Author's Accepted Manuscript

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PII: S0376-7388(16)32195-0
DOI: http://dx.doi.org/10.1016/j.memsci.2017.04.062
Reference: MEMSCI15226

To appear in: *Journal of Membrane Science*

Received date: 7 November 2016
Revised date: 30 March 2017
Accepted date: 25 April 2017

Thermally treated polyaniline/polybenzimidazole blend membranes: Structural changes and gas transport properties

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Abstract:
Polyaniline/polybenzimidazole (PANI/PBI) blend membranes with various ratios of PANI/PBI were prepared by *the* solution casting method. The resulting free-standing membranes were subsequently doped with hydrochloric acid. In the next step, the membranes were heated up to 600 °C in an inert nitrogen atmosphere. FTIR spectroscopy and Raman scattering *show* the conversion of the blend to a nitrogen-containing carbon-like material. The permeability and sorption properties with respect to H_2, O_2, N_2, CH_4, and CO_2 were determined. The separation qualities of *the* thermally treated PANI/PBI blend membranes significantly *exceed* those of non-thermally treated membranes. The permeation properties *show* a strong dependence on *the* PANI concentration in the blend and on its doping. The best separation performance for H_2/N_2, CO_2/N_2, and CO_2/CH_4 *is* obtained with the thermally treated undoped PANI/PBI 20/80 blend membrane.

Keywords: polybenzimidazole, polyaniline, thermal treatment, gas permeation, gas sorption

1. Introduction

Separation of gases on *the* industrial scale *has* increasingly *been* accomplished in recent years by membrane technology, which offers size compactness, process simplicity, energy efficiency, and low environmental *impacts* compared to conventional separation techniques [1,2]. *Different materials have been used for membranes manufactured for ammonia purge gas processing, natural gas dehydration, oxygen enrichment, syngas production, CO_2 separation, and hydrogen purification [1,2], including zeolites [3], silica [3], metal organic frameworks (MOFs) [3], graphene-based materials [3], organic–inorganic hybrid materials [3–5], high-performance polyimides (PI) [3–5], thermally rearranged (TR) polymers [3–5], polymers of intrinsic microporosity (PIMs) [3,4], and ionic liquids (ILs) [3–5]. The choice of a membrane material depends on the specific requirements of the gas separation application. Up to now, particular attention has been paid to polymeric membranes because of their cost effectiveness, high chemical stability, and excellent processability [6–10]; however, their performance is circumscribed by a trade-off between permeability and selectivity [11–13]. Thermally treated membranes have attracted considerable attention because of their chemical stability in corrosive environments, applicability at high temperatures, and gas separation behavior [14–17].* The most notable advantages of these membranes have been recently reviewed [18] to demonstrate *their* attractive features in comparison to polymeric membranes and to depict their suitability for membrane gas separation.

Hitherto, numerous polymers have been investigated for the preparation of thermally treated membranes. However, only a few studies *have* applied the idea of blending for the development of thermally treated membranes [15,19–23]. *Rather than synthesizing new polymers, p*olymer blending is a unique time- and cost-effective technique *that can* generate new polymeric materials with superior properties because it combines the advantages of each polymer *to obtain* a new material with synergistic properties [2,24]. Moreover, the new