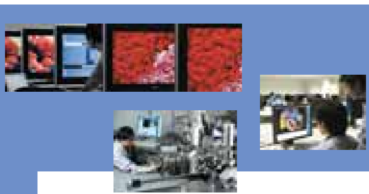
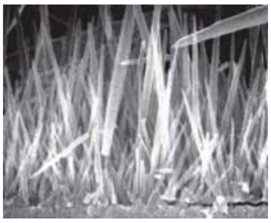
CANON TECHNOLOGY HIGHLIGHTS 2007

Canon

VISUAL INDEX





INPUT DEVICES

Want to learn more about our technologies? Here you will find a variety of content, including computer-generated animations illustrating the basic functions of Canon products, behind-the-scenes interviews with our development staff, the wonders of "light" and "nanotechnology" in our daily lives, and more.

URL: www.canon.com/technology

CANON TECHNOLOGY

NOW

Contributing to Global Prosperity and Welfare — the Innovative Technology Behind Canon's Five Imaging Engines

Canon's corporate philosophy is *kyosei*. The ideal behind this philosophy is a society in which all people harmoniously live and work together for the common good.

Over the 10 years since 1996, Canon has implemented the first two five-year phases of its Excellent Global Corporation Plan, a plan that seeks to continuously contribute to society through technology with the aim of making Canon a company admired and respected throughout the world. In 2006, the 11th year of the plan, Canon embarked on Phase III, in which we will enhance our current operations and develop new technologies in pursuit of sound growth.

Our Five Imaging Engines — Image Capture, Electrophotography, Inkjets, Photolithography, and Display — are pillars for enhancing current operations. Basic research, leading-edge technology development, and research capabilities support operational growth.

Born of the integration of various technologies, Canon's Five Imaging Engines have established the superiority of our products. We will continue striving for further innovations in these Engines while also seeking to create new engines.

The Five Imaging Engines Supporting Canon Products

Technology has been the key pillar supporting Canon's growth. The Five Imaging Engines — born of the integration of various technologies nurtured throughout Canon's history — led to the creation of Canon's current products and will propel the company toward sound growth.

Image Capture Engine

Canon's image-capture technologies achieve high resolution and high image quality for lens, sensor, and image-processing technologies.

Electrophotography Engine

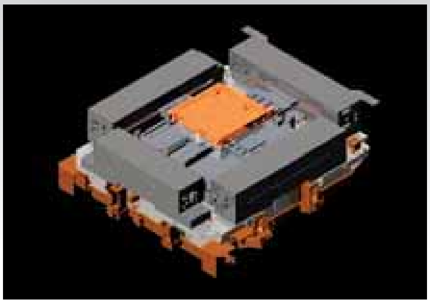
Electrophotography technology serves as the heart of laser beam printers and copying machines that have been rated as the best in the world.

Display Engine

SED next-generation flat-screen display technology delivers large-screen, high-quality images with low power consumption.

Inkjet Engine

Inkjet technology is capable of delivering microscopic ink droplets as small as 1 picoliter (one-trillionth of a liter), making possible even DNA chip fabrication.



Photolithography Engine

Canon's semiconductor exposure technology represents the integration of the ultimate optical and ultraprecision positioning technologies.

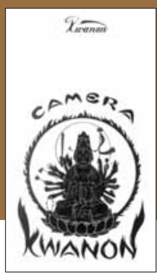
Certification System for Engineers of Exceptional Caliber

Canon designates exceptional engineers as MCATs (Members of the Canon Academy of Technology). Through product development and research-paper presentations, MCATs have earned outstanding reputations both within and outside Canon, with some members winning prestigious global awards. The MCATs pursue technological advances, train in-house junior engineers, and promote Canon technologies throughout the world. There are currently 14 members, two of whom have been designated as Canon Fellows, engineers of the very first rank.

"Specialists Cultivating Technology"— Introducing the MCATs

URL: www.canon.com/technology

CANON TECHNOLOGY
HISTORY



Canon is Driven by its Never-Ending Dedication to Original Technologies

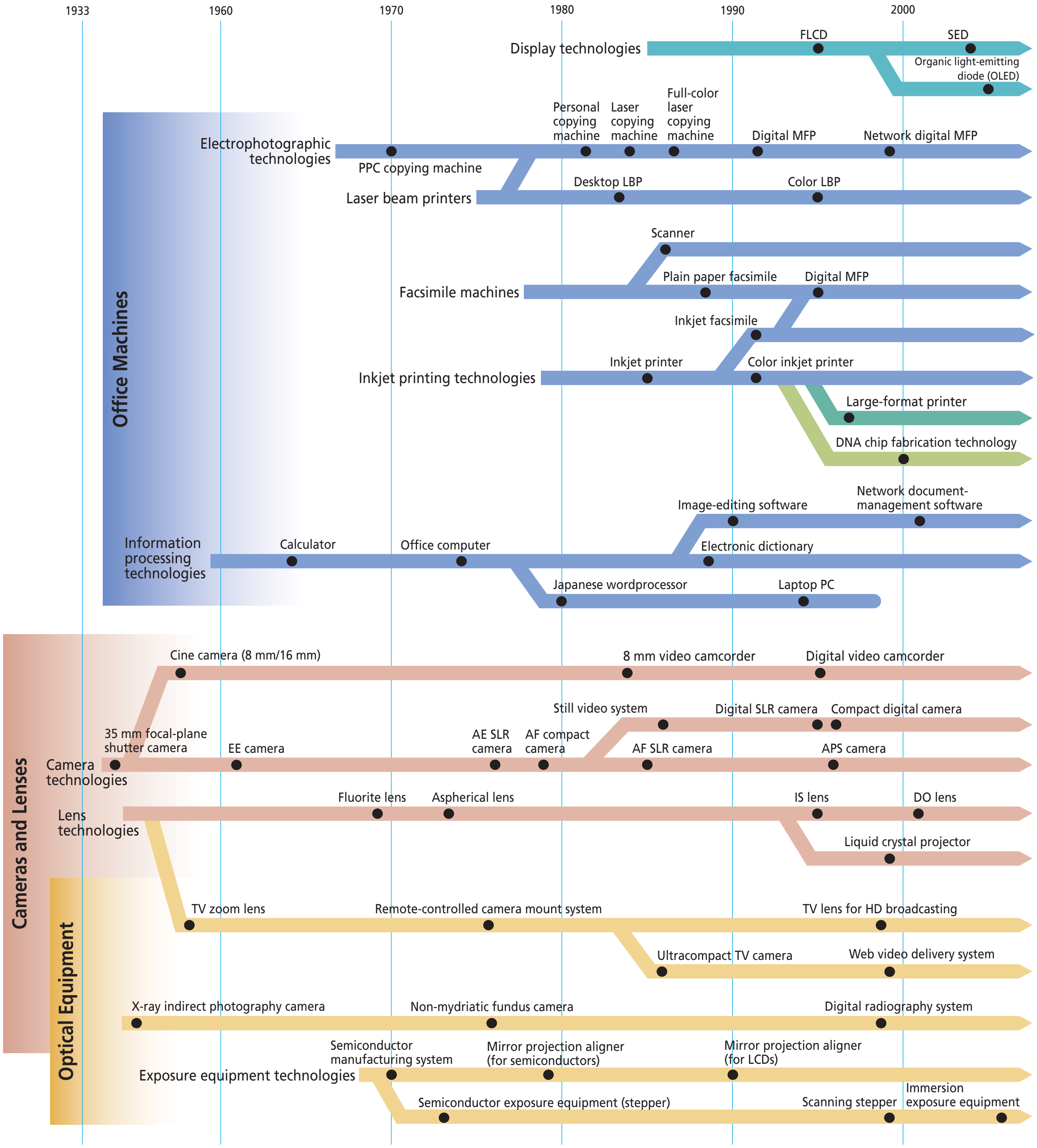
Canon was established in 1937 based on an ambitious vision — to build the world's best cameras.

Canon's history lies in the history of its technological developments. Canon has cultivated a wealth of optical technologies, precision-instrument technologies and electronics with the aim of achieving the ultimate in imaging performance. These disciplines have been integrated as optomechatronics technology, realized not only in Canon cameras, but also in copying machines and laser beam printers (LBPs), providing support for the company's diverse range of business operations and product lines. Canon proprietary technology has also led to the development of innovative inkjet printers and facsimile machines.

Canon's continuing pursuit of technology is reflected in the number of patents the company has registered in the United States, the heart of global business. Over the past 14 years, Canon has consistently ranked among the top three patent recipients, another indication of its status as a global technology leader.

By carefully nurturing the seeds of new technology born of research discoveries, Canon continues to breathe new life into products, making the Canon name synonymous with technology innovation.

Canon: A History of Technological Development



Patents Registered in U.S. from 1997 to 2005

2005		
1	IBM	2,941
2	Canon	1,828
3	Hewlett-Packard	1,797
4	Matsushita Electric	1,688
5	Samsung Electronics	1,641

Year	Number (Rank)	Year	Number (Rank)
2004	1,805 (3rd)	2000	1,890 (3rd)
2003	1,992 (2nd)	1999	1,795 (3rd)
2002	1,893 (2nd)	1998	1,928 (2nd)
2001	1,877 (3rd)	1997	1,381 (2nd)

CANON TECHNOLOGY
FUTURE

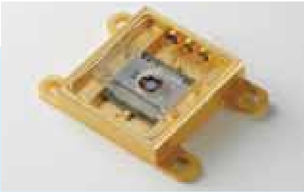
Pioneering Next-Generation Technologies: Canon's Ongoing Efforts to Make the Impossible Possible

Technology paves the path to Canon's future. In June 2005, the company completed its Leading-Edge Technology Research Center, an R&D base at Canon's headquarters in Tokyo. Equipped with state-of-the-art facilities, the Leading-Edge Technology Research Center supports research activities to further bolster core technologies and explore new business domains through the integration of Canon technologies. The Center also serves as a venue for management and in-house and outside researchers to share insight and engage in dialogue.

Canon is also actively involved in expanding research capabilities to explore completely new technologies and in promoting joint research with universities, university-affiliated research organizations, and other entities. And these research activities are not carried out only in Japan. R&D efforts are also conducted in various forms overseas. These diverse global activities provide Canon with the confidence to create innovative technologies for the next generation. At Canon, the pursuit of new next-generation technologies is a never-ending endeavor.

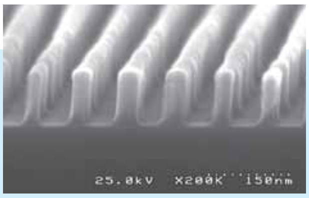
Canon Next-Generation Technologies for the Future

To realize further innovations for its Five Imaging Engines and to create new engines, Canon is focusing its energies on research in the field of next-generation technologies, including basic research, the development of leading-edge technologies, and the development of key components. Next-generation technologies will pave the path to Canon's future and support continued sound growth.



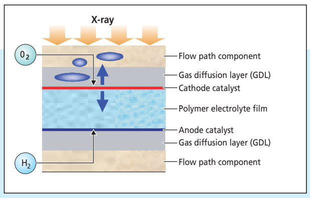
MEMS Technology

High-precision processing technology for ultracompact components based on exposure technology.



Near-Field Optical Technology

Near-field light, an area that had been largely neglected to date, makes possible next-generation lithography tools.

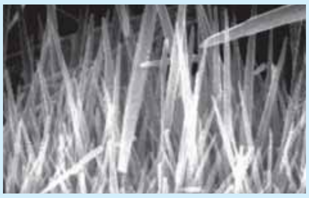


Material Analysis Technology

Material analysis technology, employing synchrotron radiation to make possible visualization technologies, is being put to use in the development of fuel cells.

DNA Chip-Fabrication Technology

DNA chip fabrication technology applies inkjet technology for dramatically improved efficiency in DNA testing.

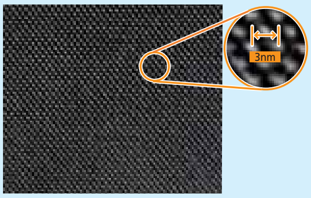


Inorganic Nanostructural Materials

Striving to create new devices and achieve high functionality through the merging of material self-assembly and process technologies.

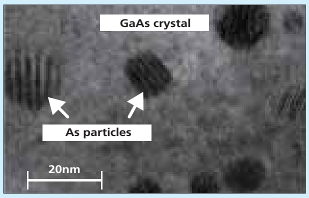
Mixed Reality Technology

Merging the virtual and real worlds to create simulations achieving higher levels of realism.



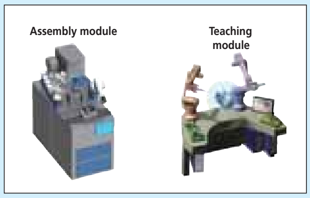
Mesoporous Materials

Mesopores on a scale of several nanometers offer unlimited potential for semiconductors.



Nanostructural Analysis Molecular Imaging Technology

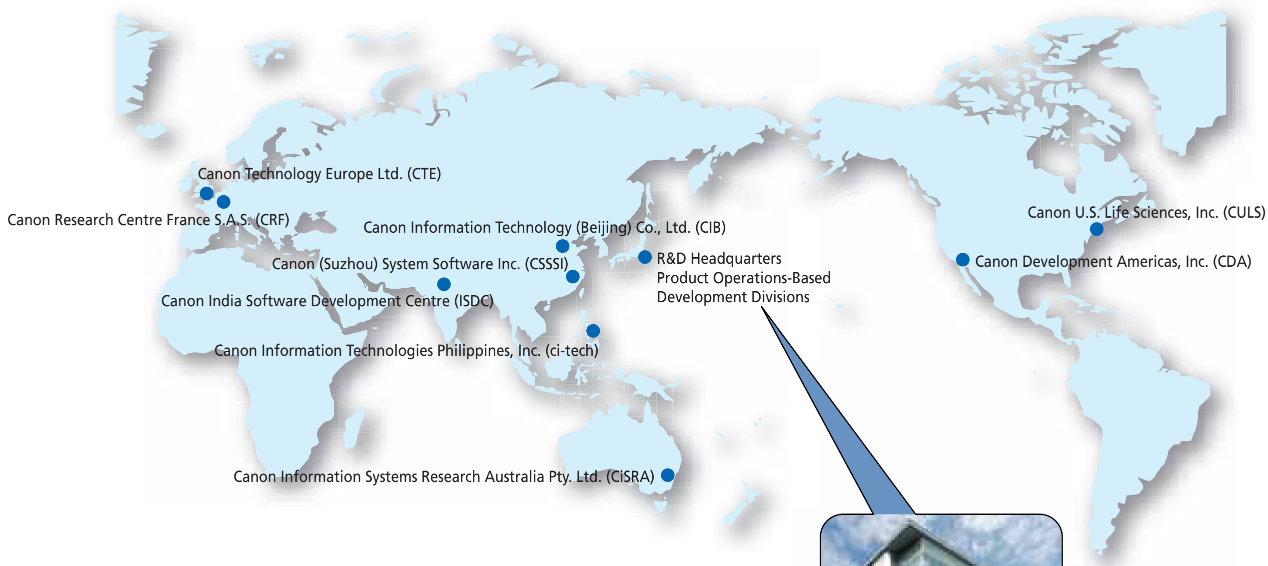
Supporting the development of new materials and products through the in-depth analysis of material structures and properties.



Robot System Technology

Robot eyes and hands capable of outperforming humans can make possible fully unmanned inspections and provide improved quality and precision.

Canon R&D Bases



Leading-Edge Technology Research Center —
supporting basic research to explore new business domains

Displays

While Canon's origins lie in the pursuit of optical technology, the company's pursuits have expanded to encompass imaging output, utilizing high-precision processing technology and electronics. Today, Canon's broad range of technologies includes displays capable of expressing human imagination through stunning high-quality video images. Capitalizing on a wealth of cutting-edge imaging technologies accumulated throughout its history, Canon is setting new standards in the field of video displays.

SED Next-Generation Flat-Screen Display

Large Screen, High Image Quality, and High-Speed Video Response

Digital HD broadcasting marks the advent of an era of high-definition and high image quality content, including the introduction of next-generation DVDs, home-use HD video camcorders, and other products in the years to come. To do justice to this content, displays must achieve even higher levels of image quality and offer larger viewing screens. Due to the nature of CRT (cathode ray tube) displays, larger screens mean significant increases in weight and depth. SEDs (Surface-conduction Electron-emitter Displays) represent the solution to this challenge.

● High-definition through self-emission

Like CRT systems, SEDs are self-emitting displays, based on a principle that utilizes the collision of electrons with a phosphor-coated screen. While offering the same fast video response and high contrast as CRTs, because they do not require laser beam deflection, SEDs combine a slim body design with high-definition, low-distortion imaging performance.

Electron emitters, which fulfill the role that the electron gun serves in CRT systems, are distributed in a number equal to the number of pixels on the display. The electron emitters, at the heart of the SED, are characterized by a "nanogap," an extremely narrow gap measuring only a few nanometers in width, formed between two electrodes on the electron-emitting layer. When voltage of approximately 10 volts is applied, electrons are emitted from one side of the nanogap. Some of the electrons are accelerated by voltage of roughly 10 kV applied between the glass substrates, striking the phosphor coating and emitting light.

● High efficiency for low power consumption

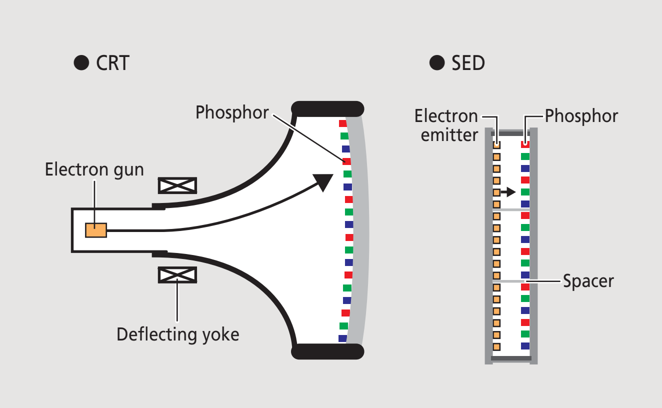
Compared with other types of displays, SEDs convert electric energy into light with greater efficiency, achieving higher luminous efficiency and low power consumption. The SED is an environmentally sound display technology to meet today's energy-conservation needs.

● Targeting low-cost production through semiconductor-production technologies

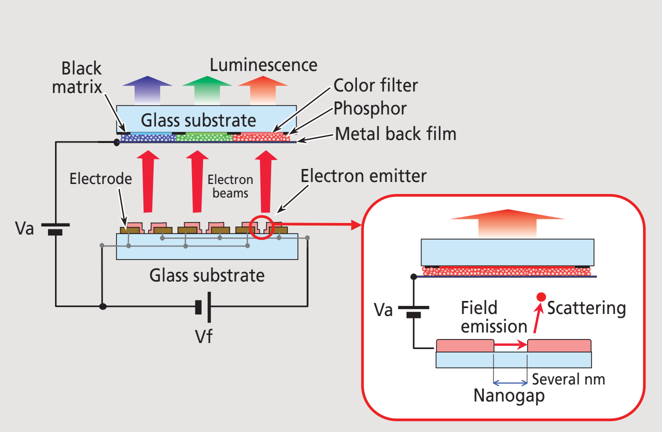
Applying inkjet printing technology, Canon's forte, to form the vast number of high-precision electron emitters in the SED, and printing technology to produce the matrix wiring, Canon is actively working to create the production technologies needed to manufacture these large-screen displays at low costs.

Canon began SED research in 1986 and, in 2005, Canon ANELVA Corporation, boasting expertise in vacuum technology, was welcomed into the Canon Group. With these efforts, the groundwork is being laid toward the commercialization high-image-quality, low-cost SED products.

SED Prototype



Comparison of CRT and SED



SED Structure

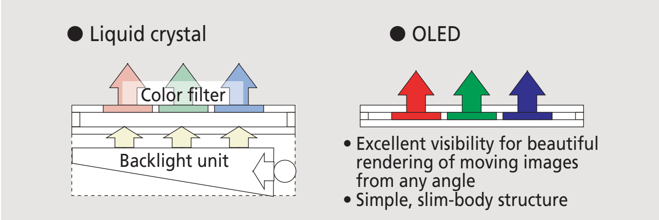
Organic Light Emitting Diode (OLED) Displays

Offering High Visibility Even Outdoors, the Ideal Next-Generation Display for Mobile Devices

OLED displays are garnering attention for use in such mobile devices as digital cameras. These self-emitting displays are based on the phenomenon of organic electroluminescence, which occurs when voltage is applied to excite organic materials sandwiched between two electrodes. When the materials revert to their original state after being excited, they release energy as light. Because they are self-emitting, these displays are remarkably bright and unlike liquid crystal displays, offer a wide angle of view. Additionally, the technology features fast response speeds and emits light while generating virtually no heat, ensuring low power consumption and making them ideally suited for use in mobile devices.

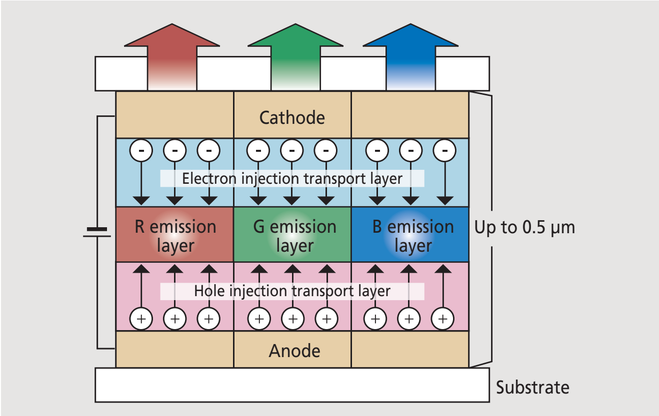
Leveraging photosensitive-material technologies for electrophotographic devices, Canon has developed original RGB light-emitting materials and carrier-injection materials for OLED displays, achieving levels of efficiency and color purity among the highest in the industry.

The top emission structure of OLED displays, a structure designed to convey light to the top of the emission layer, also provides a large NA, achieving high luminance, low power consumption, and prolonged life. Canon is currently devoting its energies to the development of device and process technologies for commercialization in the near future. The company aims to mass produce high-performance OLED elements at a low cost to achieve advanced functionality in mobile devices.



Comparison of Liquid Crystal and OLED Structures


Example of an OLED Display (Prototype)



Structure of OLED Display

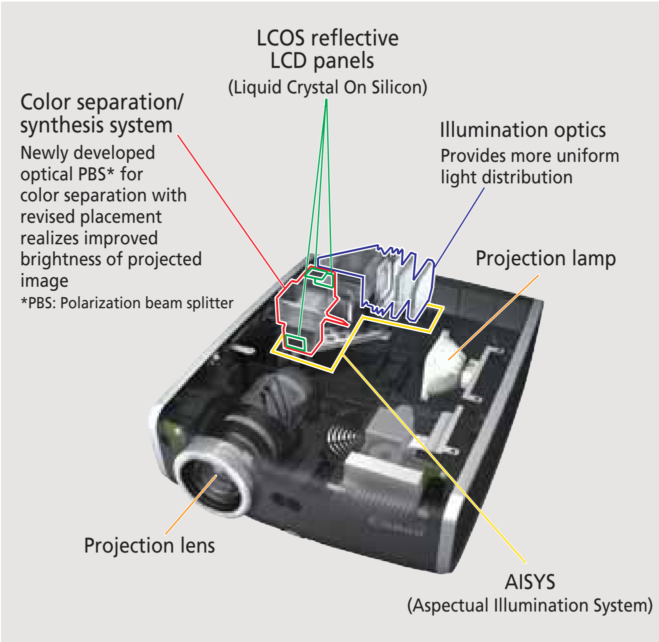
AISYS (Aspectual Illumination System)

New Optical System Enables Remarkably Compact Body with High Image Quality

Of the various microdisplays used in LCD projectors, LCOS panels are known for enabling projected images free of lattice-like grid patterns, making them ideal for use as high-resolution image display elements. Achieving both brightness and contrast, however, had proven extremely difficulty, which is why LCOS panels were not used in ordinary projector products.

To overcome this problem, Canon employed cylindrical lenses to develop the unique AISYS optical system. AISYS independently controls the vertical and horizontal components of light from the light source. It causes the vertical component to converge for enhanced brightness and changes the horizontal component into parallel beams to prevent light seepage in the PBS (polarization beam splitter) and LCOS panel, thereby ensuring high contrast. The system makes possible an LCOS panel LCD projector characterized by high luminance and image quality with a compact body size. The multimedia projector models SX6/SX60/X600 also employ a PBS with newly developed color-synthesis capabilities, ensuring compatibility between ever-smaller optics and higher image quality.

AISYS Illumination Optics Configuration Diagram



Power Projector SX6 Configuration Diagram

Next-Generation Technologies

To sustain sound growth, Canon aims to expand upon its Five Imaging Engines, creating future business based on new engines by boosting basic research, leading-edge technology development, key-component technology development, and next-generation research capabilities.

Robot System Technologies

Robot Eye and Hand Technologies that Coexist with Humans

With the goal of achieving robot eyes and hands capable of outperforming those of humans, Canon is currently carrying out R&D activities targeting three different approaches: robot eyes for high-accuracy visual inspections; robot eyes and hands for multifunctional assembly; and robot eyes and hands to coexist with humans.

●Robot eyes for high-accuracy visual inspections

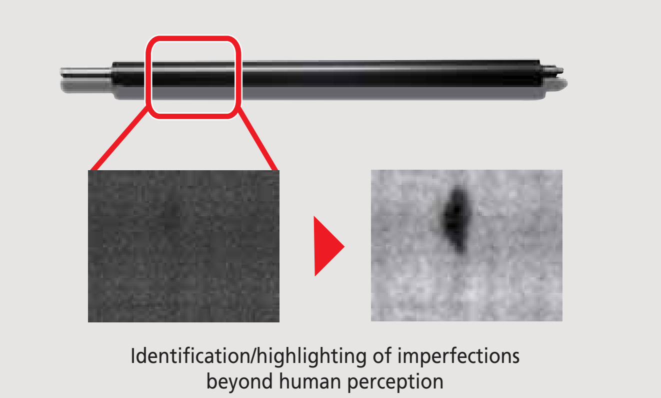
Targeting production-engineering applications, Canon is currently developing a robot capable of conducting visual inspections. Such inspections for components used in copying machines, for example, require the high-speed, high-accuracy identification of even the slightest surface imperfections, conditions largely beyond human perception. Visual inspection robot technology, equipped with advanced intelligent sensors that outperform the human eye, can pave the way for a revolution in production-engineering technology, facilitating fully unmanned inspections, improved quality and precision, and fully automated assembly processes.

●Robot eyes and hands for multifunctional assembly

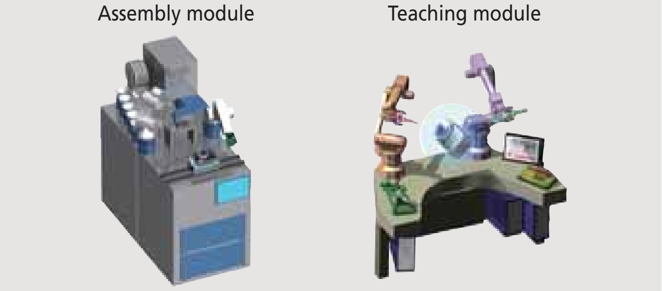
In addition to visual information obtained by a vision module, assembly robots require elemental technologies encompassing force sensors designed to sense applied pressures, and motion-control technologies that reproduce the agile movements of human fingers. Moreover, the development of visual-information synchronization and feedback-control technologies will pave the way for establishing deformable-object-handling technologies, which represents an extremely difficult challenge, raising hopes for multifunctional robots capable of handling multi-product, variable-volume production, or learning robots capable of learning movements under varying circumstances.

●Robot eyes and hands to coexist with humans

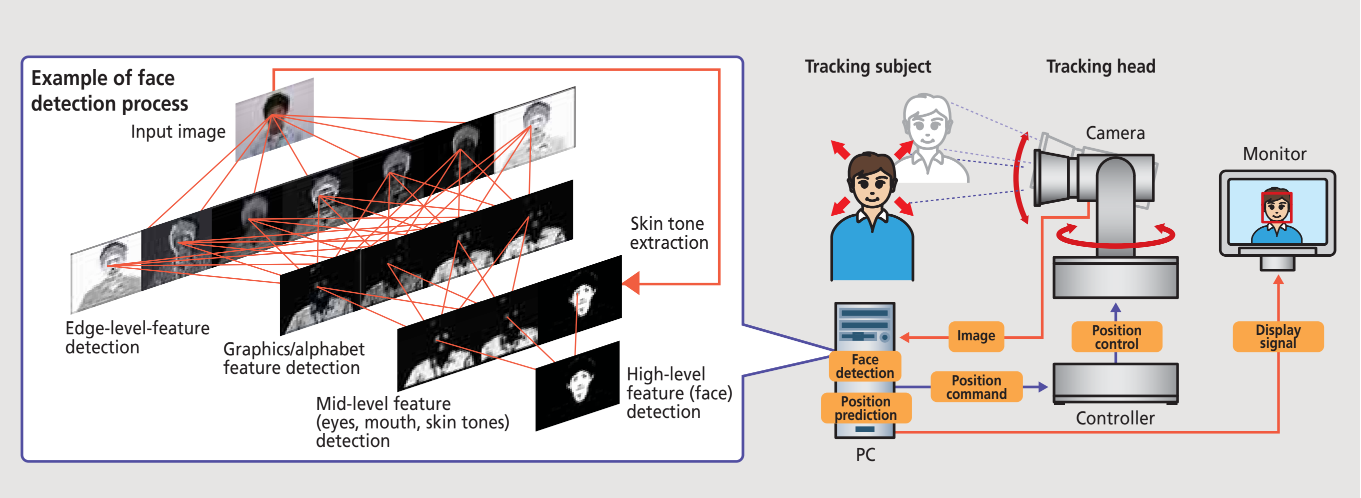
Assistance robots must be able to recognize human movements and synchronize their movements accordingly. Canon's proprietary Face Detection Algorithm was developed as an elemental technology. A highly accurate detection technique capable of recognizing moving subjects, the technology extracts local facial features, and hierarchically integrates and learns the features for detection. Development began with an automatic face-tracking camera that integrates high-speed face-detection and tracking algorithms, and coordinated software- and hardware-control technologies. As a face-tracking camera, the technology achieves a level of response performance among the highest in the world. In the future, Canon will enhance the recognition and sensing capabilities of this technology and integrate them with deformable-object-handling technologies to create robots for coexistence with humans.



Visual Inspection Using a Robot Eye



Conceptual Image of Assembly Robots



Face detection Process and Automatic Face-Tracking Camera

Mixed Reality Technology

Merging the Virtual and Real Worlds into a New Reality

MR (Mixed Reality) refers to imaging technologies designed to seamlessly integrate the real and virtual worlds in real time. As advances in digital technology fuel a steady increase in 3-D video data with each passing year, demand is on the rise for visualizing such data in a 3-D format. MR is playing a role in this new era of imaging technology.

● Head-mounted display (HMD)

Canon is developing a unique video see-through HMD, a key MR technology device that incorporates a compact built-in camera. The Canon HMD aligns the optical axes of the camera and display optical systems to eliminate parallax between the lines of sight of the observer and the camera. When wearing the HMD, computer-generated (CG) virtual objects appear to exist in real space, enabling users to easily grasp the scale of the virtual objects within real-world surroundings.

● Image-alignment technology

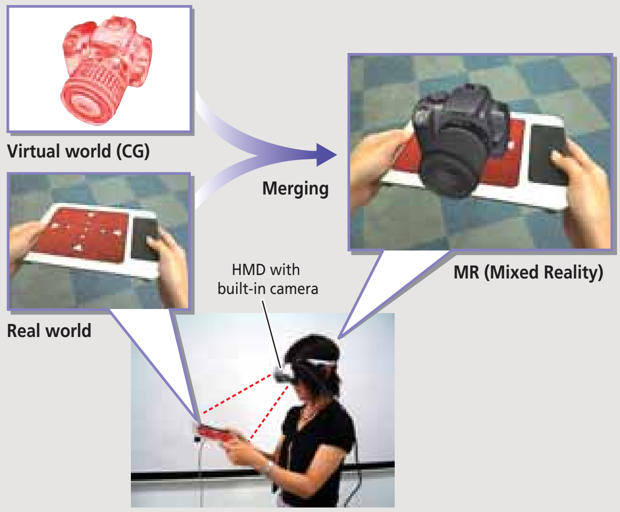
The key to enabling MR technology for practical use is eliminating discrepancies in alignment, timing and imaging when merging the real and virtual worlds.

In order to ensure proper alignment between the real and virtual worlds, it is necessary to calculate in real time the position and orientation of the observer's head within the three-dimensional real world. To address this need, Canon is developing hybrid approaches that combine sensors and advanced image-processing technology.

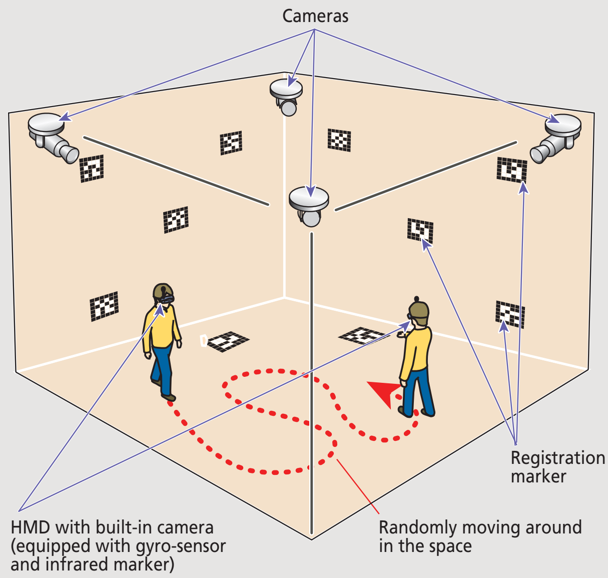
More specifically, the Canon system combines the HMD's built-in camera, independent cameras located in the real world, and a gyroscopic sensor contained in the HMD. Compared with the effective operational range of around 1 meter achieved in earlier attempts, the current technology allows users to experience mixed reality while moving around within a wider area. Canon aims to further improve the precision of its MR technology while developing the system for use in a broad range of applications.

● Use of MR technology

The application of MR technology to digital prototyping is currently underway. In the case of car body design, for instance, the system enables designers to view a vehicle as it would appear if parked on a city street, allowing them to inspect such design factors as the overall appearance, styling details, and color variations. MR technology enables the viewing of realistic three-dimensional products that have still yet to be created. As such, it enables a variety of simulations from the initial design stages, facilitating valuable exchanges of opinions between related product-development divisions. Exploring industrial applications of this technology is expected to yield such benefits as shorter development times and fewer prototyping cycles.



Overview of MR Technology



Registration Combining Image Processing and Gyrosensor

● Real image

● MR image

Example of an MR Technology Application

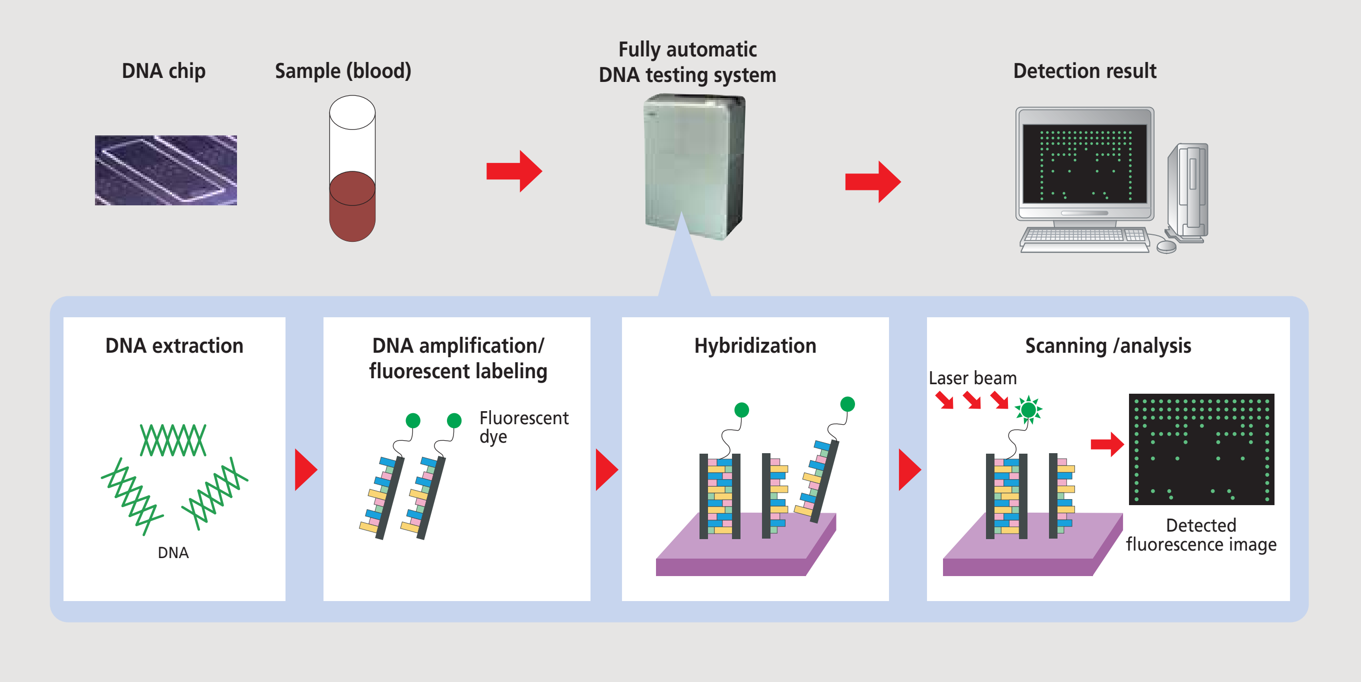
DNA Chip-Fabrication Technology

Speedy Diagnostics by Dramatically Improving Efficiency in DNA Testing

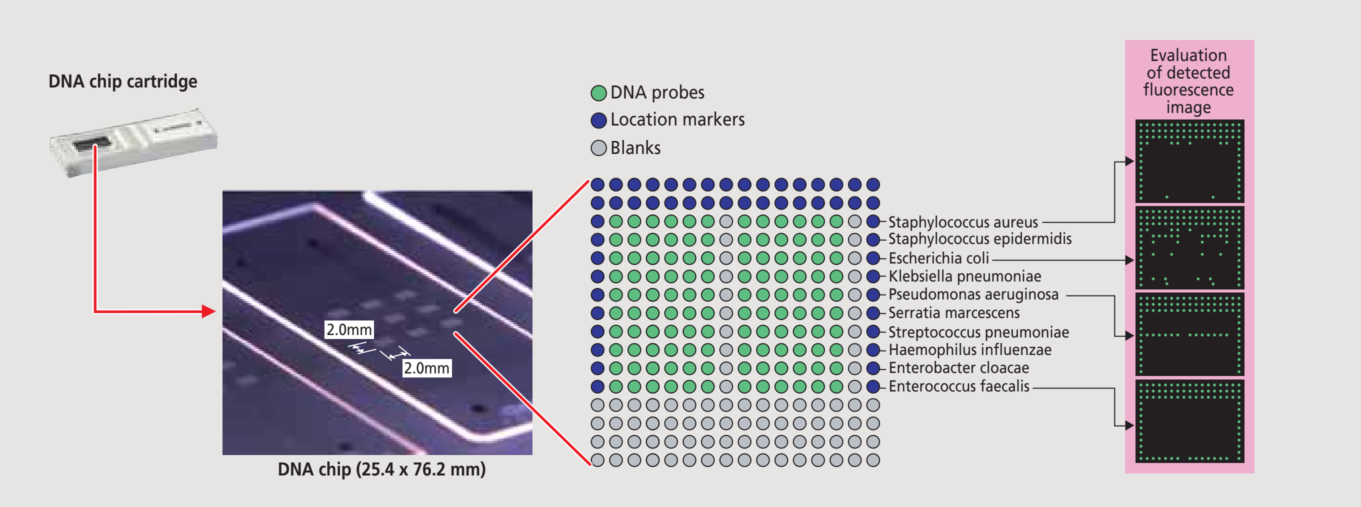
DNA chips consist of an array of DNA probes (artificially synthesized DNA segments) immobilized on the surface of a glass or other substrate. When the DNA probes are allowed to react with sample DNA extracted from a specimen, researchers can simultaneously detect multiple types of DNA. Various DNA probes can be placed on a chip according to the purpose of the test, enabling the detection of DNA mutations which cause cancer or other diseases, DNA indicating differences in genetic make-up, and DNA of microbes that have invaded the body. DNA testing using DNA chips ensures dramatically faster diagnosis, holding promise for the realization of treatments optimized for each individual patient by accurately identifying types of diseases and stages of progression.

Canon has developed an inkjet head specially designed for DNA chip fabrication that incorporates extremely small tanks to hold 1,000 varieties of DNA probes. Simultaneously printing 1,000 types of DNA probes makes it possible to fabricate highly reliable DNA chips accurately and in large quantities. In addition to ordinary analysis methods, Canon also led the world in developing a technology for visualizing DNA probes on glass substrates.

These technologies will enable stable supplies of high-quality chips suited to clinical applications. The company has already initiated development of a fully automatic DNA testing system that makes possible even faster and more accurate DNA testing.



Fully Automatic DNA Testing System



Example of a DNA Chip for Infectious Disease Diagnosis

Inorganic Nanostructural Material

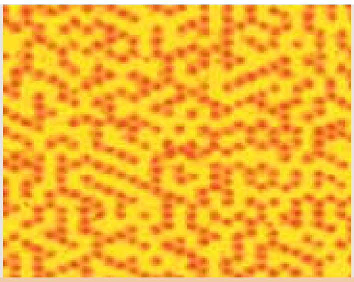
Creating New Devices with Nanostructural Materials

Canon is conducting research into inorganic nanostructural materials to create more highly controlled structures by merging the self-assembling properties inherent in the materials themselves with conventional process technologies. This research is expected to yield such devices as ultra-high density memory media and photonic elements.

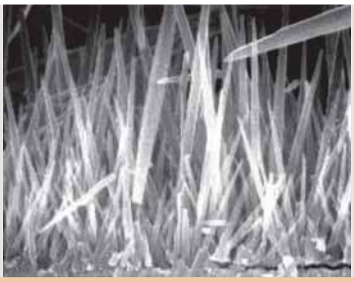
One example of inorganic nanostructural materials is anodized aluminum. Countless aluminum nanoholes are formed when aluminum film is anodized in an acid solution. Canon has succeeded in aligning nanoholes of various dimensions into regular arrangements and in transforming the bottoms of the nanoholes into electrodes.

By filling the regularly arranged nanoholes with magnetic substances, Canon is exploring potential applications for an ultra-high-density magnetic recording medium called "patterned media."

Canon is also conducting research into nano-oxide crystallization, including the fabrication of zinc oxide (ZnO) nanowhiskers by means of a plating process. Taking advantage of ZnO's properties as a transparent semiconductor, Canon is studying applications of this technology to dye-sensitized solar cells.



