京都大学
KYOTO UNIVERSITY

2024 年度 SP+ Fund 報告書（ECR）

Project Report: SP+ Fund 2024 (ECR Program)

研究課題名（英語）／Name of research project (in English)
Asymmetric Pore net-worked membrane for gas separation

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派遣・招へい期間 Period of visit	From 2025/01/11 Until 2025/01/21
主な研究分野 Main research fields	Porous material
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研究課題の実施内容／Summary of research project

受入大学にて何を行ったのか、それが自身の研究にどのような効果をもたらしたのか等記載してください。／ Please describe what you did at the host university, how it benefited your research project, etc.

In this collaborative study, we evaluated the single-gas permeation performance of composite membranes, specifically asymmetric pore-networked membranes (aPNMs) based on a metal-organic framework (MOF) gel (UiO-66-NH_2). As control samples, we utilized a pure polymer membrane and traditional asymmetric mixed-matrix membranes (aMMMs), which were prepared using MOF (UiO-66-NH_2) powder. Additionally, dense membranes of all three membrane types, fabricated via drop casting, were subjected to single-gas permeation testing.

The permeation result of dense membranes indicate that the configuration of PNMs exhibits higher permeance compare to pure polymer, however, the selectivity of CO_2/N_2 decreased from 15.05 to 9.57. Meanwhile, the MMMs demonstrate even higher permeance than PNMs but suffer a significant reduction in the selectivity of CO_2/N_2 (from 15.05 to 1.76). This suggests that the increasement of permeance observed in MMMs is primarily due to the presence of non-selective micro-voids at the interface between the MOF powder and polymer matrix. Conversely, the PNM configuration not only enhances permeance but also retains selectivity to a greater extent, indicating improved compatibility between the polymer and the MOF gel.

For the asymmetric membranes, the single-gas permeation results reveal that all aPNMs exhibit gas leakage, whereas neither the pure polymer membrane nor the aMMMs show any signs of leakage. We hypothesize that the phase inversion process used in the fabrication of aPNMs may induce the formation of a mesoporous network within the polymer-MOF gel structure. If this assumption holds true, aPNMs may not be suitable for gas separation applications; however, they could be advantageous for processes requiring enhanced mass transfer properties, such as water purification and catalysis.

今後の展望／Prospects for future research collaboration

In the future, we plan to optimize the preparation process of aPNMs and repeat the single-gas permeation test to verify the accuracy of our current conclusions. Additionally, we aim to enhance the compatibility between the polymer and MOF gel by exploring alternative polymer materials.