novelties are: (1) leveraging two-dimensional amino-functionalized covalent organic frameworks (COFs) specially tailored as value-adding enhancers with high CO_2 affinity, (2) a new class of CO_2-selective layer for a high-performance thin-film composite (TFC) membrane design, and (3) the adaptation of hollow fiber configuration to offer separation versatility for different CO_2 gas pairs not seen in any commercial hollow fiber membranes thus far. Notably, the unique CO_2 selectivity of our TFC hollow fiber membrane arises from a two-pronged structural design, comprising a CO_2-selective layer on top of the CO_2-selective COFs. We proposed three work packages (WPs) to realize this design.

The first WP focuses on the development of CO_2-selective layer on a hollow fiber support using polyethylene oxide (PEO)-based materials via scalable coating techniques. The second WP will work on the design and synthesis of novel amino-functionalized COFs as CO_2-selective gutter layer and/or filler to augment WP1. When WP1 and WP2 amalgamate, the specially tailored COFs are expected to enhance the CO_2 affinity and molecular sieving effect of the PEO-based CO_2-selective layer to further elevate CO_2 permeance and induce high selectivity to both CO_2/N_2 and CO_2/H_2 gas pairs. Our third WP will be to demonstrate strong versatility under realistic mixed-gases testing conditions as proof-of-concept of our membrane design for decarbonizing the power sector. Start TRL is at 1-2 with expected TRL at 4 upon project completion.

CO_2 SEPARATION MEMBRANES



Covalent-organic frameworks (COFs) with pore size and chemistry optimized for CO_2 capture



Versatile thin-film composite membranes that can selectively separate CO_2 from both CO_2/N_2 & CO_2/H_2 gas pairs

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Objective: **Decarbonize Singapore's power sector**