Spin torque oscillator for microwave assisted magnetic recording

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Microwave assisted magnetic recording (MAMR) [1]is one of the potential techniques for the next generation high density magnetic recording up to 2T bit/in^2 and beyond [2]. MAMR is based on the principle where ac magnetic field ($\mu_0 H_{ac}$) generated from a spin torque oscillator (STO) is applied to the recording media having high thermal stability for lowering the switching field of magnetization of magnetic grains[3-5]. One major challenge for realizing MAMR is the development of a STO consisting of a field generating layer (FGL) having large magnetic volume and spin-injection layer (SIL) with device diameter size D ~ 30 to 40 nm that is able to generate a large enough $\mu_0 H_{ac}$ > 0.1 T from FGL with a frequency, f over 20 GHz at small bias current density J_C < 1.0 X 10^8 A/cm^2 [6, 7]. Particularly, the reduction of J_C is the most difficult task because the magnetic volume of FGL must be large for a sufficient ac magnetic field. Therefore, in our recent studies, we have fabricated various types of STO for MAMR having highly spin-polarized Heusler SIL layer to investigate the effect of spin-polarization on the oscillation dynamics in FGL layer. In order to simulate the behavior of STT-induced dynamics in the STO against various material parameters such as magnetization and spin-polarization, we employed a micromagnetic simulation using the code magnum.fe [8], which solves the coupled dynamics of magnetization (m) and the spin accumulation (s) simultaneously using the Landau Lifshitz Gilbert (LLG) equation and the time dependent 3D spin diffusion equation, respectively.

In this talk, we will show the result of two different STOs. First one has a perpendicularly magnetized Heusler SIL in which thin Heusler layer is deposited on perpendicular magnetized FePt. In this device, we clearly confirmed from both experiments and simulations that out-of-plane (OPP)-mode rf oscillation in FGL can be excited under lower J_C by using Heusler SIL compared with usual CoFe SIL.[9,10] The oscillation peak with the f of over 20 GHz was detected by slightly tilting magnetic field direction from the device normal (Fig.1). In order to reduce the total thickness of the STO device, we have recently fabricated the device with in-plane magnetized thin SIL, in which the synchronized OPP oscillation was predicted to generate between SIL and FGL by flowing electron from SIL to FGL.[11] The analysis of R-H curves under different current density with the micromagnetic simulations will be shown.

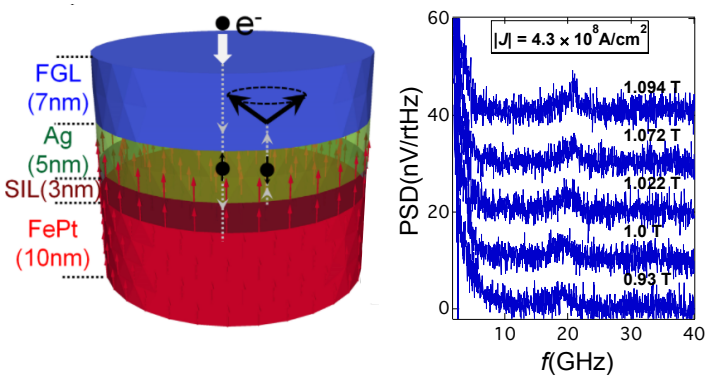

Figure 1. The stacking structure of STO for MAMR(Left), The rf spectra by applying magnetic field to 5 degree titled direction from the device normal (Right).[10]

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