Nanostructural Material Filled with Magnetic Substance



Zinc Oxide (ZnO) Nanowhiskers

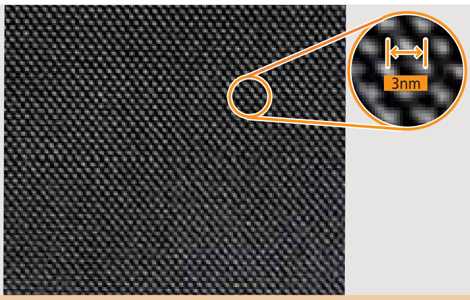
Mesoporous Materials

Facilitating Microscopic Control

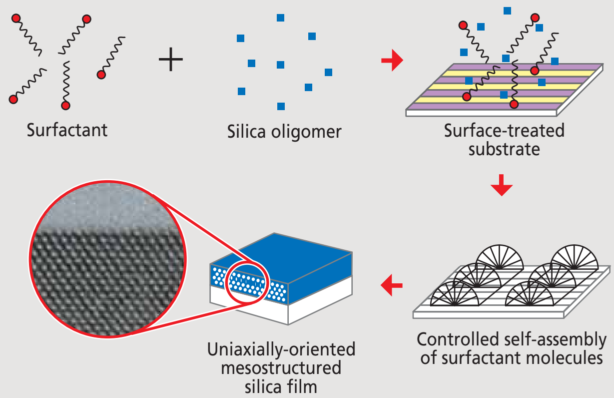
Discovered in 1992, mesoporous materials are porous materials with regularly arranged, uniform mesopores (2 nm to 50 nm in diameter). Their large specific surface area, as high as 1,000 m^2/g, makes them useful as catalysts or adsorbents.

Canon has established the technology required to form mesoporous silica films with aligned tubular mesochannels of 3 nm in diameter on a glass substrate. The film is formed by holding a glass substrate in an acidic reactant solution containing a surfactant and silica-oligomer. The key to Canon's success is a unique surface treatment which aligns the surfactant molecule assemblies on the substrate. When the reaction is maintained in the solution for approximately three days, a thin silica film containing directionally aligned tubular mesochannels forms on the surface-treated glass substrate. Further, it is possible to control the diameter of the pores.

Mesoporous materials have potential for a wide variety of applications. A small laser array can be fabricated using a patterned mesoporous silica film by incorporating dyes into the mesochannels. A solid electrolyte can be obtained by incorporating ion-conductive materials, and a fluorescent film can be prepared by incorporating small silicon clusters. These remarkable nanoscale materials are set to open a new gateway to future technologies.



TEM (Transmission Electron Microscope) Image of Mesoporous Material



Formation Process for Aligned Mesoporous Silica Film

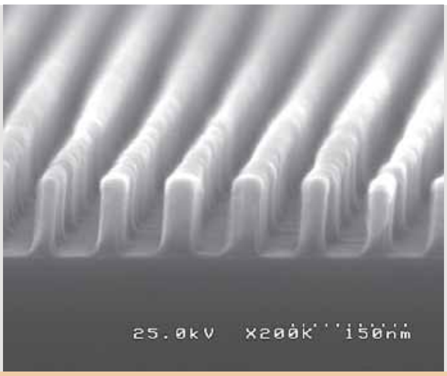
Near-Field Optical Technologies

Micropatterning on the Nanometer Scale

With conventional optical technologies, the diffraction limit makes it impossible to achieve beam diameters smaller than half the wavelength of the light source. But, using near-field light — light generated around the irradiated material — enables the formation of extremely small beam spots that are unaffected by the diffraction limit.

Canon has developed a metal film with through-pores and grooves of 100 nm or smaller and is conducting research on lithography technologies to use this film as a photomask. Producing near-field light on the mask surface and using this light for exposure makes it possible to create resist patterns of 1/10 or less the width of the wavelength of the light source.

Canon is working to develop this near-field mask exposure technology with the aim of applying it to next-generation lithography tools capable of micropatterning on the order of several tens of nm without the need to use large-scale equipment. Development of near-field optical technologies also holds the promise of applications for optical-recording and micro-optical devices.



Nano Resist Pattern Using Near-Field Mask Exposure

MEMS Technology

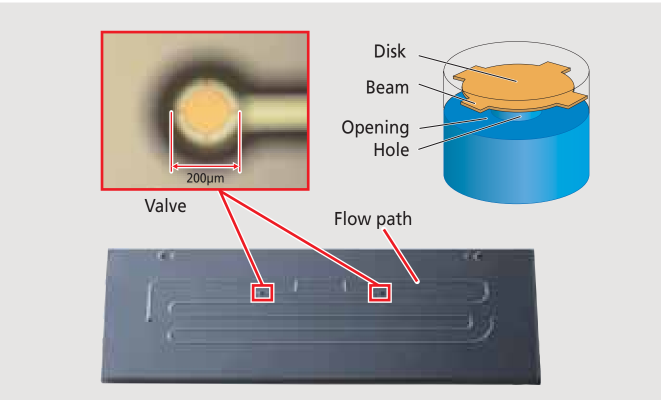
Opening the Way to the Future with Micromechanical Devices

MEMS (micro electro mechanical system) refers to the technology of fabricating micromechanical devices. Canon's MEMS technology has already been introduced into manufacturing processes for inkjet printer print heads, sensors, and optical devices to achieve high-density machining of components and high-precision head manufacturing. Canon is also actively pursuing MEMS machining technologies for next-generation products, with research currently underway in such areas as microvalves and micromirrors.

● Microvalves

Microvalves — valves with a diameter roughly equivalent to that of a human hair — are used to control the flow of minute amounts of liquid. The microvalves developed by Canon open or close through liquid pressure, which is used to press a silicon semiconductor disk against the hole, making it possible to control opening and closing depending on the flow speed of the liquid.

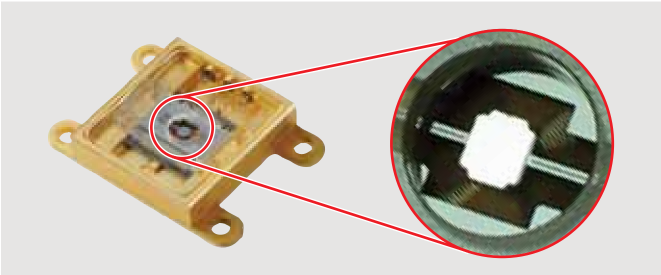
If a small chemical reaction chip that incorporates such micro valves can be produced, it would make possible such advancements as a multi-diagnosis chip capable of various diagnostics using a single drop of blood, or a palm-sized chemical reaction system capable of efficiently synthesizing chemical substances.



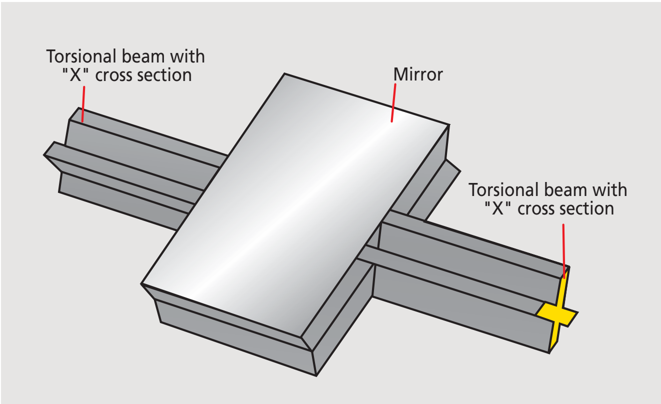
Microvalve Shape and Mechanism

● Micromirrors

Unlike conventional polygon mirrors, micromirrors do not rotate, but instead oscillate back and forth to scan laser beams. These tiny mirrors, measuring 1.3 x 1.5 mm with a thickness of 0.2 mm, are fabricated from silicon wafers. An X-shaped torsional beam above and below the mirror ensures stable operation. These mirrors hold promise for applications in next-generation laser-scanning displays and optical switches.



Micromirror



Micromirror Structure

Material Analysis Technologies

A Quest for the Essence of Unknown Substances

Raw materials research and verification technologies are essential for developing unique materials, devices, and products. In collaboration with research organizations, both in Japan and overseas, Canon is currently devoting its energies to developing new material analysis technologies that incorporate the latest findings from academic research.

●Nanostructural analysis

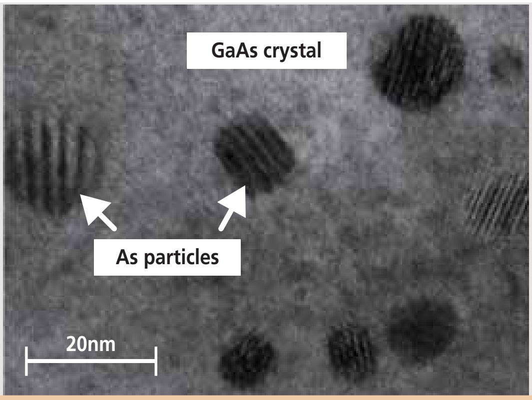
Crystal structure analysis is critical for developing new materials. Within its R&D activities, Canon is currently employing nanometer-level structural analysis by conducting internal structural observations of materials with transmission electron microscopes (TEMs), and surface structure observations of materials with scanning electron microscopes (SEMs). For example, through the company's development of THz electromagnetic wave-generation/detection devices using optical switches, observations of low-temperature-grown gallium arsenide (GaAs) crystal thin film, a device material, with high-resolution TEMs has clarified the relationship between the distribution condition of As particles in thin films and the efficiency of THz electromagnetic wave generation.

●Molecular imaging technologies

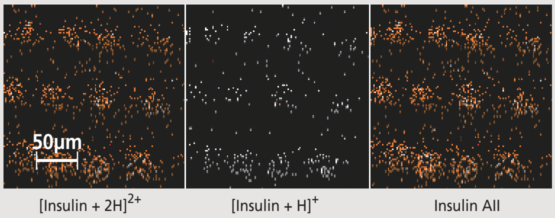
Canon has developed a tool capable of visualizing protein distribution at the sub-micrometer level with TOF-SIMS (time of flight secondary ion mass spectrometry) and inkjet printing technology to support research efforts in various biotechnology-related fields. MALDI (matrix-assisted laser desorption/ionization) is a "soft" ionization method that avoids the fragmenting of the protein, but does not facilitate the obtaining of a two-dimensional distribution image with a high spatial resolution. Using TOF-SIMS it is possible to obtain a secondary ion image with a high spatial resolution, but as protein molecules are large, the approach results in decomposition, making it difficult to distinguish protein types. Canon, by combining the advantages of the MALDI method with its high-precision inkjet microdroplet-ejection technology, has made possible the printing of a uniform layer of ionization-enhancing agents such as insulin onto a specimen. The technology succeeds in enabling the identification of protein types and the visualization of the two-dimensional molecular distribution for each type.

●Using synchrotron radiation

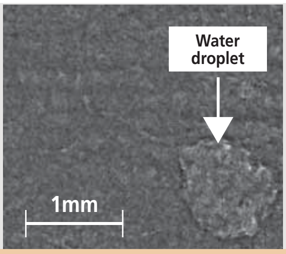
By making use of SPring-8, Japan's premier synchrotron radiation facility, Canon has developed a technology for dynamically visualizing water generated in fuel cells, which the company is applying toward fuel-cell development.



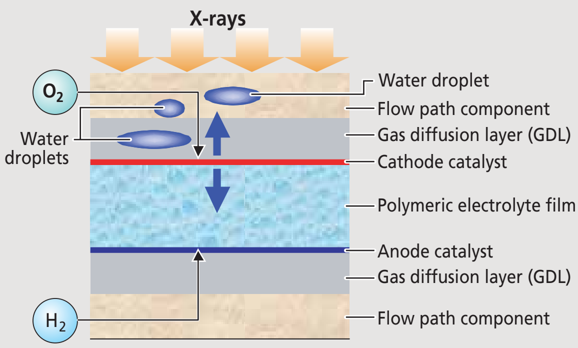
TEM Photo of As Particles in Gallium Arsenide (GaAs) Crystal
Stripes of particles create a moiré pattern arising from differences in structure between GaAs and As crystals.



Analysis Result for Demonstration Sample with Insulin (molecular weight: 5733) Arranged in Dot Formations



Water Droplet Generated in a Fuel Cell, Visualized by SPring-8



Cross-Sectional Illutration of Fuel Cell

Compact Digital Cameras

Canon compact digital cameras package a variety of functions into a small body. Their high image quality and high functionality, in addition to outstanding portability and ease of use, have won the loyalty of a wide range of users. The PowerShot and PowerShot DIGITAL ELPH (DIGITAL IXUS) series are the result of Canon's years of experience as a camera manufacturer and the company's advanced technologies, including leading-edge optical technologies, high-density mounting technologies, electronic device technologies, and color management technologies.

Shutter button

Zoom lever

Digital Image Processor (DIGIC III)

→ P.17 DIGIC III
→ P.17 Face Detection Technology
→ P.17 iSAPS Technology

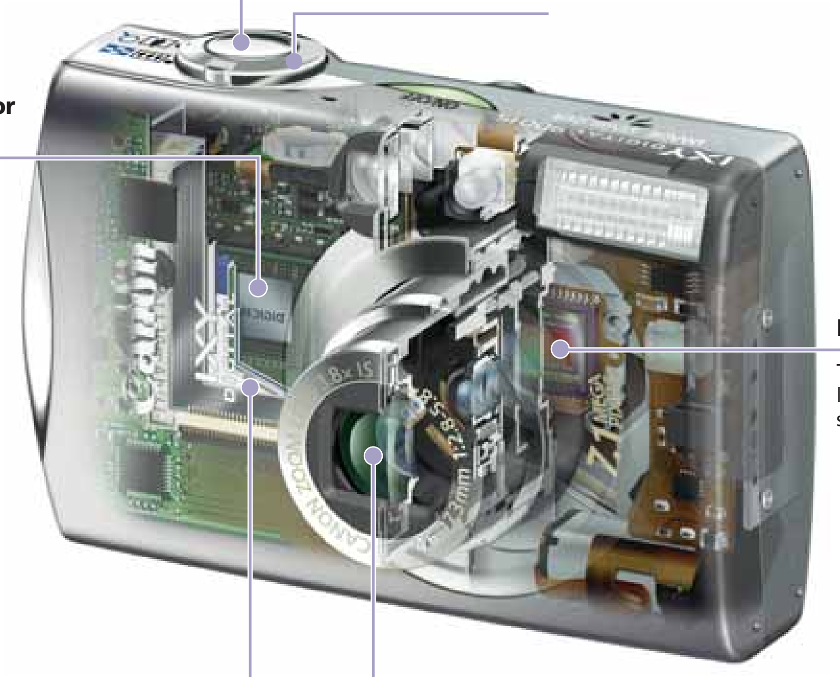


Image Sensor

The CCD image sensor detects light and converts it into electric signals

Memory Card

Uses a high-speed, high-capacity SD/MMC memory card as the recording medium

Lens Unit

→ P.16 Ultracompact Lens Unit

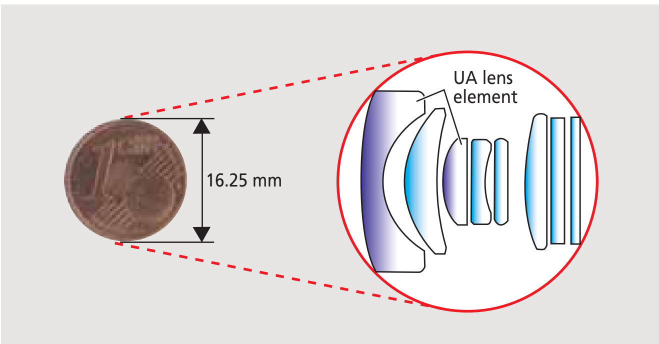
Ultracompact Lens Unit

Fitting a 3x Optical Zoom Inside a Compact Body

Canon's PowerShot DIGITAL ELPH (DIGITAL IXUS) series digital cameras package high image quality and high functionality in a compact body. Their slim and lightweight bodies are made possible by the development of an ultracompact lens unit utilizing Canon's advanced optical technologies.

For example, the PowerShot SD600 DIGITAL ELPH (DIGITAL IXUS 60) incorporates a 3x optical zoom lens with a focal length of 5.8-17.4 mm (equivalent to 35-105 mm in 35 mm film format) within a space measuring 20.2 mm in depth. The lens unit employs two proprietary glass-molded (GMo) UA (Ultra high refractive index Aspherical) lens elements within a five-group/six-element configuration. Since UA lenses have a significantly higher refractive index than ordinary aspherical lenses, the lens unit could realize an unparalleled compact size. Revising the aperture, shutter and lens-barrel structure also contributed to the achievement of a smaller lens unit. The total size of lens unit is small enough to fit onto a one-cent euro coin (16.25 mm in diameter).

But this ultracompact lens unit isn't just small. In addition to an aspherical lens element, it incorporates an optimal combination of lenses with various optical characteristics, such as two lenses with different optical characteristics bonded together, to deliver the clear, sharp images that are the hallmark of Canon camera lenses.



PowerShot SD600 DIGITAL ELPH Lens Unit

DIGIC III

Dramatically Improved Processing Capabilities from Advanced, Newly Designed Imaging Processor

Light entering a digital camera through the lens is converted into electric signals by an image sensor. The digital image processor removes noise from the signal and generates image data with natural color reproduction and rich gradation. DIGIC is a high-performance image processor developed by Canon. Operating with a Canon-original algorithm designed to minimize CPU loads, DIGIC handles such processing tasks as reducing false colors and moiré, and canceling noise during long exposures, with exceptional speed.

DIGIC III achieves advanced imaging performance, including faster computing speeds, noise reduction for high-sensitivity image capture, and higher resolution LCD monitor signal output. Moreover, the processing and memory components are configured in a stacked structure to conserve space.

DIGIC III Digital Imaging Processor

Face Detection Technology

Detecting Faces and Adjusting Focus and Exposure

DIGIC III incorporates a Face Detection function that can distinguish human faces in the picture plane and adjust the focus and exposure accordingly. Face Detection AF detects and adjusts focus to a face identified in the picture plane. The Face Detection AE automatically sets the exposure to prevent a person's face from being washed out or covered in shadow. This function ensures optimal focus and exposure, even in backlit or dark settings.

Face Detection AF Function

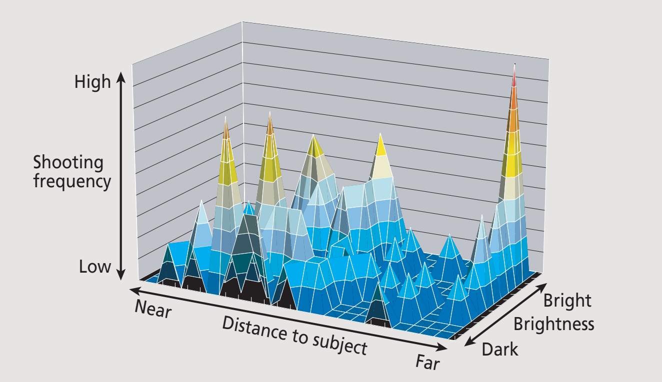
Face Detection AE Function

iSAPS Technology

Making Possible High-Speed, High-Precision Control

Over many years of camera development, Canon has collected a huge volume of photographic data and made extensive statistical analyses of the correlation between focal length and zoom settings, and surrounding brightness and subject-to-camera distance. Based on this data, Canon developed iSAPS (intelligent Scene Analysis based on Photographic Space) technology, which envisages the scene to be photographed and selects optimal settings of key functions.

As the user prepares to take a picture, iSAPS estimates the subject-to-camera distance based on the focal length, zoom position and surrounding brightness. It also estimates the camera-to-subject distance by factoring in parameters based on previous shots. iSAPS High Speed AF predicts in advance the focus position based on previously analyzed scenes. Since a correction of the pre-estimated position is all that's needed at the time of actual shooting, less time is required for focusing. iSAPS Intelligent AE/AWB applies optimal algorithms for each shot according to the shooting mode selected by the user, assuring fewer mistakes thanks to more precise exposure and white balance commensurate with the selected mode and surrounding environment.

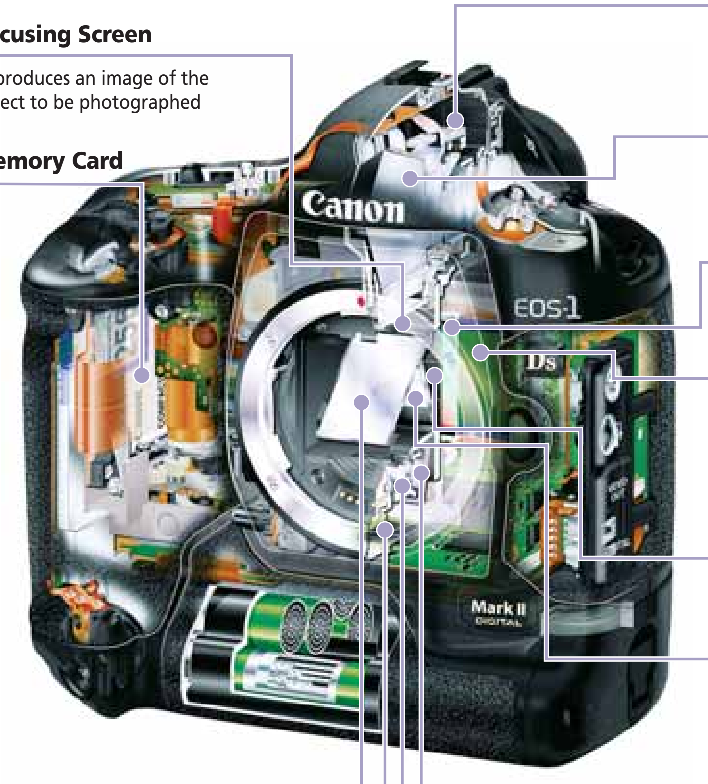


"Photographic Space" Database
(Analysis of subject position based on a given focal length)

SLR Cameras

Originally founded as a camera company, Canon has cultivated the most advanced optical technologies in its pursuit of the ideal single-lens reflex (SLR) camera. The company continues to be a front-runner in today's digital age, developing proprietary digital image sensors and processors that produce high-quality images. Canon will continue to produce innovative products, expanding the boundaries of photography and opening up a new world of imaging possibilities.

■ **Digital SLR Camera**



Focusing Screen

Reproduces an image of the object to be photographed

Memory Card

Metering Sensor

21-zone metering sensor linked to 45-point area AF

→ P.20 Multiple-Zone Evaluative Metering

Pentaprism

Rotates the image on the focusing screen 180 degrees into an erecting image for viewing through the viewfinder

Low-Pass Filter

→ P.18 Infrared-Cut Low-Pass Filter

Image Sensor

Detects light and converts it into electrical signals (comparable to the film in a film camera)

→ P.19 Full-Frame 35 mm CMOS Sensor
→ P.61 Pixel-Reduction Technology

Shutter

Opens during exposure to allow light to reach the image sensor

Submirror

Elliptical-shape mirror that directs light to the AF sensor and the secondary image-formation lens

Main Mirror

Guides light from the lens to the focusing screen, metering sensor, and viewfinder. During exposure, it flips up to open a path for light to reach the image sensor

Area AF Sensor

Employs a dedicated sensor capable of high-speed data reading to calculate the distance between camera and subject using four images with different parallax

→ P.20 Area Autofocus

Image Processor

The DIGIC high-speed image processor converts electrical signals into image data

Secondary Image-Formation Lens

Splits light from the submirror into four paths, forming four images on the CMOS area AF sensor

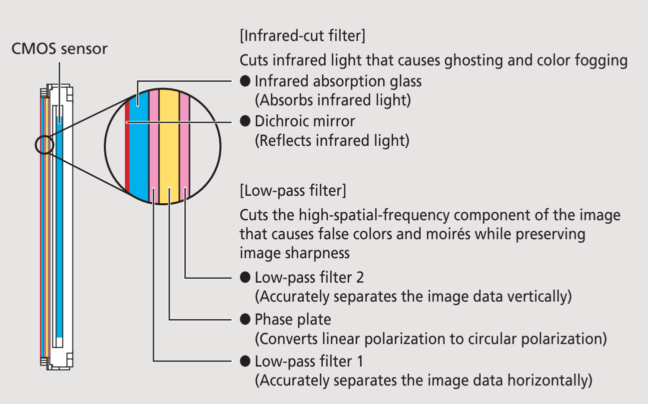
■ **35mm SLR Film Camera**

Infrared-Cut Low-Pass Filters

Reducing False Colors and Moirés

The appearance of false colors — colors not found in the actual subject — and moiré patterns are phenomena specific to digital cameras. They occur when light of high spatial frequency (typically in fine patterns or boundaries between light and dark areas) enters only a single pixel, causing the light to be perceived as a color different from the original color.

The optical low-pass filter, located directly in front of the CMOS sensor, is designed to reduce these problems. Canon developed a new three-layered optical low-pass filter in response to increasing CMOS pixel counts. Two of the three layers are single-crystal substrates that separate the image data into horizontal and vertical directions. To preserve image sharpness while cutting the high-spatial-frequency component of the image that causes false colors and color moirés, a phase plate designed to apply circular polarization to light is sandwiched between these substrates and the image data is accurately separated. Additionally, this optical low-pass filter features a hybrid structure that incorporates an infrared-cut filter to suppress ghosting and color fogging.



Structure of Low-Pass Filter

Full-Frame 35 mm CMOS Sensor

Realizing High Resolution and High-Speed Transfer

Users familiar with conventional 35 mm SLR film cameras generally know how they want to render their subject and have a rough idea of how the picture will look in terms of perspective based on such factors as the focal length of the interchangeable lens used. Image sensors (CCD and CMOS sensors) in most digital SLR cameras, however, are smaller than the size of a single frame of 35 mm film (36 x 24 mm). To correctly estimate how the subject will look, it is necessary to calculate the difference compared to a frame of 35 mm film, based on the focal length of the interchangeable lens used.

In 2002, Canon developed its own full-frame 35 mm CMOS sensor, measuring 36 x 24 mm, and incorporated it into the company's top-of-the-line EOS-1Ds digital SLR camera. This development enabled users to utilize the full range of interchangeable lenses for EOS-series SLR cameras, ensuring faithful angles of view and perspectives according to the lens's focal length.

Furthermore, in 2004, Canon developed a second-generation CMOS sensor boasting exceptional image resolution with approximately 16.7 million effective pixels.

● Partition exposure technology

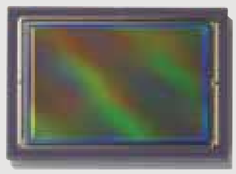
Canon's semiconductor-production technologies (→ P.60) played a major role in the development of the full-frame 35 mm CMOS sensor. The company developed a high-precision partition exposure technology for the manufacturing process wherein each sensor is exposed three times. This process enables the production of large, high-resolution CMOS sensors at relatively low cost.

● Eight-channel high-speed reading technology

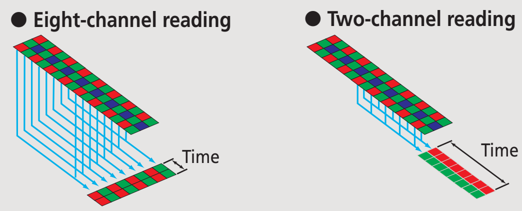
The challenge associated with image sensors of approximately 16.7 million pixels is how to read huge volumes of image signals at high speeds. CMOS sensors offer higher reading speeds than CCD sensors, but in order to increase reading speeds even more, Canon developed a reading technology that utilizes eight channels to simultaneously transfer signals from each line of the image sensor. This technology improved reading speeds to four times that of conventional CMOS sensors, which used only two channels.

● CMOS sensor design technology

To realize rich color expression from highlights (brightest areas) to shadows (darkest areas), Canon developed a CMOS sensor with a structure that allows each pixel to store more electrical charge, allowing a higher saturation point. As a result, the CMOS sensor achieves a dynamic range on par with that of conventional reversal film.



Full-Frame 35 mm CMOS Sensor



High-Speed Eight-Channel Parallel Reading Technology

EOS Integrated Cleaning System

Comprehensive Measures Against Sensor Dust

The EOS Integrated Cleaning System (EOS I.C.S.) incorporated into the EOS DIGITAL REBEL XTi (EOS 400D DIGITAL) is a generic name for Canon's technology for minimizing sensor dust, which is specific to digital SLR cameras. The company focused attention on a series of processes from dust generation to adherence and removal, and came up with a variety of stop measures.

● Mechanisms and materials to minimize dust generation

In addition to employing materials and a construction that help prevent the buildup of dust inside the camera, the camera's exterior uses scratch-resistant material in such places as the body cap for the EF mount.

● Anti-static technologies to minimize dust adherence

The infrared-cut low-pass filter located right in the front of the CMOS sensor employs an anti-static mechanism to minimize dust from static cling.

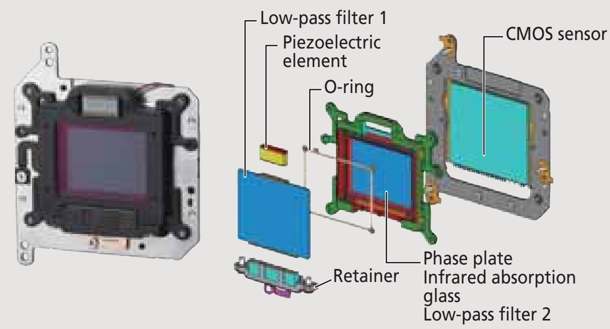
● Self Cleaning Sensor Unit that removes dust*

The Self Cleaning Sensor Unit consists of the CMOS sensor, which features a sealed structure to keep out dust and the infrared-cut low pass filter; a Sensor Cleaning Mechanism, which uses ultrasonic vibrations to shake off any dust that may accumulate on the surface of the low-pass filter; and peripheral components to adsorb dust shaken off from the filter's surface. Users have the choice of two sensor-cleaning modes: Auto mode, which operates for about one second when power is turned on or off, and Clean Now mode, which is accessible through the menu interface.

● Digital Photo Professional 2.2 Dust Delete function

The position of dust particles that continue to stick to the infrared-cut low-pass filter surface after sensor cleaning are detected by the CMOS sensor and added to the image as Dust Delete Data. Dust Delete enables shadows from dust that may not have been shaken off by the Self Cleaning Sensor Unit to be removed after shooting using the bundled RAW-image-processing application Digital Photo Professional 2.2.

* Effectiveness depends on the type of dust.



Self-Cleaning Sensor Unit and its Composition

Area Autofocus

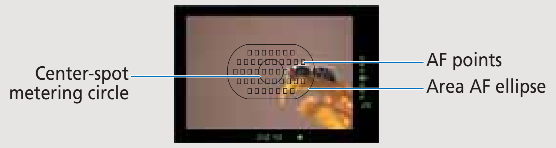
Capturing Moments with 45-Point Area AF

In 1987, Canon released an autofocus (AF) SLR camera. Despite having just a single focus point in the center of the viewfinder, the AF-equipped camera was hailed for its revolutionary technology. In 1990 and 1992, the company launched cameras with three-point (central horizontal-axis direction) and five-point AF, respectively. Then, in 1998, Canon developed the EOS-3, an SLR camera with 45-point Area AF covering a wide range of 8 mm x 15 mm, putting the company in a class of its own for autofocus technology.

Autofocus automatically measures the distance between the camera and the subject, after which the lens automatically moves to the correct focus position. In the case of SLR cameras with five-point AF, five sets of line sensors are used to measure distance, guiding light that passes through the lens to the appropriate secondary image-formation lens for each AF point via the submirror. Since it was impossible to measure all 45 points by this method due to design constraints, Canon developed a new mechanism. Canon engineers made the submirror using an elliptical curved surface mirror, allowing light rays from 45 locations to be gathered by a single mirror and directed to two sets of secondary image-formation lenses. This new mechanism is based on the principle that light emanating from one elliptical focal point that is reflected from an elliptical surface must converge at a single point.

After light converges at the focal point, it once again passes through the secondary image-formation lens before being directed to the area AF sensor. The secondary image-formation lens, which comprises two sets of lenses equivalent to the left and right eyes of humans, as well as upper and lower "eyes" that humans do not have, form four parallax images on the area AF sensor. The distance from these images is calculated and, based on the value of the AF point selected by the photographer or automatically selected by the camera, the lens moves accordingly.

The area AF sensor was designed to conform to the 45-point Area AF. This sensor has 30 to 40 times more pixels than conventional AF line sensors, making possible quick and accurate detection of an image for each of the 45 points — a task that was impossible for previous sensors. Since 45-point area AF eliminates the need to position the subject at the center of the viewfinder, photographers can capture split-second photo opportunities with greater ease. The wide AF range enables photographers to successfully capture moving subjects, and is also well suited for sports photography.



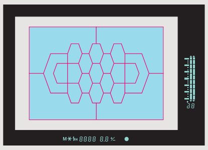
45-Point Distribution

Multiple-Zone Evaluative Metering

Reading Subtleties of Light with Precision

Canon developed a 21-zone metering sensor to accommodate 45-point area AF. Using a newly developed algorithm, this metering system performs high-speed calculations of output from 21 zone sensors and AF information, and adjusts exposure instantly.

This configuration enables the camera to make compensations appropriate to shooting conditions and maintain exposure stability. The system also incorporates an average metering element that factors in periphery conditions, providing accurate exposure even when the composition changes slightly, or when the subject covers multiple metering points.



Multiple-Zone Metering Sensor

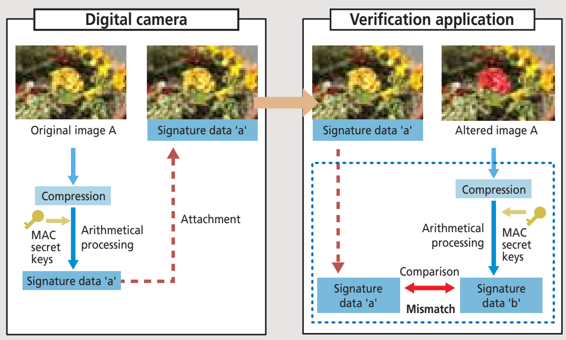
Original Image Verification System

Detecting Falsified in Digital Data

While digital cameras offer advantages over film cameras by dispensing with development processes and enabling the capture of images that do not deteriorate over time, they also have some disadvantages. Digital images can be easily edited and modified, making their authenticity difficult to prove. To address this problem, Canon developed its Original Image Verification System, which detects whether or not digital image data has been altered.

First, original image data captured by a camera is compressed. The data is then arithmetically processed using a MAC (Message Authentication Code) secret key to create "signature data a." "Signature data a" is attached to the original image data, or "original image A," and sent to the verification system. The verification system separates "signature data a" from "original image A," and "original image A" is then converted into a new signature file, which is given the same MAC secret key as that assigned when the photo was taken. This new file is labeled "signature data b." When compared, if "signature data a" and "signature data b" match, then the system determines that the image data has not been altered. Inconsistency, however, would indicate that the image data had been edited. Since the same method can be used to verify whether image header information has been tampered with, the reliability of both the image itself and the attached information can be verified at the same time.

The system earned wide acclaim when it was first introduced to the world as a feature of Canon's EOS 1Ds digital SLR camera. In particular, this technology has drawn attention within industries that depend on highly reliable photographic evidence.



Overview of the Original Image Verification System

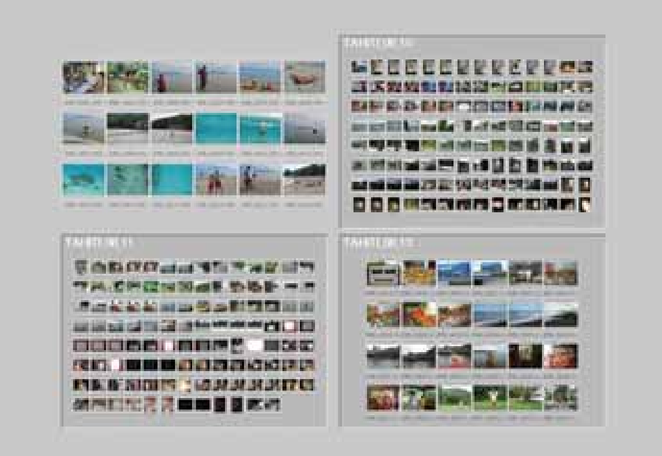
Original Software and Online Photo Services

Providing Diverse Services to Canon Users

Canon has enriched its collection of software that enables users to effectively manage images captured with a digital camera on a PC.

PhotoStitch software automatically combines portrait- and landscape-oriented images into panoramic photographs. ZoomBrowser EX (Windows)/ImageBrowser (Macintosh) is an image management/search software application that includes image download and edit functions, including image enlargement and reduction.

Canon also established CANON iMAGE GATEWAY as a community forum for Canon users. This site provides a wide range of online services, from product support information delivered by email, online album viewing from mobile phones, and options for printing album photos at home to a fee-based photo-book service that allows users to create original photograph collections. (Available in Japan and Europe from October 2006)



Example of ZoomBrowser EX Screens

DO Lens

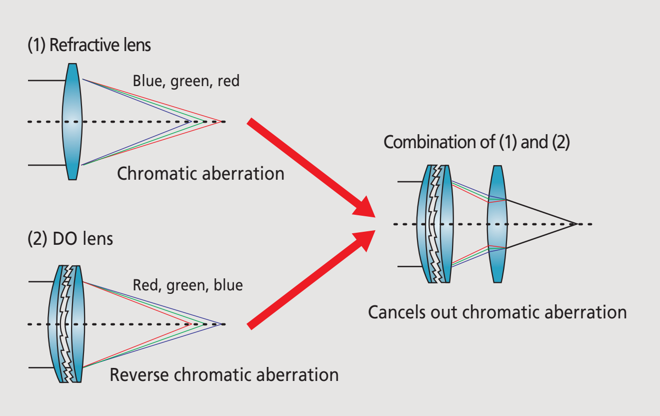
Achieving Smaller, Lighter Telephoto Lenses

The refractive index of light changes slightly according to the wavelength. As light passes through a lens, this difference in refractive index results in chromatic aberrations and reduced image quality. One way to correct chromatic aberrations is to combine convex and concave lenses. In the case of telephoto and zoom lenses, in particular, the large number of lens elements needed to correct chromatic aberrations results in larger lens sizes. Canon developed the world's first Diffractive Optical Element (DO lens) for cameras, solving the problem of chromatic aberration and, at the same time, achieving smaller lens sizes.

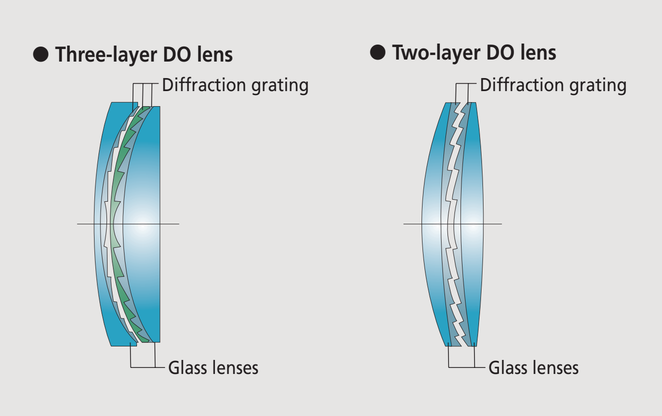
The development of the DO lens was based on the principle that chromatic aberrations occur in opposite directions in diffractive and refractive optical elements. In other words, it is theoretically possible to eliminate chromatic aberrations in lenses by combining diffractive and refractive optical elements. Since diffractive optical elements have only one diffraction grating, which causes light to branch in unnecessary directions, resulting in such problems as flare, it was unsuitable for use as a camera lens. Canon developed a unique two-layer DO lens by precisely placing two optimized diffractive optical elements a few micrometers apart to create a multi-layer grating. The two-layer DO lens, which Canon incorporated into its EF400mm f/4 DO IS USM interchangeable SLR camera lens, makes possible significant reductions in the size of telephoto lenses, and, at the same time, contributes to greatly improved imaging performance.

The next challenge was to incorporate the DO lens into zoom lenses. In the case of zoom lenses, the angle of light incidence changes considerably in response to changes in focal length, causing flare in two-layer diffractive optical systems. Canon studied the refractive index of diffractive optical elements as well as the shape of multi-layer gratings and came up with a three-layer DO lens that utilizes three diffractive optical elements. Incorporating the three-layer DO lens into the EF70-300mm f/4.5-5.6 DO IS USM zoom lens, Canon successfully achieved a reduction in the size of telephoto zoom lenses.

DO Lens



Principle for Correcting Chromatic Aberrations with a DO Lens



DO Lens Structures

Digital Video Camcorders

Video camcorders for the high-definition era must deliver high-speed, high-resolution imaging performance in addition to realizing a compact body size and low power consumption. Canon is making great strides in the development of high-definition video camcorders offering exceptional usability in addition to outstanding image quality, utilizing its impressive collection of advanced proprietary technologies, including those for CMOS sensors, optics, digital imaging, DV camcorders, and high-density mounting.

Lens

Optical zoom lens incorporating a clear, high-resolution aspherical glass lens element

Image Sensor

Designed to detect light and convert it into electrical signals. The HV10 employs a 1/2.7-inch CMOS sensor utilizing 2.07-million pixels when recording video, and 2.76-million pixels when recording still images

→ P.23 CMOS Sensor for HD Video Camcorders

→ P.61 Pixel-Reduction Technology

Optical Image Stabilizer (Lens-shift type)

Designed to counteract the effects of camera shake without reducing image quality

→ P.23 HD Video Lens and Image Stabilization

Image Processor

Converts electrical signals sent from the photosensor into video images

→ P.24 DIGIC DV II

Codec Engine

LSI designed to compress or decompress video images and audio according to the recording medium

→ P.24 HD Codec Engine

AF Sensor

The HV10 incorporates Instant AF, which utilizes external sensors, and a dual-path autofocus control system to realize high-speed focusing

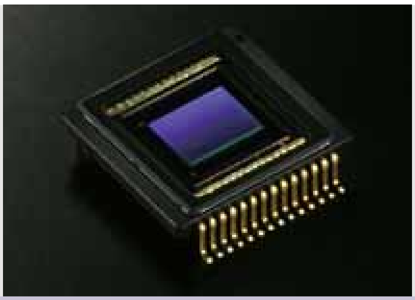
CMOS Sensor for High-Definition (HD) Video Camcorders

Supporting Full HD with High Speed and Low Power Consumption

To render images in full HD (1,920 x 1,080 pixels), HD video camcorder sensors process roughly six times the amount of data as sensors in conventional digital video camcorders. This requires high-speed, energy-efficient data reading capability. Canon developed an HD CMOS sensor by adapting the CMOS sensor technologies (→ P.19) utilized in its digital SLR cameras. The HD CMOS sensor boasts exceptional processing capabilities, enabling high-speed reading of images in full HD, and low power consumption, approximately half that of conventional CCD sensors.

By employing processing technology enabling a pixel pitch of 2.75 μm, Canon made possible the production of a 1/2.7-inch (effective diagonal length of 0.66 cm) HD CMOS sensor, which also contributes to the camcorder's compact body size. Moreover, the sensor incorporates On Chip Noise Reduction technology, which effectively cancels fixed-pattern and random noise to support high-quality video capture in low-light conditions down to 5 lux (when using the Auto Slow Shutter function).

Additionally, the sensor utilizes an RGB Beyer filter to achieve faithful color reproduction and high color resolution, minimizing edge feathering around the subject, false colors and moirés.



