Negative Adsorption and Surface Potential at the Air/Water Interface in the Presence of Electrolytes

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Mechanical and electrical properties of all interfaces, from pure water to elaborate surfaces of cellular membranes, depend on ion adsorption at these surfaces [1-4. This phenomenon plays a very important role in colloid and physical chemistry, biology and medicine [4,5]. The structure and stability of large biomolecules and membranes depend on the distribution of counterions in the aqueous phase. The transport of ions through ion channels in cellular membranes is determined by the surface potential generated by adsorption of ions from aqueous phase. Conduction of nerve impulses and effect of anesthetics strongly depend on this adsorption. Therefore, it is very important to know the structure of aqueous interfaces and distribution of ions in them [4]

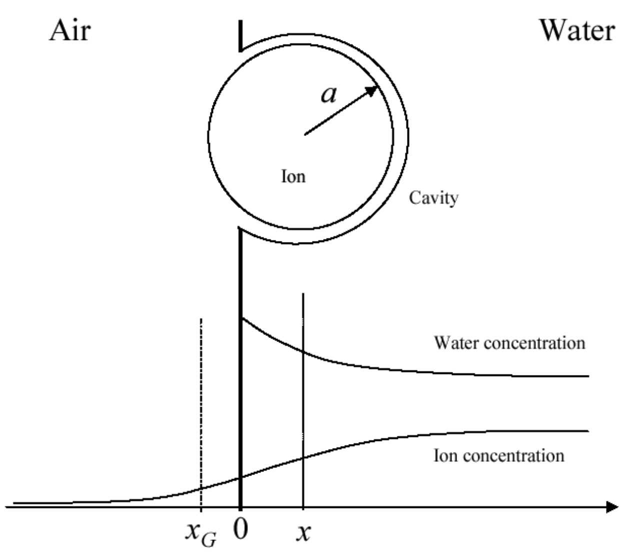

Fig. 1. Distribution of water and ion concentration at distance x from the air/water interface; x_G is the position of the Gibbs dividing surface.

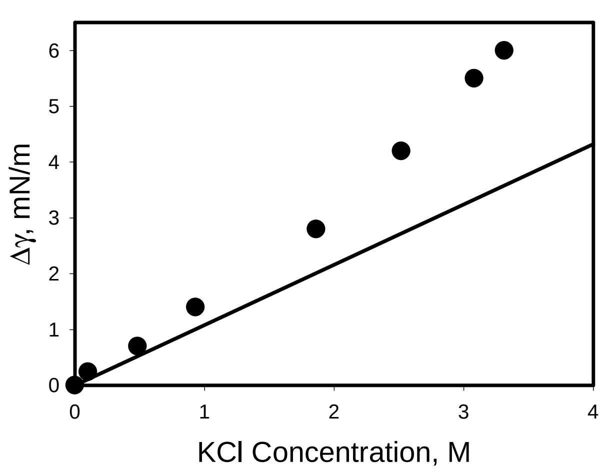

Fig. 2. Dependence of the surface tension of aqueous solution of KCl on concentration. Experimental points are taken from CRC-Handbook, the solid line is calculated.

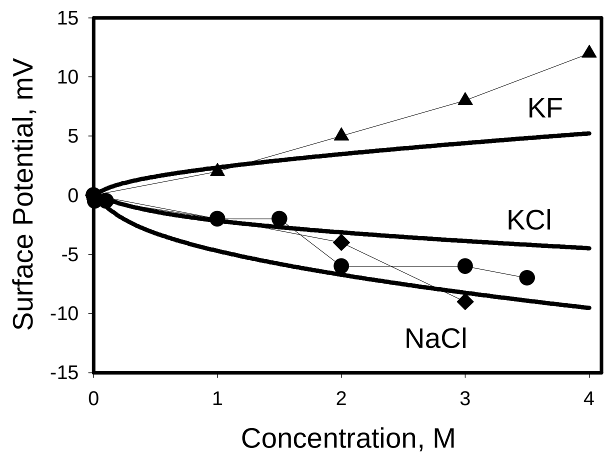

Fig. 3. Dependence of the surface potential on concentration. Solid lines are theoretical result of present work. Experimental points are taken from Frumkin [6] and Randles [7] The curves were drawn according to the following equations:

$$\text{KF} = \left[\left(2.092\sqrt{c} + 0.261c\right)^{-4} + c^{-4}/1296\right]^{-1/4},$$

$$\text{KCl} = -c\left(0.00666 + 0.0393c^{2}\right)^{-1/4},$$

$$\text{NaCl} = -c\left(0.0001 + 0.00193c^{2}\right)^{-1/4}.$$

The surface tension and surface potential of aqueous solutions of inorganic electrolytes are calculated. The new model includes image forces at liquid interfaces, ions of finite radii, the hydrophobic effect, and the Parsons-Zobel effect [8]. For the first time, a good correlation between theory and experimental data both qualitatively and quantitatively is obtained for different inorganic salts over a wide range of concentrations.

Acknowledgement

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References

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