

TOSHIBA REVIEW

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Special Reports

LED Lighting Technologies Contributing to Global Warming Prevention

Toward Realization of Energy-Saving LED Lighting

FUJITAKE Koji

Trends in LED Lighting and Toshiba's Approach

BESSHO Makoto / SHIMIZU Keiichi

Light-emitting diode (LED) luminaires are regarded as the fourth generation of light sources following incandescent lamps as the first generation, fluorescent lamps as the second generation, and high-intensity discharged (HID) lamps as third generation, due to their excellent characteristics in comparison with conventional light sources including high efficiency, long lifetime, compactness, light weight, no mercury content, and very small infrared and ultraviolet radiation. With the progress of LED lighting technologies, LED lighting is expected to further expand to a wide range of applications from sign and display devices with only small luminous flux, to downlighting, security lighting, and base lighting, and also to general indoor and outdoor lighting applications that require more luminous flux such as retail stores, business facilities, and homes. Toshiba Lighting & Technology Corporation has been developing advanced LED products and technologies, and promoting the international standardization of LED lighting to reduce the burden on the environment.

High-Efficacy LED Lamps and Thin LED Unit to Replace Incandescent Lamps

OSAWA Shigeru / IZUMI Masahiro / SAKAMOTO Shizuka

Light-emitting diode (LED) lamps have continued to replace conventional incandescent lamps and have disseminated into a broad range of facilities and residences due to the increased improvement of cost performance compared with incandescent lamps. However, the brightness of LED lamps is not yet comparable with that of 60 W incandescent lamps. Toshiba Lighting & Technology Corporation has developed the E-CORE™ series LED lamps featuring the industry's best total luminous flux of 810 lm and a high luminous efficacy of 93 lm/W by the use of chip-on-board (COB) assembly technology. We have also developed a thin LED unit as a next-generation light source containing a power supply with a GX53 type base to realize a nonconventional thin and compact downlight.

LED Luminaires for Enhancement of Energy Conservation and Cost Reduction

WATANABE Hiroaki / TODA Masahiro / SAITO Akiko

With the development of high-efficiency and high-luminosity light-emitting diodes (LEDs) in recent years, conventional luminaires for both indoor and outdoor lighting applications are being replaced by LED luminaires. LED luminaires that meet the specifications of conventional luminaires are therefore required.

For indoor lighting applications, Toshiba Lighting & Technology Corporation has developed a compact LED spotlight luminaire for retail stores as an alternative to conventional high-intensity discharge (HID) spotlight luminaires. We designed the LED spotlight using three-dimensional computer-aided design (3D-CAD) and a thermal analysis simulator to help dissipate the heat of the LED efficiently. We also employed a printed circuit board (PCB) made of iron with a high-thermal-conductivity insulating layer suitable for the ceramic package of the LED, to prevent solder cracks caused by differences in the thermal expansion coefficients of the materials. Energy conservation of about 45%, downsizing of about 40%, and cost reduction of about 35% have been achieved.

For outdoor lighting applications, we have developed an LED security streetlight luminaire that can be set at the same intervals as existing streetlight luminaires. This was achieved by both designing the reflector shape using an optical simulator to decrease glare, and realizing high horizontal illuminance. Energy conservation of about 71% and long lifetime more than 300% have been achieved.

LED Lighting Control Technologies for Energy Conservation

KAMATA Masahiko / TAKASAKA Keitaro / KATANNO Chikako

Light-emitting diodes (LEDs), particularly white LEDs, are a focus of high expectations as a general lighting source. To meet the requirements for performance and functionality of LED lighting equipment, such as low power consumption, high efficiency, compactness, and so on, a buck-boost converter provides an effective power supply for controlling the current of the LEDs, and either amplitude modulation or pulse-width modulation are selected as appropriate for the dimming control.

Toshiba Lighting & Technology Corporation is also engaged in the development of LED lighting equipment utilizing natural energy sources, such as solar voltaic energy and wind power, together with batteries.

