Laser-induced spin precessional dynamics in CoFeB/MgO/CoFeB magnetic tunnel junction under the electric field

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Voltage control of magnetic anisotropy (VCMA) attracted much attention as a magnetization reversal technique more efficient than spin-transfer-torque in magnetoresistive random access memory (MRAM) using a material with large perpendicular magnetic anisotropy (PMA) [1] [2]. Since spin precessional frequency f becomes very high, the evaluation of magnetic anisotropy using microwave-ferromagnetic resonance (FMR) is difficult for films which have a large magnetic anisotropy. Here we investigated the spin precessional dynamics using all-optical time-resolved magneto-optical Kerr effect (TRMOKE) in magnetic tunnel junction (MTJ) with perpendicularly magnetized CoFeB electrodes under the electric field E_{bias}.

The MTJ devices were fabricated using an ultra-high vacuum sputtering system and a standard microfabrication method. The stacked structure is Si/SiO_2/Ta(3.0)/Ru(5.0)/$Co_{20}Fe_{60}B_{20}$ (3.0)/Mg(0.4)/MgO(2.0)/$Co_{20}Fe_{60}B_{20}$(1.4)/Ta(1.0)/Ru(4.0) (thickness in nm) on thermally oxidized Si substrate. The junction area was 10×10 ~ 30×30 μm^2. The In-Sn-oxide (ITO) was used for a top electrode materials. The MTJs were then annealed at 300℃ in vacuum for one hour.

The optical set-up is shown schematically in the Fig. 1. An applied magnetic field of 3 kOe applied at fixed angle 83°. Pulsed laser beam was focused on the junction area of MTJ via the objective lens and spot-size was less than 1 μm in diameter. Spin precessional dynamics for the 1.4-nm-thick CoFeB layer was measured by TRMOKE. Figure 2 shows the power spectrum density of f with various E_{bias}. The peaks correspond to the FMR modes and their frequencies increased with increasing E_{bias}, from which the efficiency of VCMA was estimated to 22 fJ/Vm.

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[1] T. Maruyama, *et al.*, Nature Nanotechnology **4**, 158-161 (2009), [2] A. Okada, *et al.*, Appl. Phys. Lett. **105**, 052415 (2014), S. Kanai, *et al.*, Appl. Phys. Lett. 103, 072408 (2013).

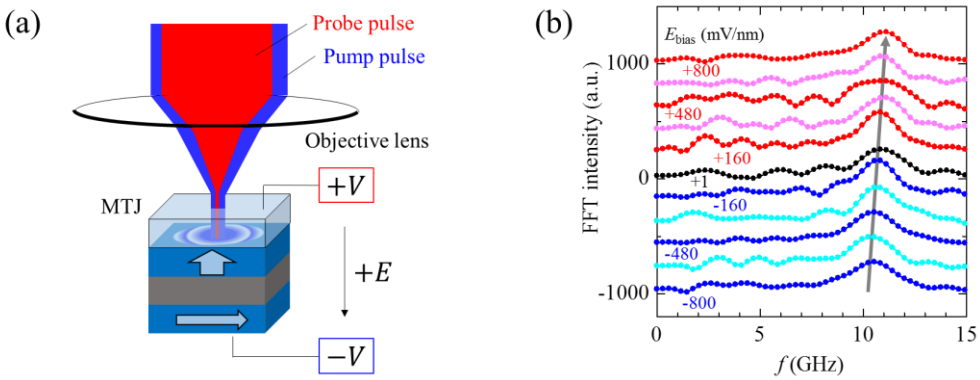

Fig. 1 (a) Schematic illustration of optical set-up for TRMOKE microscope measurement (b) the power spectrum of TRMOKE with various electric field E_{bias}.