EA03

Nano-Actuator Based High Performance Head-Disk Systems

Bo Liu, Chee-How Wong, Wei Hua and Sheng-Kai Yu
Data Storage Institute, DSI Building, 5 Engineering Drive 1, Singapore 117 608
*Corresponding author: dsiliubo@dsi.a-star.edu.sg, Phone: +65 6874 8507, Fax: +65 6777 2406

High density magnetic data storage requires an air-bearing slider to position the read/write head as close to the disk surface as possible. As technology moves to Tb/in^2 areal densities and beyond, the magnetic spacing between the magnetic head and the magnetic disk media must be reduced to a level below 7 nm and the corresponding slider-disk spacing must be reduced to a level 2.5~3.5 nm.

However, it is not easy to keep slider flying at such a slider disk spacing under all working conditions due to static and dynamic reasons. The static factors include manufacturing tolerance and the corresponding flying height offset, flying height change caused by working environment change (such as temperature change, altitude change), and so on. Dynamic factors include flying height change caused by surface waviness, shock, vibration and so on.

Thermal nano-actuator is developed and integrated to the head-slider body. The actuator adjusts the head-disk spacing and, therefore, minimizes the possible static flying height change. However, such athermal actuator works at low frequency (<10k Hz). It is difficult for such actuator to react on the flying height change caused by the above mentioned dynamic factors.

Therefore, the challenge for future head-disk interface is to have ultra low gap flying height slider with high efficiency of the thermally actuated flying height adjustment plus strong capability in following up surface waviness -- the focus of this work.

The ABS design of such approach is illustrated in Fig. 1. Thermal nano-actuator is built just next to the read/write head. The stroke of such a flying height adjustment can be up to 5~7 nm. The air pressure around the thermal nano-actuator, which is located in the isolated read/write head pad, is small and, therefore, the efficiency of the thermally actuated flying height adjustment is significantly increased.

The flying height modulation caused by disk waviness is the most important dynamic factor of flying height variation. Such a flying height modulation is proportional to the spacing between read/write head and the force center. We found that the multi-shallow step approach plus guided air flow arrangement, as illustrated in Fig. 1, shiftsthe force center towards the tailing end of the trailing air-bearing pad. Also, increasing the width of trailing air-bearing pad helps such a shifting. The above approaches have been successfully applied to the air bearing design with isolated thermal actuating pad (the RW pad).

The paper will also report details of the team's work in actuator design and design optimization.

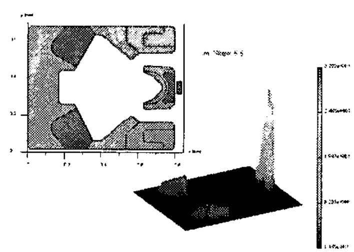

Fig. 1. Slider design and air-pressure profile.

EA04

Discrete Track Recording Media for High Capacity Hard Disk Drive

Hyung J Lee[1], Xiaodong Che[1], Ki-Seok Moon[1], Yawshing Tang[1], Nayoung Kim[1], Matthew Moneck[2], Jian-Gang Zhu[2], Nobuyuki Takahashi[3]
[1]Samsung Information Systems America, 75 W Plumeria Drive, San Jose, CA 95134, USA
[2]ECE Department, Carnegie Mellon University, Pittsburgh, PA 15213-3890, USA
[3]Fuji Electric Co., Ltd. 4-18-1 Tsukama, Matsumoto, Nagano 390-0821, Japan
*Corresponding author: hyunglee@sisa.samsung.com, Phone: +01 408-544-5918, Fax: +01 408-544-5924

Discrete track recording (DTR) has been demonstrated as a promising technology to further increase areal density after LMR to PMR transition [1][2]. Using special DTR media as shown in Figure 1, we quantitatively estimate the gain in track density comparing with current continuous media. The gain is a product of two factors: physical feature factor β and magnetic side erasure factor γ:

$$TPI_{DTR} \approx (1+\beta)(1+\gamma)TPI_{Cont.Media}$$

For high capacity HDD application, the ultimate measure of a DTR technology is the areal density increase, assuming similar linear density can be achieved by DTR media and continuous media, this TPI estimation is also a first order assessment of areal density gain with DTR media.

Besides the gain in areal density, future DTR media for HDD integrationshould have discrete recording tracks along with disk format features. Servo information can be included in the disk during the nano-imprinting lithography (NIL)process. DTR media can use more flexible servo schemes to improve servo efficiency and accuracy. We study several servo schemes for DTR media. At 250ktpi, the quality of the DTR servo bursts is compared with conventional servo bursts.

As NIL technology advances, DTR media process and volume manufacturing issues are becoming critical to be resolved [3]. In this presentation, we will discuss the key challenges that DTR media manufacturing and HDD integration will face. These will be served as a guideline for successful integration of DTR media for future high capacity HDD.

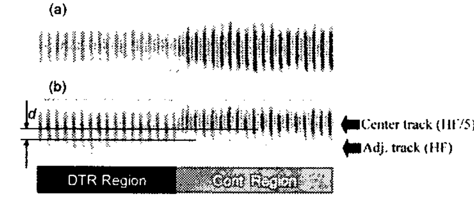

Fig. 1. Magnetic signal map of DTR and continuous media regions. (a) Before adjacent track writing; (b) after adjacent track writing with HF. The edge erased by the adjacent track writing is measured. d is the offset between the track edges for DTR and continuous media.

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