

Microwave and infrared tunnel magnetoresistance in magnetic nanocomposites

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Since the dielectric permittivity is linear with frequency-dependent conductivity, high frequency properties for any kind of magnetic materials with large magnetoresistance depend on magnetization. It manifests as magnetorefractive effect (MRE) at optical wavelengths and as magnetoimpedance at microwaves. The MRE is a new magneto-optical effect in nanostructured magnetic materials with giant, tunnel or colossal magnetoresistance. The effect consists of changes in optical properties of such systems when they are magnetized. The main mechanism of both MRE and giant magnetoimpedance in nanocomposites with tunnel-type magnetoresistance is high frequency spin-dependent tunnelling.

We report on recent results of theoretical and experimental investigations of MRE and magnetoimpedance in nanocomposites, focusing on specific features of spin-dependent tunnelling at infrared and microwave frequency regions. By considering the tunnel junction between adjacent granules as a capacitor, we obtain simple relations for MRE in reflection and transmission modes for s- and p-polarization of light. The most of obtained experimental data for MRE in nanocomposites Co-(Al-O), CoFe-MgF, CoFeZr-SiO_n, Co-(Ti-O), Co-(Si-O) are consistent with the theory. The MRE amplitude is between 0.1 and 1.5% depending on magnetoresistance and optical constants. The same approach is used to explain experimental data on giant magnetoimpedance at 30-50 GHz.

Possible applications of MRE and giant magnetoimpedance in nanocomposites are discussed.

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