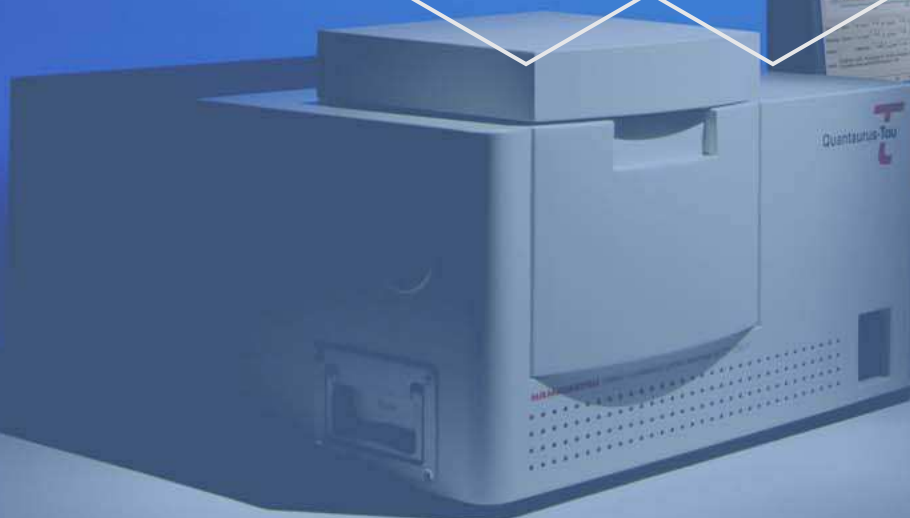
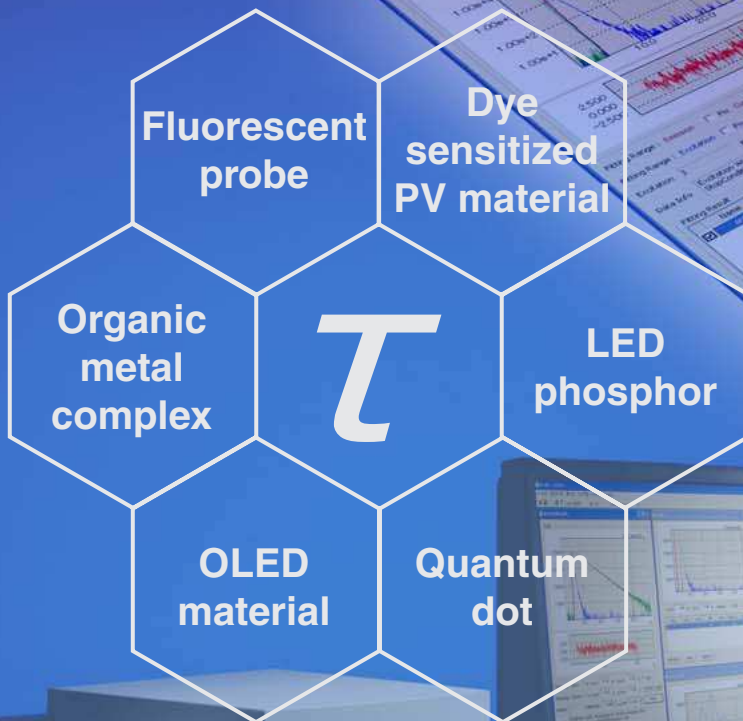
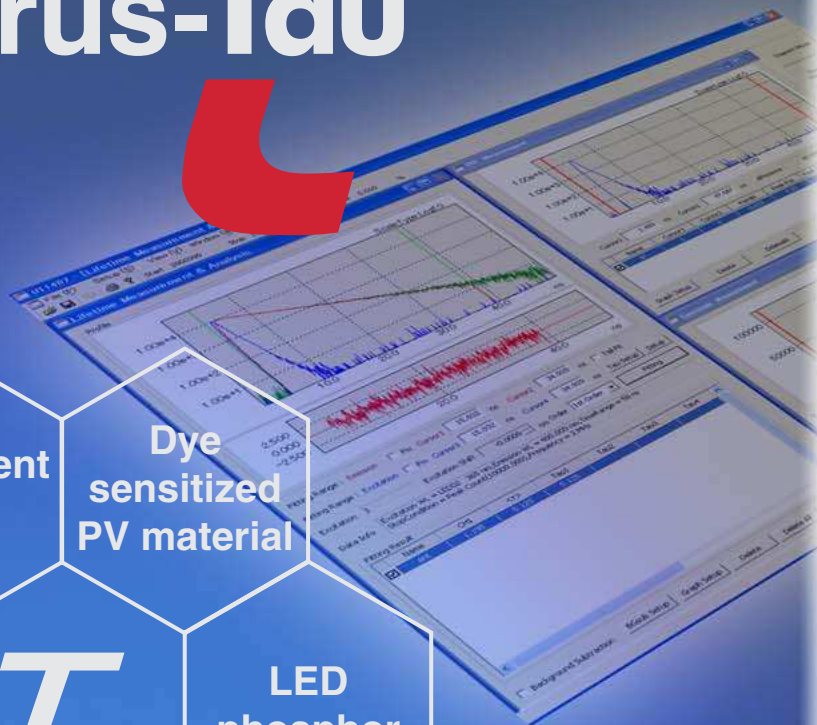


