rf power dependence of homodyne-detected ferromagnetic resonance spectra of a CoFeB/MgO magnetic tunnel junction

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We have investigated the magnetic properties of a free layer in nano-scale CoFeB/MgO magnetic tunnel junctions (MTJs) with a perpendicular magnetic easy axis by homodyne-detected ferromagnetic resonance (FMR) [1]. In this work, we study the rf power dependence of the FMR spectra, and show that the resonant frequency and lineshape depend on the power.

A stack structure, Ta/Ru/Ta/$Co_{18.75}Fe_{56.25}B_{25}$ (1 nm)/MgO (1.3 nm)/$Co_{18.75}Fe_{56.25}B_{25}$(1.8 nm)/Ta/ Ru, is deposited on a sapphire substrate by dc/rf magnetron sputtering. The stack is processed into a circular MTJ with a diameter of 100 nm on a coplanar waveguide by electron beam lithography and Ar ion milling. The two CoFeB layers have perpendicular magnetic easy axis, and the top layer is a free layer. The rf signal, which induces FMR through the electric-field effect on the magnetic anisotropy, is applied to the MTJ. An FMR spectrum is measured as dc component V_{dc} of the reflected voltage from the MTJ.

Figure shows FMR spectra as a function of rf power ranging from -30 dBm to -10 dBm under an in-plane magnetic field of $\mu_0 H_{in}$ = 100 mT. The resonant frequency shifts to lower frequency with increasing the rf power, and the shape of spectra is distorted from the anti-symmetric lineshape above -20 dBm. The power dependence of the resonant frequency and the lineshape can be reproduced by a macro-magnetic simulation.

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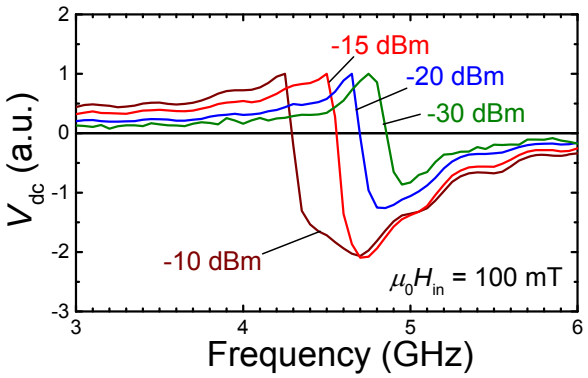

Figure: Homodyne-detected ferromagnetic resonance spectra as a function of rf power at in-plane magnetic field $\mu_0 H_{in}$ = 100 mT.

Reference

[1] E. Hirayama *et al.*, The 61st Japan Society of Applied Physics Spring Meeting, 19p-E7-2 (2014).