Chapter 1 Introduction

As the prosperous growth of the internet and multimedia, the higher capacity of H.D.D (Hard disk drive) is super necessary for the consumers to upload their mass and useful information. The areal density of magnetic recording increases by the annual growth rate of 100% in recent years. However, the bpi (bit per inch) and tpi (tracks per inch) have to be reduced as the recording density increased, which may contribute to thermal instability which is so called "super-paramagnetic effect". The super-paramagnetic effect has restricted the development of the conventional longitudinal recording while increasing the recording density. Therefore, it is so urgent to achieve the areal density beyond or even more than 100 Gbits/in^2 that we propose the perpendicular magnetic recording disks which could successfully surpass this effect. In particular, the advantages of perpendicular magnetic recoding media are both to reduce the demagnetization field, and to increase the stability of recorded bits. It follows from what has been said that perpendicular magnetic recording media possess the most potential for the next generation of the development of ultrahigh-density HDD.

1.1 Motivation

In order to achieve high recording density beyond 100 Gbits/in^2 of perpendicular magnetic recording media, low media noise performance and high thermal stability are decisive issues. Large perpendicular anisotropy is essential to thermal stability of magnetization. In addition, enhancement of grain isolation is necessary to obtain high SNR (signal-to

-noise ratio). [1].

CoCr-based perpendicular recording media is introduced for the large perpendicular magnetic anisotropy ***Ku*** in order to maintain magnetic recording properties. High-temperature fabrication process is in great demand that contributes to Cr segregate at grain boundary for the sake of the inappropriate dissolution of Cr in Co. The addition of Pt to CoCrPt media increases ***Ku*** value by the enhancement of epitaxial growth. Nevertheless, it is likely to increase the inter-granular exchange coupling due to sufficient Cr segregation to the grain boundaries. It has also been reported that the addition of Ta and B is effective to reduce grain size and interganular coupling. On the other hand, the value of ***Ku***V/kT is also reduced, i.e. poor thermal stability, by the addition of Ta and B. In addition, by the insertion of intermediate underlayer layers (ULs) between the magnetic layer and soft underlayer (SUL), grain size and intergranular coupling are also reduced. In spite of the advantage of high-temperature fabrication process, the stacking fault densities increase while increasing the temperature of film fabrication. Furthermore, the existence of stacking faults in the initial region of film growth is inevitably serious regardless of the fabrication temperature. Even though all the efforts on the improvement of perpendicular recording media performance were done, there is still lacking in a conclusive solution.

A modern granular CoPtCr-SiO_2 magnetic layer has been proposed to enhance the segregation and realize well-isolated grain structure with large ***Ku*** value. This kind of granular thin film is composite by the non-magnetic matrix (SiO_2) and magnetic grains. The oxide non-magnetic materials rarely form a solid solution with the magnetic metal and prefer to precipitate to the grain boundary without high-temperature fabrication, which is most suitable for the product manufacturing. In addition, the effective segregation of SiO_2 is likely to increase the content of Co and Pt within the magnetic grains and hence results in increasing both Ku value and thermal stability without deteriorating the c-axis orientation. For the reason of making each grain well-isolated with diminished exchange coupling, magnetic properties have to be improved such as higher coercivity, unity squarness and high negative nucleation field (Hn). Higher coercivity will prevent the recording media from fluctuation by the stray magnetic field, while unity squarness and high negative nucleation field will diminish the formation of reverse domain due to magnetostatic effect.

In order go deep into this topic, we first deposited granular magnetic layer above the proper underlayers by using ultrahigh vacuum deposition system (UHV) in high-class cleanroom, and investigated the magnetic properties of the granular film by MOKE and VSM, as well as, the microstructure identifications by XRD and TEM. After the granular system has been established, the final step is to perform full-stacked structure combining the granular system with the settled soft underlayer for low media noise performance and high thermal stability media.

As we known, there still exist many challenges of granular magnetic system, such as non-uniform grain size distribution and the indistinct segregation mechanism of SiO_2. We are going to discuss these issues within this thesis and perform the best results of the contribution to the development of ultrahigh-density perpendicular recording media.

1.2 Outline of the Thesis

The main part of this thesis is the discussion of the development and the investigation of the granular magnetic system for perpendicular recording media. Chapter 2 presents the background of the thesis, and the principles of perpendicular recording are summarized. In addition, the characteristics of granular magnetic materials as well as the previous reports of perpendicular magnetic recording are exhibited in Chapter 2. The experimental and analysis techniques used in this thesis are covered in Chapter 3. Chapter 4 presents the experimental results and discussions. The read-white performances are also included in this chapter. The summary of the thesis is presented in Chapter 5.