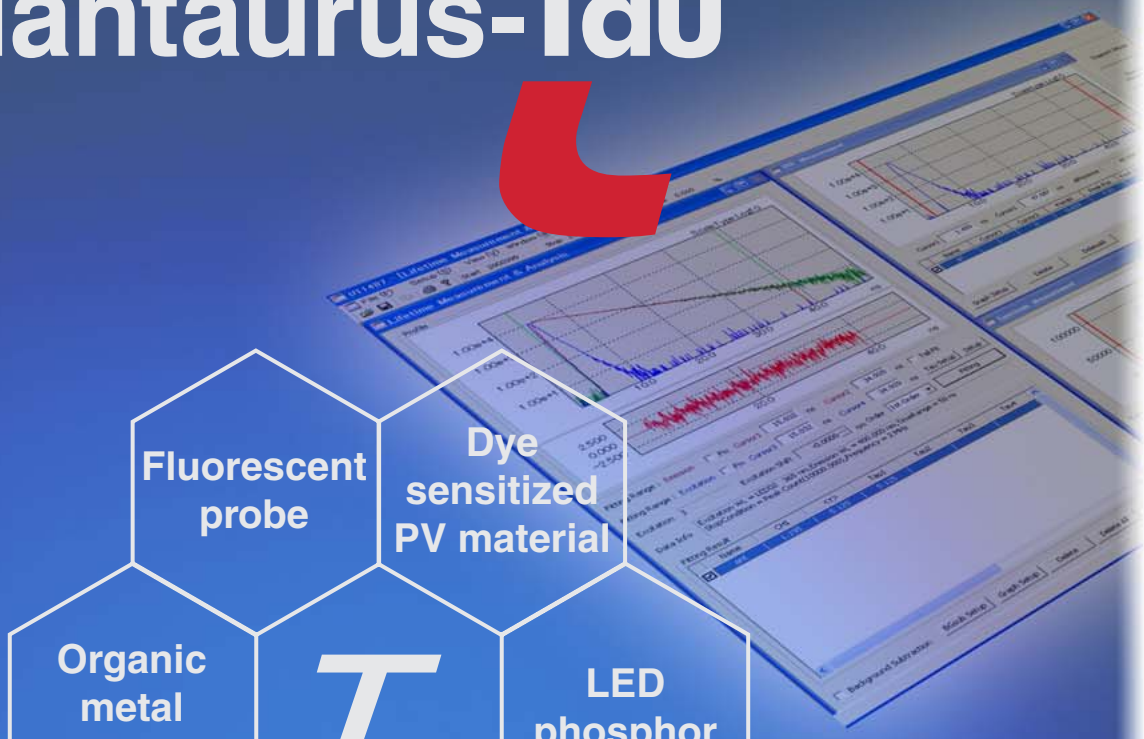
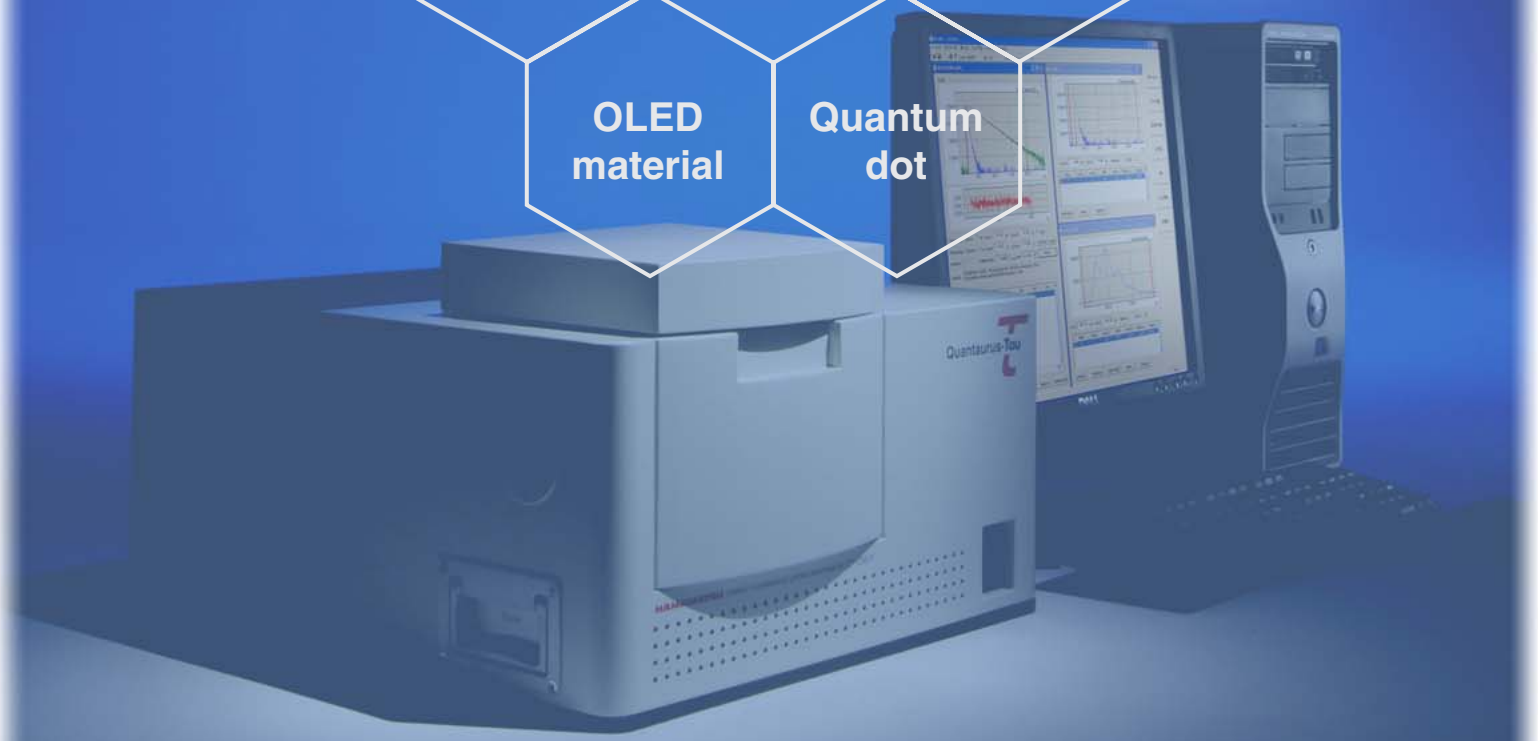
Compact Fluorescence Lifetime Spectrometer

