EFFECT OF SPIN TORQUE OSCILLATOR ANGLE IN MICROWAVE ASSISTED MAGNETIC RECORDING

Simon GREAVES[1], and Yasushi KANAI[2]

1) RIEC, Tohoku University, Sendai, Japan, simon@riec.tohoku.ac.jp

2) IEE, Niigata Institute of Technology, Kashiwazaki, Japan, kanai@iee.niit.ac.jp

I. INTRODUCTION

Microwave-assisted magnetic recording MAMR may be able to increase the areal density of hard disk drives [1]. One difficulty in realising a functional MAMR system is obtaining stable oscillation of the spin torque oscillator (STO) that sits in the gap between the main pole and the trailing shield of the write head. In recent work it has been shown that inclining the STO towards the trailing shield results in more uniform and regular oscillation of the magnetisation in the field generating layer (FGL) of the STO [2]. In this work we examine the effect of tilting the STO on recording performance to determine the effect of tilting the STO on the signal to noise ratio (SNR) and other parameters.

II. RESULTS

Fig. 1 shows a schematic of a write head with the STO tilted towards the trailing shield, with a negative tilt angle, θ, indicating the STO is tilted towards the trailing shield. In the simulations the STO was approximated by a uniformly magnetised FGL in which the magnetisation rotated at a constant angular velocity. Fig. 2 shows the effect of tilting the STO on the down-track (H_y) and vertical (H_z) high frequency (HF) field components. The fields were measured in the centre of the recording layer, 11 nm from the air bearing surface (ABS) of the write head; the FGL magnetisation was along the *z* (vertical) axis before the STO was tilted. The STO was rotated about the centre of the FGL. The height of the STO was then adjusted such that the lowest edge of the FGL remained aligned with the ABS of the write head, as indicated in fig. 2.

A finite element model (FEM) was used to calculate the head field distribution for a write head in which the leading edge surface of the trailing shield was inclined at an angle of -40°. The modelled structure was: head ABS / 5 nm magnetic spacing / 12 nm recording layer / 1 nm interlayer / soft magnetic underlayer. To better understand the influence of an inclined STO on recording performance the somewhat noisy FEM head field distribution was first approximated by an analytical model based on the FEM head field in the centre of the recording layer. The analytical head field had a constant vertical head field gradient of 400 Oe/nm behind the trailing edge of the main pole and a down-track head field gradient of 125 Oe/nm.

Tracks were written using the analytical head field and the field from a 30 nm wide, 10 nm thick, 30 nm tall FGL with M_s of 1591 emu/cm^3. The recording medium had a 4 nm thick hard layer and a 8 nm thick soft layer. The medium M_s was 750 emu/cm^3, the soft layer K_u was 3×10^6 erg/cm^3 and the hard layer K_u was varied. Fig. 3 shows the resulting SNR for tracks with a 30 nm bit length (847 kfci) written with and without the STO. The benefits of using MAMR were clear once the hard layer K_u exceeded 9×10^6 erg/cm^3. The effect of tilting the STO was more nuanced, but when the STO was tilted at an angle of -40° the SNR was higher, or equal to, that of the non-tilted STO.

Simon Greaves
RIEC, Tohoku University,
Katahira 2-1-1, Aoba ku,
Sendai, 980-8577
E-mail: simon@riec.tohoku.ac.jp
Tel: +81-22-217-5458

One reason for the higher SNR when using the tilted STO was reduced transition jitter. Fig. 4 shows transition jitter as a function of hard layer K_u and an inverse correlation with the SNR was observed. Tilting the STO had the effect of reducing transition jitter, although the reason for this is not yet clear.

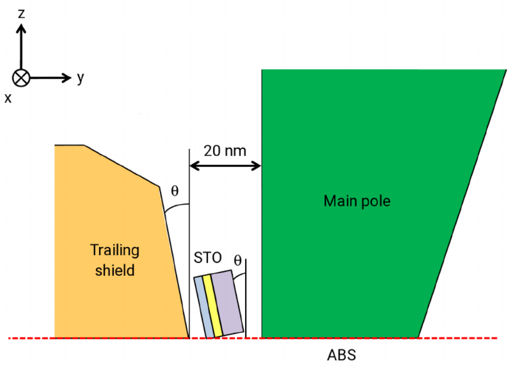

Fig. 1 Inclined STO in a trailing shield gap. Negative angles of θ denote an inclination towards the trailing shield.

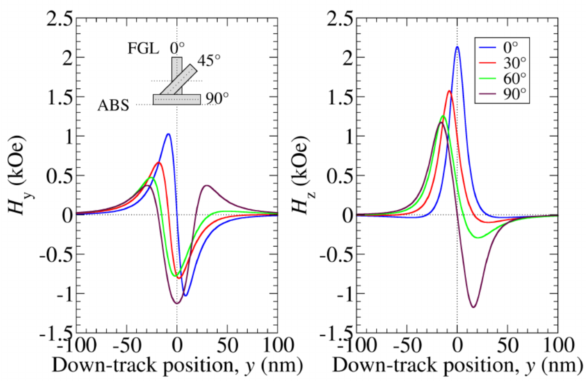

Fig. 2 HF fields in the centre of the recording layer as a function of STO angle.

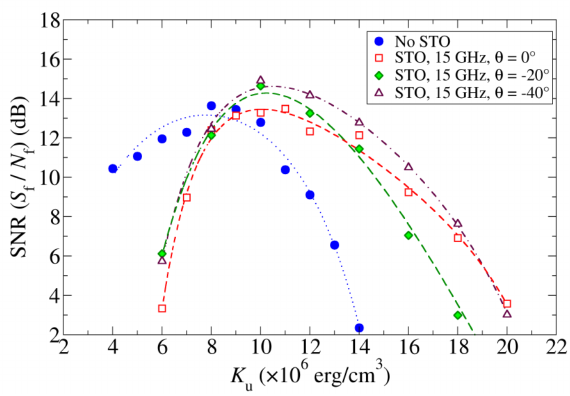

Fig. 3 SNR vs. hard layer K_u for tracks written without an STO and with an STO inclined at various angles. 847 kfci.

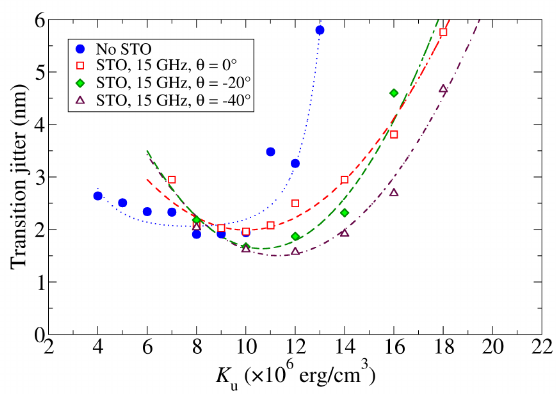

Fig. 4 Transition jitter for tracks written with and without a STO as a function of hard layer K_u.

REFERENCES

[1] J. G. Zhu and Y. Wang, IEEE Trans. Magn. 46, p751, (2010).
[2] Y. Kanai, K. Yoshida, S. Greaves and H. Muraoka, IEEE Trans. Magn. 53(2), 3000211, (2017).