Integrated investigation of electrical surface properties of detonation nanodiamond agglomerates in aqueous KCl solutions

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An integrated investigation of the electrical surface properties of the microporous agglomerates of detonation nanodiamond (DND) in aqueous KCl solutions was carried out using various experimental techniques. The adsorption isotherms of potential determining ions Γ_{H^+,OH^-} (pH) and the pH dependences of the surface charge density σ_0 (pH) = F (Γ_{H}^{+} – Γ_{OH}^{-}) of agglomerates preliminary purified from the electrolyte admixtures by dialysis are obtained in a pH range of 4.0 - 10.5 by acid-base titration of DND hydrosols containing c = 0.0001- 0.1 M KCl (Fig. 1). The titration data and obtained FTIR spectrum argue in favor of chemical nonuniformity (heterogeneity) of a DND surface containing mainly two types of the ionizable surface functional groups: amphoteric hydroxylic –COH and acidic carboxylic –COOH groups. The point of zero charge (pH_{PZC} value corresponding to σ_0 = 0) is independent of the KCl concentration and equal to 9.5.

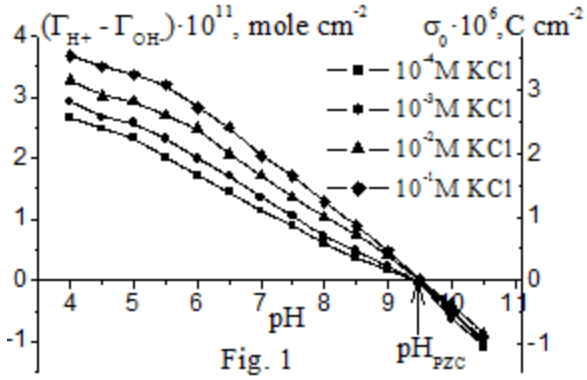

Fig. 1

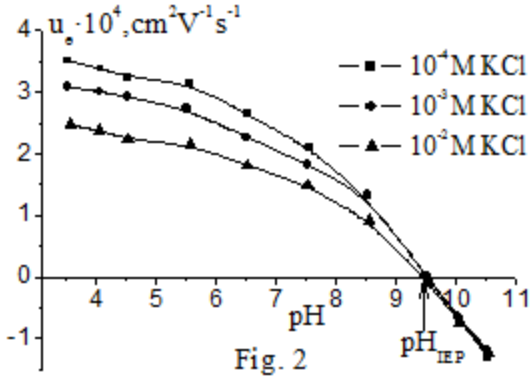

Fig. 2

The electrophoretic mobility u_e of the investigated agglomerates of DND as a function of pH = 3.5 - 10.5 and c = 0.0001 - 0.01 M KCl was measured by laser Doppler electrophoresis method (Fig. 2). The isoelectric point (pH_{IEP} value corresponding to u_e = 0) is equal to pH_{PZC} = 9.5. The conductivity of diluted DND hydrosols versus pH, c and DND volume fraction p = 0 – 0.001 was measured and conductivities K_p of microporous agglomerates impregnated with electrolyte solutions were determinated. It is shown that the magnitude of K_p is important for calculation of the correct ζ-potential values from the experimental u_e.