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Synthesis, characterization and gas permeation study of HAB-6FDA/ZIF-11 mixed matrix membranes

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Separation of carbon dioxide from natural gas is an important issue since it contributes to the economy of a country by increasing the energy content of the natural gas. The main purpose of the study was about polymeric membranes and how to increase selectivities and permeabilities of polymers for gas separation applications. Thermally rearranged (TR) polymers are considered as the next-generation of membrane materials, because of their excellent transport properties and high thermal and chemical stability. This study explores the influence of ortho-position hydroxyl functional group structures on gas transport properties of polyimides and their thermally rearranged polymers. For this work, HAB-6FDA polyimide was synthesized from 3,3-dihydroxy-4,4-diamino-biphenyl (HAB) and 4,4′-(hexafluoroisopropylidene) diphthalic anhydride (6FDA) by a two-step polycondensation method with chemical imidization. And also zeolitic imidazolate framework-11 (ZIF-11) crystals were successfully synthesized as porous filler. Mixed matrix membranes were fabricated using HAB-6FDA polyimide and a ZIF-11. The HAB-6FDA/ZIF-11 polyimide was partially converted to its corresponding thermally rearranged (TR) polymer by thermal treatments at different temperatures. The rearrangement reaction was performed at temperatures from 350 to 400 °C. Scanning electron microscopy (SEM), X-ray diffraction (XRD) and particle size analysis were achieved to investigate ZIF-11 structure. Fourier transform infrared spectroscopy (FTIR), XRD and thermogravimetric (TGA) analysis were also carried out to characterize mixed matrix membranes. Surface and cross-sectional scanning electron microscopy images of the mixed matrix membranes (MMMs) were taken to examine the dispersion of particles in the polymer matrix. No visible agglomeration between ZIF-11 particles and the polymer matrix was spotted, even at high % ZIF-11 loading. Gas separation performance of HAB-6FDA/ZIF-11 mixed matrix membranes (MMMs) with various ZIF-11 percentages were investigated at 35 °C temperature and 4 bar pressure. MMMs were described by the measured permeabilities of H_2, CO_2 and CH_4 gases and ideal gas selectivities were determined. Permeability of all gases increased with increasing ZIF-11 percentages.

Author Biography

Mehtap Safak Boroglu has received her BS degree in Chemical Engineering in1997, MSc degree in Chemical Engineering in the year 2003 from Istanbul University, and did his PhD degree in Chemical Engineering (2007) from Istanbul University, Turkey. She has been working as an AssistantP at Istanbul University, Faculty of Engineering, Chemical Engineering Department since May 2009. She has been the Supervisor of many national projects in the field of gas separation by polymeric membranes and solar cells. Her research interests include polymer synthesis and characterization, gas separation, solar cells. She has also Co-authored more than 16 scientific papers.

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