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Fabrication and electrochemical properties of polymer bilayered membranes

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In this paper we report on fabrication method of 'diode-like' polymer bilayered membranes that possess asymmetry of conductivity in electrolyte solution – a rectification effect similar to that of a p-n junction in semiconductors. To produce membranes with 'diode-like' properties, a thin semipermeable polymer layer formed by plasma polymerization of organic monomers was deposited on the one side of a porous substrate. As a porous substrate a poly(ethylene terephthalate) track membrane with a thickness of 9.5 μm and a pore diameter of 215 nm (pore density of $2 \cdot 10^8$ cm^{-2}) was used. To produce the membrane, a poly(ethylene terephthalate) film was irradiated with krypton positive ions, accelerated in the cyclotron, and then subjected to physicochemical treatment on a standard method. Thiophene, pyrrole and acetylene were used as monomers. The deposition of the polymer film on the membrane surface from monomer vapors was done in a plasma-chemical reactor using a RF-discharge in parallel plate configuration at the frequency of 13.56 MHz. Measurements of the current-voltage characteristics of the membranes were carried out with a direct current regime in the voltage range of –1 to +1 V using a PC-controlled potentiostat 'Elins P-8S' with a scan rate of 100 mV/s. A two-chambered cell with Ag/AgCl electrodes, containing a water solution of potassium chloride of identical concentration on both sides of the membrane was used for this purpose. It is shown that the appearing of the 'diode-like' properties for composite membranes formed by this way can be explained by the presence in the membranes of two layers with functional groups of different natures and also by the change of the pore geometry. Such behavior of the formed membranes allows one their use as an electrical valve. Moreover, it is shown that the variation of the semipermeable layer thickness by plasma polymerization as well as the modification of the electrochemical properties of plasma treated membranes by chemical doping with iodine or hydrochloric acid allows one to produce a wide spectrum of polymer composite membranes with asymmetric conductivity. Such membranes can be used to create chemical and biochemical sensors.

Keywords
polymer bilayered membranes
plasma polymerization method
asymmetry of conductivity