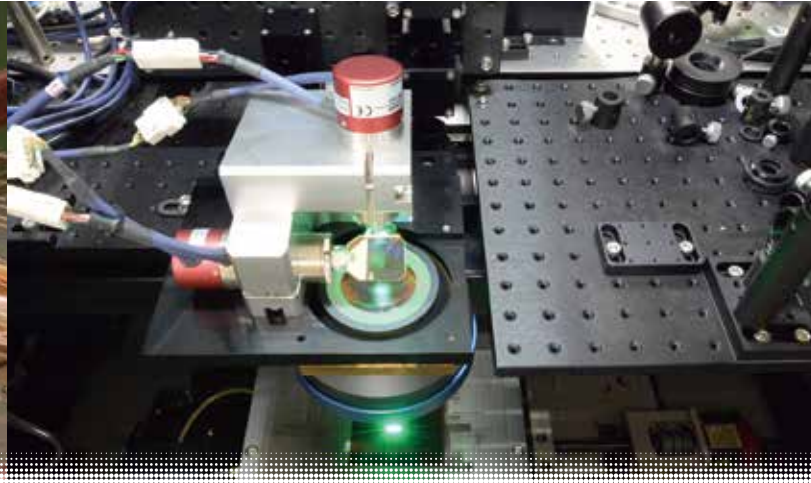
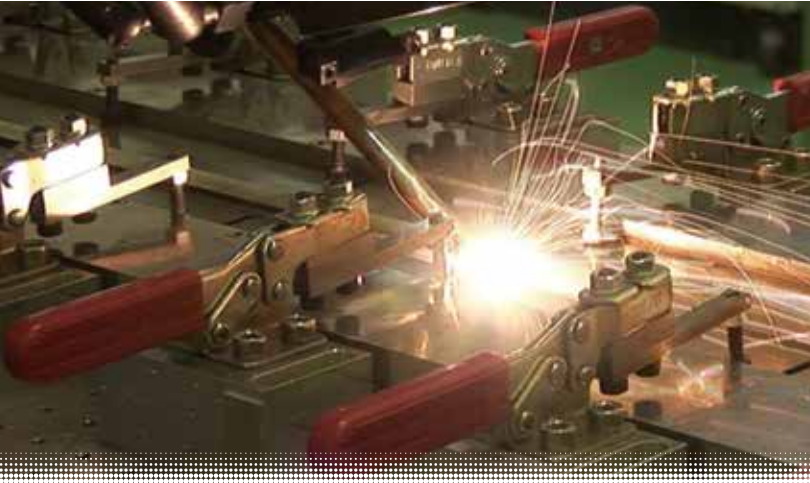


