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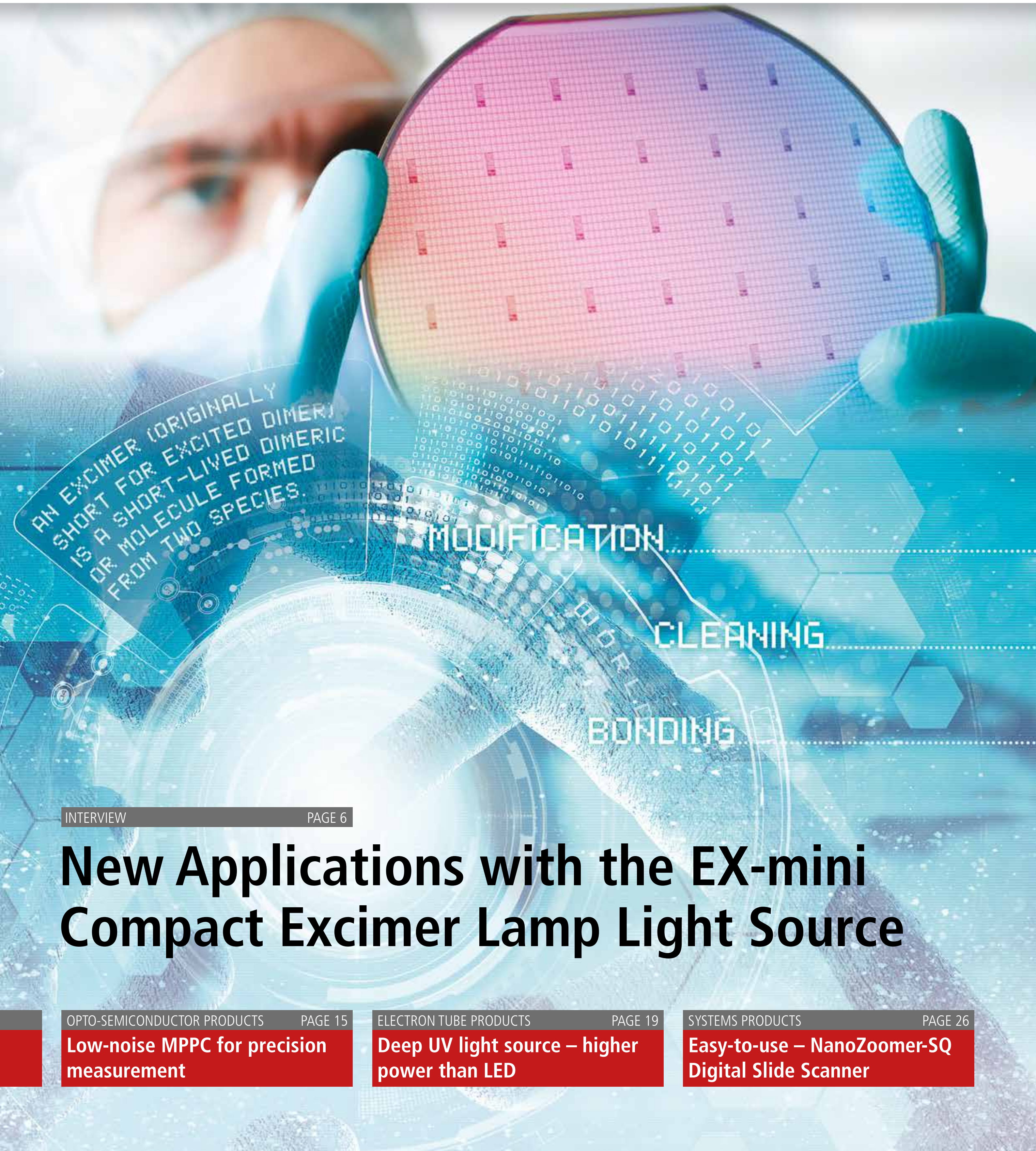
PHOTON IS OUR BUSINESS

NEWS 2015 01



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New Applications with the EX-mini Compact Excimer Lamp Light Source

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OPTO-SEMICONDUCTOR PRODUCTS												
15	MPPC®/MPPC Module S13360 Series, C13365/C13366 Series	●	●	●	●	●			●	●	●	●
16	CMOS Linear Image Sensor S13131				●					●		
17	Mini-spectrometer C13053MA				●	●				●		
18	InAsSb Photovoltaic Detector (Non-cooled Type) P13243 Series				●	●			●	●		
ELECTRON TUBE PRODUCTS												
19	Deep UV Light Source (UVCL) L12848-305	●	●			●	●			●		●
20	Excimer Lamp Light Source L11751-01, E12499, C11997						●			●		
21	Opto-Spectrum Generator L12194-00-34054				●	●						●
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23	Fast Decay Time Phosphor J12782-09D					●	●					
SYSTEMS PRODUCTS												
24	ORCA-Flash4.0 LT with W-VIEW Mode™		●		●					●		●
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COMPANY NEWS

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APPLICATION REPORT

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SERVICES

Company News

Hamamatsu holds the IEEE Milestone dedication ceremony in recognition of 20-inch photomultiplier tubes

The IEEE Milestone dedication ceremony in recognition of Hamamatsu's 20-inch photomultiplier tubes was held on November 5. On the same day, the plaque unveiling ceremony was held at Toyooka factory and the dedication ceremony and the celebration party were held in Okura Act City Hotel Hamamatsu.

In the ceremonies, Hamamatsu was honored with the attendance of IEEE President and CEO J.Roberto de Marca, IEEE Japan council members, IEEE Nagoya section members, Director of the Institute for Cosmic Ray Research University of Tokyo, and Director General of the High Energy Accelerator Research Organization. President de Marca said, "It was a challenging, daunting task. But Hamamatsu then-President Teruo Hiruma's response was one which has made technological advances possible for centuries, if not millennia." Then-President Hiruma's response was "Well, I'll give it a try." President de Marca added that he was honored to award this epoch-making achievement in the history of technology at the site of the development of 20-inch PMT.

President and CEO of Hamamatsu Photonics Akira Hiruma said, "I feel motivated every time I see the plaque at Toyooka factory. All employees must aim to create new industries that are valuable for humans and the development of photonics technology, not to mention that we all must pursue new frontiers of photonics technology with challenger's spirit."

The plaque monument was installed on the right as Toyooka factory is entered through its main gate. The bedrock of the monument is the Hida gneiss delivered from the Kamioka mine where the cutting edge experiments in particle physics are still ongoing. The monument was installed facing toward the Kamioka mine as if it is watching over the next discovery.

20-inch photomultiplier tubes

IEEE Milestone plaque monument installed at Toyooka factory

Hamamatsu establishes a new subsidiary to enhance sales support for distributors to Taiwan

Hamamatsu, Japan – December 15, 2014 – Hamamatsu Photonics K.K. has announced the establishment of a new wholly-owned subsidiary, Hamamatsu Photonics Taiwan Co. Ltd., to enhance its sales support for distributors to Taiwan. The new subsidiary will be responsible for the import and export of components and other products, local inventory, and sales contracts. It was established on December 5, and will open for business on January 1, 2015. Initially, Hamamatsu Photonics Taiwan will provide sales support along with Hamamatsu's current sales representative, while in the long term it may provide support for an expanded collection of products to distributors not only in Taiwan but also in neighboring countries.

The office of Hamamatsu Photonics Taiwan will be located in this building.

Would you like to know more about Hamamatsu's vision, innovation, major research projects or R&D philosophy "Life Photonics"?

Then visit our dedicated web pages. The new "Life Photonics" pages explain how our Company use technologies of light to help create a future world with balance among all forms of life.

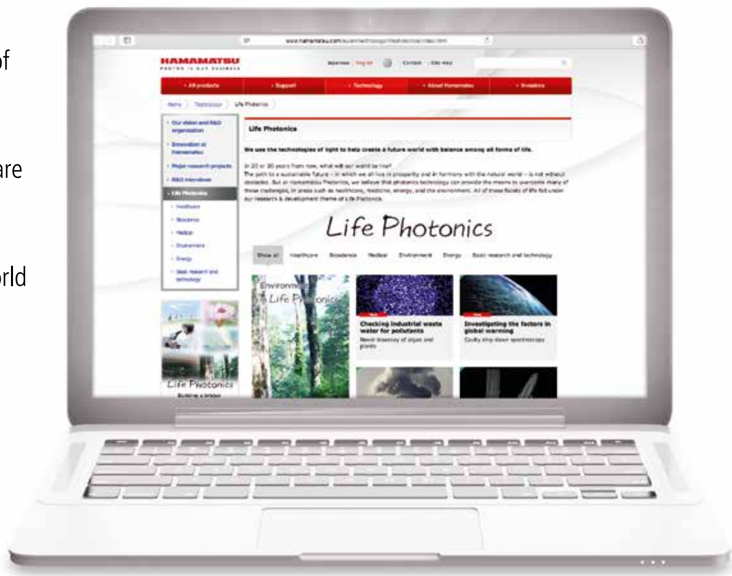
Our Vision: Exploring the unknown through "Light".

Our Innovation: A gift from Hamamatsu to the world – a 60-year history of nurturing photonics technology.

Our major research projects: Searching out the "truth" – Our products are actively used for academic and scientific research.

Life Photonics: We use the technologies of light to help create a future world with balance among all forms of life.

In 20 or 30 years from now, what will our world be like?
The path to a sustainable future – in which we all live in prosperity and harmony with the natural world – is not without obstacles. But at Hamamatsu Photonics, we believe that photonics technology can provide the means to overcome many of these challenges, in areas such as healthcare, medicine, energy, and the environment. All of these facets of life fall under our research & development theme of Life Photonics.



www.hamamatsu.com/lifephotonics/

The EX-mini compact excimer lamp light source

All the great features of excimer lamps in one compact package!

