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Manipulation of Perpendicular Anisotropy in FePt Patterned Media for Ultra-high Density Magnetic Recording

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1. Introduction

In order to realize a high-density magnetic recording media, grain size should be decreased. However as grain size smaller, thermal stability of magnetization in each bit is dramatically decreased so that the ferromagnetic material acts like paramagnetic material, referred to as superparamagnetism. To overcome superparamagnetism, the Bit Patterned Media (BPM), which consist of isolated dots, has been suggested. In BPM, the magnetic layer is created as an ordered array of highly uniform islands, each island capable of storing an individual bit. FePt have been one of the more heavily investigated candidates for the next generation high-density magnetic recording media because FePt display large perpendicular anisotropy and thermal stability [1]. In this work, we fabricated magnetic recording media by a combination of E-beam lithography and either dry etching (deposition-first process) or lift-off (deposition-last process).

2. Experiment

In order to fabricate patterned structure of the FePt, the combination of EBL and a dry etching was utilized. Using the ER patterns as etch masks, the inductively-coupled plasma (ICP) Ar etching was performed to transfer the ER patterns onto the film stack.

As an alternative process, a lift-off process (deposition-last process) was employed to fabricate the patterned media. For this process, a type of positive ER was coated on CrV layer and patterned undergoing E-beam exposure. Then a 7 nm thick FePt layer was deposited by sputtering at room temperature, followed by a lift-off [fig. 1(a)]. The magnetic properties of patterned structure were characterized by SQUID.

3. Result & Discussion

The FePt patterns of different sizes (100 and 50 nm in diameter) fabricated by the combined use of E-beam lithography and Ar plasma etching. However, the coercivities ($H_{c,pattern}$ = 450~900 Oe) of the patterned medium appear to be 4 to 7 fold smaller than $H_{c,film}$. These results indicate that the chemically ordered FCT structure was destroyed during ICP Ar etching. In order to solve this effect, We employed the deposition-last process to avoid chemical and structural disordering by impinging Ar ions (deposition-first process) for same dimensions. For a patterned medium with 100 nm patterns made by this process, the out-of-plane coercivity was measured to be 5 fold larger than its in-plane value [fig 2(b)].

4. Summary

In this study, We fabricated FePt-based perpendicular patterned media using a selective combination of E-beam lithography and either Ar plasma etching (deposition-first process) or FePt lift-off (deposition-last process). We employed the deposition-last process to avoid chemical and structural disordering by impinging Ar ions (deposition-first process). For a patterned medium with 100 nm patterns made by this process, the out-of-plane coercivity was measured to be 5 fold larger than its in-plane value. The deposition-last process may be a promising way to achieve ultra-high density patterned media.

5. Reference

[1] Takashi Hasegawa, W. Pei b, T. Wang, Y. Fuc, T. Washiya, H. Saito, S. Ishio, Acta Materialia **56** 1564-1569 (2008)

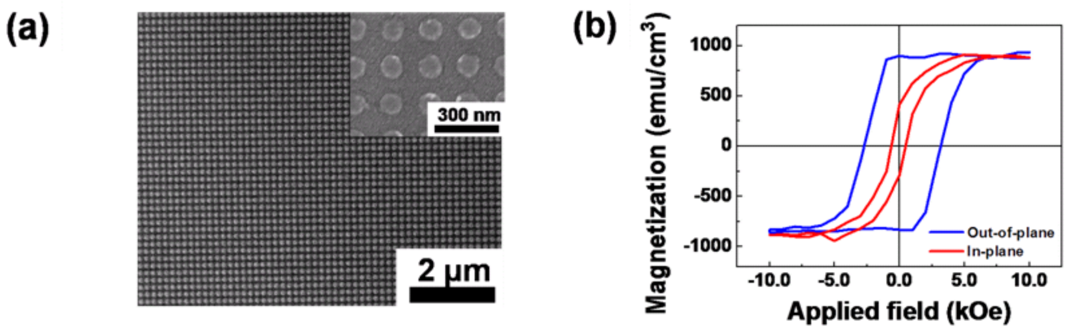

Fig. 1 (a) SEM image of FePt patterns of 100 nm diameter fabricated by the deposition-last process. Inset shows a magnified view of the pattern for clarity. (b) Comparison of M vs. H curves for the patterned medium in out-of-plane and in-plane directions.