# Product Line-up



## Thermal processing

Semiconductor lasers for thermal processing



## Non-thermal processing

Solid state lasers for non-thermal processing



## Gas analysis

Semiconductor lasers for gas analysis

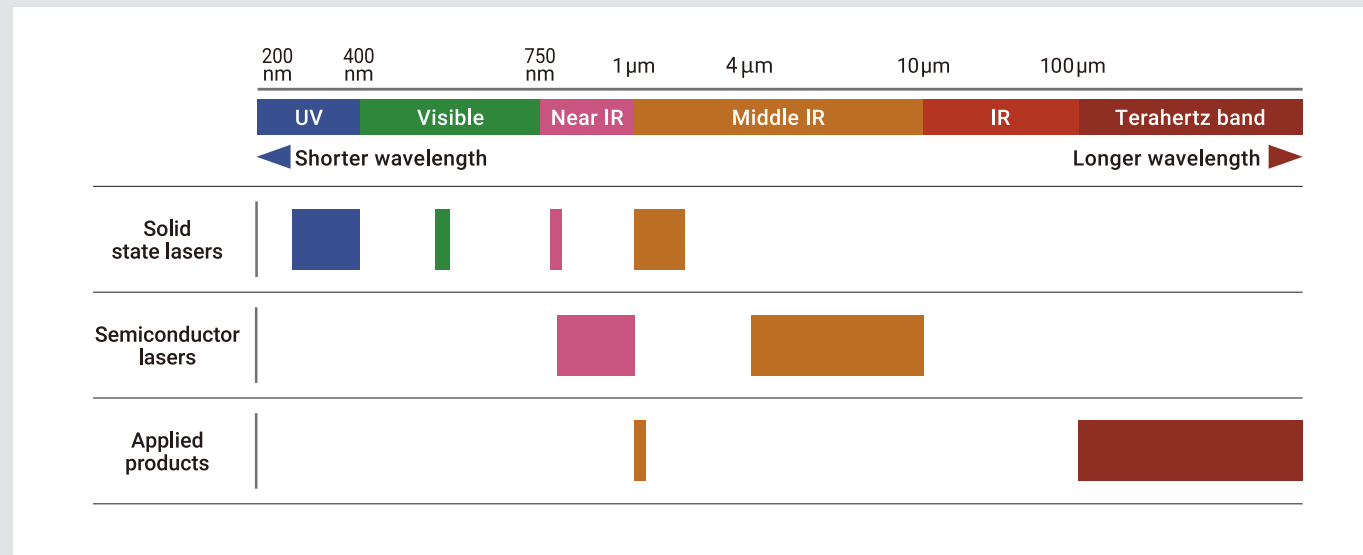


## LiDAR

Semiconductor lasers for measurement



## Product map by wavelength



## Semiconductor production process



Crystal growth



Wafer process



Mounting and assembly



Testing and screening

## Typical application examples

Hamamatsu provides high-performance semiconductor lasers also known as diode lasers all developed in-house using an integrated process from crystal growth to fabrication of laser devices and drivers. To meet specific needs, we also have a line-up of laser products that make use of semiconductor lasers as well as solid-state lasers that we manufacture using our own advanced technology.

We will continue R&D work in laser technology to open up new application fields and respond to broad and diverse customers demands.

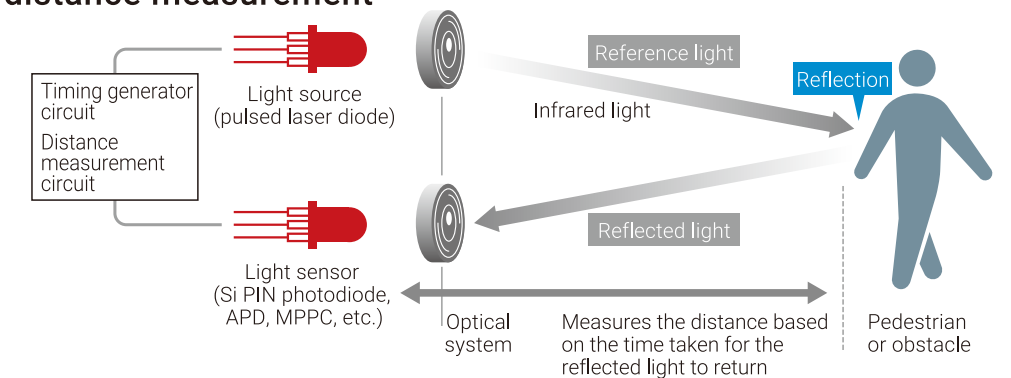
Product name		Semiconductor Lasers					Applied Products of Semiconductor Lasers	Solid State Lasers / Fiber Lasers		Laser Applied Products	Optical Components / Sensors	
		CW Laser Diodes	Pulsed Laser Diodes	Super Luminescent Diodes	Quantum Cascade Lasers	LD Bar Modules	Fiber Output Laser Diode Bar Modules	Laser Heating Systems LD Irradiation Light Sources	Pulsed Solid State Lasers	Pulsed Fiber Lasers	LCOS-SLM (Optical Phase Modulator)	Terahertz Wave Plate
Medical	Medical (general)	●			●			●	●			
	Light source for OCT			●					●			
Analysis	Gas analysis				●							●
	Drug analysis											
	LIBS							●	●			
	Photoacoustic imaging							●				
Measurement	Measurement (general)	●	●	●		●		●	●	●	●	●
	LiDAR	●	●									
	Interference microscope			●								
	THz generation							●	●			
	Fluorescence imaging							●	●	●		
	Laser ablation ICP-MS								●			
	Pre-processing of sample for SEM											
Light source	Pumping for solid state laser	●				●	●					
	IR illumination	●			●	●	●					
Processing	Liquid crystal and color filter repair						●		●			
	Soldering						●			●		
	Plastic welding					●	●	●				
	Annealing	●				●	●	●	●			
	Adhesive curing						●					
	Tape peeling (for rework)						●					
	Metal processing (welding)						●					
	Metal processing (cladding)						●					
	Metal processing (hardening)						●					
	Laser marking							●	●	●		
	Precision removal of ITO film								●	●		
	Trimming								●	●		
	Lift off						●					
	Drilling							●	●	●		
	Internal processing of transparent materials									●		
Grooving									●	●		

