Study of the Magnetic Properties on Py Films by Ferromagnetic Resonance Effect

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1. Introduction

Understanding and controlling magnetic damping is important for minimizing the switching current in proposed next generation magnetic memory switched by spin transfer torque (STT) [1] and for counteracting STT-excited magnetic noise, which may limit the areal density in future generations of hard drives that use giant magnetoresistance read heads [2]. Magnetic damping is usually characterized by the phenomenological damping parameter α.

Ferromagnetic resonance (FMR) measurement is widely utilized for determining g-factor, magnetic anisotropy constant and interlayer magnetic coupling for films and multilayers [3]. These quantities of static magnetic properties are estimated from the resonance peak positions of FMR spectra. From the FMR linewidth, one can obtain the damping parameter for magnetization precession and information regarding magnetic inhomogeneity in films.

In this work, we set the multi-frequency FMR measurement system using microwave generator and studied the magnetic properties of Py thin films, including effective magnetization, Gilbert damping constant, and g-factor using ferromagnetic resonance.

2. Experiment

Fig. 1 shows a schematic of the multi-frequency FMR measurement setup. The static magnetic field is applied in the plane of the film. Microwave field is propagated through the TEM cavity and reflected at the end of the cavity where the DUT(device under test)is mounted. The incident microwave energy is absorbed by the electron spin, when the applied microwave frequency is matched with the precession frequency. At that time, the phase sensitive detection system acquire the absorption.

3. Results

Fig. 2 shows representative FMR data for 30 nm thickness Py film. Fig. 2(a) shows a typical measured absorption derivative versus field profile for a 25.5 GHz microwave excitation. The profile is dislocated as Lorentzian function. It is caused by structural inhomogeneity influence the linewidth of thin film. The procedure by E. Patton [4] was applied to our resonance conditions. The approach is based on the equations of motion for the Kittel equation, similar to that in Ref. [4]. In order to determine the damping parameter, the resonance field linewidth (ΔH_{PP}) was also measured in resonance magnetic field (H_R) with respect to the variety frequencies. The formula of ΔH_{PP} was deduced by the general solution described, for example, in Ref. [5].

4. Summery

In summary, the FMR technique was applied to investigate the magnetic properties of Py thin films. Frequency dependence of the resonance field and line width was analyzed using Landau-Lifshitz-Gilbert equation.

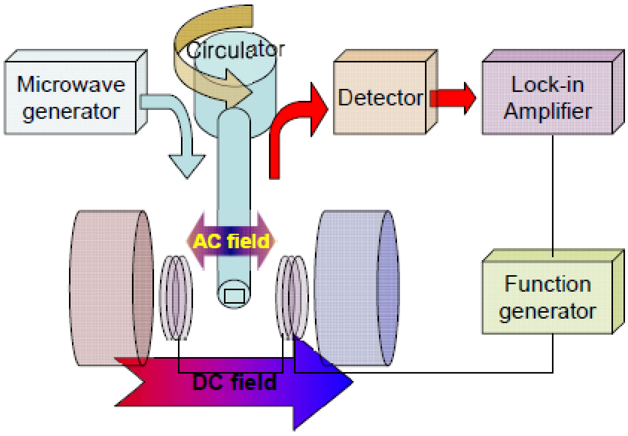

Fig. 1. Schematic of ferromagnetic resonance experimental system.

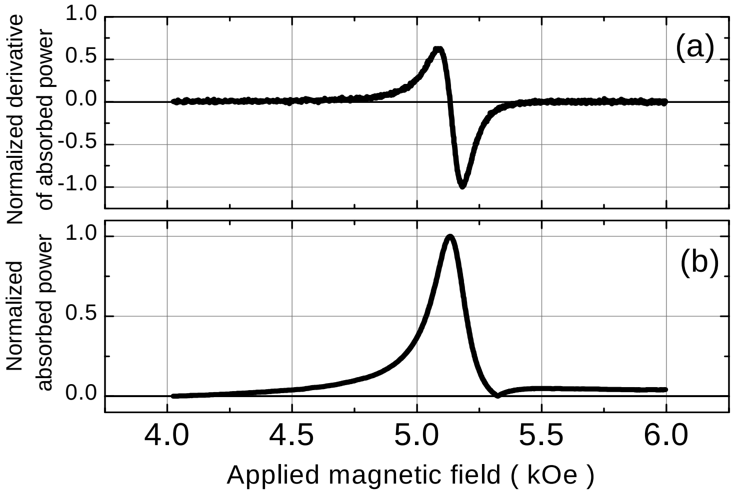

Fig. 2. Representative ferromagnetic resonance system data. Graph (a) shows ferromagnetic absorption derivative vs static applied field data for 30 nm Py film at 25.5 GHz. Graph (b) shows the normalized integrated response from (a) as a function of field.

5. Reference

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