BA05

Analytical Investigation of Switching Spin-polarized Current into the Canting model for a wo-sublattice System

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It is found that in some ferrimagnetic Rare Earth-Transition Metals (RE-TM) compounds, the exchange coupling is not strong enough to force the two sublattices into a complete alignment. This gives origin to the formation of a small canting angle between the magnetizations of the RE and TM sublattices. This canting can explain the apparent anomalies observed in anisotropy constant [1]. On the other hand, at present the spin transfer torque (STS) study is being of considerable interest due to the great potential for spintronic device fabrication [2]. In the present work we are studying, by using computer calculation, the behavior of switching polarized-spin current required for the application of the spin-transfer switching (STS) into the canting model for a two-sublattice system. The magnetization process is studied by analyzing the Landau-Lifshitz-Gilbert (LLG) equation. Based on this analysis, we have calculated critical current values as a function of exchange coupling coefficient for several applied magnetic fields, as shown in Fig. 1. This figure shows that the critical current reduces to one third of the value obtained when the large exchange coupling is considered. Moreover, we have considered the effect of the applied magnetic field orientation on the critical current, as shown in Fig. 2. Results of driven magnetic precession and magnetic switching, as well as of critical current density of the system under the canting model, will be also discussed.

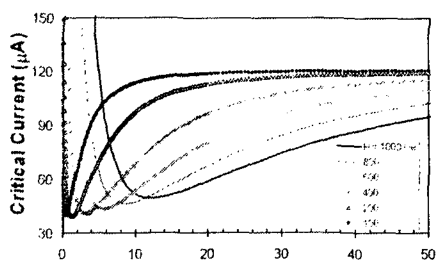

Fig. 1. Critical Current as function of exchange coupling for several applied magnetic fields.

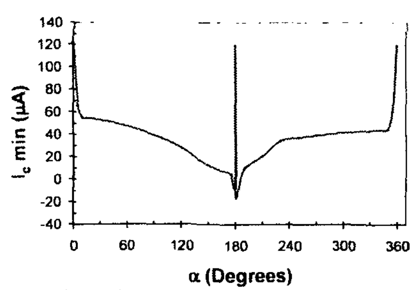

Fig. 2. Critical Current as function of orientation of applied magnetic field.

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BA06

Spin-dependent Single Electron Tunneling and Spin Accumulation in Nonmagnetic Nanoparticles

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Spin injection and accumulation give rise to a variety of phenomena useful for spin electronic devices such as magnetoresistive random access memories (MRAMs). Among various nanostructures, nanoparticles are of particular interest because its small volume causes a large chemical potential splitting when spin-polarized current is injected and consequently novel phenomena of spin-dependent single electron tunneling appear in the device structures [1]. Furthermore, it has been found that spin relaxation time is much enhanced in nanoparticles [1].

In this study, we have investigated spin-dependent single electon tunneling associated with spin accumulation in nonmagnetic nanoparticles, motivated by the fact that the problem of superparamagnetism does not arise in applications using nonmagnetic nanoparticles. Samples of double junction structures of Fe/MgO/Au-nanoparticles/MgO/Fe were prepared on a MgO(100) substrate by molecular-beam epitaxy [2]. The nominal thickness of Au layer was chosen to be less than 0.05nm, and the formation of nanometer-sized Au particles and their magnetotransport properties have been investigated by scanning probe microscopy and magnetoresistance measurements, respectively.

A double junction sample of MgO buffer (20 nm)/Fe (20 nm)/MgO (1.5 nm)/Au (0.01 nm)/MgO (2.5 nm)/Fe (5 nm)/Co (3 nm) shows clear Coulomb blockade with a threshold voltage of ~ 100 mV at 4.2 K. Furthermore, TMR appears and increases with increasing current above the Coulomb threshold, and reaches about 12% at 250 mV. The behavior of TMR shows that remarkable spin accumulation occurs in the Au nanoparticles, resulting in the observed TMR. The spin relaxation time in a Au nanoparticle, estimated from the value of current in which finite TMR emerges, is of the order of 10 nsec. This is much longer than that estimated from CPP-GMR in FePt/Au/FePt trilayers, supporting our previous finding that spin relaxation time is much enhanced in nanoparticles [1]. The results of the double tunnel junctions with a AlO barrier [3] and related phenomena will be also presented.

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