

The Optical Properties of Water and Aqueous Solutions Close to Ion-Exchange Membrane

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Here we describe the experiments on the modulation interference microscopy related to the study of the spatial distribution of refractive index n of water and some aqueous solutions close to the Nafion interface in the optical frequency range. Nafion is a proton-exchange membrane widely used in manufacturing of the low-temperature hydrogen elements. As was obtained in our experiments, at the Nafion interface the value of $n(x = 0)$ for pure water exceeds by a factor of 1.1 its equilibrium value n_0 ; the refractive index decreases at higher distances far from the interface, taking on its equilibrium value in the bulk of water at the distance of $R \gg 50$ mm from the interface. The values of R and $n(x = 0)$ essentially depend on the magnitude of pH of water sample and the temperature. In the same way we investigated the action of the Nafion membrane in the water-free Glycerol and the water – glycerol mixtures at various content of water. It occurred that Nafion does not affect the water-free Glycerol, while in the case of the water – glycerol mixtures the value of $n(x = 0)$ is less than that in the bulk of the liquid, while at higher distances from the interface the refractive index grows. This effect can be interpreted only if one assumes that Nafion extracts water molecules from the mixture toward the interface. The nature of this effect is the electrostatic attraction between the Nafion membrane and the molecules of water and glycerol; this attraction is more effective for water molecules. The electrostatic attraction originates from charging of the Nafion interface in the process of swelling Nafion in water. A qualitative theoretical explanation of this phenomenon is given.