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The magnetoresistance and magneto-optical properties in amorphous CoFeNiSiB alloys

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A large room-temperature magnetoresistance effect to ac current has been demonstrated in thin $Co_{71}Fe_7Si_{12}B_{10}$ and $Co_{59}Fe_5Ni_{10}Si_{11}B_{15}$ amorphous ribbons in applied fields $H < 80$ Oe. The peak value of the magnetoresistance ratio is very sensitive to the Co and Fe concentration in the alloys. The optical and magneto-optical properties of amorphous CoFeSiB ribbons were investigated for incident photons energy range from 0.05 to 2.2 eV. The optical conductivity was determined from the results of spectroscopic ellipsometry measurements. The Kerr rotation spectra for the amorphous films in the 0.6–2.2 eV region have a shape quite similar to that of bulk Co. The optical conductivity of the amorphous CoFe(Ni)SiB alloys in the IR region increases slowly as a function of frequency (proportional to $\omega^{1/3}$).

Показано наличие значительного магниторезистивного эффекта в тонких аморфных лентах $Co_{71}Fe_7Si_{12}B_{10}$ и $Co_{59}Fe_5Ni_{10}Si_{11}B_{15}$ на переменном токе при комнатной температуре в магнитных полях $H < 80$ Э. Максимальное значение магниторезистивного отношения весьма чувствительно к концентрациям Co и Fe в сплавах. Исследованы оптические и магнитооптические свойства аморфных лент CoFeSiB при энергии падающих фотонов 0,05–1,2 эВ. Оптическую проводимость определяли из результатов спектроскопической эллипсометрии. Вращательные спектры Керра для аморфных пленок в области 0,6–2,2 эВ подобны спектрам для массивного Co. Оптическая проводимость аморфных пленок CoFe(Ni)SiB в ИК области медленно возрастает как функция частоты (пропорционально $\omega^{1/3}$).

Amorphous ribbons of soft ferromagnetic alloys have attracted considerable attention in recent years due their unique physical properties and potential technological applications. One possible application of thin films of such materials is in high-frequency resistive sensors in novel devices for reading information from high-density magnetic and magneto-optical disks. Magnetic ribbon systems also attract considerable interest from the fundamental viewpoint, owing to their isotropic giant magnetoresistance (MR) effect [1–3]. Most of the results in the literature [1–4] concerning CoFeSiB has been previously explained by classical electrodynamics [2,3]. Thus, the impedance of the sample is approximately [5]:

$$Z = (1 - i)L/(2Sc) \cdot (2\pi\rho_0\omega_{ac}\mu_t)^{1/2} \quad (1)$$

where c is light speed, ρ_0 is the dc resistivity, and ω_{ac} ($= 2\pi f$) is the angular frequency of the ac current, μ is the effective magnetic permeability, S and L are the ribbon width and length, respectively. The effective magnetic permeability depends on the type of domain structure [1–3]. The resistivity values are defined according to Cambell and Fert [6] by the corresponding densities of electron states at the Fermi level:

$$\sigma_s = (\rho_{0s})^{-1} \approx N_s(E_F) \quad (2)$$

where $N_s(E_F)$ is the density of states for d-electrons of spin orientation $s = \uparrow, \downarrow$.

In this paper we present the results of an optical and magneto-optical study of ribbons