STRUCTURAL INTERACTION OF LAYERS IN THIN FILM Fe/Tb_2O_3

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Thin films, consisting of contacting layers of iron group metals Fe, Co, Ni and rare earth metals oxides are perspective for use in spintronics. Due to exchange f–d interaction at them interface, magnetization and magnetoresistance of this d – metals are rising [1]. Since a magnetization of thin films greatly depends on them structure, it would be interesting to consider of structural influence from rare earth metals oxides to Fe, Co, Ni metal layers too. In this work the structural interaction is studied by example of two-layer Fe/Tb_2O_3 film, in which Fe and Tb were selected as having one of greatest magnetic moments in their groups (3,18 and 9,7 μB, accordingly), that is great energy of exchange f–d interaction.

Fe and Tb_2O_3 layers were deposited by electron-beam evaporation of Fe and Tb metals to monocrystalline NaCl substrate at follow conditions accordingly: p = $5 \cdot 10^{-3}$ Pa, υ=25 nm/min, t = 280°C and P O_2=$1 \cdot 10^{-2}$ Pa, υ=80 nm/min, t = 25°C. Firstly Fe layer was deposited and then Tb_2O_3. Thickness of Fe and Tb_2O_3 layers were 25 and 52 nm. After solution of NaCl substrate in distilled water and placing these films on a net with window about 25μ, the structure was investigated by electron diffraction method.

Fe layer deposited to substrate at 280°C had polycrystalline structure corresponded to cubic modification β- Fe with lattice period a = 2,904 Å, less than well known value a = 2,91Å for volume samples.

Tb_2O_3 layer, deposited at 25°C had amorphous structure. After it`s deposition on the Fe layer, stretching of cubic iron lattice to a = 2,917Å was observed. The stretching was accompanied by beginnings of strain about σ=2,206 GN/m^2 and diminution of coherent dispersion blocks from 142Å (for Fe contacting with Tb_2O_3). That stretching of Fe crystalline lattice is bound up with influence of shot range ordering of amorphous Tb_2O_3, where parameters of all structure modifications considerably exceed that at Fe. For example, at cubic Tb_2O_3 structure a=10,729Å; hexagonal a = 3,84Å, c = 6,13Å; monoclinic a = 14,03Å, b = 3,536Å, c = 8,717Å [PDF files: 19-1328, 74-2131, 86-2478].

Thus, the deposition of Tb_2O_3 to Fe layer is accompanied by both beginning of exchange f – d interaction and stretching of Fe crystalline lattice, appearance of strain, diminution of coherent dispersion blocks.

References

1. Lashkariov G.V., Kasumov A.M., Karavaeva V.M., Mikitchenko A.A., Rumiantseva Y.Y., Magnetic interaction of nanosize Ni and Dy_2O_3 films, Intern. Conf. NANSIS-2016, 1-2 Dec., 2016, Kyiv, Ukraine, p.60.