### Next-generation social infrastructure devices

Sensing technology is currently used in all kinds of situations in our daily lives. Among these, non-contact optical sensing technology using light from compact lasers is very promising. Small and highly robust semiconductor lasers will play an indispensable role in every part of our daily lives, such as for various promising self-driving sensing functions including car collision prevention, human body sensing for automatic door operation on subway and railroad station platform, and for detecting people at railway crossings.



#### Principle of distance measurement

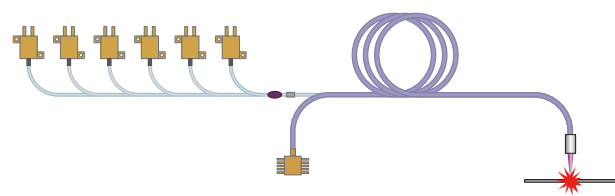


## Laser Diodes

### CW Laser Diodes (CW LD)

These LDs are designed to be driven in continuous wave (CW). Radiant power is from mW to a few W. Laser diodes (LD) capable of irradiating W class output power are called lateral multimode LDs (or broad-stripe LD). You can select from a wide variety of types with different emission area sizes, lasing wavelengths, and radiant power, etc. Applications include fiber lasers, solid state laser pumping, and many others.

### Fiber laser excitation



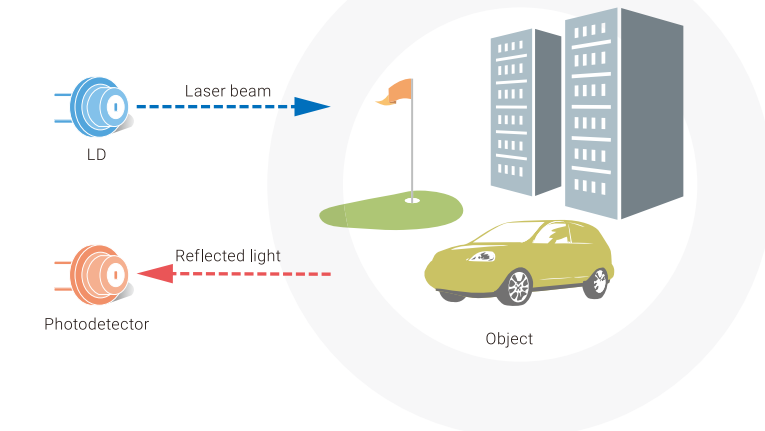
#### Applications

- Processing
- Medical treatment
- Annealing
- Measurement
- Solid state laser pumping
- Communication (EDFA)

### Pulsed Laser Diodes (PLD)

These LDs feature high peak power under pulsed operation. Various types are available with different peak output power and emission widths. These LDs can be used for distance measurements such as laser radar, hazard monitoring in security applications, etc.

### Distance measurement



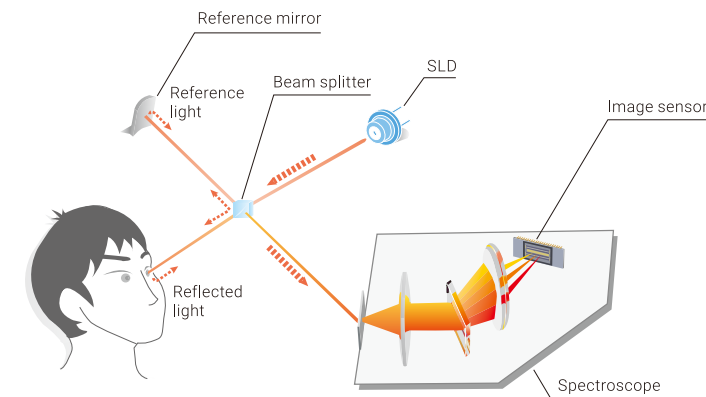
#### Applications

- Laser rangefinder (leisure, surveying)
- Security (traffic, collision prevention)
- Control & monitoring (robot, positioning)

### Super Luminescent Diodes (SLD)

Offering both the high brightness of LDs and low coherence of LEDs, SLDs work as a high-brightness light source which compensates for the weakness of LDs such as coherent noise. They are used for optical applied measurements and medical imaging.

