Research and Development

Toshiba R&D activities capture the needs of customers and make it possible to bring brand-new products (for example, notebook PCs, Mobile Terminals, and DVD Players) directly to market. To meet customer requests, Toshiba is conducting research and development on both fundamental and up-to-date technologies. Furthermore, Toshiba is integrating all innovative technologies to shorten R&D and manufacturing times and to improve product quality.

Decolorable Ink

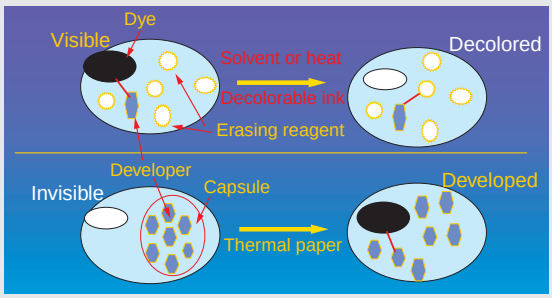
Decoloration of printed image by solvent

Toshiba has developed a new decolorable ink (imaging material) which can be erased by applying heat or solvent to the printed or written image. It is characterized by a composition of eraser (trap) and leuco dye colored by developer. The erasing process is a reverse reaction of color formation of thermal sensitive recording paper. The chemical bond of the dye-developer is switched to eraser-developer and is fixed.

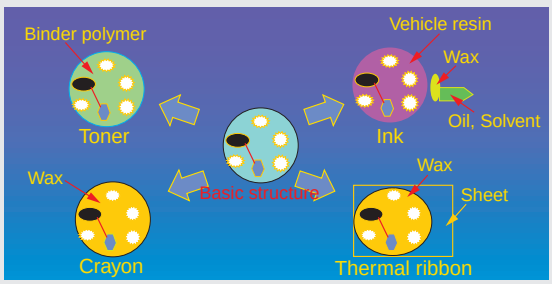
This technology enables erasure of huge volumes of used paper at once. It is applicable to printer or copy machine toner, conventional ink, stationary and ink ribbons.

The decolorable ink will reduce the cost of recycling used paper and will furthermore promote paper recycling to save forests. It will also reduce the volume of trash because approximately 40% of trash is paper, which is burned. Therefore the decolorable ink will save forests and energy and reduce CO_2 emissions and trash.

Toshiba plans to diffuse this technology world wide.



Principle of decolorable ink
(Upperr diagram) Mechanism of decoloration of color formed by developer
(Lower diagram) Mechanism of color formation of thermal sensitive paper



Applications for decolorable ink
Applicable to various image materials by incorporating basic structure into them

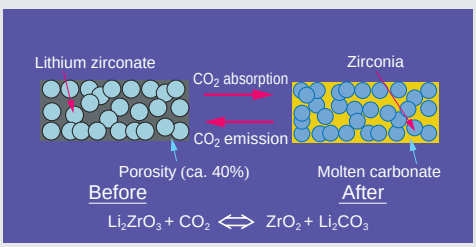
Novel CO_2 Absorbent Using Lithium Zirconate Ceramics

The inevitable production of CO_2 from fossil fuel combustion is thought to cause climate changes. Among all technical efforts to reduce CO_2 emissions, technologies to segregate CO_2 from flue gases are expected to have an immediate effect on this issue. A new material developed by Toshiba absorbs 400 times its own volume of CO_2 even at high temperatures and pressures, significantly outperforming the chemical reactants usually used.

The new substance, lithium zirconate, reacts with CO_2 and produces zirconia and lithium carbonate, which accumulate in the spaces between the lithium zirconate particles. One liter of lithium zirconate can absorb 400 liters of CO_2, more than ten times the performance of previous absorbents. The substance can be pressed and molded into a ceramic structure of any desired shape, and it functions over a wide range of temperatures from 450 to 700°C and at pressures up to ten atmospheres.

The material can be regenerated by heating to temperatures over 700°C and controlling the pressure to liberate CO_2. It is ideal for use in electric power plants and automobiles, the major sources of such emissions.

CO_2-absorbent ceramics



Reaction model of CO_2-absorbent ceramics

Development of a Motional Interface Device "Motion Processor"

Toshiba's new motional interface device "Motion Processor" can capture objects as moving 3D images against the most complex backgrounds in real time. The prototype includes infrared light sources, a lens and a C-MOS image sensor. It captures reflection images of the objects at a rate of 30 or 50 frames per second. In order to process and recognize captured images, the "Motion Processor" SDK (Software Development Kit) has been also developed.

Overview of motion processor system

The "Motion Processor" will help computers be more responsive to their users' motions and gestures in real time, regardless of how complex the background. An application using the "Motion Processor", for example, the "Paper, Rock, Scissors" game shown in Figure below would let the user control the timing of their manipulation based on their tempo. This interface is a move toward natural and intuitive human-computer interface. Future possibilities include communication with home PC and information home appliances by gestures, offering advantages for the physically challenged, the aged, and children.

When you show "scissors", (1) reads the form of hand and (2) recognizes "scissors". As the cat , opposition, (FAI) showed "paper", FAI indicated 0 mark ((3)) and YOU indicated 1 mark ((4)).

