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Two-dimensional JDF-1 zeolite-based membranes on porous ceramic supports for hydrogen separation

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Gas separation membranes can play a huge role in the future as a separation technology for hydrogen due to its potential application as an environmentally friendly energy storage- or as a propulsion system for vehicles. Natural gas streams are considered as a means of transportation for hydrogen as long as a suitable technology can be used to separate hydrogen from the rest of the gas at the end of the process. Membrane technology appears as a promising solution to this.

Interesting membrane materials, that can achieve the goal of selective H_2/CH_4 and H_2/N_2 gas separations, are 2D-based zeolite membranes thanks to their defined pore aperture, and high flux due to their low thickness [7, 9]. An interesting 2D zeolite for the separation of H_2 from bigger gas molecules, such as CH_4 or CO_2, is the titanosilicate zeolite JDF-1 due to the small pore aperture in the range of the hydrogen molecule [6]. Only a few works in the literature address the use of this specific zeolite [2, 5, 6]. Most of them focus on mixed matrix membrane (MMM) preparation by impregnation/infiltration of the 2D zeolite and related nanosheet in a polymer matrix. Such preparation leads to the formation of composite membrane materials with aggregated zeolite nanomaterial in the polymer matrix. Despite their impressive H_2/CH_4 selectivity of up to 128 [2] such MMMs exhibit inherent limitations such as their susceptibility to plasticization [3] and have usually a far bigger thickness up to the magnitude of several microns [1, 4, 8].

In this work, a new generation of 2D-based zeolite membranes made of titanosilicate nanosheets was developed directly on porous ceramic supports (Fig. 1). The preparation of these membranes requires the controlled deposition of nanosheets followed by the in-situ surface polymerization of a thin polyimide network to cover the defects and enhance the separation performance of the membrane. Relevant characterization methods were deployed to investigate the morphology and composition of the membrane and the separation performance was investigated using gas permeation measurements under pressure gradient.

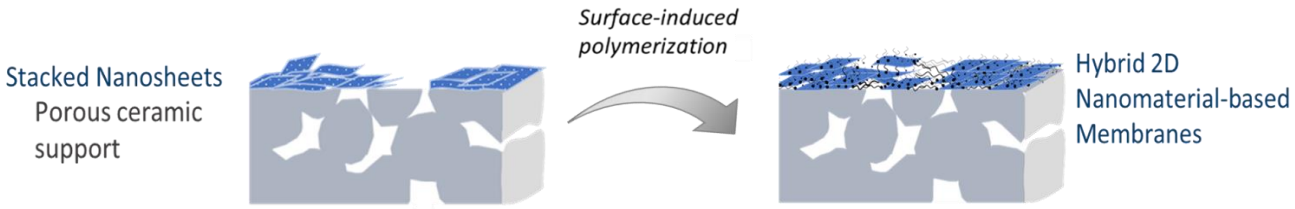

Fig 1. Scematic representation of the surface induced polymerization approach to fill the defefcts.

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