Magnetic Properties of CoCrPt Thin Films on Self-Assembled PS-PVP Diblock Copolymer Template

KAIST Jong-Ryul Jeong, Myung Chul Choi, Mi-Young Im, Mahn Won Kim, and Sung-Chul Shin

자기조립 블록공중합체위에 증착된 CoCrPt 박막의 자기적 성질에 관한 연구

한국과학기술원 정종률, 최명철, 임미영, 김만원 신성철

I. INTORDUCTION

Diblock copolymer template, which microphase-separate into a monolayer of domains, is one of the most promising candidates for nanoscale patterning otherwise inaccessible by lithographic procedures [1]. The diblock copolymers, consisted of two chemically distinct polymer segments covalently bonded together, can form ordered periodic arrays of spheres, cylinders, or lamellae depending on the volume fraction of the component. It is well known that surface and interface roughnesses greatly affect the magnetic properties such as magnetic domain structure, magnetization reversal, magnetoresistance, and spin reorientation transition (SRT) of ultrathin magnetic films [2-3]. Therefore, recent studies focus on artificially roughened surface, since it could be possible to systematically understand the effect of roughness on the magnetic properties as well as to investigate novel physical properties. In this study, we have investigated magnetic properties and growth structure of $Co_{68}Cr_{18}P_{14}$ thin films deposited on periodically modulated self-assembled PS_{21400}(styrene)-PVP_{20700}(vinyl pyridine) diblock copolymer surface.

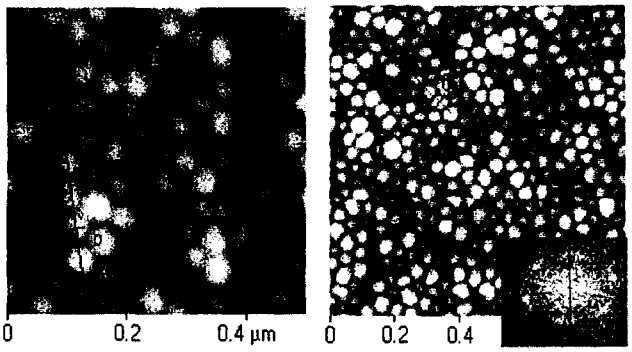
II. EXPERIMENTS

A silicon wafer was cleaned in $NH_4OH:H_2O:H_2O_2$=1:5:1 solution at 80 °C for 15 min. followed by Milli-Q water(>18 mW) rinsing. Water contact angle was measured to be < 5°. Monodisperse diblock copolymer PS_{21400}-PVP_{20700}(NPS-NPVP=205-200) was dissolved in toluene, which was a good solvent for the PS block and a non-solvent for the PVP block. It formed spherical micelle with 49 nm in diameter, which was measured by Dynamic Light Scattering (DLS). In toluene solution the core of the 3-dimensional micelle was composed of the PVP block, while the PS chains form the corona. The critical micelle concentration(CMC) was 0.7 mg/ml and aggregation number is 6 (chains per micelle) as determined by Light Scattering. Cleaned Si substrates were immersed in 10 mg/ml PS_{21400}-PVP_{20700} (in toluene) solution for 20 seconds and then, were rinsed in pure toluene for 5 seconds to remove any weakly bound residues. The $Co_{68}Cr_{18}P_{14}$ films were prepared at ambient temperature by dc magnetron sputtering under a base pressure of 8×10^{-7} Torr and Ar sputtering pressure of 3 mTorr. Typical deposition rate, obtained under an applied power of 150 W to each target and a target-to-substrate distance of 50 mm, was 1.9 Å/s. The growth structure and surface morphology of CoCrPt films were characterized using a high-angle x-ray diffractormeter (XRD) and an atomic force microscope (AFM), respectively.

III. RESULTS AND DISCUSSION

Fig. 1(a) shows a surface morphology of coated diblock copolymer on Si(100) measured by a non-contact atomic force microscope (AFM PSI Autoprobes CP) with Si_3N_4 tip having spring constant of 3.2 N/m. As shown in Fig. 1, the surface of self-assembled PS-PVP shows a highly-ordered spherical morphology with the micelle islands height of 4 nm and width of 40 nm. On this spherically modulated surface, the CoCrPt thin films were deposited with varying the film thickness from 30 to 500 Å. AFM measurement reveals that the surface morphology of CoCrPt also shows a regular and highly ordered spherical islands similar to the PS-PVP template as shown in Fig. 1(b). However, the islands are measured to be 7 nm in height and the root-mean-square (RMS) surface roughness increased drastically after deposition of 60-Å CoCrPt film on PS-PVP template. The inset

shows the fast fourier transformation (FFT) image obtained from the film morphology. In Fig. 2, we demonstrate magnetic hysteresis loops for the representative samples of 200-Å CoCrPt/PS-PVP/Si(100) and 200-Å CoCrPt/Si(100). It can be noticed from Fig. 2 that the squareness ratio, defined as the remnant Kerr rotation angle divided by the saturation one, of the 200-Å CoCrPt/Si(100) sample is 0.34, but it becomes 0.85 for the 200-Å CoCrPt/PS-PVP/Si(100) sample. This result indicates that perpendicular magnetic anisotropy (PMA) of CoCrPt film could be much enhanced when the film is deposited on nanopatterened PS-PVP polymer surface. The coercivity is also enhanced from 150 Oe to 544 Oe for the 200-Å CoCrPt/PS-PVP/Si(100) sample, compared to the 200-Å CoCrPt/Si(100) sample. *In situ* stress measurement and growth structure study reveal that the enhanced PMA in CoCrPt films on PS-PVP template could be ascribed to the reduced magnetic dipolar anisotropy and increased magnetoelastic anisotropy.



(a) (b)

Fig. 1. (a) 0.5 μm × 0.5 μm AFM image of self-assembled PS-PVP block copolymer on Si(100). (b) 1 μm × 1 μm AFM image of 200-Å CoCrPt/PS-PVP/Si(100).

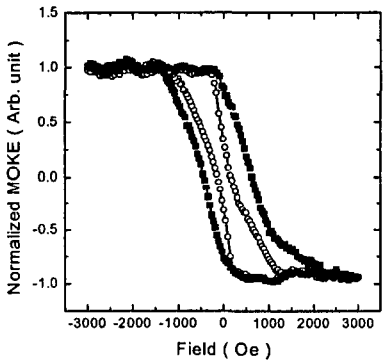


Fig. 2. Magnetic hysteresis loops for the samples of 200-Å CoCrPt/PS-PVP/Si(100)(black square) and 200-Å CoCrPt/Si(100)(open circle).

IV.ACKNOWLEDGEMENT

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V. REFERENCES

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