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Inorganic - polyimide hybrid membranes by sequential molecular grafting

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Inorganic – organic hybrid membranes may combine the advantages of their organic and inorganic constituents. Inorganic materials have superior thermal and mechanical stability, and do not suffer from plasticization and swelling. Organic materials allow for versatile molecular selectivity. We aim to construct hybrid materials in which an organic polymer is confined in the pore structure of a porous ceramic, resulting in moderated macromolecular dynamics and accordingly a reduced propensity to swelling and plasticization. The approach is based on sequential molecular grafting of aromatic polyimide precursors on to meso-porous γ-Al_2O_3 membranes. The selected precursors are hexafluoroisopropylidenediphthalic anhydride (6FDA) and hexafluoroisopropylidene dianiline (6FpDA).

Surface chemistry and morphology of the hybrid materials were characterized with Fourier transform infrared spectroscopy and nitrogen physisorption. The data confirm covalent bonding of the organic molecules to the metal oxide surface. Upon each sequential grafting step, the surface area, pore volume and average pore diameter decrease. After several grafting steps, nitrogen sorption isotherms indicate an increased amount of micro-pores and a reduced amount of meso-pores. Concurrently, the permeance of N_2 and CH_4 decreased. These observations suggest filling of pores with organic functional groups. In contrast to N_2 and CH_4, the permeance of CO_2 gradually increases with the number of sequential grafting steps, due to the raised concentration of organic groups with high CO_2 affinity. Optimization of the sequential grafting process is required to further improve CO_2 selectivity, while avoiding the effects of plasticization and swelling. The resulting membranes could display high performance at elevated pressure and temperature, where non-confined polymers typically suffer from swelling

and plasticization.

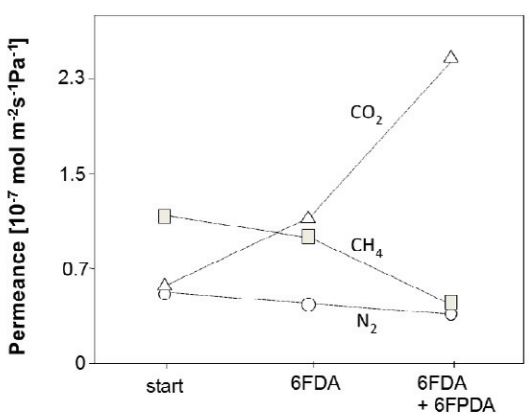

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Figure 1 Single-gas dead-end permeance for sequential molecular grafting steps of a meso-porous γ-alumina membrane.

Keywords: Gas seperation, g-alumina porous membranes, Polyimide membranes, Grafting