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Special Reports
Advanced Technologies for Nuclear Power Plants

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***The 21st Century and Nuclear Energy**
NIWANO Masao

***Trends in Advanced Technologies for Nuclear Power Plants**
SASAKI Norio
Toshiba has established a technology development strategy to consolidate future nuclear power business based on its experience accumulated up to now and perspectives for major changes in the world. In the field of plant construction, we are managing, from both the economic and social reliability standpoints, to take advantage of the merits of scale and advances in breakthrough technologies for operating plants to develop technologies with the aim of realizing improved value.

Toward the completion of the nuclear fuel cycle, we are developing technologies that will contribute to minimized back-end costs in the long run. Furthermore, aiming for harmony of effective energy use and the environment, we are concentrating our efforts on the development of cutting-edge technologies and their realization as applied technologies.

***Near-Term and Next-Generation Nuclear Power Plant Concepts**
SHIGA Shigenori HANDA Norihiko HEKI Hideaki
Near-term and next-generation nuclear reactors will be required to have high economic competitiveness in the deregulated electricity market, flexibility with respect to electricity demand and investment, and good public acceptability. For near-term reactors in the 2010s, Toshiba is developing an improved advanced boiling water reactor (ABWR) based on the present ABWR with newly rationalized systems and components; a construction period of 36 months, one year shorter than the current period; and a power lineup ranging from 800 MWe to 1,600 MWe.

For future reactors in the 2020s and beyond, Toshiba is developing the ABWR-II for large-scale, centralized power sources; a supercritical water-cooled power reactor with high thermal efficiency for medium-scale power sources; a modular reactor with siting flexibility for small-scale power sources; and a small, fast neutron reactor with inherent safety for independent power sources. From the viewpoint of efficient uranium resource utilization, a low-moderation BWR core with a high conversion factor is also being developed.

***Application of Advanced Flow Simulation Technology to Nuclear Reactors**
TAKIGAWA Yukio SHIRAKAWA Noriyuki SHIMIZU Takeshi
For near-term and next-generation nuclear reactor development, there is a strong need for the use of large-scale, highly accurate simulation in design work to reduce development costs and shorten development schedules. There is also a need to construct models to clarify micro- or meso-scale physical phenomena and to replace experiments with simulation.

To meet these needs, Toshiba has been promoting the development of large-scale, highly accurate simulation methods using numerical science techniques, and has been applying them to virtual numerical experiments for realizing optimum design considering the balance between performance and economy, and for evaluating new ideas for components and structures of nuclear plants.

***State of the Art of Toshiba Maintenance Techniques for Reactor Internals**
MAEKAWA Osamu HATTORI Yasuhiro SUDO Akira
As the number of aged plants increases, maintaining the integrity of the reactor pressure vessel and reactor internals in aged plants has become an essential issue to ensure continued stable operation and achieve higher plant operability. A major issue with regard to reactor internals is stress corrosion cracks (SCCs). Laser-applying techniques have many features suitable for preventive maintenance work on reactor internals.

Toshiba has developed various laser-applying preventive maintenance techniques and accumulated considerable field experience utilizing these techniques in various aged plants. Moreover, in view of the importance of confirming the soundness of reactor internals in aged plants, Toshiba has developed and applied sophisticated nondestructive testing techniques for this purpose.

***Latest Nuclear Monitoring Instrumentation and Control System and Its Planned Application**
KAWAKAMI Seishiro SATO Toshifumi IKEDA Jun
With the recent rapid progress made in electronic devices used in digital monitoring and control systems, Toshiba has developed special-purpose digital monitoring equipment and human-machine interface equipment that meet the special requirements of high reliability and long-term supply and maintainability for nuclear power plants, and is scheduled to apply these new products to actual nuclear power plants. Moreover, for the in-core sensor, which is a special-purpose product for nuclear power plants, Toshiba has been developing a new local power range monitor (LPRM) detector as the comprehensive result of improvements made up to now, and has developed the first domestic gamma-thermo (GT) detector as a pivot of the next-generation neutron monitoring system.

***Innovative Radioactive Waste Management Technology--Toshiba Compact Radwaste System**
YAMAGUCHI Shinichi TOYOHARA Masumitsu NODA Tetsuya
Various techniques are required in the field of liquid, solid, and gaseous radioactive waste (radwaste) management to adequately and economically decrease effects on the environment, conform with disposal regulations, and provide operability. As a total nuclear plant supplier with a record of many achievements, Toshiba has utilized its original technologies to develop a number of innovative radwaste systems with high potential and applied them to the latest boiling water reactor (BWR) type nuclear power plants. We are continuously developing improved radwaste technologies offering higher performance and appropriateness for future disposal policy.