Quantaurus-Tau®



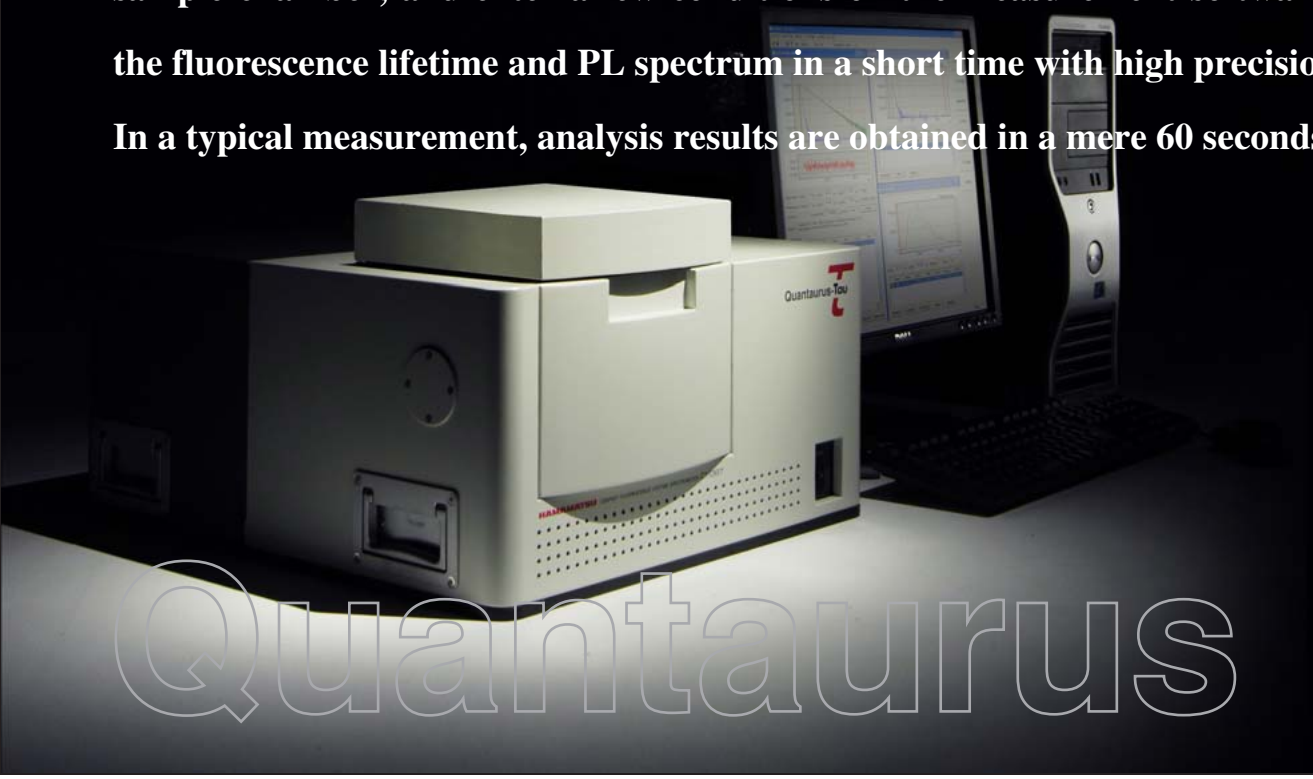


HAMAMATSU

PHOTON IS OUR BUSINESS

Quantaurus-Tau is a compact system for measuring fluorescence lifetimes in the sub nanosecond to millisecond range. Operation is simple, just set the sample into the sample chamber, and enter a few conditions on the measurement software to measure the fluorescence lifetime and PL spectrum in a short time with high precision.

In a typical measurement, analysis results are obtained in a mere 60 seconds.



Quantaurus

Tau Fluorescence Lifetime

Fluorescence lifetime measurement

Measuring an excited-state relaxation process

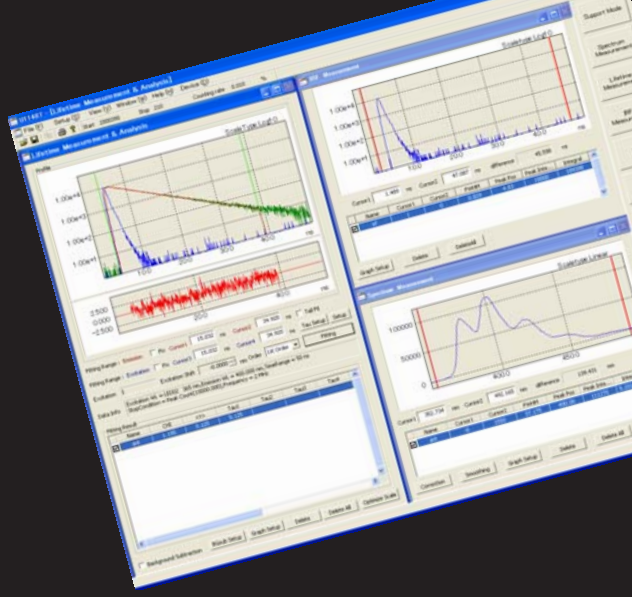
The fluorescence spectrum obtained from an organic material or fluorescent probe is a vital parameter for controlling and evaluating the material functions and characteristics such as the peak wavelength and fluorescence intensity. However, a fluorescence spectrum usually shows time-integrated information, and so when the material contains multiple substances and reactive elements, their fluorescence spectrum can only be acquired as integrated information. An effective approach in such cases is to observe the light emission dynamics by making use of the time axis parameter. This is generally called fluorescence lifetime measurement, in which the time required for the substance excited by the pulsed light to return to its ground state is measured in the sub-nanosecond to millisecond region. This measurement allows obtaining more information such as multiple different fluorescence lifetimes even at the same wavelength and the percentage in which they are present within the material, etc.

