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Current-induced spin-wave excitation in single-layered ferromagnetic/normal metal nanocontact

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1. Introduction

These days interests in spin-transfer torque such as multilayered giant magnetoresistance (GMR) device are increasing for its potential for next generation device application [1]. Moreover, it has been reported that interfacial microwave oscillation in single-layered ferromagnetic devices is also originated from interfacial spin-transfer torques. Experiments on the single-layered structure require very small contacts, or nanocontacts. One of methods, the tip-contact method [2, 3], found that the structural spin precession gives the excitation of the spin-wave in the soft magnetic layer and it is not detected in the ballistic contacts. Another method, using nanopillar devices [4], claimed that it is caused by the structural asymmetry of the junction [5].

2. Experimental Methods

To systematically investigate the spin-wave excitation of single-layered magnetic films, we used nano-bridge devices [6, 7]. Fabrication methods are well introduced in the papers of Ref. 6 and 7. The size of our nanocontact devices ranges from 10 nm to 20 nm in diameter. In order to check the integrity of our overall process and device size, we measured successfully the transport phonon spectroscopy of Cu-Cu and Au-Au contacts. All the films were deposited by in-situ sputtering on both sides. Contacts were made between the normal metal films (100 nm thick Cu, Au, Al, and Mg) and the ferromagnetic thick film (100 nm thick CoFe).

3. Results and Discussions

Among all combinations of those materials, we observed excitation phenomena only in the contacts of Cu-to-CoFe when we applied zero magnetic field. The spin wave excitation phenomena were found to depend on the direction of the electron's flow; it is present only when the electrons flow from Cu to CoFe. We believe that these are related to the relatively long spin diffusion length in Cu. In Cu, the accumulated spins at the interface give an additional spin torque to the interfacial ferromagnet, which results in the local spin precession of the ferromagnet.

4. References

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