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Application of laser speckles for analysis of structural dynamics of nanofluids based on carbon nanotubes

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Nanofluids are colloidal solutions of particles with a size of 0.1-100 nm. The unique physical and chemical properties of nanofluids make them promising materials for electronics, energy, pharmaceuticals, etc. The high value of the surface energy of nanoparticles contributes to their tendency to aggregation, which causes the structural instability of nanofluids.
We demonstrate the possibility of using dynamic laser speckle analysis to control the state of an aqueous solution of multilayered carbon nanotubes.
Dynamic speckle is a moving speckled pattern that arises as a result of the scattering of coherent radiation on moving inhomogeneities. The dynamics of speckles reproduces the dynamics of nano- inhomogeneities in the liquid medium. A standard optical scheme and a special signal processing algorithm were used [1].
Decorrelation is a decrease in the similarity of the picture over time, which is characterized by a certain law of decay and occurs for any dynamic speckle. In nanofluids, particles are in a state of Brownian motion. The autocorrelation function of their dynamic speckle has the form of a decaying exponent, where the decay constant depends on particle size, viscosity, and temperature. If other factors remain constant, the aggregation of nanoparticles leads to an increase in the decay constant.
We recorded different types of behavior of the aqueous suspension of carbon nanotubes depending on the concentration, sonication time, and storage duration. The obtained results will contribute to the optimization of nanofluidic technologies. It was also established that surface-active substances are able to stabilize the suspension for a certain time.

1. V.Pobiedina, A.Yakunov. Speckle decorrelation study of phase heterogeneous liquid medium. In SPIE Photonics Europe. 2016. International Society for Optics and Photonics.

Topics

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