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MODIFICATIONS OF PERFLUORINATED SULPHOCATIONIC MF-4SC MEMBRANES FOR FUEL CELLS
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Fuel cells are electrochemical devices with high energy conversion efficiency and minimized pollutant emission. The membrane materials for fuel cells should have the stable hydrophilicity and high proton conductivity [1]. This work aims to provide an overview of membrane modifications with high proton conductivity and a presentation of characterization methods. Samples of perfluorinated sulphocationic MF-4SC membranes, modified by various additives, were prepared in JSC “Plastpolymer” (S.-Petersburg, Russia). Polyvinyl alcohol, polyvinyl butyral, sulphonated polysulphone, and hydrogen zirconium phosphate were used as modifying agents. Several standard techniques have been used to membranes characterization [2]. Water content, exchange capacity, specific conductivity, diffusion permeability and current-voltage curves of modified and hybrid membranes in the HCl and NaCl solutions were measured. The structural characteristics of membranes were investigated by method of standard porosimetry. The obtained results confirmed the efficiency of modifying. The experimental data on concentration dependences of conductivity and diffusion permeability were used for calculation of the transport-structural parameters of membranes according to the model approach. These parameters were used for the estimation of the transport numbers of ions in membranes. It was shown that the selectivity of modified membranes does not change. The water immobilization in the membrane structure due to modifying additives was confirmed by voltammetric method. The slope of the ohmic portion of current-voltage curve is the same because the membrane contribution in the general resistance of system is not essential. The effect of a longer plateau of the limiting current was observed in the current-voltage curves of the modified membranes. The analysis of experimental data permits to propose membranes materials with optimal set of electrochemical characteristics to improve the performance of fuel cells. Hybrid materials on the base of perfluorinated sulphocationic MF-4SC membrane and hydrogen zirconium phosphate are more perspective for the application at high temperatures.

Perspective materials for fuel cells are composite membrane on the basis of MF-4SC and the polyaniline. The polymerization of aniline proceeded in the membrane matrix (bulk modification) and on the membrane surface (surface modification). The current-voltage characteristics of composites in the “free standing” state were studied. The effect of stabilization of limiting current density is observed for MF-4SC membrane after bulk modification: the potential of transition to the overlimiting state for the composite membranes is above 3 V, whereas for the original membrane this value is 0.85 V. It has been shown that the plateau length depends on the type and concentration of solution, characteristics of the original membrane and polyaniline oxidation degree. The effect of current-voltage curves asymmetry is observed for different orientation of the polyaniline layer towards the current direction for an anisotropic composite membrane after surface modification [3]. Chemical template synthesis of polyaniline in MF-4SC as a basic matrix was carried out both in static conditions and in external electrical field. The saturation of a membrane by monomer and process of aniline polymerization in MF-4SC matrix proceeds faster in electrical field. The prepared samples have enough high conductivity (≈ 3 Cm/m) and stable hydrophility which are necessary for application in fuel cells. This method is more environmentally friendlier and faster compared to preparation of composite membrane in static conditions.

The present work is supported by the Russian Foundation for Basic Research (project № 12-08-01092).

References