NOTES

Combined Polyethylene–Polyaniline Membranes

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We previously developed a technique for the preparation of microfiltration membranes of low-density polyethylene (PE) involving melt extrusion at a high flow velocity with subsequent annealing, drawing, and thermal stabilization.[1,2] The microporous films obtained by this technique have a mean pore size of 0.045 microns, high permeability, small thickness, and good mechanical properties. Owing to these parameters, the films can be efficiently used as a support for depositing a layer of another polymer which is either unable to form film or the film made from it has poor mechanical characteristics but reveals separating ("membranelike") properties. Such a polymer is polyaniline (PANI), which is able not only to retain or to exchange anions under an applied voltage[3] or without it,[4] but also to separate neutral species (solutes and gases).[5–7] The first case is associated with the change of pK_a, and the second case is connected with the variation of polymer morphology upon changes in the degree of oxidation of PANI. The utilization of the useful separating properties of PANI, however, is hindered by the poor processability and poor mechanical properties. Thus, the preparation of combined PE–PANI membranes represents considerable scientific and practical interest. It should be noted that, to the best of our knowledge, no information on the preparation of PE–PANI membranes is available at present.

In this article, we now report a method for the preparation of combined membranes on the basis of a microfiltration PE membrane and PANI. Combined PE–PANI membranes which are resistant to mechanical effects and to nonaqueous media (including solvents and electrolytes) were produced in the following way. A thin PANI layer was deposited on the PE membrane surface from an aqueous dispersion of PANI with particles of about 0.3 micron in size, obtained by polymerizing aniline in an aqueous solution of poly(vinyl alcohol) (PVA).[8] The layer of thickness of 4–7 microns, consisting of PANI particles embedded in the PVA matrix, revealed high adhesion to the PE membrane surface. The adhesion remained high also upon exposure to solvents such as ethyl alcohol and propylene carbonate, and no peeling of the PANI-containing layer occurred even upon breakdown of the membrane.

It should be noted that conventional PE films obtained by melt extrusion exhibit low adhesion to the majority of polymeric and nonpolymeric materials. Actually, a PANI-containing layer formed by the same way as onto PE membranes is readily separated from both as-spun and annealed PE films. On the other hand, a film of neat PVA exhibits poor adhesion not only to the conventional PE films, but also to the surface of PE membranes. These facts allow one to suggest that the reasons of the high adhesion of the PANI-containing layer are associated to both the highly developed surface of the PE membrane and the peculiarities of the structure of PANI-containing layer.

The electrical conductivity of the PANI-containing layer of combined membranes measured by a conventional four-probe technique (σ = 0.2 S/cm) is equal to that of a film cast from the initial PANI dispersion. The latter, however, has a much greater thickness and fairly low mechanical properties. This result suggests that the PE surface does not affect the formation of the conducting PANI "network."

A combined membrane obtained by deposition of a PANI-containing layer on both surfaces of a PE membrane is permeable to ethyl alcohol. In this solvent, the

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sample becomes transparent, which is evidence of the permeability of the PANI-containing layers. This fact allows one to suggest that the PE–PANI membrane obtained has to combine not only the intrinsic properties of the microfiltration PE membrane and PANI, but also the properties of the PANI-containing layer itself.

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