EP14

Magnetic Property of Transition Metal Monolayer on Ta(001) Surface

S. J. Youn[1]* and S. C. Hong[2]

[1]Deptartment of Physics Education, Gyeongsang National University, Jinju, 660-701, South Korea
[2] Department of Physics, University of Ulsan, Ulsan, 680-749, South Korea

*Corresponding author: e-mail: ysj@gnu.ac.kr

Magnetic properties of 3d transition metal (Mn, Fe, Co) monolayer on Ta(001) surface have been studied by using the first-principles density functional theory. Recently, antiferromagnetism of Fe and Co monolayer on W(001) surface has been observed theoretically or experimentally[1,2]. We have studied the systematic trends as the top layer atoms on Ta(001) are changed in order to investigate the effects of a substrate on magnetism of the transition metal thin monolayer including the possibility of stable ferromagnetism of the 3d transition metal monolayers with respect to their antiferromagnetism. Optimal interlayer distances between the transition metals and Ta are found by minimizing the total energy, at which magnetic properties are determined. The magnetic easy axes are determined by calculating the magnetic anisotropy energy between in-plane and out-of-plane magnetism. Hybridization of orbitals between 3d-transition metal and Ta plays an important role in determining magnetic properties. Detailed discussion on the relationship between electronic structure and magnetism will be given by comparing the physical properties of the monolayers on W(001).

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EQ01

Capacitance Effect on Microwave Power Spectra of Spin-Torque Oscillator with Thermal Noise

Bo Guan[1], Yan Zhou[2], Franklin G. Shin[1]*, and Johan Åkerman[2]

[1]Dept. of Applied Physics, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong
[2] Microelectronics and Applied Physics Department, Royal Institute of Technology (KTH), Kista, Sweden

*Corresponding author: e-mail: apafgshi@inet.polyu.edu.hk

Theory predicted that a spin-polarized current can exert a torque on a nano-scale magnet. This torque can excite magnetization precessional motion with a steady frequency. Experimentally, even at 100 K, the microwave emission has the quality factor Q on the order of 10^4 [1]. But Q determined by both numerical simulation and analytical approach is much smaller [2]. As STOs have been implemented in different materials and configurations, we believe that capacitance effect will influence thermal stability of the system, and keep the Q factor at a high level.

In our model, a GMR trilayer STO has been connected in parallel with capacitance. A stochastic magnetic field vector is added into the modified Landau-Lifshitz-Gilbert (LLG) equation to represent the thermal fluctuation. The emitted power spectrum is derived by Fast Fourier Transform, and fitted to a Lorentzian profile.

In the presence of thermal noise, the spectra get broadened with increasing temperature. Fig. 1(a) shows the spectra at 30K with and without the capacitance. The fitted Q values are 4200 and 1550 respectively. Fig. 1(b) shows the same results at 100K where Q values are 2300 and 1100 respectively. The addition of a small capacitance can hence enhance the quality factor about a factor of 2. Increasing the capacitance is also found to increase the quality factor even further.

In summary, the capacitance effect does influence the stability of the system, and improves the Q factor even in the presence of thermal fluctuation. It is hence possible that some the underlying reasons for the high quality factors observed in experiments may be ascribed to either intrinsic or extrinsic sources of capacitance in parallel with the STO. And the result of I-V phase shift suggests that there may be an optimum capacitance where the thermal stability of the system can be most enhanced.

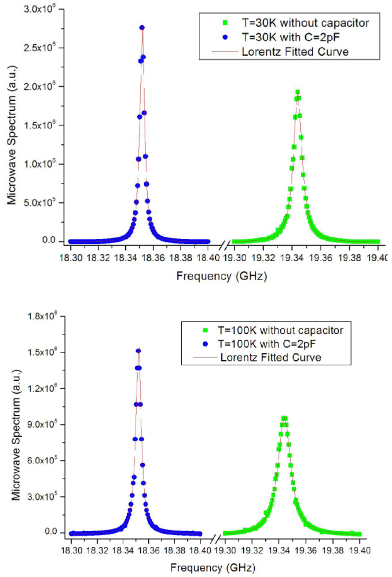

Fig. 1. The microwave spectrum at T = 30 K (a) and 100 K (b) with and without C = 2 pF, individually.

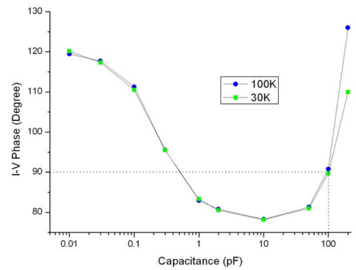

Fig. 2. The I-V phase shift.

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