CMOS Sensor for HD Video Camcorders

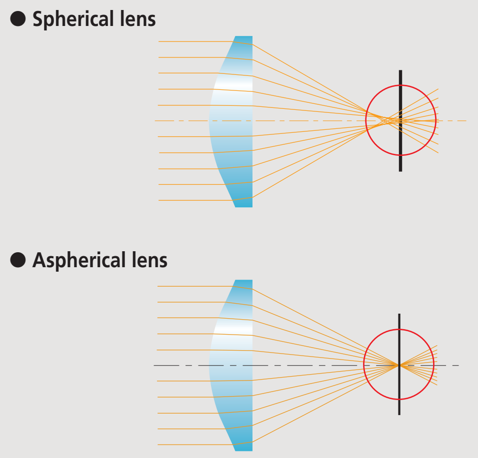
HD Video Lenses and Image Stabilization

Optical System to Support High-Definition Image Capture

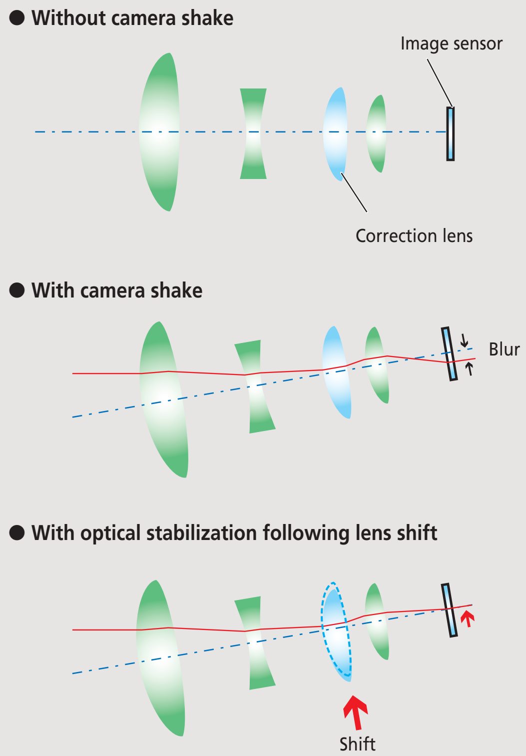
Since HD lenses require imaging capabilities beyond what conventional lenses can achieve, aspherical lens elements should be used. While spherical lenses alone cannot gather light to a single point, aspherical lenses can, enabling the creation of sharp, high-resolution images. Utilizing its accumulated lens know how, Canon adjusted the position and shape of the aspherical lens element to achieve the best possible lens configuration.

Another problem with video camcorder recording is camera shake. The higher the zoom magnification, the more significant the effects of camera shake become. For this reason, the HV 10 employs a lens-shift-type Optical Image Stabilizer (OIS) system, which moves the lens in tandem with the movement of the camcorder. Gyro sensors detect the angle and speed of movement and the system compensates by moving the correction lens in parallel with the movement so light is refracted to cancel image blur. In this way camera shake can be corrected without compromising image quality.

The system also employs a Super Range OIS, which detects and corrects a wide range of vibrations, from difficult-to-detect low-frequency subtle movements to fast swings, such as when shooting from a moving vehicle. This feature enables stable camera-shake correction covering a wide range of swing frequencies, avoiding such problems as image leaps.



Focal Point Alignment with an Aspherical Lens



Principle of Lens-Shift Image Stabilization

DIGIC DV II

Image Processor for HD Video Processing

In 2003, Canon developed DIGIC DV, an image processor specially designed for digital video processing. DIGIC DV II is a new image processor that inherits the concept of DIGIC DV while adding the capacity to process HD video images containing vast amounts of information.

Canon's proprietary video-image-processing algorithm ensures reduced noise in flat and dark areas and the recording of beautiful images boasting faithful color reproduction and rich gradation. Increased processing speeds not only enable high-quality HD image recording and playback, but also support such features as simultaneous video- and still- image capture, and high-speed continuous shooting.

Canon concentrates its vast expertise in the field of imaging and its digital signal-processing technology into a single chip, paving the way for higher image quality and functionality in digital video camcorders.

DIGIC DV II High-Speed Image Processor for Digital Video Camcorders

HD Codec Engine

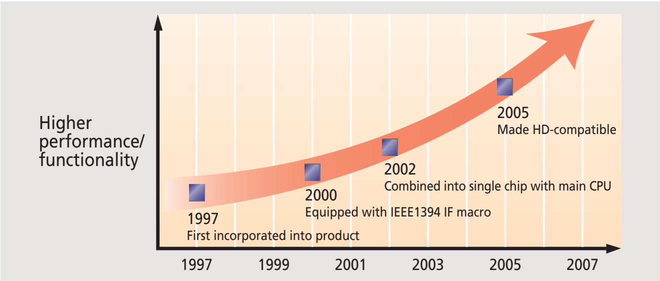
Supporting Diverse Functionality, Starting with HD Video Recording and Playback

The HD codec engine is an LSI chipset that controls such camcorder functions as compression and decompression of video and audio signals, recording and playback of video saved to media, and input/output processing of video signals and digital data.

Canon developed a new HD codec engine to keep pace with the commercialization of HDV-compatible video camcorders. Not only does this chipset support 1080i (interlace) HD video recording and playback — the same specification for digital HDTV broadcasting — it also makes possible a variety of functions in all recording modes.

Canon's XL H1 video camcorder, designed for broadcast industry professionals, also offers a "cinema look" 24F (24 frames per second) mode, which uses the same frame rate as movie film, and a four-channel audio recording/playback mode in addition to incorporating broadcast-industry-standard HD-SDI (Serial Digital Interface) output connectors.

Since 1997, continued demand for more advanced codec engines in terms of performance and density has not only contributed to improved functionality, reduced body size, and lower power consumption in products, but has also played a significant role in price erosion.



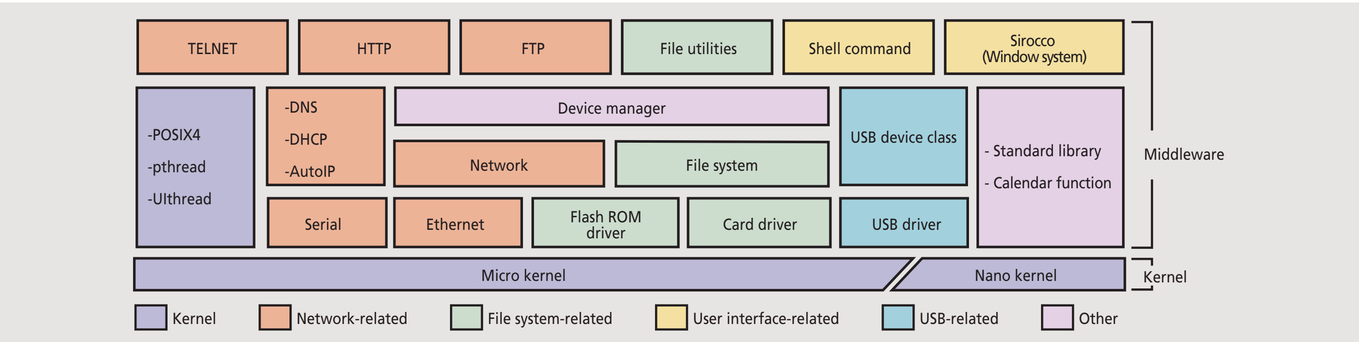
Codec Engine Evolution

DRYOS

Real-Time Embedded Operating System for Higher Product Functionality and Performance

DRYOS is the name of a real-time operating system (OS) developed exclusively by Canon and employed in the system LSI for its digital video camcorders. A major feature of DRYOS, which has a kernel module at its core, is its flexible structure, which can be expanded from as small as 16 kilobytes, facilitating customization to the needs of the target device and hardware resources. Canon also developed a USB- and middleware-compatible device driver for file systems and network functions to meet the needs of increasingly diversified digital products.

DRYOS is currently compatible with more than 10 CPU types, and also provides a simulation-based development environment for debugging. By developing platform software in-house, Canon can more effectively promote reuse and sharing of software modules while raising product functionality and quickly addressing the trend toward high-performance devices.



DRYOS Module Hierarchy

TV Broadcasting Lenses and Network Cameras

Canon is proud to be the global market leader for broadcast equipment, including television broadcast lenses, which deliver the outstanding performance and exceptional reliability demanded by television stations worldwide for capturing everything from live news and sports to studio programming. In addition, Canon puts its advanced technologies to use in commercial video equipment, including broadcast pan-tilt systems and network camera systems that make possible high-quality remote monitoring from a PC.

100x Zoom TV Lens

Achieving the World's First 100x Zoom Lens

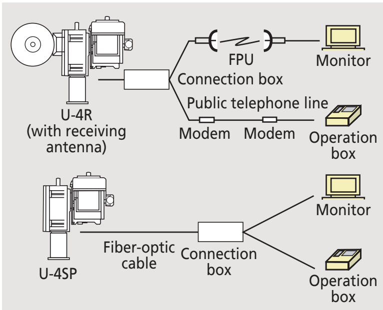
Renowned for their outstanding optical performance, Canon's television broadcast lenses are the top choice of broadcast industry professionals worldwide. The flagship among these lenses is the HDTV-compatible DIGISUPER 100 xs, the world's first 100x zoom lens. This lens incorporates Canon's original optical element manufacturing technologies — such as ultralow-dispersion (UD) glass, a new glass material, and fluorite — enabling the correction of various types of aberrations. The special characteristics of this optical system are maximized by Canon's proprietary optical design technology. Together, these technologies ensure ample compensation for phenomena such as chromatic aberration and curvature of field, while maintaining a practical, manageable lens size. Additionally, Canon's original Optical Shift Image Stabilizer effectively compensates for the slight vibrations that cannot be avoided when shooting at super-telephoto focal lengths with television broadcasting cameras, while a digital servo system determines zoom and focusing positions with exceptional accuracy.

DIGISUPER 100 xs

Remote-Controlled Pan-Tilt System

Outdoor Camera System that Delivers Video in Real-Time

Canon's remote-controlled pan-tilt system is used for communication camera systems that are permanently mounted outdoors at airports, scenic spots, or atop buildings to capture images for use in news broadcasts and weather reports. The system offers flexible configuration patterns to meet diverse user needs. In order to provide the high-quality images required for broadcasting, the system incorporates high-precision control technology to ensure smooth operation of the pan-tilt head, communications and networking technologies to allow remote control from a broadcasting station, fiber-optic technology to enable transmission of the high-volume broadband video signals required for HDTV broadcasting, and environment-resistance technologies to enable the system to withstand severe weather conditions, from storms with winds up to 60 meters per second to sub-zero temperatures. In addition to images of seasonally changing scenery and current weather information, the system can deliver live coverage of emergency situations or natural disasters directly to viewers' televisions.



Remote-Controlled Pan-Tilt System

U-4R HD-Compatible Communication Camera

Network Cameras and Image Gathering Software

Monitoring and Accumulating Remote Video Over the Net

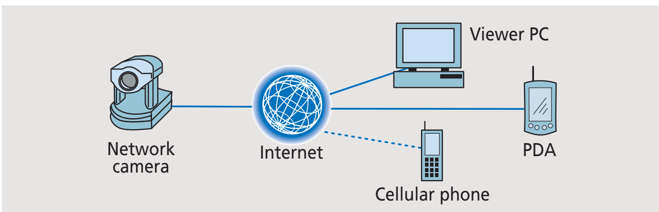
● Network cameras offering high image quality and advanced functionality

Canon's VB series of network camera systems enables easy operation and display of remote video images using a Web browser or dedicated viewer software. Since the camera angle and zoom range can be adjusted by remote control, the images transmitted to viewers have more of a live aspect than those captured by conventional stationary cameras. The network camera server compresses up to 30 frames per second in Motion JPEG format, and can transmit video images to as many as 50 locations at a time, making it easy, for example, to send images to a small community of viewers or establish a crime-prevention system.

This system incorporates original Canon technologies that have been added to the standard Internet protocol using Java applets and other technologies. TCP/IP and HTTP are used to transmit camera-control information and image data to ensure compatibility with Web browsers and other Internet-related software. The system also supports mobile Internet environments, allowing image transmission to cellular phones.

● Network video-recording software

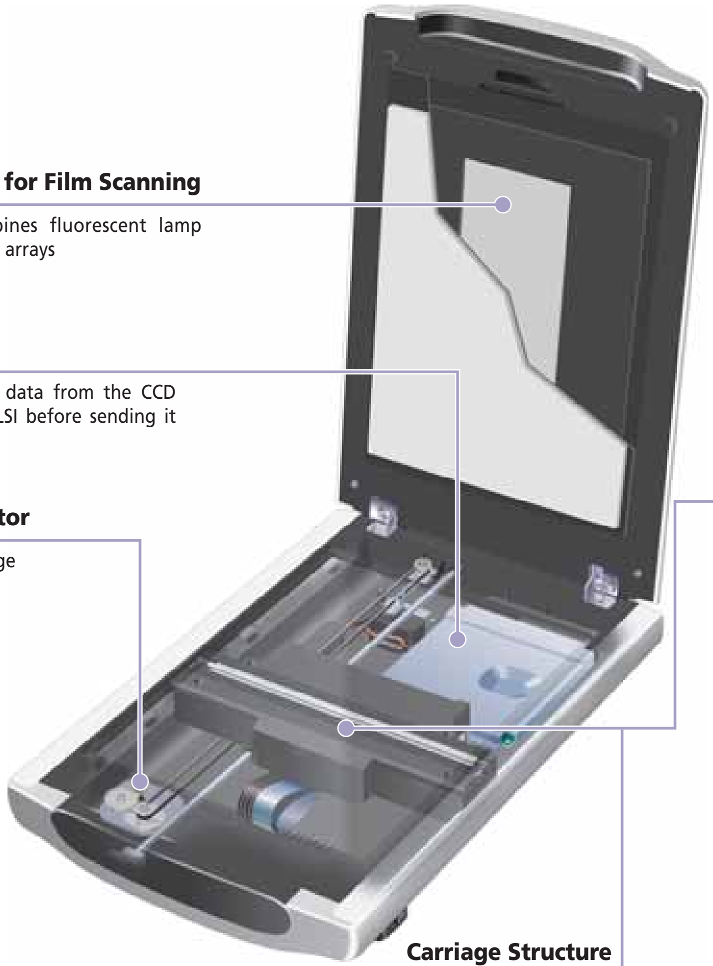
Network video-recording software can be used to simultaneously monitor and record video images at multiple locations. Video images from up to 64 network cameras can be simultaneously recorded to a single recording server. The software also permits the management of multiple recording servers from a single viewer. Additionally, since the system can be configured using LAN or IP networks, crime-prevention systems for buildings and condominiums can be easily established. Moreover, image recording via an IP network allows the safe and secure storage of image data away from the camera site, meaning that stored image data is secure from fire and vandalism.



Example of Network Camera System Configuration

Scanners

Canon combined several advanced technologies, including those for optics, mechanics, electrical and electronic engineering, and software, to develop a 4,800-dpi high-resolution scanner. Not only documents, but also printed photos and 35 mm film can be converted into high-grade digital data. In addition to its CCD scanner models, Canon has equipped its slim CIS scanners with an extensive array of functions, offering complete digital imaging support.



Light Source for Film Scanning

Efficiently combines fluorescent lamp and infrared LED arrays

Controller

Processes image data from the CCD with dedicated LSI before sending it to the PC

Carriage Motor

Drives the carriage

Carriage

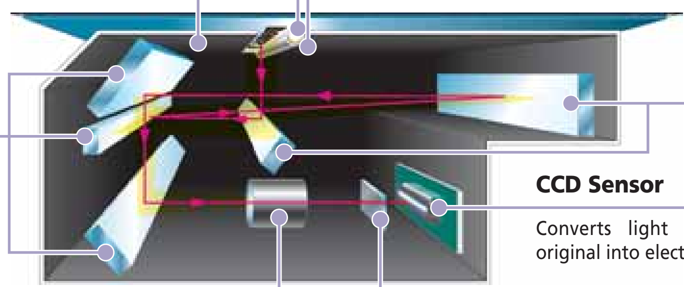
Optical unit equipped with a fluorescent lamp, mirror, lens, and CCD. The carriage scans the document from the bottom up

Light Source

Dual Reflector

Reflectors on both sides of the light source greatly increase the amount of light generated, enabling high-quality, low-noise scanning

Carriage Structure



Reflective Mirrors

Reflect light back and forth several times, creating a path for light hitting the document to pass through the lens and form an image on the CCD

Reflective Mirrors

CCD Sensor

Converts light striking the original into electrical signals

Lens

FARE Glass

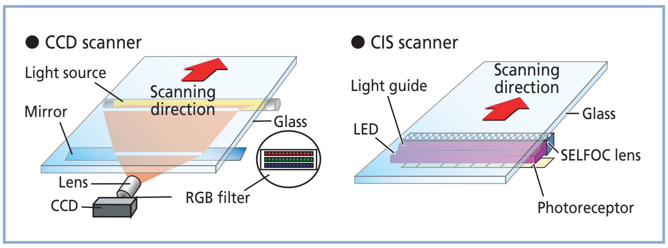
Adjusts for difference in optical path lengths between infrared and normal light

CCD and CIS

Canon offers two types of flatbed scanners: CCD and CIS.

CCD models incorporate high-precision optics and high-density CCD line sensors, which illuminate the document with a strong light source, to deliver sharp, high-resolution images.

CIS scanners are slim-bodied, energy-efficient models that utilize a three-color RGB LED as the light source and read documents with a CIS (Contact Image Sensor) of the same width as document originals.



Film Automatic Retouching and Enhancement

Offering an Array of Image Correction Features for a Variety of Documents

It's not just the scanning mechanism that determines scanner performance. The driver that processes data from the scanner and reproduces the image is equally important. Canon's ScanGear scanner driver was designed not only to enable exceptional ease of use, but also to deliver a wide-range of image-processing features.

● Dust and scratch removal (dust/scratch reduction for film and photo prints)

When reading photographic film using a high-resolution scanner, minute dust particles and scratches that are invisible to the naked eye are picked up. The dust/scratch removal function first detects dust and scratches with infrared light, and then determines the size and shape of the dust/scratches along with the characteristics of the surrounding image using a normal white light scan. The dust and scratches are then automatically removed through the high-level integration of hardware and software processing, producing a beautiful reproduction. In the case of reprints from existing photographs, dust and scratches are minimized with software processing.

● Discoloration correction function (film and photo prints)

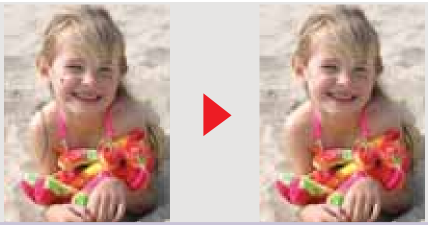
This function restores vivid colors to film or photo prints with discoloration or color seepage. The histogram of the scanned image is analyzed and the hue, color balance, contrast and saturation are automatically adjusted to appropriate levels.

● Backlight correction function (film and photo prints)

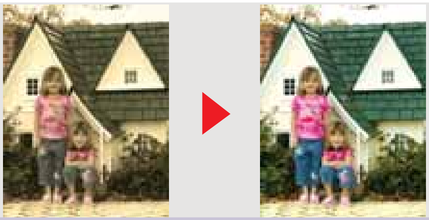
When correcting heavily backlit images, simply increasing the overall brightness causes bright areas to become completely washed out. The backlight correction function analyzes the image and automatically adjusts the overall image brightness and contrast according to the darkness of areas that need correction.

● Book-binding shadow correction (bound documents)

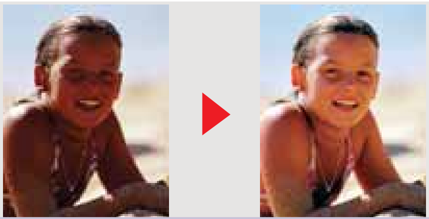
This function reduces the shadow that occurs when an open book or magazine is scanned. The shadow created by the book's spine is detected using a shape-recognition density table, and the brightness is adjusted accordingly.



Before and After Dust and Scratch Removal



Before and After Discoloration Correction



Before and After Backlight Correction

Before and After Book-Binding Shadow Correction

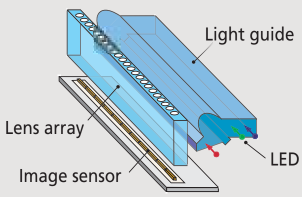
LIDE Technology

Supporting one-plug scanning with slim, energy-efficient scanners

Reducing the size, weight and power consumption of scanners is equally as important as achieving high-precision scanning performance. Unlike CCD-based carriages in conventional scanners, which utilize an optical lens unit, Canon's LIDE (LED indirect exposure) carriage employs the CIS scanning method to realize a significantly smaller body size. A smaller carriage size also enables a smaller, more energy-efficient motor to be used.

The ultra-micro motor used to drive LIDE consumes only 2.5 W when in operation. As such, it doesn't require a dedicated AC power source, making possible "one-plug scanning" operation through a single USB cable connected to a computer. Small, lightweight, slim and energy-efficient, LIDE has changed the common perception of scanners.

Canon's LIDE scanner is the world's first CIS scanner capable of handling film scanning. 35 mm film can be scanned using Canon's proprietary FAU (Film Adapter Unit), which can be placed directly on the glass platen. The FAU also incorporates an infrared LED, enabling dust and scratch removal when the film is scanned.

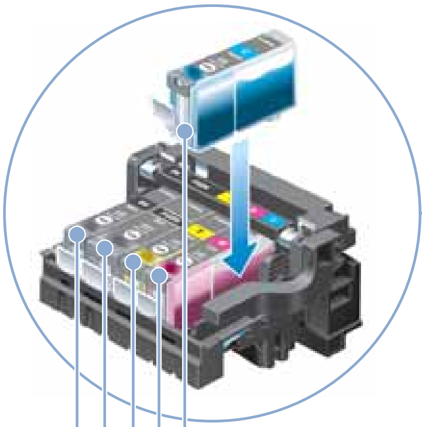


LIDE Configuration

CanoScan LiDE 600F (CIS Scanner)

Inkjet Printers

During an experiment at Canon in the mid-1970s, a soldering iron came into contact with the needle of a syringe filled with ink, causing ink to suddenly spurt out. Canon's unique Bubble Jet printing technology was born out of that unexpected incident, and the company's first Bubble Jet printer was commercialized in 1985. Ongoing R&D has led to further advancements, making possible the outstanding image quality, high print speeds and exceptional usability realized by Canon inkjet printers today.



Ink Tanks

The PIXMA MP810 employs a five-color ink system comprising cyan, magenta, yellow, black and pigment-black inks

→ P.30 ChromaLife100

Scanner

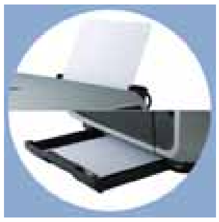
The PIXMA MP810 incorporates a 4,800-dpi CCD scanner for high-definition scanning and copying

→ P.31 Dual Color Gamut Processing Technology

Paper Feeding Mechanism

Incorporates an automatic duplex printing unit and offers 2-way paper feeding — from the paper cassette at the front or from the auto sheet feeder at the rear. A tray guide enables DVD/CD label printing and copying

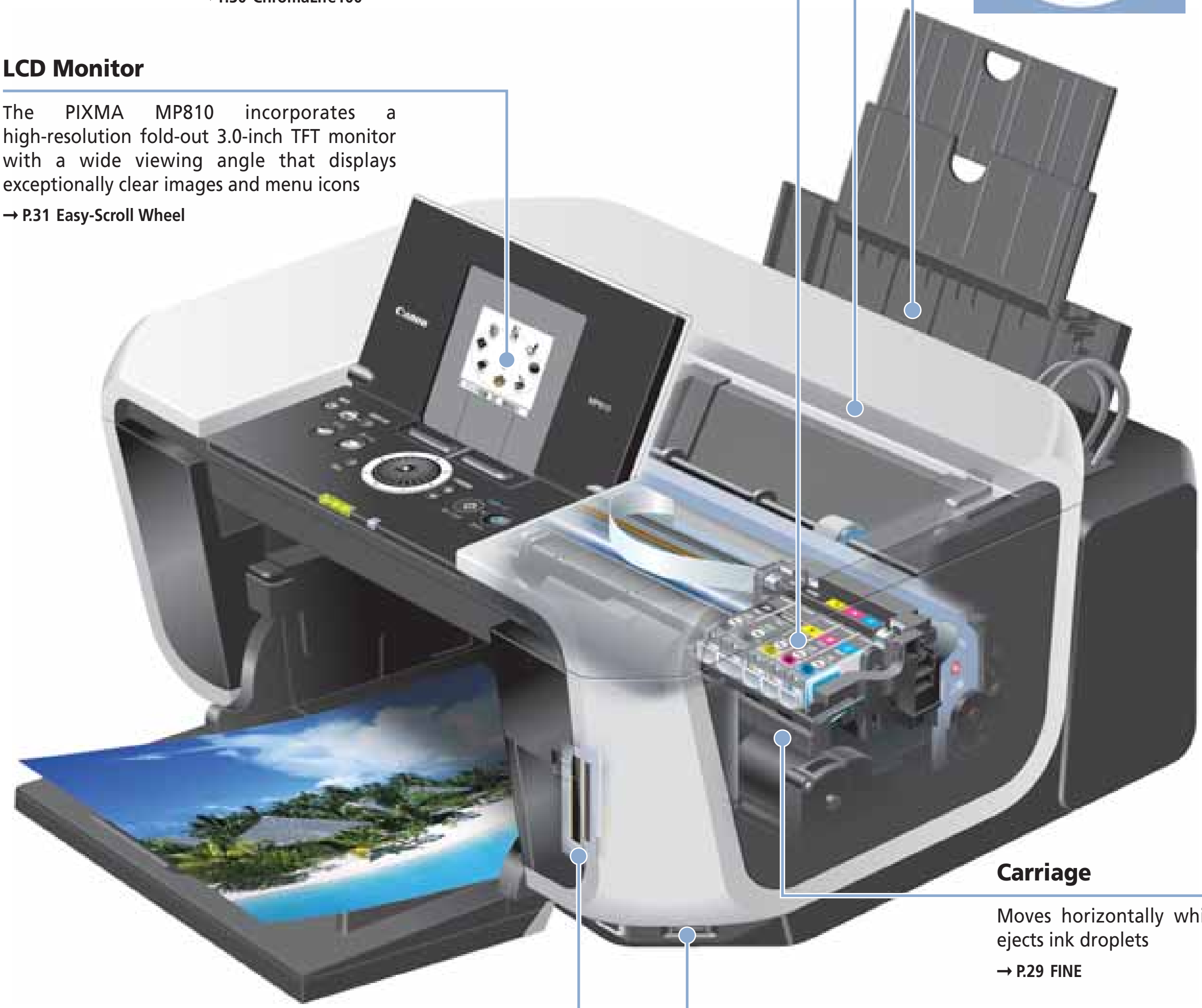
→ P.31 Advanced Media Handling



LCD Monitor

The PIXMA MP810 incorporates a high-resolution fold-out 3.0-inch TFT monitor with a wide viewing angle that displays exceptionally clear images and menu icons

→ P.31 Easy-Scroll Wheel



Carriage

Moves horizontally while the print head ejects ink droplets

→ P.29 FINE

Card Slot

Supports direct printing from a wide range of memory cards

PictBridge-Compatible Direct Print Port

Allows the direct printing of photos simply by connecting a USB cable to a PictBridge-compatible digital camera or digital video camcorder

FINE

Print Head Technology from a Completely Different Perspective

FINE (Full-photolithography Inkjet Nozzle Engineering) is an innovative key technology for inkjet printers developed in response to the challenge of simultaneously increasing both image quality and print speed. Rather than refining existing technologies, Canon engineers went back to the origin of the company's Bubble Jet technology and reexamined the ejection mechanism and print head manufacturing technology from a completely different angle, resulting in dramatic improvements in image quality, tonal expression, and image stability.

● Ejection mechanism for accurate placement of microscopic ink droplets as small as 1 pl

Microscopic ink droplets and ejection precision are the keys to high image quality. With conventional ejection systems, however, the finer the ink droplets, the more vulnerable they are to disturbances from print head movement and changes in ink viscosity due to temperature fluctuations, resulting in uneven and inconsistent ink dot placement.

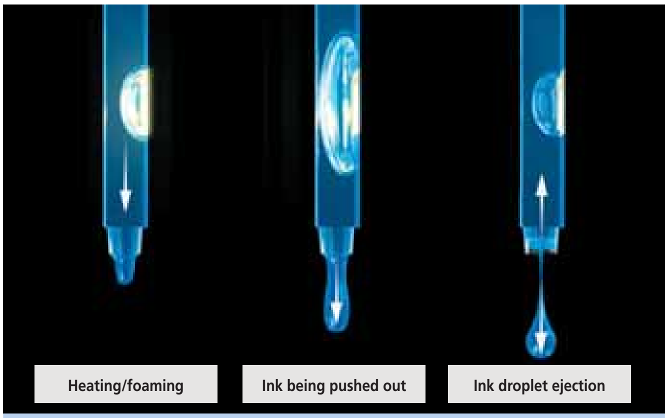
Canon's FINE ejection system ensures all the ink under the heater is pushed out in a single thrust, creating precise, uniform droplets. Additionally, ejection speed has been increased to more than 1.5 times that of conventional systems, enabling more efficient application of ink droplets by reducing their susceptibility to airflow disturbances and increasing placement accuracy.

Canon's PIXMA MP810 ejects ink droplets as small as 1 picoliter (one trillionth of a liter) with exceptional precision, achieving excellent placement accuracy on the paper.

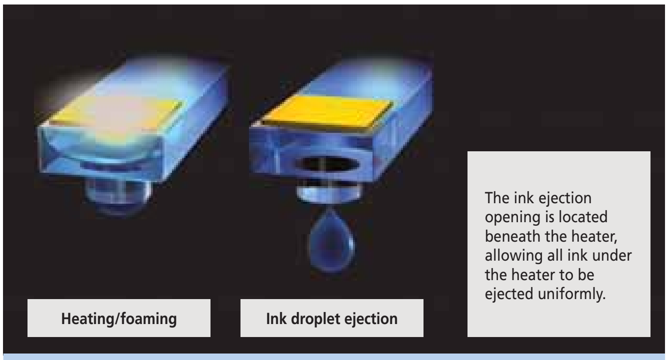
● Print head manufacturing technologies using nano-precision semiconductor exposure equipment

Achieving smaller droplets and higher print speeds requires high-precision fabrication technologies to enable the placement of a greater number of nozzles over a wider area. With ordinary inkjet printers, print heads are fabricated by bonding components fitted with fine grooves and holes. Limitations in the precision of component fabrication and bonding associated with this approach make it impossible to arrange great numbers of nozzles in a precise, uniform manner.

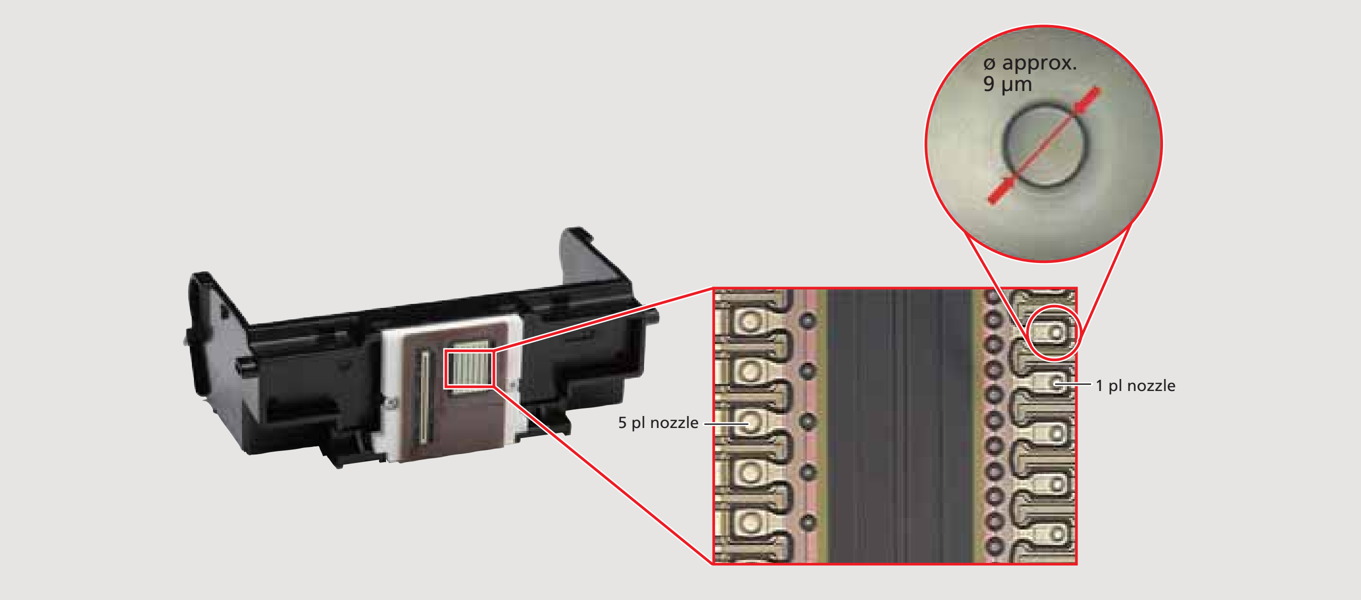
Supported by FINE technology, Canon print heads are made by integrating the heater and the nozzles into a single unit on a wafer using a process that makes the most of the company's expertise in semiconductor production, as well as its original material technologies and innovative processing technologies. The ability to fabricate nozzles with high precision over large areas without bonding processes makes it possible to arrange 6,000 or more nozzles within an area measuring a mere 20 mm x 16 mm — the size of a thumbnail.



Conventional Bubble Jet Ink-Ejection Process



FINE Ink-Ejection Process



Print Head with Enlarged View of Nozzle Configuration

Image-Quality Improvement Technologies

Rendering the Beauty of Photographs

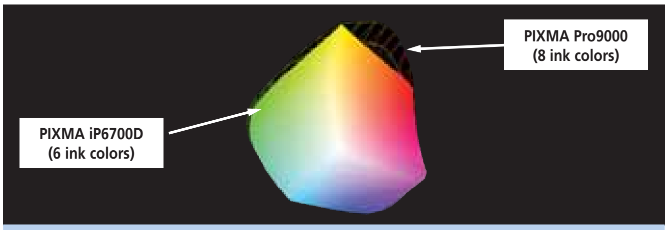
To realize digital photo prints with the beauty of photographs, Canon divided image enhancement elements into six areas, and is conducting extensive research in each of these areas.

● Pursuing color reproduction on a par with traditional film

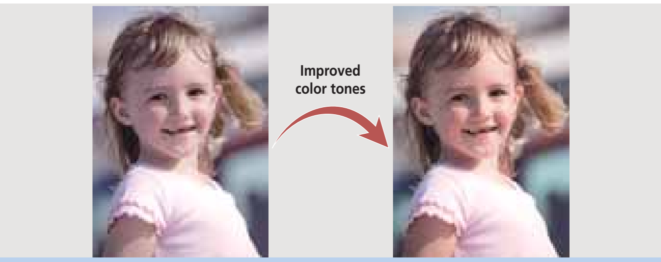
The color space of a digital camera dramatically exceeds the color range (color space: sRGB) that can be displayed on a PC monitor. This difference in color space is one reason why digital photographs seem to have different coloring than the original when seen on a PC monitor. Although Canon inkjet printers were capable of reproducing vivid colors beyond sRGB, they could not faithfully reproduce the well balanced, wide color space of conventional photo film. By adding red and green inks with high brightness and saturation to its existing ink colors, Canon succeeded in enhancing saturation in the red and green regions by 1.6- and 1.2-fold, respectively. This resulted in photo image output with improved depth and translucence, and color reproduction comparable to that of prints from photo film.

● Rendering color tones pleasing to the human eye

Color development based on Canon's Color Management Technology (→ P.54), which incorporates human color preference factors, is reflected in the company's inkjet printers as "Canon Digital Photo Color." Through a wide variety of panel tests, Canon improved gray shades, contrast, and saturation, making possible vivid expression of skin tones and landscapes with low-chromatic colors pleasing to the eye.



Enhanced Color Reproduction with Addition of Red and Green Inks



Color Adjustments for Natural, Vivid Skin Tones

● Adjusting contrast and gradation for well-balanced photo prints

Based on optimal gradation curves from Canon Digital Photo Color, Canon added photo black ink to cyan, magenta and yellow for photo prints that not only offer high contrast but dynamic depth as well. To achieve smoother color transition from the highlight to mid-density and shadowed areas of digital photos, and higher definition, Canon developed processing technology that surpasses the conventional 8-bit (256 levels) level.

● Achieving smooth, natural-looking images with reduced graininess

Canon's high-density FINE print head can apply microscopic 1-picoliter (pl) ink droplets to paper with micrometer precision. This precise placement of ink droplets minimizes visible graininess even in the highlights where it is most visible, and eliminates noise even in half-tone areas, contributing to extremely smooth image expression.

● Expressing fine details with sharpness

Canon's FINE print head ejects precise amounts of ink with bubbles generated at the tip of each ink nozzle, and the energy created when these bubbles are formed is efficiently converted into a powerful ejection force. As a result, each ink droplet is accurately placed, unaffected by air-flow caused by head movement, resulting in sharp, detailed images.

● Preserving the long-lasting beauty of colors

Canon's ChromaLife100 system, which combines the company's genuine dye inks and photo media, makes possible image permanence on a par with conventional photo prints, realizing 100-year album life in addition to 30-year lightfastness in normal indoor light and 10-year gas fastness in normal indoor atmospheric conditions.*

* The values are projections based on accelerated tests and are not guaranteed. 100-year album life can be achieved with Photo Paper Pro, Photo Paper Plus Glossy, Photo Paper Plus semi-gloss, and Glossy Photo Paper when stored in an archival album with plastic cover sheet and kept in the dark. 30-year lightfastness and 10-year gas fastness are achieved with Photo Paper Pro paper when kept indoors under normal atmospheric conditions and away from direct sunlight.

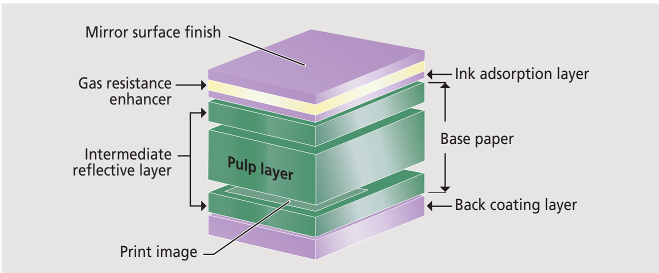
ChromaLife100

A System for Beautiful, Long-Lasting Color

ChromaLife100 is an advanced system for preserving the beauty of photos through a combination of genuine Canon dye inks and select Canon photo papers.

Since the inks used in Canon's inkjet printers are instantaneously heated to temperatures of 300°C or more, they must remain stable under high heat. Other requirements include the capacity to form spherical droplets without clogging nozzles, proper adherence to paper, and a chemical composition that satisfies the strict regulations of countries worldwide concerning the use of hazardous materials. Canon's original dye inks boast high brightness and superb optical density (OD) value, making possible outstanding image quality even on plain paper. These inks also resist fading and improve image permanence. In order to accurately evaluate image permanence over time periods as long as 30 or 100 years, Canon established a test method that simulates image fading under accelerated conditions.

Canon genuine paper comprises multiple layers, including a pulp layer to quickly absorb ink and firmly fix colors, an ink adsorption layer with a mirror surface finish that contains an agent to improve resistance to atmospheric contact, and a back coating layer to shield colors from light and gases.



Structure of Photo Paper Pro

Easy-Scroll Wheel

Intuitive Operation

Canon was the first company to equip its inkjet all-in-one models with an "Easy-Scroll Wheel" interface, which allows users to operate various functions in a far more intuitive way.

Replacing operating buttons with a wheel and displaying icons representing basic functions on the home screen enables users to easily select and operate various functions. The Home key allows users to go back to the home screen and start over if they are unsure about their selection. The combination of an animated graphical user interface and scroll wheel leaves users wanting to come back and play with it time and again.

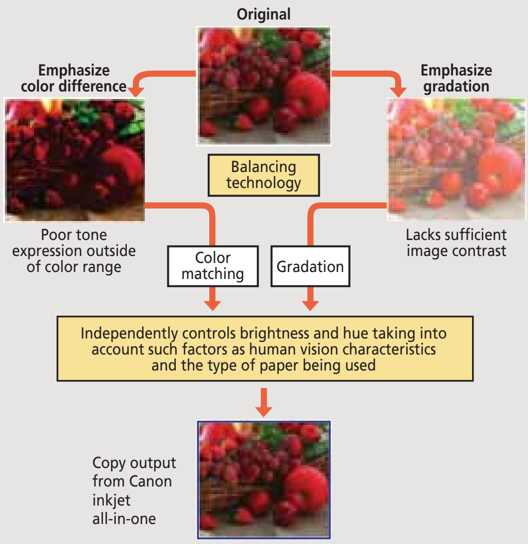
Easy-Scroll Wheel

Dual Color Gamut Processing Technology

Targeting Faithful Color Reproduction of Originals, Including Photographs

Inkjet all-in-ones make copying easy. In the case of color photographs in particular, however, the key to achieving faithful color reproduction lies in reconciling the differences between the color range of the scanned original and the range of expression possible by inkjet printing devices. Canon developed Dual Color Gamut Processing Technology as a means to faithfully reproduce original documents (photo or other printed material) using the copy function.

Dual Color Gamut Processing Technology takes advantage of Canon's vast experience in office imaging equipment. By taking into account factors such as human vision characteristics and the type of print paper being used, this technology independently controls hue and brightness to achieve the same color balance as the original. Fully utilizing the color-reproduction capabilities of scanners and printers, Dual Color Gamut Processing Technology makes possible the creation of copies with rich gradation and minimal color difference.

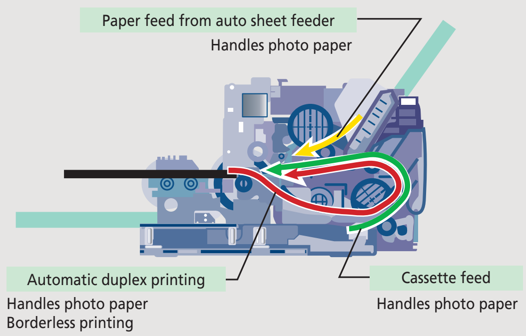


How Dual Color Gamut Processing Technology Works

Advanced Media Handling

Diverse Features Integrated into a Compact Unit

Despite their compact sizes, Canon PIXMA printers offer 2-way paper feeding — from the paper cassette at the front and from an auto sheet feeder at the rear — and automatic duplex printing. Only available as options previously, these features have become standard thanks to the development of a simple U-turn Path. This configuration allows paper that enters from the front cassette to come back out the front after making a U-turn inside the printer. The path is shared with the paper feed mechanism for duplex printing to help achieve smaller dimensions for the paper handling mechanism and printer unit. Canon also developed original tools to find and simulate the ideal transport route based on elaborate studies of paper movement, transport resistance, curvature, materials, and motor control. This technology enables double-sided and borderless printing without damaging the photo paper surface.



U-Turn Paper Feed Path

Large-Format Inkjet Printers

Striving for larger, more true-to-life imaging performance, Canon meets customer demand with large-format printers incorporating 1-inch-wide print heads based on FINE print head technology. Canon's high-density, high-resolution print head ensures unrivaled image quality and print speeds for applications in a diverse range of areas, including graphic art, photography, office documents, posters, and CAD.