### OCT (fundus oculi observation)



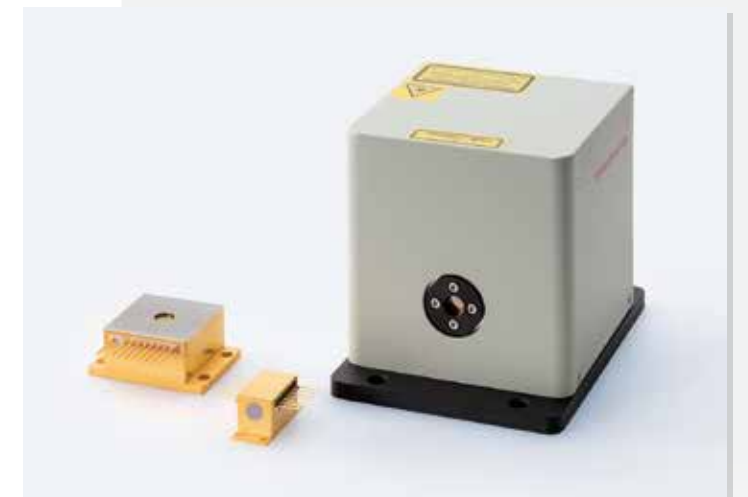
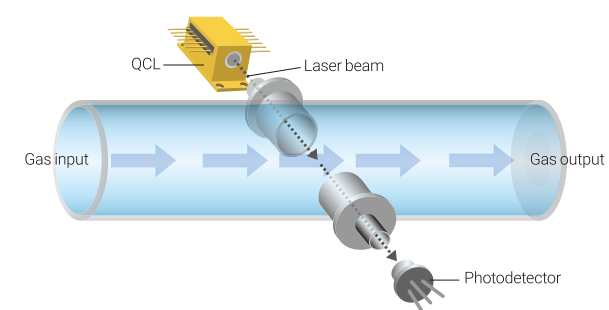
#### Applications

- Optical gyroscope
- Optical communication
- Measuring device using light
- Medical imaging

### Quantum Cascade Lasers (QCL)

QCL is a semiconductor laser with emission wavelength in the mid-IR range (4  $\mu\text{m}$  to 10  $\mu\text{m}$ ). Because its emission principle is completely different from normal LDs, the QCL has gained attention as an innovative solution for mid-IR applications such as trace gas analysis in environmental monitoring. Our products are available in both HHL and butterfly packages.

### Gas analysis (transmittance)



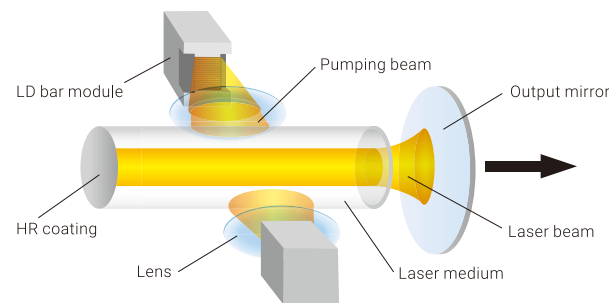
#### Applications

- Trace amount gas analysis**
  - Environmental measurement
  - Combustion gas measurement
  - Plasma measurement
  - Bio-related gas measurement
- Infrared molecular spectroscopy**
  - Chemical sensing
  - Molecular vibration study

## CW Laser Diode Bar Modules / Pulsed Laser Diode Bar Modules

With their emitting areas arranged in line to make a linear array, LD bar modules achieve high performance, high power and high reliability when coupled with cooling devices. When stacked, the output power can be as high as a few kilowatts. There are primarily three cooling methods: the compact and simple Peltier-type Open Heatsink (OHS), the more efficient Water cooling, and Hamamatsu's original Funryu cooling (highest cooling efficiency). The appropriate cooling method should be selected in accordance with the required radiant power, driving conditions, and application.

