D-08

# Effect of semi-hard layer thickness on read/write characteristics of composite perpendicular media

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## 1. Introduction

In perpendicular magnetic recording (PMR), magnetic materials with ultra-high Ku such as ordered FePt alloys will be useful to extend linear recording density. However, the high writing field required to write this media will be a serious problem, since it is roughly proportional to Ku/Ms (Ms: saturation magnetization). A composite magnetic recording medium consisted of two exchange-coupled magnetic layers has been proposed as an approach to alleviate the writing field limitation of perpendicular magnetic recording heads.[1,2] Top hard magnetic layer is main recording layer and bottom semi-hard layer is magnetically soft but not conventional soft layer because the magnetic grains in the semi-hard layer are well magnetically decoupled. With a proper exchange coupling constant (Jex) between the recording and semi-hard layers , the semi-hard grains rotate first under the external field and at the same time this provides an exchange and magnetic static field to the hard grains so that effectively tilt their easy axis, which achieve a lower switching field. In this work, the effect of semi-hard layer thickness on read/write characteristics of composite perpendicular media was investigated.

## 2. Micromagnetic model

To understand and verify the enhanced recording characteristic of the composite perpendicular media, the magnetic dynamics of total recording system with single pole head, recording layer, semi-hard layer, and soft underlayer were examined by a 3-D micromagnetic model using unit cell size of 7nm×7nm×10nm. Fig. 1 shows a schematic diagram of the simulated composite perpendicular recording system. Bs, write track width and pole thickness of write head were 2.4 T, 70 nm, and 126 nm respectively. Head-medium velocity was 40 m/s. The maximum head field with the magnetic separation of 10 nm was about 8000 Oe at the recording layer center. The thickness of recording layer and soft underlayer were 10 nm and 80 nm, respectively. SNR was calculated by the reciprocity principle of a shielded magnetoresistive head.

## 3. Results and discussion

Through the writing process, two types of field gain from the bottom semi-hard layer were confirmed. One is magneto-static field from the early switched magnetization of the bottom layer and the other is the exchange coupling field. When Jex was +1 erg/cm$^2$, the media with maximum Ku of $3.4\times10^6$ erg/cm$^3$ of the recording layer was writable. Recordable conventional media showed maximun Ku of $2.8\times10^6$ erg/cm$^3$. It has confirmed that with a proper interlayer exchange coupling between the recording layer and semi-hard layer helps their magnetizations reversal in high Ku recording layer. The linear recording density is 907 kfci. Fig. 2 shows the Signal, Noise and SNR with different semi-hard layer thickness of 10 nm and 60 nm. SNR shows the maximum values at Jex of ~0.6 erg/cm$^2$ and SNR in the case of semi-hard layer thickness of 60 nm is larger than that of semi-hard layer thickness of 10 nm. The magnetization in a thicker layer will be reversal incoherently. This incoherency may cause noise in the thicker semi-hard layer to decrease.

## 4. Conclusion

SNR is linear with increasing semi-hard layer thickness. Therefore in the composite media, a thicker semi-hard layer is positive to a higher SNR.

## 5. Reference


[1] K. Z. Gao and N. Bertram, IEEE Trans. Magn. 38,3675 (2002)

[2] R. H. Victora and Xiao Shen, IEEE Trans. Magn. 41, 537(2005)


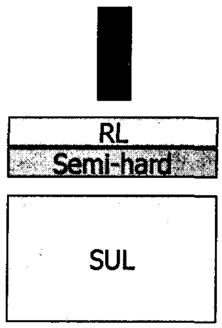


Fig. 1. Schematic diagram of recording system for composite perpendicular media.

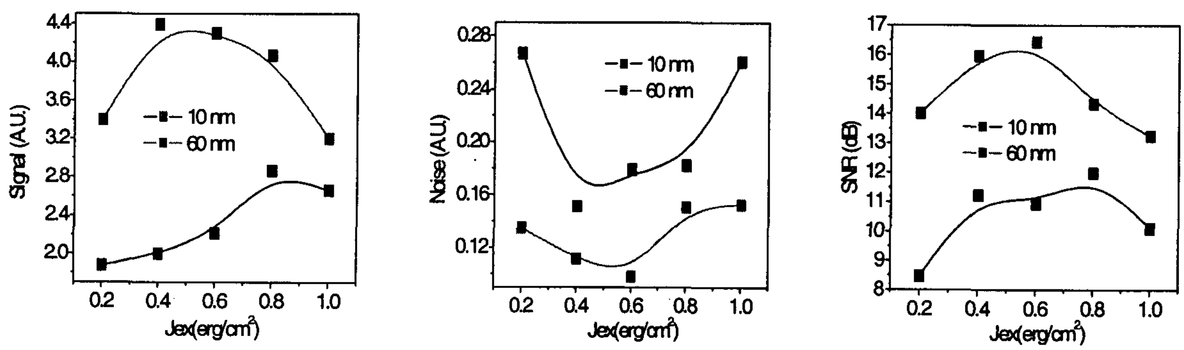


Fig. 2. Signal, noise, and SNR as function of interlayer exchange coupling between recording layer and semi-hard layer with different semi-hard layer thickness of 10 nm and 60 nm.