DECOUPLING ADJUSTMENT OF CROWN AND CAMBER FOR FLYING HEIGHT CONTROL

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ABSTRACT

An active slider with an H-shaped PZT and a U-shaped or grooved slider body is proposed for flying height control. The active slider has a decoupled crown and camber adjustment to improve the flying height adjustment ability. It can achieve more than 2nm flying height adjustment with a 12V voltage input.

INTRODUCTION

The projected flying height for 1Tb/in² hard disk drive is only about 2.5nm. The scheme used in conventional hard drives to achieve lower fly-height is to through improved air bearing design. While achieving a relatively low flying height of 2.5 nm is generally possible through novel ABS and HDI designs, conventional sliders faces tremendous reliability issue posed by the limited physical clearance available between the slider and the disk. An active slider with an adjustable flying height control can offer an improved reliability and read/write performance at this extremely small head-disk spacing.

Many factors affect the flying height stability of the slider in the hard disk drive. The slider’s performance is affected by the component manufacturing and assembly tolerances. The flying height is also affected the environmental changes such as temperature, humidity and altitude. An active slider that can adjust its flying height thus offers an advantage in improving the slider’s performance.

The active slider also can be employed for proximity-on-demand to greatly reduce the contact induced wear and increase the life-time of the head disk interface.

Another advantage of active slider is to provide a method to precisely set the slider’s flying height at a defined value in order to compensate fabrication tolerances in every individual hard disk drive.

The approaches for flying height control mainly include: 1) adjusting gram load; 2) controlling air bearing surface profile; and 3) moving the reading/writing elements directly. [1-4]

If a piece of PZT is bonded to the back of a slider, both crown and camber of air bearing surface (ABS) will be increased or decreased when a electric potential is applied. Normally the slider flies higher with a larger crown and flies lower with a larger camber. In order to increase the ability of flying height control, it is necessary to decoupling the adjustment of crown and camber.

In this paper a novel structure of an active slider for flying height adjustment is proposed. An H-shape PZT actuator and a U-shape or grooved slider body are used, to reduce the change of the camber during the crown profile adjustment for improved flying height control.

STRUCTURE OF THE ACTIVE SLIDER

The proposed structure for the flying height control is shown in Fig. 1. The length and the width of the active slider are 1.25 mm and 1.0 mm respectively. The total thickness of the PZT and the slider is equal to the standard thickness of a pico slider (0.3mm).

The PZT is fabricated with an H-shape structure. The separated two-beam structure can minimize the change of camber during the surface profile adjustment. The slider is fabricated with a U-shape or grooved along the camber direction. This results in the reduced stiffness along the crown direction and thus increasing the change of crown during adjustment of surface profile.

SIMULATION RESULTS OF THE ACTIVE SLIDER

The deformation of the active slider is analyzed with the finite element analysis software ANSYS. The flying height of the active is simulated with CML air bearing design program. In the simulation, the voltage applied on PZT is 12V, and the active slider is bonded on a gimbal which thickness is 18µm.

H-shape PZT

The structure of the H-shape PZT is shown in Fig.2. L and W is the length and width of the bridge in the center of the H-shape PZT, T is its thickness.

When T is 0.15mm and W is 0.2 mm, the relationship between the change of crown and camber with the length (L) of the bridge is shown in Fig. 3. When L is reduced from 1.2mm to 0.05mm, change of camber is reduced from 3.9mm to 1.7mm, but the change of crown is reduced only from 6.3mm to 5.4 mm.

When bridge length L is 0.1mm, bridge width W is 0.2mm,
Fig. 3 Change of Crown and Camber vs Length of Bridge

Total thickness of PZT and slider is 0.3 mm, the relationship between the change of crown and camber with the thickness of PZT (T) is shown in Fig. 4. When T is reduced from 1.2 mm to 0.05 mm, the change of crown and camber reach their maximum value when thicknesses of PZT are 0.16 mm and 0.14 mm respectively, both thicknesses are near the half of the total thickness of the active slider.

U-shape Slider

In order to further improve the adjustment of crown, the slider is fabricated to a U-shape as shown in Fig. 5. W₁ is the width of bonding area, T₁ is the thickness of bonding area, and T₂ is the thickness of central area.

Improvement of Flying Height Adjustment

The flying height adjustment abilities of the active sliders 1 with a flat PZT (thickness of PZT = thickness of slider = 0.15 mm) and a ungrooved slider and the active slider 2 with an H-shape PZT and a U-shape slider (T = T₂ = 0.075 mm, L = 0.15 mm, W = 0.15 mm) are listed in Table 1, four ABS designs with about 8 nm flying height are compared. The adjustment ability is improved 134% to 852%. It is possible to realize 2 nm flying height adjustment with a 12V voltage.

CONCLUSION

The active slider with the H-shaped PZT and the U-shaped slider can decouple the adjustment of crown and camber. This leads to improved flying height adjustment ability for flying height control. The simulated sliders’ flying height adjustment abilities are improved 134% to 852%. The simulation results show the proposed active slider can realize 2 nm flying height adjustment with a 12V voltage.

REFERENCES