Absolute PL quantum yield spectrometer C11347 series

Quantaurus-QY®

HAMAMATSU

PHOTON IS OUR BUSINESS

Quantaurus-QY® is a system for instantaneous measurement of absolute photoluminescence quantum yields by photoluminescence method.
Just by loading a sample holder and entering a few instructions in the measurement software, photoluminescence quantum yield, excitation wavelength dependence, and PL excitation spectrum can be measured in a short time.
For basic measurements, it takes about 60 seconds to get to the analysis results.

QY Absolute PL Quantum Yield

Measuring absolute photoluminescence quantum yields (internal quantum efficiency) of light-emitting materials

In developing new light-emitting materials, it is essential to improve their photoluminescence efficiency.
Improving this efficiency requires accurate techniques for measuring the quantum yield. Quantaurus-QY® includes an excitation light source consisting of a xenon lamp and a monochromator, an integration sphere with optional nitrogen gas flow, and a multichannel detector capable of simultaneous multi-wavelength measurement, which are all integrated into a single package. The system utilizes dedicated software for making the measurements. The detector is a cooled, back-thinned CCD sensor and so makes instantaneous measurements with high sensitivity.
Quantaurus-QY® handles solution, thin-film and powder samples, and it can cool solution samples down to liquid nitrogen temperature.

Features

- Measures absolute photoluminescence quantum yield of light-emitting materials (PL measurement)
- Utilizes an integrating sphere to measure all luminous flux
- Cooled, back-thinned CCD sensor allows measurements with ultra-high sensitivity and high S/N ratio
- Automatically controls the excitation wavelengths
- Space-saving, compact design
- Wide selection of analysis functions
  - Photoluminescence quantum yield
  - Excitation wavelength dependence
  - Photoluminescence spectrum
  - PL excitation spectrum

Instantaneous measurement

The multichannel detector captures the sensitivity-compensated spectrum, and calculates the quantum yield in a process that instantaneously finds the absolute value of the quantum yield.
Dialog-style dedicated software keeps the measurement process simple.

Fully automated hardware

The software-controlled monochromator allows selecting excitation wavelengths so that the sample can be excited by various excitation wavelengths. Wavelength dependence of quantum yields and excitation spectrum can be automatically measured.

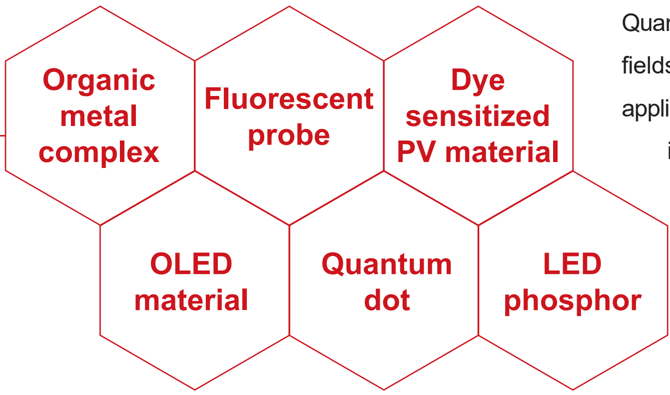
Analyzing different sample forms

Quantaurus-QY® handles solution, thin-film, and powder samples. With a Dewar flask holder, solution samples can be cooled by liquid nitrogen to -196 ˚C (77 K).

2 models available

Two product types are provided according to the wavelength range for sample excitation and photoluminescence: one covers a spectral range from 300 nm to 950 nm and the other from 400 nm to 1100 nm.

Model	Type number	Range
Standard	C11347-11	wavelength 300 nm to 950 nm
NIR	C11347-12	wavelength 400 nm to 1100 nm



Quantum yield measurements are made in a wide range of fields to meet needs in development and research applications. Typical applications include improving quality in various types of light-emitting materials such as organic EL materials, white LED, and phosphors for FPD; researching organic metal complexes; evaluating fundamental characteristics of dye-sensitized solar cells; and measuring fluorescent probe efficiency in biological fields.

