B-7

Characteristics of Bit Pattern Written by a Planar-Type Head

KIST S. H. Lim,
Kogakuin Univ. K. Yoshida
Hitachi Central Res. Lab. H. Takano

The density of magnetic recording on continuous longitudinal media has been increasing at a very fast rate (currently 60 % per year, for example) for the last several decades. One of the most popular routes to high density recording is to decrease the transition length between the bits by reducing the medium thickness and the grain size [1]. A weak signal due to small medium thickness is a source of concern, but this problem has been solved with a highly sensitive GMR read sensor. However, the reduction of the medium thickness and the grain size results in a small grain volume so that the magnetization direction of a grain is subjected to thermal fluctuation. This is a fundamental problem that cannot be solved through technological refinements. Another route to high density recording is to use the medium with a high value of the anisotropy energy (K), since the transition length decreases with the increase of K [1]. The use of the medium with a high K value is also good for improving thermal stability. This route, however, suffers from the limitation imposed by low values of the write field which can be generated by conventional heads. In this work, an attempt is made to achieve a very high density recording on continuous longitudinal media with a newly designed planar-type write head (see Figure 1). A particular emphasis is placed on the writability of the planar-type head on the medium with a very high value of K. Some important head parameters of the planar-type head are: the gap length of 0.12 μm, the track width of 0.16 μm (head dimensions); the relative permeability of 500, and the saturation flux density of 1.9 T and the magneto-motive force of 0.4 A-Turn (magnetic properties). The maximum value of Hx obtained from the present planar head is 14183 Oe at the distance of 17.5 nm below the gap center. The head field is much higher than the values ranging 6000~8000 Oe from conventional heads. A two-dimensional array of honeycomb-shaped and completely packed hexagons was used to simulate the longitudinal media. The grain size, which corresponds to the center-to-center distance between neighboring grains, is 7 nm, and the thickness (the hexagon height) is 13 nm. This gives the grain volume of 552 nm3. The grains were assumed to possess only uniaxial anisotropy. Several media with varying values of K ranging from 1.2×105 to 5.0×105 J/m3 were investigated. The well-known LLG equation was used to obtain the evolution of magnetization in time [2]. It is shown that, for the media with the wide coercivity range, the optimum write field is higher than the medium coercivity by only 3400 Oe, namely Hw-Hc=3400

Oe. This new relationship provides a significant increase of the medium coercivity and hence a further increase of the recording density by relieving, among many others, the most critical and fundamental problem of the thermal instability. It is demonstrated that the medium with a very high coercivity (> 11 kOe) can be written with a planar-type head. Specifically, a reasonably good bit pattern with a bit density of 605 kfci has been generated on the medium with a coercivity of 11720 Oe, and, combined with a high track pitch density of 100 ktpi, it is possible to reach a recording density of 60 Gb/in2 (see Figure 2). The recording density can further be increased to 75 Gb/in2 with the improvement of the design of the present planar-type head, particularly with regard to the reduction of the track width of the bit pattern. It is important to note that, even at this density, the media will not suffer from the thermal stability problem, since the value of KV/kT at room temperature is approximately 60, which is considered to be high enough to provide ample room thermal stability [3].

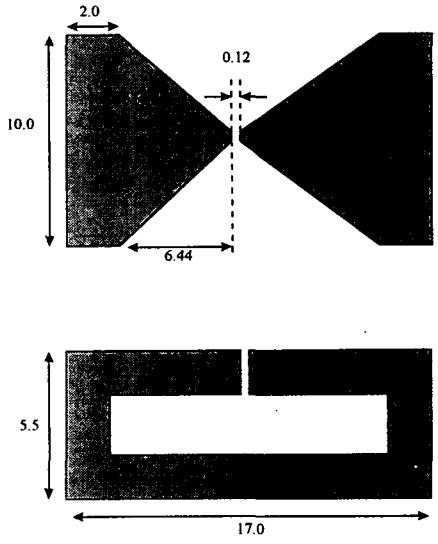

Figure 1. The planar-type head used in this work. The dimensions are in μm.

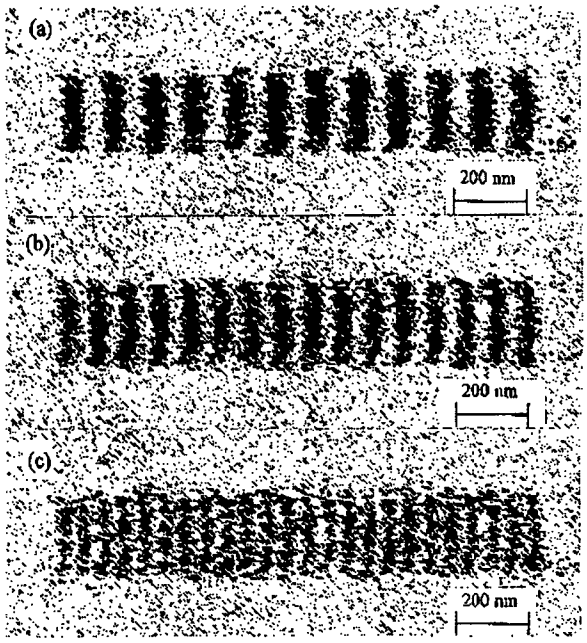

Figure 2. The recorded bit pattern for the media with $K=4.5\times10^5$ J/m^3 at various densities of (a) 454 kfci, (b) 605 kfci, and (c) 907 kfci.

Reference

[1] B. K. Middleton, J. Magn. Magn. Mater., 193 (1999) 24-28.

[2] W. D. Doyle, S. Stinnett, C. Dawson and L. He, J. Magn. Soc. Japan, 22 (1998) 91-106.

[3] D. E. Speliotis, J. Magn. Magn. Mater., 193 (1999) 29-35.