Features

- **High sensitivity measurement by photon counting method**
- **Time resolution better than 100 ps** (by deconvolution)
- **Cooling function for solution sample** (-196 °C) (option)
- **Phosphorescence measurement** (option)
- **Time-resolved measurement of fluorescence anisotropy** (option)
- **Fluorescence spectrum measurement**
- **Space-saving, compact design**

Easy and quick measurements

Emission Lifetime can be gotten easily and quickly only by putting the sample into sample box and setting the 4 measurement conditions.



7 excitation wavelength

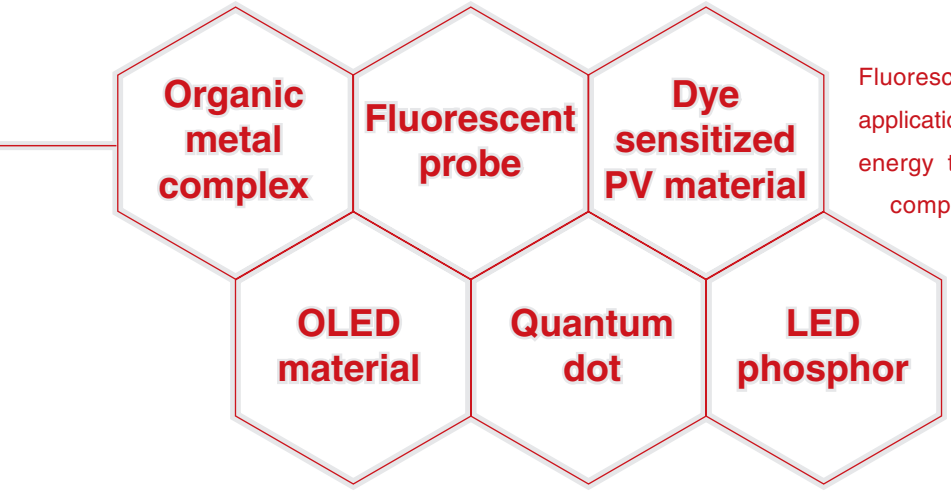
280 nm, 340 nm, 365 nm, 405 nm, 470 nm, 590 nm, and 630 nm.

Analyzing diffrent sample forms

Thin-film, solid, solutions and powder.

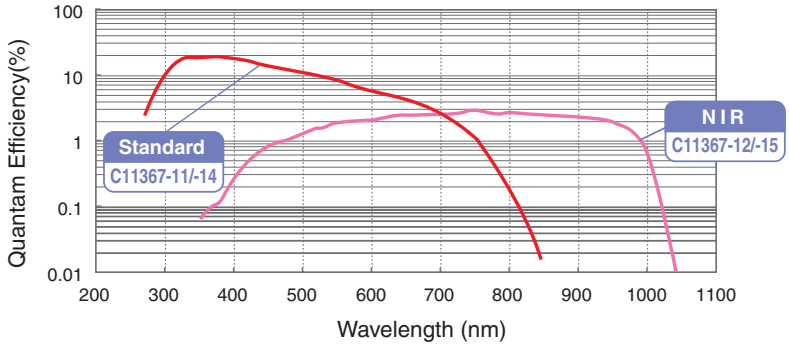
2 selection of detector

Standard	NIR
C11367-11/-14	C11367-12/-15
wavelength 300 nm to 800 nm	wavelength 380 nm to 1030 nm



Fluorescence lifetime measurement is applicable to varied applications. Typical applications include electron movement and energy transfer reactions within or between organic metallic complex molecules, as well as fluorescence and phosphorescence lifetime measurement of materials essential for developing organic EL devices, FRET (fluorescence resonance energy transfer) in fluorescent proteins, and pass/fail testing of compound semiconductors for solar cells and LED, etc.

Detector spectral sensitivity



Measurement procedure

Software designed taking account of the measurement procedure ensures easy and quick measurements.

Set sample

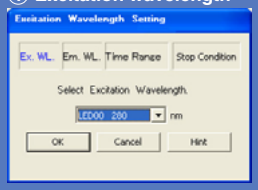
Sample

thin-film | solid | solution | powder

Input

4 measurement conditions

① Excitation wavelength



② Emission wavelength

③ Time range

④ Stop conditions

Shifting delay, Light intensity is automatically adjustable.

