HDD FULLY ACTIVE HEAD-MEDIA SPACING CONTROL IN VACUUM

Peter R. GOGLIA[1], Karim KADDECHE[2] and John WANG[3]

1) L2 Drive, Irvine, CA, peter.goglia@l2drive.com

2) L2 Drive, Irvine, CA, karim.kaddeche@l2drive.com

3) L2 Drive, Irvine, CA, john.wang@l2drive.com

I. ABSTRACT

Areal density growth has slowed as PMR recording technology is reaching fundamental limits. New technologies such as HAMR, MAMR and Bit Patterned Media are proposed to advance areal density. While advances have been significant, there are yet obstacles to overcome and products utilizing these technologies remain in the future. Magnetic head/media spacing (HMS) limits areal density of magnetic recording independent of the recording technology. Both reading and writing benefit from smaller HMS. This paper proposes a new technology replacing the air bearing with a servo-to-media surface technology. Drives can be run in vacuum with no need for air or helium at the interface. Vacuum eliminates corrosive elements in the drive and thus allows thinner head and media coatings. Disk flutter is also greatly reduced and windage on the actuator is eliminated thus improving servo. Reduction of magnetic HMS from the current 8-9 nm to 4-5 nm is feasible. The paper describes servo-to-media surface technology and the benefits to drive performance.

II. RECORDING PERFORMANCE VS HMS

Marchon et al [1] reviewed the history of areal density performance Vs HMS and found that the trend is somewhat independent of recording technology. Fig. 1 shows the relationship of AD to HMS. Fig. 2 shows the relationship to be HMS = 0.6 X bit length. PMR is limited to a modest improvement in AD due to write performance limitations. MAMR and HAMR improve write performance allowing media optimization for thermal stability at higher density and smaller grain size. Improvements in areal density for PMR, MAMR and HAMR all depend on lower HMS to advance AD. From Fig 1, a 4 nm HMS is required for $4TB/in^2$.

III. CURRENT HMS AND LIMITATIONS

The components of HMS for products today is in the range of 7-10 nm as shown in Fig. 3a. The approximate 10 nm spacing is comprised of coating thickness for the head and disk as well as lube, roughness, back-off spacing (fly height during reading or writing with heater engaged) and pole tip recession. Coating thickness and lube dominate the HMS. Lube and coatings are used to prevent corrosion both in the component manufacturing process and during the life of the HDD in operation.

IV. LOWER HMS WITH SERVO-TO-DISK SURFACE IN VACUUM

Servoing the head to the disk surface eliminates the need for an air bearing. The interior of the HDD module may be placed in vacuum, eliminating gas (air or helium) and at the same time eliminating corrosive elements present in the gas. No corrosive elements means that coatings on the head and disk may be thinned or eliminated. Servoing-to-media surface guarantees that the head and media never contact, eliminating the need for lube. Figure 3b shows spacing for the servo-to-disk surface head to media achievable in vacuum.

V. FLUTTER AND POWER REDUCTION IN VACUUM

Figure 4 shows an LDV time-domain trace of a spinning disk in air and in vacuum. The trace in vacuum clearly shows the significant reduction in flutter when operating in vacuum. The result is improvement in servo performance as well as reduction in servo bandwidth requirement for HMS control. Vacuum also reduces drive power. Without pumping losses and turbulence, the spindle motor of a 7,200 RPM enterprise 95mm drive requires about 35% less power in vacuum compared to air as shown in Figure 5.

VI. SERVO-TO-DISK SURFACE SOLUTION

L2Drive has introduced technology to control Head-to-Disk spacing utilizing a z-direction piezo actuator. Spacing feedback is accomplished with capacitive sensors integrated into the head structure. Figure 6 illustrates the concept. No air bearing is required. The loadbeam and gimbal are replaced with a rigid and fully active suspension to control the fly height. Spacing is controlled with active, closed loop servo utilizing feedback from an integrated capacitive coupling device measuring HMS at about 60 KHz. The piezo-electric z-actuator adjusts the HMS at about 15 KHz, Elimination of the air bearing reduces the recording head size.

