

Toshiba First-of-Their-Kind Products Incorporating Spirit of Technology Innovation — Inauguration of Toshiba Science Museum

Toshiba Science Museum Passing Leading-Edge Technologies on to Next Generation

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Sources of Toshiba's Technologies and Their Evolution

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Toshiba Firsts of Their Kind, published in 2005 followed by a second edition in 2011, presents Toshiba's history of creating and manufacturing a wide range of products for the first time, either in Japan or worldwide, embodying the company's passion and spirit of inquiry over the past 130 years.

The realization of these first products and technologies has been based on three key trends: (1) the development of electronics technologies evolved from tube technologies, (2) the development of manufacturing technologies supporting electric power generation and distribution, and (3) the development of technologies combining electronics with new market needs such as environment-conscious manufacturing. Applying our corporate heritage cultivated through this long experience, we are continuously developing and improving products in various fields including digital devices, medical systems, semiconductors, facilities supporting stable electricity supplies, and infrastructure for smart communities.

From Development of Japan's First Incandescent and Fluorescent Lamps to LED Lighting as Leading Lighting Technology

YASUDA Takeo / OHKAWA Hideki

Ichisuke Fujioka, the founder of a company called Hakunetsu-sha that was one of the forerunners of Toshiba, succeeded in developing Japan's first incandescent lamp on August 12, 1890, using carbon filament made from bamboo. A century later, Toshiba investigated the structure of the carbon filament used in this epoch-making lamp by means of nondestructive Raman scattering spectroscopy and confirmed that the filament had been fabricated by a baking process at a temperature exceeding 1,000°C, which had been believed to be difficult at that time.

In 1940, Japan's first fluorescent lamps under development by Toshiba were applied to the lighting for a project to reproduce the murals at Horyuji Temple. Subsequently, as a result of the petroleum shortages following the oil crisis in the 1970s, attention was increasingly focused on energy conservation. We launched a lineup of integrated compact fluorescent lamps on the lighting market in 1980 as representative energy-saving products, and have been continuously improving the performance of such lamps over the past three decades. Recently, with the rapid dissemination of light-emitting diode (LED) lighting, we have been actively focusing on the development of not only environmentally conscious products with higher luminous efficacy, but also dimming and color control technologies for LED lighting.

Evolution and Future Prospects of MRI Systems Three Decades since Their Commercialization

SUGIURA Satoshi / OKAMOTO Kazuya

Toshiba developed the MRT-15A, the world's first commercial magnetic resonance imaging (MRI) system, which was authorized by the Ministry of Health and Welfare and put on the market in 1983. Although the MRT-15A was a 0.15-tesla MRI system equipped with a resistive magnet, the basic configuration remains much the same in current MRI systems. Since then, technological development has been rapidly progressing, and MRI systems have established a firm position in the field of medical diagnostic imaging. Improvement of the signal-to-noise ratio due to the high magnetic field generated by superconducting magnets has contributed to the realization of shorter scan times and higher spatial resolution, resulting in dramatically enhanced diagnostic capability. The evolution of data acquisition technologies to achieve high-speed imaging has also led to the development of a number of imaging methods for various clinical purposes.

With the aim of widely disseminating MRI systems, the research and development of advanced technologies for automated operation and cost reduction are also being promoted. In the future, MRI systems will not only serve as diagnostic imaging devices but will also be an essential research tool in the medical science field. Toshiba Medical Systems Corporation has been pursuing possibilities for MRI systems through these activities.

Evolution and Ongoing Development of Image and Audio Technologies for TVs

ITO Masayuki / KIMURA Tadayoshi / YAMAMOTO Toshifumi

In analog broadcasting, there was a conspicuous difference between natural images and images displayed on cathode-ray tube TV sets due to the lack of sharpness. With the changing circumstances of the TV industry including the advent of liquid crystal display (LCD) TVs, the increase in the number of pixels associated with the improvement of resolution from standard-definition (SD) to high-definition (HD) levels, and the introduction of digital broadcasting, image resolution has recently become increasingly sophisticated.

Even in such a highly evolved environment, Toshiba has been uncompromisingly working on the development of image and audio technologies for TVs, super-resolution technologies to restore images to their natural state, and acoustic correction technologies for better sound reproduction under the physical limitations imposed by stylish designs. Accompanying the ongoing dissemination of flat-screen TVs with larger displays, we have been engaged in the development of state-of-the-art technologies aimed at realizing the highest possible resolution and sound quality based on our half century of TV development history.

