Nontrivial damping of ferromagnetic resonance in nanocomposites Co/Al_2O_3

[1]Dmitriev A.I., [1]Lashkarev G.V., [1]Radchenko M.V., [1]Bugaiova M.E., [1]Slynko E.I., [1]Timofeeva I.I., [2]Knoff W., [2]Story T.,

[1]I.M. Frantsevych Institute for Problems of Material Science, National Academy of Sciences of Ukraine, Kyiv, Ukraine

[2]Institute of Physics, Polish Academy of Sciences, Warsaw, Poland

Ferromagnetic nanocomposites (FMNK) Co/Al_2O_3 with the Co nanoparticles (NPs) content 41% were grown on the polycor substrates using the laboratory single-chamber electron-beam facility. Ferromagnetic resonance (FMR) studies were performed on a Bruker spectrometer (9,4 GHz) in the temperature range T = (3÷270)K. Amplitude (A) damping for FMR signal lowers with decreasing temperature until it disappears at T ~ 60K, as well as reducing the experimentally determined resonant magnetic field H_R.

The resonance condition in inhomogeneous media is the following

$$h\nu=\mu(g+\Delta g)(Hr+\Delta H)$$

where μ - Borr magniton, Δg - correction due to an influence of disturbing factors, ΔH - internal magnetic field.

T, K	H_R, KOe	A, abr.un.
261	5.63	16
231	5.56	15
202	5.41	14
161	489	8
125	3.81	6

For cobalt $g\cong 2$ it appears H_r = 3.3 KOe, what is much lower than its experimental values H_R (see. Table.). The temperature variation of g is very small $\Delta g \ll g$. Consequently, there is an internal magnetic field, and temperature-dependent violation for resonant precession of the magnetic moments. The reason for this is the interaction of ferromagnetic NPs with their antiferromagnetic CoO shell. The Neel temperature (T_N) for bulk CoO is 291K, but it is strongly dependent on NPs size. For example the low width of CoO shell about 2 nm has T_N = 55K. It is supposed that NPs dispersion determine the smooth damping FMR.

The presence of CoO in FMNK evidenced by our researches: X-ray analysis; bend type temperature dependence of the thermoelectric power. The existence of antiferomagnetic CoO shell also was confirmed by "exchange bias" of the hysteresis loop and the asymmetry of the angular dependence of H_R.

Therefore nontrivial FMR damping with decreasing temperature is due to the conflict of ferromagnetic Co NPs and their antiferromagnetic cobalt oxide shells.