Enhanced magnetooptics in magnetic nanocomposites

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Magnetic nanocomposites, consisting of nano-scale magnetic particles embedded in an insulating matrix are of unique consideration for the technological application and fundamental physics. They display a wide variety of unusual both linear and nonlinear transport, optical and magnetooptical properties. For example, the enhanced transversal Kerr effect (TKE) in diluted MnAs:GaAs alloys and in discontinuous multilayers Co/SiO_2 has been discovered [1,2]. The strong magnetorefractive effect (MRE) in the infrared region of spectrum has been found in some nanocomposites with tunnel-type magnetoresistance [3,4].

In the presentation, we will discuss recent experimental and theoretical results on magnetooptical spectra in magnetic nanocomposites $(Co_{45}Fe_{45}Zr_{10})_x(SiO_2)_{100-x}$, $(Co_{41}Fe_{39}B_{20})_x(SiO_2)_{100-x}$, $(FePt)_x(SiO_2)_{100-x}$ in the visible and infrared spectral region, focusing on changes in magnetooptical response for compositions close to the percolation threshold.

The enhanced magnetooptical response was discovered in all studied nanocomposites when their composition is close to the percolation threshold. Using experimental data on optical parameters and TKE we calculated diagonal and off-diagonal elements of the dielectric permittivity tensor. It was shown that off-diagonal elements depend non-monotonically on the metallic volume fraction and exhibit drastic changes close to the percolation threshold. The calculated TKE spectra in the framework of the symmetrized Maxwell-Garnett approximation are in a good agreement with experiment.

The MRE is a new magnetooptical effect, which arises in nanocomposites due to high frequency spin-dependent tunnelling [3,4]. The magnitude of the MRE varies from 0.1 to 1.5% for different nanocomposites and strongly depends on the frequency of light and magnetoresistance. By studying the MRE in a wide range of compositions it is shown that the MRE reaches its maximum for compositions below the percolation threshold.

The possible applications of enhanced magnetooptical effects and MRE in nanocompomposites are discussed.

References

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