



Organosilica membrane with ionic liquid properties for separation of toluene/H₂ mixture

Yuichiro Hirota^{a,*}, Yohei Maeda^a, Yusuke Yamamoto^a, Manabu Miyamotob, and Norikazu Nishiyama

^aDivision of Chemical Engineering, Graduate School of Engineering Science, Osaka University, 1–3 Machikaneyama, Toyonaka, Osaka 560–8531, Japan. E-mail: yhirota@cheng.es.osaka-u.ac.jp

^bDepartment of Chemistry and Biomolecular Science, Gifu University, 1-1 Yanagido, Gifu 501-1193, Japan.

Supplementary Materials

Table of contents

- 1. Cross-sectional SEM image of the tubular support
- 2. Toluene/H₂ separation test apparatus
- 3. Cross-sectional SEM image and EDX analysis of the ILOS membrane

1. Cross-sectional SEM image of the tubular support

Cross-sectional SEM image of the tubular support (purchased from eSep Inc.) is shown below.



Figure S1. Cross-sectional SEM image of the tubular support.

2. Toluene/H₂ separation test apparatus

Separation of a binary mixture of toluene/H₂ (toluene : H₂ = 1 : 3 (molar)) was conducted at 343 K. A schematic diagram of separation test apparatus is shown in Figure S2. The binary mixture and N₂ as a sweep gas were fed into a feed and a permeate side of the membrane, respectively. Flow rates of H₂ and N₂ as a sweep gas were controlled using mass flow controller. Toluene was sent to vaporizer by a syringe pump. The flow rates of H₂, toluene vapor and N₂ were 50, 16.6 and 20 cm³/min, respectively. The total pressure on the feed side and the permeate side was kept at 0.12 and 0.1 MPa, respectively. Permeate stream was analysed using a gas chromatograph (Shimadzu GC-8A). The toluene vapor and H₂ permeation performance of the membrane was evaluated based on permeance [mol m⁻²s⁻¹Pa⁻¹] and separation factor. Toluene/H₂ separation factor was calculated as the ratio of toluene and H₂ permeance. The detection limit of toluene/H₂ permeation test was 10⁻¹² mol m⁻²s⁻¹Pa⁻¹.



Figure S2. A schematic diagram of separation test apparatus.

3. Cross-sectional SEM image and EDX analysis of the ILOS membrane

Cross-sectional SEM image and EDX chemical map for F atom of the ILOS membrane were shown in Figure 3S. The IL was existed not only in nanoporous SiO_2 layer but also in a macroporous Al_2O_3 support.



Figure S3. Cross-sectional (a) SEM image and (b) EDX chemical map for F atoms of the ILOS membrane. (White dot represents F atoms.)