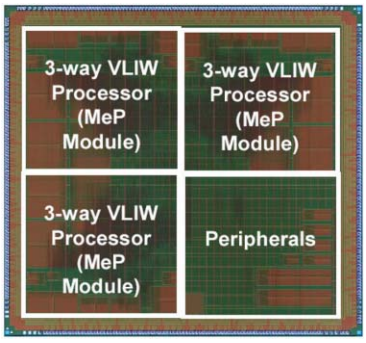
Corporate Research and Development

Toshiba R&D sections are focusing on research and development to forge the way into the next age as the foundation for the continued development of Toshiba Group companies. Furthermore Toshiba is creating new business through innovative research and development.

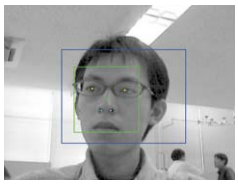
Visconti™ Image Recognition LSI

Toshiba has developed an image recognition LSI named Visconti™ to provide advanced safe driving assistance: an essential function for automobiles in the coming decade. The architecture of this LSI is based on a MeP (Media embedded Processor), which gives the LSI the optimum capabilities for automobile image processing; i.e. high performance, low cost and low power consumption. Using a Visconti™ chip in combination with a couple of memory chips and 3 vehicle mounted video cameras, it is simple to construct an obstacle detection system that alerts a driver in the event of dangerous situations, e.g. a car ahead or passing cars in two neighboring lanes. As an additional benefit, using the same hardware but modifying the software, we can also realize an efficient face recognition system which can be applied to driver monitoring and anti-theft protection. Owing to its outstanding capabilities, Visconti™ is expected to become a de facto standard for automotive applications of image recognition technology.

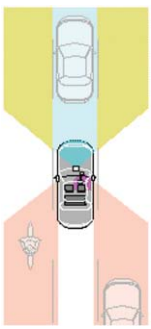


VLIW: Very Long Instruction Word

Micrograph of Visconti™



Face recognition system



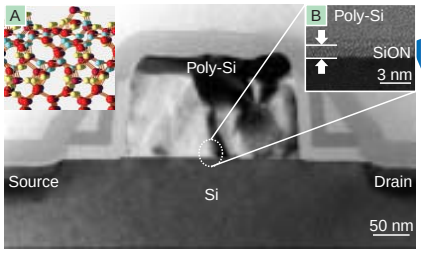
Obstacle surveillance system

Novel Fabrication Techniques to Realize Ultra-Thin and Ultra-Low Leakage SiON Gate Dielectrics

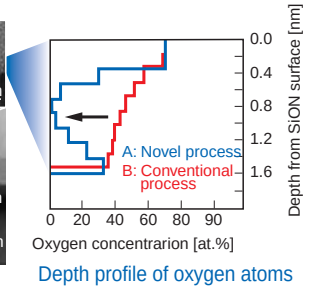
Toshiba has developed the world's thinnest gate SiON film for next-generation ultra high speed CMOS (Complementary Metal-Oxide Semiconductor).

For the next-generation ultra-thin gate SiON film structure, a double-layered structure which consists of an ultra-thin bottom SiO_2 layer with excellent interfacial characteristics and a top Si_3N_4 layer with high dielectric constant and high thermal stability is desired. However for the conventional sequential process of initial Si_3N_4 film formation and its oxidation, interfacial SiO_2 formation hinders the realization of a thin SiON film with a high dielectric constant, because the Si_3N_4 film is fully oxidized due to the poor oxidation resistance of Si-N bond.

Toshiba attempted to control the atomic-scale nitridation and oxidation phenomena by making the most effective use of first principles calculations, atomic level physical analyses, and the aggressively scaled CMOS process technologies. Toshiba found that the oxidation resistance of the initial Si_3N_4 film could be dramatically improved by uniformly arranging perfectly-coordinated high-density N atoms ($N(-Si)_3$) just at the Si surface. Toshiba succeeded in developing an ultra-thin SiON film containing a lot of oxygen atoms in the Si_3N_4/Si interface, suppressing the oxidation of the film as a whole. By using this novel process, Toshiba realized the high-quality ultra-thin gate SiON film, with the world's thinnest oxide thickness at 0.7 nm and a low leakage current of 100 A/cm^2 which is 1/10 of that of the conventional SiON film or less, while retaining high electron mobility as the proof of good interface integrity.

