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Development of Microwave-assisted Magnetic Recording for Next-generation Super High-density HDD

Rewriting of Magnetic Information Using a Magnetic Head-mountable Spin Torque Oscillator Verified

NEDO and Hitachi, Ltd., in cooperation with Hitachi Global Storage Technologies, Ltd., have jointly developed basic technologies for microwave magnetic recording which are expected to dramatically expand the recording density of HDD and validate magnetic recording experimentally.

In microwave-assisted magnetic recording, a high-frequency magnetic field is applied to a microscopic region of a recording media in order to make the writing of magnetic information easy. NEDO and Hitachi, Ltd. today announced the development of a **magnetic head-mountable spin torque oscillator** which can generate a high-frequency magnetic field. During testing of the new spin torque oscillator device, data writing of magnetic information onto recording media has been validated experimentally.

There have been several published reports related to the effects of microwave assist using an external microwave generator. The **verification of magnetic data rewriting using a magnetic head-mountable tiny oscillator** at this time indicates that practical use of microwave-assisted recording can be expected in the near future.

This research was carried out as part of NEDO's Development of Nanobit Technology for Ultra-high Density Magnetic Recording (Green IT Project) project.

Details regarding the results of NEDO's research will be presented at the 55th Annual Conference on Magnetism and Magnetic Materials (55th MMM Conference) to be held in Atlanta, Georgia on November 14-18, 2010.

Note: Spin torque is a current flow in a laminated medium composed of magnetic/nonmagnetic/magnetic materials that cause torque which tends to change the direction of magnetization by means of the spin flow of magnetic materials.

1. Background

Hard disk drives (HDD) have become a crucial component for an information society as a high-capacity storage device used in large-scale database systems, personal computers, hard disc recorders and digital recording equipment for consumers. Given the growing amount of information stored by data centers, power consumption has become an issue that needs to be addressed. For this reason, technology to increase the density and capacity of HDD has received much attention as a means of developing energy-saving IT equipment and realizing an environment-friendly society.

In recent years, the development of microwave-assisted recording which utilizes a recording density of 1 Tbit/inch² or more is advancing as a next-generation perpendicular magnetic recording technology. Microwave-assisted recording is a magnetic recording system which uses the magnetic resonant effect to ease the local reversal of recording media magnetization.

Until recently, the principles and effects of microwave-assisted recording were demonstrated only through computer simulation, although there have been some reports that verified the reversal of magnetization of magnetic materials by applying a microwave generated from external equipment. However, in order for this to become practical, the microwave device must be miniaturized so that it can be integrated on the writing head.

2. Technical contents

During NEDO's project, Hitachi, Ltd. developed a spin torque oscillator capable of generating a high frequency magnetic field with a sufficient amount of power to reverse the magnetization of media. Using this device together with perpendicular magnetic recording media, magnetization reversal was verified.

(1) Spin torque oscillation device for generating a high-frequency field

An electric current flow across a magnetic multilayer composed of a free magnetic layer and fixed magnetization direction layers results in a polarized electronic spin flow from the fixed layer to the free layer. Under suitable conditions, the magnetization of the free layer turns simultaneously due to the generated torque from the spin flow. This phenomenon is called spin torque oscillation, which is when the high frequency magnetic field for assisted recording is emitted from the free layer. High frequency oscillation in the 10 GHz range was confirmed using the developed spin torque oscillator.

(2) Oscillation device and experimental verification of assist effect with recording media

In microwave-assisted recording, a weak magnetic field can reverse the magnetization of recording media by means of the assistive effects of a high frequency magnetic field. Using a combination of the developed spin torque oscillator and perpendicular magnetic recording media, it was confirmed that magnetization inversion of the recording media occurred just under the oscillator. The confirmation was performed using the spin torque oscillation device close to the recording media while applying a weak magnet field to the recording media without magnetization inversion.

The research results show that microwave-assisted recording is a feasible technology both in principle as well as experimentally. In addition, by using microwave-assisted recording, it was confirmed through computer simulation that a recording density of 3 Tbits/inch² is feasible. Details regarding NEDO's results will be presented at the 55th Annual Conference on Magnetism and Magnetic Materials (55th MMM Conference) to be held in Atlanta, Georgia on November 14-18, 2010.

Note 1: The change in direction of magnetization can be compared to a spinning top. The magnetization is the rotational motion having a tilted axis, which is called precession movement. If the frequency of an external electromagnetic or oscillating field corresponds to that of the rotational motion, the precession motion is amplified and the angle of the rotation axis tilts more and more. As a result, the magnetic resonant effect is a kind of resonant phenomenon of magnetization for a specific frequency.

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