Feature Articles

***Device Simulators for Optical Semiconductor Devices**
HATAKOSHI Gen-ichi
Toshiba has developed device simulators for optical semiconductor devices. Optical, electrical, and thermal characteristics can be analyzed on a standard personal computer with a graphical user interface providing easy operation for general-purpose use. These device simulators are useful for the design and analysis of optical semiconductor devices such as laser diodes and light-emitting diodes.

***New High-Density Wiring Technique Using Nanoporous Substrates and Photoinduced Selective Plating**
HIRAOKA Toshiro HOTTA Yasuyuki MATAKE Shigeru
Toshiba has developed a new high-density wiring technique for portable information devices such as cellular telephones and PDAs. A fine three-dimensional wiring can be created within a nanoporous substrate using photoinduced selective plating. Various devices such as logic ICs and memory ICs can be integrated in a compact space using this technique. This process is potentially applicable to advanced information apparatus such as wearable computers.

***Spin-Valve Transistor**
SATO Rie MIZUSHIMA Koichi
A new field called spin electronics is now growing, in which technologies in the fields of semiconductors and magnetism are combined to produce new-concept devices. Toshiba has proposed a high-sensitivity magnetic field sensor called a spin-valve transistor, which is under development for application to a magnetic recording head for terabit magnetic storage.

***Sn-Ag-Cu Alloy Lead-Free Soldering Technology and Reliability of Latest Notebook PCs**
OGAWA Hideki TAKAHASHI Kuniaki MAKITA Sadao
This paper describes the adoption of Sn-Ag-Cu alloy lead-free solder paste for the printed circuit boards (PCBs) of notebook PCs. Since the melting point of lead-free solder paste is higher than that of Sn-37Pb alloy solder paste, the reflow peak temperature of the PCB also becomes higher. Attention must therefore be paid to the heat-resistance reliability of electronic devices.

We investigated the heat-resistance reliability of electronic devoices and confirmed the soldering joint reliability of PCBs in which the lead-free solder paste was used. The lead-free solder paste was adopted for the system board of the DynaBook$_{TM}$ SS4000 notebook PC.

***Credit Risk Management Based on Data Mining－From CRAFT Scoring Model Web Site to Sales Risk Management System**
NISHIKAWA Takeichiro MORITA Kosuke UCHIHIRA Naoshi
Toshiba has developed a default model built on 20,000 company data with the Center for Research in Advanced Financial Technology (CRAFT). This model has two significant features: stability of the results, and capability to modify results according to economic fluctuations. A credit risk evaluation tool containing this model has been put on a Web site. This is the only free site where a default model built on such a large amount of data can be used. Toshiba has also commercialized this model as a sales risk management system by adding portfolio management functions.

***Real-Time Management Information and Control System for PCB Manufacturing (PCB-REALMICS$_{TM}$)**
KOGA Yasutaka TANAKA Hiroyuki MIZUSAWA Hideo
The manufacturing of printed circuit boards (PCBs), a key part of electrical equipment, has been employing surface mounting technology machines and automatic optical inspection machines. However, the manufacturing and quality management processes depend on humans.

Toshiba has developed the PCB-REALMICS$_{TM}$ real-time management information and control system for PCB manufacturing, which can manage the shop floor with a minimum number of supervisors and can improve manufacturing efficiency and quality. The new machine interface can connect different vendors' machines using Internet technology, and the visualization of manufacturing information can support PCB manufacturing innovation by kaizen (improvement) experiments.

***10 kW Diode-Pumped Nd:YAG Laser**
AKIYAMA Yasuhiro YUASA Hiroshi
In the Advanced Photon Processing and Measurement Technologies Project, Toshiba has been developing a laser diode (LD)-pumped Nd:YAG laser with an output power of more than 10 kW as a tool for high-speed and highly precise material welding. The LD pumping module is constructed by arranging several LDs around the laser rod, while the resonator head is configured by arranging several LD pumping modules in a series to achieve an average output power of 10 kW.

Toshiba has succeeded in obtaining an output power of 12 kW with an efficiency of 23 %, which are, to our knowledge, the highest values for an Nd:YAG laser. The Technology has been transferred to Shibaura Mechatronics Corp., which has started to supply the LD-pumped Nd:YAG laser system with an output power of 4.5 kW.

Toshiba Technologies for the New Century

***12. Web-based Fusion of Electrical and Mechanical Technologies**