ABOUT A NATURE OF A HIGH-COERCIVITY STATE IN EPITAXIAL FILMS OF MAGNETIC GARNETS

Kostishyn V.G., Morchenko A.T., Medved' V.V.

The State Technologic University "Moscow State Institute of Steel and Alloys",
Russia, 119049, Moscow, B-49, Leninsky prospect, 4
E-mail: drvgkostishyn@mail.ru

The coercive force H_c is a fundamental operational characteristic of epitaxial magnetic garnet films. And if for one devices (elements of bubble domain memory, magnetooptical controlled transparencies, modulators and deflectors) it is important that the functional material has a minimum level H_c, for other devices (magnetooptical medium for thermomagnetic recording of the information) one of base requirements is, vice-versa, the presence of high coercivity. The efforts of the physicists and technologists have given to noticeable successes in an possibilities of control of value H_c in magnetic garnets. However, full understanding of a nature of coercivity in epitaxial garnet films till now is not still reached. The purpose of the present work is study of a high-coercivity state nature for the indicated materials.

As objects of research the films of following composition were chosen: $(YSmLuCa)_3(FeGe)_5O_{12}$, $(YEuTmCa)_3(FeGe)_5O_{12}$, $(YBi)_3(FeGa)_5O_{12}$, $(YYbBi)_3(FeGa)_5O_{12}$, $(BiTm)_3(FeGa)_5O_{12}$ and $(YPrLuBi)_3(FeGa)_5O_{12}$. The samples were grown by a method of high-temperature liquid phase epitaxy from solution in melt on substrates $Gd_3Ga_5O_{12}$ and $(GdCa)_3(GaMgZr)_5O_{12}$ with crystallographic orientations <111> and <210>. The following fluxes were used for epitaxy: $PbO\text{-}B_2O_3$, $PbO\text{-}Bi_2O_3\text{-}B_2O_3$ and $CaCO_3\text{-}Bi_2O_3\text{-}V_2O_5$.

The improvement of chemical film composition was performed with microanalyzer "JEOL-JXA" by method of X-ray spectral analysis. The coercive force was defined on a hysteresis curve, and by method of oscillating field also. The hysteresis curves were recorded with the magnetooptical hysteresigraph and/or with vibration magnetometer M-155 of the EG&G.PARC corporation. The identification of growth defects in films was carried out by the methods of hunting curves and thermally activated current spectroscopy.

The value H_c measured: 80 A/m – 250 A/m for films of (Ca, Ge) system and 30 A/m – 720 A/m for films of Bi-containing garnets. The carried out investigations have allowed to deduce that the high values H_c in these objects are due to the following reasons [1] :
1). Excessive and "parasitic" ions of Ca^{2+} getting in the crystal lattice of film during growth.
2). Giant stress of a discrepancy caused by high concentration Bi^{3+} ions with large radius.

The influence of each mechanism on formation of a high-coercivity state is analysed in detail. It is shown that the Yb^{3+} and Tm^{3+} ions essentially cancel "stretching" effect of Bi^{3+} ions.

References

[1] V.G. Kostishyn, L.M. Letyuk. Role of Ca^{2+} ions uncompensated with isovalent ions in the formation of magnetic properties in $(YSmLuCa)_3(FeGe)_5O_{12}$, $(YBi)_3(FeGa)_5O_{12}$, $(YYbBi)_3(FeGa)_5O_{12}$ and $(YBi)_3(FeGa)_5O_{12}$ epitaxial films. J. of Magnetism and Magnetic Materials, 2003, v. 254-255. – P. 559-561.