EX-mini

Hamamatsu provides excimer lamp light sources that are designed for production line use and incorporate special features not found in products of other manufacturers. We have also developed a compact excimer lamp light source named “EX-mini.” This is an easy-to-use one-package unit yet still delivers a stable and high output, making the EX-mini a highly useful excimer lamp light source starting to take root in the market. The EX-mini comes in a user-friendly design that allows you to start using it immediately after purchase and so is opening up new applications of excimer lamps. We talked to 4 staff members who helped develop the EX-mini.

HAMAMATSU excimer lamp light sources

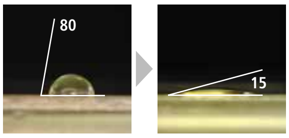
Solving the problems of competing products and getting a foothold in the market

Hello everyone, could you start off by telling us about the special features and unique points of excimer lamps?

Onoda: The excimer lamp is a light source that allows modification and cleaning materials by vacuum ultraviolet light. Corona discharge/plasma treatment can do the same tasks, but they discharge directly onto the material and so it might possibly get damaged by them.

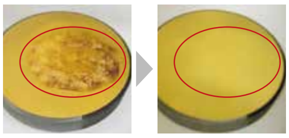
Application examples (modification and cleaning)

Surface modification of resin



Before irradiation — After irradiation

Optical cleaning of evaporated gold coatings on laser mirrors



Before irradiation — After irradiation

Miyamoto: The excimer lamp emits only vacuum ultraviolet light and so causes virtually no damage to the material. It is also a clean process generating no dust particles. One great feature is that it applies a uniform processing effect over a large surface area.

What makes the Hamamatsu excimer lamps unique compared to other company products?

Onoda: Our company started the development and production of excimer lamps after other manufacturers. To enter the excimer lamp market, we took advantage of long years of accomplishment amassed from developing other light sources such as xenon lamps, and solved the problems of the products that had already been used.

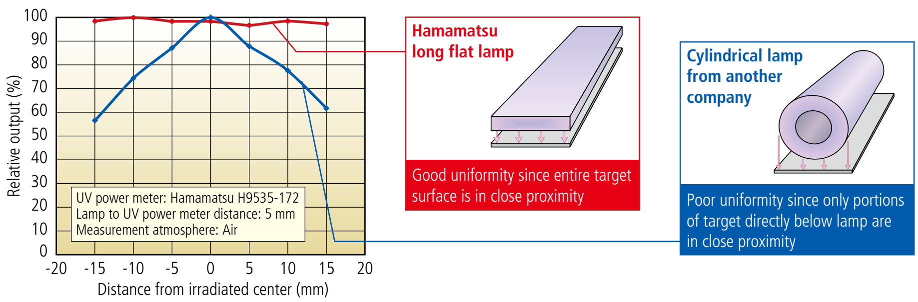
Kanbe: Hamamatsu excimer lamps have 3 features that really stand out from our rivals. One feature is its long flat lamp. This lamp offers excellent uniformity compared to the cylindrical lamps made by rival companies since its entire surface can be placed in close proximity to the object for processing.

A second feature is a radio-frequency (RF) discharge power supply we have developed in-house. This power supply ensures stable discharge with minimal flicker.

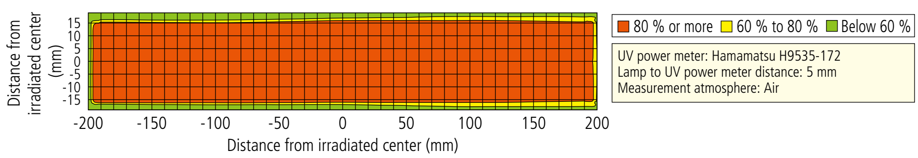
A final third feature is our original auto tuning method. Auto tuning is a function for automatically adjusting the frequency so that there is no change in performance even if the customer replaces the lamp.

Uniformly irradiates a large area by using a long flat lamp

Uniformity characteristics (along short axis) — Long flat lamp vs. cylindrical lamp



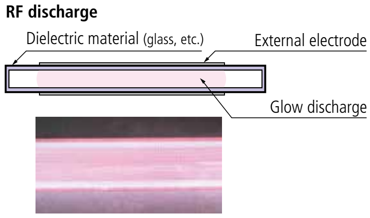
Irradiation intensity distribution of long flat lamp



Gives stable output with minimal flicker by using RF* discharge

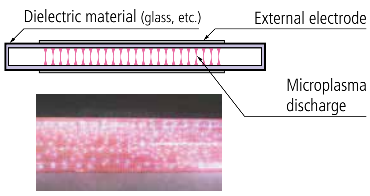
RF discharge vs. dielectric barrier discharge

RF discharge



Uniform discharge without irregular light emissions

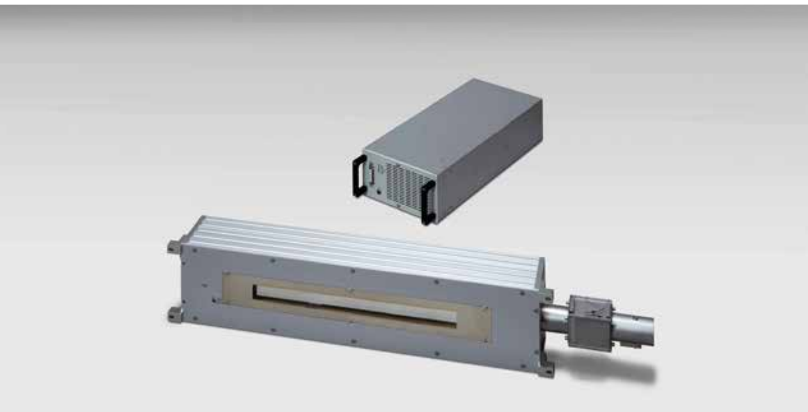
Dielectric barrier discharge



Thread-like discharge with irregular light emissions

* radio frequency

Interview



For production line

For R&D

Currently how many product types do you have on the market?

Sakuma: We initially released products mainly for use on production lines. But in July 2013, we put the compact one-package EX-mini which was developed for the laboratory and other tasks on the market. Our sales are now steadily expanding.

Onoda: Customers presented us with a long list of needs in various fields such as adhesive and coating preprocessing and improving the wettability prior to the ink coating process. Many different cases are being evaluated to determine if we can actually meet customer needs or not.

Miyamoto: The prototype for the EX-mini was a demo model of excimer lamp light source developed for production line use. We designed the demo model to show at events such as exhibits where customers could experience the performance of our excimer lamps. After checking out our one-package light source, customers found out how handy and versatile it really was, and said "This is the one we want."

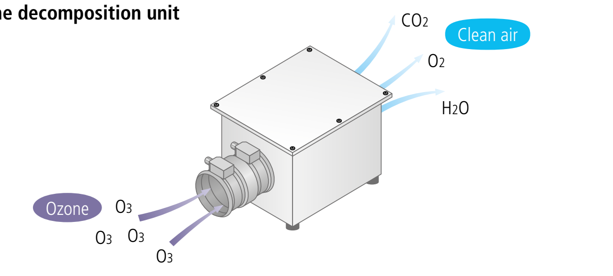
Sakuma: Questioning the customer in more detail revealed that up till now they had been separately purchasing power supplies, light sources and irradiation boxes, and making their own devices by hand for use in laboratories and elsewhere. But, if these could all be offered in one package, then they could buy it and start using it right away. This convenience was what they rated so highly.

Onoda: On learning this, we redesigned that original demo model in terms of safety and user operability to develop what is now the EX-mini. We also added an ozone decomposition unit at that time as an option.

Sakuma: Using an excimer lamp generates ozone, so joining the equipment to an exhaust duct is necessary. But, this restricts the locations where the equipment can be mounted and also requires installing a duct. To eliminate this inconvenience, we designed an ozone decomposition unit capable of breaking down the ozone according to the amount generated.

Miyamoto: Comparing the EX-mini to compact excimer lamps made by rival companies reveals that the EX-mini has at least a 5 times greater output. Besides the convenience of being usable right after purchase, the huge boost in operating efficiency also offers a big advantage to the customer.

Ozone decomposition unit



We never even considered giving up on our "same power in small body" concept

Where did you run into a lot of trouble when developing the EX-mini?

Sakuma: The EX-mini was rated as a device for assessing production line usage and we clung to the concept that its output must be equivalent to that of the current model used on production lines.

Kanbe: Making the device small also required changing the internal wiring. Utilizing a big lamp requires virtually no changes in the wiring but using a small lamp would affect the output due to the wiring. So we kept struggling down to the final stages with the thorny problem of using a small size lamp but with no drop in output.

Onoda: We hadn't solved this output problem yet even after more than half the development period had elapsed. At product exhibits, customers who saw the demo models insisted they needed a small device as soon as possible, so this kept us tense and on edge when looking for a solution.

Sakuma: In the end, things weren't quite so dramatic. We kept modifying the power supply and improving the lamp and finally achieved both a small unit and a satisfactory output.

Expansion of the Point of Care Testing (POCT) market has broadened applications to include microfluidic devices

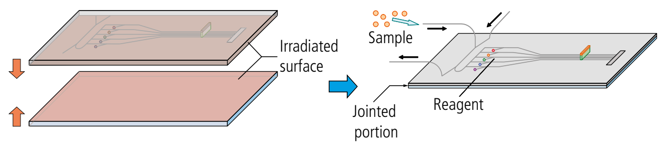
What future applications do you foresee for the EX-mini?

Onoda: Excimer lamps have usually been used by materials manufacturers for developing new types of materials and cleaning of specialized materials. As one new type of application from hereon, we foresee a demand for microfluidic devices.

Sakuma: More specifically, we believe that excimer lamps can contribute to processes for manufacturing microfluidic devices that are gradually becoming feasible in medical and bio-science fields. Microfluidic devices align and bond diverse types of materials together and form tiny flow paths along which chemical reagents flow. If we used the EX-mini to do this, then microfluidic devices could likely be made easily with a high degree of bonding accuracy compared to conventional manufacturing processing that uses adhesive agents.