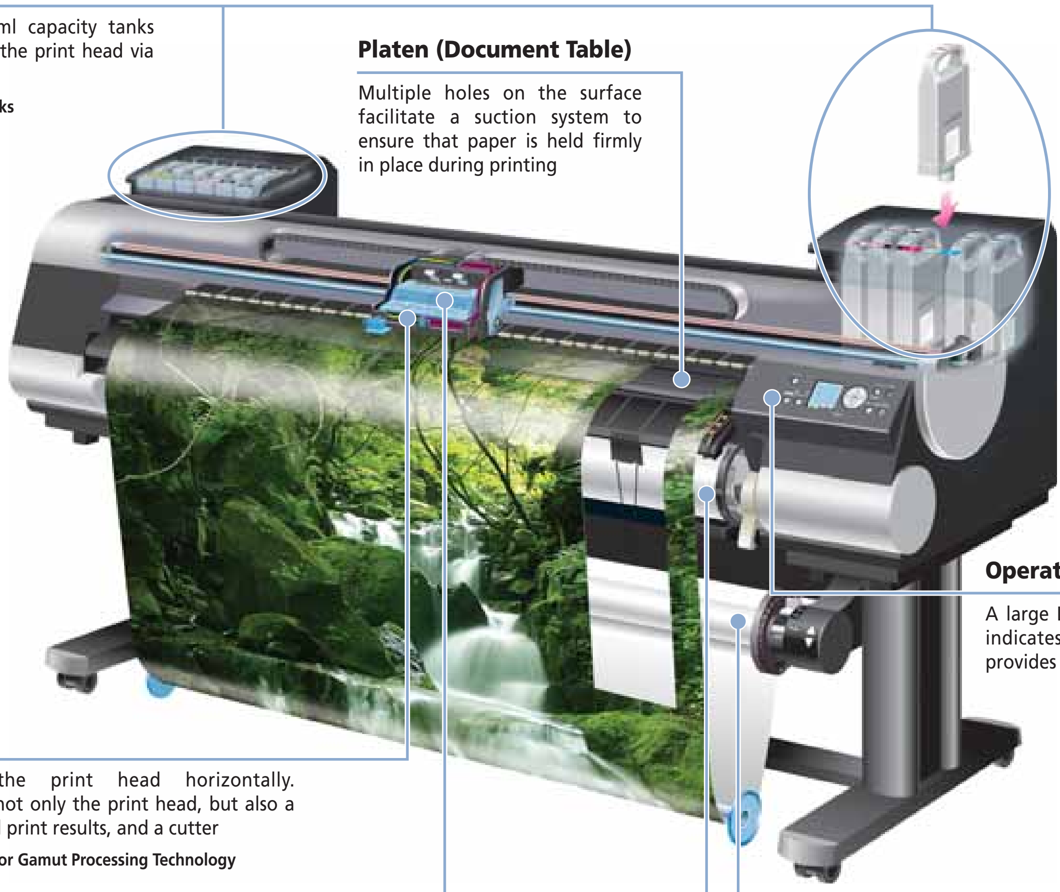
High-Capacity Ink Tanks

330 to 700 ml capacity tanks supply ink to the print head via tubes

→ P.33 LUCIA Inks

Platen (Document Table)

Multiple holes on the surface facilitate a suction system to ensure that paper is held firmly in place during printing



Operation Panel

A large LCD panel graphically indicates printer status and provides operational guidance

Carriage

Transports the print head horizontally. Incorporates not only the print head, but also a sensor to read print results, and a cutter

→ P.31 Dual Color Gamut Processing Technology

Print Head

Ejects ink to form an image. The imagePROGRAF iPF9000 is equipped with two 1-inch-wide print heads, printing with a total of 30,720 nozzles

→ P.33 1-Inch Wide Print Head

Roll Paper

Take-Up Unit

Automatically winds print output

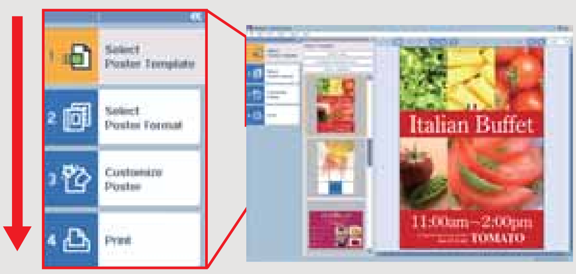
Poster Creation Software for Large-Format Printers

Easy, Problem-Free Poster Creation for Users of All Levels

PosterArtist, Canon's poster creation software application for large-format printers, offers an intuitive, easy-to-understand user interface that lets users of all levels easily create professional-looking posters. Since it is linked to the printer driver, PosterArtist lets users specify borderless printing, print quality, and other settings via one-click control from the PosterArtist screen.

Canon's unique image processing engine makes it easy to achieve such advanced effects as creating translucent objects and combining two images, tasks considered difficult to perform in conventional image processing applications. Additional features supporting full-fledged poster creation include a Page Capture function, which captures desired data from such office applications as Word, Excel, or PowerPoint, and a PosterArtist QuickCopy function, which works with Canon scanners to create large color copies.

Creating posters in four easy steps



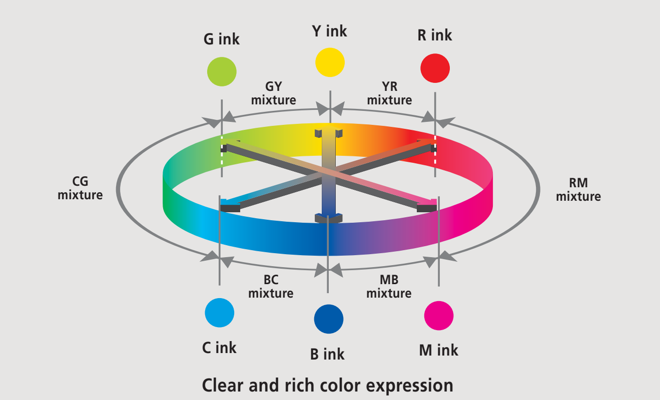
PosterArtist Poster Creation Screen

LUCIA Inks

12-Color Pigment Inks to Satisfy Demanding Art Professionals

Canon developed LUCIA pigment inks to meet professional demand for fine-art quality printout that renders natural tones in both color and black-and-white printing for photos, while producing vivid artificial colors — colors extending beyond those found in nature — for industrial design output. In addition to the six standard colors for large-format printers, LUCIA employs 3 primary colors — red, green and blue (RGB) — and two shades of gray, achieving an expanded print-color gamut with clear color expression.

Previously, gray tones were created by combining color inks. By contrast, the use of gray and photo-gray inks in Canon's LUCIA system achieves a rich grayscale and smooth gradation for stunning black-and-white photographs, accurately expressing the grayscale range from highlights to shadows. The innovation makes possible stable high-quality monochrome printing free of lapses in color representation.

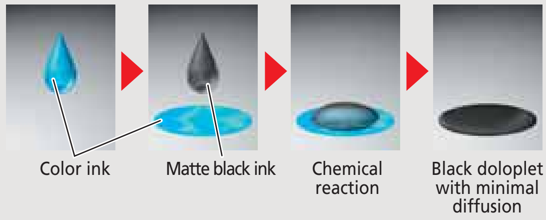


Comprehensive Color Expression with CMYRGB Inks

Reactive Ink Technology

5-Color Dye and Pigment Inks for High-Definition, High-Speed Printing in CAD and Business Applications

Canon's 5-color dye and pigment reactive inks combine a pigment-based matte black ink with four vivid dye-based inks: cyan, magenta, yellow, and black. Reactive ink technology, which utilizes the reaction when matte black ink is combined with dye color ink, prevents ink from spreading at borders between color and black output to achieve black text and lines that are clear and sharp. Two matte-black ink tanks ensure high-speed printing with a placement accuracy of ±0.1% and minimum line widths of 0.02 mm for CAD applications, which require ultra-fine lines and ultra-small text.



Reactive Ink Technology

L-COA

High-Speed Performance, from Image Processing to Printer Control

Canon large-format printers, which print over a wide surface area, must process high volumes of image data at high speeds while controlling the print head and managing the ejection of 12 ink colors. To meet these requirements, Canon capitalized on its strength in the field of SOC (System On Chip) technology to develop L-COA, a processor specially designed for large-format printers.

L-COA integrates protocol processing, image processing and printer control — functions that had been handled by multiple chips — onto a single chip for faster signal processing and high-resolution printing.

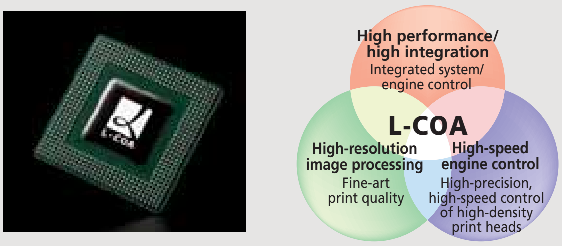
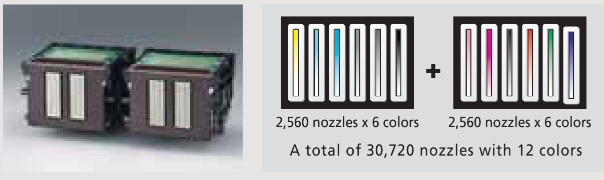


Image Processor L-COA and Conceptual Overview

1-Inch Wide Print Head

Achieving Even Better Image Quality and Faster Printing

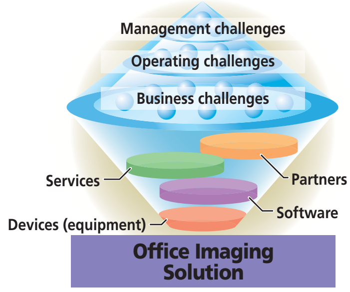
A key feature of Canon large-format printers is their 1-inch-wide print head. Utilizing its FINE print head technology (→ P.29), Canon has developed a print head measuring one inch in width with 2,560 nozzles per color, achieving a density that is double that of conventional print heads. Also, combining two 1-inch-wide heads yields a 12-color system with a total of 30,720 nozzles. The high-density nozzle configuration of these print heads results in broader print areas per print scan to realize faster print speeds. Additionally, Canon's original image processing technology provides both high resolution and high image quality.

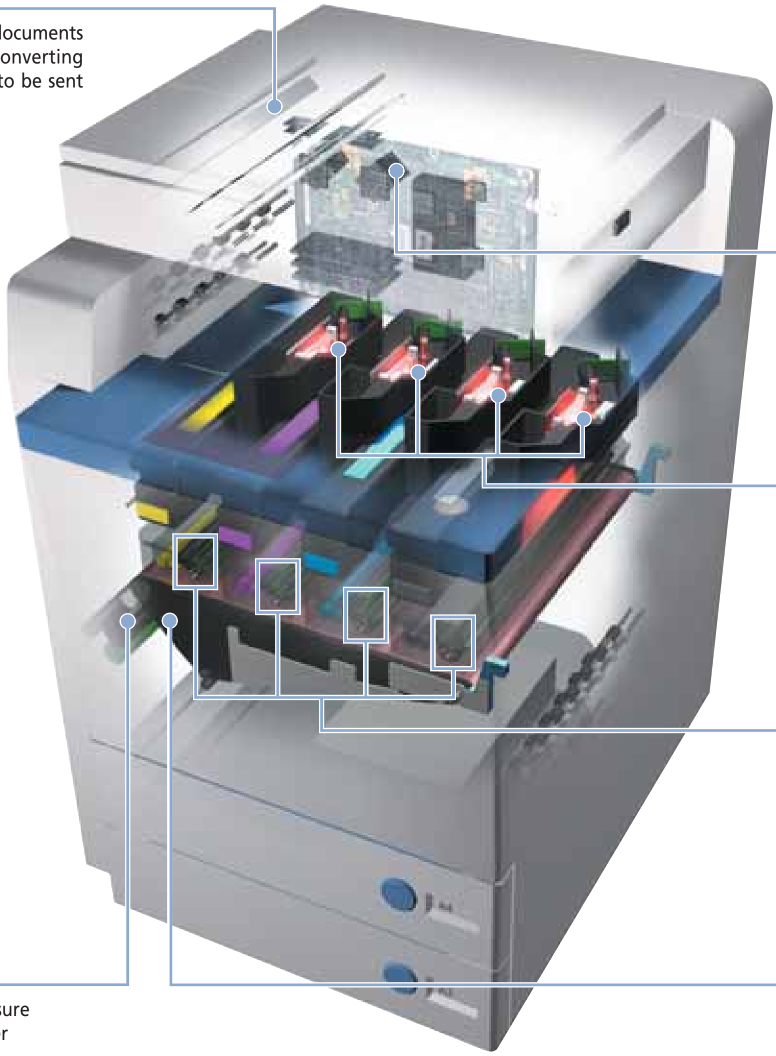


1-Inch Wide Heads

Network Digital MFPs

Canon's imageRUNNER (iR) series of network digital MFPs play a central role in document input and output procedures in the office.
The Office Imaging Solution concept, centered on the imageRUNNER (iR) series, seamlessly integrates devices, services, software, and partner-supplied systems to create optimal solutions in response to the various challenges facing enterprises today.





Scanning Unit

Illuminates and scans documents using a CCD sensor, converting them into image data to be sent to the controller

iR Controller

Incorporates a system LSI to simultaneously handle multiple functions in parallel, including copying, printing, scanning, and networking

→ P.35 iR Controller Architecture

Laser Units

Incorporating a laser transmitter unit, polygon mirror, and lens system, one laser unit is provided for each color — C (cyan), M (magenta), Y (yellow) and K (black) — in a tandem configuration

→ P.36 Advanced FLAT4 Engine

Drum Units

A photosensitive drum, electrical charging roller to charge the photosensitive drum, developer, and developing roller are incorporated into a single compact unit, with one drum unit provided for each of the CMYK colors

→ P.36 Cleaner-Less/Toner-Reuse System

Fixing Unit

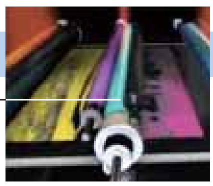
Applies heat and pressure to fix toner to the paper

→ P.35 Twin-Belt Fixing

Intermediate Transfer Belt

Transfers the image formed on the photosensitive drum to the paper. The belt transfers the image directly in one step, ensuring efficiency and consistent results

Printing Process

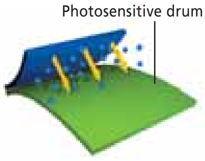

Photosensitive drum

Electrophotographic equipment such as network digital MFPs, high-speed full-color copying machines (→ P.44), and laser beam printers (→ P.46), all employ the same printing principle.

1 Electrical Charging

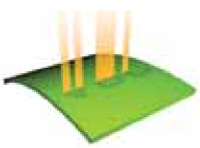
The surface of the photosensitive drum is negatively charged with a static charge of 700V.

Photosensitive drum



2 Exposure

Laser beams scan the photosensitive drum to form an image. Areas exposed to laser beams lose their electrical charge.



3 Developing

Toner is brought in close proximity to the drum and affixes to non-charged areas.

4 Transferring

The photosensitive drum is brought into contact with the paper and a positive charge is applied, which transfers toner onto the paper.

5 Fixing

Heat and pressure are applied to fix the toner to the paper.

iR Controller Architecture

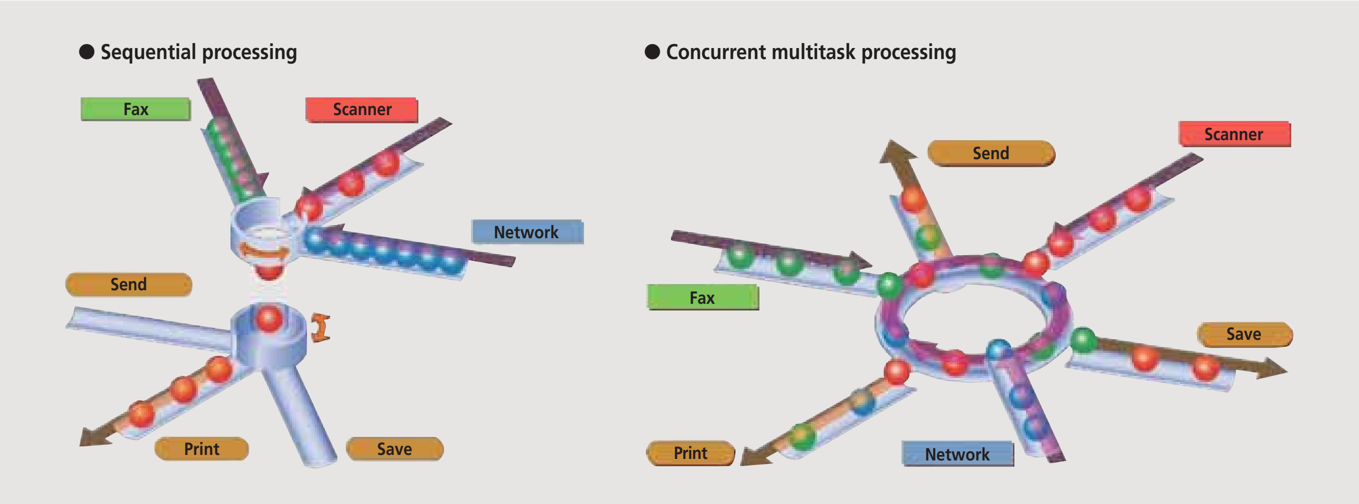
The Heart of Network Digital MFPs

Network digital MFPs allow streamlined simultaneous multitask processing of high volumes of data for input and output procedures, including scanning, printing, faxing, and networking. The iR Controller, the heart of Canon's imageRUNNER (iR) Series, incorporates a dedicated LSI that integrates two CPUs and image-processing technologies onto a single chip. This chip, which makes possible the highly efficient processing of multiple functions, was developed by upgrading the company's System LSI Integrated Design Environment.

The Color iR Controller employed in Canon's color-model imageRUNNER MFPs handle color data, which generally contains 30 to 40 times the volume of monochrome data, and is made up of not just a CPU that controls the system, but also a graphic engine for processing all images in the same dimension, the SURF rendering engine for processing print data, and other components. The graphic engine relies on Dual Direct Mapping for high color reproduction and an error dispersion processing T-MIC for reduced graininess and superior gradation to ensure high image quality. The SURF rendering engine incorporates a parallel processing technology called pipeline architecture for significantly enhanced processing speeds.

The third-generation iR controller built into the imageRUNNER C (iR C/CLC) series incorporates ERS (Effective Resolution Systems) for the efficient processing of 1,200 dpi images, delivering high-definition output with high efficiency through simultaneous multitask processing.

Color iR Controller Board

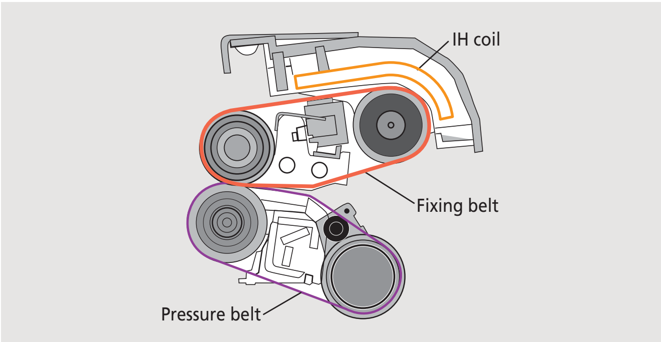


MFP Sequential and Concurrent Multitask Processing

Twin-Belt Fixing

A New Concept for Stable High-Speed Output and Low Power Consumption

In offices in which color network MFPs simultaneously serve the needs of multiple users, stable high-speed performance is a must. Through the integration of IH (Induction Heating) technology (→ P.75), commonly used in cooking appliances, and a new concept employing two belts to deliver faster output and enhanced stability, Canon developed the Twin Belt Fixing method. The fixing system utilizes a fixing belt that heats toner from the front side of the paper, and a pressure belt that applies pressure to the paper from the back. Unlike the rollers found in conventional systems, the belts expand the area on which pressure is applied from a line to a plane, enabling significantly improved fixing stability during high-speed output. The most significant feature is the heating of the fixing belt from the outer side (the side that comes into contact with the paper) using an IH heating coil. Also, since the fixing belt is made of a low-thermal-capacity material, the system achieves approximately 20% greater thermal efficiency than conventional systems while consuming less power.



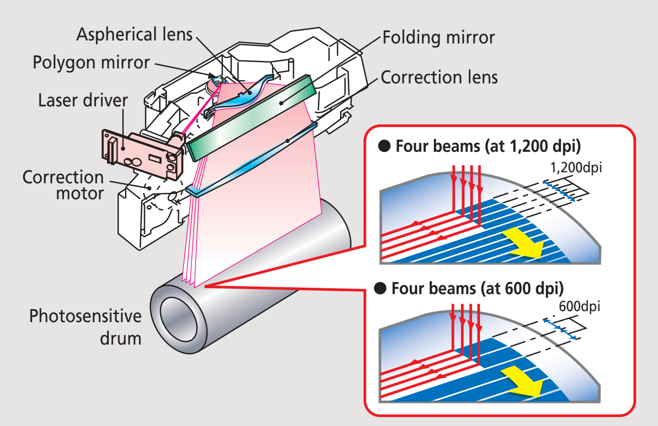
Twin-Belt Fixing

Advanced FLAT 4 Engine
High-Definition, High-Speed Output

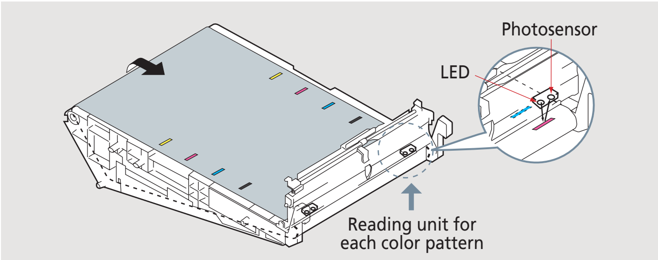
The engine section of Canon's color network digital MFPs employs a laser unit and drum unit for each CMYK color, arranged serially in tandem. The approach enables higher output speeds than the single-drum method of image creation.

The optical system employs a High-Definition 4-Beam Laser Unit that simultaneously emits four laser beams onto the photosensitive drum via a polygon mirror that scans beams horizontally. This compact mirror, which measures 20 mm diagonally and has four surfaces, controls laser beams by rotating at a speed of 37,000 rpm. Compact rotation motors and improved bearings reduce rotating noise. Laser units are L-shaped and positioned adjacent to the drum units to reduce overall dimensions.

Compared with single-drum systems, tandem systems are believed to be more susceptible to color blurring and variations in image density. Canon employed advanced sensing technologies to solve such problems. To eliminate color blurring, the engine measures each color pattern formed on the intermediate transfer belt with a photosensor to automatically correct the writing position of each color to the photosensitive drum. Variations in image density are automatically corrected by forming a patch of each color on the intermediate transfer belt and scanning it with an RRPS sensor capable of sensing image density with remarkable precision.



Structure of 4-Beam Laser Unit and Writing on the Photosensitive Drum



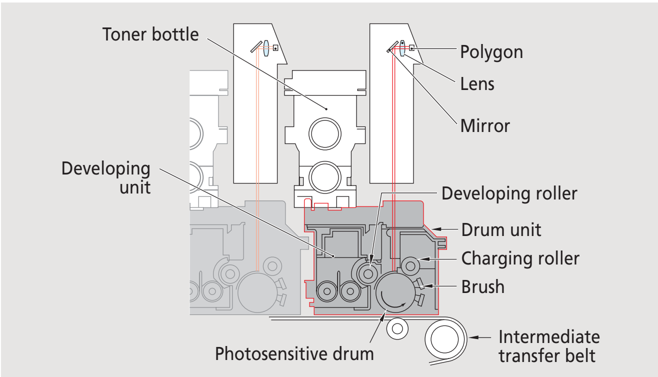
Registration Correction

Cleaner-Less/Toner-Reuse System
Achieving High Image Quality with Low Operating Costs

Canon developed its Cleaner-Less/Toner-Reuse System to achieve a balance between low operating costs and consistent image quality in color network digital MFPs.

With MFPs, toner often remains on the photosensitive drum following the transfer of toner from the drum to the intermediate transfer belt. Earlier systems used a cleaner mechanism to recover this toner. Canon's Cleaner-Less/Toner-Reuse System replaces this mechanism with a charged brush, charging roller, and developing roller. Toner is recovered into the developing unit by the developing roller for later reuse. Once the remaining toner is recovered, the charged brush recharges toner particles charged at different potentials for reliable recovery and reuse.

This system ensures the most efficient use of toner possible by using toner that would otherwise be disposed of as waste. And removing the cleaner mechanism eliminates the need to scrape the photosensitive drum surface with a cleaning blade, facilitating prolonged drum life while maintaining high image quality.

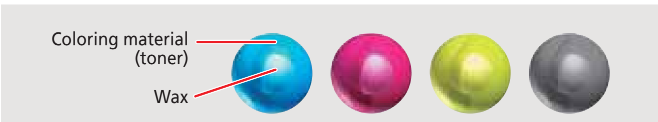


Cleaner-Less/Toner-Reuse System

S-Toner
Removing Gloss from Color Prints

Because conventional toner is produced by finely crushing colored resin, not even the most accurate tools can achieve a uniform shape and size for individual toner particles, which places limits on the level of image quality that can be attained.

In response, Canon has developed S-Toner, a unique spherical microparticle toner with a microcapsule structure. To produce S-Toner, Canon mixes coloring materials, wax and a monomer, polymerizes it by applying heat, and then solidifies the material. The result is similar to fine, uniformly dispersed oil droplets produced by stirring a mixture of water and oil which is then solidified chemically. S-Toner particles are spherical and have equable dimensions, making possible the creation of beautiful images with remarkably fine lines. Also, because the particles contain wax that protects fixing rollers, there is no need for roller protection oil, which enables the creation of printout free from the glossy look that results from this oil.



S-Toner Structure

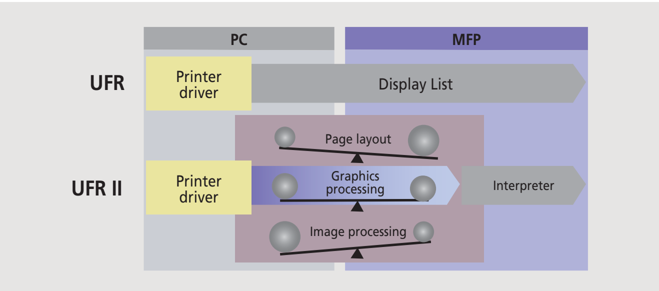
UFR and UFR II

Dramatically Faster Data Processing

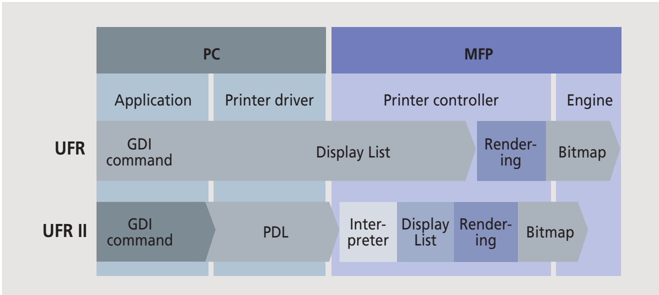
Achieving faster engines and higher resolutions means print controllers with higher CPU performance and memory capacity. In turn, that means higher costs. Canon developed the UFR (Ultra Fast Rendering) printing system to address this problem. The system integrates a number of printing functions previously processed with the iR controller CPU into a single chip. Distributing print data processing to the PC enables high-speed output at low cost.

SURF — UFR's rendering engine — employs a pipeline architecture, a technology that delivers improved processing speeds by dividing instruction execution into several stages and performing multiple stages in parallel. Making full use of the microprocessor's capabilities at all times, SURF ensures high-speed rendering with an inexpensive CPU and low-capacity memory.

Network MFPs and laser beam printers incorporate UFR II, a page description language created for Canon printers. UFR II, a next-generation extension of Canon's original architecture nurtured in UFR, incorporates a load-balancing capability for efficient distribution of data processing loads between the PC and printer. UFR II delivers stable output that is unaffected by variations in process data or print environment, and achieves dramatically increased processing speeds — up to five times faster than conventional architectures.



Overview of UFR II Load Balancing



Overview of Data Processing (UFR and UFR II)

MEAP/MEAP Lite

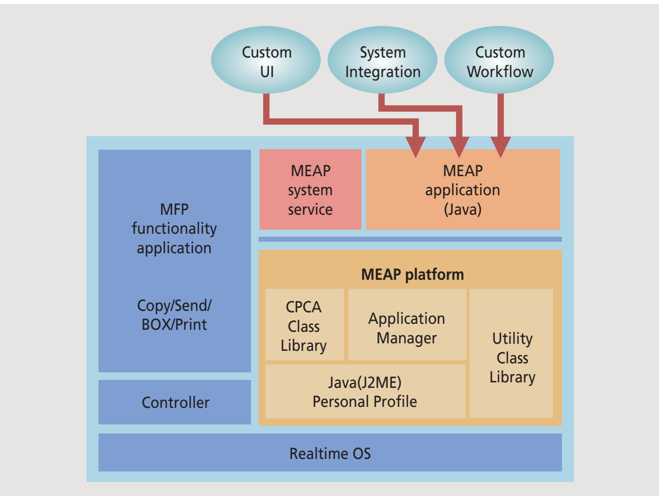
Expanding the Potential of IT Terminals

MEAP (Multifunctional Embedded Application Platform) is an application platform incorporated into Canon network digital MFPs. MFPs equipped with MEAP can be controlled using applications developed in the Java language (Java ME). Featuring outstanding portability, Java enjoys wide use in various devices, including mobile phones. MEAP provides network digital MFPs with dramatically enhanced potential as IT terminals and broader interaction with external devices and software.

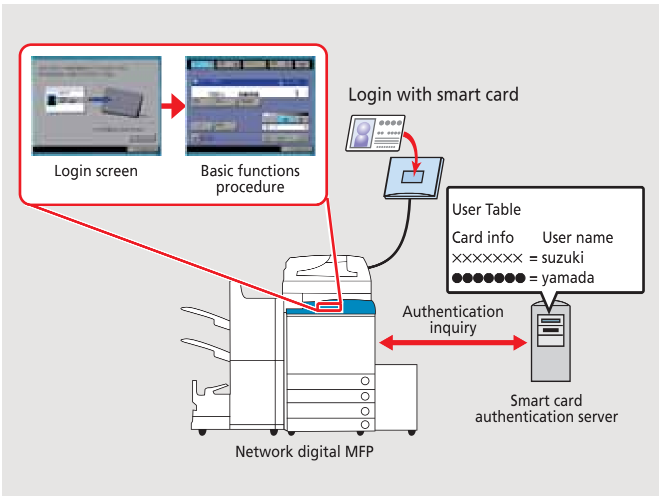
The MEAP architecture consists of three main components: the MEAP platform, MEAP system services, and MEAP applications. The MEAP applications allow users to issue and control printing, scanning and copying jobs in accordance with desired workflows. An innovative concept that involves providing an application platform on the MFP lets users exploit the power of Java applications.

As of October 2006, more than 40 MEAP applications have been released. These applications include the imageWARE Workflow Portal, designed to allow users to distill individual processing patterns into routine buttons, and Smart Card Authentication for MEAP, which adds authentication features in combination with smart card readers to meet a wide range of workplace needs.

MEAP Lite, a printer-version MEAP platform, was developed for LBPs operating in server-less printer systems.



MEAP Architecture



Overview of Smart Card Authentication for MEAP

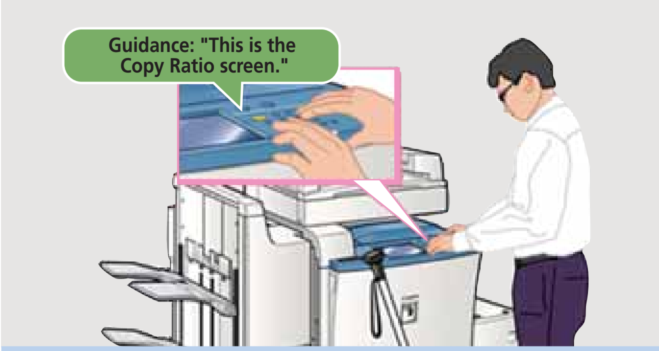
PureTalk Speech-Synthesis Engine

Transforming Text into Natural-Sounding Speech

Speech-synthesis, a computer technology that converts text into speech, is used in products to facilitate accessibility. Text is converted into speech through a process in which the language is analyzed and estimations are made regarding pronunciation, stress, phrasing, and intonation. The PureTalk* speech synthesis engine, developed by Canon, offers clear, natural-sounding speech and is now capable of reading out sentences written in Japanese as well as in English.

The most distinguishing feature of PureTalk is its audio quality, among the industry's highest level for a speech-synthesis system for compact electronic devices with built-in speech synthesis functions. PureTalk can generate male and female voices, both young and old. Efforts to achieve a compact speech synthesis engine for acoustic and language processing have resulted in a system of 1MB in size (for Japanese), without sacrificing sound quality. PureTalk is now built into imageRUNNER (iR)-series network digital MFPs and select facsimile machine models.

* PureTalk is a trademark used in Japan.



Audio Guidance for Copy Operations

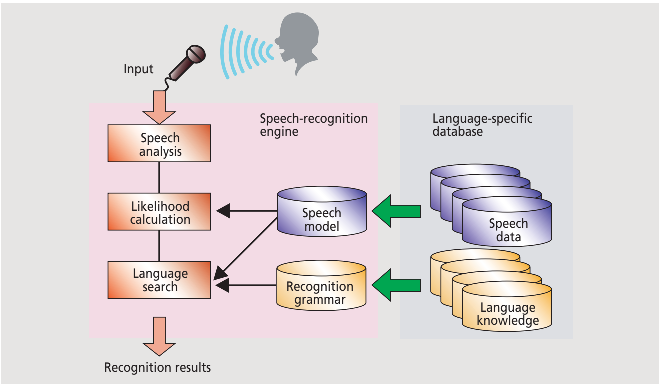
"VoiceMaster" Speech-Recognition Engine

Accurate Human-Voice Recognition for Equipment Control

Speech recognition is a computer-processing technology that converts the human voice into text or commands, making possible more user-friendly products by enabling equipment to be controlled and information to be input into computer systems by voice alone.

Canon's VoiceMaster speech-recognition engine achieves a recognition rate among the industry's highest, with a high level of accuracy even when the speaker's voice has not been registered beforehand. The engine is capable of quickly recognizing not only individual words, but also continuous speech such as phrases and sentences, and can operate even amid surrounding noise, thanks to Canon's environment-response technology. The system handles both English and Japanese, and the speech-recognition engine lineup offers recognition vocabularies ranging from one hundred to tens of thousands of words, based on the intended use and performance capabilities of the target device. With the aim of improving product usability, Canon is currently working to develop and expand this technology, moving ahead in the research and development of next-generation speech-recognition technologies and engines to provide such functions as multi-language support.

* VoiceMaster is a Japanese trademark.



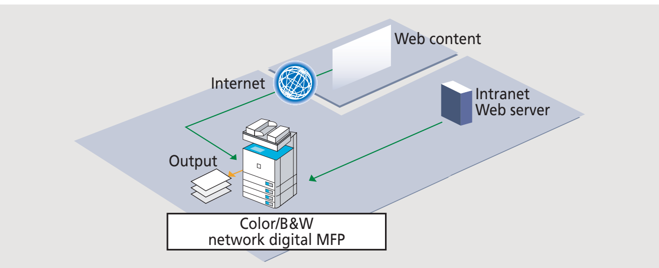
Speech Recognition Flow

Web Browser Function

Direct Content Viewing and Output for Improved Efficiency

Canon's Web Browser function provides direct access to Internet or intranet content from the operation panel of a network digital MFP for browsing or printing without the need for a PC. This capability contributes to improved work efficiency by making possible such tasks as accessing and printing PDF files stored in an intranet database.

Canon has customized embedded browsers for mobile phones and other information appliances, linking them to Canon's proprietary authentication functions (ID management by department, MEAP-based authentication, system management) and embedding them into network digital MFPs as browser applications. Design considerations included the filtering of high-load Web content to ensure that high-priority functions continue uninterrupted, as well as processing algorithms on the browser side that permit Web browsing with relatively modest device resources.



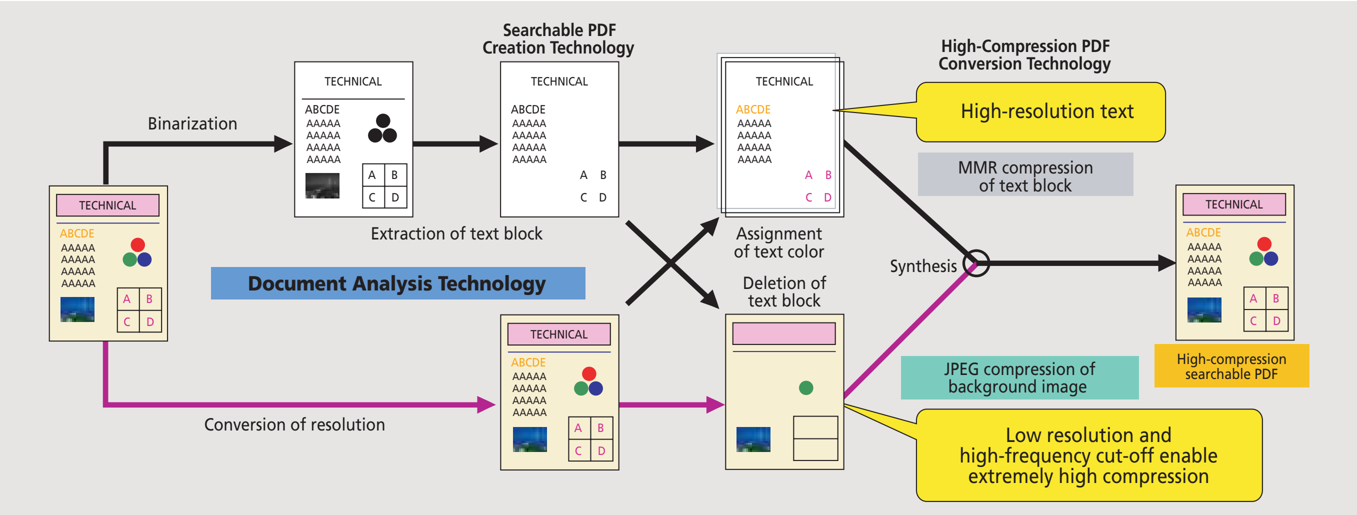
Overview of Web Browser Function

Example of a Web Browser Screen

Document Processing Technology

Enabling the Effective Use of Documents as Data

Canon's network digital MFP imageRUNNER (iR) series does more than just provide copies of scanned originals. Equipped with document-processing capabilities, the machines also analyze document layouts, identifying text and graphics to support the effective use of data.



How High-Compression PDF Creation Works

Document-Analysis Technology:
Identifying Text and Graphics from Images

Document-analysis technology evaluates each component contained within a document image layout, creating basic data to convert text into character code data, lines into vector data, and photos and illustrations into bitmap data. The separate identification and conversion of each of these data types make it possible, for example, to search for documents and determine forms from a layout to create a database.

In addition to printed text, the technology can recognize hand-written Japanese characters, numbers, alphabets, and some symbols, and, in addition to Japanese and English, supports multiple languages, including Chinese, Korean and European languages.

Searchable PDF* Creation Technology:
Text searches in Image PDFs

The searchable PDF creation technology is designed to enable text searches by overlaying text data, extracted using document-analysis technology, over the original image in transparent text layers. This technology enables the searching of text contained within images, allowing users to create searchable PDF files at high speeds — 7.5 pages per minute for A4 size paper — with accuracy rates of 97.75% (based on in-house Japanese-language evaluation samples). In addition to Japanese, the technology also supports English and other European languages.

High-Compression PDF Conversion Technology:
High Resolution and Low Data Volume

High-compression PDF conversion technology employs document-analysis technology to extract text and image data from scanned images, separating the data into multiple layers. The technology achieves high compression ratios by using optimized compression methods for each layer, and then reintegrating the layers. Document components such as text, graphics, and backgrounds are separated and compressed optimally, enabling high compression ratios while maintaining high resolution. With conventional JPEG compression, an A4-size color document scanned at 150-dpi resolution would create a file approximately 2 MB in size. Using this technology, however, the same document scanned at a resolution equivalent to 300 dpi is compressed to roughly one-tenth that size.

Outline PDF:
Achieving Beautiful Text in Any Environment

Canon's document-analysis technology contributes to improved image-data handling by enabling high compression while maintaining the high resolution of scanned images. Through the achievement of further advancements in this technology, Canon developed Outline PDF. With conventional high-compression PDF conversion technology, text and image data extracted from scanned images are combined. With Outline PDF, however, text data is converted into outline vector data and compressed, making possible the display of crisp text regardless of the image-data reproduction environment. Moreover, text and graphics data converted by Outline PDF lends itself for reuse in Adobe Illustrator, expanding the range of applications for such image data.

Smooth Text Reproduction in any Environment

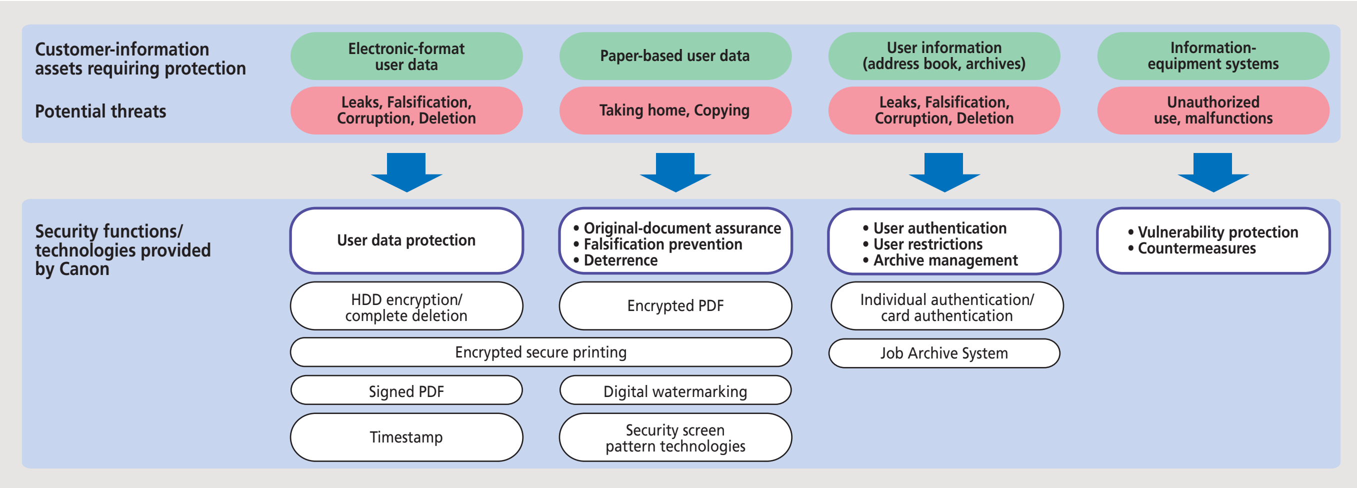
* PDF (Portable Document Format), a document-exchange format developed by Adobe Systems Inc., is widely used to exchange documents and post them on the Internet.

Security Technologies

Total Hardware and Software Security

Office security awareness now encompasses all information resources, including not only data and systems but also paper media. Canon views the entire office-information flow as a document cycle, the center of which is the imageRUNNER (iR) series of network digital MFPs, providing total security from the perspectives of both hardware and software.

Canon develops exhaustive security technologies for various stages of the document cycle by identifying information assets requiring protection and potential threats.



Comprehensive Security Technologies

Digital Watermarking Technology:
Safeguarding Image and Document Copyrights

Digital watermarking technology can provide copyright protection for photos, illustrations and other images in digital form, as well as DVD and other video data, and other document contents. The technology enables the name of the copyright owner, the date of creation and other relevant information to be encoded and embedded within the digital content.