### Solid state laser pumping (side pumping)



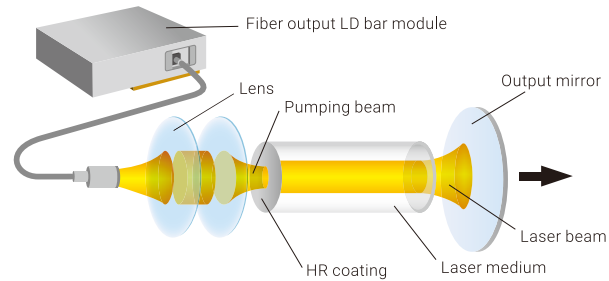
#### Applications

- Measurement (control & monitoring)
- Laser printer
- Infrared illumination
- Solid state laser pumping
- Heat treatment

## Fiber Output Laser Diode Bar Modules (FOLD)

FOLD is a LD bar module that condenses a laser beam generated from the internal LD stack and transmits it through an optical fiber. It achieves high light output and stable spectrum. In addition to solid state laser pumping, it can also be used for selective laser heating.

### Solid state laser pumping (end pumping)



#### Applications

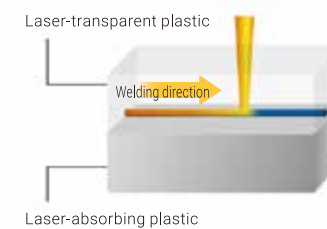
- Solid state laser pumping
- Selective laser heating
- Soldering

## Laser Heating Systems / LD Irradiation Light Sources

This is an LD irradiation light sources that is compactly integrating a fiber output type LD bar module and its driver. And, a laser heating system with built-in temperature monitoring function for processing point is also available. These products can be used in a wide range of application, including plastic welding, soldering, sintering of metal nano ink, and metal processing such as hardening (quenching).



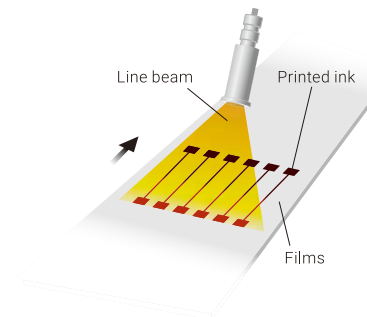
### Plastic welding



### Soldering



### Sintering of metal nano ink



### Hardening



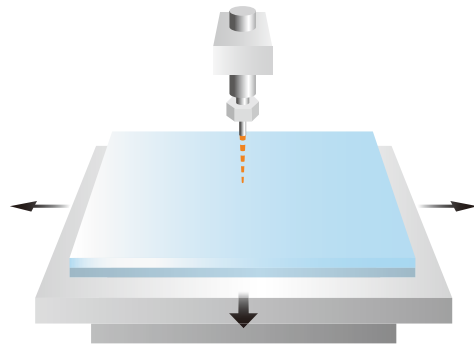
#### Applications

- Plastic welding
- Sintering of metal nano ink
- Soldering
- Hardening

## Pulsed Solid State Lasers

Solid state laser products developed by merging our optical design technology, optical thin film technology, MOEMS (Micro-Opto-Electro-Mechanical-Systems) and optical nanoscale technology and other cutting-edge technologies. It has excellent stability and ease of maintenance. A choice of products is available to best suit various applications, including industrial applications.