Principle of quantum yield measurement

Measurement of reference
(Only for quartz cells)

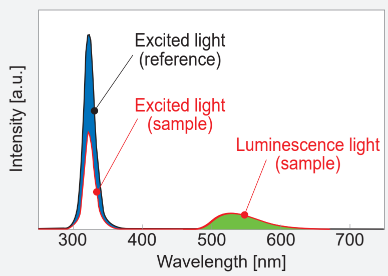
↓

Measurement of sample
(Quartz cells containing sample solution)

↓

Calculation of photoluminescence quantum yield

$$\text{Photoluminescence quantum yield} = \frac{\text{Number of photons emitted as photoluminescence from sample}}{\text{Number of photons absorbed by sample}}$$

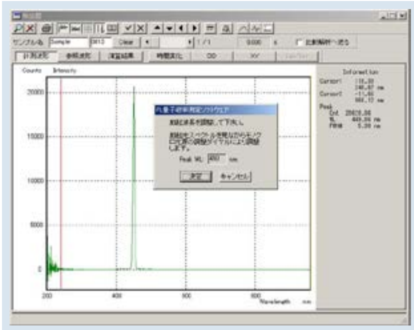


◀ Excitation light on reference and sample and photoluminescence spectrum measurement example

The dedicated software ensures simple and rapid measurements.

Select excitation wavelength

Input excitation wavelength



Auto-set measurement condition

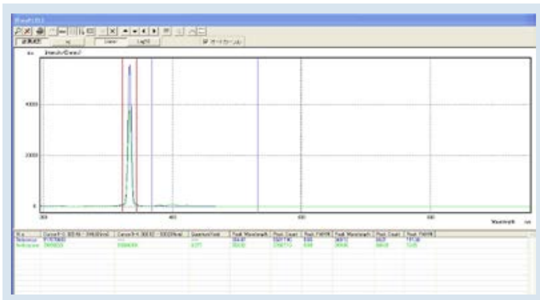
Load sample

Sample

- solution
- powder
- solid
- thin-film

Measure reference and sample data

Measurement data



Analysis

Measurement results of a standard sample, i.e. anthracene solution, are obtained within **about 60 seconds** after starting sample measurement.

Displays the analysis results as:

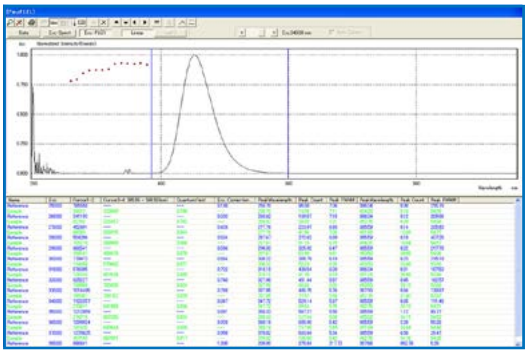
Photoluminescence quantum yield and peak emission

Specimens can be analyzed manually

- Display emission spectrum
- Chromaticity analysis
- Plot excitation-wavelength dependence of photoluminescence quantum yield
- Display excitation spectrum

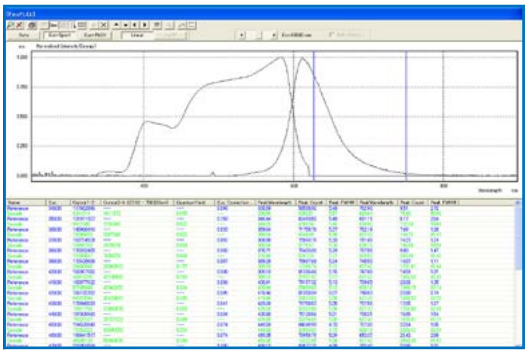
Simple-to-use dedicated quantum yield measurement software

Dependence on the excitation wavelength



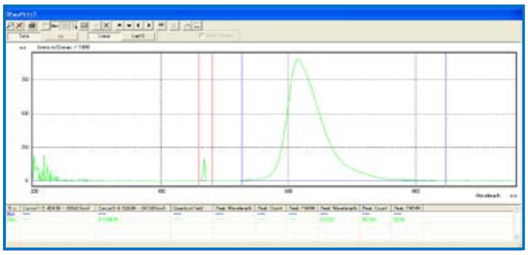
This screen shows the dependence of PL quantum yield on excitation wavelength.