Peter R. Goglia, Ph.D.
E-mail: peter.goglia@l2drive.com
tel: +1 925-32-4940

Instead of a flat ABS, the heads are narrow at the sensor allowing accurate tracking and improved disk utilization. Heads and media never come into contact.

REFERENCES

1. B. Marchon, T. Pitchford, Y-T Hsia and S. Gangopadhyay, "The Head-Disk Interface Roadmap to an Areal Density of 4 Tbit/in^2", Advances in Tribology, Vol. 2013, Art. ID 521086, (2013)

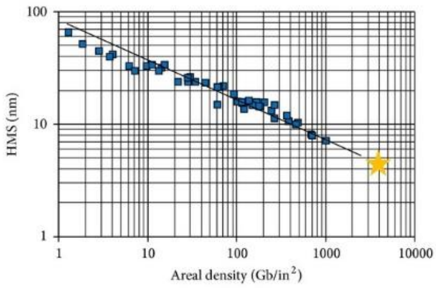

Fig. 1 Historical variation of HMS VS AD [1]

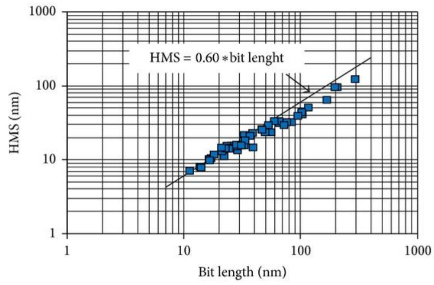

Fig. 2 Historical relation between Bit Length and HMS [1]

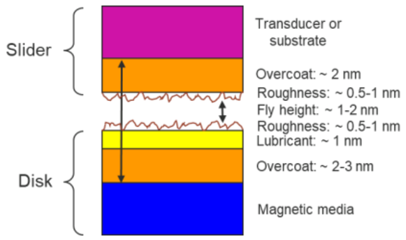

Fig. 3a. HMS today = ~7-10 nm

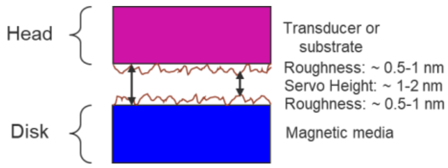

Fig 3b. Servo-to-Disk in vacuum HMS = 3-4 nm

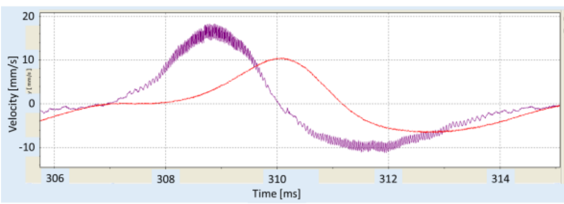

Fig. 4 Measured disk flutter in Air Vs Vacuum

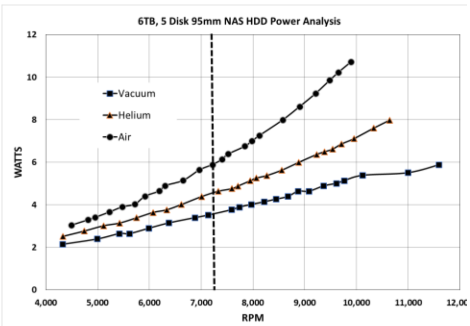

Fig. 5. Measured spindle power in Air vs. He Vs Vacuum

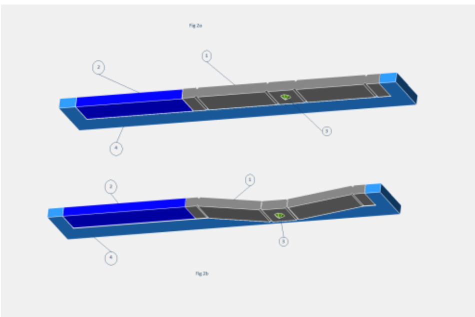

Figure 6. Z-direction piezo actuator

Peter R. Goglia, Ph.D.
E-mail: peter.goglia@l2drive.com
tel: +1 925-32-4940