Critical Conditions for Demagnetization and Data Loss in Perpendicular Magnetic Recording Disk Under Sliding Contact

Lei Yang, Wenjing Zhan, Ke Mu, Dongfeng Diao*

Key Laboratory of Education Ministry for Modern Design and Rotor-Bearing System,
School of Mechanical Engineering, Xi'an Jiaotong University, Xi'an 710049, China
*Corresponding author: dfdiao@mail.xjtu.edu.cn

1. Introduction

Disk damage due to high velocity sliding contact between slider and disk in perpendicular magnetic recording (PMR) disks can be classified into demagnetization and data loss. However the previous studies confused these two important phenomena. Therefore, the study on the critical conditions (critical stress and critical temperature) for demagnetization and data loss in PMR disk induced by sliding contact is necessary.

2. Experiment

A tribo-test is performed on the PMR disk. Figure 1 shows the schematic sketch of the tribo-test apparatus. The apparatus includes a microforce loading system with diamond tips (5 μm and 0.5 mm) and a magnetic disk scanning system. After the tribo-test, disk samples in the contact area were observed by Atomic Force Microscopy (AFM) and Magnetic Force Microscopy (MFM).

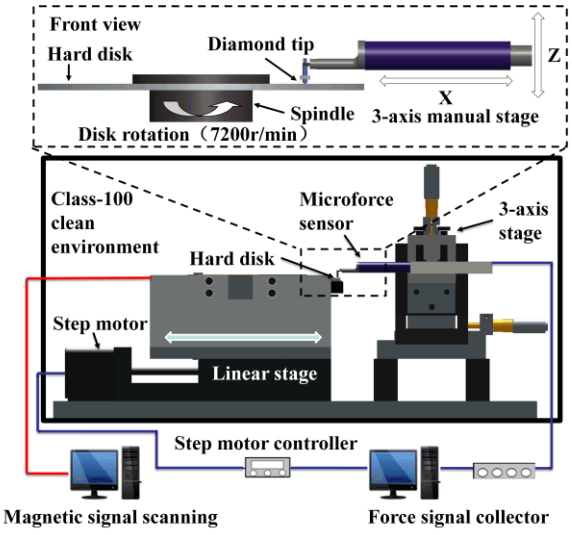

Fig.1 Schematic sketch of the tribo-test apparatus

3. Results

We define data loss occurred when damaged sectors were detected by the scanning system. It was found the critical force for data loss was 0.025 mN at the loading position with a sliding velocity of 18.85 m/s. However, according to the AFM and MFM results, the critical force for demagnetization was 8 mN at the loading position with a sliding velocity of 18.85 m/s. Figure 2 shows the AFM and MFM images of the contact area at normal force of 8mN with a sliding velocity of 18.85 m/s. We can see that the magnetic domains in the contact area could not be observed, which indicates demagnetization occurred.

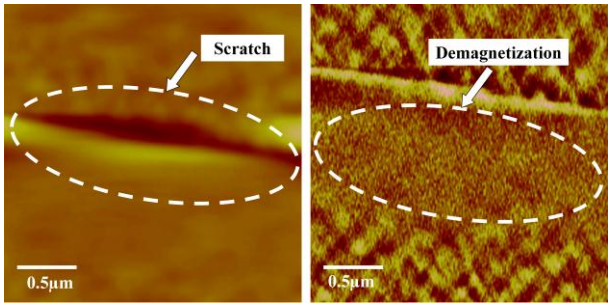

Fig.2 AFM and MFM images in the contact area

4. Finite Element Analysis

A finite element model using a thermomechanical coupling was developed to calculate the critical stress and temperature of the magnetic disk based on the experiment results. Figure 3 shows the 3-D finite model.

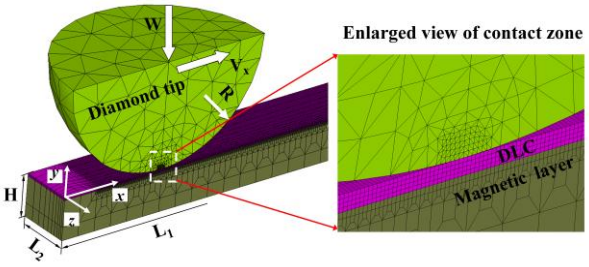

Fig.3 Illustration of finite element model

According to the FEA results, data loss temperature and von mises stress in the magnetic layer are $T_{data\ loss}$ =52.24 °C, $\sigma_{data\ loss}$ =0.405 GPa, while demagnetization temperature and von mises stress in the magnetic layer are $T_{demagnetization}$ = 172.57 °C, $\sigma_{demagnetization}$ =4.517 GPa.

5. Conclusions

The critical conditions for data loss and demagnetization of the PMR disk under sliding contact were studied. It was found demagnetization did not occur in the data loss area under the experimental conditions. The critical stress and temperature of demagnetization were much higher than those of data loss.

6. Acknowledgement

The authors would like to thank the National Nature Science Foundation of China under Grant Numbers of 90923027 and 51050110137 as well as the Fundamental Research Funds for Central Universities for their supports.