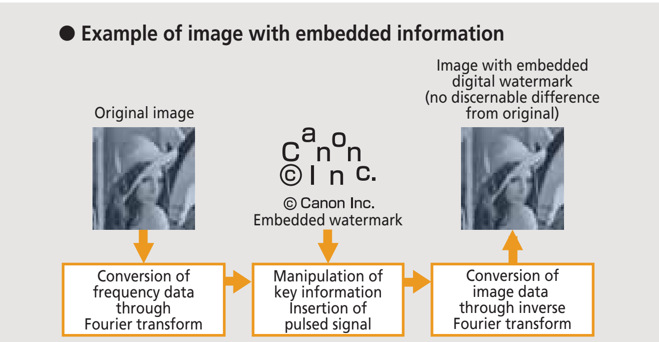
Canon has also developed an error-correcting coding technology that utilizes mathematical processing to decode difficult-to-discern signals corrupted by noise. This allows the recovery of embedded information, even when part of the content has been subjected to unauthorized deletion or modification, as well as the easy detection of unauthorized image use. Additionally, Canon has developed digital watermarking technology for text documents that maximizes the capabilities of optical-character-recognition technology. There is absolutely no difference in appearance between the original document and the document with embedded data, and the embedded data can be detected on paper should the document be printed out. The application of these technologies will make possible the realization of effective methods for protecting important documents.

Security Screen Pattern Technology:
Protecting Critical Information with Simple, Low Cost Processing

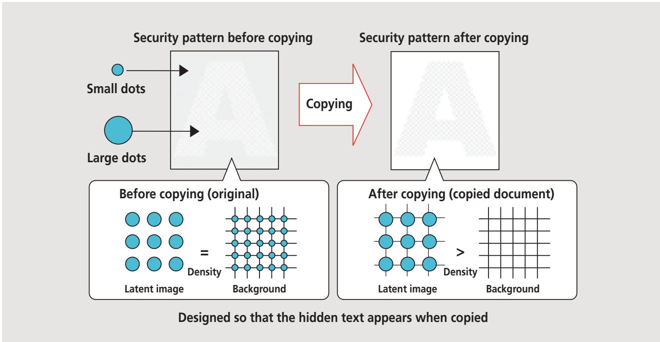
Security screen pattern technology is a security technique that deters unauthorized copying through hidden text that appears when paper printout is copied, enabling the creation of original security screens without using special printer paper.

Security screen patterns are composed of a hidden text string (which remains when copied) and a pattern (which disappears when copied), with the hidden text rendered in large dots, and the pattern in small dots when printed. During copying, the small dots are not scanned and thus disappear, leaving behind only the hidden text printed in large dots.

For this technology, a process for effectively concealing boundaries between fields of large and small dots had to be developed. The process ensures uniform density, preventing the hidden text from standing out. The technology determines the individual imaging capabilities of the printer, enabling the easy setting of optimal densities by means of a density calibration function.



Digital Watermarking

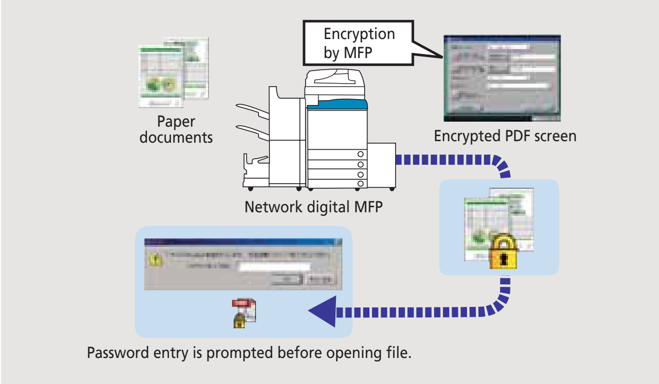


Principle Behind Security Screen Pattern Technology

Encrypted PDF Creation Technology:
Supporting PDF Data Security

In addition to enabling the creation of PDF* data from scanned images, Canon network digital MFPs also offer compatibility with the password-based security used by Adobe Acrobat.

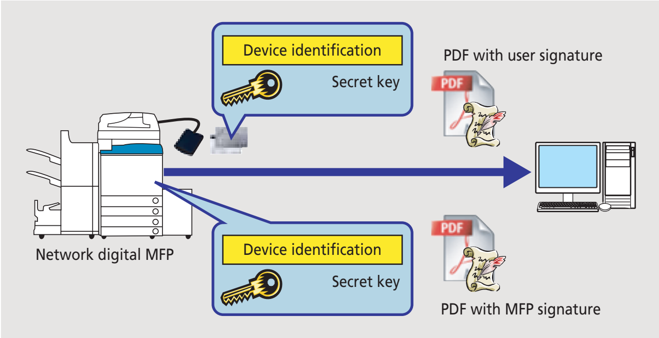
This function allows users to assign a password when scanning to encrypt PDF and high-compression PDF data. Encryption is based on private-key cryptography, requiring the entry of a password to view the data. The security feature ensures that only those individuals or departments who have been notified of the password are provided access to the information, even if the data should be accidentally sent to the wrong destination. The system also incorporates features designed to prevent transmission errors before they occur, including a function that restricts the destinations to which data can be sent, supporting both enhanced operability and security.



Overview of PDF Encryption

Signed PDF:
Enabling Information-Source Authentication

Signed PDF is a technology designed to identify the source of a PDF file. During image scanning, the network MFP used to create the PDF file adds device-specific identification and a secret-key-generated device signature. Users can verify whether or not a document has been falsified by comparing this information. The system also allows users to attach personal identification and a secret-key user signature in place of the device signature.

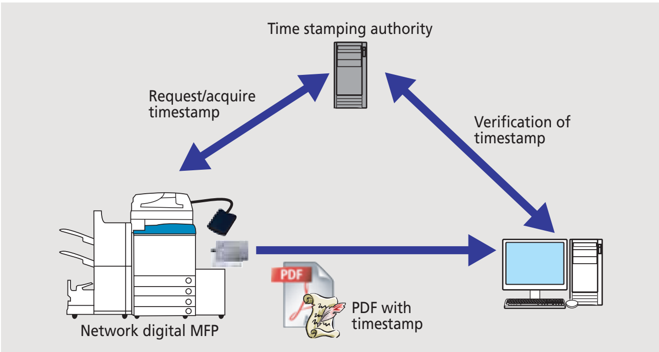


Overview of Signed PDF

Timestamp:
Making Possible Time-of-Creation Authentication

Timestamping is a technique used to indicate when an image PDF file was created by attaching time information, issued by an official time-stamping authority, to the PDF file. This technology makes it possible for the receiver of the PDF file to verify the time stamp or inspect files for falsification.

* PDF (Portable Document Format), a document-exchange format developed by Adobe Systems Inc., is widely used to exchange documents and post them on the Internet.



Overview of Timestamp

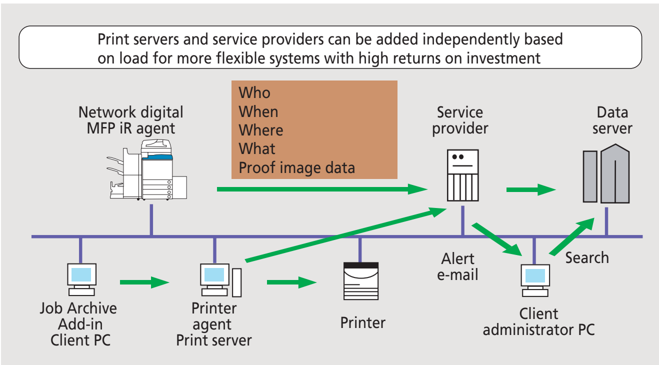
imageWARE Job Archive System

Providing High-Tech Security for Paper Media

Managing personal and confidential information in the office place is a matter of critical importance. Canon's imageWARE Job Archive System uses digital MFPs and laser beam printers to manage and track printed information in order to deter information leaks.

Network digital MFPs supporting the imageWARE Job Archive System automatically track copy, print and fax jobs, and record logs (who, when) and image data prior to job execution. The recorded data can be analyzed, enabling the search of job-content information.

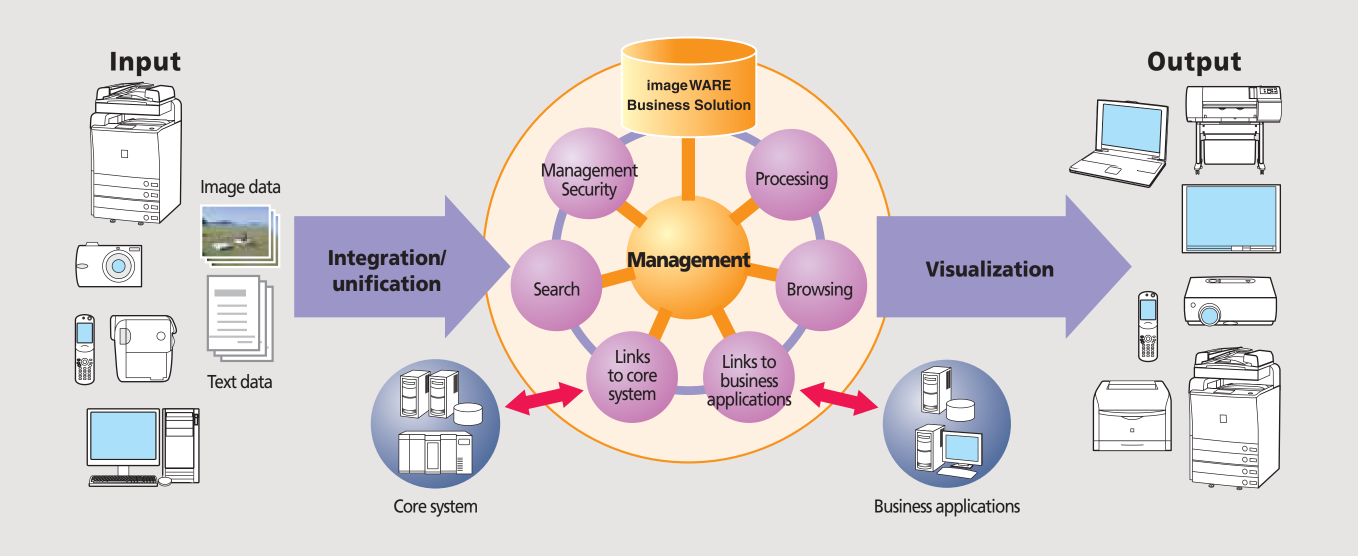
Canon plans to further extend this technology into larger-scale user environments. The adoption of this system as a printer and network MFP security infrastructure is expected to grow more widespread.



Data Flow for imageWARE Job Archive System

imageWARE Business Solutions

Optimal Solutions for Flexible Systems



Configuration of imageWARE Business Solutions

Communication for office tasks can be dramatically improved through visual data. Taking full advantage of its diverse hardware, software, and business know how, Canon provides imageWARE Business Solution as a one-stop solution in which visual data plays a pivotal role.

The imageWARE Business Solution platform is the product of Canon's vast expertise in a diverse range of input and output devices and software, and technological capabilities. Unlike conventional commercial or custom-developed software, this solution helps users build customizable systems as efficiently as possible. Each function required to build a business system is available in the form of a component, allowing users to realize the optimal system by combining components to suit specific needs. This optimal solution is also based on comprehensive usability testing to allow flexibility in the changing and extending of system functionality.

imageWARE Form Manager/Output Manager Select

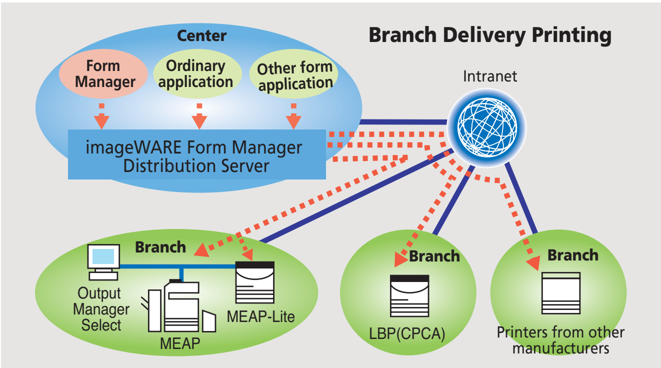
Total Management of Large-Scale Form Output

Many businesses seek greater efficiency in the handling of the vast number of forms — including billing and purchase-order forms — that need to be output on a daily basis. Canon developed its imageWARE Form Manager and imageWARE Output Manager Select systems to address this need. These solutions improve operational efficiency and contribute to reduced TCO (Total Cost of Ownership).

For forms output from a key system, the current norm is a centralized system using high-speed large-scale printers. While such systems provide lower printing costs, they result in costs associated with delivering printed matter, and make immediate response problematic. Canon's imageWARE Form Manager incorporates a delivery-print function that makes use of the office MFPs and laser beam printers at branches for the printing out of forms instead of high-speed large-scale printers. Combining imageWARE Form Manager with the imageWARE Output Manager Select print management system delivers increased overall form-printing efficiency at each branch, from print-job monitoring to total print assurance, and provides improved reliability as a core system.

Performance targets during the development of the imageWARE Form Manager's print-delivery function (Distribution Server) included the ability to serve 1,000 printers from a single server and total print assurance for up to 100,000 jobs. When considering computer performance capabilities, however, simultaneously managing the transmission of 1,000 sessions is unrealistic. For this reason, Canon developed a delivery scheduling function that supports the handling of 1,000 sessions by having the server simultaneously and constantly monitor 100 sessions at a time.

For example, if print processing at one of the destinations should be interrupted due to a printer error, the server terminates the session with that destination and processes print instructions for the next destination, thereby maintaining high efficiency. Usually, when a session is canceled, the system loses track of that print job. With this system, however, Print Server for Meap/Meap-Lite software in the printers functions as a proxy to handle print jobs following session terminations. By reconnecting the session to the server after the error has been resolved, the server is able to continue monitoring print jobs. Through the comprehensive optimization of the server and memory with the aim of ensuring the management of 100,000 jobs, this function is capable of handling as many as 300,000 jobs.



Configuration Example of Delivery Printing System Using imageWARE Form Manager Distribution Server Function

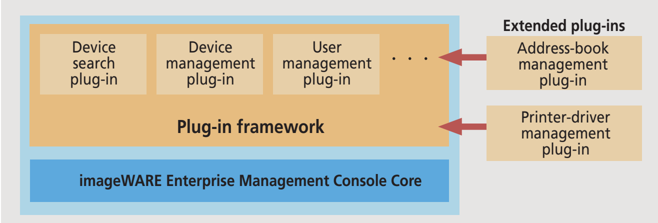
imageWARE Enterprise Management Console

Ensuring Efficient Printing Device Management for System Administrators

The growing numbers of printing devices connected to networks has led to a corresponding need to perform numerous management tasks, including output device setup and configuring client PC print environments. Until now, each of these tasks has required a different utility, making the job of system administrator unnecessarily complex.

To solve this problem, Canon developed imageWARE Enterprise Management Console, an application that integrates the management of various tasks previously handled by several utilities, including printing-device setup, address-book delivery, and printer-driver installation.

This software is designed so that functions are added as plug-ins, making it possible to add address-book management, printer-driver management, and other functions, in addition to such basic functions as device discovery, device-setting management, and user-account management. Combining these functions creates a wide-ranging solution set that allows administrators to easily register and automatically implement printing-device settings and install printer drivers for specific client groups.

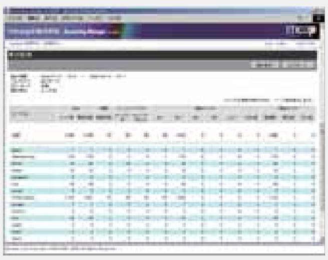


imageWARE Enterprise Management Console Configuration

imageWARE Accounting Manager

Recording and Managing Device Use Status

Canon's imageWARE Accounting Manager tallies and analyzes total output, including printing and copying, by department, user and device. A record of who, at what time, performed what type of printing or copying task for each device is retained in the device itself with imageWARE Accounting Manager for MEAP, and in server-based databases with imageWARE Accounting Manager Compact Package and imageWARE Accounting Manager Full Package, and this information can be reviewed as necessary. Gaining an understanding of the output levels from each department makes it possible to transfer appropriate expenses, achieve the optimal distribution of output devices, manage color output, manage paperless activities and targets, and check for the printing of confidential and personal documents.



imageWARE Accounting Manager Screen

● imageWARE Accounting Manager for MEAP

imageWARE Accounting Manager for MEAP is a MEAP application that requires no dedicated server or PC, facilitating the tabulation of output levels by department, down to specific printout details.

● imageWARE Accounting Manager Compact Package

This server package software supports not only network digital MFPs, but also laser beam printers. The application enables the centralized management of output information without installation on client PCs.

● imageWARE Accounting Manager Full Package

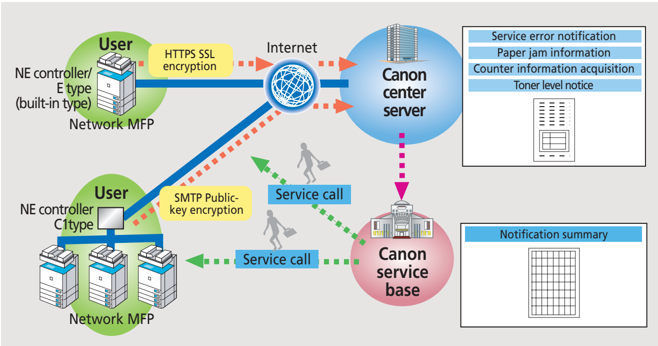
This server package software enables the management of not only devices targeted by the imageWARE Accounting Manager Compact Package, but also printers and Canon copying machines. The installation of the software on client PCs enables the collection of more accurate output information. The package also incorporates imageWARE Accounting Manager Central Server software for the centralized management of multiple imageWARE Accounting Manager Servers.

e-Maintenance

Remote Monitoring System for Automatic Detection of Problems and Toner Levels

Canon's e-Maintenance system uses networks to provide automatic detection of low toner levels and other potential problems involving Canon network digital MFPs. Should consumables run out or a problem arise, the system automatically notifies the center, which in turn contacts a Canon service base for the prompt delivery of the required services.

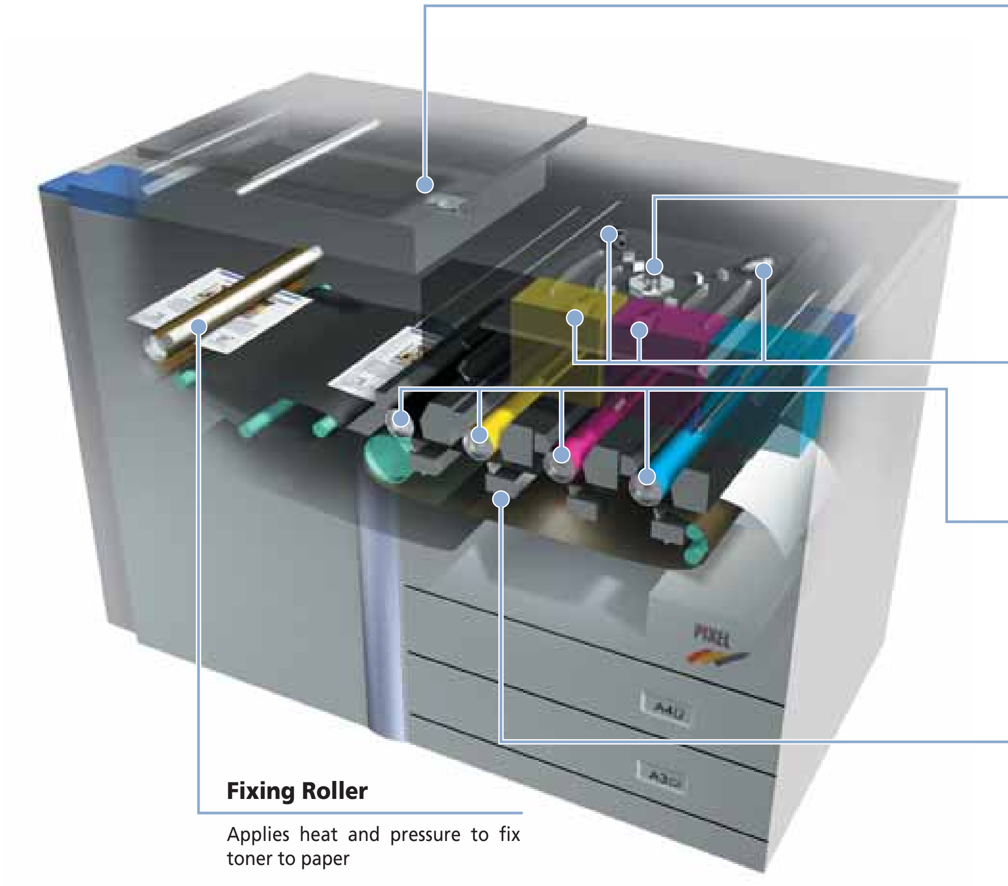
The e-Maintenance remote monitoring system only sends information to a designated central server. Moreover, to provide users with peace of mind, data is transmitted securely using HTTPS protocol incorporating SSL (Secure Socket Layer)-based transmission path encryption functions, or via e-mail encrypted using public-key encryption.



Overview of e-Maintenance

High-Speed Full-Color Copying Machines

Canon continues to pursue cutting-edge electrophotographic technologies in its high-speed full-color copying machines, which are now capable of achieving a level of imaging performance comparable to that of offset printing. Amid increasing demand for not only accurate color matching, stability and speed, but also rich imaging expression capability and high productivity, Canon's high-speed full-color copying machines have earned the trust of creative professionals around the world.



Scanner Unit

Illuminates the original image and scans image data with a CCD sensor, then sends the image data to the controller

→ P.45 Image-Processing Algorithm

Polygon Mirror

With 8 to 10 surfaces, this mirror rotates at speeds ranging from 20,000 to 30,000 rpm to scan laser beams laterally

Laser Transmitter Unit

Emits laser beams. The CLC5100 has four laser transmitters, one each for C (cyan), M (magenta), Y (yellow), and K (black)

Quattro Engine

Four engines, handling the four processes of charging, exposure, developing, and transfer, are arranged in series for high-speed output

→ P.44 Auto-Registration Servomechanism
→ P.45 Full-Color Copying Machine Toner

Transfer Belt

In close contact with the Quattro engine, the transfer belt feeds paper for toner application

→ P.45 Image Processing Technology ARCDAT

Fixing Roller

Applies heat and pressure to fix toner to paper

How Full-Color Machines Work

Using the same printing method as that employed in network digital MFPs, toner is applied in the order of cyan (C), magenta (M), yellow (Y), and black (K), and is fixed to the paper.

Auto-Registration Servomechanism

Supporting High Image Quality with a Precision Tolerance of 5 μm

To enable the printing of 50 A4 pages per minute, Canon's high-speed full-color copying machines use the Quattro Engine, a four-drum system with a structure similar to that of a printing press. The engine incorporates one photosensitive drum for each of the CMYK colors, with the four drums configured in series to transfer images by color in sequence for full-color printing. With a high-speed four-color system, however, even the slightest errors in the laser-emission timing, tilt of the laser beams for each color, or magnification can result in color misalignment. Canon has developed various auto-registration servomechanisms to prevent the occurrence of misaligned colors.

For example, a CCD sensor measures the degree of any color misalignment immediately after printing and a built-in computer instantaneously computes the amount of correction required. The optical system then adjusts accordingly, moving vertically and laterally as needed in microscopic 5 μm increments to ensure proper alignment.

In addition, the system achieves improved image definition in units of single dots thanks to visible-light ultra-small spot lasers, and delivers greater precision accuracy for image density and tonality through automatic gradation control and Dual ATR (Attenuated Total Reflection), which controls toner density.

The Four-Drum Quattro Engine

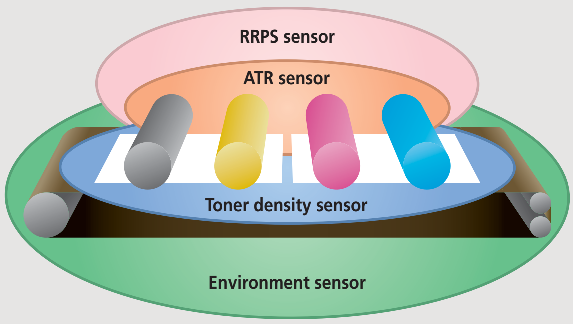
Image Processing Technology ARCDAT

Monitoring Toner Status in All Processes for Image Quality Approaching Offset Printing

A stable supply of the proper amount of toner is needed to ensure consistent output from high-speed full-color copying machines over extended periods. Canon's ARCDAT (Automatic and Reciprocal Color Density Adjustment Technology), which employs four types of sensors, was developed to enable the real-time automatic adjustment of toner density.

Comprising an ATR sensor that controls the toner and carrier mixture ratio, and a toner density sensor that senses toner density on the photosensitive drum, the Dual ATR controls toner density based on various environmental conditions, including temperature and humidity, and automatically adjusts the supply of toner. The environment sensor, which gauges temperature and humidity, controls the electric potential of the photosensitive drums and corrects image parameters. The regular reflection photo sensor (RRPS), which provides accurate detection of low toner densities on the photosensitive drum and is particularly effective with light colors, works in conjunction with the Dual ATR toner density sensor, which provides effective performance with dark colors, to enable real-time toner density control.

ARCDAT monitors toner conditions throughout a series of high-speed color copying processes for the optimal control of toner density in real time. The technology minimizes image density inconsistencies to achieve a 170% improvement in image stability compared with conventional models.



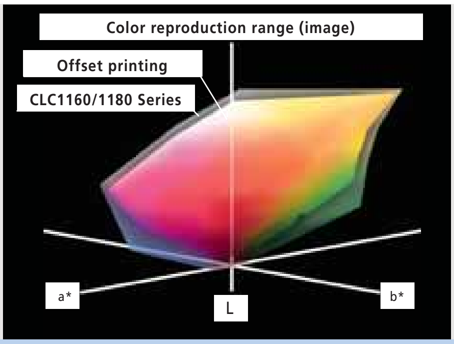
Overview of ARCDAT Automatic Image Density Control Technology

Full-Color Copying Machine Toner

Color Reproduction on a Par with Offset Printing

Due to differences between the color tones produced by toner and those of printing ink, the color reproduction capabilities of color copying machines sometimes fall short. Following comprehensive research beginning with the color materials used to produce color toner, Canon has succeeded in developing a new toner that offers a 30% wider color reproduction range than conventional toner, making possible a color space that approaches that of offset printing. The new toner also realizes improved heat-fusion properties for faster fixing, enabling an approximately 1.5-fold increase in processing speed.

With the introduction of this toner, Canon high-speed full-color copiers now offer a level of image quality that enable the machines to fulfill the role of offset proof press, meeting the needs of such high-end users as professional designers and printing industry professionals.



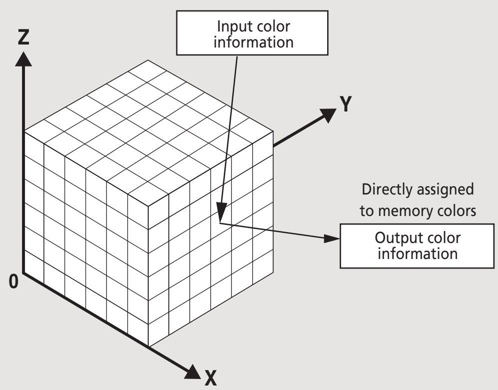
Conceptual Image of CLC1160/1180 Series Color Reproduction Range

Image-Processing Algorithms

Maximizing Toner Performance

Since copying machines read originals in three-color RGB and print in four-color CMYK, they must convert RGB input data into CMYK data. To take full advantage of the expanded color-reproduction range made possible by its toner, Canon incorporated technological innovations into its image-processing algorithms.

This technology incorporates direct-mapping computing processing, which directly assigns input signals to memory colors, and matrix-computing processing, which adapts output signals to human perception based on various engine characteristics. The combination of this technology with the toner achieves the reproduction of subtle highlights and all the gradation and delicate texture required to naturally convey such qualities as skin tones.



Color Spaces and Direct-Mapping Computing

Laser Beam Printers

In developing laser beam printers (LBPs), Canon has always been sensitive to user needs, examining them from various perspectives and responding promptly. From enhanced practicality to environment-conscious performance, the company continues to focus on usability during product development, striving not only to offer improved basic performance in terms of image quality, speed, and ease of use, but also network compatibility and extensibility to satisfy the latest user needs.

Toner Cartridge

Each cartridge contains either C (cyan), M (magenta), Y (yellow), or K (black) toner

Polygon Mirror

With four to six surfaces, this mirror rotates at speeds from 20,000 to 30,000 rpm to scan laser beams laterally

Intermediate Transfer Belt

Transfers images formed on the photosensitive drum to paper. The belt transfers the image directly in a single operation for consistent results and high efficiency

Electrical Charging Roller

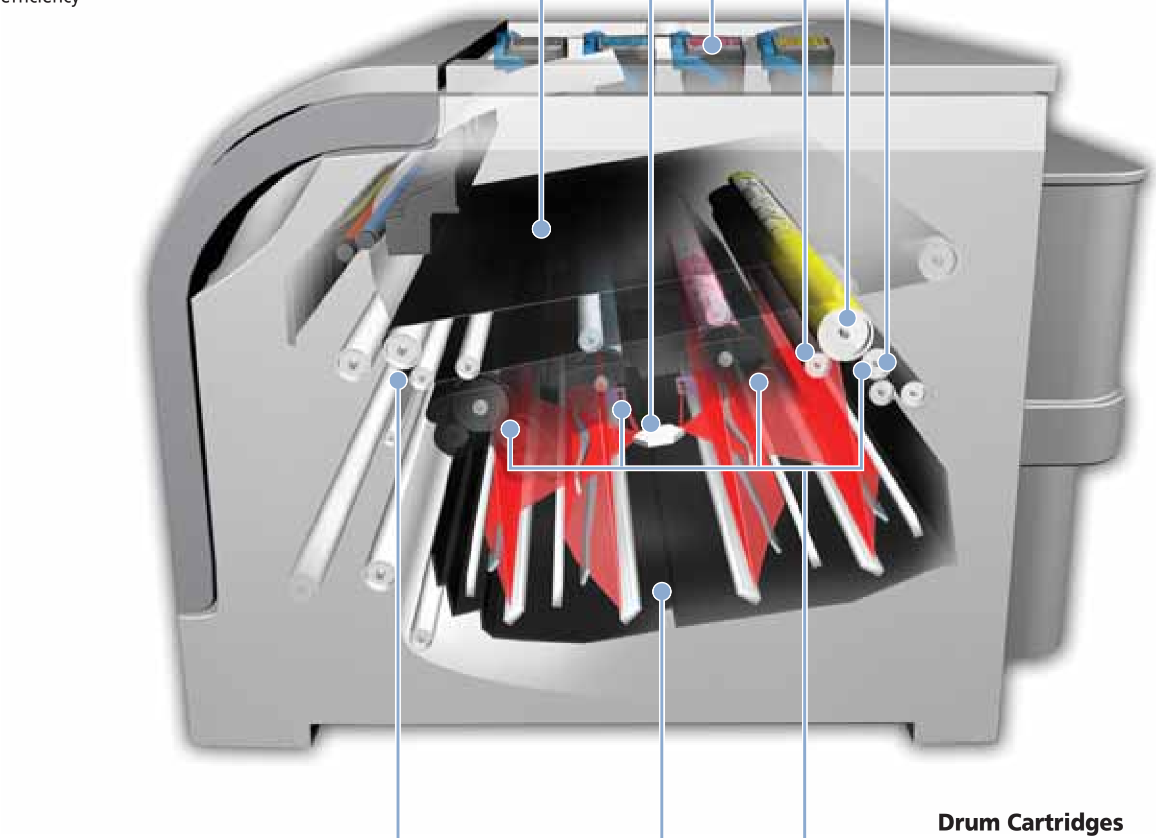
Applies an electrical charge to the photosensitive drum

Photosensitive Drum

Forms image when laser beams scan the surface of the drum, causing it to lose its charge

Developing Cylinder

Attracts the magnetic substance contained within into the toner to draw toner to the cylinder surface, then transfers toner to the photosensitive drum



Drum Cartridges

Facilitating ease of maintenance, each cartridge includes a single integrated photosensitive drum and developer each for the colors C (cyan), M (magenta), Y (yellow) and K (black)

→ P.47 Four-Color Vertical In-Line Engine

Paper Path

Transfers the image from the intermediate transfer belt onto the paper and sends the paper to the fixing unit

→ P.47 Ultra-Short Path

Laser Scanner

Directs laser beams onto the high-speed-rotating polygon mirror to laterally scan the photosensitive drum

→ P.47 4-in-1 Laser Scanner

New-Concept Ultra-Compact Design Technology

Realizing the World's Smallest A3 Color Laser Beam Printer

Color printing with an LBP requires toner in the four CMYK colors. This, in turn, requires that each color have its own toner cartridge, photosensitive drum and laser scanner, resulting in color LBPs that are large and, consequently, inconvenient for many users. Canon, by reexamining every aspect of the structure of LBPs until now, overcame the problem of size with the introduction of a four-color vertical in-line engine, a 4-in-1 laser scanner, and an ultra-short path. These efforts resulted in the birth of an unprecedented compact A3 color LBP.

Four-Color Vertical In-Line Engine:
Space Savings Through New-Design Layout

The LBP5900, with photosensitive drums each measuring 30 mm in diameter aligned at a pitch of 70 mm, was designed to realize the smallest possible footprint, which is comparable to that for monochrome models. With conventional models, however, such a small drum pitch would not enable fast enough toner replenishment to support high-speed printing. To solve this problem, Canon developed a four-color vertical in-line engine incorporating four photosensitive drums arranged diagonally so that they overlap vertically, thereby achieving a balance of compact dimensions and high-speed printing. The diagonal layout of the drum cartridges ensures easier front-panel operations and improved operability.

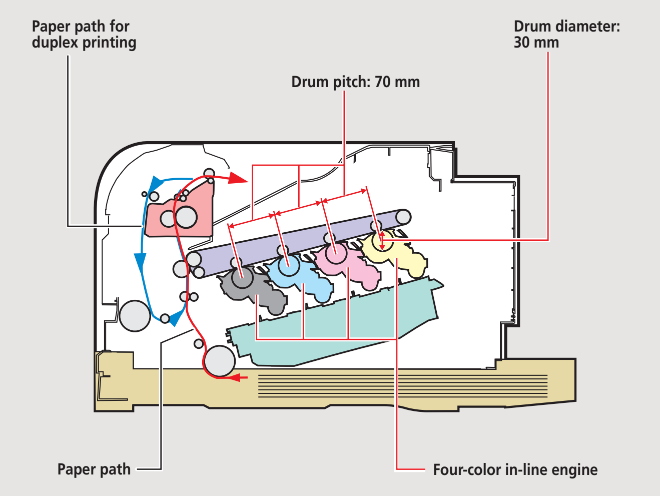
Ultra-Short Path:
Enabling Space Savings, Automatic Duplexing and High-Speed Printing

To realize a space-saving printer design, Canon thoroughly reviewed every aspect of the paper path, which led to the creation of an ultra-short path. Providing a short paper path doesn't just reduce dimensions, it makes possible a variety of benefits, including faster printing speeds and fewer components. This streamlined paper transport route also allowed the company to easily incorporate an automatic duplex (double-sided) printing transport route as a standard feature.

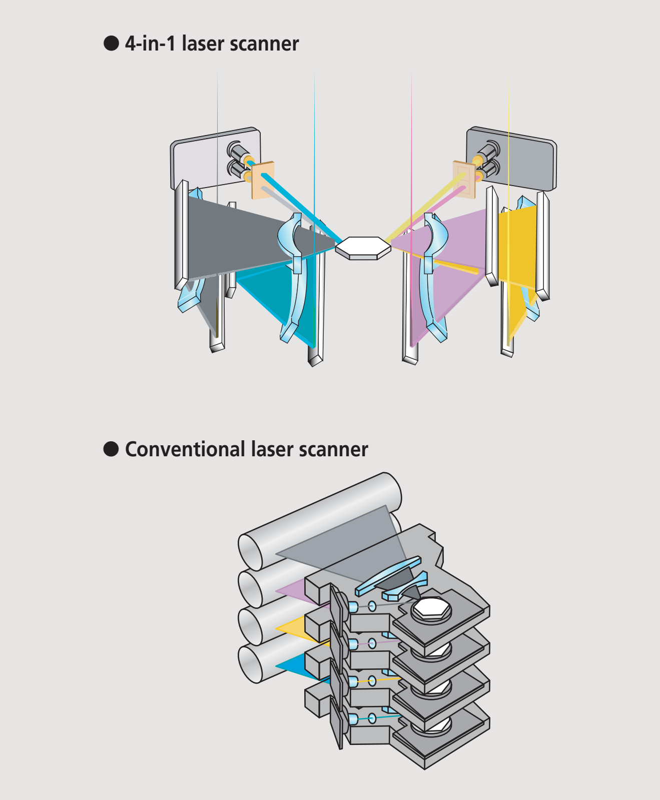
Achieving high image quality and high-speed printing with the shortest paper path requires advanced control technologies. To this end, Canon developed advanced paper transport simulation software to enable the thorough verification and optimization of the distances and relative positions between the paper rollers, intermediate transfer belt, and fixing unit. As a result, Canon was able to achieve first-print speeds of just 9 seconds for color and 7.5 seconds for monochrome.

4-in-1 Laser Scanner:
A Single-Unit Design Achieves Space Savings and Reduced Cost

In conventional color laser beam printers, each photosensitive drum for each of the four toner colors required its own laser scanner. Canon's LBP5900 successfully integrates these into a single laser scanner unit, directing four color laser beams to a polygon mirror at oblique angles (oblique incidence technology) to split the light path into four directions and guide each toward its respective photosensitive drum. The result is the 4-in-1 laser scanner, which realizes revolutionary space savings, and a significant reduction in parts for lower costs.



Paper Path of the LBP5900



4-in-1 Laser Scanner

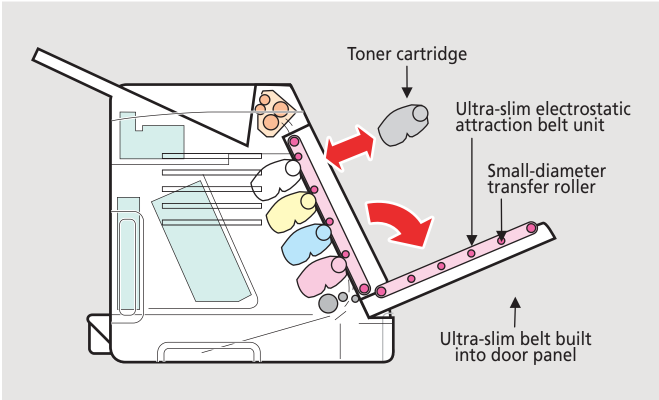
Electrostatic Attraction Belt Unit

Ultra-Slim Unit for Compact Design, Improved Operability and Low Cost

The attraction belt unit of color LBPs must be capable of reliably attracting and transferring paper, then accurately registering the 4-color toner image on the paper. In previous systems paper was attracted and transferred by being positively charged with an attraction-charging roller. Also, a transfer roller was required for each color, making it hard to reduce the size of the attraction-belt unit.

By modifying the belt material, Canon developed a technology that generates a consistent attractive force regardless of temperature or humidity, making it possible to eliminate the attraction-charging roller. This, combined with efforts to reduce the diameter of the transfer rollers, led to a significantly slimmer electrostatic attraction belt unit.

With Canon's LBP5000, this ultra-slim attraction belt unit (approx. 35 mm thick) is built into the inner side of the door panel on the face of the printer, allowing one-step toner cartridge replacement upon opening the panel, achieving a revolutionary level of operating ease. The design combines the benefits of compactness, ease of use, and low cost.



Electrostatic Attraction Belt Unit

All-in-One Cartridge

Easier Maintenance for Copying Machines and LBPs

There was a time when printers and copying machines required regular professional maintenance. This changed in 1982, when Canon developed the world's first all-in-one toner cartridge for copying machines, adopting a design that enabled users to easily perform cartridge replacement. This cartridge integrates into a single unit all parts that require frequent maintenance, including the photosensitive drum, charging unit, cleaner, and developer, along with the toner reservoir. Canon has acquired several hundred patents for its all-in-one toner cartridge innovations.

Canon also developed slim all-in-one toner cartridges for its color LBPs, allowing users to replace all consumable parts simply by replacing the four color cartridges.

Canon has also been collecting and recycling used toner cartridges worldwide since 1990.

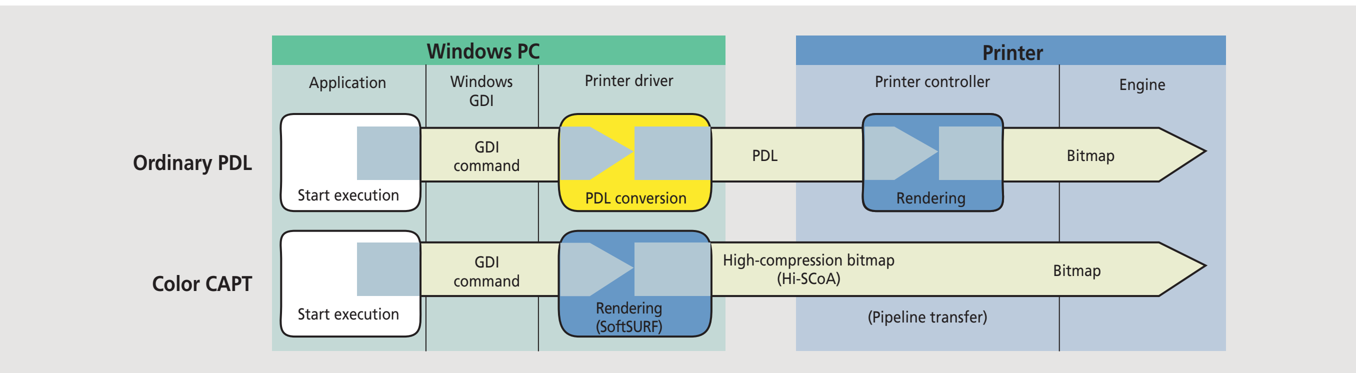
Color LBP Toner Cartridges

Color CAPT (Canon Advanced Printing Technology)

Using PC CPUs to Reduce Printer Processing Loads

An ordinary PDL (page description language) analyzes the received print data (e.g., text, graphics, photos), converts the data into rendering data (a collection of dots), and then transmits it to the laser scanner. If any of these processes are slow, fast printing cannot be achieved. By using a main processor for data analysis and a dedicated rendering chip for bitmap conversion, the most time-consuming process, Canon realized fast processing speeds.

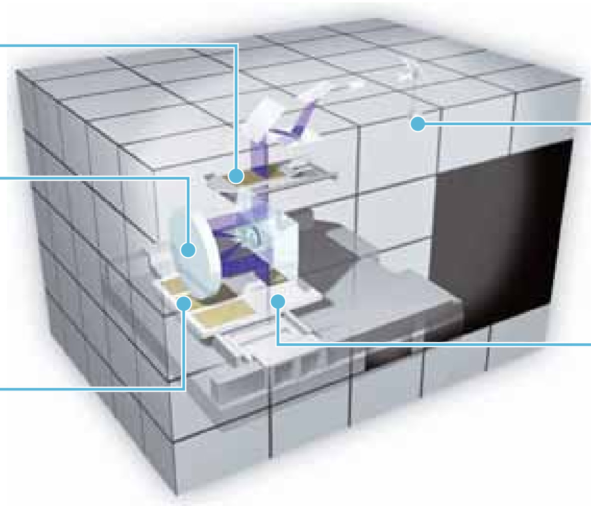
Canon also developed Color CAPT (Canon Advanced Printing Technology), which leverages increasingly powerful PC CPUs, sending rendering data processed by the PC to the printer for printing. Utilizing the PC rather than the printer controller to handle the rendering process reduces the load on the printer CPU, facilitating the printing of large volumes of image data, even with limited printer memory.