### Processing image



#### Applications

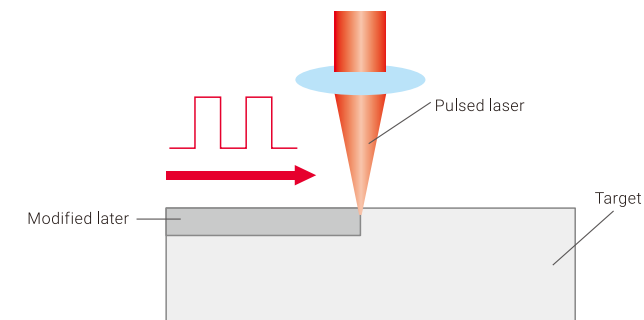
- Spectroscopy (LIBS\*, Raman spectroscopy)
- Measurement (Photoacoustic imaging, Pump source for THz OPO)
- Ablation processing

\*LIBS: Laser Inducted Breakdown Spectroscopy

## Pulsed Fiber Lasers

This is a highly stable and compact fiber laser that has been made possible by pursuing high reliability and manufacturing the main components in-house. Various specifications from nanosecond to femtosecond are available for a wide range of applications from processing to measurement.

### Marking (surface reforming)



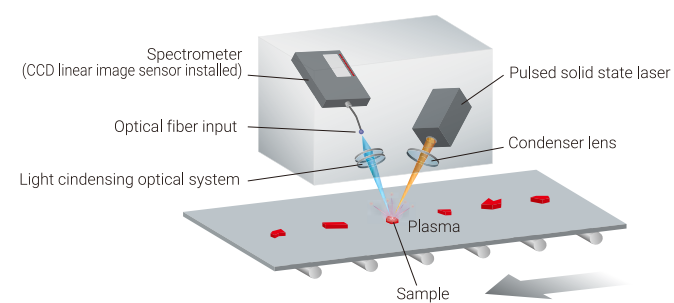
#### Applications

- Marking (surface reforming)
- Thin film removal
- Trimming
- Cutting
- Two-photon excitation fluorescence imaging
- Light source for terahertz wave generation

## Featured topics | LIBS

LIBS is an elemental inspection method by irradiating laser to the target surface, turning it into plasma and measuring the spectrum of the plasma. Since it is possible to sort materials such as plastic, metal and glass of any shape or condition by LIBS, it is expected that LIBS advances "in-line" inspection methods in the various factories. We have a short pulse and high peak power pulsed solid state laser suitable for LIBS.

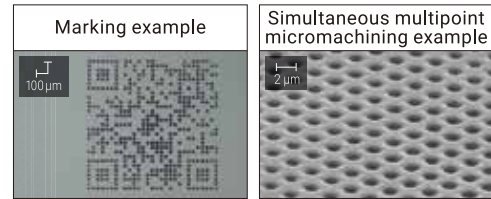
### In-line measurement image



## LCOS-SLM (Optical Phase Modulator)

Reflective spatial light phase modulator that freely modulates the phase of light. By precisely controlling the wavefront of the laser beam, arbitrary beam patterns can be generated. The line-up also includes wavefront shaper with a built-in LCOS-SLM for easy handling and connection to optical equipment.

### Processing examples



#### Applications

- Optical beam shaping
- Aberration correction, adaptive optics
- 3D simultaneous multipoint generation
- Simultaneous multiple points fine process using interference between multiple divergent light beam
- Optical manipulation
- Optical vortex generation

## Terahertz Wave Plate

This is a Fresnel rhomb wave plate for controlling terahertz wave polarization. The adoption of Fresnel rhomb makes it possible to handle a terahertz wave over a broad band. In addition, stacking total reflection prisms simultaneously achieves a large aperture and a small size of the component. The prisms are made of high-resistivity silicon, which highly transmits a terahertz wave.



#### Applications

- Terahertz wave phase control
- Terahertz polarization imaging
- THz-STM (Terahertz scanning tunneling microscope)

## Quantum Cascade Photodetector (QCD)

This is an ultrafast mid-infrared photodetector with a response bandwidth of 20 GHz.

QCD explores the application such as the high frequency and high time resolved measurement like a Heterodyne detection in the mid-infrared region.