Miyamoto: Looking towards the future, we expect the POCT (Point of Care Testing) market to expand and are moving ahead with product evaluations for this field. Other areas where we anticipate new usage of microfluidic devices include protein and DNA analysis, drug discovery support, cell experiments, and chemical monitoring.

Application (Microfluidic device bonding)



How will excimer lamps from Hamamatsu evolve from now on and in what direction?

Sakuma: The first step to take is getting a lot of requests and needs from customers and moving to respond to those requests. There is a whole stack of issues remaining to be tackled including a long lamp service life, developing further lamp variations, and boosting lamp processing capability and throughput capacity.

Onoda: Our excimer lamps get a great deal of attention from customers when put on display at exhibits and shows, and this makes us feel that excimer lamps have a lot of advantages to offer. After perfecting this compact laboratory model, we will shift our focus towards designing compact models for use on production lines.

Members (from the left):

Makoto Miyamoto
Electron Tube Division, Manuf. #4

Kazuyuki Kanbe
Electron Tube Division, Manuf. #4

Ryosuke Sakuma
Electron Tube Division, Manuf. #4

Yuji Onoda
Electron Tube Division, Business Promotion Group

Application Report

Tumor detection in fluorescent tissue microarrays enables high-throughput analysis of multiple cancer biomarkers

Automation in immunohistological image processing is currently an essential technological development taking place in the clinical hunt for objective biomarkers in research and diagnostics. In cancer research one of the most important but also extreme challenges is the development of methods for the automatic separation of tumor and stroma tissue.

An important method routinely used in this context is the Tissue Microarray (TMA) technology, introduced in 1998. TMAs allow the simultaneous immunohistochemical analysis of several hundred tissues on a single slide. The manual detection of tumor regions in Tissue Microarrays is routinely based on the quantitative analysis of protein levels by pathologists or other experts. Yet manual detection is subjective, time consuming and most importantly suffers from intra and inter-observer variability.

A route to objectivity in histological tumor evaluation is automation and quantification by software routines. This will require computational methods capable of automatically identifying tumor areas and differentiating them from the stroma in a high quality microscopic image of the tissue, obtained by a virtual slide scanner.

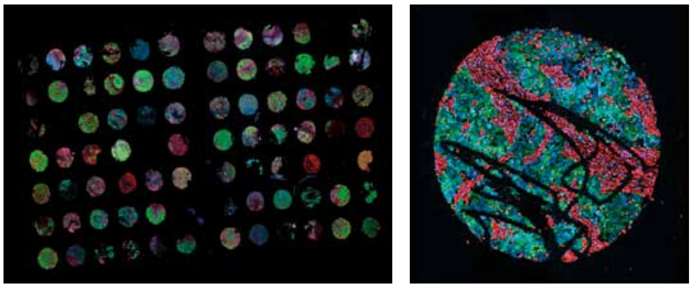


Figure 1: Microscopic image examples of TMA slides (left) and cores (right). Representation of all 3 channels of a fluorescence stained core in RGB colour space. Red representing stromal marker (CK19), green the tumor marker (Vimentin) and blue the DAPI channel highlighting the cell nuclei.

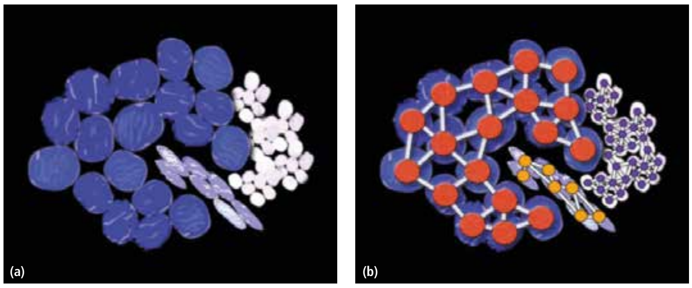


Figure 2: Conceptional representation of cell graphs.
(a) Artificial sketch of three different cell types: tumor cells (blue), lymphocytes (white) and fibroblast (purple).
(b) Cell graph representation of (a). Cells are depicted as nodes and the links between them represent biological relations.

"To overcome the key problems of bright field staining caused by the objective and automatic capturing of distinct biomarker signals, we use fluorescence staining", PD Dr.-Ing. Niels Grabe, Scientific Head of the TIGA center explains. Although fluorescence helps in the quantification of individual cells, it does not as such help in differentiating tumor and stroma. Consequently fluorescence stained tissue slides are frequently counterstained with DAPI (4'6-diamidino-2-phenylindole) taking the role of a conventional background stain.

"For scanning our fluorescence stained TMAs we used the NanoZoomer 2.0 HT scan system capable of scanning whole slides in high resolution", Bernd Lahrmann (PhD student) explains. Glass slides were scanned at 20x magnification (resolution of 0.46µm/pixel). The slide scanner automatically detects the region of interest that contains the array of cores and also determines automatically a valid focal plane for scanning. Single core images were located and extracted from the TMAs using template matching.

"As no histological biomarker is available which would exclusively stain tumor tissue, pathology routinely uses morphological criteria as a spatial reference system. To combine the advantages of fluorescence with automatic image acquisition and processing we developed an algorithm for tumor-stroma separation and classification in immunofluorescence histological slides solely from a DAPI background stain", explains Bernd Lahrmann.

Due to the restriction to a single color channel this is inherently challenging. We formed cell graphs based on the topological distribution of the tissue cell nuclei and extracted the corresponding graph features. By using topological, morphological and intensity based features we could systematically quantify and compare the discrimination capability individual features contribute to the overall algorithm. We found that when classifying fluorescence tissue slides in the DAPI channel, morphological and intensity based features clearly outpace topological ones which have been used exclusively in related previous

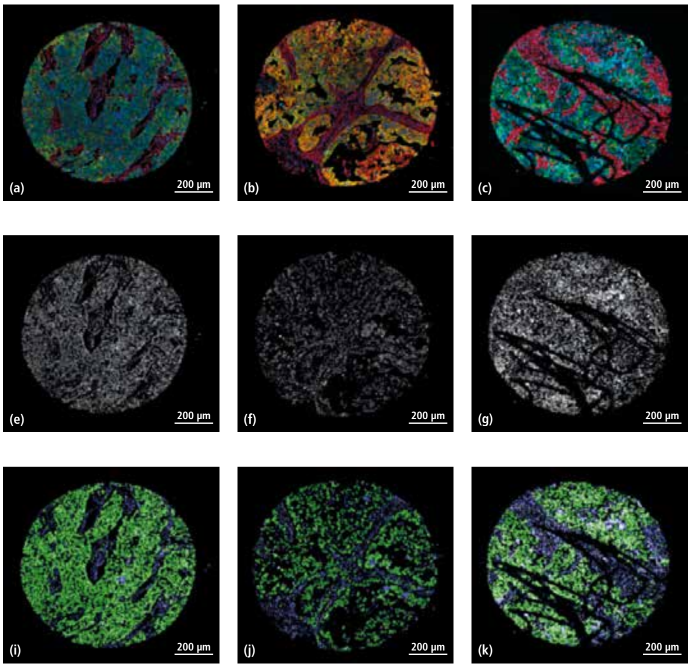


Figure 3: Results of classification.
(a-c) Showing the original RGB core images.
(e-g) Showing the corresponding DAPI channel as an intensity image of the cores (a-c).
(i-k) Showing the results of the classification step:
green = cells classified as tumor cells,
blue = cells classified as stroma cells.

approaches. We assembled the 15 best features to train a support vector machine based on Keratin stained tumor areas. Figure 2 shows an artificial sketch of 3 different cell types (tumor cells, lymphocytes and fibroblasts) and a cell graph representation of this sketch. Cells are depicted as nodes and the links between them represent biological relations. Cell graphs are used to train a SVM for the classification step.

On a test set of TMAs with 210 cores of triple negative breast cancers our classifier was able to distinguish between tumor and stroma tissue with a total overall accuracy of 88%. Figure 3 shows the results of the image processing steps. Cells classified as tumor in green, stroma in blue.

Our method yields first results on the discrimination capability of features groups which is essential for an automated tumor diagnostics. Also it provides an objective spatial reference system for the multiplex analysis of biomarkers in fluorescence immunohistochemistry.

The TIGA Center is a cooperative project which started in 2007 at the University Heidelberg with the goal of establishing a bioinformatics platform dedicated to the quantitative analysis and modeling of tissues. A strong emphasis is placed on clinically relevant research projects.

At the heart of the TIGA's technology platform are automated microscopic scanners for whole slide imaging of glass slides. By integrating such imaging systems in a technical pipeline, ranging from organotypic in vitro cell cultures to computational tissue modelling, the TIGA generates a wealth of yet unexploited clinically highly relevant tissue data.

PD Dr.-Ing. Niels Grabe is the scientific head of the TIGA center, and Dipl.-Bioinf. Bernd Lahrmann is a PhD student in medical informatics at the TIGA center.

For further information see "Lahrmann B, Halama S, Sinn HP, Schirmacher P, Jaeger D, Grabe N. Automatic Tumor-Stroma Separation in Fluorescence TMAs Enables the Quantitative High-throughput Analysis of Multiple Cancer Biomarkers, PLoS ONE. December 2011; Vol 6(12): e28048" and http://tigacenter.bioquant.uni-heidelberg.de/

PD Dr.-Ing. Niels Grabe

Bernd Lahrmann

TIGA
HAMAMATSU
TISSUE IMAGING & ANALYSIS CENTER

Investigations of emission quantum yields of blue, green, and red emitting organo-metallic complexes in a wide temperature range

Highly efficient OLEDs are based on emitter materials that exhibit high emission quantum yields. (1) Therefore, scientists are always looking for new materials. Up to now, $Ir(ppy)_3$ represents one of the most attractive green light emitting compounds for OLED applications. Among several reasons, this is due to the compound's thermal stability, the exceptionally high emission quantum yield of almost 100 % over a wide temperature range, and the relatively short emission decay time at ambient temperature. This behaviour is related to the high transition probability between the emitting triplet T_1 and the electronic ground state S_0. In contrast, blue and red emitting materials often lack sufficient long term stability or efficiency due to low emission quantum yields. For a better understanding of the inherent photophysical properties of the emitting materials, we investigated the phosphorescence quantum yields of three selected materials, the blue emitting $Ir(biqa)_3$, the green emitting $Ir(ppy)_3$, and the red emitting Pt(thpy)(acac) over the wide temperature range between 370 K and 1.5 K.