Overview of Color CAPT Data Processing

Mirror Projection Aligners

Amid ever increasing screen sizes, LCD television sets have enjoyed a rapid surge in demand. Supporting the production of these products are Canon's mirror projection aligners, which are used to expose the LCD panels used to make LCD televisions. As the screen sizes for these TV sets has grown, so has the size of the glass substrates used to create them, resulting in the need for mirror projection aligners capable of achieving precise exposure patterning over wide areas. Canon mirror projection aligners, which can accommodate substrates measuring 2,160 mm x 2,460 mm, offer the world's largest full-field exposure size to support the efficient single-exposure production of 57-inch widescreen television displays. (As of September 2006)



Mask

Original plate for 1:1 projection exposure onto glass substrates

Large Concave Mirror

World's largest 1.5 m-diameter ultra-high-definition concave mirror enables single-exposure production of widescreen LCD TV panels up to 57 inches in size

→ P.49 Large Concave Mirror

Glass Substrate

Accommodates substrates measuring up to 2,160 mm x 2,460 mm for the patterning of up to six 52-inch widescreen LCD panels from a single substrate

Light Source

This mercury lamp uses three wavelengths (365, 405, 436 nm) in the UV range

Stage

Used to position the glass substrate. The precision-driven stage is irradiated with light reflected from the concave mirror

→ P.49 Ultra-Large Stage Drive Technology

Large Concave Mirror

World's Largest Concave Mirror, with a Surface Processing Accuracy of 0.015 μm

Manufacturing large LCD panels requires large exposure areas. Forming fine patterns over such large areas with micrometer-level precision requires lithography tools equipped with large-diameter, high-precision concave mirrors.

By making use of extremely sophisticated technologies, including processing, measurement, polishing, and high-precision metal-vapor-deposition technologies, Canon successfully developed the world's largest ultra-high-precision concave mirror, measuring 1,514 mm in width with surface-processing accuracy of 0.015 μm. This mirror makes possible the manufacture of 57-inch widescreen LCD TV panels through a single-exposure process.

Large-Diameter High-Precision Concave Mirror

Ultra-Large Stage Drive Technology

Driving the World's Largest LCD Panel Glass Substrate at 700 mm per Second

Initially measuring a mere 320 mm x 400 mm around 1989, glass substrates for LCD panels have grown rapidly in recent years, reaching dimensions of 2,160 mm x 2,460 mm in the current eighth generation. The projection system employed in Canon's mirror projection aligners incorporates a large concave mirror, twice the diameter of conventional mirrors, and a large stage capable of moving 50% faster than conventional stage systems, enabling the full-field exposure of the world's largest substrate size: 2,160 mm x 2,460 mm. With external body dimensions measuring 8,360 (W) x 9,300 (D) x 5,394 (H) mm and weighing 88 tons, the enormous MPA-8800 is Canon's largest product.

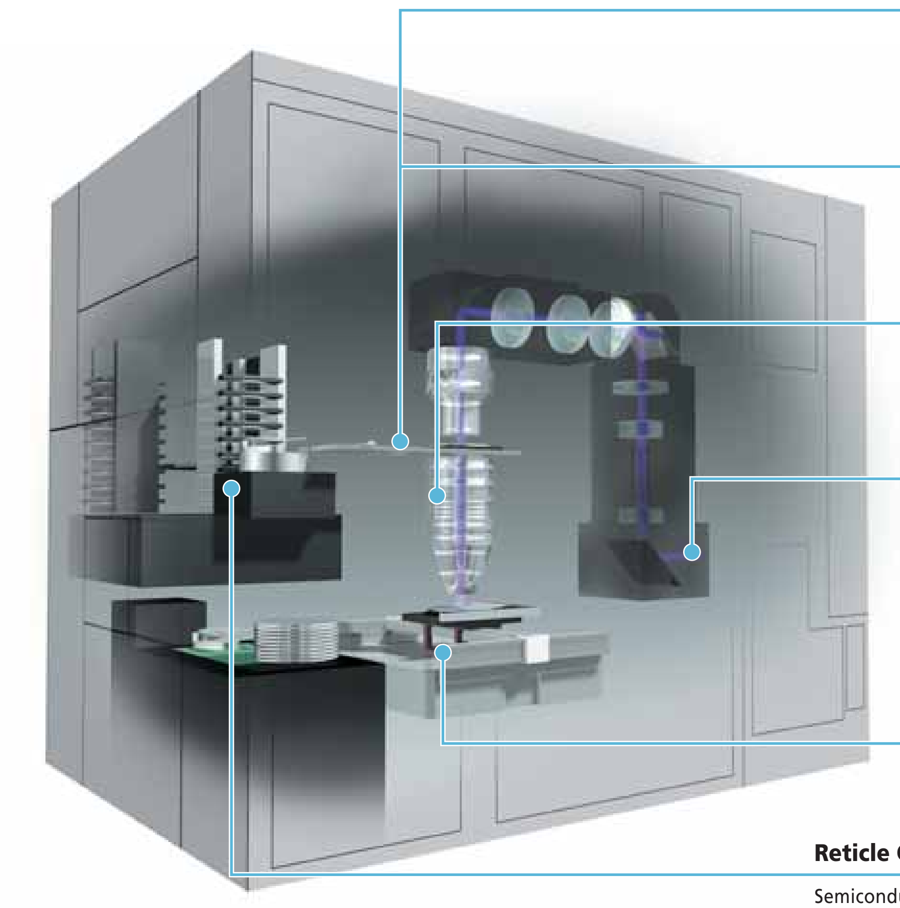
By itself, the stage that supports and moves glass substrates during exposure weighs 3.9 tons. This stage, which uses vacuum suction to secure glass substrates measuring 0.7 mm in thickness with a surface area of roughly 5 m^2, employs linear motors to drive the panels. Laser interference sensors control the position and rotation of the stage with remarkable precision. The stage, which achieves a speed of 700 mm per second in just 0.5 seconds once motion has been initiated and comes to a complete stop in a mere 0.2 seconds upon arriving at the stop position, ensures an extraordinary level of precision during the exposure of glass substrates.

Combining the benefits of large-substrate handling with a high-speed stage, the MPA-8800 enables the simultaneous exposure of six 52-inch widescreen LCD TV panels to make possible a fast throughput rate of 260 panels per hour.

Mirror Projection Aligner

Semiconductor Exposure Equipment

The performance of semiconductors improves on an almost daily basis. The mass production of semiconductor chips with 65 nm (1 nm is one-billionth of a meter) circuit widths is now getting underway. Canon continues to look toward the future as it develops state-of-the-art semiconductor exposure equipment designed to meet the demands of this cutting-edge industry.



Reticle

Source image on which the circuit pattern is drawn, which is scaled down by the lens and projected onto the surface of the silicon wafer

Reticle Stage

Holds reticles and moves in conjunction with the wafer stage at high speeds and with high precision during exposure

Lens

The most important component of semiconductor exposure equipment; requires several-thousand times the precision of an ordinary camera lens

Light Source

Employs light of extremely short wavelengths (e.g., i-line, KrF/ArF excimer lasers)

Light	Wavelength
i-line	365 nm
KrF excimer laser	248 nm
ArF excimer laser	193 nm

Wafer Stage

Secures the wafer and moves in conjunction with the reticle stage at high speeds and with high precision

Reticle Changer

Semiconductor manufacturing requires that the exposure-development-processing cycle be repeated several tens of times, with each cycle necessitating a different reticle

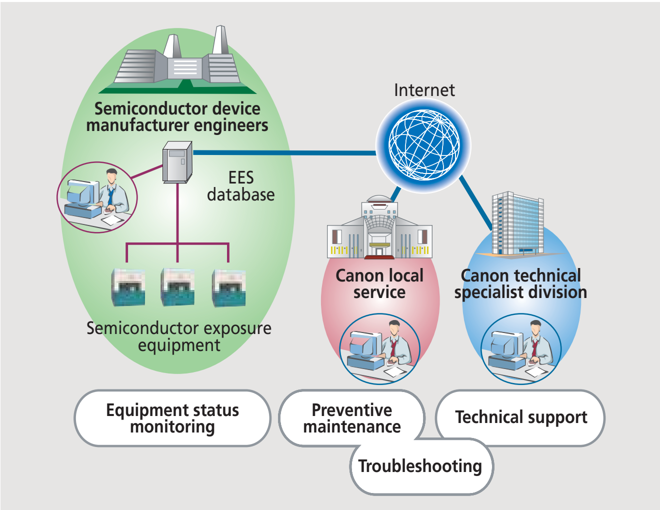
EE Support Program

Supporting Enhanced Equipment Use Rates Through Proactive Problem Prevention

Costing several billion yen per unit, semiconductor exposure equipment is extremely expensive, and even a one-hour interruption in production could result in the loss of millions of yen in potential sales for the device manufacturer. The semiconductor industry is currently working toward the establishment of an EES (Equipment Engineering System) environment that will allow for the creation of a detailed equipment database and the sharing of equipment information, which had been maintained on an individual-manufacturer basis. Canon has participated in this project from the outset and has proposed an EE Support Program conforming to the EES environment with the goal of improving equipment operating efficiency.

Detailed equipment data stored in the EES Database will be distributed to equipment engineers and managers at semiconductor device manufacturers, as well as to the Canon Technical Support Group. Continually monitoring the operational status of equipment installed worldwide and performing analysis linked to the equipment maintenance history and database will make it possible to provide a timely response to reduce equipment downtime. Expectations are also high for an approach to predicting equipment malfunctions based on slight variations in operational status and past case histories, enabling preventive maintenance and replacement before malfunctions occur.

The EE Support Program is currently undergoing joint evaluation by semiconductor device manufacturers with services scheduled to begin in 2007.



How the EE Support Program Works

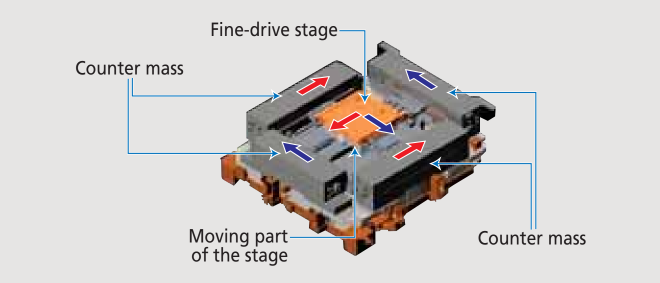
Ultraprecision Positioning Technology

Supporting the World's Leading Overlay Accuracy and Throughput

Ultraprecision positioning technology is as central to semiconductor manufacture as circuit-miniaturization technology. The positioning precision of the wafer stage that holds silicon wafers affects semiconductor yield rates while stage speed affects productivity, as measured by hourly throughput (productivity). In particular, scanning steppers, in which both the reticle stage and the wafer stage are in motion during exposure, require that both stages move in precise synchronization. High-precision control and manufacturing technologies are needed to provide faster stage speeds while maintaining precision.

For its semiconductor exposure equipment, Canon employs full non-contact coarse- and fine-drive wafer stages. The coarse-drive stage generates no friction because its moving portion floats above the base via a non-contact air guide, enabling high-speed positioning. A drive-reaction force-canceling structure was also adopted. When the moving part of the stage accelerates, a counter mass moves in the opposite direction, canceling the drive reactive force and eliminating drive vibrations to achieve a level of acceleration that previously had not been possible. Lastly, airflow simulations achieve ultraprecise temperature controls in the stage space.

These technologies provide Canon semiconductor exposure equipment with the capacity to scan with high precision at a speed of 500 mm/second, with an overlay accuracy of less than 10 nm and a high throughput exceeding 100 wafers per hour (122 shots) for 300 mm wafers, and 170 wafers per hour (58 shots) for 200 mm wafers.



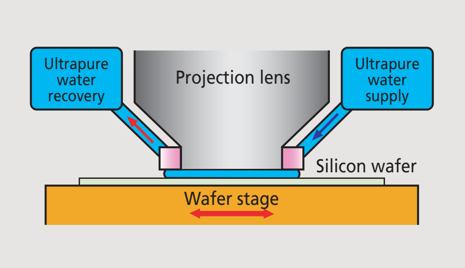
Wafer Stage Structure

Immersion Exposure Technology

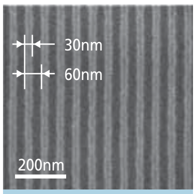
Pushing the Limits of Miniaturization with Water and ArF Excimer Lasers

In order to respond to shrinking circuit line widths of semiconductor devices, it is necessary to reduce the wavelength of the light source in exposure equipment or increase the numerical aperture (NA) of the projection lens. Because NA is proportional to the refraction index (n), when using ultrapure water (n = 1.44), for example, light at the same angle would yield an NA that is 1.44-times greater. Immersion exposure technology exploits this principle, whereby the gap between the semiconductor exposure equipment's projection lens and the wafer is filled with ultrapure water. When combined with an ArF excimer laser (193-nm wavelength), which provides the shortest wavelength available for lens optics today, immersion lithography can shrink circuit line widths from 65 nm — previously believed to be the limit — to 45 nm. Immersion exposure technology would allow even higher-density circuit patterns using current facilities and equipment, significantly reducing capital investment and other costs.

Canon is actively working to develop ArF immersion exposure technology and focusing on practical applications of liquid film immersion methods and a projection lens (ultrahigh-NA catadioptric lens). As work progresses on liquids with high refractive indexes and the means to apply them, coupled with advances in projection lenses, we may eventually draw closer to light sources in the EUV (Extreme Ultra Violet) region, enabling circuit patterning with line widths of 30 nm.



Liquid Film Immersion Method Using Ultrapure Water



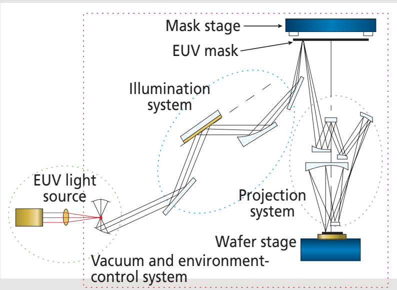
Verification Example Using a High-Refraction-Index Liquid (Source: JSR)

Next-Generation Exposure Technology

Seeking to Reach Beyond the World of Light

Canon is currently conducting research on exposure equipment that exploits 13.5 nm-wavelength EUV (Extreme Ultra Violet) light to achieve higher-integration semiconductor devices. Because this EUV exposure technology cannot use a lens-based refractive optical system, it employs a reflective system made up of ultrahigh-precision multilayer-coated mirrors. To create such a system, however, requires the development of various new elemental technologies, including equipment technology to put the entire apparatus in a vacuum because EUV light does not travel through air, nanometer-level positioning technology using a projection optical system consisting of six multilayer-coated mirrors, environmental control technology to prevent the contamination of the multilayer-coated mirrors, and ultrahigh precision processing technology for multilayer-coated mirrors (→ P.66). Canon is currently developing an EUV Small Field Exposure Tool (SFET) that incorporates a projection system with two mirrors, which will be made available to clients for use in resist-process development.

EUV exposure technology will make its introduction for 32 nm line widths, and is expected to propel miniaturization through to the 22 nm generation.



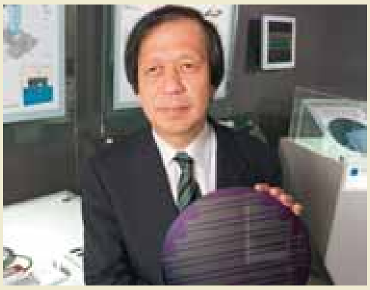
Structural Overview of EUV Stepper

Optical Equipment

With extensive expertise as an optical equipment manufacturer, Canon has introduced a wide range of optical technology-based products to the market, including copying machines and lithography tools for the production of semiconductors and LCD panels. The technologies fostered through these products are making contributions in the fields of academic research and the development of space technology.

Message from a Canon Fellow

Taking on the ultimate technological challenges "Addressing ever-evolving technologies requires tireless effort"



Akiyoshi Suzuki
Semiconductor Production Equipment Development Center 4

Currently active in the development of semiconductor exposure equipment designed to expose circuit patterns on semiconductors, the heart of digital devices, Suzuki is recognized as the face of Canon at the many international academic conferences he takes part in. He has established a number of new theories in the broad field of lithography tool technology and tackled the development of various devices, with significant achievements to his credit. In 2005, he was the first Japanese researcher in the field of lithography to be elected Fellow of the SPIE (The International Society for Optical Engineering).

I am currently involved in semiconductor exposure equipment that uses ArF laser light. I'm particularly interested in immersion exposure-based high-precision optical technologies.

This technology, a culmination of exposure technologies, is revolutionary and will be a part of the company's future mainstay products. New challenges are constantly emerging in this field, such as the switch expected to take place in the 2010s to EUV, which uses light with the shortest wavelength (13.5nm).

Understanding both theory and design is essential in developing state-of-the-art exposure equipment. I consider myself an engineer in the sense that I'm both a researcher and a developer. As an engineer, I find making things fascinating. It's such an amazing feeling to come up with a new idea or theory and discover its potential reach. It's also great fun to develop theories into technologies, then into products. And it's such a delight to see people using the resulting product. My hope is that as many people as possible will be able to share in this experience.

[Canon Fellow]
An engineer of the very first rank, even among the Canon-certified Members of the Canon Academy of Technology (→ P.3)

Prime Focus Corrector Lens for the Subaru Telescope

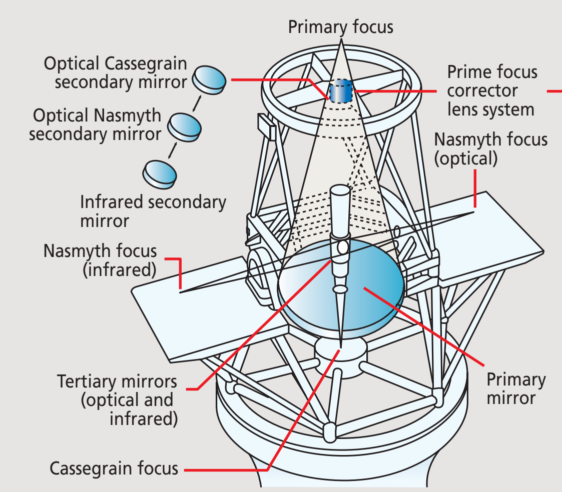
Canon's Lens Technology Plays an Active Role in Astronomical Observations

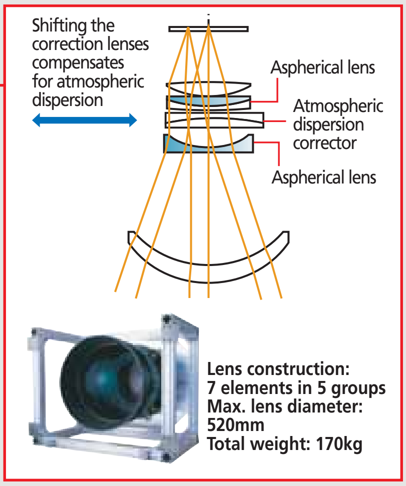
Along with other powerful world-renowned telescopes located atop Mauna Kea in Hawaii Island, stands the Subaru telescope, a large optical-infrared reflecting telescope operated by the National Astronomical Observatory of Japan. The Subaru has the world's largest single primary mirror (8.2 m in diameter) and an optics system links images to the primary focus point with a prime focus corrector lens made possible by Canon's advanced lens technologies.

The primary focus has a shorter focal length than the Cassegrain and other foci, allowing it to capture bright images from a wide field of view. In conventional large-scale reflecting telescopes, however, it was not possible to install an optical system in the primary focus because the resulting lens system would be too large. To address this issue, Canon developed a prime focus corrector lens system approximately 70% smaller and 50% lighter than conventional systems, thus enabling its installation. With a 30 arcmin field of view, it offers an angle of view more than five times wider than the Cassegrain focus.

The system also incorporates a new feature conceived by Canon that compensates for atmospheric dispersion, which occurs due to differences in refractive index encountered when light from distant stars enters the earth's atmosphere.

Since it began operating in 1999, the Subaru telescope has capitalized on its wide viewing angle to achieve numerous outstanding scientific results, including discoveries of a galaxy seed at the end of the universe and a galaxy 12.7 billion light-years away, while also making contributions to research into the history of galactic formation.





Structure of the Subaru Telescope

Spiral Galaxy (NGC2403), 10 million light-years from Earth, photographed by the Subaru telescope (Source: National Astronomical Observatory of Japan)

Medical Equipment

As the trend toward digitization and networking continues within the medical industry, Canon continues to focus on patient-friendly treatments, developing products that capitalize on the company's unique optical and digital imaging technologies to meet the needs of the medical community.

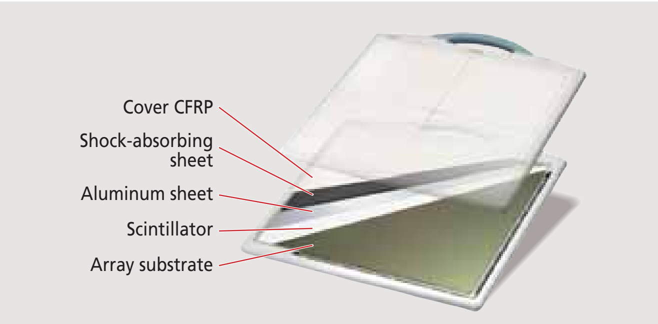
X-Ray Image Sensor

Accelerating the Digitization of Medical Imaging

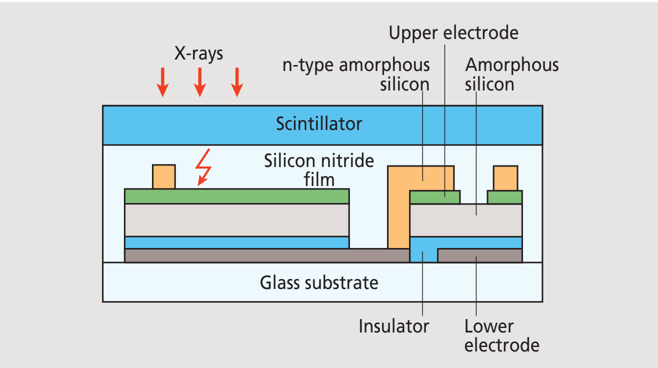
With conventional diagnostic X-ray imaging systems, X-rays passing through the patient's body are absorbed by a scintillator, and light from the scintillator is projected onto a film that records an image. The LANMIT (Large Area New MIS Sensor and TFT) X-ray image sensor developed by Canon is made up of a scintillator on top of a photosensor. X-rays passing through the patient are converted into visible light by the scintillator layer, which is then directly read by the photosensor. The X-ray image appears on the monitor a mere three seconds after X-ray exposure and the system does away with the need for development. The image sensor significantly increases the speed and efficiency of X-ray procedures compared with conventional film-based X-ray systems and systems based on laser-scanning technology.

The most difficult challenge in the development of the X-ray image sensor was noise. The problem was eventually solved by developing a low-noise IC, signal processing circuits, and power supplies, which made possible an image sensor with a 43 cm x 43 cm imaging area — the largest in the world for such a sensor — that realizes 7.2-megapixel resolution.

After launching the world's first X-ray digital radiography system in 1998, Canon launched upright and bucky-type digital X-ray systems and, in 2001, a portable model. In 2003, the company introduced a lighter and smaller upright, horizontal-bed-type model that uses lower X-ray doses, as well as a portable model that allows shots with broader fields of view, thereby covering nearly the entire range of ordinary radiography. Canon digital radiography systems do not only display X-ray images on the operator's monitor, but also transmit images to workstations, printers, and archives, allowing information to be shared within the hospital via a network, and transmitted outside the hospital. Supporting off-site diagnoses and emergency care, the systems are ideally suited to the diversifying needs of medical care today.



Structure of Portable Type CXDI-50G



Cross Section of LANMIT

Fully Automatic Noncontact Tonometer

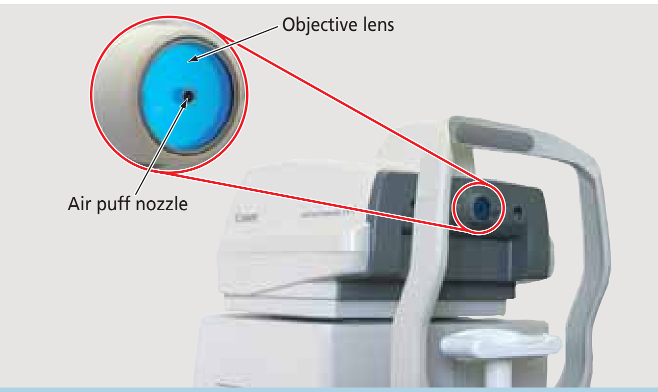
Enabling Fully Automated Precision Measurement

Glaucoma, one of the leading causes of vision loss, affects one in 17 people aged 40 or over. Noncontact tonometers are used in the screening and treatment of glaucoma.

With a noncontact tonometer, an air puff nozzle built into the center of an objective lens is placed very close to the surface of the patient's eye. A puff of air is then blown at the center of the cornea and measurements are taken. Since the patient's eye is constantly moving, it is difficult for the operator to align the machine manually. Canon's TX-F Full Auto Tonometer is a revolutionary device in that it allows the operator to rapidly measure the intraocular pressure of both eyes automatically, with one simple press of the start button. Over the course of achieving full automation of the intraocular pressure measurement procedure, Canon developed the following technologies.

1. Rough auto-alignment drive technology that quickly and safely identifies the patient's eye within a wide field of view
2. Fine auto-alignment drive technology that, even with eye movement, quickly and precisely identifies the correct position of the apex of the cornea
3. Safe drive-control technology that avoids the hazards of bringing the air puff nozzle too close to the patient's eye
4. 3D-drive technology to ensure the smooth transport of the measurement unit (objective lens)

The TX-F, which enables safe, precise tonometry with extremely simple operation, is being adopted not only by ophthalmic hospitals, but is also being used in regular physical checkups and in scanning for lifestyle diseases.



View of the TX-F from Patient's Perspective with Enlarged View of Nozzle Portion

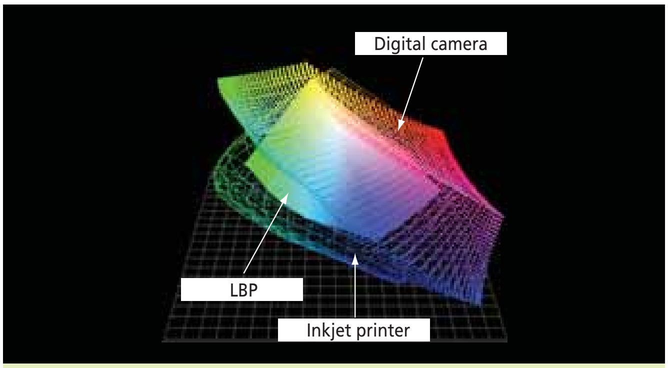
Platform Technologies

IT continues to grow increasingly sophisticated, with evolving network environments undergoing transformations that include broadband, wireless, and ubiquitous connections. To keep pace with the speed of these developments, Canon is working to boost its platform technologies — technology that structures and shares information technologies by elemental orientation. Sharing state-of-the-art technologies among various products ensures faster product development and improved quality.

Color Management Technology

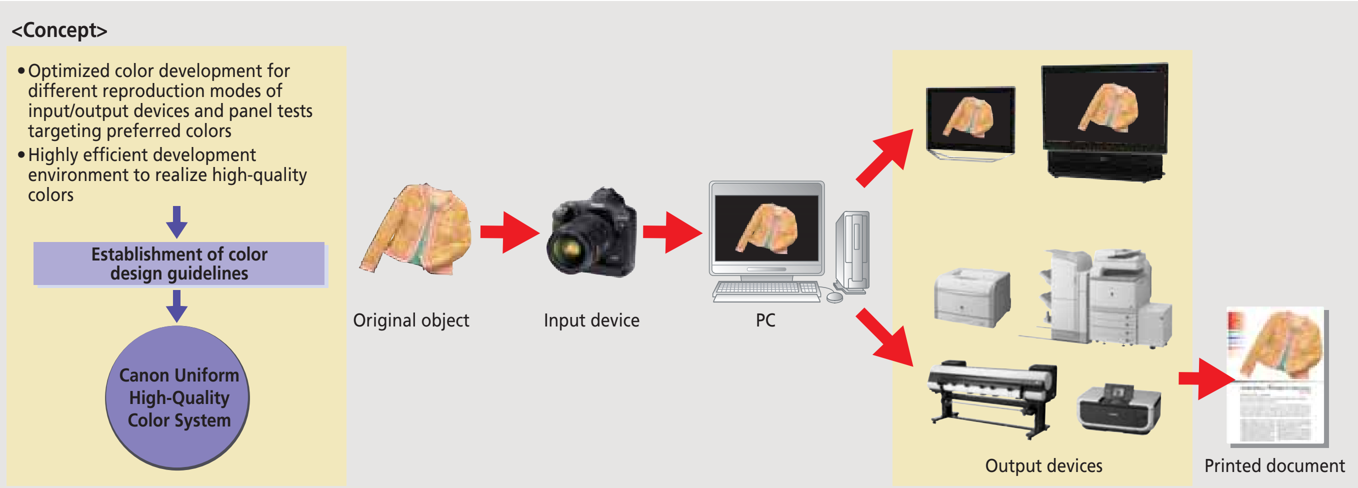
Achieving Uniform High-Quality Colors for All Input and Output Devices

Input and output devices have their own distinct characteristics, and due to differences in the color gamut that each device is capable of reproducing, colors appearing on displays or printed by a printer are sometimes inconsistent with those from the original input image. To address this problem, Canon focused on color reproduction capabilities and consistency for its input and output devices. As a result, the company achieved uniform high-quality color and has integrated this technology in its products. Additionally, Canon developed this technology to create Kyuanos, a high-precision color management system.



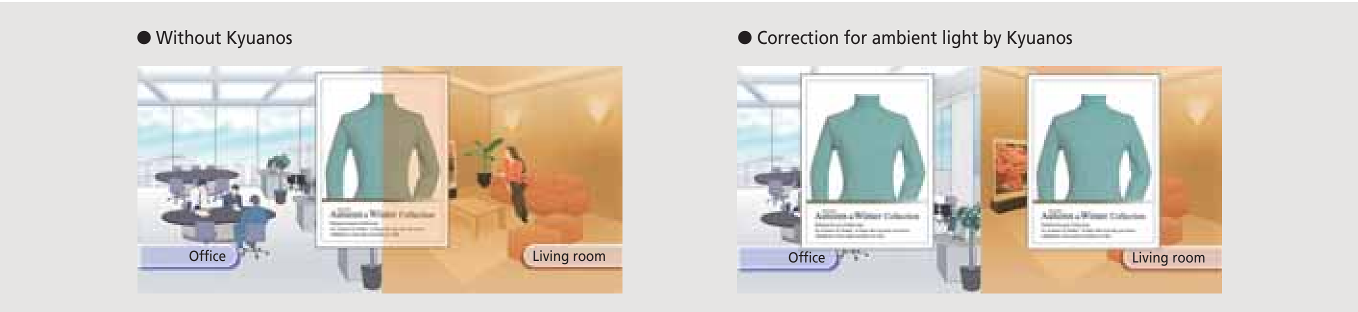
Differences in color tones between input and output devices result from differences in reproducible color gamuts

Differences in Reproducible Color Gamuts Between Devices



Color Management Technology

Kyuanos does more than reduce color discrepancies between input and output devices to achieve consistent color tones. The technology makes possible high-quality image reproduction by maintaining precise color management in any environment and for any application, regardless of such factors as lighting conditions or print media, which can affect the way colors appear. For example, Kyuanos enables colors used in a catalog prepared in a design room under one type of lighting conditions to match colors displayed in a presentation room with a different type of lighting.



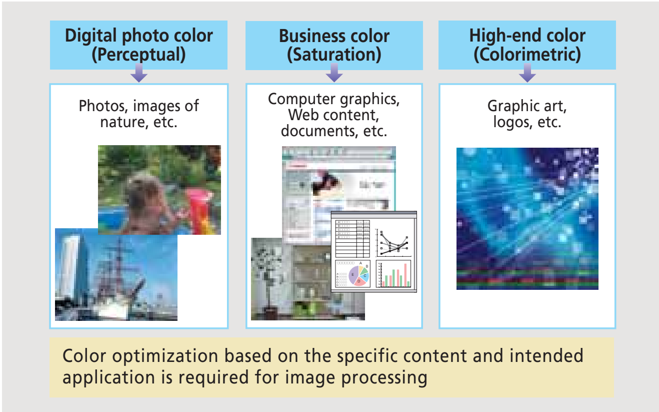
Controlling Color Appearance with Kyuanos

●Color optimization for different devices and panel tests that targets preferred colors

The optimal color-reproduction method varies depending on the content and intended use of the image. Canon classifies color-reproduction methods into three modes — digital photo color, business color, and high-end color — each with its own design guidelines for input and output devices. The digital-photo-color mode emphasizes natural images, while the business-color mode covers colors commonly encountered in commercial applications, with a focus on documents and graphics. The high-end-color mode is used when the accurate reproduction of original tones is of critical importance.

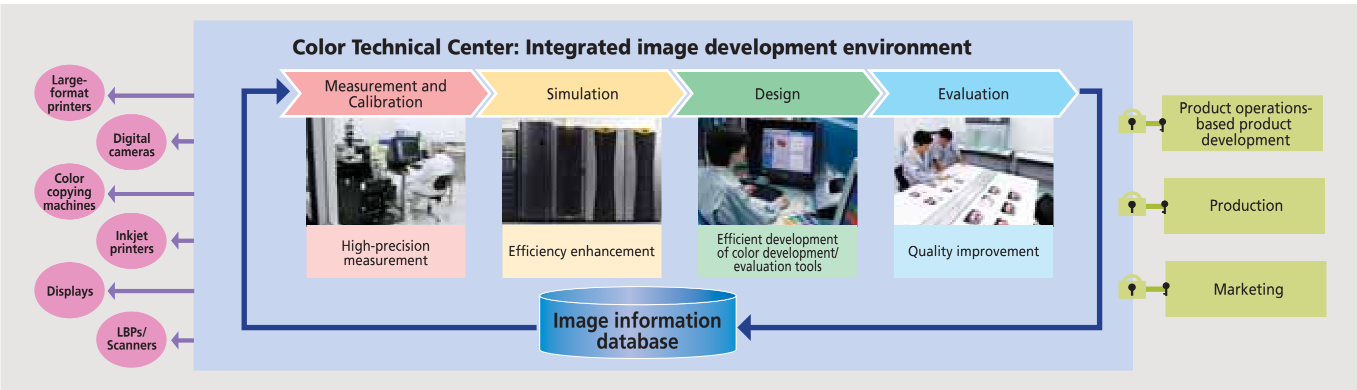
Within the digital-photo-color and business-color modes, the way we view colors is affected by individual preferences. Canon's Visual Information Technology Development Laboratory applied its wealth of expertise in image-evaluation, measurement, and processing technologies to assign quantitative values to preferred colors to enable the creation of color targets based on those values.

To make final decisions on the optimal values, the laboratory carried out large-scale panel tests in Japan, North America, and Europe. A wide range of participants, from ordinary users to designers and professional photographers, provided subjective assessments for multiple image samples under different observation conditions. Through these tests, the researchers established universally accepted product-independent preferences for top-quality color images. These results are now reflected in the development of all Canon digital imaging products.



Optimal Color Development by Color Reproduction Mode

●Development, design, and evaluation environments for high image quality in all Canon products



Integrated Image Development Environment for Consistent, High-Quality Colors

Canon's Color Technical Center is where the company carries out R&D, design and evaluation activities targeting high-image-quality color. The Center, which aims to establish next-generation color technologies, provides an integrated image development environment to enable consolidated development flows, extending from R&D and design to production and sales.

(1) Measurement and Calibration
Maintaining high image quality requires accurate and stable color measuring instruments. Canon has established its own color measurement and assessment standards and created measurement environments in each of its business divisions to enable high-precision measuring. The Color Technical Center formulates strict traceability (operational history and tracking) standards for measuring instruments (colorimeters, in particular) within each division, from development to quality-assessment operations, managing all measuring instruments with a master instrument.

(2) Simulation
At the Color Technical Center, Canon performs high-precision measurements of colors from its input and output devices, and conducts high-precision image simulations on a supercomputer. The supercomputer is used to conduct simulations designed to automatically select optimal colors from the 270 trillion possible color combinations that can be obtained from ink used in inkjet printers.

(3) Design
To achieve consistent colors across all Canon products requires the development and company-wide sharing of tools for the efficient development and assessment of colors in accordance with design guidelines. Using data based on 3-D technologies and the actual characteristics of human perception, Canon developed its own high-precision distortion-eliminating algorithm that transcends the limits of human perception. Using this algorithm to create a 3-D Color CAD design tool, the company achieved a significant reduction in the time required to develop advanced color tables for specific products.

(4) Evaluation
Canon has established a benchmarking environment that provides matrix evaluations of both its own input and output products, as well as those of other companies. Targeting the achievement of high image quality, this environment supports the objective assessment of color performance between not only Canon products, but also combinations with other manufacturers' products.

(5) Image Information Database
An extensive variety of development and evaluation data has been accumulated in the image information database and is available for re-use. Additionally, development-support tools and assessment tools are network-accessible from any development facility throughout the company, realizing an environment that enables optimal development activities regardless of location.

System LSI Integrated Design Environment

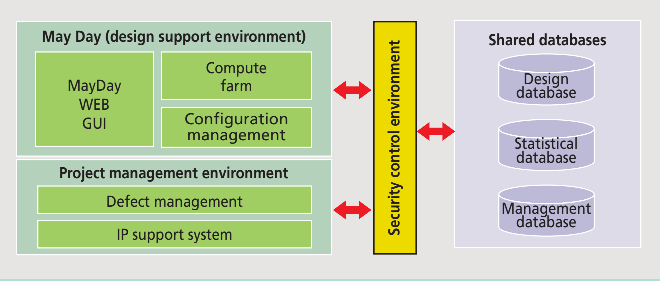
Ensuring Rapid, Efficient Development of Large-Scale System LSIs

Canon develops its own system LSIs (large-scale integrated circuits) — ICs that contain all system components, including the hardware and software necessary to run the device, on a single chip. Since system LSIs combine such extensive functions, it is important that they be developed rapidly by a collaborative team of multiple design engineers and technicians within an efficient development environment. Canon began independently developing system LSIs around 1996 and has since established a highly efficient system LSI integrated design environment.

Organized as shown in the accompanying diagram, Canon's system LSI integrated design environment provides comprehensive support for the entire development process, from specification checks to physical design. In the design support environment, MayDay, a unique design support tool, plays a pivotal role. Operated by an easy-to-understand Web-based graphical user interface (GUI), MayDay fosters communication and progress for each member of development teams of several hundred individuals in scale. The compute farm underlying MayDay automatically activates the tool, managing licenses for numerous CPUs and high-priced electronic design automation (EDA) tools, and offering licenses for appropriate computing servers according to demand for such resources. Configuration management allows the easy recycling of design assets, making possible the user-friendly management of design-results files and entire directories needed for compilations and simulations.

Defect management within the Project Management Environment allows the sharing of bug information for each project and linking to development flows, enabling multi-conditional searches and tracking. The IP support system promotes the reuse of the IP (Intellectual Property) core, a large-scale function block, to reduce the number of support processes.

Environments such as these have become essential to shorten development times for digital products and improve design quality.



Overview of System LSI Development

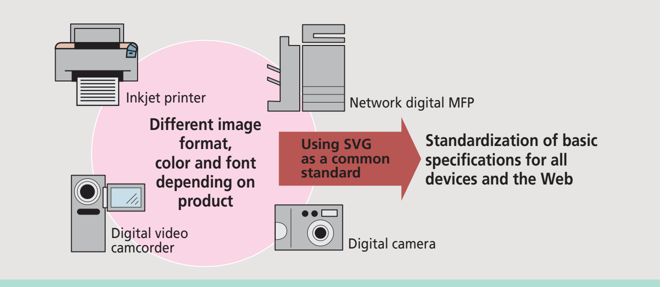
SVG Imaging

Next-Generation Web Graphics Format

Scalable Vector Graphics (SVG), which has garnered attention as a next-generation Web graphics format, was endorsed by the World Wide Web Consortium (W3C) in 2001 and went on to become an industry standard. As a manufacturer of imaging devices, Canon actively promoted SVG from the early stages and took part in the establishment of SVG specifications. SVG Tiny 1.2, incorporating SVG user-interface-compatible functionality, is to be recommended by W3C by 2007.

SVG is an XML-based markup language for describing geometrical shapes, such as Bezier curves and rectangles. Unlike with such raster graphics image formats as GIF and JPEG, in which images are created using dot patterns, scalable vector graphics can be freely enlarged or reduced without sacrificing image quality, and support high-resolution printing and text searches. SVG makes possible the creation of an easier-to-use next-generation user interface with rich expressive capabilities, including, for example, visual effects employing animation or scalable display regardless of monitor size. Also, in the future, we may see the emergence of new solutions based on this technology, such as one that would enable the exchange of SVG-based Web content via the Internet.

While graphics specifications currently differ from imaging device to imaging device, in the future, it is possible that specifications will be standardized for devices and the Internet based on SVG.



Overview of SVG Imaging Technology

Java Technology

Facilitating Upgrading and Customization

Java is a programming language and execution environment developed by Sun Microsystems, Inc. Java runs independently of any particular CPU, OS, or other platform, and offers high levels of security. Updating and adding functions to Java-enabled devices is easy, due to the wide availability of downloadable software. Canon has adopted the "Java Platform, Micro Edition (Java ME)," a Java platform for embedded devices, and is developing a variety of Java technologies to suit the characteristics of various specific devices.

●JavaVM (Java Virtual Machine) high-speed execution technology

Java applications comprise a CPU- and OS-independent intermediate language (byte code). Since the JavaVM must interpret that language one byte at a time, processing speeds tend to be slow. Canon resolved this problem with HotSpot, which enables high-speed execution by compiling frequently called functions during execution into CPU-native code.

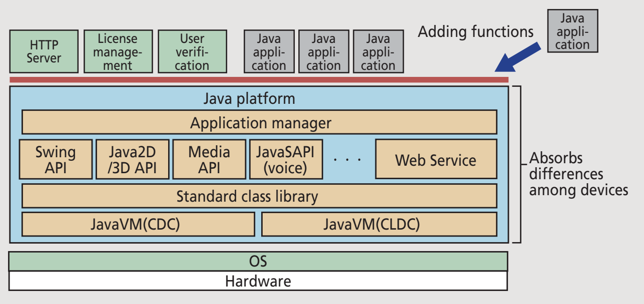
●Java application management technology

Canon has developed a Java application management system designed to manage the application life cycle: installation, launch, stopping, and deletion. The system, which makes it easier to update and add functions to devices, also complies with an industry-standard framework to facilitate application development. To ensure tighter security when adding applications, Canon also developed verification and license management functions.

●User interface improvement

In addition to Java's standard GUI components, Canon makes available a wide collection of device-compatible GUI components to realize user interfaces with a consistent feel, and also aims to achieve higher speeds and improved usability through a variety of hardware, including graphic accelerators. Additionally, looking ahead to the future, the company is working to convert GUI components into vector graphics and is tackling such technologies as Java 2D/3D API, Swing API, and animation.

These Java technologies are incorporated into various Canon products as a common platform for launching programs. In the future, Canon intends to meet market needs by expanding its collection of middleware required for product-specific customization and functional additions.



