THE STUDY OF THE LIGHT SCATTERING IN LIQUID DISPERSIONS OF CYLINDRICAL AND SPHERICAL GOLD NANOPARTICLES

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Non-spherical metal nanoparticles, such as gold nanorods, are of great interest because of their plasmonic properties. The methods of studying of nanoparticles geometrical parameters based on the light scattering have several important advantages. They allow studying particles in a liquid medium without sample preparation and studying the dynamics of various processes, for example aggregation.

The dynamic light scattering method (DLS) is based on the measurement of time-dependent correlation function of the scattered light. In this method, the particle size is calculated based on analysis of fluctuations of intensity of the scattered light caused Brownian motion of particles in a liquid medium. All existing devices for dynamic light scattering measurements are based on the assumption of nanoparticles spherical shape. Measurement of geometrical parameters of non-spherical particles is much more difficult. One of the ways that allows determining the geometric parameters of non-spherical particles such as nanorods is the measurement of the polarization characteristics of the scattered light. However, in this case the presence of spherical admixtures in the sample has a great influence on the result.

In this work, light scattering in samples of mixtures of nanorods and nanospheres is studied. A mathematical model for cylindrical nanoparticles randomly oriented in the liquid dispersion is suggested. The model is based on the assumption that each particle has the certain effective area, which maintains polarization, and the certain effective area, which realizes the light depolarization. The model allows calculating the dependence of the scattered light depolarization ratio on the aspect ratio. The proposed model takes into account non-uniform distribution of the particle aspect ratio and the presence of quasi-spherical admixtures in the studied sample.

A number of experiments is carried out to verify the proposed model. The depolarization ratio of light scattered in water dispersion of gold nanorods with different aspect ratio is measured. The measurements are carried out using a custom-made particle size analyzer. There are studied several samples of gold nanorods water dispersion with aspect ratios ranging from 2.9 to 10 and with different concentration of quasi-spherical admixtures. The experimental and calculated values of aspect ratio are in good agreement if the quasi-spherical admixtures are assumed into the proposed model.

On the one hand, the proposed approach allows to find the average aspect ratio of nanorods, if the amount of quasi-spherical admixtures is known (for example, without admixtures). On the other hand, the proposed approach allows to find the number of quasi-spherical admixtures, if the average aspect ratio of nanorods is known. Obtained results can be used for the express analysis of geometric parameters of non-spherical particles.

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