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POSSIBILITIES OF 40 Gb/in^2 PERPENDICULAR RECORDING

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Introduction

Recording performance and bit error rate characteristics of a perpendicular recording system, using a single-pole-type (SPT) head and a double-layered medium, were measured. An analytical model was also developed for estimating the isolated transition length obtained by the SPT head and the double-layered medium, and also for designing an ultra-high-density perpendicular recording system. These measurements and analysis show that the perpendicular recording system should be able to achieve an areal recording density of 40 Gb/in^2 (600 kFCI / 70 kTPI: 16/17 coding, aspect ratio 8).

Experimental

Parameters of the heads and media used in this study and the target design parameters for 40 Gb/in^2 are listed in Table 1. The write operation was done by the SPT head designed and fabricated by Tohoku Univ[1]. The thickness of the main pole was 0.4 um. The GMR head designed for a 10 Gb/in^2 longitudinal recording system (400 kFCI / 28 kTPI: 16/17 coding) was used for the read operation. A CoCrPt/CoTaZr double-layered perpendicular medium was used[2]. Squareness of the CoCrPt recording-layer was 0.85. Saturation magnetization Bs, coercivity Hc, and permeability of CoTaZr under-layer were 14 kG, 0.35 Oe, and 600. Between the recording-layer and the under-layer, a 20-nm-thick CoCr non-magnetic interlayer was inserted to improve the crystalline orientation of the recording-layer.

The recording conditions and the typical data are also listed in Table 1. The ABS structure of the SPT head was designed to keep the same flying height as that of the GMR head at the same velocity. Bit-error-rate (BER) performance was evaluated by simulation with an 11-tap equalizer and a full-state ML detector. The rate 16/17 coded PR(1,2,2,1) channel[3] was used in order to evaluate the perpendicular recording system.

Results and discussions

First, measured roll-off is shown in Fig. 1 as circles. In this case, the recording density D_{50} was 190 kFCI. On the other hand, roll-off derived from the analytical model, using the head / medium parameters and recording conditions listed in Table 1, is indicated as a thin line. This figure shows that the measured and calculated roll-offs agree well. The transition parameter pai-a is 112 nm. The roll-off expressed by the solid line is derived from the parameters for 40 Gb/in^2 recording density listed in Table 1. To obtain this roll-off curve, shield-to-shield separation of GMR reader should be decreased from 130 to 80 nm and magnetic spacing between the head and the medium should be decreased from 30 to 20 nm. At the same time, squareness of the recording-layer should be increased from 0.85 to 0.98, and non-magnetic interlayer thickness should be decrease from 20 to 5 nm. Under these conditions, pai-a is expected to decrease to 36 nm and the resolution at 600 kFCI is increased to 8.5%.

Figure 2 compares the BER characteristics. This figure shows that the present SPT head and double-layered perpendicular medium (indicated by circles: A) have a potential for realizing a recording density of 8 Gb/in^2 (300 kFCI / 28 kTPI) with an acceptable on-track BER of 10^{-8}. According to the 40 Gb/in^2 roll-off as shown in Fig.1, BER characteristics are estimated to improve as indicated by triangles(B). Improvement of signal-to-noise ratio is attainable by decreasing the medium noise and increasing the read head sensitivity as listed in Table 1. In this case, an acceptable BER can be obtained at 600 kFCI as indicated by rectangles(C). Recording performance under these conditions for 40 Gb/in^2 recording density will be presented at the conference.

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Table 1. Parameters of heads and media and recording conditions.

		Present condition	40 Gb/in2
Media	Hc [Oe]	3600	3600
	Mr [G]	4000	4000
	Mr/Ms	0.85	0.98
	Rec. layer thickness [nm]	20	20
Read head	Track width [um]	0.55	0.2
	Gap length [nm]	130	80
	Sensitivity [uVpp/um]	5300	7500
Channel		16/17 coded PR(1,2,2,1)	16/17 coded PR(1,2,2,1)
R/W	pai-a	112	36
	Media SNR @ 600kFCI [dB]	19	26
	Magnetic spacing [nm]	30	20

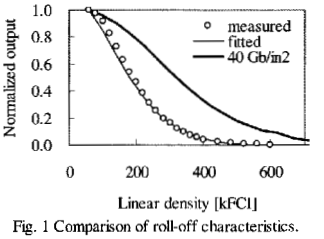

Fig. 1 Comparison of roll-off characteristics.

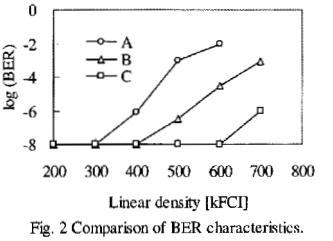

Fig. 2 Comparison of BER characteristics.