SUMMARY OF Ph.D. DISSERTATION

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Title

Study of Magnetic behaviors in Pinned layers of Read heads for High Density Magnetic Recording

Abstract

With the recent rapid increase in recording density of hard disk drives, read head sensor track width has been decreasing to a hundred nano - meter. A ferromagnetic (F) film exchange coupled with antiferromagnetic (AF) film is used as a pinned layer in the sensor. Sensors require much more robustness to thermal and magnetic stress. Mechanism of temperature and time dependences on the exchange coupling is studied. Magnetic behaviors of the pinned layer in read heads are also studied.

A model for exchange coupled F grain and AF grain is established. Blocking temperature, in which exchange coupling field (H_p) disappears, depends on the AF grain size. Lager AF grain shows higher blocking temperature. Each AF grain has its own blocking temperature, which is called as local blocking temperature.

Temperature dependences of H_p and coercivity (H_c) are observed and calculated using observed grain size distribution in CrMnPt AF layer. The calculated results agree with the experiments. The thermal fluctuation of Magnetization in the AF grain dominates the temperature dependence of H_p. Local blocking temperature distribution becomes narrower with the increase of AF thickness.

Thermal decay of H_p in Co/CrMnPt system is observed with magnetic field stress. H_p decays more rapidly in higher temperature. The model explains the decay at lower temperature than 130℃, but it does not at higher temperature than 150℃. It suggests that coherent magnetic rotation occurs in AF grains at the low temperature and incoherent magnetic rotation occurs in AF grains at higher temperature. Making AF layer thicker is effective to suppress the decay of H_p.

Abnormal magnetization behaviors of pinned layers are observed in read heads. They are classified into 7 categories. Normal behaviors are achieved by increasing exchange coupling energy E_u between F & AF films, narrowing the local blocking temperature distribution, and making two pinned layers (AP1 & AP2) compete with each other in the uniaxial-anisotropy energy constant. As the results, read heads for recording density 170Mbit/mm^2 (100Gb/in^2) are realized.