NAND Flash Memory Technologies Realizing Storages with Larger Capacity and Lower Cost

NAKAI Hiroto / KIRISAWA Ryohei / SUKEGAWA Hiroshi

As the world pioneer of flash memory, Toshiba launched the research and development of flash memories with the goal of realizing a future storage technology with large capacity. We developed the world's first flash memory cells in 1984 and have been continuously advancing the development of various large-capacity memories since then, typified by NAND flash technology, in order to create a new nonvolatile memory market. We are now expanding the lineup of NAND flash memories with larger capacity and lower cost toward realizing various applications, ranging from those used in all areas of people's daily lives such as memory cards, mobile phones, and solid-state drives (SSDs) for PCs to data servers equipped with large numbers of NAND flash memory modules.

The technology node of NAND flash memories has been shrinking year by year in line with Moore's Law, although the pace of scaling has recently shown a decelerating trend. To overcome the physical limits of lithography, we have also been making efforts to develop three-dimensional (3D) memories consisting of vertically stacked memory cells.

Toshiba's 120-Year History of Manufacturing Hydroelectric Power Generation Facilities and Future Approaches

MORI Junji / KUBO Toru / TEZUKA Kotaro

Hydroelectric power generation is expected to further expand not only as the most widely used renewable energy source, but also due to its high responsiveness in maintaining stable power supply by compensating for power fluctuations resulting from the use of other renewable energy sources such as wind and photovoltaic systems that are affected by weather conditions. Toshiba has been engaged in the hydroelectric power business for 120 years since Shibaura Engineering Works Co., Ltd. (now Toshiba Corporation) manufactured Japan's first utility hydraulic generator for Japan's first commercial hydroelectric power station in 1894. In 1940, we supplied the world's largest capacity hydraulic turbine generators for the Suiho Power Station in Korea. Since then, with the increase in larger scale hydroelectric and pumped-storage power stations, we have manufactured and supplied record-breaking numbers of hydroelectric power generation facilities. Furthermore, we have realized the practical application of an adjustable-speed pumped-storage system for the first time, contributing to the stabilization of power systems connected with other renewable energy sources, and are now constructing the world's largest capacity system of this type.

Evolution of Vacuum Circuit Breaker Technologies Supporting Electric Power Distribution

KUBOTA Nobutaka

The development and evolution of various types of electric power equipment are contributing to stable supply of electric power and higher capacity of power transmission. Switchgears with the functions of protecting, monitoring, and controlling electric circuits are one of the main types of equipment supporting electric power distribution facilities, ensuring the secure and efficient transmission and control of electricity. In the event of a problem such as the detection of excess voltage or current in a circuit, such a switchgear can immediately disconnect the failed equipment from the circuit. It can also change the circuit according to the power usage conditions. Vacuum circuit breakers (VCBs) are a key component of switchgear used in many different applications.

Toshiba released Japan's first vacuum switch (7.2 kV-100 A) in 1965. Since then, we have been developing leading-edge technologies for various types of VCBs with low- to high-voltage capacities in response to the changing requirements of the market.

Inverter Control Technology Playing Leading Role in Era of High-Speed Gearless Elevators

NAKAJIMA Yutaka

Toshiba Elevator and Building Systems Corporation took the initiative in applying inverter control technology to high-speed elevators and in developing a gearless traction machine to effectively increase speed. We released the world's first inverter-controlled high-speed gearless elevator in 1983. Since then, inverter control technology has been rapidly progressing and inverter-controlled gearless elevators have been expanding into the mainstream of high-speed elevator systems.

We have enhanced this technology and offered various products ranging from the world's fastest elevator to large-capacity, downsized, and medium- and low-speed elevators. In response to the evolving needs of global markets, we are continuing to focus on the technological innovation of elevators aimed at maximizing comfort, ease of use, and energy saving.

DD Inverter Technologies Bringing Innovation to Automatic Washing Machines with Quiet Operation and Evolution of Toshiba Washing Machine Products

OKAZAKI Kiyoshi

Reduction of operating noise was conventionally an issue in the field of fully automatic washing machines. Accompanying the lifestyle changes that have taken place in the Japanese market in recent years, the performance and functionality required for washer-dryers has shifted from washing performance, low vibration and noise, and drying performance to shortening of the washing time while maintaining the primary capabilities of washing, rinsing, spinning, and drying. Water-saving and power-saving technologies are also essential, reflecting the rising awareness of global environmental issues.

In response to these customer requirements, Toshiba developed and launched Japan's first fully automatic washing machine applying direct-drive (DD) inverter technology in September 1997. Since that time, we have been further evolving washing machine products through the development of DD inverter technologies to achieve a balance between high torque and high speed, to improve energy saving, and to attain high power at low cost.

