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Magnetization Reversal in Perpendicularly Magnetized $L1_0$-FePt / Permalloy Nanodots under RF Field Application

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[Introduction] In order to overcome the superparamagnetic effect and continue the everlasting increase of the storage density, materials with high magnetic anisotropy (K_u), e.g. $L1_0$-FePt, have become candidates for recording media of hard disk drives. However, high magnetic anisotropy often translates into an excessively high magnetization reversal field. To solve this writability problem, Seki *et al.* [1] reported an effective switching method called spin wave-assisted magnetization switching. The exchange-coupled bilayer film consisting of a Permalloy ($Ni_{81}Fe_{19}$; Py) layer and an in-plane magnetized $L1_0$-FePt layer showed a spatial twisted spin structure, and the reversal of the hard magnetic $L1_0$-FePt layer could occur at an extremely low magnetic field by utilizing the spin wave excitation in the soft magnetic Py layer. For practical application, it is important to demonstrate the spin wave-assisted magnetization switching in a perpendicularly magnetized configuration. The formation of the perpendicularly magnetized $L1_0$-FePt / Py nanodots showing spring back behavior has been reported in the 61st JSAP spring meeting [2]. In this study, magnetization dynamics was investigated for perpendicularly magnetized $L1_0$-FePt / Py nanodots. The switching field reduction of the nanodots was evaluated under a static magnetic field and a radiofrequency (RF) magnetic field.

[Experiment] The stacking of thin films was MgO (100) subs. // Fe (1 nm) / Au (60 nm) / FePt (10 nm) / Py (150 nm) / Au (5 nm) / Pt (3 nm). Thin films were microfabricated into devices with nanodots on coplanar waveguides by using electron beam lithography and Ar ion milling. The size of the nanodots is about 200 nm in diameter, and the interval between nanodots is 200 nm as well. The ferromagnetic resonance spectra of the nanodots were measured by using a vector network analyzer, and multiple resonance peaks were observed in the resonance spectra. The switching fields of the FePt layer were evaluated from the polar magneto-optic Kerr effect (MOKE) loops of the nanodots, which were measured by a μ-MOKE system. The RF magnetic field was generated by using a signal generator. By applying the RF magnetic field, the switching field of FePt layer was clearly reduced, and the magnitude of the reduction was varied depending on the frequency of RF magnetic field. The largest reduction was observed at the frequency of 10.5 GHz, which is attributable to the excitation of the spin wave dynamics in the Py layer.

[1] T. Seki, *et al.*, *Nat. Commun*., **4**, 1726 (2013).

[2] W. Zhou *et al.*, 61st JSAP spring meeting, 17p-E7-3.