Java Platform Execution Environment

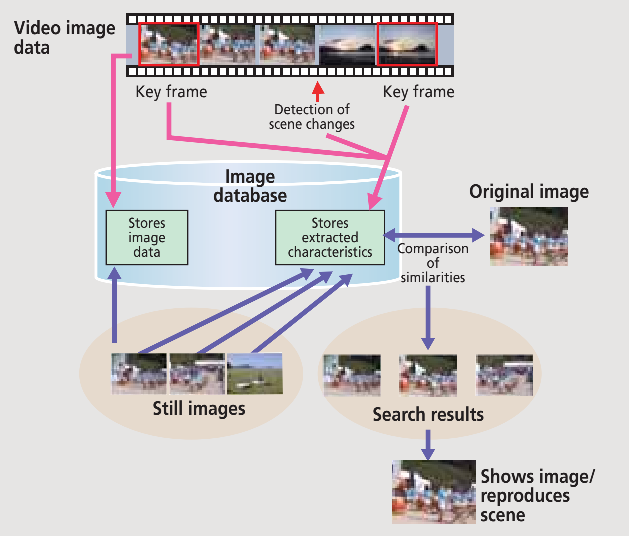
Image Retrieval Technology

Enabling Searches for Similar Images and Video Clips

The widespread use of digital cameras, digital video camcorders, and the Internet has led to an increasing need to search for still and video images. Attaching keywords to images to enable searches, however, is a tedious and time-consuming process and, as often happens, this approach leads to disappointing results when the attached keywords do not match those used when conducting a search.

To resolve this issue, Canon is developing an intuitive image-retrieval system that does not require keywords, but rather searches for images based on resemblances to a specified image. Using the system, users conduct searches by first selecting a still image to serve as the basis for the search, and then setting priority levels for such characteristics as color, pattern regularity, and composition. Search results are displayed as a list and can be narrowed down to enable users to quickly locate the images they are looking for.

Canon is also developing a video-image retrieval system based on the company's still-image retrieval system. This technology has established a means of identifying video clips by detecting an appropriate number of scene changes and finding desired scenes using representative key frames of the scene. When a video clip (represented by a still image) is selected, the system displays a list of video images with similar key frames, enabling users to rapidly find specific scenes, even from among large volumes of video image data. Amid the increasing popularity of hard-disk video-recording devices and digital home appliances, Canon's image-comparison search and retrieval systems have attracted high levels of attention.



Overview of Still/Video Image Comparison-Based Retrieval Technology

High-Speed Connectivity Technologies

Enhancing Network Connectivity Among Devices

Canon is currently developing wireless direct-connection technologies that will provide anywhere/anytime accessibility to enable users to easily connect such devices as printers and digital cameras to a network. Also, based on these technologies, the company is developing cooperative networking technologies for quick and easy access, and high-speed video communication technologies that allow transmission while preserving high-definition image quality.

Wireless Direct Connection Technology

Canon wireless direct-connection technology provides a framework for easy connectivity, automating the performance of various settings that were often problematic for users, such as wireless-parameter and device setup. For the wireless communication interface technologies that make up this technology, Canon selected such short-distance wireless communication standards as Bluetooth and Wireless USB, and wireless LAN technologies like IEEE802.1 1b/g/a/n. The company is working to create a common platform that will take full advantage of its products' features, and also seeks to develop technologies enabling easy setup, automatic connection, and wireless security (encryption and authentication) as middleware to facilitate easy connectivity and promote standardization. These technologies will continue to spread the trend toward networking among devices.

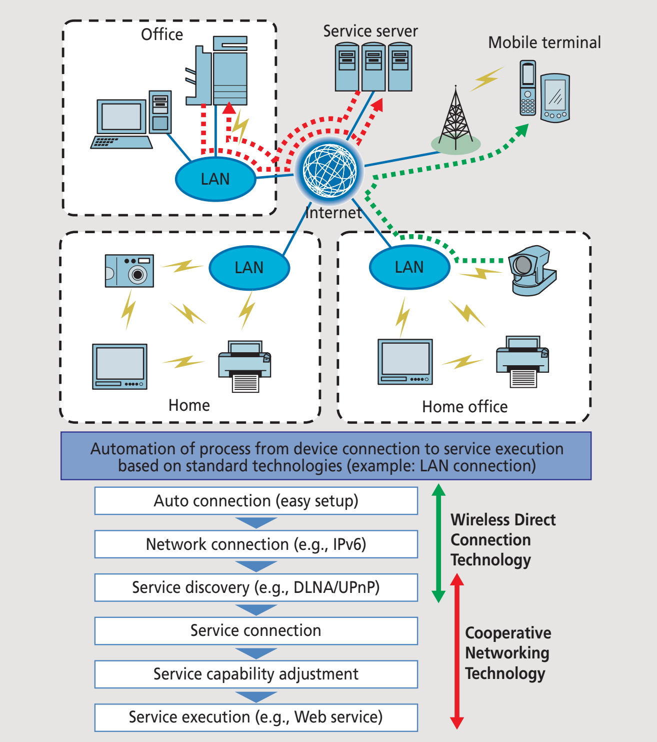
Cooperative Networking Technology

The objective in developing cooperative networking technologies is to build highly functional systems specialized for image-input and output devices.

One important factor in the creation of these systems is the automation of processes, from the connection of the device to the network, through to the execution of the desired task. Canon selects and functionally integrates the most appropriate technologies for each of the device's operating steps. For instance, among major standard technologies, Canon has been reviewing IPv6 for network connectivity; UPnP for service discovery, service access, and service capability adjustment; and XML Web Service technologies to provide service level status information, service execution, and interactivity functions.

High-Speed Video Communication Technology

Transmitting images between networked devices requires technologies capable of appropriately controlling ever-changing images and transmission quality. High-speed video communication technologies will enable the realization of networks supporting the transmission of high-resolution images from high-definition imaging devices that will soon become the industry standard.



Conceptual Overview of Device Connection and Operation Through Wireless Direct Connection and Cooperative Networking Technologies

Simulation Technology

Researching New Technologies and Reducing Product Development Times

During product development, simulation technologies for analyzing phenomena and predicting product performance help advance technological innovations while shortening product development times.

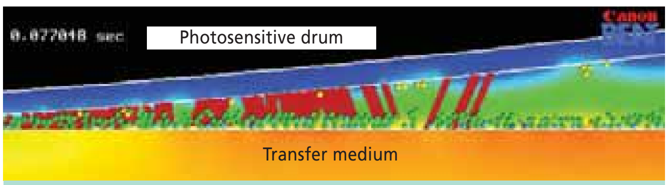
● Simulating the electrophotographic process

The electrophotographic process, which is used to form images in laser beam printers and copying machines, represents an important engine in these products. The process involves charging, exposure, latent image, development, transfer, fixing, and cleaning. Each of these steps, however, entails multiple and complex phenomena with many unknowns that, until now, were difficult to model mathematically. Canon developed its own simulation technologies for these electrophotographic processes, enabling technological innovations and ensuring improved product-development efficiency.

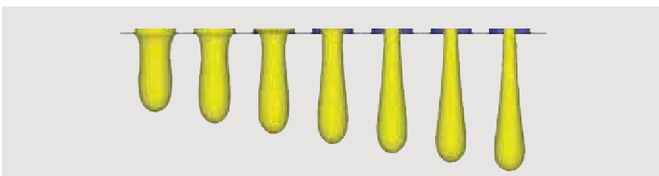
● Simulation of inkjet heads

When developing inkjet print heads, the structure of each nozzle is a critical design item to ensure the optimal ejection of ink droplets.

Canon developed a simulation program for calculating ink-ejection phenomena, which was then applied to successfully calculate ejection behavior based on nozzle structure and driving conditions. This software has made it possible to identify the relationship between nozzle structures and ink-ejection characteristics before prototyping, enabling the development of high-performance heads within short timeframes.



Example of Simulated Transfer Process for Copying Machines



Example of Simulated Ink Droplet Ejection

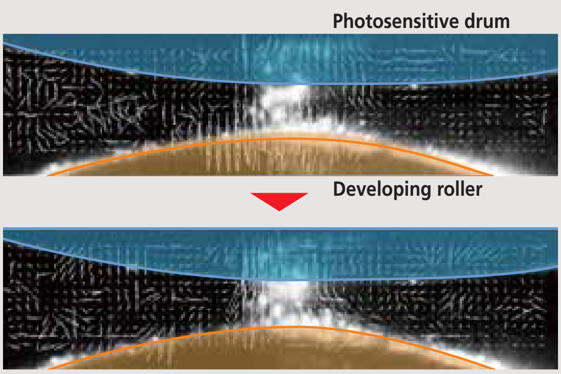
In-Process Visualization

Analyzing Device Operating Mechanisms for Technological Innovation

In order to achieve better and faster imaging performance in products and also increase reliability, employing design procedures that rely on past experience alone is not enough; it is necessary to accurately grasp the phenomena actually occurring within the device, subjecting these mechanisms to thorough micro-analyses. But accurately observing such phenomena, which occur at high speeds and on a minute scale, can be extremely difficult. By creating observation samples and model devices that enable the observation of the processes that take place within the actual devices, in-process visualization technologies have enhanced the company's understanding of the underlying mechanisms. Observation phenomena were captured by ultrahigh-speed cameras, and the images were analyzed and converted into quantitative data. Canon currently uses this technology to visualize such processes as toner development and fixing in laser beam printers and copying machines, as well as ink droplet ejection in inkjet printers.

● Visualizing the toner development process

Canon has succeeded in visualizing toner particles as they fly from the developing roller to the photosensitive drum. By tracking particles individually and in groups as they cross the extremely narrow gap, engineers can analyze toner movement and regularity, enabling the clarification of mechanical positioning and optimal control voltages.



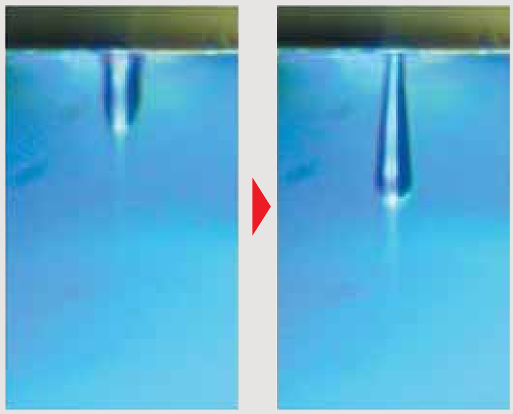
Visualized Toner Particles Flying to the Photosensitive Drum

● Visualizing the toner-fixing process

Using an observation device, Canon is able to observe the melting, expansion, and re-hardening of toner on the fixing component. The findings were integrated with physical data on temperature, pressure, and displacement to enable simulation-based analysis. These techniques have contributed not only to product development, but also to the development of fixing mechanism components, and to enhancing the understanding of the nature of toner itself.

● Visualizing the ink droplet ejection process

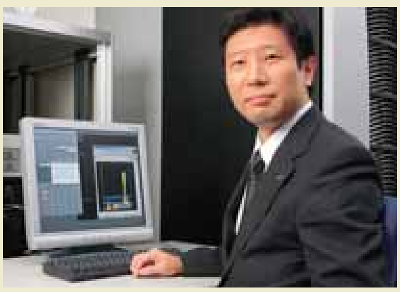
The diameter of ink nozzles in Canon's inkjet printer heads measure a mere 10 μm to 20 μm. Ink droplets ejected from the nozzles move at extremely high speeds, striking the paper in less than one-one thousandth of a second. To visualize this minute, high-speed ink-ejection process, Canon successfully combined spatial analysis capabilities at scales approaching the wavelength of light and time analysis capabilities at scales around one-millionth of a second. This approach enabled the company to accurately track the movement of droplets inside the nozzle, which has greatly benefited the company in the development of new breakthrough inkjet technologies.



Example of Visualized Ink Ejection Process

Message from a Canon Fellow

What's important is to get as close as possible to the essence of the phenomenon. "I would like to make analytical assessment a Canon core competence."



Akira Asai
Analysis Technology Center

Specializing in fluid dynamics and fundamental technology, in particular simulation technologies, Asai has been involved throughout the development of Canon's original inkjet printing technology.
Major achievements: Analysis of basic phenomena (BJ-80 inkjet printer), analysis of print head ink bubble-formation/ejection mechanism, which led to the development of FINE (→ P.29) (BJ-F850 printer, capable of realizing photo-image quality)

I'm currently working on a computer-based simulation technology for basic-principle models. It's the job of the Analysis Technology Center to apply this simulation technology to product development.

I've always been interested in the process of scientifically demonstrating and explaining the secrets behind natural phenomena. To develop a product, you have to understand the basic underlying principles. The process of demonstrating and explaining the secrets behind natural phenomena is endlessly fascinating. First, you experience the thrill of doing science. Then, after you clarify and gain an understanding of a phenomenon, you create a computer model to confirm whether or not your assumptions are correct. Although seemingly unrelated to natural phenomena, we can use computer simulations to create models of various natural phenomena. I experience something like the enjoyment you get out of building models, which also involves the joy of creation. Lastly, it's a great satisfaction to see your model incorporated into the design of practical products. All of these delights are different, which makes my job even more satisfying. These three factors are what make computer simulation for product development so interesting.

[Canon Fellow]
An engineer of the very first rank, even among the Canon-certified Members of the Canon Academy of Technology (→ P.3)

Device Technologies

Predicting the emergence of digital cameras, Canon began developing photo sensors in the 1970s. In 2000, Canon released the EOS D30 digital SLR camera, which was equipped with a high-quality CMOS image sensor. Widely praised for their high sensitivity and high image quality, Canon's CMOS sensors continue to evolve as a key device in digital cameras and digital video camcorders.

CMOS Sensor Technologies

Achieving a 35mm Full-Frame CMOS Sensor Based on Accumulated Technologies

Digital cameras use either a CCD or CMOS sensor. Although CCD sensors are capable of achieving high image quality, they have the disadvantage of slow data-reading speeds. CMOS sensors, on the other hand, offer high data-reading speeds, but are prone to noise, which affects image quality. Predicting from the very early stages that pixel counts and data-reading rates for digital cameras would continually increase, Canon pursued research on CMOS sensors, accumulating wide-ranging technologies that eventually led to the development of high-quality CMOS sensors.

Optical Utilization Technology

The key to high photosensor performance is capturing as much light as possible while minimizing noise. Utilizing its micropatterning technology, Canon fabricated a microlens for each pixel, which measures only a few micrometers in size, for higher light intensity. The company also repeatedly improved its color filter, which is essential for color reproduction, to ensure enhanced color photosensor performance.

Technology to Eliminate Metal Contamination and Achieve Silicon/SiO_2 Interface Control

A high-sensitivity, low-noise photosensor is needed to obtain high-quality images from long exposures of starry night skies with a digital camera. This means reducing dark current to the lowest possible point. Canon improved the crystal structure of its silicon substrates and eliminated heavy metals (metal contamination) by employing various innovative manufacturing devices and by thoroughly controlling manufacturing processes, thereby reducing dark current as much as possible. Canon's photosensors offer the high sensitivity and high image quality required for astrophotography.

Photodiode Potential Design Technology

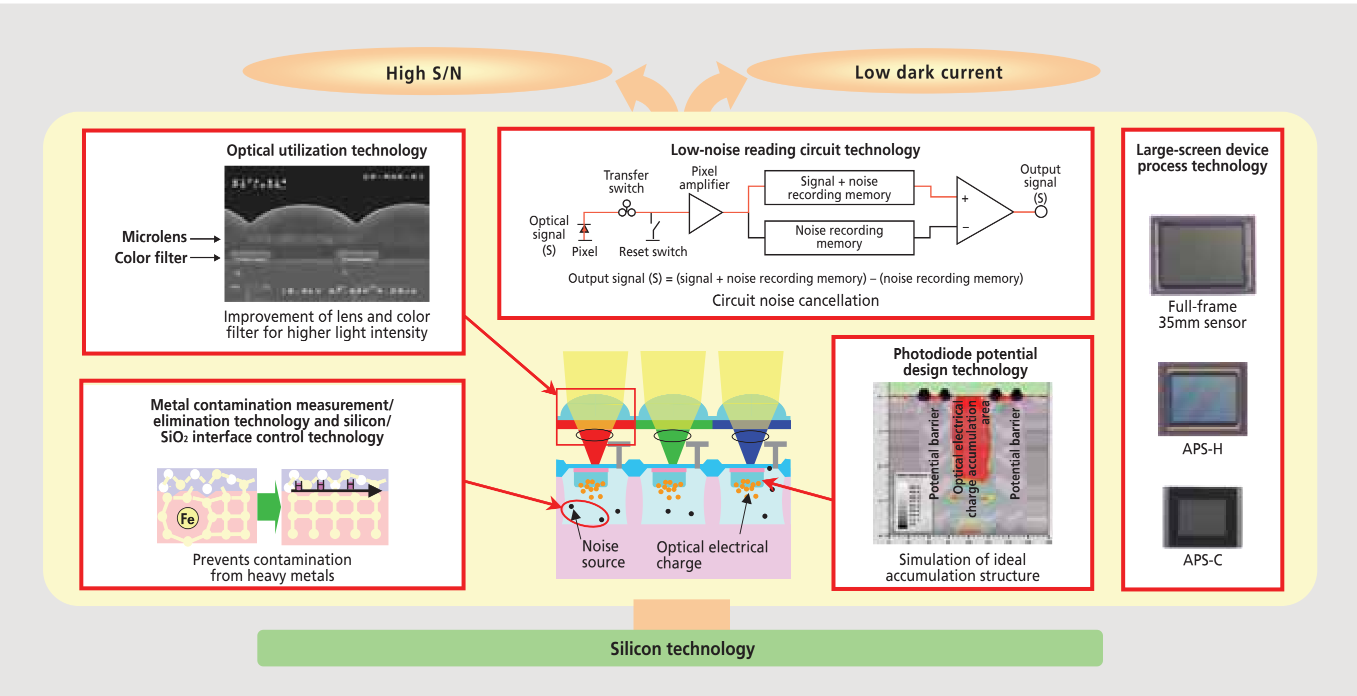
Photosensors collect electrical charges when exposed to light. The resulting charge is read out from each sensor site and converted into image data. For optimal device design, Canon simulates the ideal charge collection structure with a device simulator. This makes it possible to design a sensor with highly efficient charge collection, opto-electronic conversion, and reading over short periods of time.

Low-Noise Reading Circuit Technology

Reducing noise in the photosensor is meaningless if the data-reading circuit is subject to high noise levels. Canon achieves low-noise data reading through a pixel configuration called the four-transistor pixel structure, and a noise cancellation circuit. In 2004, this technology received a National Commendation for Invention, Japan's most prestigious invention award. Recognized for its superiority, the circuit is now widely employed as the industry standard.

Large-Screen Device Process Technology

Canon's full-frame 35 mm CMOS sensor measures 36 x 24 mm, an area equal to a frame of traditional 35 mm film, which far exceeds the maximum area that can be covered in a single- exposure process using conventional semiconductor exposure equipment. Canon developed a multiple-exposure technology for its semiconductor exposure equipment enabling mass production of full-frame 35mm CMOS sensors.



CMOS Sensor Technologies

Cleanroom Technology

Cutting-Edge CMOS Sensors Manufactured in Industry-Leading Clean Conditions

Cleanrooms play a vital role in the manufacture of semiconductors. Based on the standard benchmark of cleanroom cleanliness, Class 100 cleanrooms, which represent the highest level of cleanliness, contain 100 or fewer particles measuring 0.5 μm or larger for each cubic foot of air. Canon has created a cleanroom in which the air contains no more than a single particle measuring 0.1 μm or larger per cubic foot. Leading-edge CMOS sensors are manufactured in this optimized facility, which is strictly controlled to ensure exceptional cleanliness.

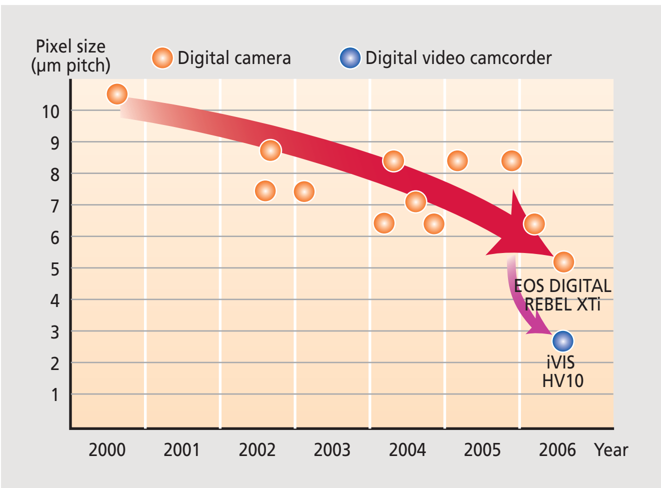
Cleanroom

Stepper for Manufacturing CMOS Sensors

Pixel Reduction Technology

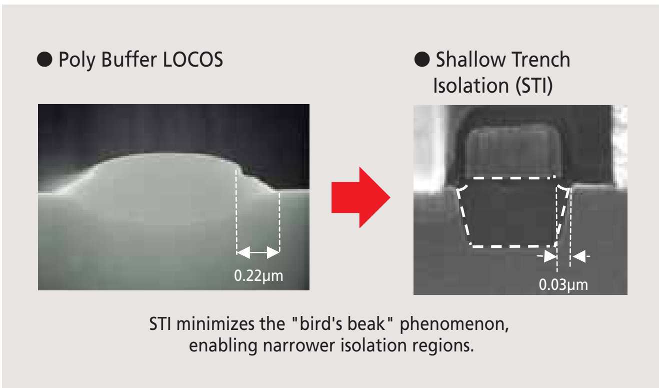
Isolating Pixels in High-Quality, High-Density CMOS Sensors

As pixel counts for digital cameras continue to increase, the size of pixels in CMOS sensors decreases. The HD CMOS sensor incorporated in Canon's HV10 HD video camcorder, released in 2006, realizes a pixel pitch of 2.75 μm.



Advancement of Pixel Sizes

To achieve pixel reduction of this extent, pixel isolation technology is as important as pixel- and wire-pattern design technologies. Canon developed a pixel reduction technology called STI (Shallow Trench Isolation), which is designed to reduce isolation regions, in addition to a reduction in dark current, enabling mass production of high-quality, high-density CMOS sensors.



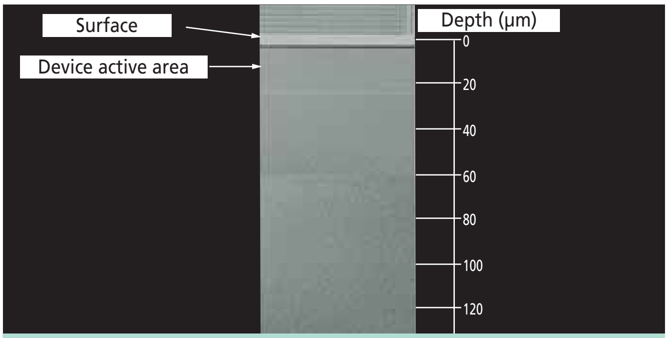
Pixel Isolation Technology

CMOS Sensor Dark Current Reduction Technology

Isolating Crystal Defects in Silicon Substrates

Dark current refers to leakage currents in photosensors attributable to high temperatures or lengthy exposures. Dark currents result in photosensor noise, degrading image quality in CMOS sensors. Reducing dark currents is critical for maintaining image quality.

Drawing on its vast material analysis technologies, Canon reexamined the structural aspects of silicon substrates, discovering that crystal defects in silicon substrates can influence dark currents. Through manufacturing process innovations, Canon developed a technology to eliminate crystal defects from the surface of a silicon substrate, where CMOS sensor operations occur, isolating these defects in the deep region of the substrate where they cannot affect sensor performance. This technology made possible the mass production of high-performance CMOS sensors with minimal dark current.



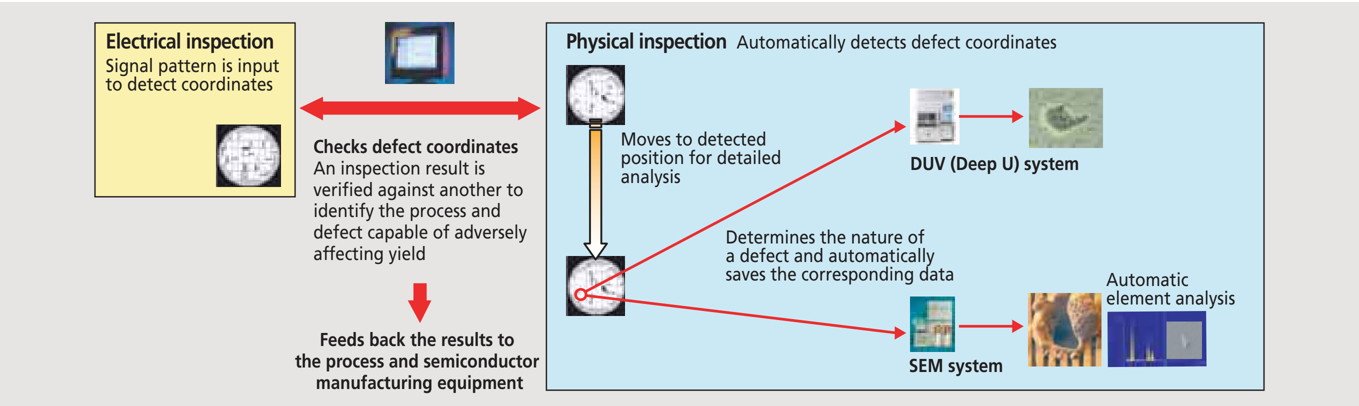
Cross-Sectional Photo of Silicon Substrate

CMOS Sensor Yield Improvement Technology

Eliminating Defects by Analyzing All Possible Contributing Factors

Yield refers to the ratio of acceptable units to total number of units produced. The fewer the number of defects in the manufacturing process, the better the yield. Yields can significantly affect product costs and profits. Given the unprecedented large size of CMOS sensors, improving their yields proved a daunting task.

Semiconductor defects have many sources, including dust, material and gas impurities, process design issues, and equipment malfunction. Canon developed a yield analysis system that automatically checks electrically measured coordinates of a defect against physically detected coordinates in a precise manner. Pinpointing the contributing process and the cause of defects from among all possible factors, coupled with continuing improvements in processes, materials, and equipment, ultimately leads to higher yields.



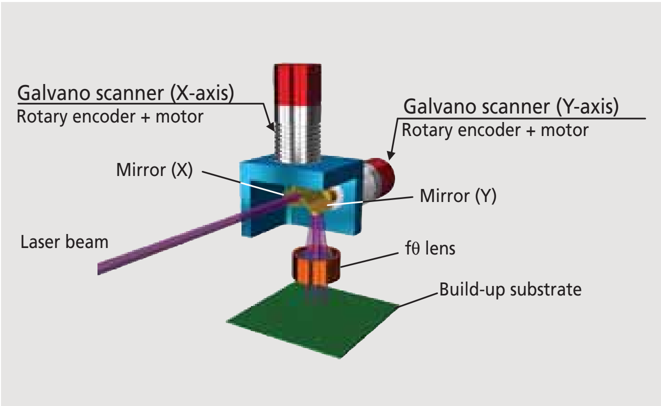
How the Yield Analysis System Works

Galvano Scanner

Precision Laser Beam Control

Galvano scanners are responsible for the high-speed, high-precision control of mirror angles, making them a critical component for patterning on high-density multi-layer substrates for mobile phone and other devices.

Canon's galvano scanner, which combines the company's proprietary optical rotary encoder technologies and fully-closed digital servo technology, achieves a precision of 0.5 μ radians (a radian is a unit of angle; 1 μ radian = 0.000057 degrees) and positioning resolution of 0.1 μ radian, with a speed of 0.7 msec/step. The sensor realizes minimal drift due to temperature variations enabling expanded application in areas where reliability and environmental stability are critical.



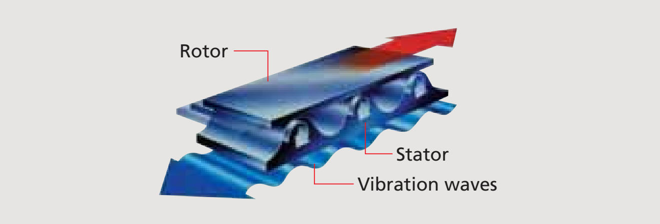
Example of Galvano Scanner Application: Laser Via-Hole Drilling Equipment

Ultrasonic Motor (USM)
Driving the Focus and Zoom Lenses by Ultrasonic Vibrations

Canon developed the world's first ultrasonic motor (USM) as the drive motor for the AF function of a single-lens-reflex (SLR) camera lens, incorporating it into its autofocus EF lenses for the company's EOS-series SLR cameras.

Ultrasonic motors work on the principle that a stator (elastic body) subject to vibration results in friction that turns the rotor (moving body) in a specified direction. Small vibrations are repeatedly employed to induce motion, making possible low-speed movement with considerable force. This type of motor produces higher torque than a similar-sized conventional electromagnetic motor, and realizes smaller dimensions for the same amount of torque. Major features of ultrasonic motors include and absence of gears, highly precise operation and low noise.

In addition to ring-type ultrasonic motors, Canon has also developed pencil-type micro motors, which are also used in digital camera zoom lenses. Canon aims to use ultrasonic motors in a variety of products, utilizing their special characteristics — compact size, quiet operation, and high precision.

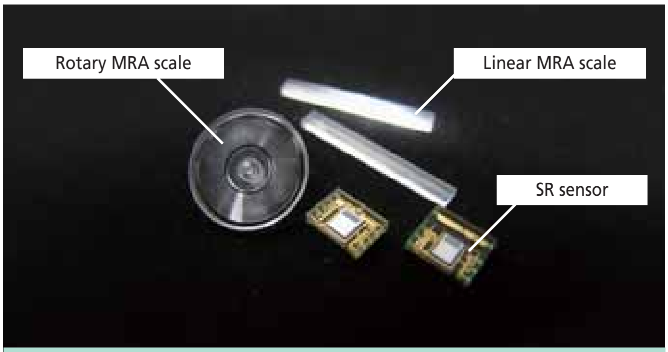


USM that Converts Ultrasonic Vibrations into Linear or Rotary Motion

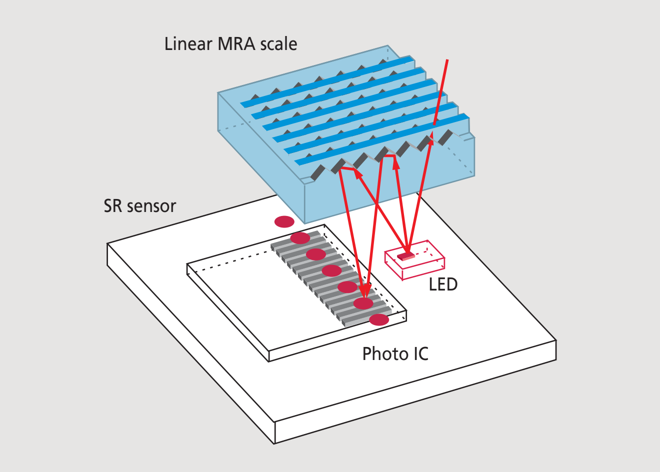
Ring USM, Micro USM, and Micro USM II

Ultra-Compact Encoder (SR Sensor)
Accurately Detecting Movements as Small as 0.1 μm

Encoders are sensors that convert positional changes into electrical signals using high-precision scales (graduations). Drawing on its store of original technologies, Canon developed an ultra-compact encoder with a 4 x 5 mm detection head capable of high-resolution (0.1 μm) position detection. Achieving significantly reduced power consumption thanks to its MRA (Micro Roofmirror Array) scale and high-sensitivity, low-noise SR sensor, Canon's ultra-compact encoder is used in the company's digital video camcorders, interchangeable lenses (EF lenses) for SLR cameras, and broadcast television lenses. Other types of encoders include ultrahigh resolution laser rotary encoders that rely on optical diffraction and interference.



MRA Scales and SR Sensors



How Ultra-Compact Encoders Work

Micro Laser Interferometer
For Ultra-Sensitive Positional Change Detection to 0.08 nm

Using a semiconductor laser as a light source, laser interferometers employ a noncontact method to measure slight displacements and vibrations on the object's mirror reflection. Canon developed a microlaser interferometer based on the Michelson interferometer method that achieves an unprecedented resolution of 0.08 nm (a nanometer is one millionth of a millimeter).

Canon's unique optical design has allowed the development of a light and compact interferometer weighing about 50 grams and measuring a mere 38 mm x 47 mm x 19 mm. This dramatic size reduction enables the interferometer to be used in piezoelectric measurement equipment, wafer-stage position control for EB drawing systems, and surface measurement of silicon wafers.

Micro Laser Interferometer

Production Engineering Technologies

Production-engineering technologies supporting next-generation manufacturing are equal in importance to the technologies used in product development. These include the realization of fully automated production lines that are not subject to the effect of labor costs, making possible the in-house production of key components and processing equipment that provide new functionality, higher performance and reduced costs, as well as state-of-the-art ultra-precision nano-order processing and measuring technologies.

Toner Cartridge Production System

Satisfying the Highest Levels of Cost, Space, and Reliability Requirements

Automating production systems is an extremely effective way to overcome rising costs, particularly in regions like Japan, where high labor costs have led to the transfer of production sites overseas. Automation is essential for bringing production back to Japan.

Employing Canon-developed production-engineering and production-device technologies, the company automated several hundred processes required in the production of toner cartridges for Canon laser beam printers, from parts processing and assembly to inspections and packaging. Technologies created to achieve this feat include the Automated Moltopren Sealing Apparatus used to seal the toner. Moltopren, an adhesive foam material, had been considered difficult to handle in automated procedures due to its susceptibility to the effects of temperature, humidity and tensile force. Canon, however, drawing on proprietary technologies, completely automated the moltopren sealing process, from the supply procedure to cutting, processing, precision sealing of containers, and inspection. A proprietary high-precision dispenser is also used to apply grease and lubricants. Canon's toner-cartridge automated assembly lines, which now operate at several of the company's manufacturing sites in Japan, effectively fulfill cost, space and reliability requirements.

Such production systems are unique to Canon and based on in-house development and design. Employing the latest technologies, including 3-D CAD, analysis simulation, and virtual reality, Canon is working to quickly realize new production systems for use in actual production lines. Targeting the cutting edge of production technology, Canon is actively pursuing the realization of fully automated production lines.

Toner Cartridge Production Line

Chemical Component Technologies

Materials that Deliver Well-Balanced Functionality

Components in which the materials from which they are made must be functional are called functional components. These include components used in Canon copying machines and laser beam printers such as high-image-quality fixing materials, electrostatic transfer and intermediate transfer belts, electric separation transfer and electrical charging rollers, and low friction blades. Canon carries out detailed analyses of the physical phenomena that take place during each process of a product's operation. After thoroughly assessing the necessary properties, the company proceeds to develop materials capable of delivering the required functions in a well-balanced manner.

More specifically, Canon adapts raw materials from basic organic and polymeric materials, including plastics and rubbers, through the application of chemical reactions, degeneration, and blending, followed by additional processing steps that make these materials appropriate for use. These technologies are called chemical component technologies. In addition to active efforts to develop unique functional components and produce them in-house, Canon is also working on the in-house production of processing systems for functional components.

Rollers Used in Copying Machines and LBPs

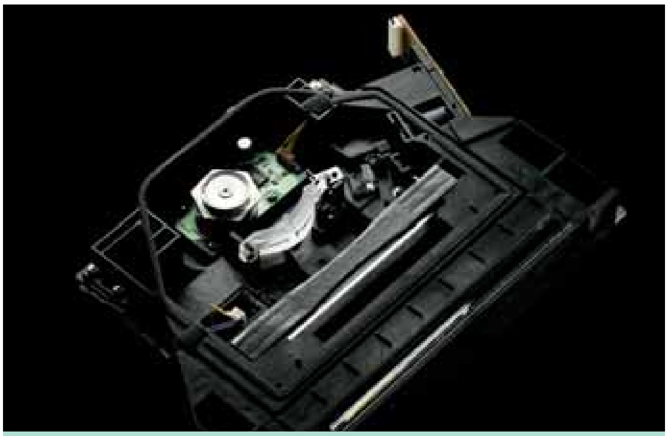
Transfer Belts Used in Copying Machines and LBPs

High-Precision Metal-Cutting Technologies

Developing Machining Systems for High Precision and Low Costs

To achieve higher-resolution image quality in copying machines and laser beam printers, it is necessary to improve machining precision for such key metal components as photosensitive drums, development sleeves, and polygon mirrors. Such components have become so sophisticated that specifications often call for machining with a runout accuracy of several tens of μm and surface roughness of several tens of nm. To attain such high levels of precision in machining, Canon has developed and manufactures in-house high-precision cutting machines that employ air-bearing technology, enabling advanced machining accuracy and cost savings that cannot be achieved by commercially available systems. The company is also working toward the development of machining processes to ensure stable machining.

High-Precision Cutting Machine for Polygon Mirrors



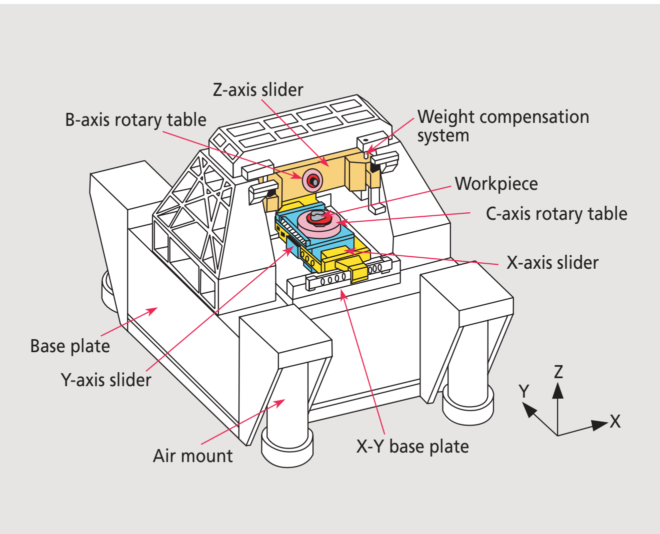
Laser Unit Incorporating a High-Precision Machined Polygon Mirror

Processing and Measurement System Technologies

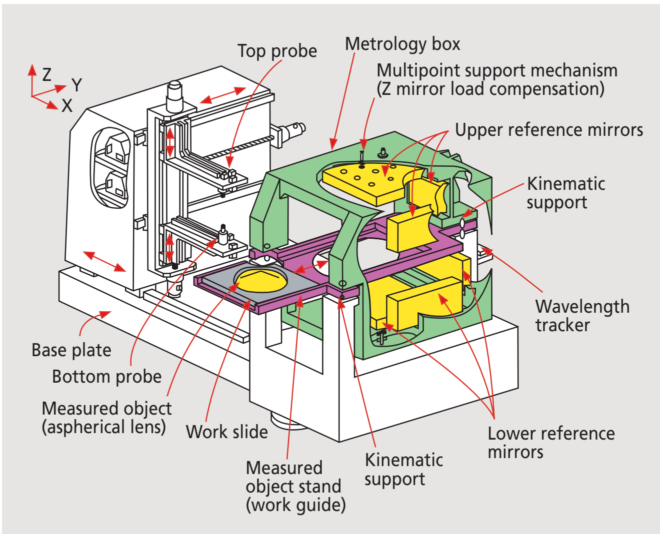
Realizing Nanometer Level Precision in Optical Elements

Optical elements like lenses and prisms continue to evolve with advances in design technologies, from spherical to aspherical shapes, and from axisymmetric to free-form surfaces. In the case of optical elements that demand nanometer-order levels of precision (a nanometer is one millionth of 1mm), conventional production technologies are incapable of achieving free-form surfaces involving large curvature differences. Such applications require the development of new processing and measurement systems.

For its free-form processing machine, Canon developed various proprietary technologies to enable the high-precision control of the high-speed cutting tool, including highly rigid air bearings and a high-performance controlling system. The company's free-form measurement machine, which makes possible the ultra high-precision measurement of the entire surface of optical elements through contact probes that are in contact with the element, also employs a variety of advanced technologies. A metrology box with a unique box-shaped structure provides the system's precision standard while a laser interferometer comprising a work guide sandwiched between six mirrors is used to cancel contact-probe motion errors, making possible measurements of nanometer-order precision.



Free-Form Processing Machine (A-Former)



Free-Form Measurement Machine (A-Ruler)

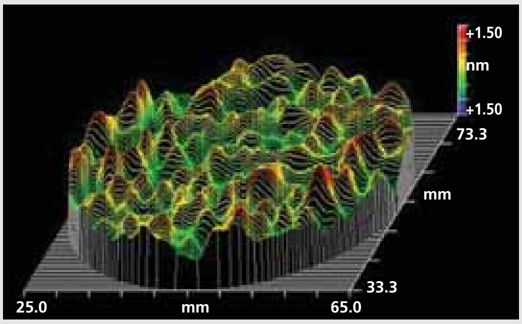
IBF (Ion Beam Figuring) Processing Technology

Fabricating Multi-Layer Mirrors with Atomic Precision

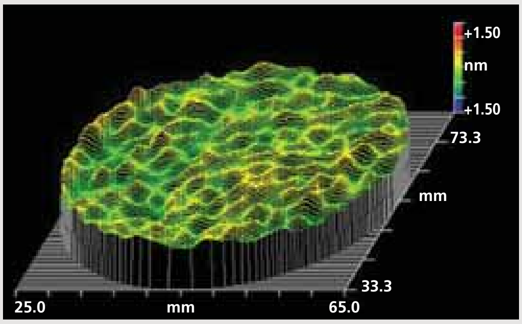
Instead of conventional lenses, exposure equipment operating in the EUV (Extreme Ultraviolet) wavelength range requires the use of multi-layer mirrors, which incorporate alternating layers of film made of different materials. Creating such mirrors demands the most advanced level of ultra-precision processing in the world, requiring accuracy at the atomic level (the radius of a hydrogen atom is approximately 0.1 nm). In addition, because of the aspherical shape of the mirrors, the processing techniques must also be highly sophisticated.

Canon is currently working on IBF (Ion Beam Figuring) technologies to refine the shape of mirrors used in EUV exposure equipment. The IBF technology ensures high-precision figuring over a spatial frequency domain of the shape without degrading surface roughness. Selecting the figuring diameter of the IB gun also makes it possible to correct shapes over a wide spatial frequency domain.

In tests using a Canon-developed IBF system, mirrors with 0.36 nmRMS (Root Mean Square) roughness before correction were successfully corrected to 0.13 nmRMS roughness, achieving the world's highest level of surface accuracy and clearly demonstrating the system's high figuring accuracy. The development of the IBF system was assigned to the EUVA (Extreme Ultraviolet Lithography System Development Association) by NEDO (New Energy and Industrial Technology Development Organization) as part of Japan's Ministry of Economy, Trade and Industry's Program for Fundamental Technologies in Advanced Semiconductor Device Processing as a theme of the Extreme Ultraviolet (EUV) Lithography System Development Project.



Before processing: 0.36 nmRMS roughness (2.510 nmPV)



After processing: 0.13 nmRMS roughness (0.975 nmPV)

Results of Shape-Correction Testing Using a Mirror Material

Optical Thin-Film Technology

Providing 99.9% Light Transmittance

Reflections from glass lenses are typically between 4% and 8% per surface, but a lens set, normally made up of from 5 to 10 lenses, loses more than half of its light transmittance without anti-reflective coatings. Anti-reflective films make use of the light-wave interference effect. Applying a multilayered, anti-reflective coating over the lens surface makes it possible to ensure light transmittance of 99.9% across the spectrum, from ultraviolet to near infrared, for remarkable image clarity, free of flaring and ghosting.

For the lenses used in excimer laser steppers, which require an extraordinary level of performance, Canon introduced the world's-first plasma-assisted sputtering technique, realizing extreme UV lithography with high-precision, stable films. This thin-film technique improves light transmittance in stepper lenses by 10% or more.