PL excitation spectrum



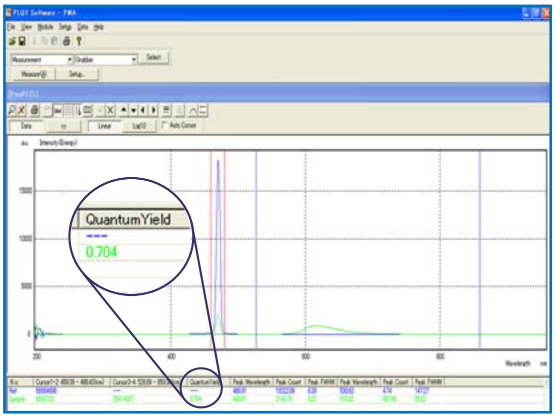
Excitation spectra can be measured by using a motorized excitation monochromator.

PL spectrum



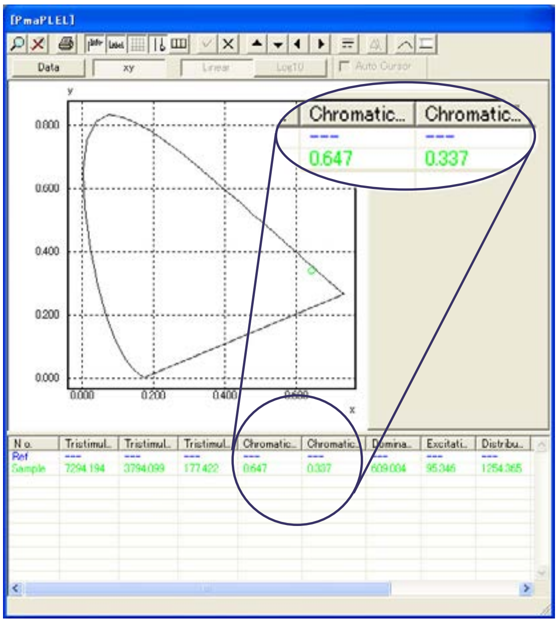
A PL spectrum is displayed after subtraction of residual excitation light components. A spectrum measured by Quantaurus-QY® always contains excitation light which was not absorbed by the sample. The software offers a function for removing these remaining excitation light components and enables the user to show a purified emission spectrum.

PL quantum yield measurement



This is a basic screen for quantum yield measurements. The luminescence quantum yield is automatically calculated after measurement. Excitation and emission bands are defined by adjusting the cursors. The value of the quantum yield is displayed in the table below the spectrum next to emission intensities, peak wavelength, peak counts, and peak band (FWHM).

x-y coordinates

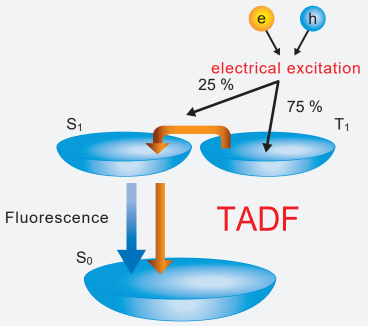


Besides displaying PL spectra and calculating quantum yields, the software also includes a function for color coordinates. In addition to the chromaticity coordinates (x, y) of the measured sample, the three stimulus values (X, Y, Z) are displayed.

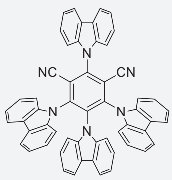
Measurement examples

Our long and proven record in quantum yield measurements is the reason our products are favored by many users in a wide range of fields.

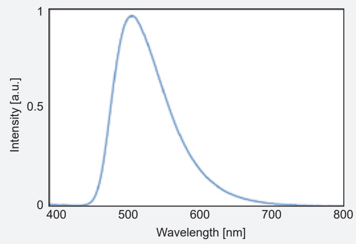
PL quantum yield measurement of highly-fluorescent TADF materials



Thermally activated delayed fluorescence (TADF) materials are well known as the third generation OLED materials. TADF is the fluorescence generated by reversed intersystem crossing process (RISC) from the lowest triplet to the singlet states and the RISC is promoted by the small energy gap between the lowest excited states (ΔEST). A novel TADF material (4CzIPN) was successfully developed by precise molecule design. The material has small ΔEST and it shows high PL quantum yield as 0.94 +/- 0.02.

