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Synthesis and gas transport properties of substituted bicyclodianhydride-based polyimides

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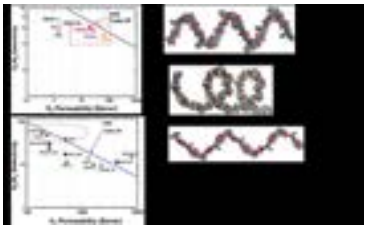
Three novel polyimides were synthesized from a 9,10-dimethyl-2,6(7)-diaminotriptycene (T) with a commercially available *bicyclo[2.2.2]oct-7-ene-2,3,5,6-tetracarboxylic dianhydride* (BC) and its halogenated derivatives. The non-halogenated T-BC polyimide derivative was made as a reference material to evaluate the effect of the halogen groups in T-BCCl$_4$ and T-BCBr4 on its gas transport properties. Pure-gas permeability coefficients of He, H_2, N_2, O_2, CH_4, and CO_2 were measured at 35 °C and 2 atm. The BET surface area based on nitrogen adsorption at 77 K of T-BC was 570 m^2 g^{-1} while those of tetrachloro-functionalized T-BCCl4 and tetrabromo-functionalized polyimide T-BCBr$_4$ were reduced significantly to 340 and 30 m^2 g^{-1}, respectively. The decrease in BET surface area in the halogenated polyimides resulted from reduction in their pore volumes relative to that of T-BC due to occupation of free volume space by the halogens. The freshly prepared T-BC membrane had a pure-gas O_2 permeability of 66 Barrer and O_2/N_2 selectivity of five. The permeability decreased significantly by replacing the hydrogen groups by the chloro- or bromo groups in the cycloaliphatic dianhydride building block. For example, the permeability of O_2 decreased by 3-fold from 66 in T-BC to 20 Barrer in T-BCBr$_4$, while the permeability of nitrogen was reduced from 13 to 3.4 Barrer. As expected for lower permeability polymers, the O_2/N_2 selectivity increased concurrently from 5 in T-BC to 6 in T-BCBr$_4$. Long-term testing over 365 days resulted in only ~ 15% loss in gas permeability's and without significant changes in selectivity's, which demonstrated that these polyimides were resistant to physical aging. These combined results suggest that BC-based polyimides are promising candidate membrane materials for gas separation applications.



Biography

Mahmoud A. Abdulhamid is a PhD student at King Abdullah University of Science and technology (KAUST) located in Saudi Arabia at the shore of the Red sea. He earned his Bachelor and master's degrees from the Lebanese University in Organic and Polymer chemistry; he did his master's thesis in France, university of Pau where he worked on an industrial project for six month to modify the natural polymers by green chemistry. Mahmoud has been working on his PhD thesis entitled Structure-property relationship for membrane-based polyimides, where he synthesizes monomers and then making different type of polymers and test for gas separation. Mahmoud is an inventor on one US patent application and co-inventor on other two applications.

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