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IMPROVING GAS BARRIER PROPERTIES USING MIXED MATRIX MEMBRANES BASED ON ION EXCHANGE CAPACITIES OF THE POLYMERS

Abstract:

Membranes are alternative solution for industrial and domestic separation processes, from water treatment, gas separation, and electrochemical devices. The urgency to limit landfill and petroleum dependency leads the development of new environmentally friendly and economic barrier materials as protective packaging applications (Piringer & Baner, 2000).
Chitosan (CS) is a polysaccharide prepared by the deacetylation of chitin. Due to the inherent characteristics, CS has been highly studied as a promising material for membrane separation and active packaging. Poly vinyl alcohol (PVA) can be blended with CS to improve its mechanical properties without reducing hydrophilicity and ion exchange properties (García-Cruz et al. 2015).
AM-4 is a layered titanosilicate built of TiO6 octahedra and SiO4 tetrahedra. UZAR-S3 is a layered stannosilicate prepared from isomorphously substitution of Ti by Sn of layered titanosilicate. Both offer a high ion exchange capacity because of the Na+ exchangeable cations between the layers and this contributes to the compatibility with the CS-PVA matrix and the final membrane properties.
This work studies the preparation of AM-4- and UZAR-S3/CS-PVA mixed matrix membranes by the direct dispersion and exfoliation of small amounts of AM-4 and UZAR-S3 in the polymer solution. The membranes are characterized regarding their thermal, ion exchange, water uptake, chemical structure and gas barrier properties. The barrier properties were characterized by single gas permeation of N2, O2 and CO2 at 20ºC and 2 bar. The best ion exchange capacity and lowest mechanical swelling were those of the UZAR-S3/CS-PVA membrane, which had also lower gas permeability than the pristine CS-PVA membrane. The mechanical swelling of the membranes decreases in the order CS-PVA > AM-4/CS-PVA > UZAR-S3/CS-PVA, probably due to the lower alkylation of –O-H from free water in the latter membrane than in the others. This also agrees with the lowest permeability of UZAR-S3 compared to AM-4/CS-PVA.

Keywords:

chitosan; poly vinyl alcohol; layered titanosilicate AM-4; layered stannosilicate UZAR-S3; ion exchange; barrier

JEL Classification: Q53, Q56, Q55

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