Determination of structural properties of magnetic FePt-Films

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Magnetic data storage devices are widely used in our everyday life. During the last couple of years, the storage capacity of these devices has been continuously increasing. This increase has only been possible by a direct increase in storage density. However, the superparamagnetic limit, where the thermal energy is sufficient to reverse a magnetic grain, is a severe barrier for a further increase of the storage density. As the volume of the magnetic grains in granular media has to be scaled down to increase the storage density, new materials with higher anisotropy than current CoCrPt alloys have to be introduced to ensure that these grains do maintain the required thermal stability. (001) textured and chemically ordered FePt films exhibit the necessary perpendicular magnetic anisotropy to reach this aim [1].

Thin FePt-films have been prepared by sputter deposition on Si-wafers covered with a 100 nm thermally grown amorphous SiO_2 top layer. The films have been prepared with thicknesses of 3 nm, 5 nm, 9 nm and 20 nm and exhibit a chemically disorderd A1 structure. This disordered structure transforms into the $L1_0$ ordered structure during a rapid thermal annealing (RTA) process similar to an approach presented by Yan et al. [2]. The duration of the annealing process has been varied in the range from 1 s to 600 s. The structural changes and the development of mechanical stress within the films caused by the annealing process in dependence of the film thickness have been investigated by X-Ray diffraction techniques. The aim of this investigations was to study the underlying mechanisms involved in the evolution of the (001) texture, which are still not completely understood.

The X-ray diffraction experiments have been carried out at HASYLAB beam-line G3. The energy of the incident radiation was chosen to be 8048 eV which is equivalent to the Cu-K_α-radiation used at our own laboratory equipment. Using a LaB_6 powder sample the calibration of goniometer and radiation energy was verified. The samples have been investigated using θ-2θ-geometry.

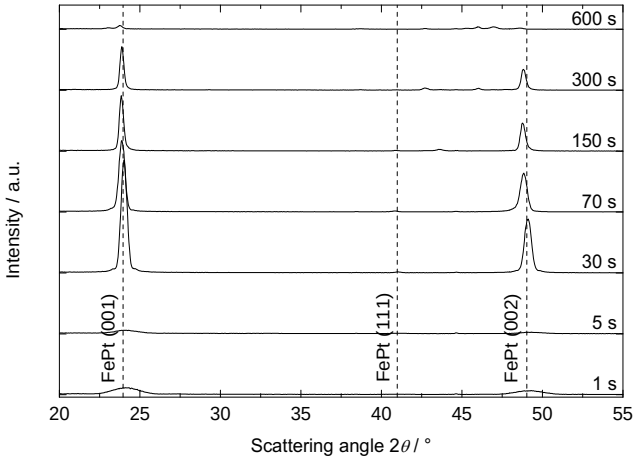

Figure 1: X-ray diffraction patterns measured at 5 nm thick films annealed at a temperature of 800°C for the times displayed in the figure.

Figure 1 shows the diffraction patterns of the 5 nm thick FePt films annealed for various times. The measurements exhibit the (001) and (002) peaks of the FePt $L1_0$ phase only. This fact and the

absence of the (111) peak in the diffraction patterns point out a strong (001) texture of the films. The observed peak intensities increase up to annealing times of 30 s. Longer annealing times yield decreasing intensities and a peak shift to smaller angles. A complete change of the film structure was observed after 600 s of annealing.
Figure 2 shows the diffraction patterns recorded from FePt films with different thicknesses annealed for 30 s. The pattern of the 20 nm thick FePt film exhibits the (111) peak additional to the (001) and (002) peaks. A peak shift to larger angles is observed with increasing film thickness. The 5 nm thick film shows the best agreement with the theoretically predicted peak positions.

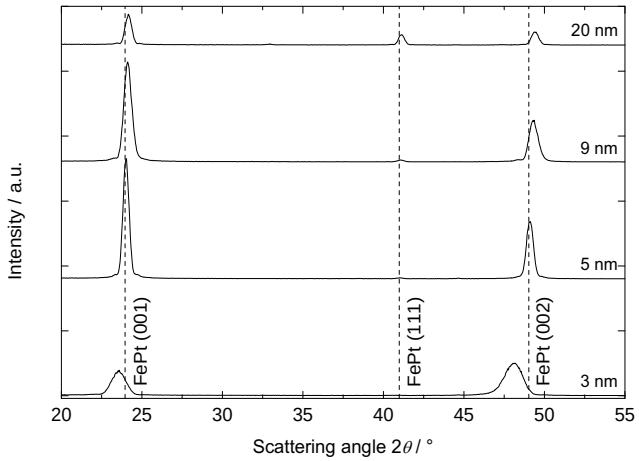

Figure 2: X-ray diffraction patterns measured at samples with thicknesses as displayed in the figure annealed 30 s at a temperature of 800°C

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References

[1] D. Makarov, C. Brombacher, F. Liscio, M. Maret, M. Parlinska, S. Meier, P. Kappenberger, and M. Albrecht, J. Appl. Phys. 103, 053908 (2008)
[2] M. L. Yan, N. Powers, and D. J. Sellmyer, J. Appl. Phys. 93, 8292 (2003)