Temperature Dependence Magnetic Anisotropy in Co/Al_2O_3 Nanocomposite Films.

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. Magnetic films nanocomposites CoX/Al2O3(1-X), X in at%, were grown on polycore substrates using two-crucible electron beam facility. The anomalous low-temperature damping of superparamagnetic (SPMR) for Co16 and ferromagnetic (FMR) for Co41 resonances in these samples were observed [1]. The experimental studies were fulfilled in the range T=(3÷270) K by Bruker spectrometer operating at 9.4 GHz.

Magnetic resonance field (HR) has been measured as a function of a temperature (T) and angle (θ) between the magnetic field (H) direction and the plane of substrate . The HR(T,θ) dependence shows major deviations from the Gilbert phenomenological damping model [1] and significantly differ from the uniform rotation prediction [2].

Asymmetry HR, relatively to θ = 90 deg., HR maximum deviation from the orientation which external magnetic field H is perpendicular to the film plane (θ =0deg.), and their temperature changes, are features of the angular dependence of HR (ADH). ADH is determined by two factors: the crystallographic magnetic anisotropy (MA) and the shape anisotropy. The latter does not depend on temperature. Then ADH is a consequence of the existence of a disturbance magnetic field HD(T). It is causing the change of MA.

The observed phenomena were analyzed taking into account the real structure of nanoparticles shell. The possible source of MA perturbations is an ensemble of magnetic oxygen vacancies on the interfaces Co-CoO-Al2O3. The presence of CoO in NCs was proved by our researches of X-ray diffraction and magnetic "exchange bias" of the hysteresis loop [3], also by bend type temperature dependence of the thermoelectric power [4].

Pair interaction of the two doubly charged identical surface defects (oxygen vacancies) has an integer spin 1 (bosons ?) and the ferromagnetic state inducing HD(T) [5,6].

The general reasons for SPMR, FMR, GTEP damping's and Hr(T, θ) dependence for Co/Al2O3 nanocomposite films probably are due to the conflict between ferromagnetic Co NPs and magnetic state of their shells (interfaces). When the concentration of Co increases from superparamagnetic state for 16at.% Co up to ferromagnetic state for 41at.% Co, the conflict becomes sharper.

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