ELECTROMAGNETIC SECOND STAGE MICROACTUATOR FOR A HARD DISC RECORDING HEAD

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Introduction

A flying height adjustment as well as a second stage track following capability for fine tracking is desirable for the realization of advanced hard disc drive (HDD) recording heads. A dynamic flying height adjustment during writing and reading, respectively, allows for a further decrease of the the head-to-disc spacing. This approach was proposed in 2004 by Kurita et al. and was implemented into the latest generation of recording heads [1]. A second stage actuation may compensate the frequency related limitations of the main actuator and supports the achievement of a perfect track registration. Different designs for second stage actuation were suggested previously [1,2]. But so far, the additional costs related to the implementation of such a second stage actuator prevented its establishement in the industry. However, a solution has to be found matching both requirements: providing flying height and track following adjustment as well as a cost competitive way of fabrication and integration.

Concept of a Slider with Integrated Microactoator (SLIM)

To fulfill the defined requirements, the following approach was taken. An electromagnetic microactuator was integrated into a pico slider resulting in a slider with an integrated microactuator (SLIM) [3]. The microactuator mobilizes a mounting block attached to the chiplet with the read-write element at the front side. The actuator enables not only an adjustment of the flying height by moving the read-write element on the chiplet in vertical direction, but also allows for a second stage actuation in lateral direction. The fabrication of SLIM is very costs competitive compared to a present day HDD slider since SLIM is much less complex because the chiplet with the read-write element amounts to only thirty percent of a pico slider's space and batch fabrication is applied.

Modelling and Thin-film fabrication of SLIM

SLIM is fabricated in thin-film technology. The fabrication is based on a two-wafer approach. While the bottom wafer contains the actuator magnetics part, the top wafer carries the actuator mechanics. Top and bottom wafer are bonded by a spacer compensating for the magnetic actuator's building height. A pair of variable reluctance (VR) microactuators create the actuator magnetics part [4], while the actuator mechanics consist of a mounting platform suspended by a pair of micro leaf springs. The read-write element attached to the chiplet is located at the end of a mounting platform. Exciting both microactuators at the same time allows for an adjustment of the chiplet's flying height, while exciting them alternatively leads to a precise rotation of the chiplet and thus to a lateral displacement of the attached read-write element. The proposed design thus allows for both, flying height adjustment as well as track following. The aimed lateral displacement of ±625 nm causes a rotation of 0.18°. This small rotational angle changes the flying height by only about 1 nm.
The fabrication of SLIM is carried out on two Si wafers, one containing the actuator magnetics and the second one the actuator mechanics. For the fabrication of the actuator magnetics, high aspect ratio micro structure technology (HARMST) is applied to achieve a high volume and thus to a high energy which is proportional to a microactuator`s volume [4]. For fabricating the microactuator mechanics, Si micromachining processes are applied. At the backside of the bottom wafer, an air bearing surface (ABS) will be created using ion milling. The ABS will be covered by a diamond-like carbon (DLC) layer the make the slider sufficiently wear resistant. Since the initial testing is intended to be performed on a static tester, this ABS will not be included on the first prototypes.

Evaluation of the System

A static test-stand was built to investigate the capabilities of SLIM. In this test-stand, a SLIM device can be mounted in a position similar to its future application when flying on a data disc. The SLIM microactuators are excited by a set of drive electronics allowing for a lowering of the chiplet as well as a rotation of the chiplet. The test chiplet used for this evaluation contains a permanent magnet allowing for the application of a GMR monitoring system to detect the motion of the chiplet.

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[2] F. Chen, H. Xie, G. K. Fedder: A MEMS-based monolithic electrostatic microactuator for ultra-low magnetic disk head fly height control. IEEE Transaction on Magnetics Vol. 37, No. 4, pp. 1915-1918, 2001
[3] H.H. Gatzen: Schreib-/Lesekopf mit integriertem Mikroaktor (Read-Write head with integrated micro actuator) German Patent 10260009
[4] H.H Gatzen, Dragan Dinulovic, Henry Saalfeld: Integrated electromagnetic second stage micro actuator for a hard disk recording head. Intermag 2008, Madrid (submitted)

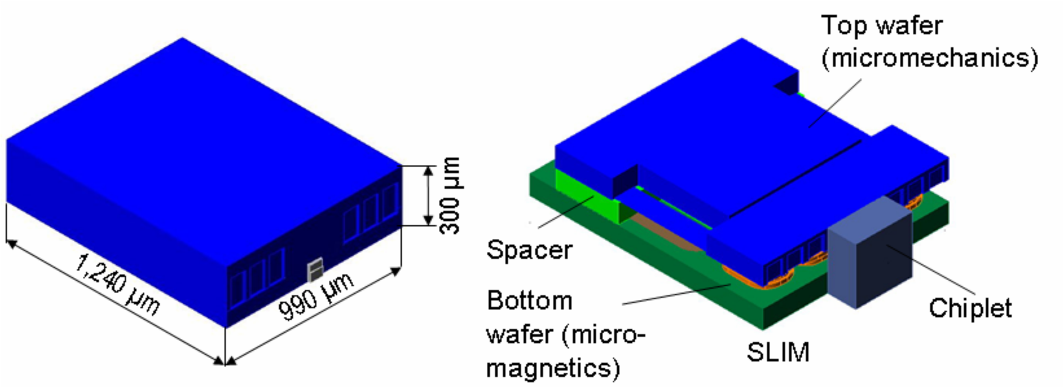

Figure 1: *Left: Standard pico slider, right: Slider with Integrated Microactuator (SLIM)*