スピントルク発振器を用いた媒体層の磁化反転磁場の減少

Switching-field reduction of the media layer by using a spin torque oscillators

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Microwave-assisted magnetic recording (MAMR) is expected to be one of the prospective recording technologies for the recording density > 1 Tbit/inch^2. Recent simulation predicted that the switching field for recording is effectively reduced using a circularly-polarized- (CP-) high-frequency (HF) field [1]. In our previous study [2], we prepared spin-torque oscillators (STOs) with an in-plane magnetized free layer and a perpendicularly magnetized reference layer, which can generate CP-HF fields from the STO [3]. We actually confirmed two properties; i) the excitation of out-of-plane (OP) precession of the free layer in the STO and ii) the change of the precession axis depending on the bias voltage (V_B) polarity. Both characteristics are indispensable to generate chirality-controlled CP-HF fields. In this study, we combined a media layer (ML) with perpendicular magnetic anisotropy and an STO to demonstrate MAMR. We studied the effect of the HF field from the STO on the switching field of the ML.

A ML consisting of [Co (0.2)/Pt (0.2)]$_3$ /Co (1.4)/[Pt (0.2)/Co (0.2)]$_3$ (in nanometers) was fabricated on top of an STO with a stacking structure similar to our previous report [3]. The STO was separated from the ML by a 20-nm-thick non-magnetic layer. We measured the device resistance and the emission power spectra sequentially. The spectra confirmed that OP precession of the free layer is excited at $V_B \leq$ -100 mV. The positive current is defined as electron flowing from the top to the bottom layer. Figure 1 shows the magnetoresistance curves of the device with a diameter of 200 nm measured at V_B of -50 mV and -300 mV. OP fields were swept from the negative to the positive direction. At -50 mV, the small resistance change appeared at ~1.7 kOe (indicated by dotted arrows), which corresponds to the magnetization switching of the ML (shown in the inset). When V_B = -300 mV, the switching field was reduced to ~1.0 kOe. By considering the fact that OP precession is excited at $V_B \leq$ -100 mV, and that the rotation direction of the free layer magnetization coincides with that of the ML in this measurement condition, the switching field reduction is possibly related to the magnetization dynamics excited in the free layer. We will discuss the relationship between the switching field reduction and the free layer magnetization dynamics..

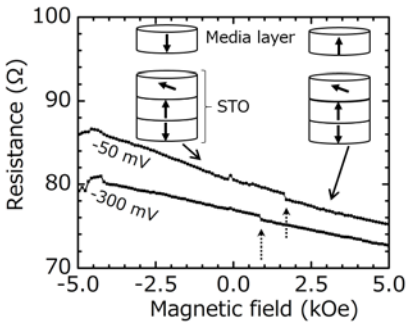

Fig. 1. Magnetoresistance curves of the STO at V_B of -50 mV and -300 mV. Dotted arrows show the switching field of the ML. Inset shows the magnetization configuration of the STO and the ML.

[1] J.-G. Zhu and Y. Wang, IEEE Trans Magn. **46**, 751 (2010). [2] R. Hiramatsu *et al.*, Appl. Phys. Express **9**, 053006 (2016). [3] H. Suto *et al.*, J. Appl. Phys. **112**, 083907 (2012)