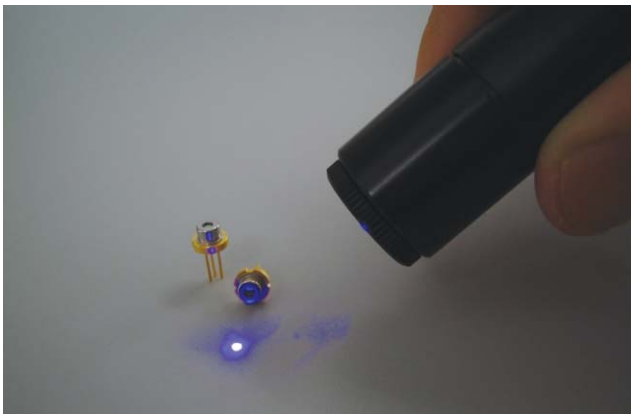


Cross sectional photograph of a test chip
Inset A: Structure of SiON/Si interface
Inset B: Magnified view of the SiON thin dielectric



Depth profile of oxygen atoms in SiON film after oxidation

High Power and Low Noise Blue-Violet Semiconductor Laser Diodes



GaN based blue-violet laser

The blue-violet semiconductor laser is an essential component for the next generation of optical disc players and drives.

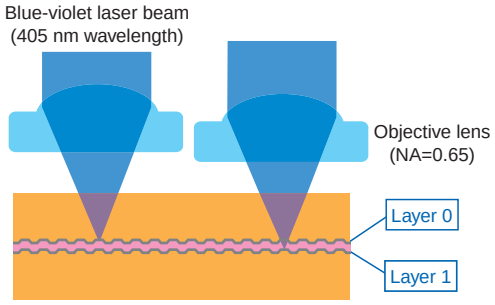
The gallium-nitride (GaN) based blue-violet lasers developed by Toshiba offer a high optical output of 200 mW with low noise.

High quantum efficiency is achieved by optimization of the dopant density. High-power single transversal mode operation is realized by a newly developed self-alignment process to produce the waveguide and the electrodes.

The new laser offers low relative intensity noise of –132 dB/Hz at an optical output of 3 mW.

Laser wavelength	: 409 nm
Threshold current	: 35 mA
Operation current (at 200 mW)	: 164 mA

High-Density Single-Side-Dual-Layer Rewritable DVDs of the Next Generation for High-Definition Video Disc Recorders

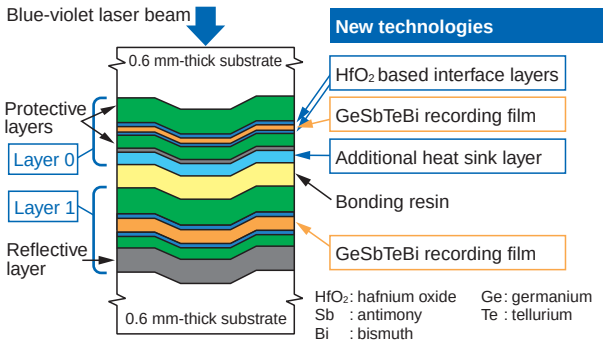


Operation of next-generation dual-layer rewritable disc

Toshiba has developed a high-density dual-layer rewritable optical disc on which information can be recorded and erased using a blue-violet laser diode.

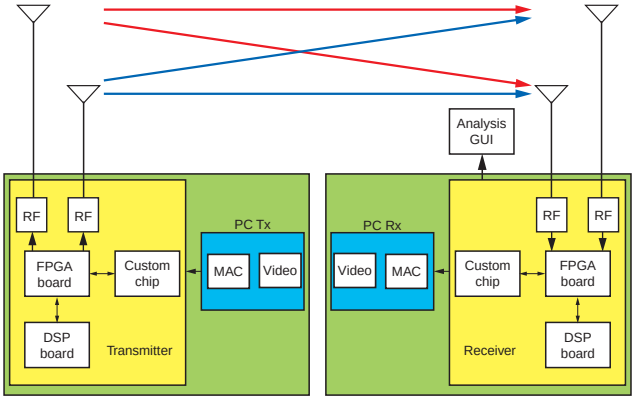
One of the benefits of using optical discs such as DVDs is that the information can be properly reproduced even if the disc has some dusts or small scratches on the surface. Such small obstacles do not practically damage the readout signal as long as we use the structure we applied, which is very similar to the current DVDs. Toshiba has already achieved the recording capacity as high as 20 Gbyte on the format. As a next step, Toshiba has also developed a "dual-layer" type disc, which utilizes two recording layers. One of the layers is semi-transparent so that the other layer can be recorded or played without flipping the disc. A total capacity of 36 Gbyte has been successfully demonstrated.

Discs of this type can be produced in a process that is very similar to that of the current rewritable DVDs such as DVD-RAM. We expect that high-definition video recorders using these discs will be commercialized in the near future.