Absolute photoluminescence quantum yields were measured with a Hamamatsu C9920-02 system at T = 300 K and at 77 K, respectively, using a nitrogen dewar. For quantum yields at other temperatures, the integrated emission intensity, being proportional to the photoluminescence quantum yield Φ_{PL}, was measured. Subsequently, these relative quantum yield data were calibrated by use of the absolute Φ_{PL} values measured at 300 K and 77 K. Samples were investigated in poly (methylmethacrylate) (PMMA) or in 2-methyltetrahydrofuran (MeTHF) solution. MeTHF forms a glass at low temperature. The phase transition glass-liquid at about 140 K has no significant influence on the photophysical properties of the investigated compound. The results of our measurements are summarized in Figure 1.

The photoluminescence quantum yield Φ_{PL} of the green light emitting $Ir(ppy)_3$ in PMMA shows no significant change between 300 K (and even 370 K) and 77 K (Figure 1b). Φ_{PL} is constant and amounts to 96-97 %. However, upon cooling to helium temperatures, the quantum yield decreases to about 88 % at 1.5 K, with a "plateau" between 12 K and 22 K at a value of $\Phi_{PL} \approx 90\%$. The explanation for the decrease of Φ_{PL} at low temperatures is traced back to the respective contributions of the three energetically split T1 substates (I, II, and III). Each of them exhibits an individual set of radiative and non-radiative rate constants. A change of population according to a temperature

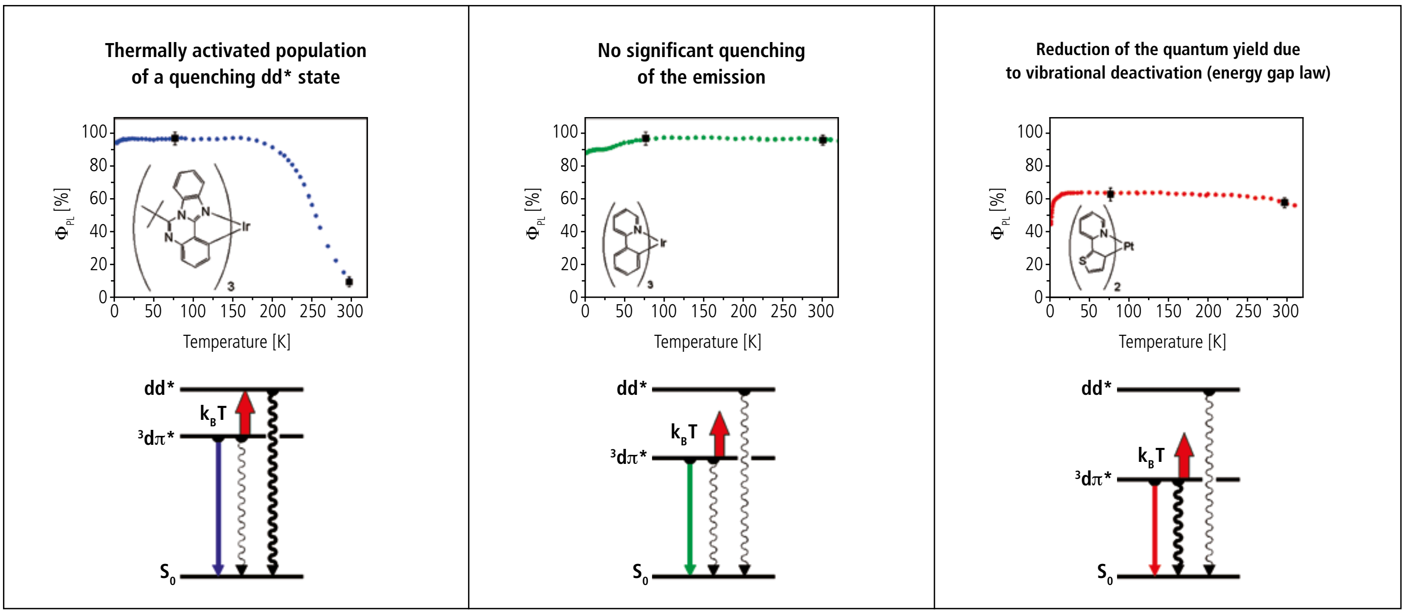


Figure 1: Temperature dependence of the emission quantum yield of (a) $Ir(biqa)_3$ in MeTHF (10^{-5} mol/l), (b) $Ir(ppy)_3$ in PMMA (0.01 wt%), and (c) Pt(thpy)(acac) in PMMA (0.01 wt%). The experimentally determined data were calibrated using the measured absolute photoluminescence quantum yields at 300 K and at 77 K, respectively.

change leads to different contributions of each state and thus, to a change of the overall-phosphorescence properties. (2) The blue emitting compound $Ir(biqa)_3$ shows a different behaviour (Figure 1a). The quantum yield drops drastically from 97 % near 200 K to 10 % at 300 K. This behaviour is explained to be a consequence of a thermal activation of quenching ^{1,3}dd* states from the lowest triplet of ^{3}dπ* character (T_1 state). (3, 4) The low-temperature behavior (T < 170 K) is similar to the behaviour as described for $Ir(ppy)_3$.

The quantum yield of Pt(thpy)(acac) is almost constant over the whole temperature range at a value of about 60 % (except below 20 K according to the influence of the T_1 state splitting, see above). This lower value is, in comparison to the almost 100 % quantum yield of the other two materials (at low temperature), due to a substantial direct vibrational deactivation of the emitting triplet state according to the so-called energy gap law. (5) The smaller energy gap between the emitting triplet state and the electronic ground state causes a higher radiationless rate from T_1 to S_0. The non-radiative deactivation is competing with the radiative phosphorescence, resulting in a quantum yield of well below 100 % for the red light emitting Pt(thpy)(acac). (6)

In conclusion, quantum yield measurements at different temperatures can (in combination with lifetime measurements) be highly useful for an identification of deactivation paths of emitter materials. In particular, also radiative and non-radiative rate constants of the transitions from the emitting triplet substates can be determined. (2) Furthermore, our investigations show that the environment, i.e. the matrix cage around the emitter, strongly influences photophysical properties of emitter materials, for example, by disturbing the complex's geometry and thus also the involved states. These effects have to be considered when trying to optimize the performance of an emitter material to be applied in OLEDs. (3, 7)

Thomas Hofbeck and Hartmut Yersin, Institute for Physical Chemistry, University of Regensburg, Germany

For more information please visit http://www.ur.de/~hartmut.yersin
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USB3.0 extenders for use with Hamamatsu USB3.0 cameras

Advanced USB solution

Many of Hamamatsu's new cameras use a USB3.0 interface for connecting the camera to a computer. But as scientific setups become more and more complicated it becomes apparent that standard USB cables are not long enough to cover the distance between the camera and the PC. This is where USB3.0 extension kits come into play.

Several solutions of such USB3.0 extenders are available on the market today. They are mainly based on fiber optic cables and differ in the length available. The ones recommended in this article have been tested with an ORCA-Flash4.0 V2 camera and can be recommended to be used with Hamamatsu USB3.0 cameras like the ORCA sCMOS cameras.

The test environment consisted of a PC with Windows 7, 64bit OS, IOI USB3.0 interface board IOI U3-PCIE1XG202-10, DCAM API version September 2014, Hokawo application software version 2.9 pf0 and ORCA-Flash4.0 V2 camera.

Hamamatsu USB3.0 cameras

1. Unibrain USB3.0 Active Optical Cable

- Fiber optic cable
- Available lengths 20 m, 50 m and 100 m, customized lengths possible
- Powered by secondary connection to USB3.0 hub
- RoHS2, REACH compliant
- Detailed information: http://www.unibrain.com/products/usb-3-0-active-optical-cables

2. Icron Spectra 3022 2-Port USB3.0 Multimode Fiber Extender

- Multimode fiber optic cable, LC connector type
- Available lengths of up to 100 m
- Remote extender with integrated port hub and power supply on secondary connection
- RoHS2 compliant
- Detailed information: http://www.icron.com/products/icron-brand/usb-extenders/fiber/usb-3-0-spectra-3022/

3. Icron Spectra 3001-15 1-Port USB3.0 15 m Active Extension Cable

- Active copper cable
- Available length 15 m
- Powered from host computer
- RoHS2 compliant
- Detailed information: http://www.icron.com/products/icron-brand/usb-extenders/cat5/usb-3-0-spectra-3001-15/

4. Corning USB3.0 Optical Cables

- Based on fiber optic cable plus copper wire for power
- Available lengths 10 m, 15 m, 30 m and 50 m
- Powered from host computer
- Detailed information: http://www.corning.com/opcomm/OpticalCablesbyCorning/products/USB-3.Optical.aspx

Authors: Tanja Acker and Holger Hermann, Hamamatsu Photonics Germany

NEW

MPPC®/MPPC Module S13360 Series, C13365/C13366 Series

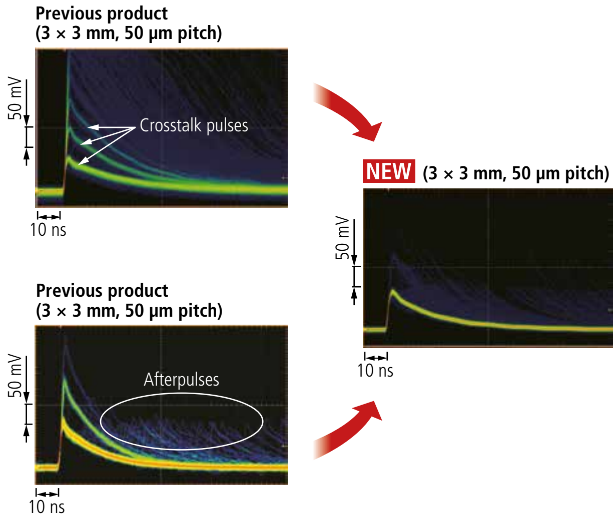
Low-noise MPPC and MPPC module for precision measurement

MPPCs and MPPC modules for precision measurement inherit the high photon detection efficiency of their predecessors and at the same time provide lower crosstalk, lower afterpulse, and lower dark count.