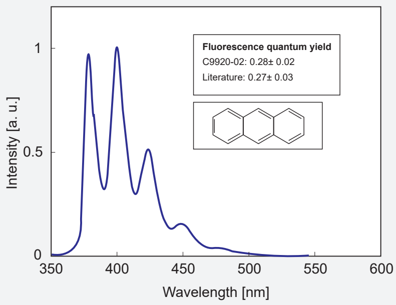


4CzIPN



Data courtesy of Prof. Chihaya Adachi, Hajime Nakanotani
Center for Organic Photonics and Electronics Research, Kyushu Univ.
H. Uoyama, K. Goushi, K. Shizu, H. Nomura, and C. Adachi, *Nature.* **492**, 234 (2012).

Re-evaluation of photoluminescence quantum yield of representative standard solutions



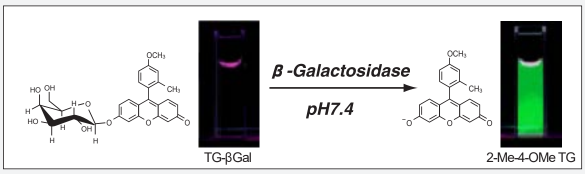
The quantum yields of fluorescence standard solutions were measured with our Absolute PL quantum yield measurement system. The fluorescence standard solutions have been used for determining PL quantum yield based on a relative method. For the most compounds, the quantum yield measured by our system shows excellent agreement with the values given in the literature, proving the high reliability of our system.

Figure: Fluorescence spectrum and quantum yield of anthracene solution

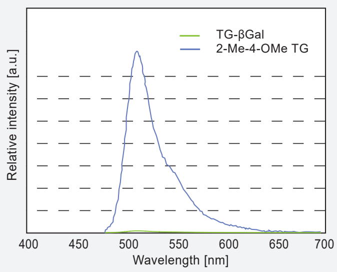
Collaborative research of Hamamatsu Photonics K.K.; A. Kobayashi, S. Kaneko, K. Takehira, T. Yoshihara, and S. Tobita, Faculty of Engineering, Gunma University; H.Ishida, Y.Shiina, and S.Oishi, School of Science, Kitasato University
K. Suzuki, A. Kobayashi, S. Kaneko, K. Takehira, T. Yoshihara, H. Ishida, Y. Shiina, S. Oishi, and S. Tobita, *Phys. Chem. Chem. Phys.*, **11**, 9850 (2009).

Quantum yield measurement of fluorescent bioprobe

Fluorescent probe for enzyme reaction detection: Quantum yield provides a comparative measurement.



Compounds	Fluorescence quantum yield
TG-βGal	0.01
2-Me-4-OMe TG	0.72



Fluorescent probe TG (Tokyo Green) -β Gal for β-galactosidase activity detection is nonluminescent (Φ_f= 0.01) but exhibits strong fluorescence after reacting with β-galactosidase. The quantitative difference in amounts of light emitted before and after the enzyme reaction can be found by comparing their quantum yields Φ_f.

Data courtesy of Yasuteru Urano, Ph.D., Graduate School of Medicine, the University of Tokyo.

We also offer a lineup of quantum yield measurement systems allowing diversified material evaluations on the same sample.

Fluorescence Lifetime and Absolute PL Quantum Yield

There are two processes when substances are excited by light irradiation from the ground state to excited singlet state (S1), then deactivated to the ground state again. One is radiative process such as fluorescence or phosphorescence, and the other one is a non-radiative process released as heat.

The fluorescence lifetime τ (tau) is defined as

$$k_f + k_{nr} = 1/\tau$$

where kf is the radiative rate constant and knr is the non-radiative constant.

