

FOR IMMEDIATE RELEASE

Successful verification of the principle of a “phase multi-level read/write method” for doubling the data capacity of optical discs

Tokyo, Japan, 20th July 2011 – Hitachi, Ltd. (NYSE: HIT/TSE: 6501, hereafter, Hitachi) today announced the proposal for a “phase multi-level read/write method,” which significantly increases the data capacity of optical discs for archiving video and music, and the successful verification of the principle of the proposed method, which reads/writes data using four phase^{*1} levels, thereby doubling data capacity of optical discs. With this method, a micro interference pattern (a “micro hologram”) obtained from interference^{*2} of two light waves is used as a recording mark and multi-level^{*3} read/write is performed by forming a recording mark in the depth direction of an optical disc. In this way, it is possible more than triple data capacity compared to current optical discs, such Blu-ray DiscTM; namely, multi-level recording with eight or more phase levels becomes possible. It is expected that this method will significantly improve capacity of optical discs.

As optical discs are suited for long-term data storage and have high reliability, they are commonly used to archive video and music. For this reason, there is a large need to further increase optical disc capacity and data-transfer rate, and worldwide research to this aim has been ongoing. Optical discs are media which record and read data by forming marks or pits in the recording layer, the absence or presence corresponding to a 0 or 1 data, namely 1 bit. One promising method of dramatically increasing the data capacity of optical discs is multi-level recording whereby marks are formed in a multi-level recording layer using four phase levels (2 bit) or eight phase levels (3 bit) to double or triple capacity.

In response to this need, Hitachi has developed a phase multi-level read/write method which achieves multi-level recording using the phase levels of light (wave) to form a recording mark. The method developed can read/write recording marks under four phase levels (namely, twice data capacity of current optical discs). Details of the method are described below.

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(1) Phase multi-level read/write method

Recording marks are formed in the optical disc recording layer using a micro interference pattern (micro hologram) obtained from the interference of two light waves. By controlling the phase of the light waves, multi-level recording is possible by forming a recording mark in the depth direction of the optical disc. Further, recording marks recorded in the depth direction of the optical disc are reproduced by using homodyne detection technology,^{*4} which amplifies the detection signals by using the coherency of light.

(2) Verification of recording and reproducing data using four phase levels

In this experiment, the light path of the signal light was varied by moving a piezoelectric element at intervals of 20 nanometers to record data at four phase levels (0, 90, 180, 270 degrees) in a recording medium containing lithium niobate. Using homodyne detection technology to read these for data points, it was confirmed that the four signal levels could be distinguished and reproduced.

As this principle can be expanded to 8, 16, and 32 phase levels, it is expected that the proposed method will significantly increase the capacity of optical discs. Further, through multi-leveling, the amount of information recorded per layer (areal density) is increased, contributing to data-transfer rate improvement.

Further work for the practical application of phase multi-level read/write technology will be conducted through verification experiments using a compact phase multi-level read module embedded in read/write equipment.

These results will be presented at the Joint International Symposium on Optical Memory & Optical Data Storage Topical Meeting (ISOM/ODS2011) which will be held from 11th to 20th July 2011 in Hawaii, USA.

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Notes

- *1. Phase: Time delay in a wave cycle, represented as an angle.
- *2. Coherency of light: Light is a form of electromagnetic wave, and thus has wave properties. When two waves overlap, if the time delay of the wave (phase) is the same, the waves strengthen each other's intensity; if the phase is opposite, the waves diminish each other. This phenomenon is known as light

interference, and the striped patterns obtained from the interference are referred to as the interference patterns.

- *3. Multi-level recording: Method to record multi-bit information in a single recording mark. Since digital data is binary data, the data capacity of optical discs can be increased two, three, four, or five times by using $4(2^2)$, $8(2^3)$, $16(2^4)$, or $32(2^5)$ levels.
- *4. Homodyne detection technology: Technology to detect light waves by causing interference between a reference beam (which includes information represented by light intensity and a phase) and a signal beam. It can detect a weak signal beam and phase signal which cannot be easily detected by conventional technology.
- *5. Piezoelectric element: An element which uses voltage to control a micro position.
- *6. Light path: An optical path. It represents a multiplication of an actual distance and a refractive index. The phase can also be varied by varying a light path.

About Hitachi, Ltd.

Hitachi, Ltd., (NYSE: HIT / TSE: 6501), headquartered in Tokyo, Japan, is a leading global electronics company with approximately 360,000 employees worldwide. Fiscal 2010 (ended March 31, 2011) consolidated revenues totaled 9,315 billion yen (\$112.2 billion). Hitachi will focus more than ever on the Social Innovation Business, which includes information and telecommunication systems, power systems, environmental, industrial and transportation systems, and social and urban systems, as well as the sophisticated materials and key devices that support them. For more information on Hitachi, please visit the company's website at <http://www.hitachi.com>.

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