MPPC®/MPPC module

Features

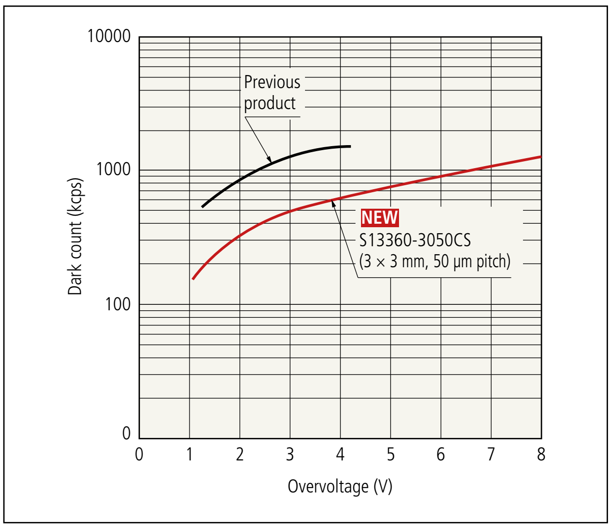
- **Low crosstalk**
  The pixel that detects photons may affect other pixels, making them produce pulses separate from output pulses. This phenomenon is called crosstalk. The MPPC for precision measurement employs a structure that suppresses the occurrence of crosstalk. This has drastically reduced crosstalk in comparison with previous products (rate of occurrence reduced from 44 % to 3 %).



- **Low afterpulses**
  While an MPPC detects photons, delayed signals may be output separately from the output pulses. These signals are called afterpulses. The MPPC for precision measurement provides low afterpulses.

- **Low dark count**
  Improvement in material and wafer process technology has reduced the dark count down to approximately half that of previous products.

Dark count vs. overvoltage (Typ. Ta = 25 deg. C.)



CMOS Linear Image Sensor S13131

NEW

Compact and thin package

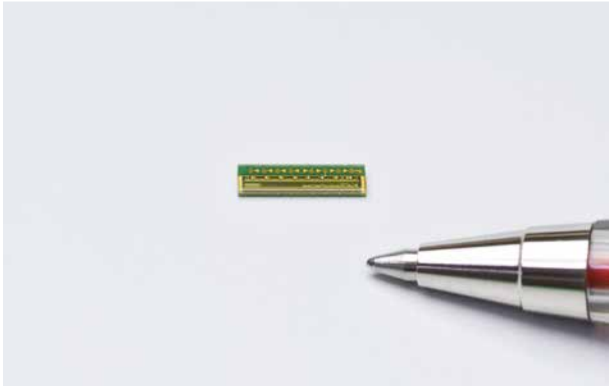
The S13131 is a linear image sensor developed for barcode readers, encoders, and other various types of scanning applications. It is a COB (chip on board) type implemented in a compact (close to chip size) and thin (half the thickness of the previous product, 0.8 mm) package.

Features

- Compact and thin package: 9.1 x 2.4 x 0.8 mm
- High sensitivity, low noise (0.4 mV rms)
- Pixel size: 5.5 x 63.5 μm
- 3.3 V single power supply operation
- Video data rate: 2 MHz max.

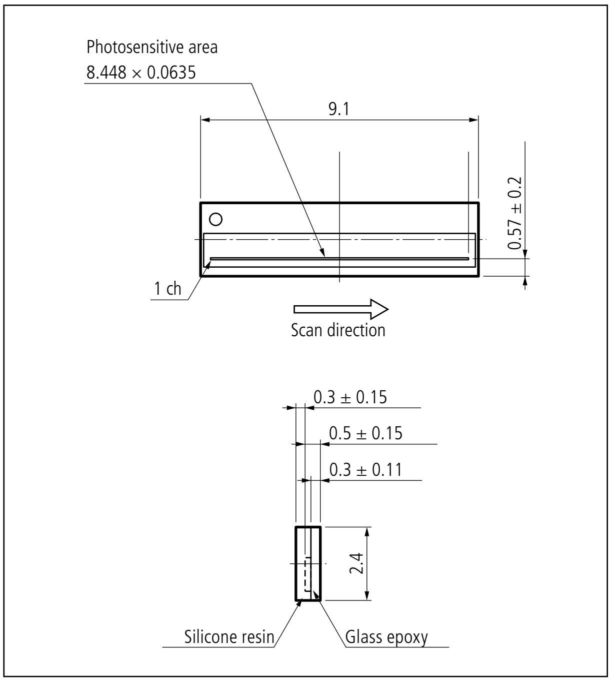
Applications

- Barcode reader
- Encoders
- Various types of image scanning



S13131

Package diagram (unit: mm)



Specifications

Parameter	Specification	Unit
Number of pixels	1,536	pixels
Pixel pitch	5.5	μm
Pixel height	63.5	μm
Photosensitive area length	8.448	mm
Spectral response range	400 to 1000	nm

NEW

Mini-spectrometer C13053MA

Compact and thin, built-in high-sensitivity CMOS image sensor

The mini-spectrometer FT (flat type) series is a polychromator provided in a compact, thin case that houses optical elements, image sensor, and driver circuit. Spectrum data can be acquired by guiding measurement light into a mini-spectrometer through an optical fiber and transferring the measured results to a PC via the USB connection. The incorporation of a high-sensitivity CMOS image sensor maintains high sensitivity equivalent to that of a CCD and achieves low power consumption. Moreover, the trigger function that can be also used for short-term integration enables spectroscopic measurement of pulse emissions.

C13053MA

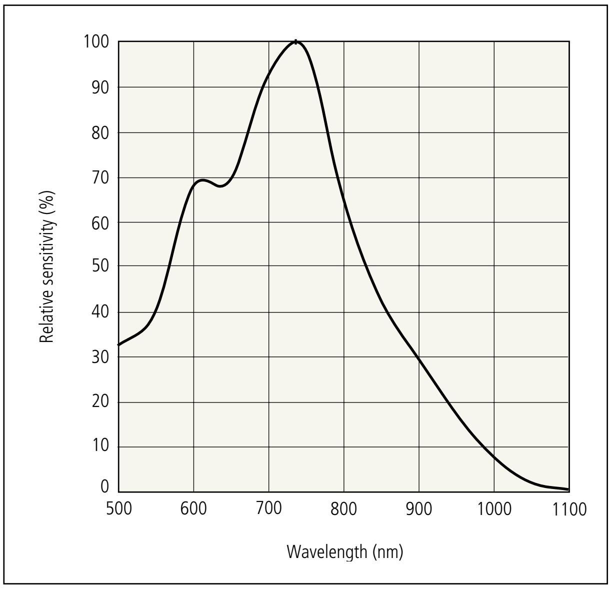
Features

- Compact, thin case
- High-sensitivity CMOS image sensor built in (high sensitivity equivalent to that of a CCD)
- With a trigger function
- High throughput using quartz transmission grating
- External power supply not necessary (USB bus powered)

Applications

- Sugar content and acidity detection of foods
- Plastic sorting
- Thickness gauge

Spectral response (Ta = 25 deg. C.)



Specifications

Parameter		Specification	Unit
Spectral response range		500 to 1,100	nm
Spectral resolution (FWHM)*1	Typ.	2.5	nm
	Max.	3.5	
Wavelength reproducibility*2		-0.4 to +0.4	nm
Wavelength temperature dependence		-0.04 to +0.04	nm/deg. C.
Spectral stray light*1, 3		-33 max.	dB
A/D conversion		16	bit
Integration time		11 to 100,000	μs
Interface		USB 2.0	-
USB bus power current consumption	Typ.	220	mA
	Max.	250	

*1 When the slit (25(H) x 250(V) μm) is used. The spectral resolution depends on the slit.
*2 Measured under constant light input conditions.
*3 The ratio of the count measured when an 800 nm light is input to the count measured when an 800 ± 40 nm light is input.

InAsSb Photovoltaic Detector (Non-cooled Type) P13243 Series

NEW

Compact SMD package – no cooling required

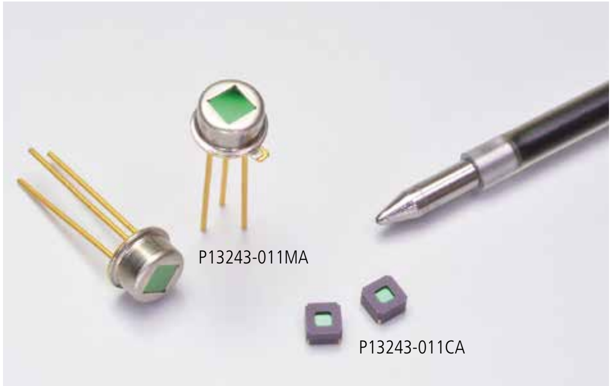
The P13243 series are InAsSb photovoltaic detectors that achieve a high sensitivity up to 5 µm without using TE-cooling. Its package is reduced and is easy to handle because no cooling is required.

