Nanocarbon-based cellulose acetate membranes for CO$_2$ separation applications

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ABSTRACT

Mixed matrix cellulose acetate (CA) membranes were prepared and studied with regard to their CO$_2$ separation properties from CH$_4$ & N$_2$ mixtures. Multiwalled carbon nanotubes (M-CNTs) were used as membranes' filler material in cellulose acetate (CA) using diacetone alcohol (DAA) as common solvent.

For the physicochemical characterization of the M-CNTs numerous techniques such as scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy (FTIR), x-ray diffraction (XRD) and nitrogen adsorption isotherms at 77K were used.
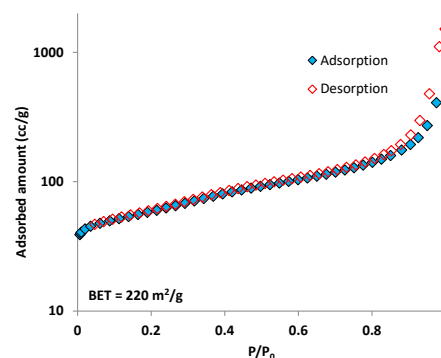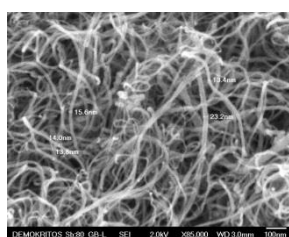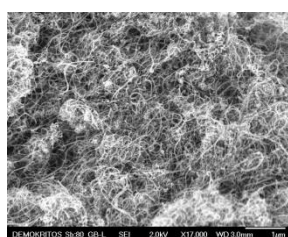
Figure 1. SEM images of M-CNTs (*left*), N$_2$ adsorption isotherm at 77K of M-CNTs (*right*).

M-CNTs in DAA can be dispersed using combined techniques with high shear rates leading to stable dispersions, but during long-term storage and especially when added to polymer solutions (which is necessary for membrane manufacture) M-CNTs tend to reagglomerate. Therefore, a secondary dispersion step becomes necessary. The secondary dispersion of the M-CNTs into the solvent took place by using both ultrasonic and rotor/stator techniques and the results were compared and discussed. For both systems the critical parameter is the energy input, which was systematically changed under the consideration of different treatment durations and equipment performances.

Furthermore, the parameter of the polymer concentration into the M-CNTs/Polymer/Solvent mixtures was determined as a long-term stability factor of the M-CNTs dispersions. We investigated the impact of the
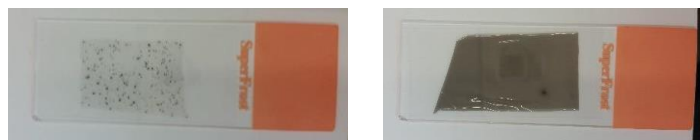
Figure 2. Comparison membrane (a) 2.5 wt% CA (low viscosity) (b) 5 wt% CA (high viscosity)

dispersing method and the formulation of the polymer solution on the quality of the final membrane. The above-mentioned dispersions were used for the production of mixed matrix membranes via dry cast which are characterized by scanning electron microscopy, thermal analysis, electrical and mechanical properties in regard with their CO$_2$/CH$_4$ and CO$_2$/N$_2$ separation performance. Figure 2 depicts two membranes prepared by different solution viscosities.

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