Example of display of "Rock, Paper, Scissors" game using motion processor

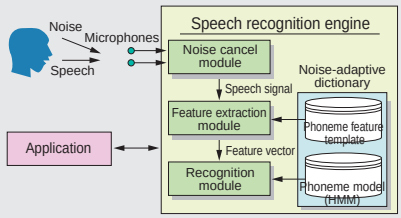
Speech Recognition Highly Robust against Noise

Using noise cancellation and noise adaptation techniques, Toshiba has developed a speech recognition system suitable for devices that are mostly used in noisy situations, such as vehicle navigation systems and personal digital assistants.

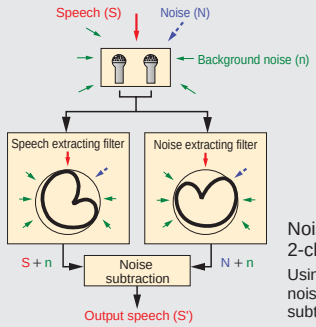
The noise cancellation technique eliminates the surrounding noise and extracts the signal coming from the speaker's direction with a 2-channel microphone array. Using this technique, Toshiba has achieved a remarkable improvement of 15 dB SNR (Signal-to-Noise Ratio).

The noise adaptation is based on our proprietary noise immunity method. This method takes the dictionary (speech models) that have been trained off-line for ideal clear speech and adapts it to the real speech, i.e., the output signal of the noise cancellation.

Currently, Toshiba has produced a speaker independent, one thousand word speech recognition system using the above two techniques as a middle wave for TX39, a Toshiba RISC chip.

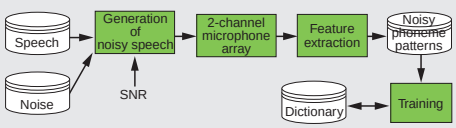


Configuration of speech recognition system



Noise cancellation method using 2-channel microphone array

Using two filters separates speech from noise and cancels background noise by subtraction of the outputs of the filters.



Noise immunity method

The training uses clean speech data first and gradually decreases the SNR of training to immunize the dictionary against noise.

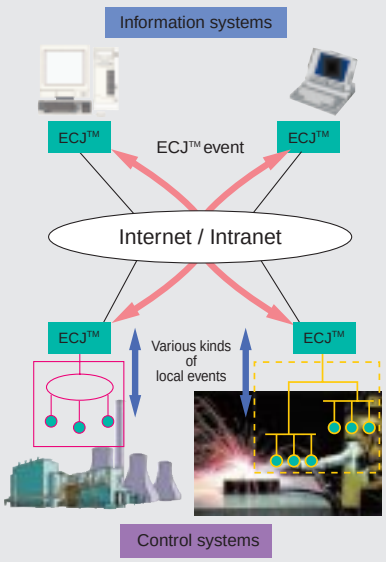
ECJ™: Event-Driven Distributed Java Application Framework

Event Centric for Java (ECJ™) is a framework which supports construction of event driven distributed systems with particular emphasis on reducing development time. ECJ™ enables easy development of Java application systems that integrate information and control systems.

ECJ™, a compact package written in Java, realizes high-speed asynchronous communication. This asynchronous communication mechanism complements the remote method invocation (RMI) mechanism which is supported in the Java standard environment. ECJ™ can also be used within embedded systems.

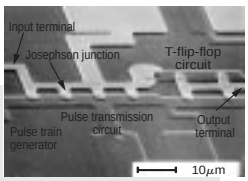
ECJ™ works in terms of the ECJ™ event, which unifies various kinds of local events used with individual control systems and/or information systems. This enables transparent exchange through the network. Consequently, ECJ™ smoothly realizes a network computing architecture composed of a variety of system types.

" Java" is a trademark of Sun Microsystems.



Example of remote supervisory control and data Acquisition (SCADA) system using ECJ™

A 200 GHz Frequency Divider Utilizing High-Temperature Superconductors



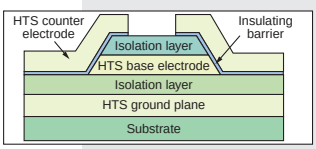
SEM photograph of frequency divider based on SFQ circuitry

A frequency divider based on single flux quantum (SFQ) logic circuitry has been developed using Josephson junctions made of high-temperature superconductors. The correct operation of the circuit at frequencies of up to 200 GHz has been confirmed.

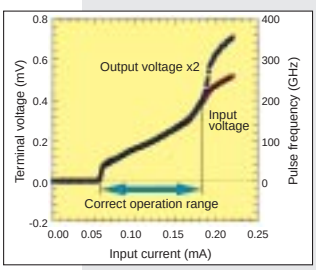
SFQ circuits based on high-temperature superconductors are expected to be key components in future communication and information processing systems due to their intrinsically high speed operations in a temperature range easily accessible by a small refrigeration system.

