Novel TAMR Head Using Focusing Waveguide

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1 Introduction

We propose a practical optical system using a focusing waveguide for thermally assisted magnetic recording (TAMR). TAMR is known as an effective recording method beyond the recording density of 1Tbit/inch^2 overcoming the heat fluctuation problem.[1] The optics which focus the laser light on a plasmon head for thermal assistance should be smaller than 1 mm in height to be integrated into a flying slider between the platters of HDD. The beam spot diameter should be less than 0.5 μm considering the optical efficiency of the plasmon head and total power consumption. Though various optics have been reported so far[2~3], our proposal is most practical.

2 Optical setup for TAMR with the focusing waveguide

Schematic illustration of the proposed optics is described in **Fig.1**. Light irradiated from the optical fiber is bent at the prism and goes into the focusing waveguide which is integrated into a flying slider. The diameter of the light spot is about 5 μm at the top surface of the waveguide. It is reduced to about 0.5 μm while the light propagates 200 μm in the focusing region of the waveguide[4]. Then the light illuminates the plasmon head mounted on the bottom surface of the waveguide. The plasmon head generates evanescent light of 20 nm in diameter which is used for a light source of TAMR.

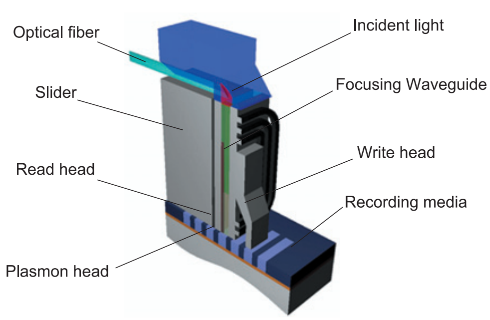

Fig.1 The TAMR optics

The focusing waveguide consists of three parts as shown in **Fig.2**. Namely, the first core made of silicon, the second core made of SiOx, and the clad made of SiO_2. The first core has a tapered shape, whose cross-section is 400 nm × 220 nm at the bottom and 80 nm × 220 nm at the middle of the waveguide. The cross section of the second core was 3 μm×3 μm. The mode field diameter (MFD) of the light in the second core was estimated to be 5 μm. The second core was covered with the clad layer of over 5 μm in thickness. The incident light first coupled with the second core is coupled gradually with the first core and MFD of the light becomes smaller while the light goes through the tapered region. The MFD is smaller than 0.5 μm at the bottom of the first core, because the light is confined strongly due to the large refractive index difference.

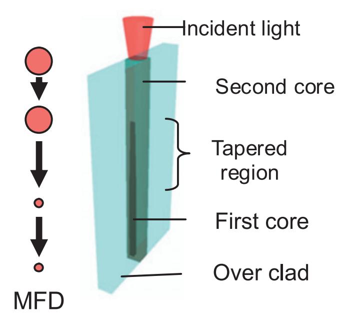

Fig.2 Schematic layout of the focusing waveguide

3 Evaluation of optical spot focused by the waveguide

The focusing waveguide was fabricated by silicon on insulator based process and assembled with an optical fiber precisely. Then a light of 1310 nm in wavelength propagated through the fiber and entered into the

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Focusing Waveguide. The MFD of the light at the bottom surface of the focusing waveguide was measured using the scanning near-field optical microscope (SNOM). The spot size was less than 0.5 μm, while the MFD at the top surface was about 5 μm. Schematic layout of the measurement system and the observed light spot are shown in **Fig.3**.

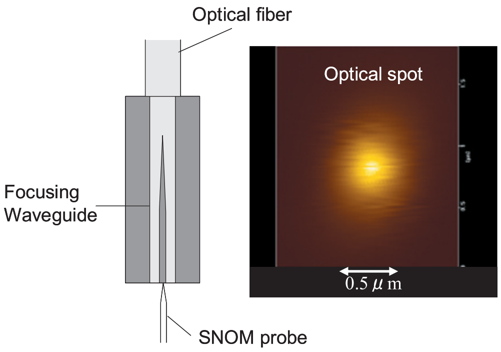

Fig.3 The measurement system for the focusing properties and observed spot.

4 Plasmon enhancements at wavelength of 1310 nm

It is required to use the light of 1310 nm in wavelength for this optics, because the core of the Focusing Waveguide is made of silicon. We confirmed that the plasmon enhancement occurs at the apex of the triangular plasmon head as shown in **Fig.4** using a finite difference time domain (FDTD) simulation

An experiment to observe the plasmon enhancement was conducted as shown in **Fig.5**. The plasmon enhancement was successfully observed. We also found that the location of the enhanced lights depends on the polarization of illuminated light as shown by the white arrows in the figure.

5 Conclusion

We have proposed novel optics using the Focusing Waveguide for TAMR. The focusing property of the waveguide and the plasmon enhancement have been confirmed successfully by the SNOM measurements. Therefore, it is expected that our focusing optics is one of the most effective solutions of thermally assisted magnetic recording.

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References

1) H.Saga, H. Nemoto, H. Sukeda, M. Takahashi: Jpn. J. Appl. Phys. 38 (1999) 1839.
2) B. R. Knight, A. V. Itagi, C. Mihalcea, K. Pelhos, T. E. Schlesinger: J. Magn. Soc. Jpn. 30 (2006) 637.
3) N. Nishida et.al.: ODF'06, Technical Digest, (2006)317.
4) T. Tsuchizawa, K. Yamada, H. Fukuda, T. Watanabe, J. Takahashi, M. Takahashi, T. Shoji, E. Tamechika, S. Itabashi, and H. Morita: IEEE J. Sel. Top. Quantum Electron. 11 (2005) 232

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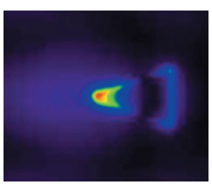

Fig.4 The simulation result of the Plasmon enhancement

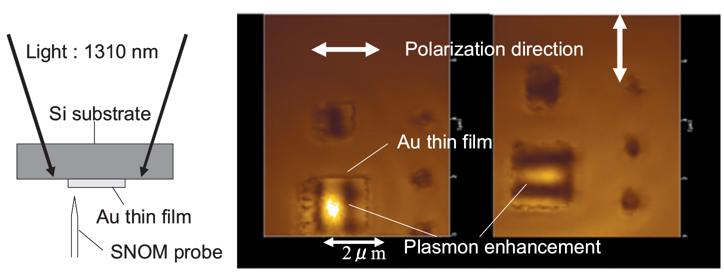

Fig.5 The measurement system for the plasmon enhancements and observed near field light