Opto-Electronic Devices

The generation and the detection of light is the goal of our Electron Tube Division and our Solid State Division. Our Systems Division designs devices that are used in many applications that exploit light to probe and manipulate matter, energy, distance and time. Hamamatsu Photonics continues to develop and evolve products and technologies to meet the demands of our increasingly high technology world.

Photodiode and Photomultiplier Technology :

Hamamatsu Photonics employs two primary technologies for the detection of light using either photocathode technology or semiconductor materials. In both methods, we endeavor to detect the basic unit of light, the photon. We produce hundreds of detectors meeting the varied requirements of space-time resolution, wavelength detection and light intensity measurements.

Photodiodes are photosensitive semiconductor detectors comprised of a PN junction operating as a photoelectric converter. The silicon photodiode is our most popular detector. It has a spectral response ranging from the near infrared to the ultraviolet regions of the spectrum. Photodiodes exhibit excellent linearity, low noise and wide spectral response. They are rugged, compact, light weight and have a long life.

Photomultiplier tubes (PMTs) also measure light in the same spectral range as photodiodes. However, their sensitivity and timing characteristics can be several orders of magnitude better than the silicon photodiode. Hamamatsu Photonics innovations include a series of TO-8 sized PMTs, metal package PMTs, PMTs with metal channel dynodes, an electron bombardment CCD tube, and PMTs exploiting new photocathode materials such as GaAsP. PMTs can be integrated into sensor modules offering low voltage operation, ease of use, high sensitivity, wide dynamic range and fast response. An example of these is our new 1/2 inch side-on PMT sensor module. This unit can be used in DNA analysis.

1/2 inch Side-on PMT Sensor Modules

Both types of detectors are used in a variety of applications. Photodiodes are useful in spectrophotometers, medical diagnostic and imaging devices and in

- Si Photodiodes
- Si PIN Photodiodes
- Si PIN Photodiodes with Pre-amplifier
- GaAsP Photodiodes
- GaP Photodiodes
- Si Avalanche Photodiodes
- CCD Area Image Sensors
- N-MOS Linear Image Sensors
- C-MOS Linear Image Sensors
- Multichannel Detector Heads for Image Sensors
- Photo ICs
- Position Sensitive Detectors
- CdS Photoconductive Cells
- InGaAs PIN Photodiodes
- InGaAs PIN Photodiodes with Pre-amplifier
- GaAs PIN Photodiode with Pre-amplifier
- PbS/PbSe Photoconductive Detectors
- InAs/InSb Photovoltaic Detectors
- MCT (HgCdTe) Photoconductive Detectors
- InSb Photoconductive Detectors
- InGaAs Linear Image Sensors
- InGaAs Multichannel Detector Head
- Pyroelectric Detectors
- Photocouplers
- Light Emitting Diodes
- Avalanche Photodiode Modules

some high energy physics applications. PMTs are used in these same areas, however their ability to detect extremely low levels of light makes them useful for biotech applications. Increasingly, photodiodes are in demand for information and data communication fields.

Light Source and Emitter Technology :

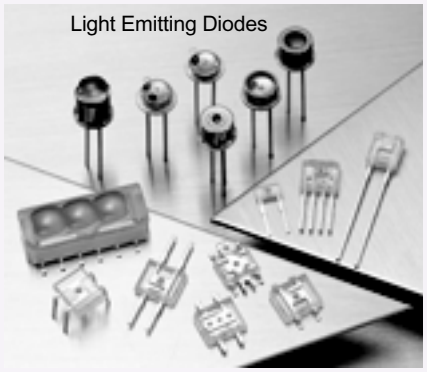
Hamamatsu Photonics continues to develop new technologies to create and manipulate photons. Electron tube technology comprises most of our product line in this area. However, interest and demand is increasing in our line of solid state emitters. Both technologies are important in a wide variety of applications.

Electron tube light sources operate by generating electron plasma from which photons are emitted. Our line of arc lamps include Xenon, Mercury Xenon and Metal Halide types. We also produce a line of Xenon flash lamps. Our Deuterium lamps operate by generating photons from plasma striking a target material. These lamps have the unique feature of a long useful lifetime derived from our use of advanced ceramic materials. Hamamatsu lamps are found in many applications involving the medical, biotech, chemical and semiconductor processing industries.

Our UV Spot Light Source is a particularly remarkable device in this line of products. This device incorporates a deuterium lamp with a fiber optic guide. It is useful in industries employing ultraviolet curing of materials such as optical communications.

We have developed a unique line of X-ray products based on our expertise in electron tube design and the control of electron plasma. Our Microfocus X-ray sources offer extremely high resolution and higher magnification than conventional X-ray sources. These characteristics are very useful for various non-destructive testing applications.

