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Special Reports
Magnetic and Optical Storage Technologies

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***Magnetic and Optical Storage Technologies for Information Technology and Audiovisual Equipment**
HASHIMOTO Yasuichi

***Current Development Status and Future Prospects of Magnetic Recording and Optical Disc Technologies**
TANAKA Yoichiro NAKAMURA Naomasa WATABE Kazuo

Hard disk drives (HDDs) have been showing a 100% annual growth rate in areal recording density, and their applications are rapidly expanding from the conventional personal computer field to new home information technology equipment, mobile audiovisual equipment, and automotive equipment. With regard to optical disc drives (ODDs), digital versatile disc (DVD), which was standardized at the initiative of Toshiba, has received wide recognition for both PC and consumer electronics use. At present, next-generation optical discs are beginning to attract attention.

This paper presents the state-of-the-art HDD and optical storage technologies and their future prospects.

***MK6021GAS 2.5-inch Hard Disk Drive**
YAMAMOTO Kotaro OHTSUBO Yasuo

Toshiba has developed the MK6021GAS 2.5-inch hard disk drive (HDD) with a capacity of 60 Gbytes, which holds two media in a height of 9.5 mm. In order to increase areal density, we developed chip on carriage (COC) technology, a high-sensitivity giant magnetoresistive (GMR) head, and low-noise media. With improvement of the head positioning accuracy achieved by a fluid dynamic bearing spindle motor (SPM) and a new servo technology, an areal density of 75.5 Mbits/mm^2 (48.8 Gbits/in^2) was attained. An improvement in operational shock resistance using a new type of suspension and lower acoustic noise during idling and seeking were also realized. A halogen-free printed circuit board (PCB) with lead-free solder was applied to the MK6021GAS, taking the global environment into consideration.

***MK2003GAH/MK1003GAL 1.8-inch Hard Disk Drives**
TOKURA Kimihide KUSUMOTO Tatsuharu

Toshiba has developed two 1.8-inch hard disk drives (HDDs): the MK2003GAH (20 Gbytes capacity), which holds two media in an 8.0 mm-high body, and the MK1003GAL (10 Gbytes capacity), which holds one medium in a thin 5.0 mm-high body. In order to realize the smallest body possible, we developed a thin, low-inertia spindle motor (SPM) and voice coil motor (VCM). A low-profile IC package and ball grid array (BGA) employed to reduce the mounting surface of the printed circuit board (PCB) enabled miniaturization of the MK1003GAL to 32% the size of a 2.5-inch HDD. For application to mobile devices, lower power consumption, a non-operating shock of 9,800 m/s^2, and an operating shock of 1,960 m/s^2 were also realized in this series.

***Mechanical Technologies for Small-Form-Factor HDDs**
ITOH Jun YANAGIHARA Shigeki

In recent years, hard disk drive (HDD) recording density has been growing by 100% annually and new HDD markets such as automotive and audiovisual applications have been rapidly emerging. Compared to the rapid growth in HDD performance and markets, the mechanism of HDDs does not seem to have significantly changed. However, mechanical technologies for HDDs are also being greatly improved by various approaches.

In this paper, we describe recent new topics in HDD mechanical technologies such as the ramp loading system and the fluid bearing spindle motor, both of which are essential innovations, and the improvement of vibration characteristics by simulation employing CAE design optimization. These technologies have been used to further enhance the performance and reliability of Toshiba HDDs.

***New Technologies for Small-Form-Factor HDDs for Emerging Markets**
SUZUKI Hiroshi ARAKAWA Yutaka TAKAMI Hiromichi

New applications for 2.5-inch hard disk drives (HDDs) are emerging in the automotive, audiovisual, and LCD desktop PC/server/RAID markets. As one of the leading suppliers of 2.5-inch HDDs, Toshiba has been making extensive R&D efforts to realize the echnologies needed in these new applications.

For automotive applications, we have developed technologies that can significantly expand the operating temperature range, prevent dew formation inside the HDD, and enable HDD operation under the high level of vibration in a running car. For audiovisual applications, real-time data handling capability and its failure recovery mechanism have been developed. For high-performance applications, high-speed rotation and high-speed seek have been realized without a significant increase in acoustic noise and vibration.

***SD-R2102 Second-Generation Slim-COMBO Drive**
SATA Tsuneyasu YOSHIDA Takaharu NAKAMURA Yuuichi

Toshiba has designed the SD-R2102 second-generation Slim-COMBO drive, featuring 8x CD-Recordable/Rewritable (CD-R/RW) writing speed and a buffer underrun error prevention function against data interruption. We have achieved the top market share by launching this drive at an early stage.

***SD-R5002 Half-Height Type DVD-RW/CD-RW Drive**
WATANABE Hiroshi

Toshiba has developed the SD-R5002 DVD-writable/CD-writable (DVD-RW/CD-RW) drive. This drive has 2x DVD and 16x CD recording capability, and 12x DVD and 40x CD reading capability. Users can easily make original moving picture DVDs, music CDs, and large-capacity data media using their normal PC with video authoring software and writing software.

***Mechanical Technology for Optical Disc Drive Design**
YAMAUCHI Akira

The market for optical disc drives has been growing in recent years in line with the expansion of the PC market, and further evolution of the mechanical technology for such drives is required. In response to this situation, Toshiba has developed the variety reduction program (VRP) mechanism. This mechanism employs common parts including the optical pickup head, motor, and other parts, and features high performance, high reliability, low vibration, low noise, light weight, and simplicity. We are manufacturing mechanisms for Half-Height drives and Slim drives for desktop PCs and notebook PCs.