Application of Plasma Diagnostic Technologies to HBr Plasma for Si Dry Etching of Semiconductor Devices

NOJIRI Yasuhiro / IINO Daiki / SUZUKI Keiji / TOYODA Hirotaka

With the progressive miniaturization of semiconductor devices in recent years, the development of semiconductor manufacturing processes is becoming increasingly critical. It is necessary to clarify etching mechanisms for accurate process development, but there have been few studies on the dependence of the process conditions on radical behaviors and the relationship to etching characteristics in hydrogen bromide (HBr) plasma for silicon (Si) dry etching.

To elucidate Br radical behavior at the surface of the Si wafer, Toshiba, in collaboration with Nagoya University, has developed plasma diagnostic technologies to measure Br radical density using appearance mass spectrometry. By applying these technologies, we have constructed surface reaction models expressing the Br radical behavior with the addition of oxygen (O₂) to HBr plasma through measurement of the Br radical density, Si surface composition, and surface reaction.

Newly Developed 550 kV Gas Circuit Breaker Offering Both High Performance and Cost Reduction

MUKAIDA Akihisa / MATSUMOTO Eiji / YOSHIMI Akihiro

Aged switchgears including air-blast breakers (ABBs) and pneumatically operated gas circuit breakers (GCBs) are still in operation in the field. As some of these switchgears have been in use for 30 to 50 years, there is an increasing need for their systematic replacement due to the difficulties involved in obtaining maintenance parts and passing on maintenance technologies. To support users in planning the replacement of aged equipment, low-cost switchgears compliant with the latest standards of the Japanese Electrotechnical Committee (JEC) are required.

In response to this situation, Toshiba has developed a new 550 kV-63 kA-60 Hz GCB appropriate for replacement projects that meets the various requirements of users including low initial cost, less maintenance work, and long lifetime, and installed the first product at the Seibu Substation of Chubu Electric Power Co., Inc.

Battery Performance Prediction Technology for Electric Vehicles

EZAWA Toru / ITAKURA Akihiro

The rate of aging-related deterioration of the performance of lithium-ion batteries; namely, their capacity and internal resistance, depends on the conditions of usage such as the operating temperature, charge-discharge frequency, and output current. In order to accurately predict the future performance of a battery installed in an electric vehicle (EV), a detailed battery usage record is required. However, users do not necessarily maintain such records, and information based on a user's imprecise recollections will result in unreliable prediction.

Toshiba has developed a battery performance prediction technology to estimate future performance from the current state of a battery's active materials at the time of EV inspection without the use of usage records. This technology provides EV users with information on the future performance of their batteries, including the mileage per charge and output power, related to battery aging phenomena.

Automatic Abbreviated DNA Detection Technology for Food-Borne Pathogen Testing Using Electrochemical DNA Chips

INADA Mika / TAKAHASHI Masayoshi / KOJIMA Yuka / YUZAWA Eiko

The mainstream method for food-borne pathogen testing still requires the complicated and time-consuming process of pathogen cultivation. Demand has therefore been growing for new technologies that can detect food-borne pathogens rapidly and efficiently in line with the greater emphasis on food safety and security in recent years.

As a solution to this issue, Toshiba has developed an automatic abbreviated deoxyribonucleic acid (DNA) detection technology for food-borne pathogen testing called the DNA chip card, using electrochemical DNA chips to improve the complicated process of genetic testing. We have conducted verification tests using DNA chip cards and confirmed that 15 major types of food-borne pathogens can be detected rapidly and efficiently by this system. This technology is contributing not only to prompt investigations into the causes of food-borne illnesses and prevention of the further spread of infection, but also to safe and secure manufacturing through application to hygiene management in the food, pharmaceuticals, and cosmetics fields.

ThO₂-Free Cathode Material for Realization of Environmentally Conscious High-Intensity Discharge Lamps

YAMAMOTO Shinichi / AOYAMA Hitoshi

Tungsten-thoria (W-ThO₂) cathodes are mainly used in high-intensity discharge (HID) lamp products applied to lithography systems for large-scale integrations (LSIs), liquid crystal display (LCD) exposure devices, and resin curing equipment, taking advantage of the high melting point, high boiling point, and small work function of ThO₂. W-ThO₂ has a ThO₂ content of 1 or 2% to improve the emission characteristics of tungsten; however, the ThO₂ material is radioactive. With the tightening of regulations on the use and transportation of ThO₂ in recent years, alternatives to W-ThO₂ are required by manufacturers.

Toshiba Materials Co., Ltd. has developed a ThO₂-free material for HID lamp cathodes by using its proprietary equipment to evaluate the emission characteristics of various candidate materials based on their discharge behavior. The new ThO₂-free material, which is currently undergoing field tests, has emission characteristics equivalent to or better than those of W-ThO₂ and is expected to contribute to the realization of environmentally conscious HID lamps.