Study of the influence of a conductive polymer on mixed matrix membranes

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Abstract

The use of membranes in water treatment has been highlighted to solve problems of drinking water scarcity due to advantages such as: low cost, high efficiency and simplicity of operation. However, the formation of membrane fouling limits the study and application of this process, due to the fact that fouling restricts the efficiency of the membrane, reducing water flow and increases the process costs. Therefore, it is necessary to develop membranes that mitigate fouling. One alternative to overcome this problem is to produce membranes with better hydrophilicity. The use of a conductive polymer such as polyaniline (Pani) offers membranes with improved hydrophilicity, as well as adjustable electrical conductivity [1-4]. In this work, mixed matrix membranes (MMM) were produced with polyethersulfone (PES) and sepiolite (Sep) in different contents (1-5 wt %). Pani was incorporated using the phase inversion methodology in order to check their potential antifouling activity. The membranes were characterized by electronic spectroscopy in the UV-Vis region using the diffuse reflectance technique, as can be seeing Fig. 1(a). It is possible to note that the PES matrix does not absorb in the visible region and has a weak absorption band around 320 nm. In the spectra of the membranes containing Pani and Sep, two broad bands are observed at 350 and 600 nm. These bands refer to the π-π* transition in the benzenoid rings and the presence of Pani polarons, respectively. The UV-Vis spectrum is characteristic of the conductive form of Pani into the membranes [5]. The hydrophilicity was analyzed by measuring the contact angle and the degree of swelling with water. Fig. 1 (b) shows that the angle of the pure PES membrane was around 75°, which is due to its hydrophobic nature. In the presence of PANI and PES, this value decreases to 58°. When analyzing the swelling data, it can be seen that the membrane containing only PES the value is around 38%, after the addition of Pani this value increased to 264.9% for the Pani 0,2% membrane and 361% for Pani.Sep 5% membrane. These data indicate that the addition of Pani increases the hydrophilicity of the membranes. This improvement can be correlated to the fact that Pani contains hydrophilic groups in its structure and due to its high surface energy [6, 7]. These values can be related to the increase in the amount of pores in the membranes, as shown in Fig.2.

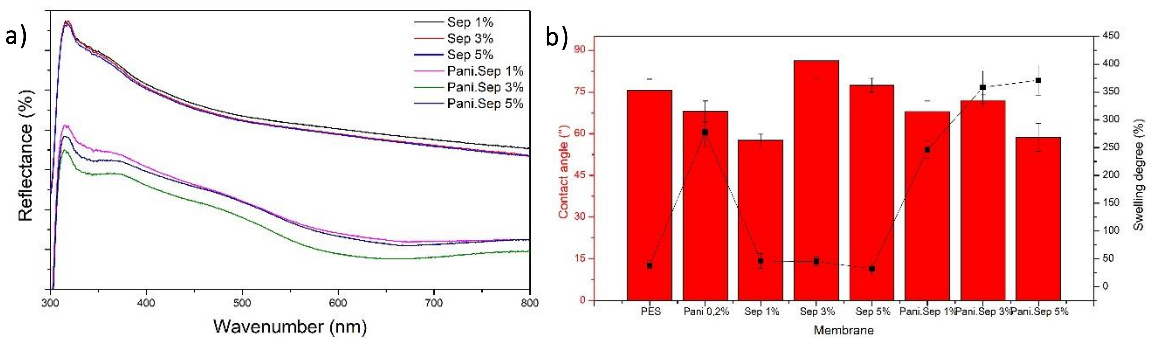

Fig. 1. a) UV–visible absorption spectra; b) Hydrophilicity of the MMMs. The error bars represent as standard deviation obtained from two replicates of experiments.

