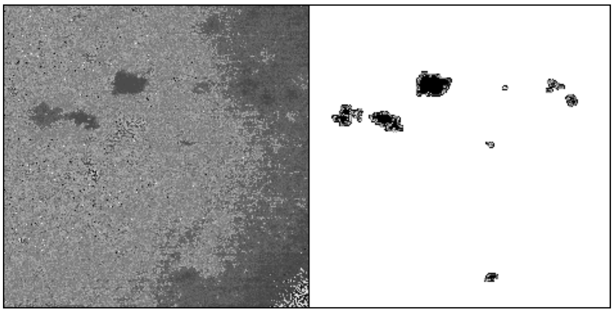

Figure 1 – Separation of copper clusters (mass concentration 1%)

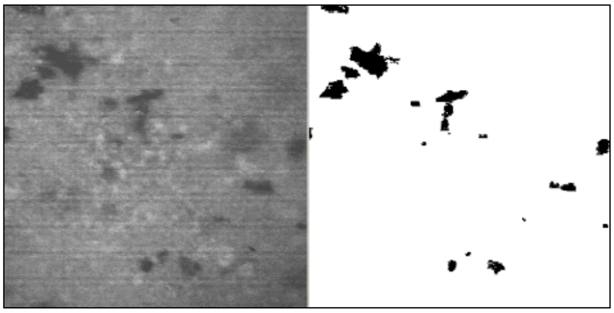

Figure 2 – Separation of copper clusters (mass concentration 3%)

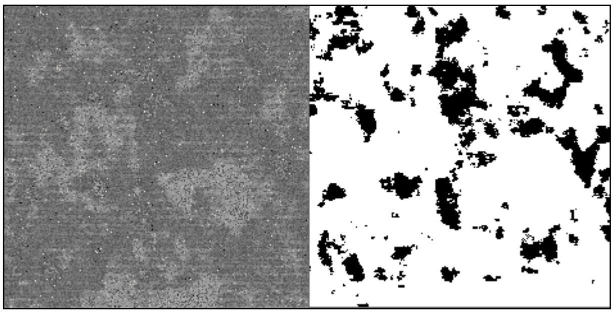

Figure 4 – Separation of copper clusters (mass concentration 20%)

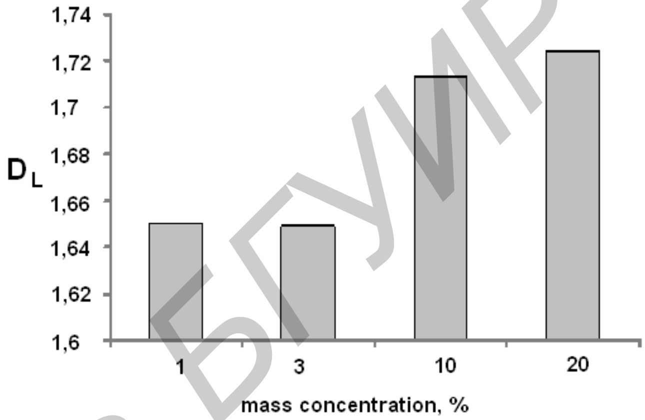

Figure 5 – Dependence of the fractal dimension of the profile of the filler clusters in the polytetrafluoroethylene matrix on the mass concentration of copper

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NANO- AND MICRO- PARTICLES SYSTEMS: UNIQUE CHARACTERISTICS IN THE MULTIDIMENSIONAL SPACE OF OPTICAL PARAMETERS

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I. INTRODUCTION

Three-dimensional disperse systems (3D DS) [1] – systems of nano- and / or microparticles (disperse phase) in a dispersive medium – are often called as dispersions, colloids, suspensions. One of the important tasks of fundamental 3D DS research is on-line monitoring of their condition. Optical data in combination with data of other methods can provide valuable information about processes within 3D DS (aggregation, sedimentation, flocculation, coalescence, fractal aggregation) and can help to create means for monitoring technological processes and the environment.

