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Dielectric relaxation of polymer composits based on a MF-4SK membrane and polyantimonic acid

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Abstract

This paper presents the results of studies of composit membranes based on MF-4SK and polyantimonic acid (PAA) with the composition $H(H_3O)Sb_2O_6H_2O·0.2H_2O$. Composite membranes were prepared by mixing disperse PAA and aqueous solution of MF-4SK in ratios of MF-4SK+3% PAA. After having been dried under the normal conditions, the samples represented elastic films with a thickness of 120-150 microns.

Dielectric characteristics of PAA were measured by a complex impedance spectroscopy technique in the frequency range from 100 Hz to 2 MHz on an *ElinsZ–1500J* impedance analyzer. We used a purpose-designed cell in the form of a flat capacitor with graphite electrodes. The sample to be studied was placed into the space between the electrodes. The cell was placed in a thermostat, which allowed the sample temperature to be varied from 220 to 300 K.

Processes related to the relaxation and proton transport in a heterogeneous system were considered. Thus, the frequency dependences of the dielectric loss tangent and of the imaginary part of permittivity at various temperatures display peaks that shift towards the higher frequency side with rise in temperature.

Cole-Cole diagrams of the MF-4SK + 3% PAA samples at different temperatures represent semicircular arcs resting on the segments $(\varepsilon_s - \varepsilon_\infty)$ with their centers positioned below the x-axis. This indicates that within the sample to be studied the processes having a range of relaxation time and with an average relaxation time τ_c occur. The static dielectric permittivity at different temperatures was derived from above diagram. Large ε_s values indicate the inheterogeneous structure of the dielectric membrane and the macrodipole formation.

The proton transport in the composite membranes has been shown to occur both within a PAA particle along the chains of alternating diaquahydrogen ions with the formation of macrodipoles and in the polymer matrix MF- 4SK. The conductivity activation energy results from the change in the mobility and concentration of protons involved in charge transport and amounts to 48 kJ/mol.

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