Redesign and Fabrication of a Magnetic Head for Gentelligent™ Products

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Abstract

The term gentelligent™ (GI) is a compound of two words: "genetically" and "intelligent". It describes a new approach in production engineering. The ability to store product information on components on the devices themselves and to readout the data in an industrial environment is the main idea of the GI approach. This possibility allows for passing the sequence of the processing steps without an external control [1]. The recording system of the GI approach uses an inductive magnetic recording head which is based on the hard disk drive technology. This work presents the development of a new magnetic head design, the fabrication, and the high precision assembly as well as first writing test results.

1 Introduction

In order to make it possible to write data on the GI components, a new low-density material, called "magnetic magnesium", was developed. Magnetic magnesium consists of a Mg matrix with integrated hard magnetic γ-Fe_2O_3 particles. For a remote readout, a magneto-optical method based on the longitudinal Kerr effect (MOKE) was chosen [2]. This readout technique requires a storage medium with a reflective magnetized surface. For this purpose, the magnetic Mg surface, which is not reflective itself, was covered with a soft magnetic magnetostriction-free and reflective "keeper layer" made of NiFe81/19. However, the magnetic head of the recording system has to fulfill the following requirements: the generated magnetic field strength H has to be strong enough to magnetize the hard magnetic γ-Fe_2O_3 particles in the magnetic Mg. Furthermore, the magnetic flux density B of the head has to be able to saturate the keeper layer and thus must be at least as high as the saturation flux density B_S of the NiFe81/19 layer which is 0.8 T.

2 Redesign of the Magnetic Head

The first prototype of the magnetic head created bits with a size of 100 µm [3]. The new design even allows for creating bits with a size of 50 µm by minimizing the air gap. For a further increase of the storage density, the magnetic track width was reduced from 700 µm to 500 µm in the new head design. The magnetic writing head was designed with the aid of FEM-simulations with ANSYS™ and consists of a magnetic core made of MnZn, two coils with 50 turns each, and an air gap. To amplify the magnetic field strength in the air gap, chamfers on both sides of the head were integrated. The chamfers with an angle of 35° lead to a higher penetration depth of the magnetic field generated by the head inside the storage medium (Fig.1). The chamfers with an angle of 5° serve to avoid the oversaturation effects in the head geometry.

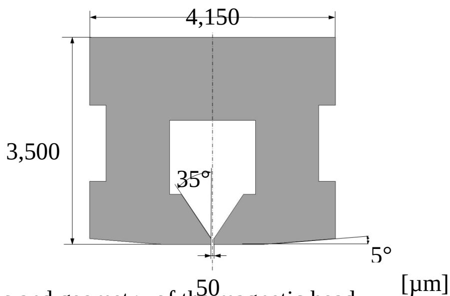
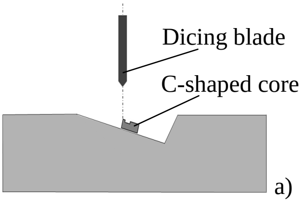


Figure 1: Dimensions and geometry of the magnetic head

3 Magnetic Head Fabrication

For the fabrication, the magnetic core was divided into two C-shaped cores, which were fabricated separately in an ultra-precision dicing process. For the fabrication of a chamfer in the MnZn component to create the core geometry, a special mounting tool was used for the dicing machine. This add-on allows for creating the required chamfer with different angles in a conventional dicing process (Fig. 2). This tool consists of a plate with the same chamfers as required in the head design geometry on the both sides, respectively. After the core had been mounted onto the required chamfer, in a dicing process the same chamfer was created in the core geometry as in the mounting tool. After that, the core was planarized by lapping and nanogrinding. A



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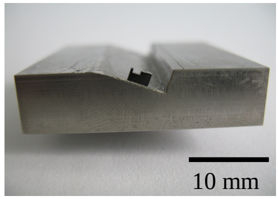
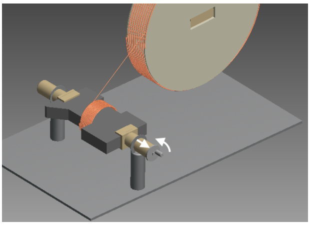


b)

Figure 2 Mounting tool a) schematic, b) head core on the mounting tool

high-precision wire winding tool was used, which creates the 50 turns of the Cu wire on each C-core by means of a semi-automatic method (Fig. 3). The head core was mounted in such a way, that it could be exposed to a rotation and translation at the same time. The Cu-wire was guided along the core until the 50 turns were achieved.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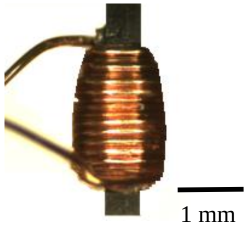

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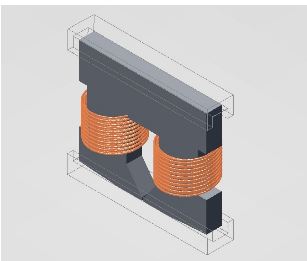
Figure 3 a) Winding tool (schematic), b) Cu-coil on the head core

After the winding process, the two parts of the C-core were assembled keeping both parts of the C-core in parallel. The parallelism during the mounting process was achieved by two glass plates (Fig. 4).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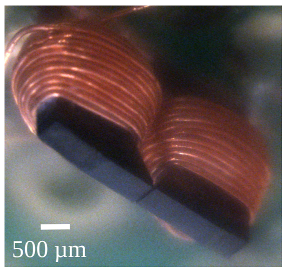

b)

Figure 4 a) Glass sliders on the top and on the bottom (schematic), b) completed head

4 Experimental Results

For the experimental test, an epoxy containing γ-Fe_2O_3 particles with a ratio of 58% epoxy and 42% particles was used. The magnetic writing head was guided directly over the sample surface. During the test, a coil current of 600 mA was applied. The readout of the magnetic tracks was performed by Kerr-microscopy. An alternating sequence of 5 “0” and 5 “1” was stored on the surface of the sample.

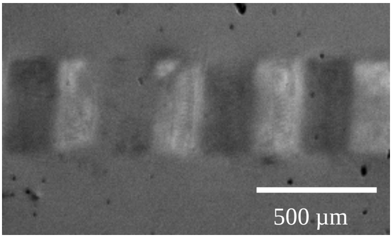

Figure 5: Magnetic track

5 Conclusion and Outlook

Both add-ons, for the dicing process and for the winding process, supported a high-precision micro fabrication of the magnetic head, which made it possible to create magnetic tracks of 50 µm length and 500 µm width. The further increase of the data density requires the reduction of the air gap to less than 50 µm. Due to the brittle MnZn, it is extremely complicated to downsize of the air gap by means of dicing. It will only be possible by the application of the thin film technology.

Acknowledgment

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