Start measurement

Set number of components

Measurement data

One-click analysis

deconvolution and fitting processes

In fluorescence lifetime measurements with a solution standard reagent - anthracene solution (QY=0.27), the analysis results are computed within about 60 seconds* after starting sample measurement

Displays the analysis results as: fluorescence lifetimes, component ratios, and chi-square test ($\chi 2$)

- Multi-component processing up to five components
- Simultaneous multiple data comparison on the same screen
- Real-time display of time profiles and spectrum

* If pre-measuring the IRF (instrumental response function)

Set parameter of multi-component processing

The range of the fitting data and IRF is specified for of each.

Set shift amount of IRF

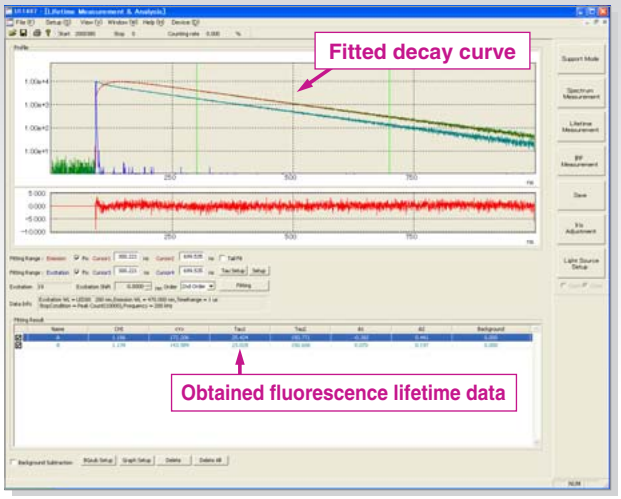
Specimens can be analyzed manually.

- Diversified analysis of lifetime components down to the order of sub-nano to microseconds
- Rise time analysis
- Fluorescence anisotropy analysis
- Spectral analysis by monochromator control

Analysis functions

Quantaurus-Tau includes a variety of measurement and analysis functions such as simultaneous multi-component fluorescence lifetime measurement and multi-sample data comparison.

Multi-component fluorescence lifetime analysis and comparison



Multi-component analysis of up to five components

In fluorescence lifetime measurement, a phenomenon often occurs where the data is observed as the sum of the attenuation curves of multi-component fluorescence lifetimes. Quantaurus-Tau easily calculates the fluorescence lifetime data and component ratio of each element by using the dedicated software.

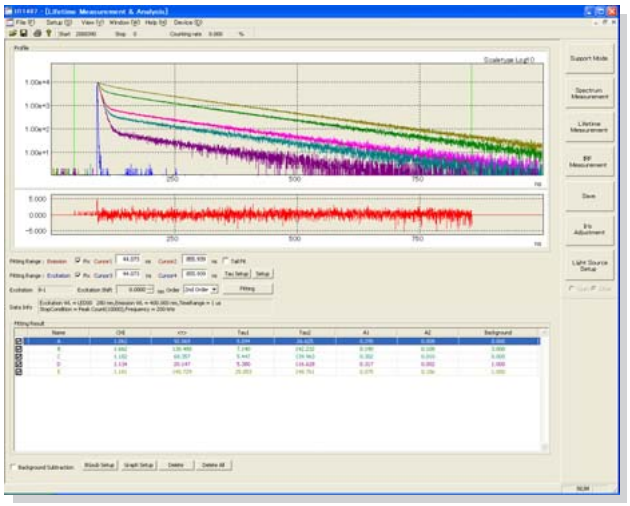
Highly accurate analysis by deconvolution

Deconvolution processing enables fluorescence lifetime analysis with high accuracy. When analyzing longer lifetime components such as phosphorescence, the "Tail Fit" function can be used instead of deconvolution processing.

Real-time display of time profiles and spectrum

Time profiles or spectrum are displayed on the monitor screen in real-time. This is a useful function for selecting the time scale during measurement or determining the analysis data range.

