GAXRD AS METHOD FOR TESTING MAGNETIC COMPOSITE MULTILAYER STRUCTURES

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The trend of modern electronics is to maximize efficiency and control of various physical phenomena simultaneously within one device. For this reason, such devices consist of complicated nanostructured materials with metal, oxide and semiconductor components. Depending on application needs (resonant absorption, tunnel conductivity or low magnetization reversal loss) these materials often include magnetic composite nanosystems.

There are a variety of methods for testing such materials, for example, glance angle X-ray diffraction (GAXRD) one. This method allows to approximate the experimental GAXRD spectra of multilayer systems so that to find the structure period, total film thickness, material density, roughness of each layer. Earlier [1], when modeling spectra for multilayer structures of (ferromagnetic metal)$_x$–(insulator)$_{100-x}$ with dielectric or semiconductor interlayers we showed advantages of modeling using stack of layers. The system appears to consist of several packages, the layers in which may have different concentrations of the metal phase. In this paper, we consider the possibilities of using the results of such modeling to find the magnetic characteristics of multilayer composite system. The objects under study were multilayer systems composed of $[(Co_{41}Fe_{39}B_{20})_x\text{-}(SiO_2)_{100-x}]_{60}$ magnetic layers separated by SiC interlayers. Thickness of each layer was 3,5-4,5 nm. Concentration of magnetic phase in composite layers was in the range of x = 24 – 55 vol. %.

It was shown by modeling that the density ρ of composite layers varies from 3 to 5 g/cm^3. These results points that volume concentration c of the magnetic alloy also varies for the packets (see Table). One can expect that packets with a concentration below the percolation threshold (c_p ~ 25 vol. %) magnetize like an superparamagnetic phase, and others, above c_p, as a ferromagnetic phase. Hence, the residual magnetization for the hysteresis loop was estimated and the magnetization region in high fields was reconstructed using the Langevin function. There was good agreement between values I_r/I_s of calculated and experimental magnetization curves.

Layer number	***Material***	***Thickness t, Å***	***Density ρ, g/cm³***	***Calculated concentration c, vol.%***
1	SiO_2	3	2.5	
20	SiC	27	2.5	
	FeCoB-SiO_2	43	5	50
20	SiC	27	2.5	
	FeCoB-SiO_2	43	3	10
20	SiC	27	2.5	
	FeCoB-SiO_2	43	3.5	20

[1] I. Shipkova, Ju. Chekrygina et al. Solid State Phenomena, 5 (233-234), 2015, pp.633-636.