Cross section of disc

Over 100 Mbps Wireless Multiple Input Multiple Output LAN Technology



RF : Radio Frequency
DSP : Digital Signal Processing
GUI : Graphical User Interface
FPGA: Field Programmable Gate Array
MAC : Medium Access Control
Tx : Transmitter
Rx: Receiver

Block diagram of 2×2 MIMO real time wireless LAN prototype system

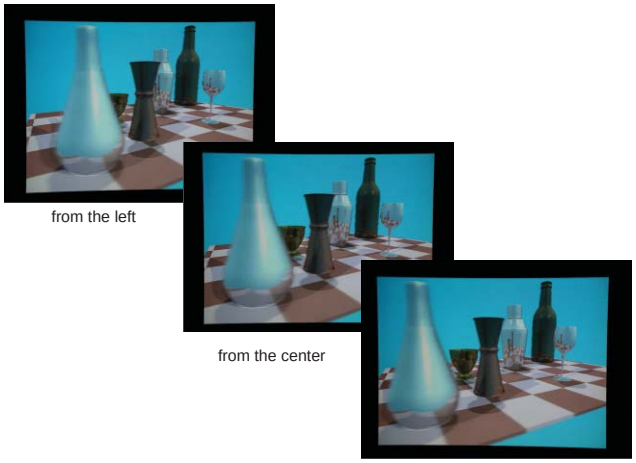
Toshiba has developed a multiple input multiple output (MIMO) wireless local area network (WLAN) prototype system operating in real time for high quality wireless video transmissions. MIMO is a key technology for enabler to increase data rates and to improve the robustness and range of wireless systems. To achieve these goals the technology utilises multiple antennas and signal processing circuits at the transmitter and the receiver. This prototype system, which is a MIMO extension of the current IEEE802.11a WLAN standard, has 2 antennas and a signal processing circuit consisting of FPGA and DSP, and demonstrates the improved reliability and quality of wireless video transmissions.

In addition, a sophisticated wireless link simulator has been developed to support the design of advanced MIMO wireless systems. This simulator uses an extensive database of actual MIMO channel measurements, which allows us to quantify the performance gains of a wide range of algorithms for realistic environments, e.g., office, home, etc. A simulated MIMO enabled WLAN system using a 6×6 MIMO configuration has demonstrated that it is possible to have 4 times the capacity (i.e. 216 Mbps) and obtain considerably improved video quality when compared with a standard IEEE802.11a system.

Unfortunately, the improved performance achieved through the use of MIMO techniques is at the cost of increased complexity and power consumption and to this end, Toshiba is currently developing technical solutions in this area.

IEEE: Institute of Electrical and Electronics Engineers

Future Autostereoscopic 3-D Display System



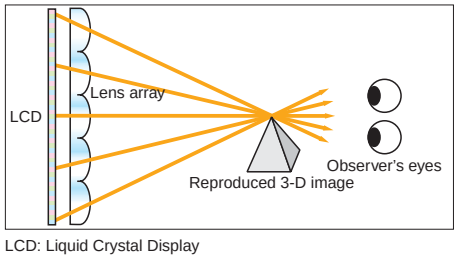
3-D images with 32 parallax observed from three different viewpoints

Toshiba has developed an integral-imaging-based three-dimensional (3-D) display technology. The integral imaging method provides an ideal 3-D experience because it closely replicates the diffused light reflected from objects. The prototype 3-D display system shows good 3-D images without wearing special glasses.

The natural 3-D images can be reconstructed by increasing parallax to a maximum of 32. However, integral imaging has a drawback in that the resolution tends to deteriorate when parallax is increased. By using a special R, G and B (Red, Green and Blue) sub-pixel matrix, it has been verified that a 3-D display with 300 horizontal pixels is possible. Vivid images and much reduced visual fatigue are complemented by smooth motion parallax and a wide viewing angle.

Toshiba has also developed 3-D content development software that transforms 3-D computer graphics (CG) content into 3-D images with parallax, and the displays feature both 3-D moving pictures and the real-time manipulation of 3-D CG scenes.

Potential applications of the new 3-D technology include advertising and arcade games, and future applications may well include autostereoscopic televisions for the home.



Principle of 3-D image reproduction using integral imaging method

LCD: Liquid Crystal Display

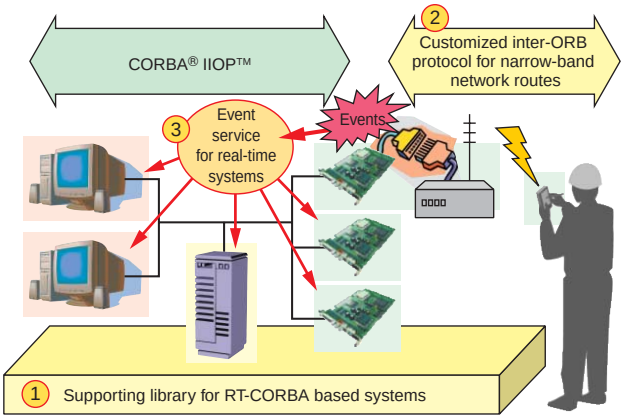
1,200 dpi Color On-Demand Printer Using Liquid Toner

