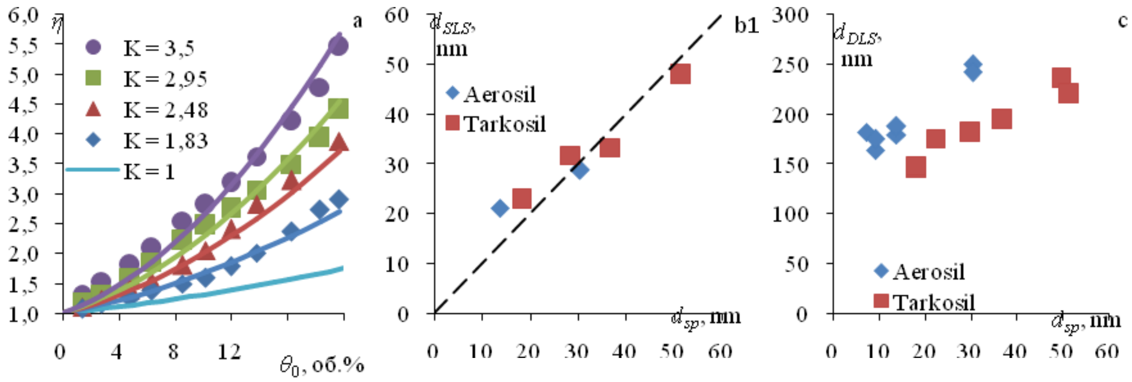
SILICA NANOPARTICLES EFFECT ON THE LIQUID AND ITS PROPERTY MEASUREMENTS

Zavjalov A.P.[1,a], *Zobov K.V.*[2]

[1]Far Eastern Federal University, Vladivostok, Russia
[2]Khristianovich Institute of Theoretical and Applied Mechanics SB RAS, Novosibirsk, Russia
[a]Zav_Alexey@list.ru

Nanotechnologies have a high growing temp and may be combined with additive technologies. Different nanoparticles may be applied to modify known additive materials or may be additive materials. Such role nanoparticle also plays in other technologies. So the problem of interaction between nanoparticles and medium is of great relevance. The carrier medium for nanoparticles often is a liquid. So we demonstrate some nanoparticles effect on liquid evidence from hydrophilic silica nanopowders in distilled water.

First of all the effective viscosity of the nanoliquid based on distilled water and different silica nanopowders much higher than in the case of distilled water with such volume concentration of micron particles which can be calculated by classical Einstein and Batchelor law [1] (Fig. 1.a). That is known fact for most of nanofluids but in earlier works this fact just was stated and some empirical dependencies were presented for experimental data descriptions [2]. We demonstrated that the assumption about some adsorbed layer on the nanoparticle surface let to use the Einstein and Batchelor formula with some effective volume concentration to describe nanofluids viscosity [3].



a b c

Figure 1. a) The relative viscosity of nanofluids η depends on nanoparticles volume concentration θ_0 in compare with Einstein and Batchelor law with rise up to K volume concentration. b, c) The particle size measurements results by SLSd_{SLS} (b) and DLS d_{DLS} (c) in compare with d_{sp} calculated from specific surface area of used nanopowders of different group – Aerosil and Tarkosil.

Similar concept of fixed water layer was previously applied to describe extraordinary water flow resistance of narrow quartz channels in compare with theoretical resistance of Poiseuille flow in such channels.High-precise experiments demonstrate the absent of any thixotropic effect in water even inlow tangential stress. So the model of raise viscosity in water layer around hydrophilic quartz channel surface was developed to completely describe the experimental data [4, 5].

The molecular structure of water layer which lay around quartz surface was investigated in [6]. So it was demonstrated that water molecular dipoles structured out of hydrophilic surface and along of hydrophobic surface. The water molecules structuring isn't immobilizing but it may effect on a dynamic water characteristic – viscosity for examples.

So it is clear that the model of adsorbed layer on the nanoparticle surface in the problem of nanofluids viscosity is some effective model and the thickness of this layer is the thickness of water layer with raise viscosity around hydrophilic silica nanoparticles surface. This conclusion also let to solve come antinomy results of measurement of nanoparticles size in water solution by Static Light Scattering (SLS) and Dynamic Light Scattering (DLS) methods (Fig. 1.b, c).

The nanoparticles in liquid scatter the light. So the intensity of transmitted thought nanoliquid light decreases. If the nanoparticles size much lower than wavelength then the nanoliquid transmitted spectrum is described by Rayleigh law. That's let to calculate the nanoparticles size. The results of such SLS measurements d_{SLS} correlate with the size of particles d_{sp} which can be calculated from the specific surface area of nanopowders which are used to prepare nanofluids (Fig. 1.b).

TheDLD method based on dynamic characteristics of scattered by nanoparticles light. Autocorrelation function of scattered light may be associated with mobility of particles. The theory Einstein-Smoluchowskyof Brownian motionusually is used to calculate the particles size from its mobility. The results of such DLS measurements d_{DLS} are much large then the size d_{sp} (Fig. 1.c). Here we see the antinomy between DLS and SLS methods. Such results of DLS measurements usually are interpreted as agglomeration of nanoparticles. But SLS clearly demonstrate that nanoparticles isn't agglomerated. Solvation of this antinomy is inapplicability of the Einstein-Smoluchowsky theory of Brownian motion. This theory does not take into account that the water viscosity around nanoparticles surface much higher than in volume water so the mobility of nanoparticles is really reduced.

So we can conclude that the applicability of nanotechnology for additive technology strongly require the fundamental investigations of the problem of the nanoparticles effect on its medium as well as the accuracy in applications of different analytical methods to measure characteristics of nanosistems.

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