Features

- High detectivity (D*)
- Non-cooled type
- Compact package
- RoHS compliant product

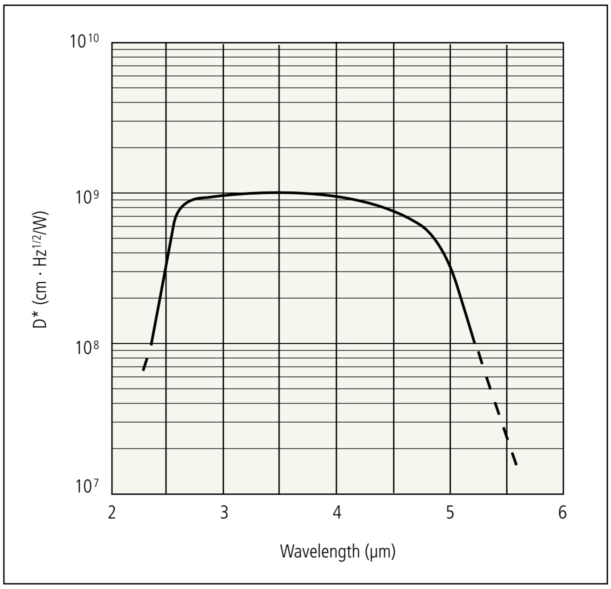
Application

- Gas measurement
- Temperature measurement



P13243 series

Spectral response (Typ. Ta = 25 deg. C.)



Specifications

Parameter	Condition	Min.	Typ.	Max.	Unit
Photosensitive area			0.7 x 0.7		mm
Peak sensitivity wavelength		-	3.5	-	µm
Cutoff wavelength		5	5.3	-	µm
Photosensitivity	$\lambda = \lambda p$	4.0	4.5	-	mA/W
Shunt resistance	V_R = 10 mV	120	240	-	kΩ
Detectivity	(λp, 600 , 1)	8.0×10^8	1.0×10^9	-	cm · $Hz^{1/2}$/W
Rise time	10 to 90 %	-	-	1	µs

NEW

Deep UV Light Source (UVCL) L12848-305

Deep UV light source with higher power than LED

The UVCL utilizes electron beam excitation to achieve UV output that is 8 times higher at 305 nm than a UV-LED and so helps improve equipment throughput. Its compact body contains a lamp, and a power supply, eliminating the need to design housing and therefore allows easy assembly into equipment.

L12848-305

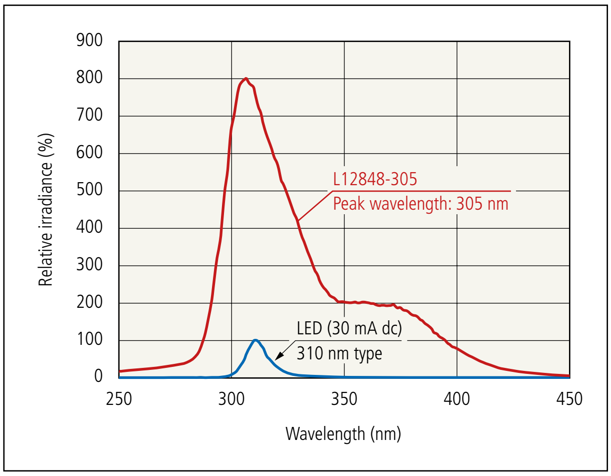
Features

- High output: 8 times higher than UV-LED (at 305 nm)
- Compact
- Mercury-free
- Long service life: 5000 hours guaranteed
- Easy assembly into equipment
- Low power consumption
- No cooling required

Applications

- Fluorescence analysis
- Environmental analysis
- UV curing
- Material resistance evaluation

Spectral distribution

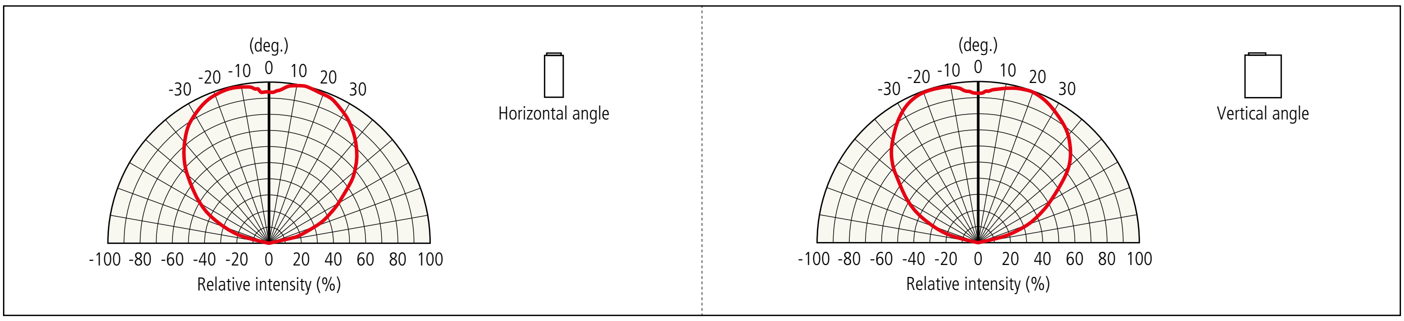


Specifications

Parameter		Specification	Unit
Spectral distribution*1		290 to 400	nm
Peak wavelength		305	nm
Light output stability*2	Fluctuation (p-p) (max.)	0.3	%
	Drift (max.)	± 3	%/h
Guaranteed service life*2, 3		5,000	h
Light-emitting point size		Approx. ϕ5	mm

*1 Please consult us if you need other wavelengths.
*2 at 305 nm
*3 Guaranteed service life is defined as the time when light intensity falls below 50 % of the initial value or light output stability exceeds the guaranteed value.

Directivity (light distribution)

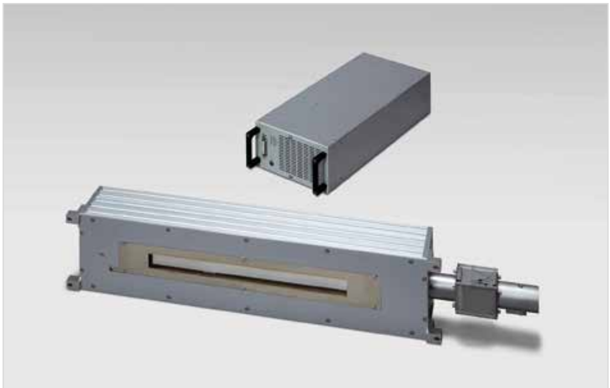


Excimer Lamp Light Source L11751-01, E12499, C11997

NEW

Modification and cleaning by light

Unlike the excimer lamps of other manufacturers, our excimer lamp light source uses a long flat lamp that ensures uniform irradiation. Processing by light (vacuum UV light at 172 nm) does not cause damage to objects, dust particle generation, and processing unevenness, which are usually caused by corona discharge/plasma treatment methods. The lamp has a service life that is twice as long as our current model (L11751), so it reduces maintenance costs. The power supply is designed to be more compact and lightweight and is available at a lower cost than our current model (C11753), making it a more optimal choice.



Excimer lamp L11751-01
Lamp house E12499
Power supply C11997

Features

- Long life
- Less flickering
- Uniform irradiation
- Instantaneous ON/OFF
- No damage to objects
- No generation of dust particles

Applications

- Surface modification
  - Pretreatment for adhesives (adhesive strength improvement)
  - Coating/printing adhesion improvement
- Material dry cleaning
  - Silicon wafer and glass substrate cleaning
  - Removal of organic films/adhesive residues
- Bonding
  - Microfluidic device

Specifications

Parameter	Specification	Unit
Emission wavelength	172	nm
Irradiance* (min.)	50	mW/cm^2
Lamp design life	2,000	h
Lamp guaranteed service life	1,000	h
Irradiation area (W x H)	400 x 38	mm
Duct suction air flow rate	0.35 ± 0.08	m^3/min

* Measured with a Hamamatsu UV power meter H9535-172

NEW

Opto-Spectrum Generator L12194-00-34054

Emits any desired wavelength in the UV range

The L12194-00-34054 Opto-Spectrum Generator emits light in the UV region (340 nm to 540 nm) by selecting any desired wavelength in 1 nm step. Using a highly stable lamp and unique optical systems we developed in-house, the Opto-Spectrum Generator is designed to be compact and yet deliver high stability, high output, and high efficiency. Opto-Spectrum Generator series are now available in four spectral ranges: 340 nm to 540 nm, 390 nm to 700 nm, 430 nm to 790 nm, and 700 nm to 1300 nm. Please select the type that matches your application.

Features

- Select any desired wavelength in 1 nm step
- Compact: W 144 mm x H 236.5 mm x D 513.5 mm
- Easy wavelength control from your PC (sample software is supplied)

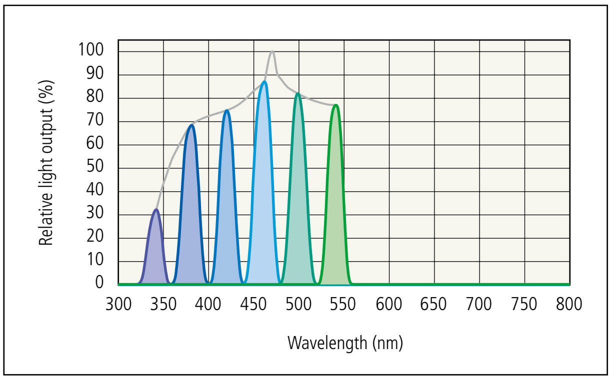
Applications

- Light stimulus to living body
- Spectral characteristic evaluation of devices
- Optical property evaluation of materials
- Illumination

L12194-00-34054

Emission spectrum example

Each graph shows emission spectra at wavelength intervals of 40 nm.



Specifications

Parameter	Specification	Unit
Emission wavelength range	340 to 540	nm
Spectral radiation half bandwidth	Approx. 15	nm
Wavelength tunable width	1	nm
Irradiation intensity*	1 or more	mW
Light output stability	± 5	%

* Initial irradiation (reference values) measured at the output end of the A10014-50-0110 light guide (sold separately) attached to the OSG. Measured with NOVA II PD300-UV made by OPHIR.

Medical Life Science Drug Discovery Measurement Analytical Semicon Prod. Optical Comms Security Industry ND inspection Academic Res.

