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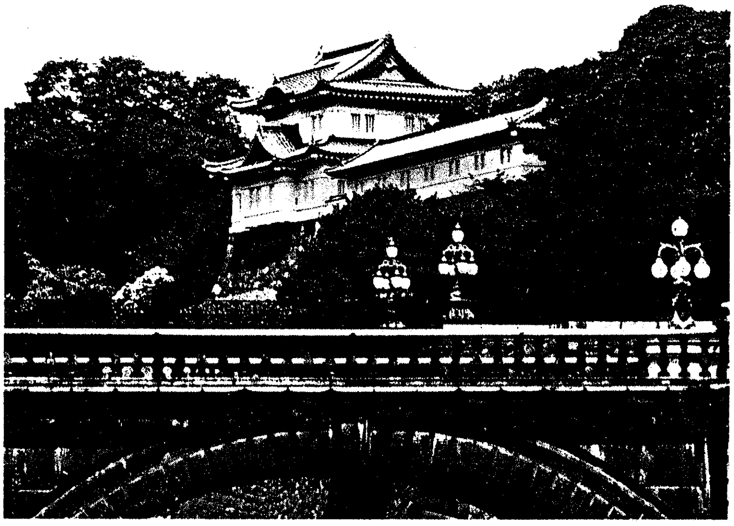

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PERPENDICULAR MAGNETIC RECORDING HARD DISK USING FERRITE SUBSTRATE

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Introduction

The feasibility of high bit density recording over 500kFRPI has been already proved in perpendicular magnetic recording in the combination of a single-pole head and a Co-Cr/ Permalloy double-layer medium[1]. As available linear bit density becomes higher, the frequency of recording and reproducing signal tends to become higher. The permeability decreases at high frequencies because of the eddy current loss when the low electric resistivity material like Permalloy is used as a backlayer of the medium. In this study, high frequency response of permeability of a backlayer was investigated, and a ferrite substrate of high electric resistivity was tried to use instead of a Permalloy backlayer.

Experiments

The permeability of a backlayer was estimated by measuring the inductance increment of a single-pole head in itself and when the head contacts with the double-layer medium[2]. Using this method, frequency dependence of the permeability of the backlayer was measured in the frequency range from 0.1MHz to 30MHz.

Permalloy Backlayer

The electric resistivity of a Fe-Ni-Nb Permalloy backlayer was 85μΩ*cm. For the Co-Cr / Fe-Ni-Nb Permalloy hard disk, the head inductance increment remarkably decreases at high frequencies because of the eddy current. It was found that the laminated Fe-Ni-Nb Permalloy layers with a 50A thick SiO_2 interlayer is effective to reduce the eddy current, which was proved by the fact that the large increment of the head inductance was measured up to higher densities compared with the case of the Fe-Ni-Nb Permalloy single-layer. However, the reduction of head inductance increment still occurs at the frequencies over 1MHz even for the media with the laminated Fe-Ni-Nb Permalloy backlayer because the eddy current that flows in the in-plane of the backlayer still exists underneath the main-pole and the ferrite return-path core of the single-pole head as illustrated in Fig.1. This eddy current is inevitable as long as the low electric resistivity material is used as the backlayer.

Ferrite Substrate

The polycrystal Mn-Zn ferrite substrate with high electric resistivity was used as a candidate backlayer and substrate material which can suppress the eddy current. The hard disk with the Mn-Zn ferrite substrate showed large head inductance increment, or high permeability even at high frequencies. It was also confirmed that the reproduced output for this medium is larger than that obtained using the medium with Fe-Ni-Nb permalloy backlayer at high frequencies over 5MHz as shown in Fig.2.

However, for this hard disk with a poly-crystal ferrite substrate, some dropouts of the reproduced voltage were found which are caused by the surface roughness of the substrate. To improve the surface roughness, we are now trying to use the single-crystal Mn-Zn ferrite substrate. The 0.2μm thick Co-Cr layers were deposited on (100), (110) and (111) surfaces of the single-crystal ferrite. For all Co-Cr layers, the $\Delta\theta_{50}$ was about 7 degrees which was almost same as that of the typical value deposited on the Permalloy film on glass substrate.

Conclusions

We found that, for the double-layered medium with a backlayer of low electric resistivity, the permeability of the backlayer decreases at high frequencies because of the eddy current in the backlayer. The eddy current that flows in in-plane of the backlayer cannot be suppressed by laminating these thinner backlayers. We conclude that the use of Ferrite substrate with high electric resistivity is the best solution to prevent eddy current and achieve excellent high frequency response in perpendicular magnetic recording using double-layered medium.

Reference

1. S. Yamamoto *et al.*: IEEE Trans. Magn., Vol.MAG-23, No.5, pp.2070-2012 (1987).
2. S. Yamamoto *et al.*: Journal of the Magnetics Society of Japan, Vol.15 Supplement, No.S2, pp.293-298 (1991).

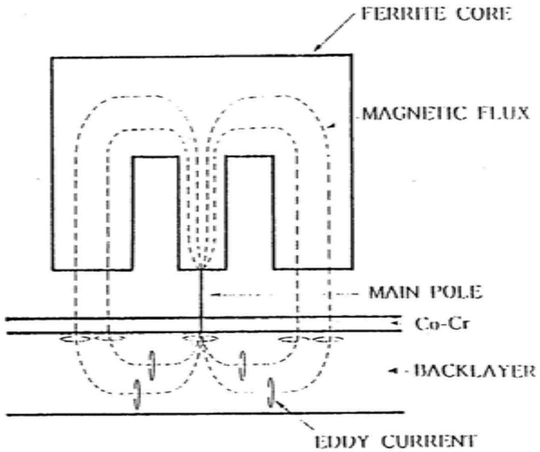

Fig. 1 Schematic illustration of magnetic flux line and eddy current and reproducing operation.

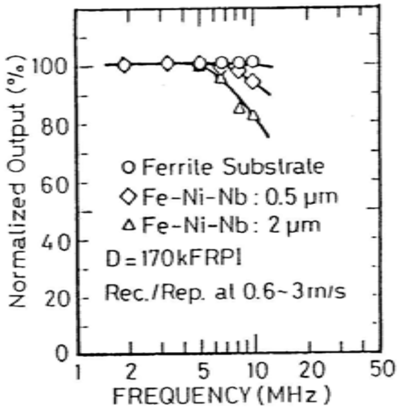

Fig. 2 Reproduced output versus frequency. Recording and reproducing was performed at 170kFRPI with varying head-medium speed from 0.6m/s to 3m/s. Reproduced output was normalized by velocity.