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Magnetic and Recording Performance of Perpendicular Magnetic Media with New Soft Underlayer Structure

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Typical perpendicular magnetic medium consists of a magnetic recording layer and a soft underlayer (SUL).From the view point of medium noise, various SUL structures such as exchange bias type [1], synthetic antiferromagnetic coupling type [2] *have been introduced to suppress the SUL induced medium noise. In this paper, we propose new type SUL structure, which* can aid to get the higher SNR and lower medium noise during reading process and efficiently record the information during writing process. The basic structure of PMR medium was glass/SUL/Ta/Ru/CoCrPt-SiO_2/carbon, and the total thickness of CoZrNb layers in SUL was set to 40 nm. In this work, the stacking sequence of CoZrNb/Ru/CoZrNb was denoted by conventional SAF and that of low H_k/spacer/high H_k, which was our proposed structure, was denoted by modified SAF. Process conditions of CoCrPt-SiO_2 recording layer and intermediate layer were kept constant and only the SUL structure was varied and the dependence of recording performance on the SUL structure was investigated. Fig. 1 shows the schematic configurations of modified SUL proposed in this work, which was designed by combining a single ferromagnetic layer, the bottom part of SUL, and a SAF structure, the upper part of SUL. The total thickness of CoZrNb layers was designed to be sufficiently thick to ensure the good OW (overwrite) performance. We could adjust the anisotropy field, H_k in SUL to achieve the optimum recoding performance by varying the thickness ratio of two parts which are separated by thin Ta layer. The corecivity and nucleation field of our typical recording layer are 4,200 Oe and 1,700 Oe, respectively. It was found that the magnetic properties of recording layer was not change by introducing the modified SAF SUL but we could obtain higher spiSNR and lower MWW by using the modified SAF SUL, compared with conventional SAF SUL, while maintaining the appropriate OW and ATE values.

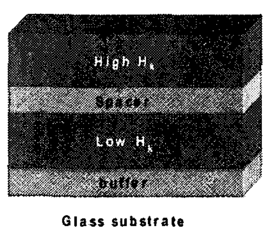

Fig. 1. *Schematic diagram of new concept SUL.*

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Study on Media Noise by In-field MFM Observation

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In order to understand the origin of the media noise and achieve high-density magnetic recording, it is essential to characterize the local magnetic property variation [1]. However, no detailed study has been addressed on revealing the relationship between media noise and local magnetization reversal field (H_R) fluctuation by direct MFM observation. In this work, we employed H_R-map method to study transition boundary zigzag noise and media noise by in-field MFM observation.

A CoPtCr-SiO_2 granular perpendicular medium with a 10 nm recording layer and 300 kfci recording signals was prepared. The sample was observed by MFM coupled to controllable perpendicular magnetic field of up to 10 kOe. All analytical and numerical calculations were carried out by MATHEMATICA®.

Fig.1 shows the H_R-map combined with bit transition boundaries and noise contour lines. The H_R-map was made as explained as reference [2]. The areas with different colours represent various H_R regions. The noise image was obtained by subtracting the ideal signal image from the recording pattern. The ideal signal image was calculated by fast Fourier transformation (FFT) for selected image data and reconstructed by an inverse FFT. It can be found that the high noise areas almost locate on low H_R area, which means that media noise prefers to appear in low H_R area. The optimal transition bit boundary should be perpendicular to recording track direction. But in experimental case, the transitions display a skew curve, which can cast the projected lines along down track direction. These projected lines (L_p) indicate disfigurement of transition and come from transition noise. If we calculated the total L_p and areal length in different H_R area, we could quantify the disfigurements for different H_R area. Fig. 2 shows the relationship between H_R and disfigurement of transition. It can be found that the disfigurements tend to present in lower H_R, and gradually reduce with increasing reversal fields.

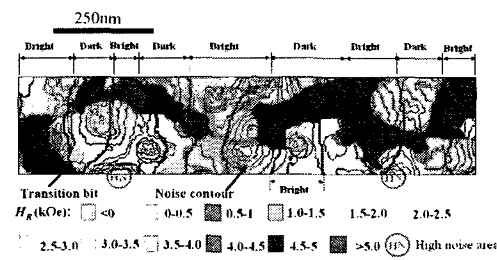

Fig. 1. H_R -map combined with medium noise. "Bright" or "dark" means MFM contrast corresponding to either up or down.

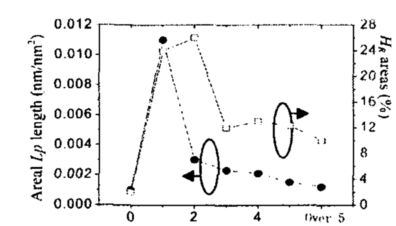

Fig. 2. The relationship between H_R and disfigurements of transition.

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