SUMMARY OF Ph.D. DISSERTATION

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Title

The Study of Ordering and Development of High Coercivity of FePt,FePtCu and FePtAu Nanoparticles

Abstract

FePt binary alloy with tetragonal L10 structure has the large uniaxial anisotropy energy Ku = 6.6 × 107 erg/cm3. FePt has been actively investigated for ultrahigh density recording media, because of the prospect of magnetic recording density of 1Tb/inch2. Recently, it was reported that the monodisperse self-assembled FePt nanoparticles were synthesized by the hot soap method. A high temperature treatment around 550 °C is necessary to obtain the ordered phase with high Ku in FePt nanoparticles. This inevitably results in the aggregation of nanoparticles due to the sintering, and then forms the randomly orientation of magnetic easy axis. These were disadvantageous to prepare the high-density recording media. So far, some approaches have been proposed to reduce the ordering temperature of the FePt alloy and to orientate of easy axis of FePt nanoparticles. In this study, I attempted the reduction of the ordering temperature and easy-axis orientation by addition of third element and magnetic heat treatment, respectively.

Chapter 1 describes the present technology of magnetic recording media and summarized the background and purpose of this work.

Chapter 2 summarizes the basic knowledge and the previous works about ordered alloy, FePt and nanoparticles that have specially relationship to this work.

Chapter 3 describes the ordering of FePtCu nanoparticles with various compositions and diameters and discusses the optimum composition for ordering. The as-made particle has a fcc structure and a disorder-order transformation is observed in high Cu concentration samples after 1 hour annealing at 400 ºC. The doping of Cu clearly plays a significant role on the reduction of the ordering temperature in the ternary FePtCu alloy. In addition, the ordering of FePtCu nanoparticles is significantly dependent on the composition of Fe and Pt. The sensitive control of composition was necessary to obtain the FePtCu nonparticles with giant magnetic anisotropy. I obtained the magnetic anisotropy energy of 9×10^6 erg/cm^3 in the $Fe_{36}Pt_{42}Cu_{22}$ nanoparticles. This value is equal to K_u of the Co bulk.

Chapter 4 describes the orientation of magnetic easy axis of FePt, FePtAu and FePtCu nanoparticles after magnetic heat treatment. These nanoparticles showed the ordering accompanied by the coalescence of nanoparticles during the magnetic heat treatment at 750 K for 4 hour. The SiO2 coated nanoparticles that was not coalesced did not order. Only in the FePt nanoparticles after heat treatment in magnetic field of 70 kOe, the difference of switching field distribution was observed dependent on the direction of applied field. The temperature dependence of magnetization during the heat treatment characterized the mechanism of ordering, i.e., the ordering of FePtAu and FePtCu nanoparticles and the coalescence occurred at the same time in contrast to the FePt nanoparticles which was not ordered fully in the time scale of magnetic measurement in heating run and slowly ordered over a long period of measurement. This slow ordering process of FePt nanoparticles should play an important role in the orientation of easy axis.

Chapter 5 summarizes the results of this study and describes the future prospects.