Plasma-Sputtering Thin-Film Deposition System

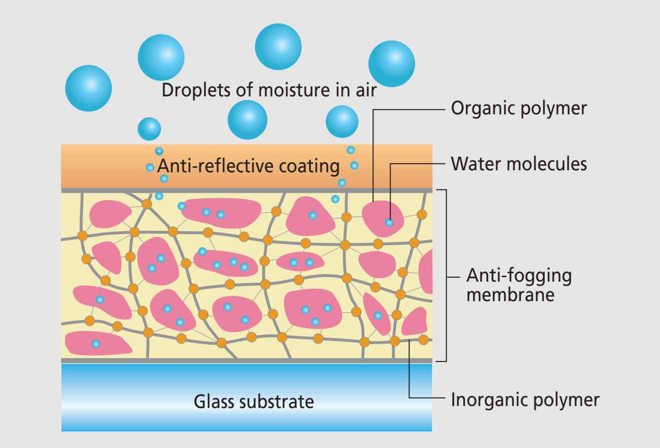
Anti-Fogging Technology

Eliminating Lens Fogging

Condensation represents a major cause of performance decline in optical products. Thanks to thin-film technology based on absorbent polymers, Canon has commercialized anti-fog binocular eyepiece lenses and camera-finder adapters.

This anti-fogging technology employs two types of polymers, organic and inorganic. Moisture on the glass surface is absorbed by the absorbent organic polymer. Since absorbed moisture tends to run off with organic polymer, the sol-gel method is used to solidify the organic polymer in the inorganic polymer before affixing the resulting stabilized layer to the glass surface of the lens.

Measuring several μm in thickness, the anti-fogging membrane has a porous anti-reflective coating on its surface that provides high anti-fogging performance while minimizing reflection.



Structure of Anti-Fogging Membrane

Molding Technologies

Enabling the Mass Production of High-Precision Aspherical Lenses and DO Lenses

Aspherical lenses have curved surfaces with continuously varying degrees of curvature across the diameter of the lens. DO (Diffractive Optics) lenses (➞ P.21), on the other hand, have fine structures designed to diffract light on the surface. Canon proprietary technologies employed in the manufacture of aspherical lenses and diffractive-optical elements include mold-making technology, considered to be the most difficult technology used in lens production. Canon uses these manufacturing techniques selectively based on the precision, diameter, and cost considerations required for each lens in response to user needs.

● Photo-replication method

In photo replication, a UV hardening resin is placed on an aspherical lens surface to transfer the mold shape, after which the resin is allowed to harden. An aspherical mold forms the resin into an aspherical lens, whereas a mold processed from a concentric Fresnel grating results in the creation of a diffractive-optical element. After years of research into mold-making techniques to fabricate finely shaped molds as well as the characteristics and physical properties of resins, Canon has perfected a technique for the precision control and transferring of fine shapes at the nanometer level, making possible the manufacture of a wide variety of lenses.

● Plastic molding method

Plastic molding involves pouring plastic into a finely crafted mold to create a lens. This technology is based on numerous innovations that ensure precise and stable molding. Used to produce aspherical lenses for compact cameras, this technique also contributes to the realization of compact product sizes.

● Glass molding method

Glass molding employs high-precision aspherical molds, which are pressed directly on glass to shape it into lens elements. Based on studies of glass materials and mold materials, Canon conducted simulations for variations in temperature and size to create molds that ensure consistently accurate performance even at high temperatures (with precision on the order of 0.3 μm or less and surface roughness of 0.02 μm). Lenses manufactured from these glass molds have found wide application due to the flexibility they offer with respect to refractive index and other optical parameters.

Molds for Manufacturing Aspherical Lenses

Roof Prisms
(for Lens-Shutter Cameras and Digital Cameras)

Large-Diameter Lens
(for LCD Projectors)

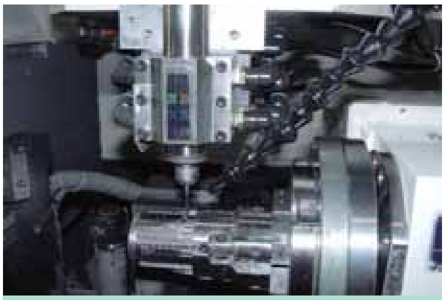
Toric Lenses
(for LBPs and Copying Machines)

Digital Metal-Mold Production Technology

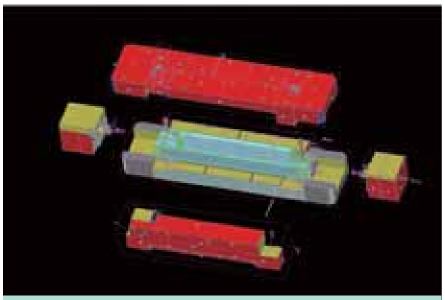
Supporting a Fast Metal-Mold Production System

Molds, which play a critical role in determining Canon's competitive edge, must meet world-class standards in quality, production times, and cost. Canon has developed a fast metal-mold production system that consolidates the metal-mold production process into a consistent 3-D system incorporating mold design and computer-aided manufacturing (CAM) programs, machining, assembly, and measurement.

By developing a dedicated computer-aided design (CAD) system that incorporates mold design know-how, and an original CAM system linked to machining technologies, Canon greatly reduced mold-design, programming, and machining times. Traditionally, shaping was accomplished exclusively using Electrical Discharge Machining (EDM), but Canon engineers succeeded in developing EDM-free technologies by establishing high-speed, high-precision cutting techniques. Canon plans to continue pursuing technological developments to further expand the scope of automation and enhance its machining technologies.



High-Speed Cutting Machine



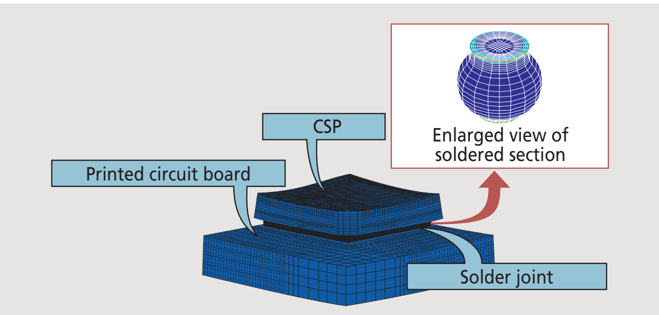
3-D Mold Design System

CAM Program Development

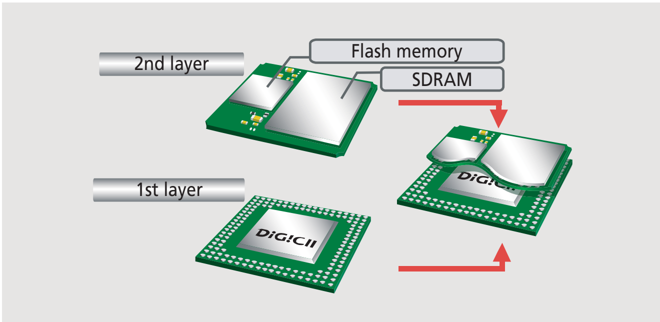
High-Density Packaging Technologies

Realizing Smaller, Lighter Products

Technological innovation improving the miniaturization, processing speeds and functionality of semiconductors makes possible the production of smaller and lighter digital devices, such as digital cameras and digital video camcorders. To reduce the dimensions of its products, Canon uses various high-density packaging technologies, including Chip Scale Package (CSP), in which solder balls are formed on area-array bonding pads on the back of the package, allowing the package to be bonded to the substrate through heating, and System in Package (SiP), in which semiconductor chips are integrated into a single package. Canon is currently conducting R&D on simulation analysis technologies to enhance the reliability of soldering connections between the package and substrate, and on solder printing technologies, which are essential for high-precision soldering jobs.



Simulation Analysis of Thermal Stress on CSP and Circuit Board



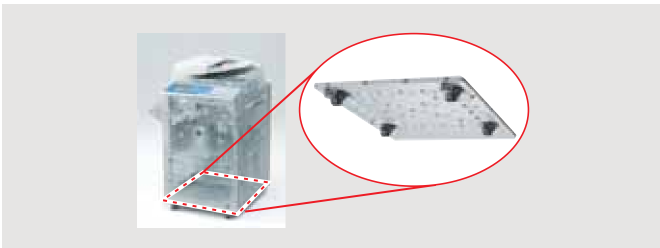
SiP Concept Employed in the PowerShot SD600 DIGITAL ELPH (DIGITAL IXUS 60)

Press Production Technologies

Achieving the Rigidity of a 10 mm Steel Plate with Two 1.6 mm Steel Plates

To ensure stable operation and high reliability in high-speed copying machines weighing over 100 kg, the structure and rigidity of the machine frame are critical. Canon conducts body-frame rigidity analyses and explores new ways to ensure the optimal design of body frames and parts. The results of these efforts are reflected in Canon's products.

For example, Canon was the first in the world to employ a monocoque structure for the bottom plate of a copying machine. The monocoque structure, which ensures the rigidity of the copying machine frame and is highly resistant to external forces, is the result of pressing together two 1.6 mm-thick steel plates, one of which is dimpled. Such a construction offers a flexural rigidity equal to that of a 10 mm-thick plate. By altering the shape, number, and layout of the dimples, as well as the materials used, the rigidity of the bottom plate can be further increased.



The Dimpled Bottom Plate of a Copying Machine

Virtual Prototyping Technology

Promoting Prototype-less Design Based on Optimization Analysis

CAE (Computer-Aided Engineering) — a technique designed to proactively predict and solve potential problems in products that may arise in prototypes and production processes — is widely used in Canon R&D, product development, production engineering, and prototyping. CAE combines "prototype-less core technology," together with actual product analysis and measurement technologies. It helps accelerate development cycles, reduce costs, and enhance product performance, functionality, and quality.

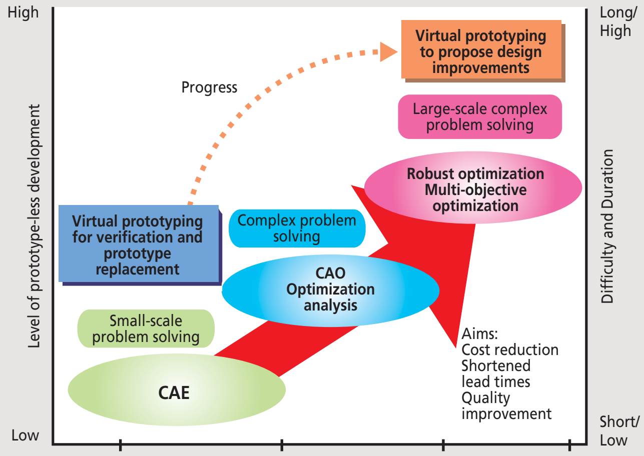
Virtual prototyping relies primarily on three techniques: 3D-DMR (Digital Mock-up Review) to identify problems in a basic product configuration using 3-D data, CAM (Computer-Aided Manufacturing) to automatically generate processing data, and CAE.

For CAE, the core of the three techniques mentioned above, Canon is working to transform virtual prototyping from a means of verifying prototype replacement to a means of proposing improvements in the design phase, taking full advantage of optimization analysis (CAO: Computer-Aided Optimization), multi-object optimization analysis, and robust optimization analysis for stable functionality and performance.

Examples of virtual prototyping at Canon include optimization analysis for the zoom lens barrels of compact cameras. To ensure ease of assembly and disassembly, usability, safety, and drivability at the product-design stage, Canon performs multi-objective optimization analyses of the drive mechanisms for the entire product with CAE to simultaneously optimize multiple design goals.

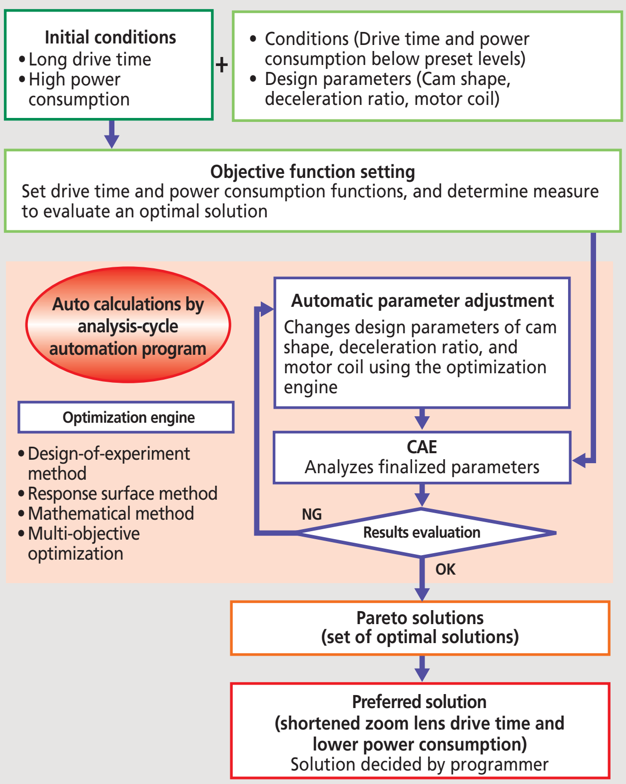
In CAO, an optimum functional value is sought by experimenting with parameter values after setting an objective function. Canon developed an original analysis-cycle automation program capable of performing optimized coupled analysis using an integrated optimization engine that performs sampling, approximation, optimization analysis, and robust optimization analysis.

In the case of the zoom lens barrel, Canon undertook multi-object analyses targeting two parameters — zoom lens drive time and power consumption, which have a tradeoff relationship — deriving a set of optimal Pareto solutions that made it possible to reduce zoom lens drive times by two-thirds while at the same time reducing power consumption.

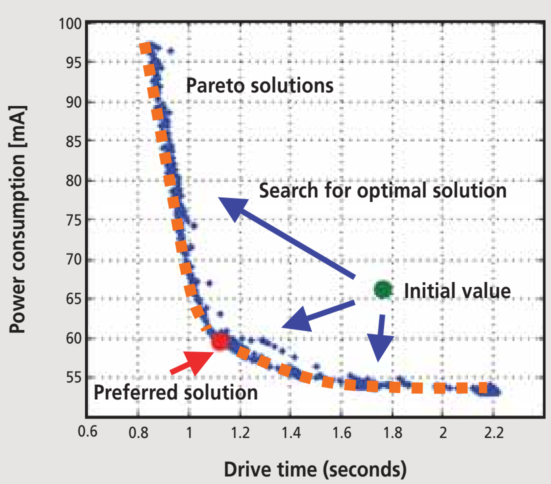


Progress of CAE Technology

Structural Model of Multi-objective Optimization Analysis For a Compact Camera Zoom Lens Barrel



Multi-objective Optimization Analysis Process



Example of Pareto Solution for Zoom Lens Drive Time and Power Consumption

Injection Molding Simulation Systems

Predicting Optimal Molding Conditions and Potential Problems in the Design Stage

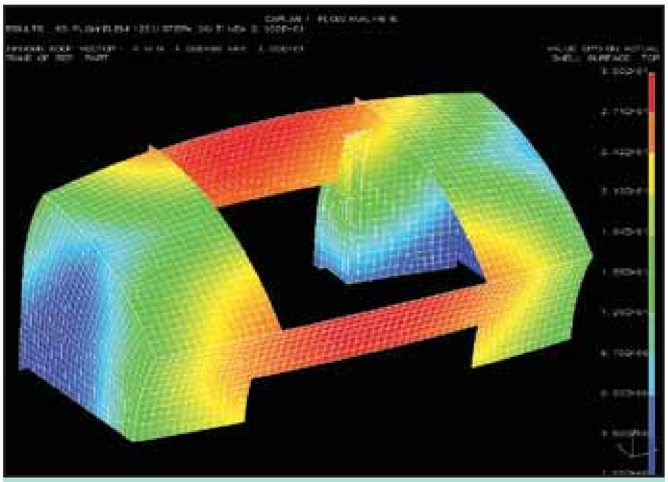
The design of metal molds greatly affects the plastic parts, formed by injection molding, that are used in various types of office equipment. Canon utilizes a proprietary simulation system enabling the efficient design of metal molds.

● Canon Plastic Analysis System (CAPLAS)

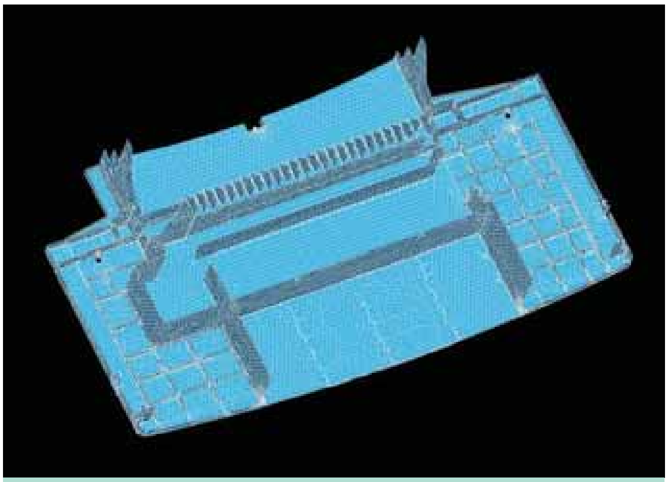
CAPLAS is an injection molding simulation system based on detailed analyses of the injection molding process. To determine the most appropriate mold conditions, each stage in the metal-mold design process is simulated, from filling resin into the metal mold to maintaining pressure and cooling in the mold, predicting optimal molding conditions, and ensuring mold optimization. This process enables the development of optimal metal molds, reduced manufacturing costs, and shortened product development lead times.

● Automatic mesh formation technology

This technology, which enables the rapid creation of analysis models from 3D-CAD data, is an indispensable tool for detecting short shots that occur in the molding stage, inspecting mold thickness, and simulating potential moldability problems to find early solutions.



Example of Simulation for Optimal Injection Molding



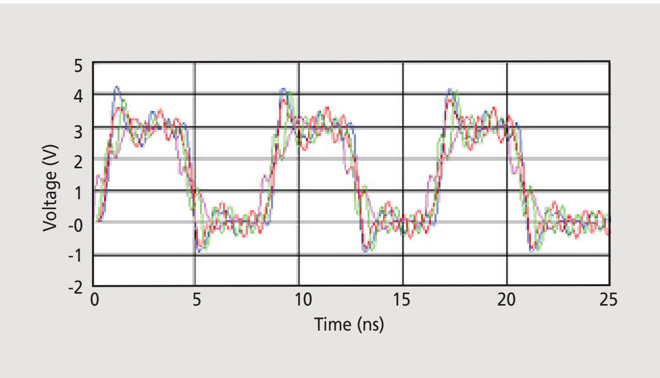
Example of Automatic Mesh Formation of Neutral Surface Elements from 3D-CAD Data

Circuit-Packaging Design-Support Technologies

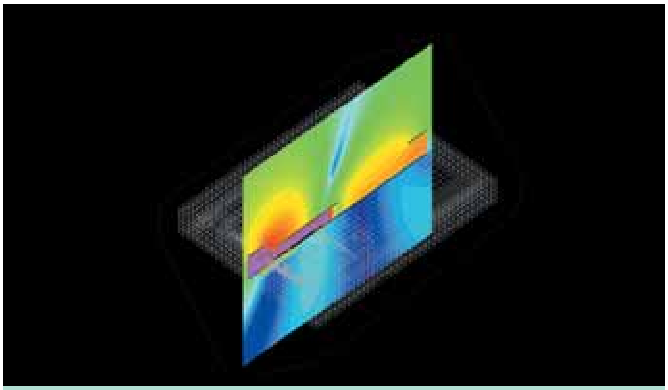
Predicting Movement and Noise in the Circuit Design Stage

Copying machines and other office equipment continue to advance in the areas of functionality, image quality, speed, and color reproduction. Their control circuitry is also improving, seemingly faster year by year. With higher circuit frequencies, it is becoming increasingly difficult to achieve stable circuit operations while minimizing noise.

In response, Canon has introduced an array of circuit-packaging design-support techniques, including transmission line simulation analysis that analyzes the travel times of electric signals transmitted on printed circuit boards in units of several tens of picoseconds, as well as electromagnetic field simulations that estimate the level of electromagnetic noise generated by electric equipment at the design stage. These techniques ensure improved operational accuracy at the prototype-testing stage and help reduce development lead times.



Transmission Line Simulation Analysis of High-Speed Digital Circuit Board



Example of Electromagnetic Field Simulation of Copying Machine Reader Unit

Quality Management Technologies

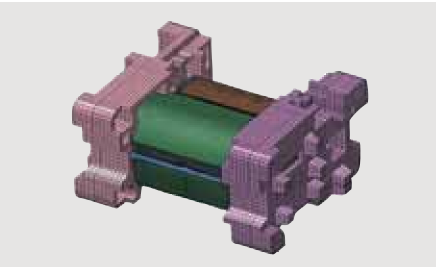
Canon carefully considers the viewpoint of users in order to consistently provide high-quality products. Going beyond the "peace of mind" provided by the guarantee of safety and reliability, Canon strives to create products that offer users exceptional functionality and endless enjoyment. In order to do so, Canon is developing a broad array of quality management technologies.

Package Design Technology

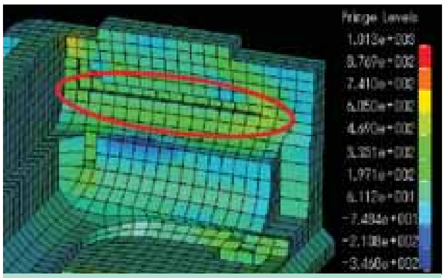
Realizing More Effective Padding Through Simulation

Canon carries out a variety of simulation-based evaluations, including structural analysis, vibration analysis, thermodynamic analysis, electromagnetic-field analysis, sound-field analysis, drop-impact analysis, and failure-time analysis. These evaluations make it possible to accurately and efficiently perform design analyses without preparing the costly test equipment or prototypes required by conventional methods.

Canon developed an analysis technique for drop-impact analysis simulations. 3D-CAD data is used to perform design analysis for shock-absorbing padding used to absorb impacts incurred during transport. This approach enables verification without damaging numerous valuable products in the process. Evaluations can then be performed on actual products after identifying areas of weakness, significantly reducing costs and improving evaluation efficiency, as well as improved padding design accuracy.



Simulation of Package Padding



Result of Package Drop Impact Simulation

Result of Drop Test Using Actual Products

Electronic Part Evaluation and Analysis Technology

Canon Technology to Ensure Enhanced Quality and Reliability

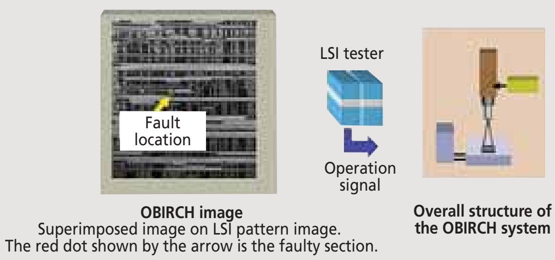
Ensuring product quality and reliability requires that the quality and reliability of each individual component be maintained and improved. These efforts are supported by electronic part evaluation and analysis technologies. Canon has developed a broad range of original technologies to meet the requirements of reduced evaluation times and improved production precision.

● LSI fault-location identification technology

LSIs can comprise up to millions of elements, and identifying faulty elements requires advanced fault-location identification technologies. Canon introduced the OBIRCH (Optical Beam Induced Resistance Change) method as a new fault-location identification approach. This method uses a laser beam to create an image of changes in current caused by temperature variations, which is combined with an LSI pattern image to detect the location of defects. When used in combination with LSI testers, the approach enables the identification of fault locations in LSIs in an operational state, achieving an approximately 40% improvement in the detection rate of fault locations compared with conventional methods.

● New fault-analysis method for laser diodes

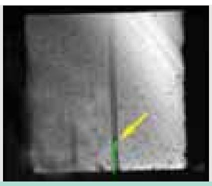
Laser diodes (LD) represent a particularly important type of optical semiconductor. Canon has established a new fault-analysis approach that applies the SEI (Seebeck Effect Imaging) principle to detect manufacturing anomalies (crystal defects, etc.) in LD chips with high precision. An infrared beam is emitted, displaying changes in thermoelectromotive force currents occurring inside the LD chip to identify such anomalies as crystal defects and damaged crystals. This approach enables the identification of anomalies that were not detected in the manufacturer's fault analysis, thereby ensuring high parts reliability.



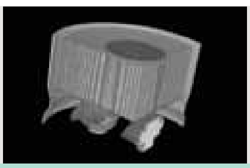
Detection of Fault Locations in LSIs Using the OBIRCH Method

● Observation of defects in electrolytic capacitors using X-ray CT scanning

A common failure mode in electrolytic capacitors is caused by electrical short circuits resulting from improper internal structures. A technique for observing internal structures using X-ray CT scanning has been used to perform high-precision examinations of the internal structures of such capacitors. This technique scans capacitors from multiple directions and displays a 3-D fluoroscopic image. Canon also uses this technique to inspect the internal structures of non-defective capacitors to rapidly assess design quality.



Detecting Defects in an LD Chip Based on the SEI Principle

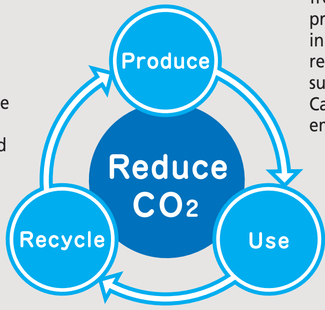


Evaluation of Internal Structure of Electrolytic Capacitor Using X-Ray CT Scanning

Environmental Technologies

Viewing the product lifecycle in terms of its three stages — produce, use and recycle — Canon contributes to minimizing environmental burden through the effective application of environmental technologies.

Canon has achieved not only the 100% recycling of consumable cartridges, but has also targeted the recycling of its products.



In production, Canon uses recycled materials and materials free of hazardous substances. The company also actively promotes innovations in its cell production system, engages in prototype-less development processes to conserve resources and energy, and pursues the development of substitute technologies to replace hazardous substances. Canon also employs transport methods that minimize CO_2 emissions.

Canon products incorporate environmental technologies aimed at improving performance and ease of use while reducing the burden on the environment.

Canon Activities to Reduce Environmental Burden at Each Stage of the Product Lifecycle

Using Plant-Derived Plastics

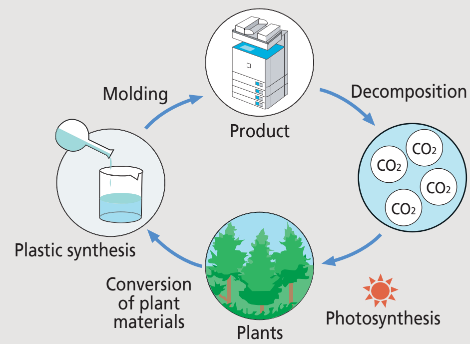
Produce

Targeting Products that Reduce CO_2 Emissions

Canon is actively examining the application of plastics derived from plants.

As shown in the diagram, plant-derived plastics can curb CO_2 emissions by drawing on the innate cyclical nature of plants. By replacing conventional petroleum-derived plastics with plant-based plastics, not only for the product bodies but also for the electrical wiring and related units, we aim to reduce annual CO_2 emissions by 10,000 tons in 2010.

By using plastics derived from plants, Canon promotes the development, design, and manufacture of products that are not only environmentally friendly in terms of performance, but also in terms of materials.



Environmental Circulation Flow of Plant-Derived Plastics

High-Performance Eco-Polymers

Produce

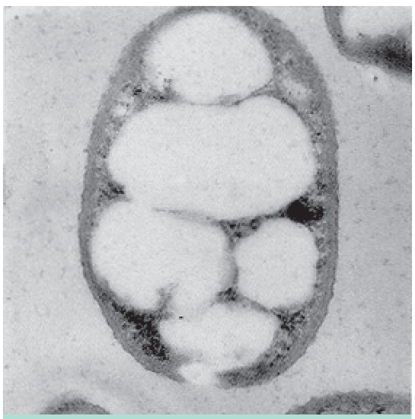
Investigating Environment-Conscious Functional Materials Through Microorganism Research

Canon is currently conducting research in biotechnology with the aim of applying the unique qualities of microorganisms to environment-conscious technologies. One example includes technology that enhances the functionality of polyester produced by microorganisms (PHA: polyhydroxyalkanoate).

Canon has discovered microorganisms capable of producing PHA, identifying four such microorganism types to date. These microorganisms are capable of efficiently synthesizing PHAs with completely new structures. By employing techniques involving the direct and indirect introduction of functional groups, Canon is exploring ways to apply PHA to piezoelectric materials. The company has also established culturing techniques that enable the efficient incorporation of PHA raw-material compounds into microorganisms — a significant step toward establishing volume production technologies toward commercialization.

Working from a biotechnology base enabling the acquisition and selective use of outstanding microorganisms and genetic applications, Canon is pursuing research targeting the early commercialization of environment-conscious functional materials.

PHA-Producing Microorganisms Developed by Canon



Polyester Synthesized Inside a Microorganism

Eliminating Hexavalent Chromium Plating

Produce

Alternative Technologies Targeting Complete Elimination of Hazardous Substances

Canon was among the first companies to grasp the environmental impact of its products and, since 1997, has promoted technologies to reduce environmental burden, producing the industry's first copying machines and digital cameras compliant with Europe's RoHS Directive*. The company also established a Product Chemical Substance Assurance System for its products, consistently eliminating hazardous substances in every stage of the product lifecycle.

For example, in 2006 Canon stopped using the hazardous substance hexavalent chromium in the plating process for interchangeable lens mounts for the company's SLR cameras. Canon promotes the creation of environmentally conscious products by eliminating hazardous substances from its manufacturing processes, which in turn results in such benefits as reduced frequency for replacing wastewater treatment filters.

* Refers to the Restriction of Hazardous Substance Directive implemented by the EU covering electric and electronic products. Use of lead, mercury, cadmium, hexavalent chromium, PBB and PBDE in products has been prohibited from July 1, 2006.

Interchangeable Lens Mount for SLR Cameras Without Hexavalent Chromium

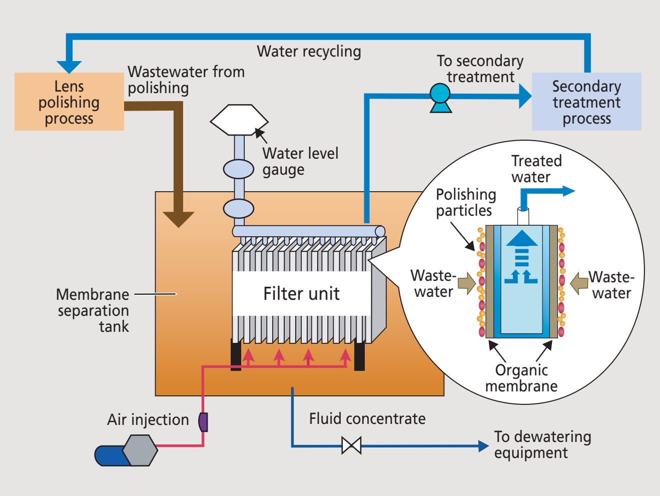
Closed Recycling of Water

Produce

Organic Membrane Filtration Apparatus Free From Aggregation Agent or Activated Carbon

Canon has traditionally used a closed system to recycle water used for polishing lenses in its lens fabrication processes. As demand grows for higher quality and higher performance in lenses due to the spread of digital photography, however, so does the demand for higher quality recycled water. To meet this demand, Canon's Utsunomiya Plant in Japan now employs a newly developed system that uses organic membrane filtration.

The filtration apparatus consists of organic membranes immersed in a membrane separation tank in which the polishing particles to be removed form a layer on the membrane surface and are continuously filtered at low pressure and low velocity. The problem of particle clogging, encountered with conventional filtration methods, has been virtually eliminated. The new system is maintenance-free and requires no back-washing or chemical washing, making possible more stable treatment of wastewater for polishing. Once the water is cleared of sediment by passing through the organic membrane, which has a pore diameter of 0.25 μm, it undergoes secondary treatment and is then recycled within the closed system to be used again in the polishing process. Unlike conventional systems, this closed water-recycling system does not employ aggregation agents or activated carbon, thus reducing the amount of chemical used and sludge generated.



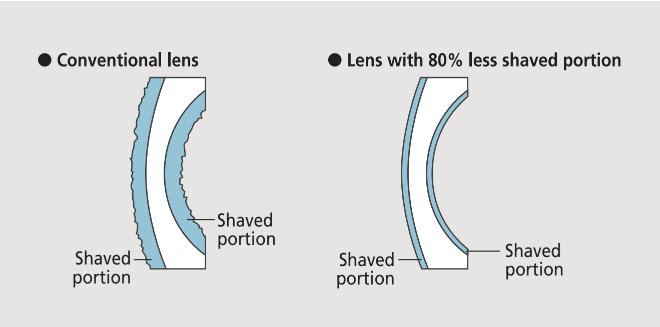
Closed Recycling of Water

Lens Sludge Reduction Technology

Produce

Reducing Lens Sludge Through Joint Research with Optical Glass Manufacturers

Lens sludge, an inevitable by-product in the lens fabrication process, is generated in the shaving process to remove coarseness from glass lenses. Sludge, however, constitutes industrial waste and must be reduced. Since 1996, Canon has been working with an optical glass manufacturer to find ways to reduce the volume of sludge generated. The result of such efforts was the development of a production method that cuts sludge from 50% to 80% compared with conventional methods. For its part, Canon analyzed the lens crevice depths to propose a shape that would minimize the shaved portion, and also developed high-precision polishing techniques. The glass manufacturer developed a high-precision pressing technique, reducing the excess shaved portions previously generated. Reducing shaving saves resources and cuts process times and manufacturing costs. Canon is also steadily implementing this production method at its overseas production sites.



Lens Design with Reduced Shaving

Biodegradable Plastic Band

Using Packaging Materials with Minimal Environmental Burden

In 2006, Canon switched its packaging band for medical equipment products from a petroleum-based material to biodegradable plastic (polylactic acid). Made from corn or other plant materials, this band does not generate toxic gases when burned. Even when buried in landfill sites, it decomposes into water and carbon dioxide* for environmentally acceptable disposal.

Canon is working to expand the use of the band to a broader range of products. In this pursuit, the company is performing numerous tests to verify performance when subjected to changes in temperature and humidity resulting from passage over the equator, and long-haul transport.

* Refers to carbon dioxide absorbed by the plant from the air, not newly generated CO_2 introduced into the atmosphere.

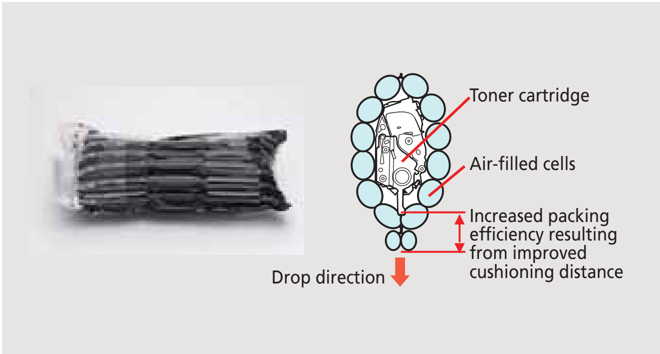
Biodegradable Plastic Band

AIRSHELL Packaging For Toner Cartridges

Packaging Material Utilizing Air Pressure for Increased Cushioning

AIRSHELL is packaging material for toner cartridges that utilizes air cushioning. Conventional molded pulp cushioning materials were designed to be bulky in order to allow room for compression under impact. AIRSHELL relies on the tendency of air to return to its original pressure in an enclosed space regardless of how many times a compressed material undergoes elastic stress. This makes it possible to provide cushioning that protects products even with minimal space between the cartridge and the outer packaging. This packaging material helps reduce product package sizes, improving shipping efficiency and reducing CO_2 emissions generated during transport by 23% to 49%.

* In 2004, AIRSHELL won a number of awards, including the WorldStar Packaging Award, at an international competition for packaging materials.



AIRSHELL Packaging and Illustrated Cross Section

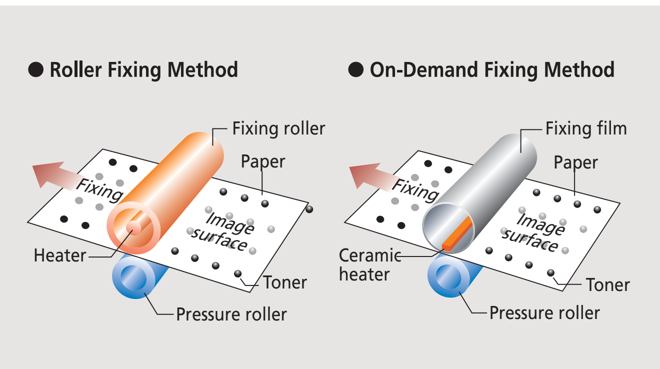
On-Demand Fixing

Drastically Reducing Power Consumption by Heating Roller Only As Needed

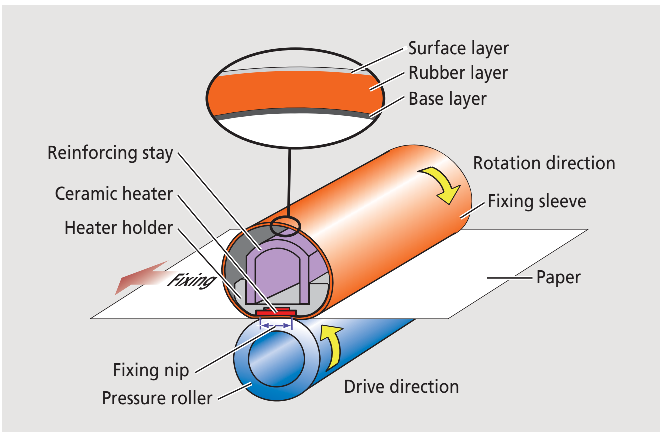
In copying machines and LBPs, toner is fixed to paper with heat and pressure. With conventional roller-fixing systems, the roller must be kept hot at all times, even in standby mode.

Canon's on-demand SURF (Surface Rapid Fixing) technology uses a linear ceramic heater and fixing film of high thermal conductivity and low thermal capacity. The heater activates only when the fixing film rotates, transferring heat via the film to fix the image. This makes possible zero warm-up time, resulting in a 75% reduction in energy consumption compared to conventional roller-fixing systems.

Canon also developed an On-Demand Fusing Method for its color printers and copiers, changing the material used for the base layer of the fixing film from a heat resistant resin to a thin metal film, and the structure of the fixing unit from two layers to three, adding a layer of rubber between the surface layer and the base layer. The soft rubber layer contributes to improved toner-fixing performance, ensuring uniform application of heat to the toner to produce high-quality, consistent color images.



How On-Demand Fixing Works



Color On-Demand Fixing System

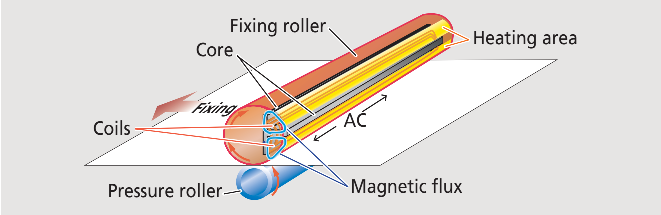
Use

IH Fixing

Reducing Warm-Up Times to Cut Energy Consumption by 70%

The widespread use of digital network MFPs has created the need to shorten warm-up times as a means of reducing power consumption. In response, Canon developed an IH (Induction Heating) fixing system that drastically reduces printer warm-up times. This system uses a fixing roller consisting of a thin-walled metal pipe with a thin fluororesin mold-release layer coating. The application of a high-frequency current through a coil built into the roller, which comes in direct contact with toner on the surface of the paper, ensures fast heat conduction, reduces warm-up times to one-sixth that of previous models, and cuts energy consumption by 70%.

Thin-walled fixing rollers made from metal are subject to rapid thermal changes and mechanical bending fatigue. By thoroughly examining heat and mechanical properties of the material and improving the roller-holding method and the anchor structure, Canon developed a fixing roller capable of producing up to 500,000 prints. To ensure stable temperature control, the company also developed a low-loss, high-frequency inverter power source for broad output control from 20 to 50 kHz.



How the IH Fixing System Works

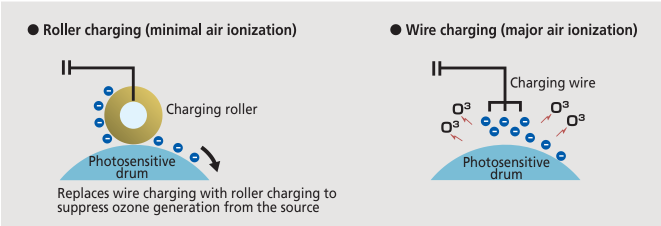
Use

Ozone-Free Electrical Charging

Drastically Reducing Ozone Emissions and Voltage Levels

Electrophotographic products like LBPs and copying machines form images by electrically charging photosensitive drums. The corona discharge method applies voltages ranging from 5 to 10kV, creating ozone that can result in an unpleasant odor and may have adverse effects on skin. To avoid this, an ozone filter, coupled with an airflow structure that properly directs ozone to the filter, need to be incorporated.

Canon took a new approach in resolving these problems, developing a roller-charging method based on an innovative concept that charges the photosensitive drum by applying a voltage generated by superposing an AC voltage over a DC voltage to a conductive roller. Compared to the conventional corona discharge method, this method reduces ozone generation to approximately 1/1000 or less, and voltage levels to approximately one-fifth of previous levels.



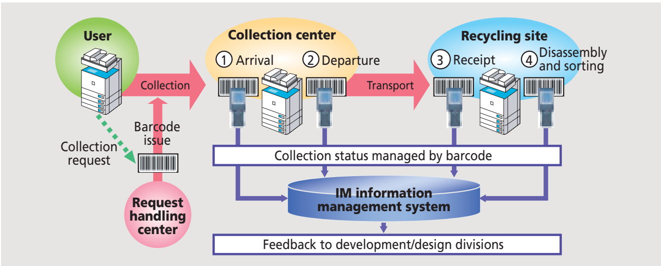
Overview of Ozone-Free Electrical Charging

Recycle

Product Development Support System

Promoting Efficient Recycling Through the Collection and Accurate Management of Used Products

To do its part to establish a society based on resource recycling, Canon is promoting a program that targets the reuse of used products that have been collected, and the reuse of parts and materials recovered through product disassembly and sorting. Since 2005, as part of this program, the company began attaching barcodes to products at collection and recycling sites in Japan to ensure thorough management procedures. Canon also linked the program to its IM (Inverse Manufacturing) information-management system to share information among other sites and to allow accurate program management and efficient recycling. Information gleaned from this system, including information on easy-to-disassemble product design and designs permitting reuse of products and parts, is returned to development and design divisions to improve future product design.



IM Information Management System

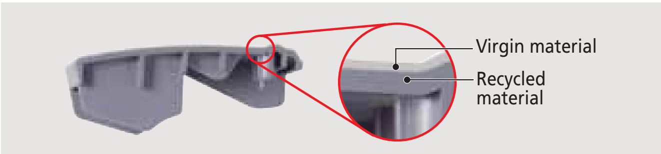
Recycle

Plastic Recycling Technologies

Helping Reduce Environmental Burden Through Resource Recycling

Since 1990, Canon has used numerous types of recycled plastic in exterior housings and other product parts in cooperation with resin manufacturers, both in Japan and elsewhere. The sandwich molding technique, in which recycled plastic is sandwiched between layers of virgin plastic, enables usage rates of up to 30% for recycled plastic. Also, targeting a recycled-plastic usage rate of over 80%, Canon began working with molding manufacturers on the development of thin-walled multi-layer injection molding technology, which could lead to the creation of parts that are more environmentally conscious than those made possible through sandwich molding, while also contributing to cost savings.

By improving the ratio of recycled plastic used in its products, Canon will continue promoting its resource recycling programs as a means of contributing to preserving the environment.



Product Made Using Thin-Walled Multilayer Injection Molding

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This brochure is printed with ink that includes no mineral oil and is characterized by superior decomposability and de-inking qualities.
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