NIR-PMT Unit H12397-75

NEW

Low dark count
Fiber input

The H12397-75 contains a compact NIR-PMT (near infrared photomultiplier tube) in a vacuum sealed housing, along with an air-cooled thermoelectric cooler to minimize dark current. A newly developed fiber-input optics is also used to reduce the dark count down to 1/50 compared to a conventional type (H10330B-75), making it possible to detect signals that have been buried in noise.

Features
- Low dark current, low dark count
- Fiber input

Applications
- Photoluminescence
- Cathode luminescence
- Fluorescence / fluorescence lifetime
- LIDAR for atmospheric research
- Optically encrypted communication

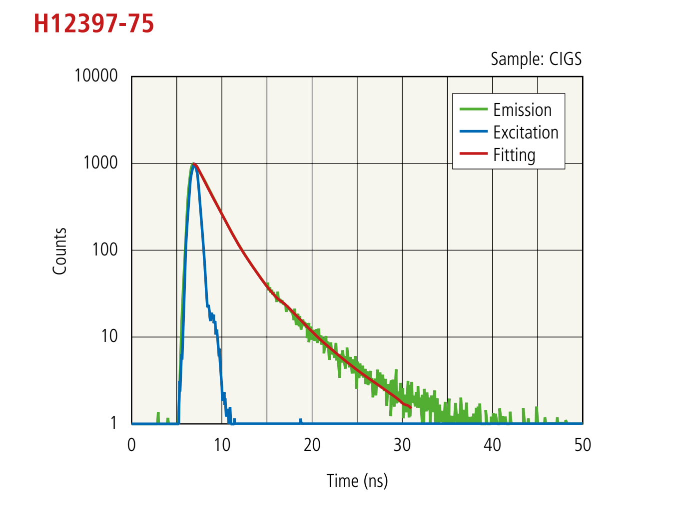
H12397-75

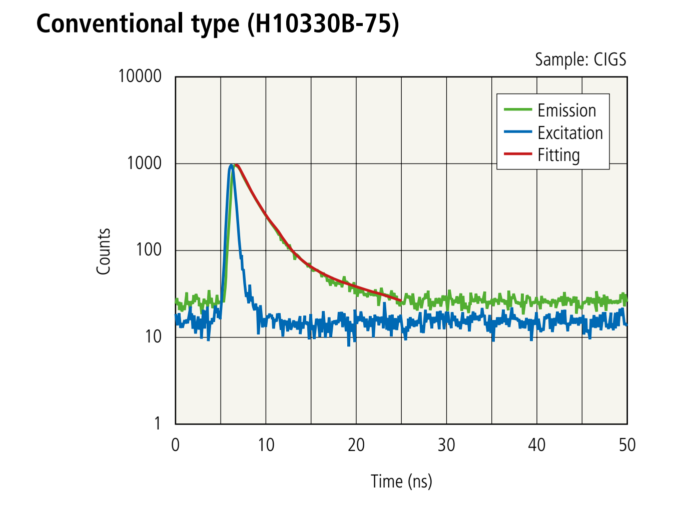
Specifications

Parameter	Specification	Unit
Spectral response range	950 to 1,700	nm
Photocathode type	InP/InGaAs	-
Cathode quantum efficiency (typ.) at 1500 nm	2	%
Dark count*	5,000	s^{-1}
TTS (FWHM) (typ.)	0.4	ns

* Supply voltage -800 V, at 25 deg. C.

Fluorescence lifetime measurement example





NEW

Fast Decay Time Phosphor J12782-09D

Short decay time

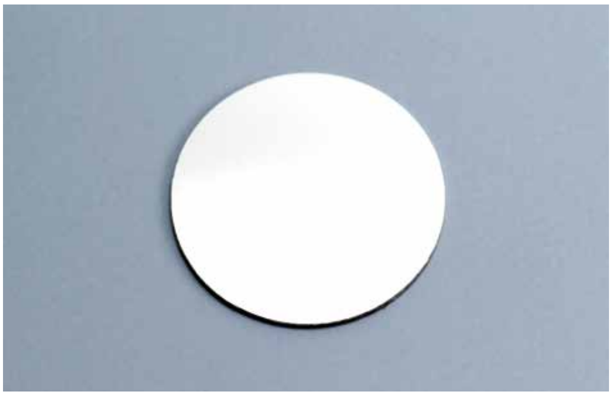
The J12782-09D is a fast decay time phosphor for electron beam detection. Its decay time is short enough to perform high-speed imaging/inspection helping to improve throughput.

Features

- Short decay time
- Long life
- High brightness efficiency

Applications

- Semiconductor inspection instrument
- SEM (Scanning Electron Microscopy)
- Mass spectrometry
- General electron detection



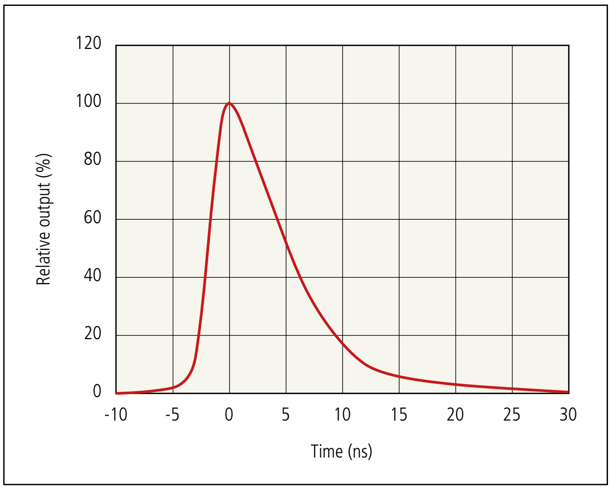
J12782-09D

Specifications

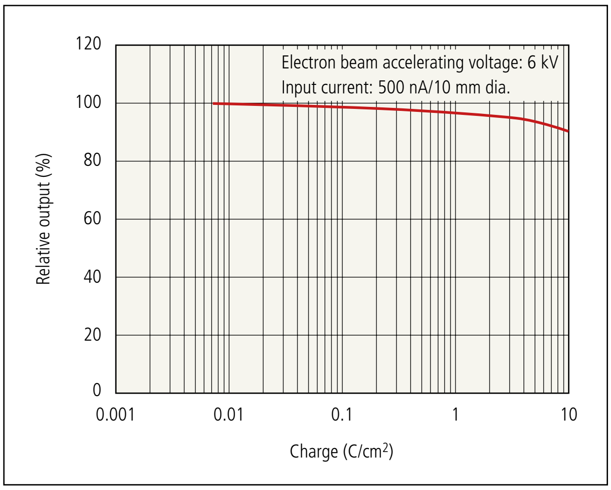
Parameter	Specification	Unit
Detection energy range (electron beam)*	6 to 15	keV
Decay time (90 % to 10 %) (typ.)	12	ns
Peak emission wavelength range	390 to 440	nm
Effective area	ϕ8.6	mm

* Lower detection energy range is available upon request.

Decay time characteristics



Life characteristics



Multiple ROI readout and exposure cycles are now decoupled

NEW

ORCA-Flash4.0 LT with W-VIEW Mode™

ORCA-Flash4.0 LT with W-VIEW Mode™

Hamamatsu Photonics introduces the new ORCA-Flash4.0 LT with W-VIEW Mode™ which enables to read out two different regions of interests (ROIs) at various exposure times.

The ORCA-Flash4.0 LT is equipped with the latest Gen II sCMOS technology having a spatial resolution of 2048 x 2048 pixels (6.5 µm pixel size) and a very low readout noise of 1.5 electrons rms. The USB 3.0 interface guarantees to capture videos at 30 full frames per second.

Operating the camera in the new W-VIEW Mode™ allows you to set independent exposure times and readout directions for the upper and lower half of the sensor (2048 x 1024 pixels) guaranteeing best image quality of dual wavelength measurements, especially when used with our W-VIEW GEMINI.

Furthermore it is now possible to read out two freely positioned ROIs of different size and independent exposure times. In this way two ROI images can be acquired at very high speed which reduces data volume and enables long time recording – a crucial feature for light-sheet applications.

The new ORCA-Flash4.0 LT in W-VIEW Mode™ allows you to capture all dual wavelength measurements easily making it the best choice for high speed ratiometric imaging or any other multiple fluorescence applications.

For further information email europe@hamamatsu.de or visit our website http://www.hamamatsu.com/eu/en/community/life_science_camera/index.html.

NanoZoomer-SQ Digital Slide Scanner C13140-21

NEW

The easy-to-use, affordable and high quality desktop scanner for whole slide imaging

NanoZoomer-SQ is Hamamatsu's new desktop single slide scanner for creating whole slide images of single tissue slides. Its very compact size makes it suitable even for the smallest lab, while maintaining the well-renowned reliability and robustness of Hamamatsu whole slide scanners.

C13140-21

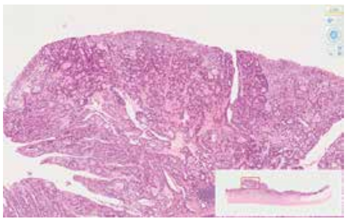
Features

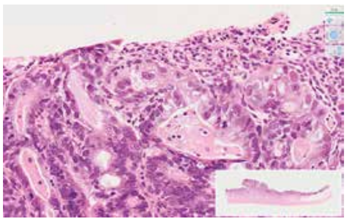
- Desktop and lightweight
- Affordable
- High quality and reliable
- Easy operation

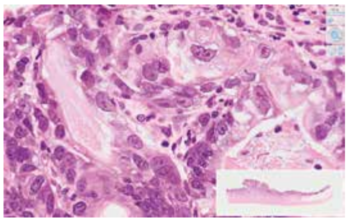
Applications

- Teleconsultation
- Education & training
- Image analysis

A push of the start button on the scanner is all that is required to create a high quality digital slide.







Has the feel of a microscope, with the possibility to view a whole tissue section, as well as a region of interest

NEW

ImagEM X2-1K EM-CCD Camera C9100-24B

The ImagEM X2-1K 1024 ×1024 version is available

High sensitivity camera with 1024 × 1024 pixel electron multiplying CCD. 18.5 frames/s at the full resolution with a high signal-to-noise ratio, enabling quantitative high-speed, low-light imaging.