Approach for Realization of Comfortable Lighting Environment Using LED Luminaires

KOTANI Tomoko / HIGASHI Hirokuni

With the improvement in luminous efficiency of white light-emitting diodes (LEDs), the use of white LEDs as light sources for indoor and outdoor lighting has shown a considerable increase. However, the performance of white LEDs, including their luminance, area of luminous surface, spectral distribution, and so on, differs from that of existing light sources. Therefore, the mere replacement of existing light sources with white LEDs sometimes causes differences in such aspects as color appearance, health effects, and glare.

Toshiba Lighting & Technology Corporation has been engaged in research and development aimed at realizing a comfortable lighting environment using LED luminaires taking differences in the characteristics of LEDs, including color appearance, non-visual effects, glare, eyestrain, and so on, into consideration.

Potential of LED Lighting from Viewpoint of Lighting Design

AMARI Norikuni / TAKEUCHI Eiki

With the wide dissemination of light-emitting diode (LED) luminaires in recent years, the mere replacement of existing products and energy-saving planning is not sufficient to ensure customer satisfaction in lighting design.

Toshiba Lighting & Technology Corporation has been putting forward differentiated proposals to enhance the specifications of LED luminaires through the selection of products, lighting plans, and system design taking into consideration the visual environment, practical utility, and rendition as well as optimal use of the features of products. In order to contribute to the further advancement and diffusion of LED lighting, we have been engaged in research and development of LED lighting design to overcome many issues related to software and hardware performance including control of glare and increase in output power.

Feature Articles

High-Reliability Technology for Metal Gate/High-k Gate Dielectrics for Advanced LSIs

FUKATSU Shigeto / HIRANO Izumi / MITANI Yuichiro

Technologies to replace silicon dioxide (SiO₂) or silicon oxynitride (SiON) films with high-k gate dielectrics as well as the polysilicon gate electrode with a metal gate electrode for gate stack structures have been under development to achieve further miniaturization of large-scale integrations (LSIs).

Toshiba has investigated bias temperature instability (BTI) and time-dependent dielectric breakdown (TDDB) in tantalum carbide (TaCx)/hafnium silicon oxynitride (HfSiON) metal-oxide-semiconductor field-effect transistors (MOSFETs), particularly the effects of a TaCx metal gate electrode from the standpoint of the trade-off between BTI and TDDB in terms of TaCx thickness and composition. Various TaCx layers were deposited on the same HfSiON layer. Both the composition of higher Ta in the TaCx layer and a thicker TaCx layer improved BTI and mobility, but worsened time to breakdown (Tbd) because of the effect of metal gate-induced defects. We clarified that control of the depth profile of the TaCx metal gate can achieve high reliability of both BTI and TDDB beyond the trade-off.

Object Detection Method Using Two Heterogeneous Features

KOZAKAYA Tatsuo / ITO Satoshi / KUBOTA Susumu

Technologies to detect a specific object in images are expected to further expand to a wide range of applications, such as face detection functions for digital cameras and so on. However, high-accuracy detection of an object with a number of different patterns remains a difficult issue.

As a solution to this issue, Toshiba has developed an object detection framework that is generic and efficient enough to deal with complicated shapes and textures at high speeds based on two heterogeneous features: joint Haar-like features, and co-occurrence histograms of oriented gradients (CoHOGs). We evaluated the combination of these two distinct classifiers through a cat face detection problem, and confirmed the effectiveness of this method in terms of both performance and computational cost.

Safety Design Technologies for Software

YOMIYA Hisashi / OBA Satoshi / TANAKA Rina

In order to realize highly safe products, Toshiba has been making continuous efforts to develop the following safety design technologies for software: (1) safety design guides that summarize various safety-related knowledge acquired during the development of past products, (2) safety design education programs for software engineers to enable them to acquire mastery of the safety design guides through practical training, and (3) safety design technologies that enable business units to effectively implement safety design into their products. We are applying these approaches to the development of products with higher safety for a broad range of markets.

