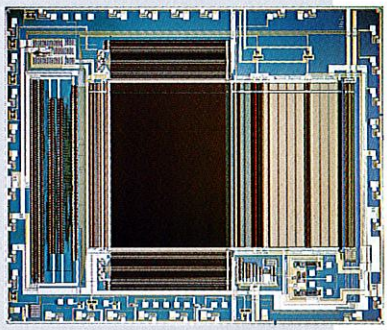
Research and Development

In its research and development activities, Toshiba employs its strengths as an integrated electronics manufacturer and its network of researchers in areas ranging from materials and devices to systems. The R&D process involves accurately forecasting future needs, developing the new products to meet those needs and quickly introducing them in the market. Consequently, Toshiba places importance on fostering the creativity of its researchers developing key innovative technologies.

1/4 Inch VGA Format CMOS Image Sensor

This 1/4 inch 330k square pixel video graphics array (VGA) format CMOS image sensor has on-chip drive circuits, timing generators and output amplifiers. Operable with a 3.3V power supply, the image sensor is suitable for use in digital cameras and mobile computers, and is currently being used in a newly developed compact digital camera.



1/4 inch 330k square pixel progressive-scan CMOS active pixel image sensor

Adopting this CMOS sensor instead of the conventional CCD sensor has allowed Toshiba to realize a low-power digital camera that is the smallest and lightest in its class.

Card-type digital camera

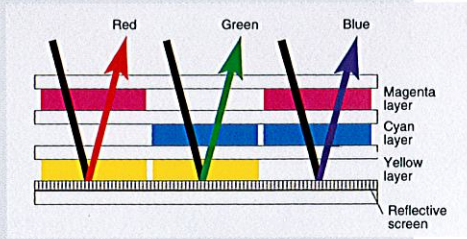
The digital camera uses a Smart Media solid state floppy disk card (SSFDC) for picture memory and a "card-slot-direct-in" structure for connections to PCs, enabling fast transfer of image data.

Although CCD sensors need three power supplies, the new sensor only needs a single power supply and consumes one-tenth the power of standard CCD sensors. The sensor adopts standard CMOS technology common to other VLSIs, giving the CMOS sensor technology the potential to realize a camera on a chip.

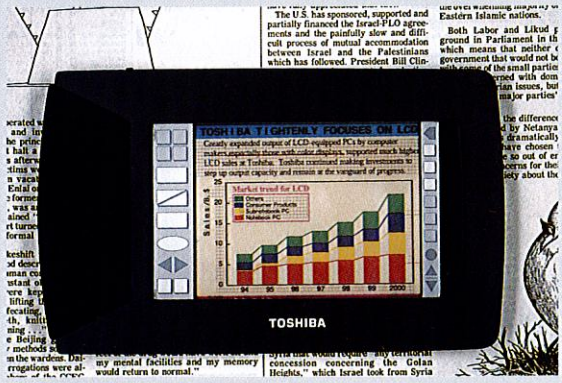
Color Reflective Liquid Crystal Display

Reflective liquid crystal displays (LCDs) without backlight units offer the very low power consumption essential for long-term battery operation. Unfortunately, conventional reflective LCDs provide poor brightness and color performance. Toshiba has developed a reflective color LCD suitable for portable information equipment that offers improved performance in these areas.

The display mode employs light absorption, which is the same color mixing system as that used for color photographs. Full color is obtained by control of light absorption and penetration among three stacked liquid crystal layers containing magenta, cyan and yellow dyes, respectively. This is the optimum structure and display mode for a reflective color LCD, providing maximum reflectivity of 45 percent and a contrast ratio of more than 5:1 on a 4 inch diagonal fixed pattern LCD, which is equivalent in brightness to a newspaper. The low power consumption and bright, full-color display will contribute to widening the range of applications for personal information systems.



Schematic device structure



Color reflective liquid crystal display

Ultra-Low-Power CMOS Circuit Technology

Toshiba's 0.5V CMOS circuit technology dynamically controls threshold voltage (V_t) by using a separate body for each transistor. Low-voltage operation is an effective method of suppressing LSI power consumption. However, excessively low threshold voltage causes unstable operation due to current leakage from off-state transistors. A variable V_t body-controlled circuit that uses silicon on insulator (SOI) technology overcomes stability problems that arise when threshold voltage is lowered to maintain operating speed.

