Structural and magnetoresistive properties of Co/Ag/Py pseudo spin-valves

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Pseudo spin-valves Co(5)/(d_{Ag})/Py(30)/S and Co(30)/Ag(d_{Ag})/Py(5)/S (Py is permalloy $Ni_{1-x}Fe_x$ at $x \cong 0.2$; the thickness of layers is in nm; S is the substrate) were prepared by electron-beam sputtering to investigate the influence of Ag layer thickness (d_{Ag}) and thermal annealing on samples crystal structure and magnetoresistive properties. The thickness of Ag layer varied within the range from 3 to 15 nm. The samples were annealed at 530 K (the temperature of healing defects) and 750 K with an exposure for 15 min.

Electron diffraction patterns reveal that the as-deposited and annealed at 530 K systems Co/Ag/Py of both types have hcp-Co + fcc-Ag+fcc-Ni_3Fe phase state. It is also shown that the changes of nonmagnetic layer thickness does not lead to the phase state changes of the samples. The annealing process at the temperature 750 K causes interdiffusion of Co and Ag layers, that sequences the formation disordered solid solution (s.s.) on the basis of fcc-Ag lattice and phase state of Co/Ag/Py systems corresponds to s.s. fcc-Ag(Co)+fcc-Ni_3Fe. Meanwhile, the phase state of pseudo spin-valves weakly depends on Ag layer thickness. The lattice parameter of s.s. Ag(Co) varies within the range from 0.405 to 0.406 nm with the increase d_{Ag} from 3 to 15 nm.

The study of transverse, longitudinal and perpendicular magnetoresistance (MR) curves, which were obtained by using software-hardware complex with current-in-plane geometry in an external magnetic field up to 500mT at room temperature, allows to conclude that value of MR of Co(5)/(d_{Ag})/Py(30)/S and Co(30)/Ag(d_{Ag})/Py(5)/S pseudo spin-valves depends not only on layer thicknesses and annealing temperature but research geometries, too. It should be noted that field dependences in perpendicular geometry are characterized by the presence of two minimums that denotes about alternate remagnetization of magnetic moments in the layers of Co and Py. In addition, the formation of s.s-Ag(Co) changes the shape of perpendicular MR curves. The Co(5)/Ag(15)/Py(30)/S system provides the highest MR value 1.1% after annealing at 750 K in perpendicular geometry. Whereas, structures with d_{Ag} = 6 nm reveal the most significant thermal stability of MR and coercivity within the temperature range 300-750 K.

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