Multi-sample fluorescence lifetime analysis and comparison



Multiple data analysis on the same screen

Calculated fluorescence lifetime values are also displayed on the same screen for easy comparison analysis.

Comparisons under the same fitting

To make comparison analysis under the same conditions, Quantaurus-Tau subjects the multiple samples to specific fitting ranges, IRF (instrument response functions), and parameter settings.

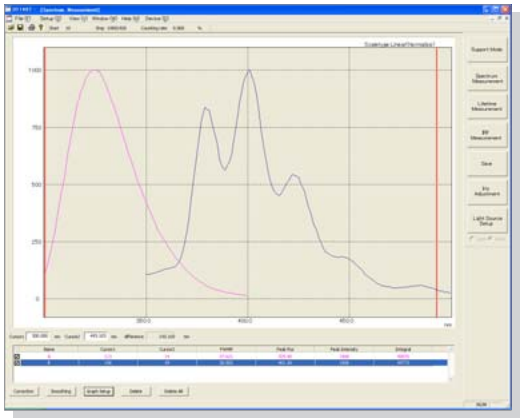
Graph editing with a graph setup feature

This allows you to change the range of each axis as needed on the comparison analysis screen so that the data can be edited to match your purpose. This feature also allows powerful normalizing whenever needed.

Acquired data can be easily stored as text data

The acquired data can be stored into the graph analysis software as text data by simple copy-and-paste operations.

Multi-sample PL spectrum analysis and comparison



Time-resolved spectrum display

Allows time-resolved spectrum display the greatest feature offered by streak camera systems.

Spectrum and fluorescence decay curve display

Displays the full width at half maximum (FWHM), peak position and peak intensity for each profile

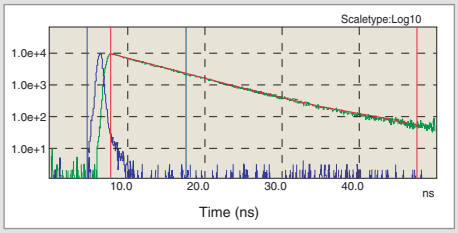
Multiple data loading and comparison on the same screen.

Normalized processing makes multiple data comparison easy.

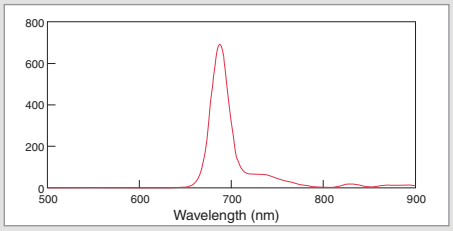
Measurement examples

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

Dye measurement of dye-sensitized solar cells

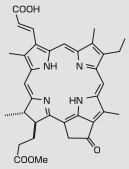


Fluorescence lifetime measurement of chlorine compound THF solvent: τ= 6.7 ns

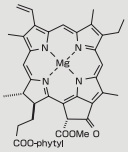


Fluorescence spectrum of chlorine compound: ex 412 nm, Φ = 0.26

1
Chlorin
(τ = 6.7 ns)



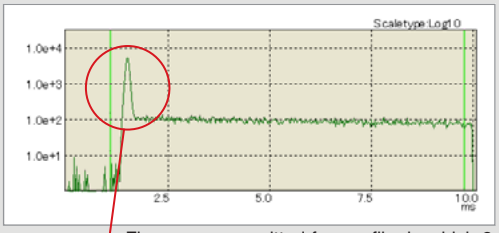
2
Chlorophyll *a*
(τ = 5.7 ns)



The chlorine compound (1) which is a chlorophyll *a* (2) derivative offers great promise as a material for high-efficiency dye-sensitized solar cells. Designing molecules where electrons efficiently move from the sensitizing dye to titanium dioxide (TiO_2) requires certain optical parameters such the fluorescence lifetime and quantum yield of the dye.