In the semiconductor light source field, we offer a line of light emitting diodes (LEDs) and laser diodes. Our customers have the ability to obtain both sources and detectors from the same manufacturer. Our Solid State Division offers modular devices incorporating these two areas. One example is our Gigabit receiver/emitter used in fiber optic communication.


Light Emitting Diodes

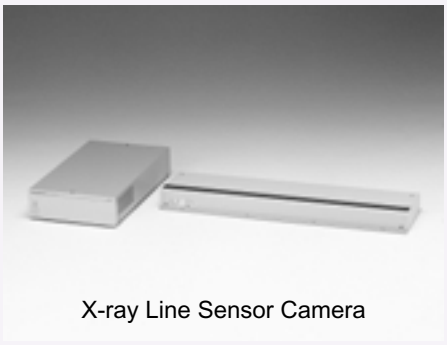
Imaging and Measurement Instruments

Hamamatsu Photonics has been a historic leader in imaging technology. Our early efforts were focused on vidicons and other electron tube based imaging devices. Vidicon technology is still useful in certain specialized applications but largely it has been supplanted by solid state imaging technology. We have followed these changes and Hamamatsu Photonics is now the world leader in the design and development of high sensitivity, low noise solid state imaging devices.

Our Solid State Division produces C-MOS, N-MOS and CCD imaging devices. Among CCD area image sensors, our Back-thinned FFT-CCD offers superior quantum efficiency in the ultraviolet to infrared regions. Our Front-illuminated FFT-CCD exhibits wide dynamic range. Numerous applications use these devices including the process control and optical communications fields.

While solid state image sensors at the component level are available, we also offer a complete line of CCD based cameras from our Systems Division. The popular ORCA camera series are high resolution, digital CCD cameras with progressive scan and no mechanical shutter. These cameras provide high speed, wide dynamic range and excellent signal to noise ratio.

Adding to our already impressive line of products for generating and detecting X-rays, our Systems Division now offers an X-ray line sensor camera featuring a thin sensor head (less than 50 mm) capable of detecting areas as wide as four meters. Applications include non-invasive and non-contact measurements in manufacturing lines. As with all of our digital cameras, the image can be processed and analyzed by computer.



X-ray Line Sensor Camera

Hamamatsu Photonics provides total solutions to the needs of our customers. We offer complete measurement systems and dedicated imaging software. An example is AQUACOSMOS, an image acquisition system with analysis software for use with high-performance digital cameras. This software's flexible design enables it to be used in a wide variety of experiments. We offer the Body Line Scanner, a device designed to measure the human body and display 3D images. Our NIRO-300 can be used to continuously measure tissue oxygenation using infrared light, non-invasively.

- Medical
- Biotechnology
- Mind/Brain Sciences
- Optical Measurement
- Optical Communications
- Optical Information Processing
- Energy
- Optical Physics
- Optical Properties of Matter
- Optical Materials
- Space
- Astronomy
- Oceanography
- Agriculture

Research & Development

In the future it may be possible to keep people healthy instead of just diagnosing disease. Photonics can be used to noninvasively study the human body. It may keep people healthy by warning them of changes that might lead to disease.

We are exploring new Positron Emission Tomography (PET) technology that we hope will someday be able to detect cancer at such an early stage that most or all patients will be cured. Already in the clinics we run in collaboration with the Hamamatsu Medical Center and with Queens Hospital in Hawaii, PET is being used by physicians to stage cancer and guide them in deciding if the patient will benefit from surgery. It prevents needless suffering and also permits healthcare money to be spent wisely. We have just completed a PET brain scanner with a flexible gantry that permits a patient to be standing or siting. This new scanner will be used for cognition studies as well as both studying and diagnosing Alzheimer's disease and other forms of dementia.

The information revolution is growing exponentially. Optical communication is responsible for the rapid expansion and inexpensive delivery of the World Wide Web. To maintain the growth of the Internet and deliver benefits such as telemedicine and long distance learning to people everywhere part of the network will need a high speed connection. The cost of laying fiber over the last mile is preventing many from obtaining the necessary broadband connections. This can be solved by fiber free through air optical communication providing connectivity in buildings, congested business districts and even rural areas.

The world population continues to expand reaching 10 billion by the middle of the century. Find a way to properly feed all of these people is essential. Photonic agriculture may be able to increase the area under cultivation without needing anymore land. Laser diodes would provide artificial sunlight for growing crops year round in an environment free from insects and disease

Positron Emission Tomography for Brain Study

It is clear that in the next few decades, we will need to find alternatives to fossil fuels. High power laser diodes are key to the future development of laser fusion which has the potential to provide limitless energy without any greenhouse effect. Even today laser bars are used in material processing, electronics manufacturing, printing and medicine.

For high speed machine vision applications we have developed a sensor capable of processing 1000 images in a second. This year also saw the development of an integrated CMOS sensor that incorporates an image sensor, drive electronics, amplifier and A/D converter on a single chip. This device will be used machine vision, automation, and security applications.