NON-INVASIVE LASER DIAGNOSTICS OF SWELLING NAFION IN WATER AND AQUEOUS SOLUTIONS OF SALTS

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As was found in experiments on taking the photoluminescence spectra from the surface of dry (water-free) and swollen in water Nafion in a scheme of grazing incidence of the pump radiation (this technique was first described in detail in Ref. [1]), the spectra of dry and swollen Nafion are absolutely identical. It was specially verified that water is not luminescent-active for the pump radiation wavelength (λ = 369 nm), used in our experiments. It turned out that the sizes of spatial area, adjacent to the Nafion surface, for which the luminescence spectra can still be detected, are essentially different for dry and swollen Nafion. In fact, in the case of dry Nafion the size of this area steeply decays with growing the distance from the Nafion surface, and amounts to 10 – 20 microns; this is associated with divergence of the pump radiation, which is taken into account by special form of the apparatus function of our experimental setup. At the same time, in the case of water-swollen Nafion the size of area, where the luminescence can be observed, extends deep into the bulk of liquid, reaching several hundred of microns. Since the luminescence signal is generated solely by the Nafion particles, we made a conclusion that such particles are dispersed in the bulk of liquid close to the Nafion surface. We found the solution to the inverse scattering problem, which allowed us to obtain the spatial distribution of the volume number density for the Nafion particles in the bulk of liquid. It turned out that the size of area, where the volume density of Nafion particles exhibits a gradient-like profile, coincides with good accuracy with the characteristic size of Exclusion Zone, which has been previously measured in experiments, carried out by Prof. G.H. Pollack [2]. Thus, when speaking about the formation of the fourth phase of water (in any case, if we mean the formation of such water close to the Nafion interface), we should always take into account the presence of Nafion particles, dispersed in this area. We conducted the same experiments with aqueous solutions of alkali metal chlorides at various concentrations and temperatures. It was found that the size of the Exclusion Zone depends on the type of cation; for more detail see our recent study [3]. Furthermore, it was found that Na^+ cations are effectively repelled from the Nafion surface, while K^+ cations tend to be adsorbed at this surface. Based on the experimental data, it was suggested that the spatial structure of the Exclusion Zone is similar to that of biological cell.

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