EFFECTIVE EXCHANGE-COUPLING IN PY/GD BILAYERS

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The antiferromagnetic coupling between Transition Magnetic Metals and Heavy Rare Earth has been widely studied in systems like Fe/Gd and Co/Gd [1-3]. However, systems of Gd and a layer of a soft magnetic alloy like Permalloy can be interesting for further applications. In this work we have studied the magnetic coupling in systems of Py/Gd in which the Gadolinium thickness (50nm) is greater than its exchange length, λ_{ex} <30nm, (calculated assuming that the Gd anisotropy is due to mechanical stresses) and different Py thickness (50-200nm), being its exchange length $\lambda_e \approx$ 80nm (calculated assuming that the Py anisotropy is the one induced by applying a magnetic field during growing).

Bilayers of Py($Fe_{20}Ni_{80}$)/Gd were grown on glass substrates by using a dc magnetron sputtering system at room temperature. A magnetic field of 100 Oe was applied in the plane of the substrates during the deposition in order to induce an easy axis in the Py layers. Mo layers of 10 and 60 nm were used as buffer and capping layers, respectively. The sample with the thinner Py thickness (50 nm) consists of two bilayers Py/Gd separated by a Mo layer of 20 nm. The structural characterization has been done by using Θ-2Θ diffraction scans. No oxygen traces have been obtained from Auger spectroscopy. A vibrating sample magnetometer (VSM) from LakeShore was used to carry out the magnetic characterization from 80 K to 300 K.

Hysteresis loops of the samples show two large Barkhausen jumps related with the magnetization inversion of the Py layer (fig 1, 2). To study the magnetic coupling between Py and Gd layers we have measured the magnetic field, H_{sw}, necessary to switch the magnetization of the Py layer, this is the half distance in the field axis between the middle point of the Barkhausen jumps. Figure 3 shows H_{sw} versus temperature for samples of different Py thickness. As can be seen for Py thickness in the order of its exchange length, H_{sw} increases largely as temperature decreases and then decreases for temperatures down 90K. This effect is greater than the expected one due to the increasing of coercive field of a single Py film when temperature decreases. The behavior of H_{sw} as a function of the temperature can be explained by both the antiferromagnetic coupling between Py and Gd layers and the increasing of the magnetization and the coercive field of Gd as temperature is reduced. A numerical simulation has been done to explain this behavior.

References:

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[2] J. L. Prieto, B. B. van Aken, G. Burnell, C. Bell, J. E. Evetts, N. Mathur, M. G. Blamire, Phys. Rev. B., **69**, 054436 (2004).
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Figures:

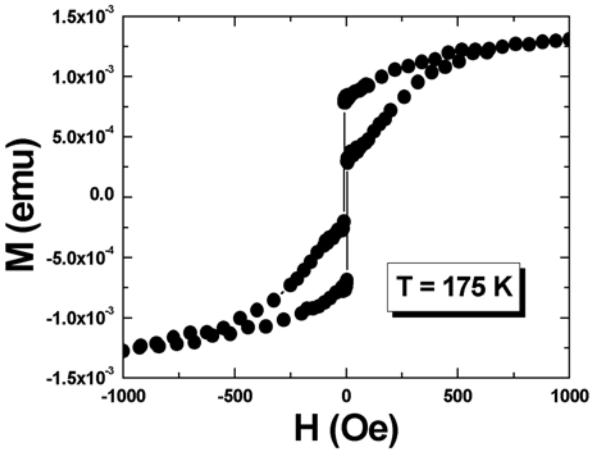

Figure 1. Hysteresis loop at 175 K of the Py(100 nm)/Gd(50 nm) bilayer.

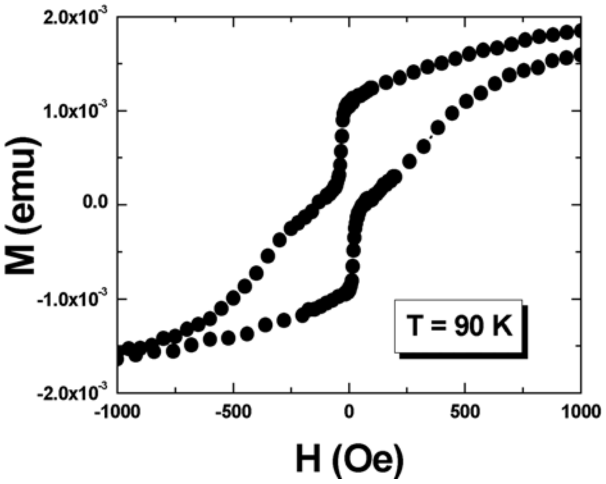

Figure 2. Hysteresis loop at 90 K of the Py(100 nm)/Gd(50 nm) bilayer.

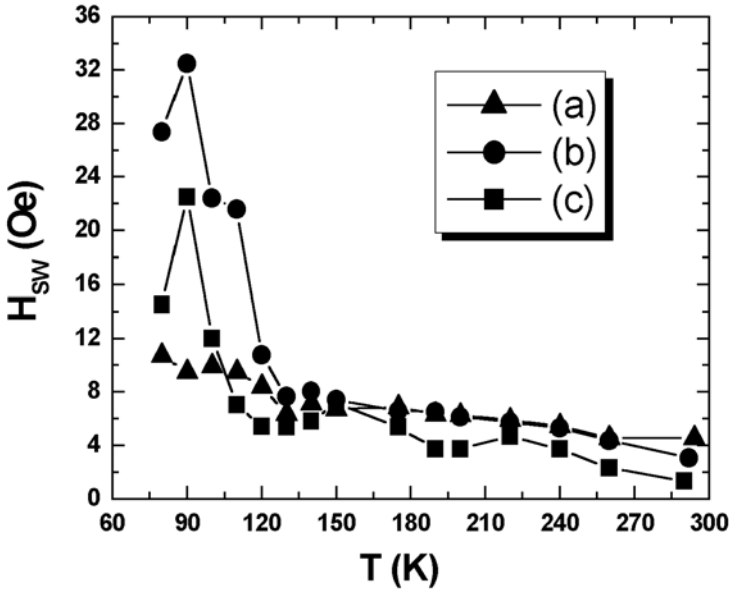

Figure 3. H$_{SW}$ as a function of the temperature, (a) Py(200 nm)/Gd(50 nm), (b) Py(100 nm)/Gd(50 nm), (c) Py(50 nm)/Gd(50 nm)/Mo(20 nm)/Py(50 nm)/Gd(50 nm).