Properties of nanocrystalline cellulose hydrosols

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Hydrosols of polysaccharide particles are widely used as biodegradable fillers for gels and plastics, coatings and drug delivery systems. Nanocrystalline cellulose (NC) is broadly used as a catalyst carrier. NC hydrosols are capable of film forming, formation of foams and porous hydrogels of high modulus.

In the current study the NC hydrosols were investigated by the methods of viscometry, refractometry, sedimentation velocity, dynamic light scattering, flow birefringence and induced dichroism. NC was obtained by the controlled hydrolysis of cellulose in the acetic acid/heteropoly acid medium, followed by the purification by dialysis. The values of the density and refractive index increment of NC hydrosol were obtained. The value of the partial specific volume of the investigated particle (υ = 1.0 cm^3g^{-1}) was estimated as well. The value of the intrinsic viscosity of the NC hydrosol was found to be [η] = 0.26 cm^3g^{-1}.

The intensity distribution of the scattered light on the hydrodynamic radius of the particles was obtained by dynamic light scattering. The main contribution in the scattering spectrum was made by NC particles with translational diffusion coefficient $D = 0.4 \times 10^{-7}$ cm^2s^{-1} and the hydrodynamic radius R_h = 65 nm respectively. The amount of the bigger size particles ($R_h \approx 250$ nm) in the distribution was negligible. According to the obtained values of the sedimentation and diffusion coefficients the molar mass of the investigated NC particles was calculated.

Furthermore, the NC hydrosols at different concentrations were studied by the method of flow birefringence. The dependences of the birefringence on the flow velocity gradient g and shear stress coefficient $\Delta\tau$ were obtained. The dependencies are well approximated by the linear extrapolation procedure, which is typical for systems in the absence of a large number of big associates. This, in turn, allowed to determine a value of the optical shear coefficient NC sample. The value was found to be positive and very large in absolute size $\Delta n/\Delta\tau = 12.2\times10^{-8}$ cm s^2 g^{-1}.

In addition, the orientation angles at low shear rates g and low concentrations C were determined. The obtained dependency is typical for rigid type particles possessing shape asymmetry. According to the initial tilt angles, the value of the characteristic flow orientation angle NC [χ/g] = 0.23 rad s^{-1} was determined. Moreover, the value of the relaxation time τ_0 of the investigated system was estimated.

The investigation of relaxation of the induced dichroism indicated that the dichroism was caused by the orientation of the NC particles/aggregates under the influence of an external electric field. The field was harmonic with a frequency of 10 kHz and the efficient value of 120 V cm^{-1} respectively. Switching off the field led to the disorientation of the hydrosol particles, which, in turn, led to a decline (relaxation) of the induced dichroism. The analysis of the relaxation curve allowed to evaluate the size distribution of the NC particles/aggregates. Besides that, the effect of the duration of the electric field on the hydrosol NC and the effect of ultrasonic influence on the different durations of the NC particles were studied.

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