Study of refractive index of nafion spheres in water and other solvents; the effect of exclusion zone

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In the experiment described here we compared the spatial distributions of refractive index in various liquids (differing from one another by the presence/absence of hydrogen bonds) adjacent to the thin plate of nafion. We choose glycerol, toluene and water as such liquids. The checking experiment consisted in comparing the same refractive index distributions in the absence of the nafion plate in the liquid sample. The refractive index measuring was performed by using the technique of modulation phase microscopy described in detail in our study [1]. In Fig. 1 we give an example of dependences of the refractive index $n(x)$ of water; here the coordinate x is the distance from the nafion surface (these dependences are shown by green and red diamonds).
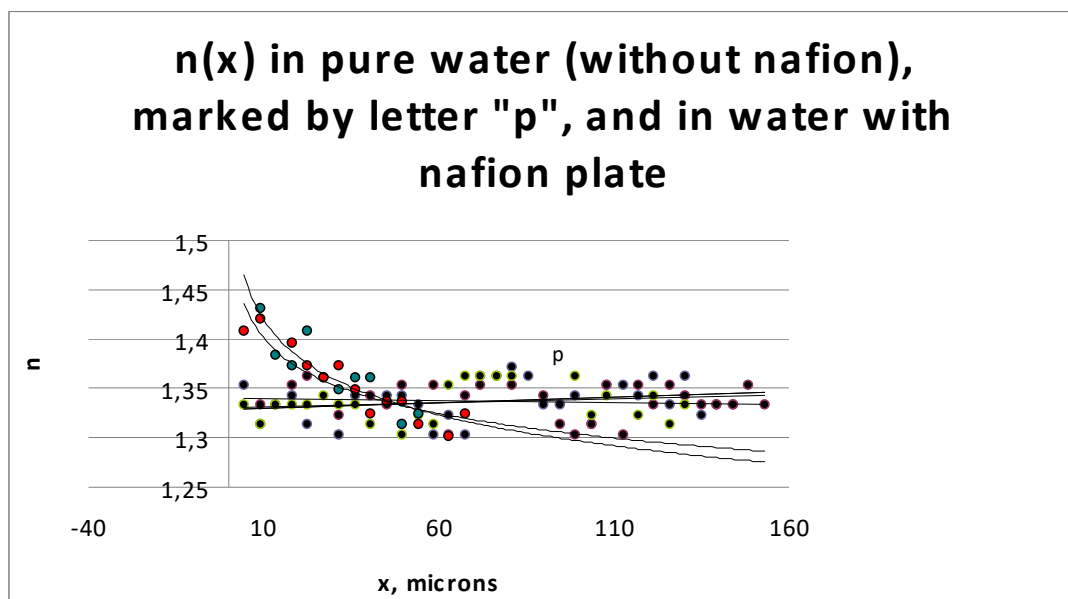

Fig. 1.
The one-dimensional spatial distributions of the refractive index of water in the vicinity of nafion plate (red and green diamonds) and in the sample of water free of nafion plate (violet and blue diamonds)

In the same Figure we also give the one-dimensional distribution of the refractive index of water without the nafion plate (violet and green diamonds); in that case the coordinate x is just the horizontal axis scaled in microns. As should be, in the latter case the one-dimensional distribution of the refractive index is uniform (with accounting for the standard experimental errors) and is centered about the value of 1.33, which is the known refractive index of water. At

the same time, if the test water is in a contact to the surface of nafion, the situation dramatically changes. As is seen from Fig. 1, the value of the refractive index at the interface water - nafion (the distance x is zero) $n(0) \approx 1.43$; this is approximately 1.1 higher than the value of refractive index in pure water. Besides, the dependence $n(x)$ decreases at growing the distance x from the nafion surface, eventually coming on the level of the refractive index of ordinary water. Thus we can consider that the graphs given in Fig. 1 by the horizontal straight lines (blue and violet diamonds) just illustrate the situation, which should take place very far from the nafion surface. It is worth to note that the effect of changing the refractive index close to the nafion plate is specific only for water: this effect is absent in glycerol and toluene. Processing the experimental data allows us to estimate the size of the exclusion zone induced by the nafion surface in water. For instance, as is seen from Fig. 1, this size is approximately equal to 50 – 60 microns.

1. N. F. Bunkin, N. V. Suyazov, A. V. Shkirin, P. S. Ignatiev, and K. V. Indukaev, Nanoscale structure of dissolved air bubbles in water as studied by measuring the elements of the scattering matrix, Journ. Chem. Phys., **130**, 134308 (2009)