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Rapid Thermal Annealing Effect on the Structure and Magnetic Properties of FE/PT Multilayer thin Films

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Ⅰ. Introduction

Rapid Thermal Annealing (RTA) was also found to be effective in promoting grain isolation, reducing the medium noise, lowering the phase transformation temperature and improving the surface smoothness of magnetic recording media [1,3]. In this study we investigated the effect of RTA on phase transformation and the structure and magnetic properties of Fe/Pt multilayer thin films. Compared with CA, RTA exposed an outstanding effect on accelerating the phase transition when the film thickness is over 40 nm.

Ⅱ. Experimental

The multilayer $[Fe(0.5nm)/Pt(0.5nm)]_{40}$, $[Fe(1nm)/Pt(1.5nm)]_{20}$ and $[Fe(3nm)/Pt(3nm)]_{10}$ films were grown by dc magnetron sputtering with a starting vacuum of $\sim 510^{-8}$ torr and working pressure of 6 mtorr. The annealing of the specimens included two methods: conventional annealing (CA) in vacuum 10^{-5} torr of the quartz tube in the electrical furnace in the temperature range from 270 to 600°C for various time spans and rapid thermal annealing (RTA) in argon atmosphere of the infrared lamps furnace at 500°C for various time spans. The heating rate was 5°C/minute and 20°C/second for CA and RTA, respectively. The crystallography and microstructure of Fe/Pt MLs was examined by using X-ray diffractometer (XRD) and transmission electron microscopy (TEM). Physical properties measurement system (PPMS-VSM) was used for measuring the magnetic properties of the films.

Ⅲ. Results and discussion

By conventional furnace annealing (CA) at 270-500°C for various time, all of the films still remained the disordered structure with the soft magnetic phase. By rapid thermal annealing (RTA) at 500°C for various time, we obtained the $[Fe(1nm)/Pt(1.5nm)]_{20}$ and $[Fe(3nm)/Pt(3nm)]_{10}$ films with $L1_2$ ordered $FePt_3$ phase which was almost ferromagnetic at room temperature. However, for $[Fe(0.5nm)/Pt(0.5nm)]_{40}$ films subjected to RTA, the disordered structure still remained as the films subjected to CA. No supperlattice peak was observed. We suppose that in this ultra-thin film, the under critical thickness impede the effect of RTA processand delay the ordering process. For the film thickness over $[Fe(0.5nm)/Pt(0.5nm)]_{40}$, RTA exposed an outstanding effect on expediting and facilitating phase transition compare with CA.

The hysteresis loop measured in the direction parallel to the film plane at room temperature of

[Fe(1nm)/Pt(1.5nm)]$_{20}$ films annealed by RTA at 500°C for 30 minutes. The films exhibited a coercivity of Hc ~ 2.8 kOe due to some degree of ferromagnetic order.

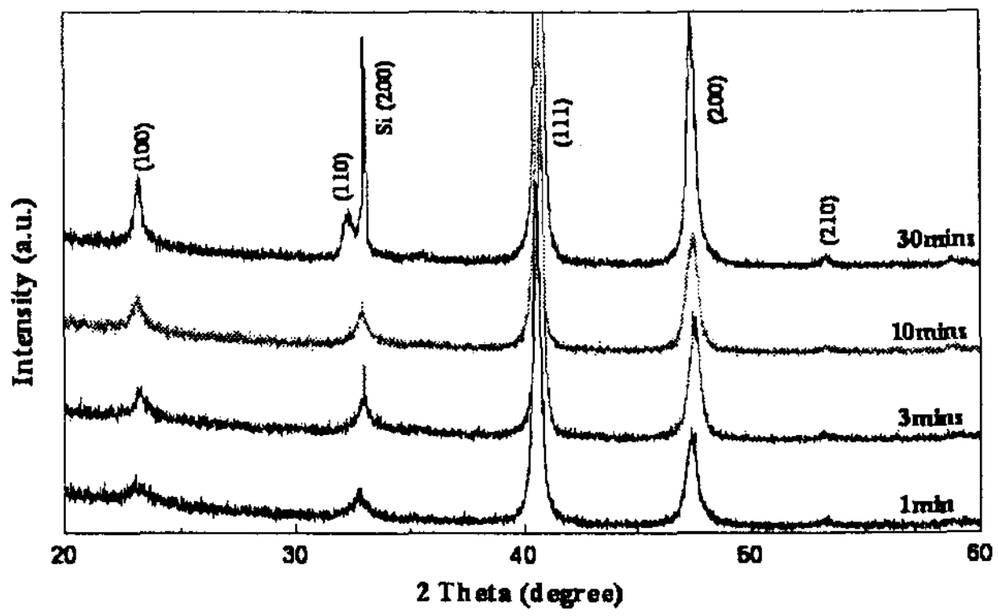

Fig. 1. XRD patterns of [Fe(1nm)/Pt(1.5nm)]$_{20}$ annealed by RTA at 500°C for various time spans.

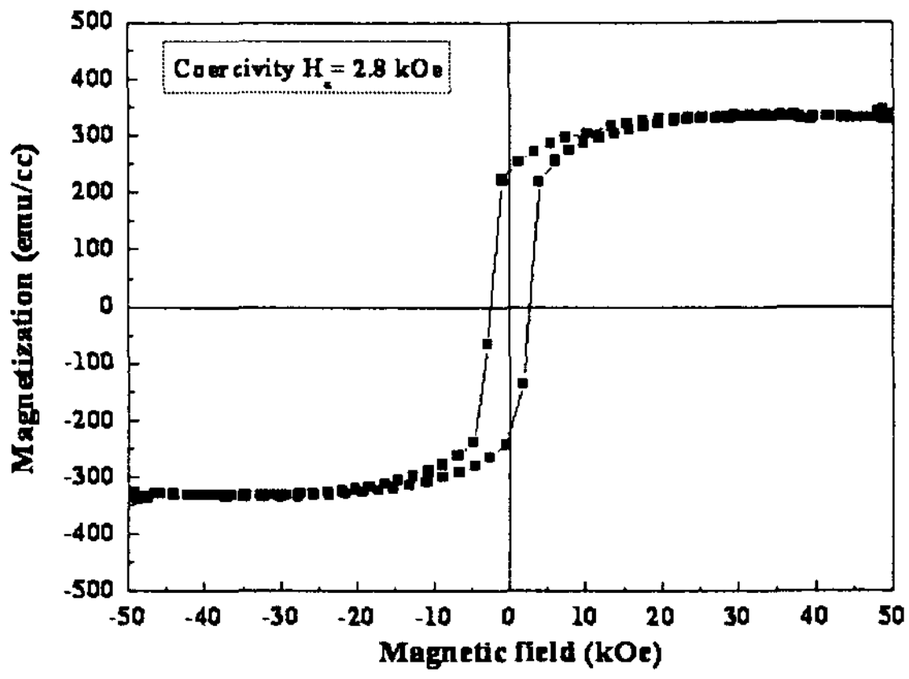

Fig. 2. Hysteresis loop of [Fe(1nm)/Pt(1.5nm)]$_{20}$ films annealed by RTA at 500°C for 30 minutes.

Ⅳ. Acknowledgement

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Ⅴ. References

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