BA01

The Effect of Spin Polarization on Spin Transfer Torque

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Current induced magnetization switching (CIMS) device is a possible candidate for next generation memory device due to its scalability. The reduction of the current required for magnetization reversal is one of the central issues to be resolved for practical application of CIMS device. The critical current density (Jc) which is currently as low as 10^7 A/cm^2 needs to be further reduced by one order of magnitude for a typical transistor to supply the current. In this paper, we analyze the effect of the bulk and surface spin polarization factors on the critical current density.

Stability analysis on the magnetization dynamics of the free layer (F2) has led to an analytical form for the critical current density [1]. The scattering matrix method has been used [2] to calculate the spin transfer torque in the free electron limit, and the comparison between the experiment and theory in the diffusive limit is made using Co/Cu/Co layer [3]. We calculate the critical current density for the parallel to antiparallel configuration (P to AP) and antiparallel to parallel (AP to P) cases in a ferromagnet/normal metal/ferromagnet (F_1/N/F_2) stack with different spin polarization factors for the two ferromagnets. We assume the diffusive limit and solve Valet Fert equation to compare our results with the previous results from [2,3].

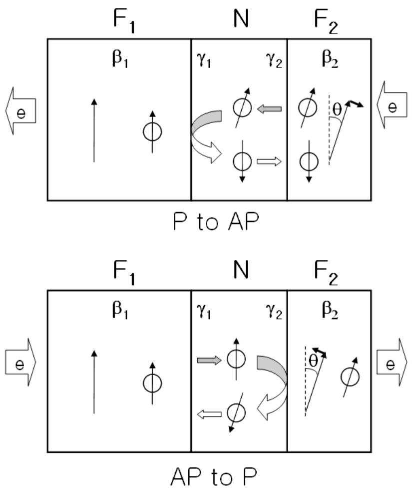

Fig. 1. Spin current for electrons incident from right(top) and left(bottom).

Our conclusion is that by using different ferromagnetic materials for the fixed and free layers, we can selectively reduce the critical current density for P to AP and AP to P state. The parameters that affect the critical current density for P to AP are found and the set of design parameters for an asymmetrical structure to reduce Jc is presented.

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BA02

Magnetic Scattering in CoFeB/MgO/CoFe Magnetic Tunnel Junctions

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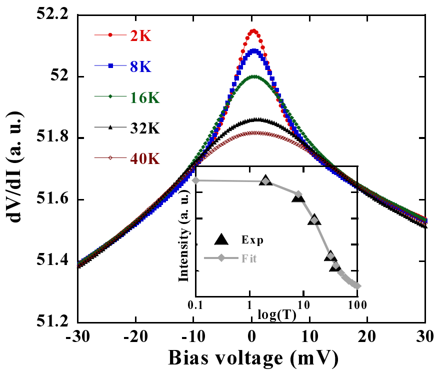
Magnetic tunnel junctions (MTJs) with the single crystalline MgO barrier have been intensively studied since the discovery of giant large tunnel magnetoresistance at room temperature [1]. However, the precise transport mechanism has not been provided a detailed understanding yet. In this study, we performed tunneling spectroscopy of MTJs with a MgO barrier [2], to investigate the effects of a coupling between localized spins and conduction electrons in MTJs [3].



A magnetron sputtering system (Canon ANELVA C-7100) was used to deposit the MTJ stack included CoFeB(3)/Mg(0.6)/MgO(1.75)/$Co_{70}Fe_{30}$(3) (in nm) onto thermally oxidized Si wafers. We measured derivative conductance curves by conventional look-in detection technique applying various ac-modulation voltages and temperatures for both parallel (P) and antiparallel (AP) configurations of CoFeB and CoFe ferromagnetic layers. Details about these procedures can be found elsewhere [2].

The derivative resistance (dV/dI) curves for both P configuration and AP configurations show zero-bias anomaly (ZBA) peaks whose intensity and half-width strongly depend on temperatures (Figure). Additionally, the difference between the spectra for P and AP configurations is also observed. Therefore, the origin of the peak is attributed to the spin-dependent process, those are, a magnon-induced inelastic scattering and a magnetic impurity scattering processes. The temperature dependence of the dV/dI peak intensity [Inset of figure] was well fit by an empirical expression proposed for Kondo effect [3]. From the fitting, we estimated that the Kondo temperature is around 20K. This value is almost identical to that observed in CoFe/AlO/CoFe MTJs [3].

To investigate the nature of the scattering centers, tunneling spectra of single crystal Fe/MgO/Fe MTJs were measured. Comparison with CoFeB/MgO/CoFeB will also be discussed.

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