Magnetization reversal processes in perpendicularly magnetized FePt dots

We study the magnetization reversal processes in perpendicularly magnetized FePt continuous films and microfabricated dots. Understanding of different mechanism of magnetization reversal is very important for practical applications such as magnetic information storage or non-volatile magnetic random access memory (MRAM). We study the magnetization reversal process by magnetic force microscopy and Kerr microscopy.

$L1_0$-ordered FePt ($L1_0$-FePt) is one of the promising hard magnetic materials to develop the ultrahigh density magnetic recording and large-scale integrated spintronic devices. In order to reveal the magnetization reversal mechanism of $L1_0$-FePt in a nanometer region, we investigate the magnetization reversal process in perpendicularly magnetized $L1_0$-FePt continuous films and microfabricated dots.

$L1_0$-FePt thin films with different thicknesses were prepared by sputter-deposition. The Microfabrication of FePt nanodots was performed by e-beam lithography followed by ion beam milling. Nanodots of various diameters such as 500nm, 100nm, 30 nm with various center-to-center distances (pitch) were fabricated successfully. Triangular shaped dots of various lengths such as 100 nm and 30 nm were also fabricated. A few designs also have the honey comb structure. Scanning electron microscopy (SEM) was performed in order to measure the diameter or length of nanodots or nano-triangles. From the SEM images, it was confirmed that the dots were well separated and no surface to surface contact was observed ruling out the possibility of any direct exchange coupling between the FePt nanodots.

Magneto-optic Kerr effect (MOKE) magnetometry in the polar geometry was performed on all the FePt thin films as well as on the nanodot patterns. From the PMOKE loops we notice that the coercivity increases when the diameter of the dots are decreased. Also designs with the same diameter of dots but smaller pitch showed decrease in coercivity which indicates magnetostatic coupling mainly of dipolar nature between the dots. Dynamic MOKE hysteresis measurements where the sweep rate is varied have been performed on the FePt thin films as well as the nanodots. Figure 1 shows the dynamic magnetization hysteresis loops of a FePt thin film with the thickness of 5 nm. We have clearly observed that the coercivity increases as the frequency of measurement increases, indicating the main contribution of domain wall motion as usually observed in ultrathin ferromagnetic thin films. Also magnetic force microscopy (MFM) has been carried out and the collective magnetization reversal processes in the ensembles of the FePt dots has been observed as a function of magnetic field, which is shown in Fig. 2. These results obtained from PMOKE and MFM will be compared with Kerr microscopy images, which is expected to find the existence of any domains consisting of a few FePt dots. [1]

References

[1] S. Bedanta, T. Seki, T. Shima, and K. Takanashi (Unpublished).

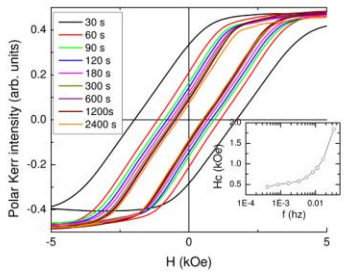

Fig. 1 Dynamic magnetization hysteresis loops of a FePt (5nm) thin film measured by PMOKE.

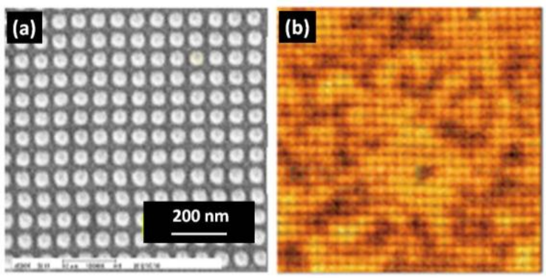

Fig. 2 (a) SEM and (b) MFM images of 25 nm FePt dots with the pitch of 75 nm. The MFM image was observed at H = -3 kOe.

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