Series: New Recording Technologies for Broadcasting

Thermally Assisted Magnetic Recording

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In order to realize a compact Super Hi-Vision (SHV) storage system, it will be required a dramatic improvement in recording density of hard disk drives. This article introduces thermally assisted magnetic recording technology, which is expected to be allied in the next generation of ultrahigh-density magnetic recording technology.

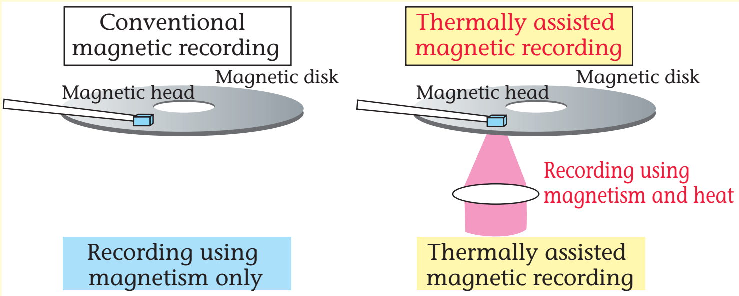

Figure 1: Thermally assisted magnetic recording principle

Issues Affecting Ultrahigh-density Magnetic Recording

As shown on the left side of Figure 1, a hard disk drive records data by using a magnetic head to magnetize the magnetic grains on the disk. Although higher recording density can be achieved by reducing the magnetic grain size, it also causes an increase in thermal fluctuations because of the thermal stability decreases with the magnetic grain size. To maintain sufficient thermal stability, it is necessary to increase the magnetic energy in a magnetic grain. However, a large magnetic energy increases the coercivity of the recording medium (making magnetic reversal difficult), leading to lower data writing performance. In particular, ultrahigh-density recording at 1 terabit per square inch, as required for recording SHV programs, obtaining a sufficiently high recording field to write on the medium is expected to be difficult, because the coercivity becomes much larger than the maximum write-head field. This causes problems, such as an inability to record using an ordinary magnetic head.

Thermally assisted magnetic recording

One possible method to overcome this problem is the thermally assisted magnetic recording (TAMR). As illustrated on the right side of Figure 1, in TAMR, the disk area where the magnetic head is recording data is instantaneously heated. Since a higher temperature lowers the coercivity of a magnetic recording layer, momentary laser heating makes recording data feasible on a disk that has a high coercivity at room temperature. This technology can facilitate both reduced magnetic grain size and stable recording, opening the way for ultra-high density recording.

Research Results

At present, advances are being made on verifying the TAMR effectiveness using granular perpendicular media. Figure 2 compares the reproduction waveforms from a recording using just a magnetic head and from TAMR on a high-coercivity disk. The small amount of reproduction data shows that no recording occurred when just the magnetic head was used. In contrast, the TAMR yielded adequate recording capability. These results will be used to improve the recording scheme and in disk development.

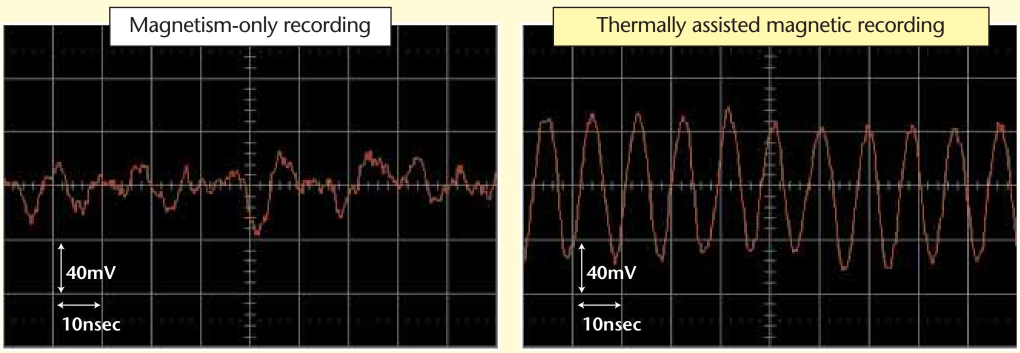

Figure 2: Comparison of reproduction waveforms from recordings on a high-coercivity disk.