#### Applications

- Heterodyne detection
- High frequency/high time resolved measurement



# Offices

## Factory / Research laboratory / Domestic sales office

### Factories

- Opto-semiconductors  
Main factory (Ichino), Mitsue factory, Shingai factory
- Electron tube products  
Toyooka factory, Tenno glass works,  
Beijing Hamamatsu photon techniques Ltd. (China)
- System products  
Joko factory
- Laser products  
Miyakoda factory, Central research laboratory  
Mitsue factory, Shingai factory

### Laboratories

- Central research laboratory
- Tsukuba research laboratory
- Industries development laboratory

### Domestic sales offices

- Tokyo sales office
- Osaka sales office
- Chubu sales office
- Sendai sales office
- Tsukuba sales office
- Nishinohon sales office



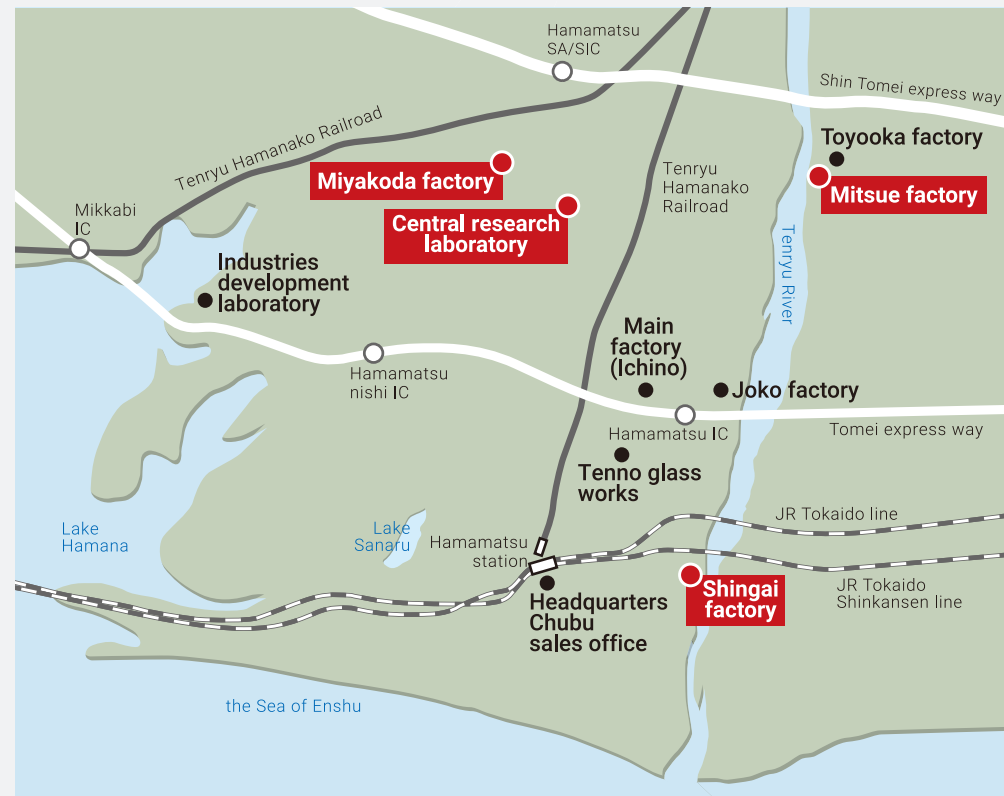
Miyakoda factory



Central research laboratory



Hamamatsu area



Mitsue factory



Shingai factory





## Main Products

### Opto-semiconductors

- Si photodiodes
- APD
- MPPC®
- Photo IC
- Image sensors
- PSD
- Infrared detectors
- LED
- Optical communication devices
- Automotive devices
- X-ray flat panel sensors
- MEMS devices
- Mini-spectrometers
- Opto-semiconductor modules

### Electron Tubes

- Photomultiplier tubes
- Photomultiplier tube modules
- Microchannel plates
- Image intensifiers
- Xenon lamps / Mercury-xenon lamps
- Deuterium lamps
- Light source applied products
- Laser applied products
- Microfocus X-ray sources
- X-ray imaging devices

### Imaging and Processing Systems

- Scientific cameras
- Spectroscopic and optical measurement systems
- Ultrafast photometry systems
- Life science systems
- Medical systems
- Non-destructive inspection products
- Semiconductor manufacturing support systems
- Material research systems

### Laser Products

- Single chip laser diodes
- Laser diode bar modules
- Quantum cascade lasers
- Applied products of semiconductor lasers
- Solid state lasers
- Laser related products

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Please thoroughly read the precautions and the prohibited uses included in the user manual before installation and use.

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