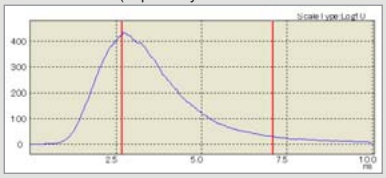
Data courtesy of Prof. Dr. Hitoshi Tamiaki, Mr. Yusuke Kinoshita
Laboratory of Bioorganic Chemistry Institute of Science and Engineering Ritsumeikan University

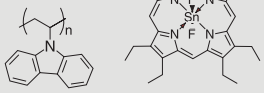
Thermally activated delayed fluorescence from organic LED material



Fluorescence emitted from a film in which 2wt%-SnF_2 (OEP) is dispersed into the PVCz host matrix
(measured at 10ms / full scale range)

Fluorescence components
(separately measured at 10 ns / full range)





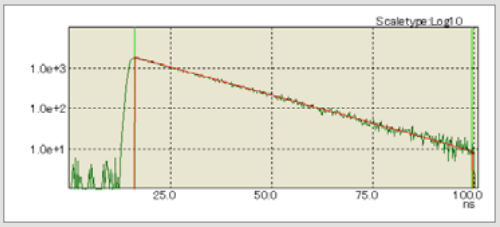
PVCz

SnF_2(OEP)

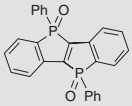
One new technique gathering a great deal of attention for improving exciton generation efficiency in organic LED is called "Thermally Activated Delayed Fluorescence" (TADF). This is a phenomenon where delayed luminescence is observed with the usual nanosecond fluorescence components and also on the order of milliseconds from light emitted at the reverse inter system crossing from a minimum triplet exciton excitation level (T_1) to a minimum singlet excitation level (S_1). Making use of this thermally activated delayed fluorescence is likely to improve the external EL quantum efficiency of organic LED.

Data courtesy of Prof. Chihaya Adachi, Dr. Takane Endo, Center for Future Chemistry, Kyushu University
Ayataka Endo, Mai Ogasawara, Atsushi Takahashi, Daisuke Yokoyama, Yoshimine Kato and Chihaya Adachi, *Adv. Mater.*, **21**, 4802-4906 (2009)

Measurement of fluorescence lifetime and quantum yield of stilbene compounds



BPS



Ladder type π-electron materials containing typical elements are a group of compounds with a unique electron structure reflecting the traits of the elements along with a rigid flat structure. Among these compounds, ladder type stilbene BPS possessing a phosphoryl group in cross-linked sections is unique and exhibits a light blue fluorescence in spite of a short π conjugation length as well as a high quantum yield (Φ=0.98). Moreover, measuring the fluorescence lifetime showed a result of τ=15.7 ns. From this results it is clear that, compared to stilbene compounds with cross-linked sections of other elements, these are specially unique π-electron materials possessing an extremely small nonradiative speed constant (6.2×10^7 s^{-1}) while maintaining a larger Stokes shift (4500 cm^{-1}).

Data courtesy of Prof. Sigehiro Yamaguchi and Dr. Aiko Fukazawa, Department of Chemistry, Graduate School of Science, Nagoya University
A. Fukazawa, M. Hara, T. Okamoto, E.-C. Son, C. Xu, K. Tamao, and S. Yamaguchi, *Org. Lett.*, **10**, 913-916 (2008).

Related products

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 (S_1), then deactivated to the ground state again. One is radiative process such as fluorescence and the other is a non-radiative process released as heat.

The fluorescence lifetime τ (tau) is defined as

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

where k_f is the radiative rate constant and k_{nr} 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 (PN_{em}) to that absorbed by molecules (PN_{abs}).

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

The PL Quantum Yield Φ is also written as

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

Thus, there is a correlation between τ (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 for everybody.

Combination of Quantaurus-Tau and Quantaurus-QY allow users to obtain complementary analysis results.