"Production Navigation System" Giving Detailed Instructions Based on Prediction of Production Load for Several Hours in Advance

KASE Akiko / ISHIHARA Yukihiko

The rapid progress of globalization and revamping of product lineup strategies have led to the widespread introduction of high-mix low-volume production systems at production sites for digital products. However, the processing times for assembly and testing vary with the type of product. Due to the resultant changes in workloads, it is necessary to maintain workforces at peak production strength to ensure on-time delivery even under a heavy workload.

As a solution to this issue, Toshiba has developed a system for predicting the production load and effectively minimizing the number of operators required, inspired by automotive navigation systems. A trial of this "production navigation system" using actual records of a notebook PC production line confirmed that it can achieve a workforce reduction of 23 %.

Image Processor Using Stereo and Vector Image-Processing Algorithms for Transportation Systems

NAKAGAWA Atsushi / AIKAWA Tetsuro

Image processors are applied to transportation systems including tunnel monitoring to detect anomalous traffic events, automatic detection of vehicles involved in accidents and traffic congestion, and so on. In recent years, the application of image-processing technologies has further expanded to such fields as the Advanced Cruise-Assist Highway System (AHS) and Driving Safety Support Systems (DSSS), and a large-scale demonstration experiment was conducted in 2008 to investigate the provision of warnings to other vehicles and pedestrians.

Toshiba has been developing image-processing technologies using stereo and vector image-processing algorithms. We have now developed a new image processor for transportation systems in which these two image-processing algorithms are incorporated into a common platform, in order to reduce the cost of image processors.

FS1000S model 2000 High-Speed and Large-Capacity Industrial Server Equipped with Quad-Core Processor

IZAKI Kosuke / MIMURA Akihiro / INARI Masaru

Toshiba released the FS1000S model 2000 industrial server, its highest level of industrial server, in May 2010. This model is equipped with up to two quad-core CPUs and up to 12 GB of main memory, allowing it to perform high-speed processing of large amounts of data in various settings. It also has scalability for connection to various types of equipment using Peripheral Component Interconnect (PCI) and PCI Express slots, as well as high reliability achieved by our original redundant array of independent (inexpensive) disks (RAID) controller.

As the FS1000S model 2000 is a key component for large-scale critical systems, we will supply this model for five years from its release and maintain it for up to 10 years for long, safe, and secure operations.

1.8-inch Hard Disk Drive Suitable for Video Cameras

HARIGAE Akihiro / SARUTA Kengo / KUWAHARA Satoshi

Toshiba has consistently led the market for 1.8-inch hard disk drives (HDDs) since the release of its first 1.8-inch HDD unit in 2000. Although they were originally designed for PC cards, the use of 1.8-inch HDDs has expanded to various applications including portable audio players, notebook PCs, and so on due to their compact size and light weight. Recently, however, demand has also risen for HDDs with optimal specifications for video cameras, which are radically different from those for notebook PCs.

To meet this requirement, we have developed a 1.8-inch HDD with a capacity of 160 GB suitable for video cameras. Among the advanced features of this model are lower acoustic noise through the application of a newly developed spindle motor and adjustment of the head speed, higher robustness against vibration by applying a newly developed carriage lock mechanism and servo control, and a higher altitude specification of 5,000 m achieved by applying a newly developed air bearing surface (ABS).

Technologies for High-Performance Smartphone with Slide-Out Keyboard

SAKAI Masaki / KOMINE Yasushi / NAGAI Takeshi

With the increasing speeds of network systems, the number of smartphone subscriptions has been rising worldwide due to the flexibility they offer in the selection of cloud services and applications according to the user's requirements. Toshiba released its first smartphone in 2009. This was equipped with a 1 GHz processor for the first time in the industry, together with a 4.1-inch display for easy Internet browsing, and the world's slimmest chassis of 9.9 mm in thickness.

For our new smartphone to be released in the summer of 2010, we have developed new technologies to further evolve the smartphone by shrinking the projection geometry of the chassis while still providing a 4.1-inch display, and achieving the world's slimmest chassis of 12.9 mm in thickness for a model with a slide-out keyboard. We have also developed a new user interface in which components on the home screen are optimally laid out based on the user's operating history.

Frontiers of Research & Development

Image Gamut Expansion Technology Based on Visual Perception Analysis