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Effects of additives in ethylene glycol-based lubricant on selective material removal in slider lapping process

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Abstract

Chemical mechanical nano grinding is a key technology in magnetic recording head manufacturing process. The magnetic recording head is an important component of hard disk drive which is used for reading and writing data in to the media. Thin film of metal alloys and metal oxides are fabricated on ceramic substrate called wafer to create the recording heads. In order to control surface properties of the recording head, the precise chemical mechanical nano grinding process is used. In this process the recording heads are treated to archive the designed surface properties by using lubricants to control the selectivity of material removal. This research studied the effect of additives in ethylene glycol based lubricant on the selectivity of material removal. Two additives were added in ethylene glycol to create the lubricant and their pHs were measured. The material removal rate can be predicted by measuring wettability of lubricant on surface of material. Nickel iron alloy (NiFe) was used to represent the surface material of magnetic shield of the recording head. The wettability of lubricants were measured on NiFe surface by contact angle measurement technique to show the selectivity on each NiFe. The results were compared with the atomic force micrograph of material after lapping process and show that the selective removal of material can be occurred by this method.

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1. Introduction

Magnetic data storages or hard disk drive are widely used for storing data in computers and other electrical devices.¹ The recording head which is called a slider is one of the most important parts of hard disk drive. It is used for reading and writing data into a media. To fabricate the sliders, metal oxides and metal alloys are sputtered on the ceramic substrate and are sliced into the individual row bars.² The row bars are lapped to create the desired surface properties such as planarization, roughness and height of individual species on the sliders. The row bars are then cut into sliders and are assembled to create the recording component of hard disk drive. The recession of softer specie tend to occur, because sliders consist of varieties of material whose properties are different.³ For this reason, the selective material removal is needed in order to control the quality of finished surface of the sliders. Chemical mechanical nano grinding is used to create the selective material removal and ethylene glycol-based lubricant is used to control the chemical effects.⁴ The lubricant consists of several additives which are added to control properties of lubricant such as pH and surface tension. Wettability of lubricant on material's surface is one of the most important factors that control the selectivity of material removal.⁵ It effects mainly on ability to create protective film on the surface of material and reduce the removal rate of the soft material. In this research, the nickel iron alloy was used to represent the material of magnetic shield of slider and the wettability of lubricants on these surfaces was measured.

2. Materials and Methods

2.1. Materials

The sliders consist of thin-film-alloy of nickel-iron or NiFe which are coated on Al₂O₃-TiC (AlTiC) by electro plating were supplied by Western Digital (Thailand) Co., Ltd. Ethylene glycol (EG), additive A and additive B which are AR grade were supplied by Merck, Germany, Tokyo Chemical Industry Co.,Ltd., and CHEMOS GmbH, respectively. Additive A is an inorganic oxidizing substance. Additive B is an organic compound with carboxylate ligand. Three different concentrations of additive A which are 0%, 0.5% and 1%, and three different concentrations of additive B which are 0%, 0.25% and 0.5% were added to create 5 samples of lubricant as shown in Table 1. The range of variation is similar to the commercial grade one.

Table 1. Concentration of lubricant samples

Recipe	EG (wt%)	Additive A (wt%)	Additive B (wt%)
1	100.00	0.00	0.00
2	99.50	0.00	0.50
3	99.25	0.50	0.25
4	99.00	1.00	0.00
5	98.50	1.00	0.50

2.2. Methods

2.2.1. Characterization of lubricant

The pH of lubricants are measured and the results are analyzed statistically to indicate the effect of each additive by using multiple regression models.⁶ These properties of lubricant can affect the removal rate and surface properties of slider.

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