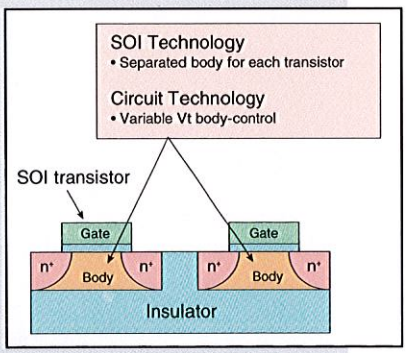
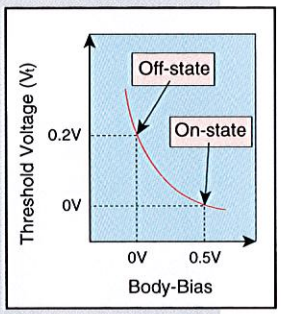


Diagram of ultra-low-power CMOS circuit

In SOI transistors, the body is completely separated by the insulation film so the gate signal can be supplied to the body of each transistor. This allows sub-0.5V, high-speed operations as a result of low threshold voltage from on-state transistors, while high-threshold voltage from off-state transistors suppresses current leakage. Using this technology, LSI power consumption is expected to decrease to 1/100 of that required to operate a 5V LSI.

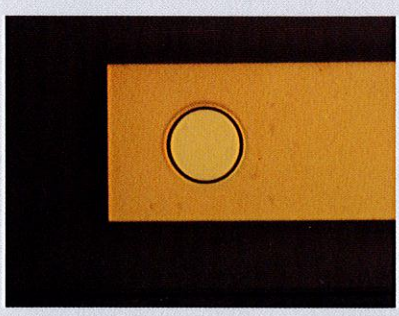


Threshold-voltage control by new circuit technology

Chip-Type DNA Sensor

Toshiba has developed a chip-type DNA sensor capable of measuring hepatitis B virus (HBV) in human blood serum at a monitoring density level of 10^5/mL. The DNA sensor uses a three-step process to determine the concentration of HBV. First, oligonucleotides (DNA probes) immobilized on the electrode of the DNA sensor selectively catch HBV DNA. Second, a DNA intercalator acting as an electrochemical signal amplifier reacts with the DNA hybrids formed on the electrode. Third, the current signal from the intercalator is measured. Using the new sensor, HBV DNA in sera can be detected in 1.5 hours, less than half the time required by the conventional method.

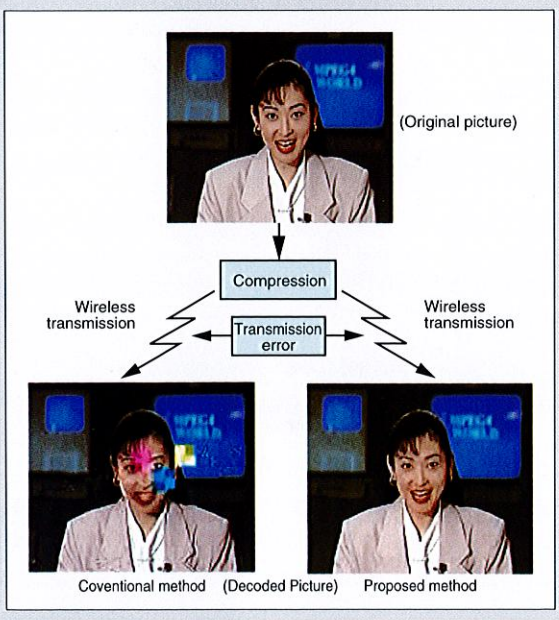
Using gold instead of carbon for the electrode in the oriented binding of the DNA probe and improvements in the signal amplifier contributed to raising the sensitivity of the DNA sensor by two digits. Introduction of a semiconductor manufacturing process helped to reduce the variance among the chip-type DNA sensors to less than five percent. Plans to further raise the sensitivity of the DNA sensor are expected to greatly increase its range of applications for the DNA of other viruses and bacteria.


Chip-type DNA sensor

MPEG4 Color Motion Picture Technology

The use of multimedia data on computers has been steadily increasing over the past few years. Multimedia data come in various forms, including motion pictures, still pictures, speech and text. Because the amount of information contained in a digitized picture is very bulky and difficult to work with, picture compression technology is used for applications that employ pictures.

In addition, continuing progress in the development of the mobile communications enviromnment and downsizing of portable information equipment has promoted an increase in motion picture applications. Due to the influence of radio waves, a certain level of data transmission error in mobile applications is inevitable. To deal with this problem, the Moving Picture Experts Group (MPEG), an organization created to develop and promote international standards, has begun discussions to create a new picture coding standard, to be called MPEG4. Toshiba has developed an error resilient coding method that can suppress degradation of picture quality due to data transmission error, and has contributed a number of proposals toward the development of a new standard.