Compact Fluorescence Lifetime Spectrometer

Quantaurus-Tau®

Absolute PL Quantam Yieled Spectrometer

Quantaurus-QY®

Specifications

Type number	C11367-11	C11367-14	C11367-12	C11367-15
Sample	Solution, Thin-film	Solid (Thin-film, Powder)	Solution, Thin-film	Solid (Thin-film, Powder)
Detector type	Standard		NIR	
Wavelength range	300 nm to 800 nm		380 nm to 1030 nm	
Excitation light source	Seven types of LED light source (280 nm, 340 nm, 365 nm, 405 nm, 470 nm, 590 nm, 630 nm)			
Excitation light source switching	Software control			
Monochromator	Czerny-Turner monochromator			
Measurement time range	2.5 ns to 50 µs / full scale			
Phosphorescence measurement (Option)	50 µs to 50 ms / full scale			
	Phosphorescence excitation wavelength (280 nm, 340 nm, 370 nm, 405 nm, 445 nm, 470 nm, 590 nm, 630 nm)			
Time axis channel	512 ch, 1024 ch, 2048 ch, 4096 ch			
Total time resolution	< 1.0 ns FWHM (IRF with 365 nm LED)			
Analysis function	Fluorescence lifetime analysis (up to five components by exponential function fitting) and spectrum analysis			
Supported OS	Windows 7 (32 bit)			

Options

Sample box

Sample box for solution sample A12178-01

A12178-01 is a sample box for measuring the solution samples (standard: compatible with 10 mm square cells) or thin film samples. The normal sample box of C11367-11 or C11367-12 is A12178-01.

Sample box for solid sample A11551-01

A11551-01 is a sample box for measuring the powder samples or thin solid film samples. The normal sample box of C11367-14 or C11367-15 is A11551-01.

Sample box for dewar flask holder A11797-01

A11797-01 is a sample box for setting A11238-04 when measuring the life-time of a solution samples at liquid nitrogen temperature.

Sample holder

Dewar flask holder for low temperature measurement A11238-04

This is used to cool the solution sample with liquid nitrogen.

Sample holder for cryostat OPTISTAT DN

This is a sample holder for setting the OPTISTAT DN (cryostat).

Sample case

For solution

Side-arm cells (3 sets) A10095-02

Sample tube for low temperature measurement A10095-04

This is used to measure a sample solution at liquid nitrogen temperature.

For powder

Laboratory dish A10095-01, -03 (with cover)

This is used for making measurements on powder samples. This contains 5 dishes made of synthetic quartz, which suppresses fluorescence and luminescence.

Light source option

External light source connection adapter A11553-01

A11553-01 is used when excitation light source is Xe flash lamp for phosphorescence or YAG laser unit or PLP-10. It is necessary to attach A11553-01 to each of A12178-01 and A11797-01.

External light source connection adapter A11553-02

A11553-02 is used when excitation light source is Xe flash lamp for phosphorescence or YAG laser unit or PLP-10. A11553-02 is used by attaching to A11551-01.

Options for phosphorescence measurement C11567-01

These include xenon flash lamps, photon counting boards, and interference filter holders.

Bandpass filter Φ25 mm for C11567-01

Selectable from among the following wavelengths:
280 nm, 340 nm, 370 nm, 405 nm, 445 nm, 470 nm, 590 nm, and 630 nm.

YAG laser unit (532 nm) C12179-01

YAG laser output power : 30 mW, Pulse width : <1.0 ns, Repetition rate : 15 kHz

YAG laser unit (355 nm) C12179-02

YAG laser output power : 4.5 mW, Pulse width : <1.0 ns, Repetition rate : 15 kHz

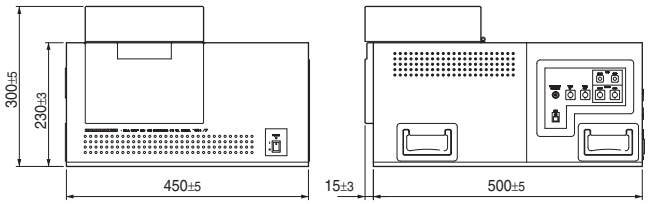
Picosecond Light Pulser PLP-10

The PLP-10 is picosecond light pulser which is used in combination with a controller C10196 and Laser Diode Head M12488 series.
Available to select the following wavelength by replacing Laser Diode Head;
375 nm, 405 nm, 445 nm, 473 nm, 485 nm, 515 nm, 655 nm, 785 nm, 850 nm

PLP adapter A12487-01

A12487-01 is adapter for attaching M12488 to Quantaurus-Tau. A12487-01 is used when excitation light source is the PLP-10.

Dimensional outlines (unit : mm) Weight : 32 kg



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