Magnetic Moment of Single Ferromagnetic Nanoparticle Determined from Cotton-Mouton Effect

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Compounds showing large magneto-optic effects are searched for because of their possible application in optical technology as fast shutters, switches, tunable phase retarders, etc. Magnetic materials are ideal for such applications, as due to the magnetic nature of compounds large optical linear and circular anisotropy can be induced by applying a relatively small external magnetic field.

Optical properties of a composite material made of ferromagnetic nanoparticles embedded in a dielectric host are studied. An effective dielectric tensor of the composite material was constructed taking into account the orientational distribution of nanoparticle magnetic moments in external magnetic field. A nonlinear dependence of the optical rotation on magnetic field resulting from the reorientation of nanoparticles is demonstrated. The theoretical findings were applied to the magneto-optical experimental data of different magnetic nanoparticles (made of cobalt, magnetite and even gold covered by paramagnetic organics) embedded in a dielectric liquid host. The dependence of the Cotton-Mouton effect was measured as a function of the external magnetic field and the wavelength of light.

We present a combination of experimental measurements and theoretical modeling [1,2], which enables determination of the magnetic moment of a mean nanoparticle. We show that particles creates flexible chains in a solution. For metallic ferromagnetic nanoparticles it is possible to determine plasma frequency.

[1] Szczytko, J.; Vaupotic, N.; Osipov, M.; Madrak, K.; Górecka, E. Phys. Rev. E **87**, 062322 (2013)

[2] Szczytko, J.; Vaupotic, N.; Madrak, K.; Sznajder P.; Górecka E., Phys. Rev. E **87**, 033201 (2013)