Simulation of $L1_0$ FePt microstructure by using phase field model

L. W. Liu[1], K. Ohsasa[2], T. Koyama[3], L. Y. Liang[4], L. R. Zhang[1], and S. Ishio[1,2]
[1]Venture Business Laboratory, Akita University, Gakuen Machi 1-1, Tegata, Akita 010-8502, Japan
[2]Department of Materials Science and Engineering, Akita University, Gakuen-machi 1-1, Tegata, Akita 010-8502, Japan
[3]Department of Materials Physics and Energy Engineering, Graduate School of Engineering, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8603, Japan
[4]Mathematics and Computer Science Division, Argonne National Laboratory, Argonne, Illinois 60439, USA

Heat Assisted Magnetic Recording (HAMR) media demands $L1_0$ FePt-X(segregant) thin films should have small and columnar FePt grains with high coercivity. In this work, the influence factors to form the columnar FePt grains were studied by using 3D phase field model based on Koyama's model.[1)]

Fig. 1 shows the 3D microstructure of the FePt-X thin films with increasing the film thickness ($L1_0$ FePt: yellow, $A1$ FePt：red, X: cyan). The simulated volume is $50\times50\times(t=2\text{-}10)$ nm^3 and using isotropic atomic mobilities. The interfacial energy is 1.82 J/m^2. Fig. 1(a) shows the morphology of the FePt-X thin films when t is 2 nm, and the columnar FePt grains can be seen clearly. Fig. 1(b) shows the FePt-X microstructure when t is 5 nm. The bilayer FePt grains start to form and the interconnected FePt grains increase. Fig. 1 (c-d) shows that the FePt grains are layer by layer or semi-spherical shape when the FePt-X thickness varies from 8 nm to 10 nm.

Fig. 2 shows the variations of 3D microstructure of the FePt-X thin films with the different mobility M_{cz} values and the same mobility $M_{cx}=M_{cy}=1.0$. The volume is $50\times50\times10$ nm^3. Fig. 2 (a)-(b) shows the number of bilayers of FePt grains reduces when M_{cz} is decreased from 0.5 to 0.1. When M_{cz} continues to decrease to 0.01 and 0.001, the microstructure of the FePt-X thin films almost fully become the columnar shape as shown in Fig. 2(c) and Fig. 2(d). These results clearly demonstrate that selecting the materials with the anisotropic mobility of atom diffusion as a segregant is vital to prepare the columnar microstructure of the FePt-X thin films.

References

1) T. Koyama, and H. Onodera, *Mater. Trans*, 44(8) 1523-1528, (2003).

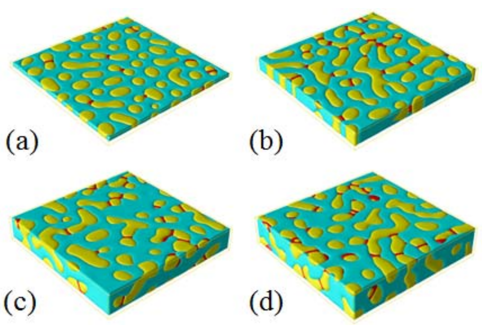

Fig. 1 The variations of the FePt-X thin films microstructure with different film thicknesses: (a) 2 nm; (b) 5 nm; (c) 8 nm; (d) 10 nm.

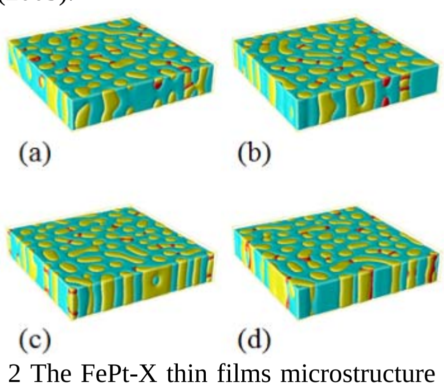

Fig. 2 The FePt-X thin films microstructure with decreasing M_{cz} at t = 10 nm: (a) 0.5; (b) 0.1; (c) 0.01; (d) 0.001.