

Magnetic Recording Disk Technology: Practical Challenges in Delivering the Areal Density Performance

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Magnetic recording media used in current hard disk drives have recording densities of the order of $\sim 60\text{G}$ bits/in² today. For a typical desktop PC drive using 95mm diameter disks, this areal density translates to 80G-bytes per platter of data capacity, and roughly 40 G-bytes per platter for a 65mm diameter disk used in a mobile drive. The industry as a whole has been increasing the areal density at a blistering pace of 100% compound annual rate of growth for many years, which provided fuel for rapid increase in inexpensive storage capacity for so many new applications of Winchester drive technology from traditional data storage in PC's and laptops, to HD video recorders and MP-3 players. In the last year or two however, the rate of growth has slowed significantly to around 50-60 % by some estimates. Figure 1 illustrates the current areal density trends. The reason for the decrease in rate of growth is due to many factors, but key amongst them is the difficulty in achieving the necessary SNR performance in the drive. Improvements in the key components such as heads and media, and the channel electronics are not coming fast enough anymore to sustain the high rate of growth. In this paper, the challenges faced by the media manufacturer in delivering the desired recording density will be outlined.

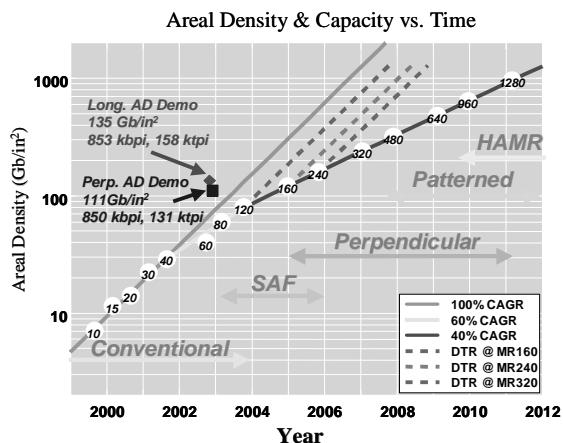


Figure 1. Areal density growth curve and projection

Current magnetic recording method employs longitudinal magnetic recording technology which has been in use for the last 40 years. The film structure consists typically of several Cr alloy underlayers, several layers of CoPt-based magnetic alloys which are now often separated by Ru layer in an AFC (antiferromagnetically coupled) configuration, and carbon overcoat film for protection. Aluminum plated with electroless NiP or glass are the only substrate material used today. It is worth mentioning that about 10 nm of magnetic film is used to store information in current media. The vast amount of valuable data in the world are now entrusted to this thin layer of cobalt alloy film which is only about 50 atomic layers thick. Considerable amount of materials science goes into making such thin film perform at the desired recording density, and also have the reliability for entrusting valuable data to it.

Perpendicular magnetic recording is gaining strong momentum now as it is considered to be the next enabling technology that will provide continued rate of growth in areal density. Current perpendicular media structure is illustrated in cross section TEM micrograph shown in figure 2. However, there are still considerable technical and practical challenges in migrating to perpendicular recording which will be outlined in this paper [1]. Another technology that can potentially play in extending the areal density curve for both longitudinal and perpendicular technology is DTR or discrete track recording technology, which utilize embossing method to lay down discrete tracks on the disk surface [2].

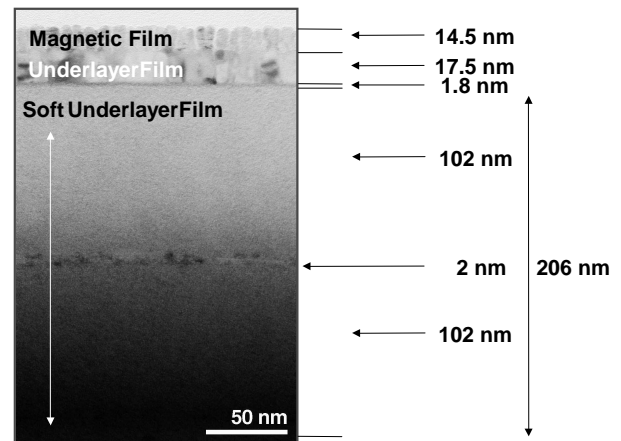


Figure 2. Cross section TEM micrograph of perpendicular media

Besides the magnetic recording requirements, there are reliability requirements placed on the media that are just as important as the magnetic performance. Drive customers and end-users demand utmost reliability to insure that valuable data is not lost. The recording heads fly today at around 10 nm above the media, which has all but 2-3 nm of protective carbon film and 1 nm of lubricant separating the head from the magnetic media. Disk can rotate up to 15,000 rpm, and the temperature inside the drive can reach 70-80 C°. These are extremely demanding conditions, and variety of tactics are used to assure end-user reliability of the drives. All of this performance then has to be delivered at very low cost. This paper hopes to outline the basic technical issues involved in delivering the performance and the solution path that the media manufacturer are taking.

1. G. Bertero, D. Wachenschwanz, W. Jiang, S. Malhotra, S. Velu, "Granular Perpendicular Magnetic Recording Media", IDEMA Perpendicular Recording Symposium, Feb 26, 2004
2. D. Wachenschwanz, "Performance and manufacturability of discrete track recording (DTR) media", *Journal of Applied Physics Letters*, submitted 2004