Bilayer thickness effect on the magnetic properties of $[Fe/Pt]_n$ films

S. C. Chou*[1], C. C. Yu[1], Y. D. Yao[1], and Y. Liou[1]

[1] Institute of Physics, Academia Sinica, 128, Yen-Chiou-Yuan Rd., Sec. 2, Nankang,Taipei 115, Taiwan

*Corresponding author: e-mail: chousc@phys.sinica.edu.tw, Phone: +886-2-27880058 ext. 1141, Fax: +886-2-27834187

FePt film displays a large perpendicular magnetic anisotropic (PMA) property and is a promising material for perpendicular high-density magnetic recording. [1] The strength of PMA effect is strongly correlated with the crystal structure and ordering in FePt alloy. [2] Recent studies showed that doping of inpurity and monolayer superlattice growth can often result in marked change of the transition tempeature of chemical ordering and the magnetic properties. Here, by using the ultra-thin bilayers growth, we successfully reduced the FePt order-disorder transition temperature from 600°C to 200°C.

By using the molecular-beam epitaxial technique, the $[Fe\ (t\ Å)/Pt\ (t\ Å)]_n$ superlattice films, $6 < t < 10Å$, were deposited on the 100Å thick Pt buffer layers on the sapphire(0001) substrates at 100°C. The total thickness of films was maintained at 300Å thick. The structure of as deposited $[Fe/Pt]_n$ superlattice films were fcc(111) as observed by X-ray diffraction. However, an additional fcc(100) orientation was observed after post annealing at T°C for an hour, 200°C < T < 600°C. Interestingly, the formation temperature of fcc(100) decreased as reducing the single layer thickness, t. For example, the formation temperature of fcc(100) for t= 6 and 10Å were 200°C and 400°C, respectively. Moreover, while FePt fcc(100) orientation formed, the coercivity of superlattice films increased from 200 Oe to 4000 Oe. In another word, the [Fe(6Å)/Pt(6Å)] superlattice possessed magnetic hard phase at 200°C post annealing temperature which was much lower than the bulk value of FePt. Finally, the coercivity reached 1.2 Tesla until annealing temperature reached 600°C in spite of layer thickness. High coercivity indicated that highly chemical ordered FePt hard phase was formed by thermal annealing. After post annealing, the saturation magnetization of $[Fe/Pt]_n$ decreased from 1100 emu/cc to 450 emu/cc. In summary, magnetic hard phase of FePt films can be obtained by using the ultra-thin bilayers growth and post annealing. The layer thickness was a key factor for obtaining FePt hard phase at low temperature.

References

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