AB09

Unambiguous Evidence for Existence of Antiferromagnetic Interlayer Coupling in Pt/Co Multilayers with Perpendicular Anisotropy

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Since the discovery of the antiferromagnetic (AF) interlayer exchange coupling (IEC)[1] and giant magnetoresistance (GMR)[2] in the layered ferromagnetic (FM) films separated by the metallic Cr spacers, these phenomena have been subjects of great interest. For most transition-metallic spacers, the AF IEC has been observed. Surprisingly enough, for the transition-metallic Pt spacer, though the RKKY theory predicts the existence of the AF IEC,[3] the experimental investigations have reported the inconsistent results. In the Pt/Co multilayers with perpendicular anisotropy, no matter the thickness of the Pt layers, only the FM IEC has been reported between the Co layers through the Pt layers.[4] However, by designing the Pt/Co multilayer with a spin- valve configuration, the AF IEC has been observed through the Pt spacer thicker than 25 Å.[5] In this work, with the assistance of an ultrathin NiO capping layer, we present unambiguous evidence to prove the existence of the AF IEC in the Pt/Co multilayers with the same Pt layers. Fig.1 gives the magnetization loop and the magnetoresistance curve at 300 K. Clearly, at 300 K, the separate sharp reversals occur in the three Co layers. The occurrence of the first sharp switching in the positive field is strongly suggestive of the AF IEC. It has been found that the reversal order is very sensitive to the thicknesses of the NiO and Pt layers. This observed AF IEC can be attributed to the effects of the thermal variations of the magnetization-dependent electron reflectivities at interfaces and the Pt polarization on the IEC.

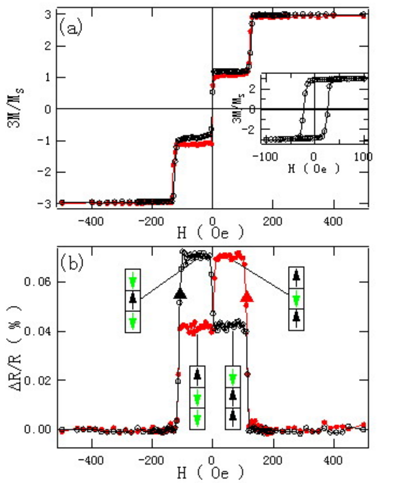

Fig.1. The magnetization hysteresis loop (a) and magnetoresistance curve (b) at 300 K for the $[Pt(26.5)/Co(4)]_3/NiO(11)$ multilayer. The thickness unit is Angstrom. Inset in (a) is the loop with the NiO layer replaced by a Pt layer. The alignment of arrows represents the magnetization directions in the three Co layers on the step.

REFERENCES

[1] P. Grüberg *et al*., Phys. Rev. Lett. 57, 2442 (1986).
[2] M.N. Baibich *et al*., Phys. Rev. Lett. 61, 2472 (1988).
[3] M.D. Stiles, Phys. Rev. B 48, 7238 (1993).
[4] J.W. Knepper and F.Y. Yang, Phys. Rev. B 71, 224403 (2005).
[5] Z.Y. Liu *et al*., Phys. Rev. B 77, 012409 (2008).

AC01

Super-Magnetoresistance in Graphene Nanoribbon Spin Valve Devices

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Graphene has emerged as a versatile material with outstanding performances in diverse types of electronic devices. Successful spin-injection into graphene and long spin-relaxation length promise bright prospects for the utility of graphenes in spintronics exploiting the quantum spin states of electrons as well as their charges. Here we report the ideal behaviour of a graphene nanoribbon as a spin-valve device with perfect transmission/reflection for the parallel/anti-parallel spin configuration [1], which exhibits tens of thousands times larger magnetoresistance than has been reported so far. This striking feature originates from the unique symmetry of the band structure in the zigzag graphene nanoribbon. Orbital symmetry matching, in addition to spin matching in conventional devices, plays a crucial role in the selective transmission of the graphene nanoribbon. We investigated the domain wall formation energy for both collinear and non-collinear types of spin waves. The non-collinear spin states were fully taken into account in a self-consistent manner with the non-equilibrium Green's function approach by using the Postrans program package [2-4]. The study of the cases for the non-collinear type domain wall is the first fully self-consistent ab initio results for transmission calculations. The non-collinear type spin wave is found to be energetically more favorable, and the domain wall size in the non-collinear type is wider than that in the collinear type, but it is not very wide (in consideration of negligible spin orbit coupling compared with the iron system). The device is able to play a role as a spin filter which selectively transmits near 100% spin-polarized current.

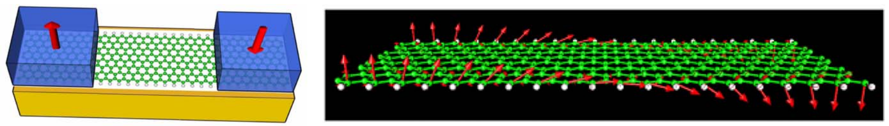

Fig. 1. Schematic of a graphene nanoribbon spin valve device and a domain wall between parallel and antiparallel spin configurations.

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REFERENCES

[1] Kim, W. Y.; Kim, K. S. *Nature Nanotech*. 3, 408 (2008).
[2] Kim, W. Y.; Kim, K. S. J. *Comput. Chem*. 29, 1073 (2008).
[3] D. Cheng, et al., *Phys. Rev. Lett*. 96, 096104 (2006).
[4] W. Y. Kim, Y. C. Choi, and K. S. Kim, *J. Materials Chem*. (in press).