The frequency divider consists of 8 Josephson junctions in which an ultra-thin insulating barrier is sandwiched between two superconductive electrodes. This circuit has the function of splitting fast pulse-train signals between two output terminals alternatively. A newly developed ramp-edge-type junction structure suitable for miniaturization together with a three-level superconductor wiring technique enables the ultra-fast operation. The maximum operation frequency was evaluated by measuring dc voltages at the input and output terminals using the fundamental proportionality between a pulse frequency and an average dc voltage across a Josephson junction, which is a unique characteristic of an SFQ circuit.

The observed operation frequency is 5 times higher than that reported so far for the fastest compound semiconductor integrated circuit with a similar function. Toshiba expects that further miniaturization of the Josephson junction will enable Toshiba to operate the circuit even at a frequency of 1 THz in the near future.



Structure of ramp-edge-type Josephson junction made of high-temperature superconductors (HTS)



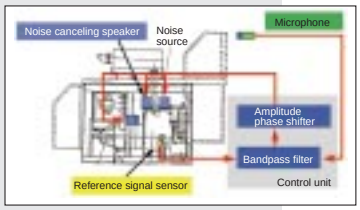
Input and output voltage observed for frequency divider and its relation to operation frequency

This work was performed under the management of FED as a part of the MITI R&D Program (Superconducting Electron Devices Project) supported by NEDO.

FED: Research and Development Association for Future Electron Devices
MITI: Ministry of International Trade and Industry
NEDO: New Energy & Industrial Technology Development Organization

Active Noise Control System for Power Generating Unit

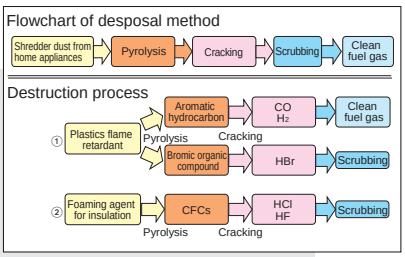
The low frequency noise radiated from engine enclosures of power generating units is one of the social problems caused by environmental noise. The performance of sound absorption materials or barriers is relatively poor at low frequencies. Therefore, the volume of the enclosure should be enlarged and the area of the soundproof cover increased.



Active noise control system for power generating

On the other hand, active noise control technology is effective at low frequencies. Therefore, Toshiba has proposed a method employing active noise control to minimize total acoustic power in engine enclosures, leading to environmental noise reduction in the entire area around engine enclosures. If active noise control is mounted on the engine enclosure, a 10 dB reduction across the range of frequencies can be realized by using sound absorption material for high frequencies without changing the structure.

Pyrolysis and Cracking Technology for Shredder Dust from Home Appliances



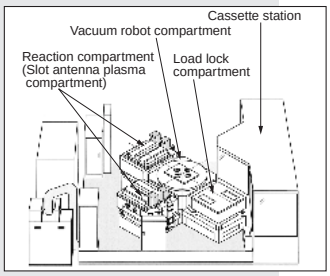
Pyrolysis and cracking system

A new law governing the recycling of specific kinds of home appliances will be enforced from 2001. Although iron and copper are easily recoverable, the recycling of shredder dust is difficult. The reason is that 80% of shredder dust are plastics, which contain vinyl chloride and halogenation flame retardant. Toshiba verified obtaining clean fuel gas containing no dioxin from these plastics by pyrolysis and cracking. This method can be applied to CFCs used for refrigerators, and is an effective technology for recycling shredder dust from home appliances.

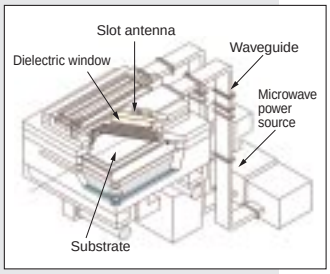
TFT-LCD Panel Manufacturing Equipment

Toshiba has developed dry etching equipment and cleaning equipment for thin film transistor liquid crystal display (TFT-LCD) panels, in collaboration with Sibaura Mechatronics Co., and has applied them to the mass production of polysilicon TFT-LCD panels.

The dry etching equipment is characterized by a continuous process of etching and resist ashing in one chamber. A slot antenna plasma source, newly developed by Toshiba, is incorporated in the equipment. This plasma source provides a high-density plasma (electron density: 2 x $10^{11}cm^{-3}$) at medium pressure (20 to 100 Pa). A large area plasma source can be easily accommodated by adjusting slot length and position. The shape of the slot antenna is optimized from the results of experiments aided by electromagnetic field simulation. A high etching rate of 0.09μm/min and ashing rate of 1.4μm/min can be achieved with ±10% uniformity over the substrate area.



CDE802 dry etcher for larger-scale TFT-LCD



Structure of plasma source using microwaves with slotted antennas

The cleaning equipment is used to perform chemical wet cleaning. For removal of organic contaminants, an excimer ultraviolet (UV) lamp and electrically ionized water are used. Toshiba realized a saving of the chemicals used and a 70% reduction in the use of deionized water compared to the conventional system. Furthermore, Toshiba was able to achieve high performance such as a low residual particle number of 0.03/cm^2(≧1.0μm) and surface metal contamination amount of 10^{10}atoms/cm^3.

CDE802 dry etcher for larger-scale TFT-LCD panel wet-cleaning equipment