Features

- High speed
- High sensitivity
- Low noise
- Great stability

C9100-24B

Faster readout

Clock: 22 MHz **(Unit: frames/s)**

Binning	Sub-array (Effective vertical width)						
	1024	512	256	128	64	32	16
1 x 1	18.5	34.9	62.7	104	156	208	249
2 x 2	34.7	62.5	104	155	207	248	275
4 x 4	61.8	102	154	205	245	272	288

By clocking pixel readout at 22 MHz, the ImagEM X2-1K is able to run 18.5 frames/s with full frame resolution.

Corner readout

Clock: 22 MHz **(Unit: frames/s)**

Binning	Sub-array						
	1024 x 1024	512 x 512	256 x 256	128 x 128	64 x 64	32 x 32	16 x 16
1 x 1	18.5	34.9	79.5	161	237	237	298
2 x 2	34.7	62.5	126	215	274	274	307
4 x 4	61.8	102	179	256	293	293	305

By selectively imaging at the edge of the sensor, closest to the read register of the chip, it is possible to achieve even greater speeds of small ROIs.

LD Irradiation Light Source (SPOLD) L11785-61

NEW

Air-cooled compact laser light source

The fiber output type laser diode module, driver circuit, and peltier cooling system are compactly combined in this laser irradiation light source. Highly customizable irradiation settings allow for laser irradiation at specific light spot diameters and beam profiles.

L11785-61

Difference from conventional product

Newly developed fiber output laser with ϕ105 μm core diameter enables more precise laser heating.

Features

- Compact body and lightweight
- Air-cooled thermoelectric cooling
- Simple and easy control
- Various types of irradiation units provided
- Minimum light condensing diameter ϕ0.1 mm available

Applications

- Plastic welding
- Soldering (bonding)
- Adhesive thermal curing
- Drying of coating, etc.

* This product is based on results obtained from a project commissioned by the New Energy and Industrial Technology Development Organization (NEDO).

Specifications

Items	L11785-61
Laser type	Laser diode (LD)
Oscillation mode	CW
Oscillation wavelength (25 deg. C.)	915 ± 20 nm
Maximum output (at standard fiber exit end)	9.5 W
Output fiber	Step index type core diameter ϕ105 μm NA 0.22
Dimensions (W × H × D)	280 mm ×100 mm × 300 mm (excluding projecting parts)
Light condensing diameter (at standard configuration setting)	Approx. ϕ0.1 mm

NEW

Super Luminescent Diode (SLD) L12856-04

Infrared emitter with high radiant flux density and low coherency

The Super Luminescent Diode (SLD) is an infrared emitter that has the advantages of both the laser diode and the LED, high radiant flux density and low coherency. The SLD was developed as a device that compensates for the disadvantages of laser diodes such as their coherent noise and is ideal for applications where a higher S/N ratio is essential, for example in optical measurements and optical communications. A photodiode chip has also been mounted within the same package for monitoring the SLD output.

Difference from conventional product

This new series achieves about 3 times more (10 mW) radiant output power of the conventional L8414 series.

Features

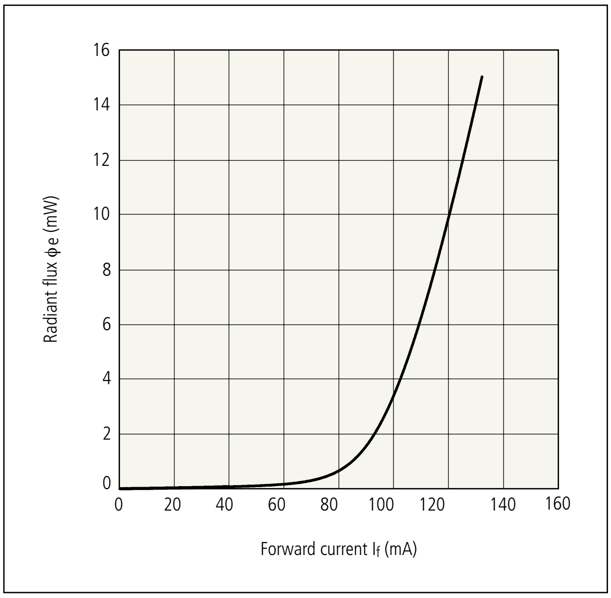
- High radiant flux density
- Low coherency

Applications

- Optical communication
- Optical measurement light source

L12856-04

Radiant flux vs. Forward current (typ.) (T_{op} (C) = 25 deg. C.)



Specifications

Parameter		Symbol	Condition	Value	Unit
Center wavelength		λc	ϕe = 10 mW	830 ± 10	nm
Spectral radiation half bandwidth		$\Delta\lambda$		10	nm
Operating current		I_{op}		120	mA
Operating voltage		V_{op}		1.8	V
Beam spread angle	Horizontal	$\theta_{//}$	ϕe = 10 mW FWHM	8	degree
	Vertical	$\theta_{\perp}$		36	
Monitor current		I_m	ϕe = 10 mW	0.12	mA

Global Exhibitions 2015

USA

May 2015

Radiation Detection Conference
May 19-21 2015, Fairfax, VA

ASMS
May 31-June 5 2015, Baltimore, MD

June 2015

Digital Pathology Congress USA
June 22-23 2015, San Diego, CA

July 2015

Ion Channel Retreat
July 6-8 2015, Vancouver, Canada

SEMICON West
July 14-16 2015, San Francisco, CA

August 2015

Optics and Photonics
Aug 11-13 2015, San Diego, CA

October 2015

IEEE Photonics Conference
Oct 4-8 2015, Reston, VA

Nuclear Science Symposium
Oct 31-Nov 1 2015, San Diego, CA

EUROPE

May 2015

PSMR 2015
May 17-20 2015, La Biodola, Italy

Sensor und Test
May 19-21 2015, Nuremberg, Germany

IOP Nuclear Physics in Astrophysics
May 19-21 2015, York, England

ELMI
May 19-22 2015, Sitges, Spain

National Electronics Week (NEW) South Africa
May 20 2015, Durban, South Africa

Vårmöte i Patologi
May 20-22 2015, Örebro, Sweden

41. Jahrestagung – Gesellschaft für Neonatologie und Pädiatrische Intensivmedizin
May 21-23 2015, Stuttgart, Germany

XIII Pisa Meeting on Advanced Detectors
May 23-30 2015, La Biodola, Italy

99. Jahrestagung – dt. Gesellschaft für Pathology
May 28-31 2015, Frankfurt, Germany

ESA-Euroanaesthesia
May 30-June 1 2015, Berlin, Germany

June 2015

6th Workshop on Nanotube Optics and Nanospectroscopy
June 1-4 2015, Kloster Banz, Germany

Northern Optics 2015
June 2-4 2015, Lappeenranta, Finland

EPHJ-EPMT-SMT
June 2-5 2015, Lausanne, Switzerland

Photonex Scotland Roadshow
June 3 2015, Glasgow, Scotland

Photonics Event
June 3-4 2015, Veldhoven, Netherlands

Photon Diag 2015
June 8-10 2015, Trieste, Italy

ESPNIC
June 10-13 2015, Vilnius, Lithuania

Automotive Interiors Expo
June 16-18 2015, Stuttgart, Germany

Digital Industrial Radiology & Computed Tomography
June 22-25 2015, Ghent, Belgium

Laser-World of Photonics
June 22-25 2015, Munich, Germany

Dublin Pathology 2015
June 23-25 2015, Dublin, Ireland

Imaging the Cell
June 24 2015, Bordeaux, France

EACTA
June 24-26 2015, Gothenburg, Sweden

CYTO
June 27-30 2015, Glasgow, Scotland

European Zebrafish Meeting EZM 2015
June 28-July 2 2015, Oslo, Norway

Microscience Microscopy Congress (MMC)
June 29-July 2 2015, Manchester, England

July 2015

40th FEBS Congress – the Biochemical Basis of Life
July 4-9 2015, Berlin, Germany

Lightsheet Fluorescence Microscopy 2015
July 5-8 2015, Genova, Italy

PhotoDet 2015
July 6-9 2015, Troitsk, Russia

UK Space Conference
July 14-15 2015, Liverpool, England

IVAS 2015
July 14-17 2015, Mezzocorona (TN), Italy

8th International Conference – PCRRT
July 16-18 2015, London, England

EPS-HEP 2015
July 22-29 2015, Vienna, Austria

Reflections on the Atomic Nucleus
July 28-29 2015, Liverpool, England

ICRC – The Astroparticle Physics Conference
July 30-Aug 6 2015, The Hague, Netherlands

August 2015

GCFs SMLMS'15 – 5th Single Molecule Localization Microscopy Symposium
Aug 26-28 2015, Bordeaux, France

September 2015

ELRIG: Drug Discovery
Sept 2-3 2015, Telford, England

ECP – 27th European Congress of Pathology
Sept 5-9 2015, Belgrad, Serbia

TAUP 2015
Sept 7-11 2015, Torino, Italy

XXXVI Convegno della Divisione di Chimica Organica-CDCO 2015
Sept 13-17 2015, Bologna, Italy

14th Conference on Methods and Applications of Fluorescence
Sept 13-16 2015, Wuerzburg, Germany

Single-Molecule Microscopy and Spectroscopy
Sept 14-16 2015, London, England

Gemeinschaftsstand Bayern Innovativ IAA
Sept 15-18 2015, Frankfurt, Germany

BMSS Annual Meeting
Sept 16-17 2015, Birmingham, England

4th Champalimaud Neuroscience Symposium
Sept 16-19 2015, Lisbon, Portugal

7th Size-Strain Conference
Sept 21-24 2015, Oxford, England

ENOVA Paris
Sept 22-24 2015, Paris, France

MipTec
Sept 22-24 2015, Basel, Switzerland

October 2015

EMBL – Seeing is Believing
Oct 6-10 2015, Heidelberg, Germany

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