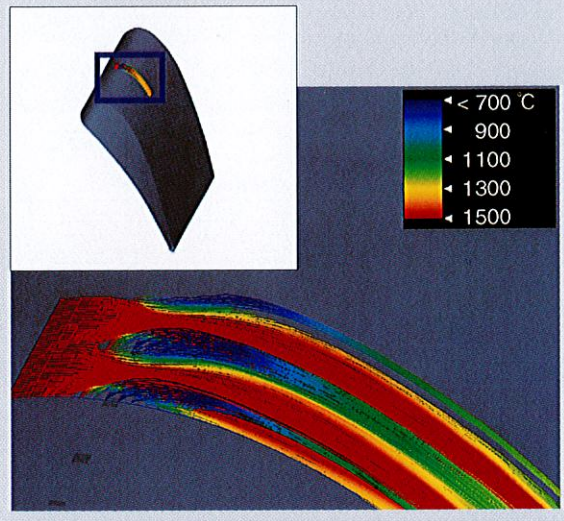


Comparison of error resilience

Three-Dimensional Flow Computation Code Development for Gas Turbines

The compressible blade row aerodynamic simulator three-dimensional version, or COBRA-3D, is a new computational fluid dynamics (CFD) code that analyzes the cooling performance of air film flowing along high-temperature gas turbine airfoil surfaces. This unique turbulence model accurately computes three-dimensional mixing dynamics of air film jets under real gas turbine operating conditions, which is difficult to simulate in wind tunnel experiments.

The code enables the design of efficient film cooling hole configurations that minimize coolant air flow rate, attaining uniform airfoil surface temperature and thermal stress. This will give higher thermal efficiency to gas turbine combined cycle power plants operated at firing temperatures of 1,500°C or higher.



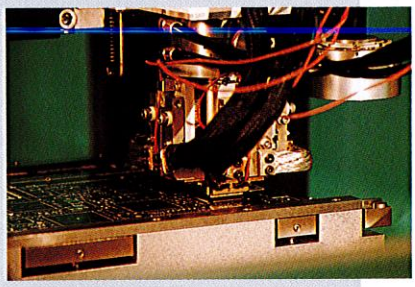
Three-dimensional CFD analysis of cooling performance of gas turbine airfoil film

Outer Lead Bonding Machine for TCP Mounting

This compact outer lead bonding (OLB) machine mounts a tape carrier package (TCP) on a printed circuit. Providing high cost effectiveness in a small size, the machine is primarily used for mobile PC products.

Refining the specifications and shortening the cycle time have reduced the necessary floor space for the OLB machine by one half, and resulted in an increase of 80 percent in the ratio of manufacturing performance to machine price, compared to conventional models. Use of a line charge coupled device (CCD) that provides high-speed recognition and an improved conveyer contributed to the shorter cycle time. Line CCDs offer higher and faster recognition capabilities than conventional CCD cameras, which require multiple images and stop between taking each picture. A new bonding sequence that prevents the heads of fine-pitch leads from bending also helped to improve reliability.

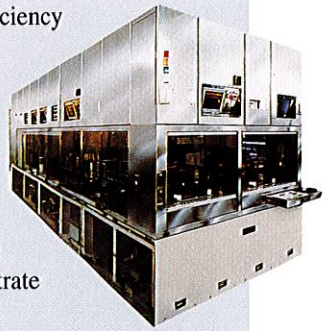
OLB machine



Bonding head

Cleaning Device for LCD Substrate Single-Plate Production Process

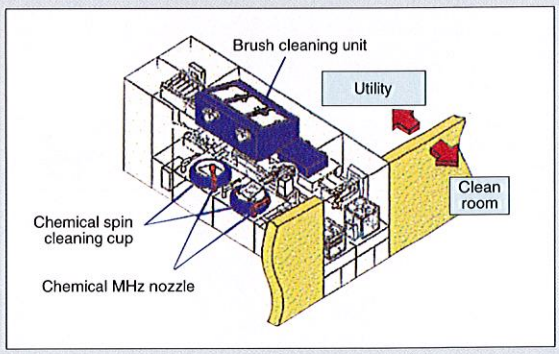
Toshiba's new compact, high-efficiency cleaning device is as effective in removing metallic contaminants as a semiconductor cleaning process but requires less than half the space, pure water and cleaning agents necessary for previous models. It is used in the liquid crystal display (LCD) substrate single-plate production process.



Compact, high-efficiency cleaning device for LCD substrate single-plate production process

The key components are a spin-cleaning cup and a nozzle made of quartz and sapphire. By means of this new nozzle, MHz band ultra-high-frequency sonic vibrations are superimposed on the cleaning solution during spin washing, which was previously impossible. This allows cleaning in a smaller space with less fluid.

Moreover, Toshiba has developed a hybrid generator to make electrolytic ionized water and ozonized water. The generator can electrolyze pure water or water containing small amounts of acid and alkali to inexpensively produce large amounts of acidic and alkali cleaning solutions. Water electrolysis through ion exchange membranes (solid electrolytes) makes possible the electrolysis of deionized water. The use of these technologies facilitates low-cost, high-efficiency substrate cleaning for LCDs. The specifications for a 550mm x 650mm substrate system include a maximum area of 13.5m^2, a processing speed of 50 sec/sheet, a residual particle number of less than 40 and a residual Fe and Cu concentration of 10^{10} atoms/cm^2 or less.



Configurement of newly developed cleaning instrument