A Structure and Physical Properties of Pure Mn, Bi and MnBi Films Obtained by Method of Triod Ion-Plasmous Sputtering

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The regularities of formation of Bi, Mn and MnBi metastable film structures obtained by modified three-electrode ion-plasmous sputtering method (IPS) were researched in this work.

X-ray analysis showed that in the as-deposited Mn films there is formed a mixture nanocrystalline β-Mn (the size of coherent scattering region L = 7.5 nm), and oxide MnO. The Mn film heat treatment in a vacuum at a temperature above 700 K leads to its complete oxidation. Initial Bi film are a mixture of rhombohedral Bi phase (L = 6.5 nm), and traces of cubic Bi. Heat treatment leads to the enlargement of the grains and the complete disappearance of Bi with a cubic lattice. MnBi films are a mixture of rhombohedral Bi phase and β-Mn in the initial state. After heat treatment, except those phases appear traces of Bi_2Mn and MnO.

The temperature dependence of the resistivity analysis revealed that the pure Mn and Bi activation energy of the phase transitions are $E_A \sim 5000$ K and $E_A \sim 8500$ K respectively. The activation energy of MnBi films are in the range of $E_A \sim 3500$ - 5000 K. After heating the Bi and MnBi films to the temperatures above 670 K and subsequently cooled to a temperature of 490 K is an abrupt change in resistance.

Analysis of the demagnetization curves showed that the hysteresis of the magnetization is observed only in the containing Bi films, because the assumed occurrences of the ferrimagnetic properties of Bi oxide in the nonequilibrium state.