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Possibilities and Problems of Future High Density Magnetic Recording Media

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The areal density of hard disk drive (HDD) has been increasing at a rate of 60 %/year in recent years. HDD products with 0.8 - 1 Gb/in^2 areal density began to be commercialized. Improvements of HDD key technologies are strongly required to keep the trend of areal density increase. Several new technologies including high-sensitive giant magnetoresistive head, PRML signal processing, near-contact head/media interface technology are vigorously investigated. High coercivity media with low noise characteristics are necessary to increase the areal density. The present talk will discuss on future elemental HDD technologies focusing mainly on high density thin film recording media.

As the areal density increases from 1 Gb/in^2 to 10 Gb/in^2, for example, the bit area decreases from 0.54μm^2 to 0.063μm^2. This means a magnitude of signal decrease in R/W process. Thus, a very high sensitive read head utilizing MR or G-MR element must be incorporated. As for the thin film recording medium, the number of magnetic crystalline grain in a bit unit will decrease from 2400 to 280, assuming the grain diameter to be 15nm which is the value for present high-end disk products. To assure a good S/N ratio and a high linear density resolution, the grain size must be accordingly decreased while enhancing magnetic separation between magnetic grains which form thin film recording medium. Enhancement of Cr segregation at grain boundaries is important to reduce magnetic exchange coupling between grains to decrease medium noise. Some of the examples with CoCrTa and CoCrPt longitudinal recording media will be presented.

At high areal density, thermal stability of recorded bits becomes an critical issue for longitudinal thin film medium where the medium thickness and the grain size must be decreased to assure a reasonable medium S/N ratio. The solution for this problem will either to increase the Ku value of longitudinal medium or to increase the medium thickness by employing perpendicular recording. Co-based alloy longitudinal thin film will be unable to keep thermal stability beyond 10 Gb/in^2, unless the track density is greatly increased by developing very accurate positioning technologies. On the other hand, perpendicular medium is advantageous against thermal decay because it employs thicker magnetic films and it is possible to use conventional Co-alloy thin film for beyond 10 Gb/in^2 recording. Distributions of grain size and Ku values must be taken into account to design the thin film media for such ultra-high density recording. Very high linear recording density resolution(D_{50}=240 kFCI) has been demonstrated feasible with a flying type head and a perpendicular recording medium. Recent results with single layer perpendicular recording media in combination with MR and ring-type heads will be presented to show the possibility of extending the areal density beyond 10 Gb/in^2.