Prototype of 1,200 dpi color on-demand printer using liquid toner

A prototype of the 1,200 dpi color on-demand printer, which realizes high quality variable printing of 1,200 dpi resolution, has been developed in collaboration with a press machine manufacturer. Toshiba's liquid toner electrophotography technology is employed for the print engine. Many original technologies were developed for this prototype; a super-fine liquid toner of 0.7 µm in average diameter, an image-on-image color process which realizes high speed and high quality output, a non-electrical shearing transfer which enables high-efficiency transfer onto various media, high speed drying technology which gives stable shearing transfer characteristics, and so on. Offset quality images of a real 1,200 dpi are printed on continuous roll paper of A3+ wide, at a speed of 140 pages per minute in A4 size. The print cost is much lower than that of the dry process, because the toner consumption in the liquid toner process is almost 1/10 of that in the dry process.

Prompt commercialization in the on-demand printing market is expected delivering "the prints required in the amount required at the time required" utilizing the advantages of media versatile characteristics.

Customized CORBA® Services for Distributed Real-Time Embedded Applications



Development of distributed embedded applications with CORBA® middleware

Toshiba has developed software service components based on the CORBA® (Common Object Request Broker Architecture) technology for distributed real-time and embedded systems. The components provide

- supporting library for RT-CORBA (Real-Time CORBA) system development which makes CORBA® programming easier, and assists system configurations for real-time features such as an objects' priorities,
- customized inter-ORB protocol which reduces its header size from standard IIOP™ (Internet Inter-ORB Protocol) for narrow-band networks, and
- a simplified event service, which can work with the RT-CORBA priority mechanism, and is capable of event filtering.

Most next generation distributed real-time embedded applications have complex quality of service (QoS) requirements, such as stringent bandwidth, latency, jitter, and dependability needs. Most of the standard CORBA® service specifications, which were developed in the 1990's, often fail to satisfy such QoS requirements, because it was not assumed that they would be used in real-time systems. Toshiba's Software Technology Center uses the customized service components to satisfy those complex and individual requirements given by in-house companies.

ORB: Object Request Broker

Ultrasonic Flip Chip Bonder

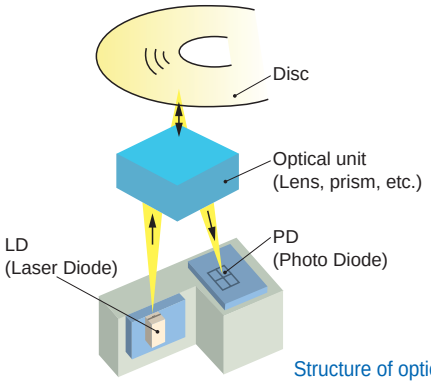
Ultrasonic flip chip bonder

Toshiba has developed a high speed ultrasonic flip chip bonder which enables interconnection of the chip bond pads to the lead-frame by gold bumps in short time in order to achieve high productivity of discrete semiconductors such as light emitting diodes (LED) and transistors.

With the decrease in chip transfer distance, decrease in driving part weight, and short bonding time, this bonding machine has achieved the shortest tact time in this field of the industry of 0.9 seconds per IC (including bonding time of 0.3 seconds).

Using a newly developed pressurization mechanism incorporating an original linear motor, this bonding machine enables a reduction in the impact force of bonding, and can be applied to low-pin-count devices that require minute force control (1 N at the minimum).

Manufacturing Machines for Slim Optical Pickup for DVD Drive Use



Structure of optical pickup

The laser diode (LD) and photo diode (PD) are key components of the optical pickup, which reads and writes information using a laser beam. In the manufacturing process of the optical pickup, the angle of the laser beam emitted from LD and the relative position of LD and PD are adjusted/mounted with a high degree of precision.

Toshiba has developed two manufacturing machines. One machine measures the LD beam angle, and the other measures the PD position automatically. A low-shock probe and image-processing algorithm make it possible to measure the beam angle, the precision of which is ±0.1°, and PD position with precision of ±1 μm. The newly developed machines have already been introduced at the manufacture site, where they are contributing to stable manufacture of optical pickups.

Outline of newly developed machines

Machine name	LD angle inspection machine LDA-200	LD-PD position inspection machine PDA-200
Appearance		
Measurement accuracy	±0.1°	±1 μm
Work carrying method	Using work carrier	
Work supply method	Supply by magazine	
Machine size	900(W)×750(D)×1,500(H)	