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Application of Single Domain Model for Planar Hall Effect in NiFe/IrMn Bilayers Study

C. G. Kim[1]*, N. H. Duc[2], N. T. Thanh[1,2], C. O. Kim[1]

[1]Department of Materials Science and Engineering, Chungnam National University, 220 Gung-Dong, Yu-Seong Gu, Daejeon, 305-764, Korea

[2]College of Technology, Vietnam National University, 144 Xuan Thuy - Cau Giay - HaNoi, Vietnam

*Corresponding author: cgkim@cnu.ac.kr, Phone: +82 42 821 6632, Fax: +82 42 822 3206

We have applied the Single Domain Model (SDM) to explain the Planar Hall Effect (PHE) in NiFe/IrMn structure fully. The sample of Ta(5.0 nm)/NiFe(10.0 nm)/IrMn(10.0 nm)/Ta(5.0 nm) thin films was fabricated by DC magnetron sputtering system under working pressure of 1 mTorr and the base pressure of 7.0×10^{-9} Torr. During sputtering process, a uniform magnetic field of 100 Oe was applied parallel to plane of films, to induce a magnetic anisotropy of ferromagnetic layers. The pattern for investigation was fabricated by lithography method with the size of 50x100 square micrometers. The simulation and calculation were based on the arranged status of magnetization due to minimum of surface magnetic energy at each certain external magnetic field. When we measured the PHE with different measurement angle between easy axis and direction of external magnetic field, the experiments show agreements with the theory. The PHE profiles are smoothly with large and change rapidly at small angles. The discussions were attributed to distribution of arrangement of magnetic domain at static of minimum energy [1, 2].

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Thickness Dependence of Mean Free Path of Electron in Ta/NiFe/IrMn/Ta Multilayer

C. G. Kim[1]*, N. T. Thanh[1,2], C. O. Kim[1]

[1]Department of Materials Science and Engineering, Chungnam National University, 220 Gung-Dong, Yu-Seong Gu, Daejeon, 305-764, Korea

[2]College of Technology, Vietnam National University, 144 Xuan Thuy - Cau Giay - HaNoi, Vietnam

*Corresponding author: cgkim@cnu.ac.kr, Phone: +82 42 821 6632, Fax: +82 42 822 3206

We have investigated the ferromagnetic layer thickness dependence of mean free path of electron in Ta/NiFe(t)/IrMn(10 nm)/Ta multilayer by using the method of anisotropic magnetoresistance and planar Hall effect for t = 3, 4, 5, 7, 8, 10, 12, 15, 20 nm. Our results of calculation revealed that the mean free path of electron in ferromagnetic and nonferromagnetic layers performed a varying function with increment in NiFe thickness. Both the parallel and perpendicular mean free path of electron in NiFe were observed to increase at first when the NiFe thickness increases from 3 nm to 10 nm; then for the NiFe thicknesses from 10 nm to 20 nm, the mean free path of electron in NiFe layer decrease as the NiFe thickness increases. However, in the nonferromagnetic layer, the mean free path of electron was observed to decrease for the whole range when the NiFe thickness increases. The measured quantities were found to be in good agreement with the theoretically estimated parameters using single domain model; thus these behaviors are well explained based on the modern electron theory transition metals and conductor [1].

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