On the other hand, the PL Quantum Yield (Φ) is expressed as the ratio of the number of photons emitted from molecules (PNem) to that absorbed by molecules (PNabs).

$$\Phi = PN_{em} / PN_{abs}$$

However the PL Quantum Yield Φ is also written as

$$\Phi = k_f / (k_f + k_{nr})$$

Thus, there is a close relationship between Φ (tau) and Φ as shown in the following equation,
and they are very important parameters for controlling the emission mechanisms of the materials.

$$k_f = \Phi / \tau$$

A diversified evaluation of the luminescence materials is available!

Quantaurus-Tau® for measuring fluorescence lifetime and Quantaurus-QY® for absolute PL quantum yield with simplified and minimized operating procedure are available.
Combination of Quantaurus-Tau® and Quantaurus-QY® allow users to obtain complementary analysis results.

Quantaurus-Tau®

Fluorescence lifetime spectrometer C16361 series

Quantaurus-QY®

Absolute PL quantum yield spectrometer C11347 series

Specifications

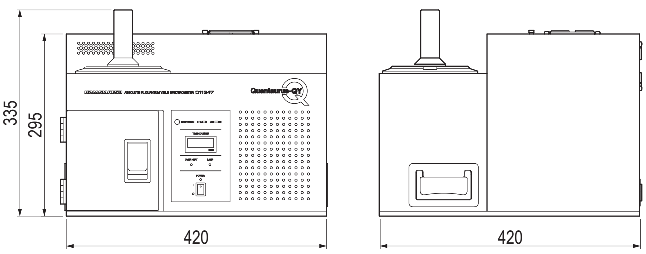
Type number	C11347-11	C11347-12
PL measurement wavelength range	300 nm to 950 nm	400 nm to 1100 nm
Monochromatic light source		
Light source	150 W xenon light source	
Excitation wavelength	250 nm to 850 nm	375 nm to 850 nm
Bandwidth	10 nm or less (FWHM)	
Excitation wavelength control	Automatic control	
Multichannel spectroscope		
Measurement wavelength range	200 nm to 950 nm	350 nm to 1100 nm
Wavelength resolution	<2 nm	<2.5 nm
Number of photosensitive device channels	1024 ch	
Device cooling temperature	-15 ˚C	
AD resolution	16 bit	
Spectroscope optical arrangement	Czerny-Turner type	
Integrating sphere		
Material	Spectralon	
Size	3.3 inch	
Software		
Measurement items	PL quantum yield	
	Excitation wavelength dependence of quantum yield	
	PL spectrum (peak wavelength, FWHM)	
	PL excitation spectrum	
	Color measurement (chromaticity, color temperature, color rendering index, etc.)	

Options

	Type number	Product name	
Sample holder for solution	A11238-04	Sample holder for low temperature	This is used to cool the solution sample with liquid nitrogen.
Sample holder for powder	A13924-01	Sample holder for temperature control	This option allows setting the maximum temperature of powder samples up to 300 ˚C. Measurements can be made in environments where phosphors for white LED are actually used. Temperature control range: RT to +300 ˚C.
Sample holder for QY series	A9924-21	Sample holder for QY series, thin films	This holder is designed for samples up to 20 mm square. A10095-11 is required for use.
Sample case for solution	A10095-02	Side-arm cell (3 pieces)	-
	A10095-04	Sample tube for low temperature measurement (5 pieces)	This is used to measure a sample solution at liquid nitrogen temperature.
Sample case for powder	A10095-01	Laboratory dish without caps (5 pieces)	This is used for making measurements on powder samples. This is a five-piece set made of synthetic quartz, which suppresses fluorescence and luminescence.
	A10095-03	Laboratory dish with caps (5 pieces)	
	A13712	Tweezers for A10095-03	Tweezers for grasping petri dishes.
Sample case for QY series	A10095-11	Laboratory dish for QY series, thin films (5 pieces)	A10095-11 is a laboratory dish exclusively for A9924-21.
Others	C13923-01	Controller for temperature control	The unit controls temperature of sample holder A13924-01.
	A11372-10	Spare part for A9924-21	-

Dimensional outlines (Unit: mm)

Weight: Approx. 26.5 kg



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