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Holographic Recording

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Optical disks, such as Blu-Ray, are popular removable recording media. However, an optical disk for the Super Hi-Vision (SHV) system will require 100 times the recording capacity and data-transfer-rate of today's Blu-Ray disks. We are working on a holographic recording technology that is capable of three-dimensional volume recording as a way of storing SHV programs conveniently.

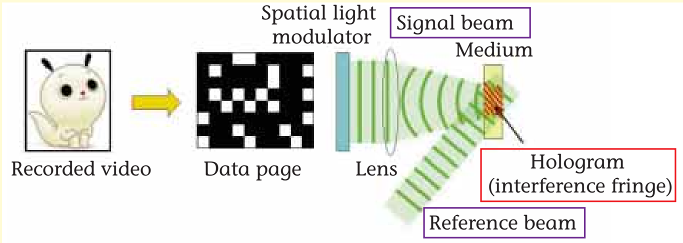
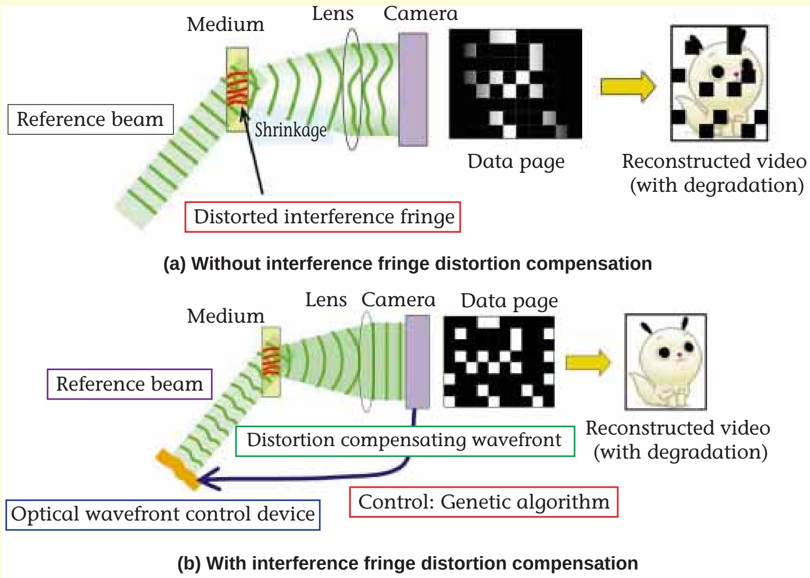


Figure 1: Data recording using holographic recording

Principle and problems for holographic recording

Holographic recording and reproduction employs data page in which black and white bits in the medium correspond to the "0" and "1" values of a digital signal (Figure 1). During recording, the data pages are displayed on a spatial light modulator to produce a signal beam with a white/black order identical to the data page. The simultaneous radiation of this signal beam and a reference beam onto a recording medium records interference fringes (a hologram) caused by the two beams interfering constructively and destructively. Data pages are reproduced by radiating only the reference beam on the recording medium from the same angle used during the recording and by capturing the reflected beam with a camera. The reference beam radiation angle can be adjusted during recording and reproduction to enable multiple sets of data page to be multiplexed at the same recording medium location, resulting in a dramatic increase in capacity (from several tens to hundred times) compared with conventional optical disks. The ability to handle data page might also enable much higher data transfer rates. The incorporation of a photopolymer in the recording medium also increases the potential for high-density multiplexed recording and the archivability of the recorded data. One related problem is the slight shrinkage of the recorded medium due to the photopolymer's response that distorts the recorded interference fringes. Distorted interference fringes degrade the reproduced data page (Figure 2 (a)).



(a) Without interference fringe distortion compensation

(b) With interference fringe distortion compensation

Figure 2: Data reproduction from hologram

Interference fringe distortion compensation using wavefront control technology

An optical wavefront control technique was devised to reduce the degradation of the reproduced data. This technique employs a device that controls the irradiating reference beam wavefront in such a way that it compensates for the interference fringe distortion. We recently developed a new control technique using the genetic algorithm that simulates the way living creatures evolve to adapt to environments. The technique significantly reduces degradation in the reproduced data due to the medium shrinkage (Figure 2 (b)).

We will continue to increase the recording density attainable with this technology, with the goal of realizing a holographic recording system with a large capacity and a high data-transfer-rate.