Fig. 2 (a) and (d) show the control membrane without Pani and Sep on the surface and in its cross section, respectively, while (b) and (e) refer to the membrane containing 0.2 % Pani, in the (c) and (f) refer to the membrane containing 3,0% Sep. When comparing the three samples, there is an indication that the addition of PANI and SEP led to an increase in the number of pores, which were larger in length. The pores of the membrane containing Pani have a finger shape, this configuration is characteristic of the type of methodology adopted to obtain the membranes, and ends up acting as a pore former. This pore model resulted in an increase in the permeability of the material, which corroborates the data seen in Fig. 1 (e). From the data collected, it can be inferred that the addition of Pani to the PES matrix improved various membrane properties. With the addition of Pani, it was possible to see an improvement in hydrophilicity, an increase in the number and size of pores, as well as their having a finger shape which favors the permeability of the membrane.

Thus, the results obtained so far in this study indicate that the material will have antifouling properties, which is of fundamental importance for the use of these membranes for water treatment.

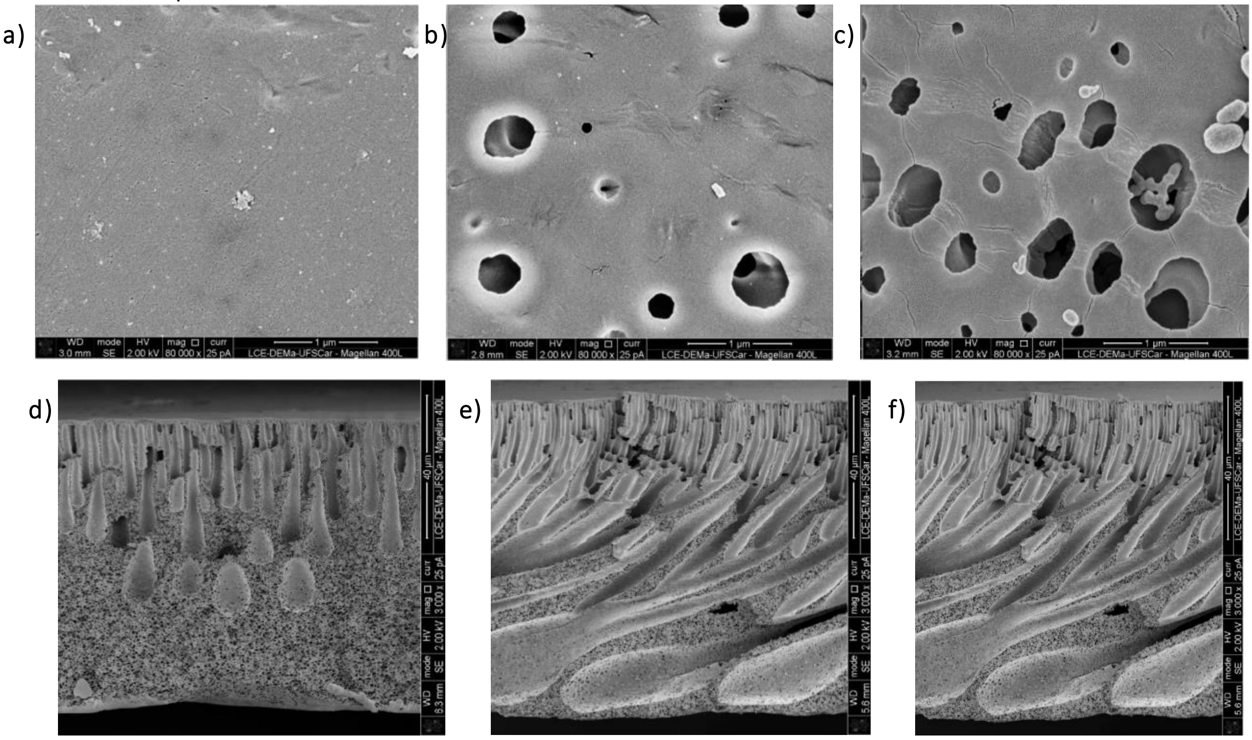

Fig. 2. SEM images of the membranes: surface of the a) PES membrane, b) PES-PANI, c) PES-SEP; cross section of the d) PES membrane, e) PES-PANI and f) PES-SEP.

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