Formation of stable nanodimensional magnetic FePt films for ultrahigh-density magnetic recording media and storage of information

Short description of technology: Fabrication of nanodimensional film in thick of 10- 30 nm on the basis of magnetic ordered $L1_o$-FePt phase by the method of magnetron sputtering with the use of the mosaic targets from the metals of Fe and Pt with the alloying elements of C, Ag, Ni, B, Cu, Au, Sb on substrate of SiO_2 or MgO, CrRu, CrMo. Heat treatment carries out by method of the thermal annealing in nitrogen or vacuum in the temperature range of (620 – 970 K) with different rates of heating and duration. For the magnetic recording of information by $L1_o$-FePt film it is possible to use technology of the thermally activated magnetic record (TAMR) at cooling from the paramagnetic state.

Novelty: Creation of devices with ultrahigh-density magnetic recording and storage of information is a significant problem of the modern science and technique. The increase of recording density by traditional methods already attained a limit. Now for the storage of digital information the magnetic disks are applicated, for the fabrication of which the layer of magnetic material is deposited on the unmagnetic substrate and then a recording is carried out. As magnetic material (a magnetic recording media) it is applicated both polymeric coverage, which contains magnetic one-domain particles (as a rule y-Fe_2O_3), and thin (of (50 – 150) thick nm) film of magnetic metal, alloy or oxide (alloys are usually utillized on the basis of Co, for example, Co-Ni, Co-Ni-W, Co-Pt-Ni et cetera). Size of magnetic domains located in a few grains is ~ 100 nm. Thin magnetic films have a grain structure with the size of grain of film thickness. Coercivity of magnetic materials which are used for the storage of information lies in a range from 8 A/m to 37 A/m, and remanence arrives for 1,5 T.

Reached density of magnetic recording and storage of information is 10-15 $Gbit/cm^2$. For the subsequent increase of density the new nanodimensional materials with lower-limit dimension of magnetic domains located in isolated grain with size of 5-15 nm are needed, which allow to fabricate recording medium of new generation with ultrahigh-density magnetic recording and storage of information (to 1 $Tbit/cm^2$). For creation of such magnetic writing devices the magnetic ordered $L1_o$-FePt phase with face-centered tetragonal structure can be used due to its large uniaxial magnetocrystalline anisotropy energy ($7 \cdot 10^6$ J/m^3 that more than on an order higher than in the magnetic recording medium, which are used) to high chemical and to anticorrosive stability. The methods of fabrication and thermal stabilization of nanodimensional (10 -30 nm) magnetic ordered $L1_o$-FePt films, management an orientation of the easy magnetization axis and magnitude of coercivity are developed. Decrease the temperature of the magnetic ordering and increase thermal stability of magnetic of $L1_o$-FeP films with the size of grains to (5 – 15) nm can be carried out due to introduction of interface energy by the use of additional layers of Cr (Au, Ag) or combinations of Pt/Cr (or Pt/Ag) in film composition of FePt/additional layer/substrate or multi-layered film composition of Fe/Pt/Fe/Pt/…, what will provide a driving force for ordering of FePt film using tension energy between FePt film and additional layer for acceleration of the ordering process. Also it is assumed that diffusion the third element with low surface energy such as Co (or Au, Ag, Sb, Bi) will stimulate the rearrangement of Fe and Pt atoms and will ensure the ordering process. Alloying atoms located on the boundaries of FePt grains carry out control for the size of grain and slow motion of domain wall of FePt during the demagnetization process that favour the increase of coercivity.

For formation of the controlled orientation of grains - textures in $L1_o$-FePt films it will be used the different substrates such as SiO_2/Si(001), amorphous particles of SiO_2 of spherical form, glass, polystyrene both at a room temperature and heated to the temperatures in the range of (620 - 770) K. At application of amorphous substrates it is assumed the using the seed layers in particular Cr(100), MgO(100).