1. Introduction

Hard disk drives (HDDs) are the still the data storage of choice due to its reliability and low cost per gigabyte. To maintain this competitiveness, the head magnetic spacing should be further decreased for areal density capacity (ADC) gain. Refer to Figure 1 for the schematic diagram of magnetic head flying across the magnetic hard disk as its rotates during operation.

The carbon nitride overcoat thin film use in magnetic hard disk should be continuous. This is to prevent moisture percolation, a presage for corrosion. Secondlly, to serve as bonding sites for functional PFPE lubricant applied topically after carbon deposition. Experiments were conducted to show the negative effects as the nitrogen content of the magnetic hard disk carbons thin film were increased.

Lubricant thin film is the primary determinant for flyability and durability of the magnetic hard disk. Experiments were conducted to showcase a HDD lubricant dilemma. This was done using commonly accepted techniques including changes to lubricant thickness, addition of additive, lowering of molecular weight of lubricant and process type such as baking or deep ultraviolet irradiation (185nm).

2. Method

Magnetic disk. 65mm glass substrate magnetic disk were used. The magnetic film thickness were at 80nm, carbon film thickness at 2nm and the lubricant film at 1nm. The magnetic disks were nitrogenized via post sputter nitrogen plasma treatment. Magnetic disk used for the lubricant related experiment have similar specification unless otherwise stated.

Corrosion. The corrosion resistances were characterized by cobalt extraction method. 0.5ml of 3% concentrated nitric acid was applied onto PFPE coated magnetic hard disks at four different positions. Nitric acid was allowed to percolate for 60 minutes before extracted for analysis by ICP-MS.

Flyability. The magnetic head was connected to an adapter mounted with an acoustic emission (AE) sensor. The protrusion element of the magnetic head was expanded by supplying power to the heating element in the magnetic head. This was done until a spike signal indicating contact between head and disk was detected as the disk rotates at 5400rpm. This is also known as the touch down value. If the power required was higher to obtain a touch down, the latter was deemed better.

Magnetic head durability. The setup was similar to the flyability test. The touch down value of a magnetic head was first determined, the protrusion element of the magnetic head then set at 10% higher so it will burnishes itself against the magnetic hard disk. It will then move from the inner diameter to the outer diameter of the disk then back. The touch down value was determined again. The difference in touch down voltage is the amount of wear to the magnetic head. This values were then convert to angstrom. Lower value means lesser wear to the magnetic head.

Magnetic disk durability. The setup was similar to the flyability test. The tests were conducted in a vacuum instead. The air bearing surface of the magnetic head becomes ineffective in a vacuum and will drag on the surface of the magnetic hard disk. A spike in the AE signal signifies breakage to the carbon protective film. Higher value signifies better durability.

3. Results

Nitrogen content

The cobalt decoration on the magnetic hard disk increased with increasing amount of nitrogen. Refer to Figure 2. Corrosion resistance of the magnetic hard disk becomes worst with increasing amount of nitrogen content. The roughness of these did not change with higher amount of nitrogen content. Refer to Figure 3.

Additive Percentage

Magnetic hard disk with additive percentage of 0, 10 and 30. The burnish rate and the wearability become better as expected. Flyability become worse as we increase the percentile of additive. From 54.7mW to 52.4mW. See Figure 5.

Molecular Weight

Lubricant with molecular weight of 1000 or 2000 dalton at each branch with lubricant thickness of 1mm were used. Burnish was worse at 12.3Å and wearability is 16.5k revolution for the lower molecular weight lubricant. Flyability improved from 53.8mW to 55.1mW. See Table 1.

Process Type

The durability is best when there is no UV irradiation. Better flyability were detected with deep UV irradiation (185nm), follow by UV with baking, and lastly was baking only. See Figure 6.

4. Conclusion

We demonstrated limitations of common techniques to reduce head magnetic spacing of magnetic hard disk. Magnetic hard disk with higher nitrogen content in carbon thin film will corrode more readily. Improvement to flyability through changes to lubricant thin film will result in worse durability, vice versa.

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References