***TPU3510 7.3 mmH Optical Pickup for DVD and CD Recording**
UCHIYAMA Mineharu SHINOZUKA Hiroshi

Toshiba has developed the TPU3510 7.3 mm-high optical pickup for DVD and CD recording, which is suitable for use in notebook computers. Applying an 80 mW pulse high-power red laser, an objective lens of numerical aperture 0.63, and a one-beam compensational push-pull method, a laser beam of more than 17 mW is obtained from the objective lens for DVD recording. The distance between the two laser diodes and the laser driver is short enough to obtain the appropriate recording pulse beam. The actuator has a tilt moving mechanism to control recording error caused by disc tilting. The TPU3510 has 2x DVD and 16x CD recording capability, as well as reading capability for all DVD and CD formats.

Feature Articles

***1 kW-Class Fuel Cell System for Residential Use**
ARAI Yasuhiro HIGAKI Shigetoshi KANEKO Takayuki

Since the polymer electrolyte fuel cell (PEFC) can be operated with higher power density at lower temperature in comparison with other types of fuel cells, it is expected to be widely applicable to various markets including automobiles and both stationary and mobile power sources. In particular, combined heat and power (CHP) application for residential use is one of the optimal applications.

At Toshiba International Fuel Cells Corporation (TIFC), several 1 kW-class residential CHP systems have been developed and evaluated. An advanced model developed in FY2001 had achieved a significant improvement in power efficiency while reducing the system volume by half.

***Rear Surveillance System for Japan Highway Public Corporation**
HAYASHI Takeshi SEKIGUCHI Shingo ONOGUCHI Kazunori

Maintenance work on highways is carried out using special types of maintenance vehicles. Although these vehicles are equipped with signboards to warn following traffic, accidents do occur due to rear-end collisions.

P-MAC (Protection system of Maintenance vehicle Against Collision) is a rear surveillance system that is being developed by the Japan Highway Public Corporation. The purpose of P-MAC is to prevent any such traffic accidents as an additional measure to the large bumper and LED signboard that are presently employed. P-MAC consists of two CCD cameras and a millimeter-wave radar as a sensor. While these two devices have different features, the output data are integrated so that the advantages of each device can serve for practical detection of danger.

This paper mainly describes the part of the P-MAC system developed by Toshiba.

***Cluster System for High-Speed Database Takeover**
IINUMA Tetsuya TANAKA Satoshi

In order to cut down the takeover time in Oracle database systems, we have developed DNCWARE$_{TM}$ ClusterPerfect$_{TM}$ for Oracle Quick Recovery. The conventional takeover time of a few or tens of minutes shrinks to tens of seconds by the mechanism of taking checkpoints and resuming the processes. The availability of an Oracle database system configured on a cluster computer system is enhanced by such quick takeover in the event of failure.

***9,000 kW Frequency Converter for Hot Bar Heater**
ITOH Katsuro MORIURA Yasutomo DOIZAKI Tetsuji

In the field of hot-strip mill facilities for steel, there is a need for large-capacity induction-heating equipment to save energy and raise product quality. Toshiba has commercialized a 9,000 kW frequency converter for induction-heating equipment with the world's largest-class rating. The latest circuit analysis techniques and microprocessor application control were applied in the commercial production of this equipment.

***Simulation of Flash Memory Programming Characteristics**
MATSUZAWA Kazuya ISHIHARA Takamitsu

Flash memories are indispensable in the information-oriented society, especially for mobile equipment. Hot electron and quantum mechanical tunneling phenomena are utilized to program a flash memory. The programming characteristics are therefore influenced by various factors as each memory cell is scaled down with ULSI miniaturization.

Toshiba has developed device simulation techniques in which hot electron and quantum mechanical phenomena are taken into account, in order to predict the characteristics of flash memory programming with various structures. The present simulator is applicable to both NOR and NAND flash memories.

***Thermally Stable Filtering System for Steam Generator Feedwater**
YAMADA Kazuya FUJIE Makoto FUKUSHIMA Tadashi

Toshiba has developed a thermally stable filtering system, consisting of a hollow-fiber filter made of fluororesin, for directly treating high-temperature feedwater supplied to steam generators in nuclear power plants and thermal power plants. Impurity elution from materials, solid particle removal efficiency, backwashing recoverability, and temperature cycle durability were evaluated to confirm the applicability of the system to high-temperature water of 230 °C, which is the design temperature of feedwater systems.

It is expected that the amount of iron carried into a steam generator can be reduced to 1/10 by directly filtering the high-temperature feedwater, and that scaling on generator surfaces can be controlled. This will greatly contribute to maintaining material soundness, ensuring good heat-transfer performance, and reducing the costs of steam generator cleaning.

***IPDU$_{TM}$ Inverter Devices for DC Brushless Motors**
KANAZAWA Hidetoshi TAKUMA Junichi FUKUNAGA Hidetoshi

Toshiba Carrier Corp. has developed IPDU$_{TM}$ (Intelligent Power Drive Unit) inverter devices to realize energy saving for DC brushless compressor motors. The IPDU$_{TM}$ features original high power factor control technology conforming to the International Electrotechnical Commission (IEC) specifications.

This paper describes IPDU$_{TM}$ inverter devices for DC brushless motors, as well as compressor efficiency improvement by advanced vector motor control. Furthermore, the IPDU$_{TM}$ based on the inverter for air conditioners can be applied not only to compressor drives, but also to DC brushless motor drives in various industries.

Techno Notes

***Cellular Phones Realizing New Lifestyles from Your Palm**

Toshiba Technologies for the New Century

15. Chemically Recuperated Type Cogeneration System