II. MATERIALS AND METHODS

In our work [2-14], compatible non-destructive optical methods are used to characterize 3D DS: refractometry, absorption and fluorescence spectroscopy, light scattering (dynamic and static, integral and differential, unpolarized and polarized, single and multiple). By these methods, the following 3D water DS containing nano- and / or microparticles (with an average diameter from nanometers up to ten micrometers) were studied: proteins (serum albumins, egg albumin, lysozyme, chymotrypsin, chymotrypsinogen, hemoglobin), serum and blood plasma, nucleoproteins, lipoproteids, liposomes, influenza virus of different strains, fat emulsions, perfluorocarbon blood substitutes, antibiotics, polyaromatic hydrocarbons, synthetic polymers based on methyl sulfate homo-polymer, cyclodextrins, latexes of different sizes, liquid crystals, bacterial and other biological cells of different strains, shapes and sizes (E. coli, acidophilus rods, thrombocytes, thymocytes, lymphocytes, erythrocyte diagnosticums, etc.), metallic powders (iron hydroxides, ruthenium dioxide, colloidal silver), kaolin, kimberlites, fullerenes, zeolites, as well as various mixtures of: proteins and nucleic acids, proteins and polymers, liposomes with various substances (radiopaque agents, metal particles, enzymes, viruses, antibiotics), liquid crystals with surface active substances, mixture of E. coli cells with kaolin (water model), mixtures of anthracene with cyclodextrin, samples of oil, petroleum products, food products, samples of natural and tap water, air sediments in water, etc.

III. RESULTS AND DISCUSSION

Three classes of parameters can be obtained from the different optical methods for nondestructive testing of 3D disperse systems with nano- and microparticles [2 – 4, 6]. As the result of our 3D DS research, the phenomenon has emerged that consists in the existence of unique characteristic for any of the studied 3D DS in the multidimensional space of the so-called "second class" optical parameters (obtained after processing experimental data without invoking any data about the particles of the dispersed phase). In other words, the characteristic of any 3D DS can be represented as a unique N-dimensional vector (a set of parameters of the second class) in the N-dimensional space of optical parameters. The N-dimensional vector of the system can reflect implicitly all its features: the structure and shape of the particles, the refractive index of the matter of particles, the distribution functions of the number and mass of particles in size, etc. The most informative parameters for a particular system can be used for on-line control sensors creation.

IV. CONCLUSIONS

Most of the studied 3D DS contain nanoparticles (these can be debris of viruses or cells). As a rule, such mixed systems are not stable and under changing conditions tend to form even micron size aggregates (associates, agglomerates). In this regard, on-line monitoring the 3D DS state is of particular importance, for example, when using different batches of blood-substitutes or for obtaining information on the pathogenic viruses or bacteria in water.

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SPATIAL EQUATIONS OF THE LINEAR KELVIN-VOIGT VISCOELASTICITY, BASED ON DEVIATORS

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I. INTRODUCTION

The aim of this paper was the theoretically substantiate derivation of a complete spatial system of equations using deviators for one of the simplest models of creep-the Kelvin-Voigt model, for which one-dimensional differential equation is well known [1]. In addition, it was necessary to determine the constraints on the physical parameters under which the constructed spatial generalization can be used to solve three-dimensional creep problems of a rigid body.

In modern scientific literature, it was sometimes mentioned that this spatial model was used [2, 3]. However, the systems of equations of state cited in these works (by means of which some spatial applied problems were solved) indicate that the authors incorrectly interpret this model and, accordingly, use incorrect equations of state in solutions.

II. ONE-DIMENSIONAL LINEAR MODELS OF KELVIN-VOIGT VISCOELASTICITY

By a one-dimensional linear viscoelastic Kelvin-Voigt model we mean the equation of state of an uniaxially loaded rod, which can be written in the form [1]:

$$\sigma(t)=E\cdot\varepsilon(t)+\eta\cdot\dot{\varepsilon}(t) \quad (1)$$

where E is predetermined modulus of elasticity of the rod material, η is predetermined viscosity of the material, $\sigma(t)$ is the priori given (control) average stress on the rod, $\varepsilon(t)$ is the required average rod deformation, $\dot{\varepsilon}(t)=\frac{d\varepsilon(t)}{dt}$. The expression "average over the rod" explains the absence of an axial coordinate in the recording of the equation of state (1). Equation (1) is also called the law of deformation of a non-relaxing body [1].

III. SPATIAL GENERALIZATION OF THE LINEAR KELVIN-VOIGT MODELS WITH HELP OF DEVIATORS

It was considered a three-dimensional space with a Cartesian coordinate system $\mathbf{x}=(x_1,x_2,x_3)$. Let $D_\sigma(\mathbf{x},t)$ is deviator of stresses [4], $D_\varepsilon(\mathbf{x},t)$ is deviator of deformations [4], $G=\frac{E}{2\cdot(1+\nu)}$ is shear modulus, ν is Poisson ratio of a body material, $K=\frac{E}{3\cdot(1-2\cdot\nu)}$ is bulk modulus [4].