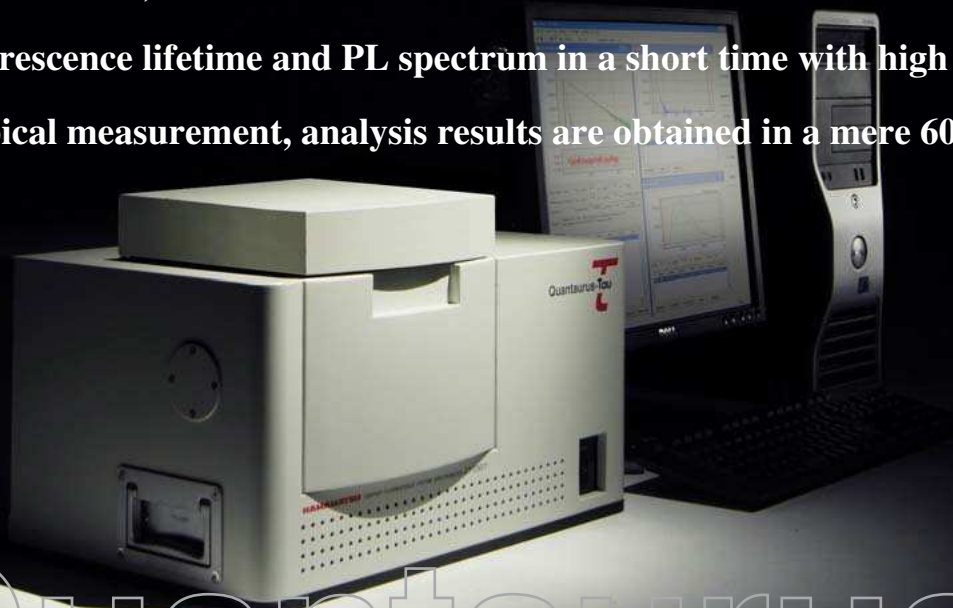
Compact Fluorescence Lifetime Spectrometer



# Quantaurus-Tau



**Quantaurs-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.**



# Quantaurs

## **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 rapid measurements

## 7 excitation wavelength choices

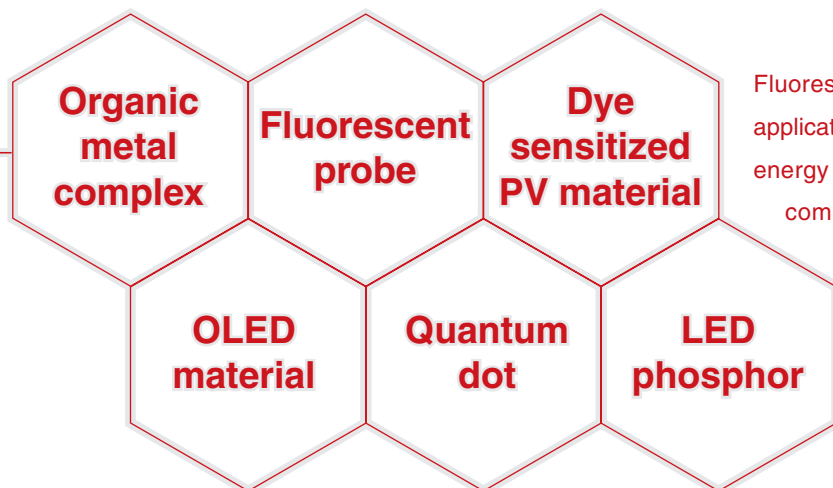
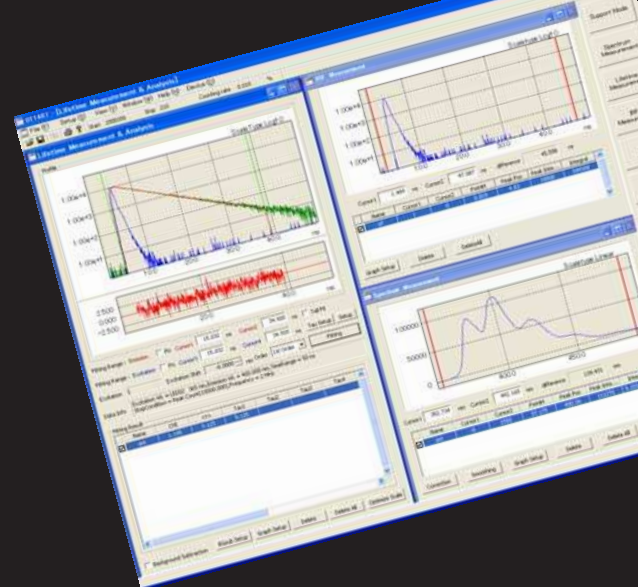
280 nm, 340 nm, 365 nm, 405 nm, 470 nm, 590 nm, or 630 nm.

## Analyzing different sample forms

Thin-film, solid, solutions and powder.

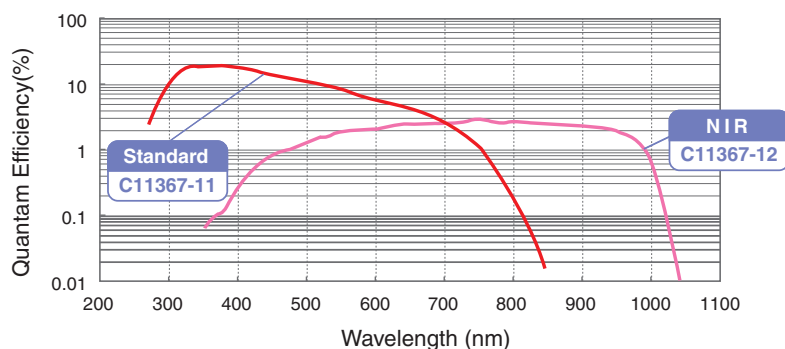
## 2 models available

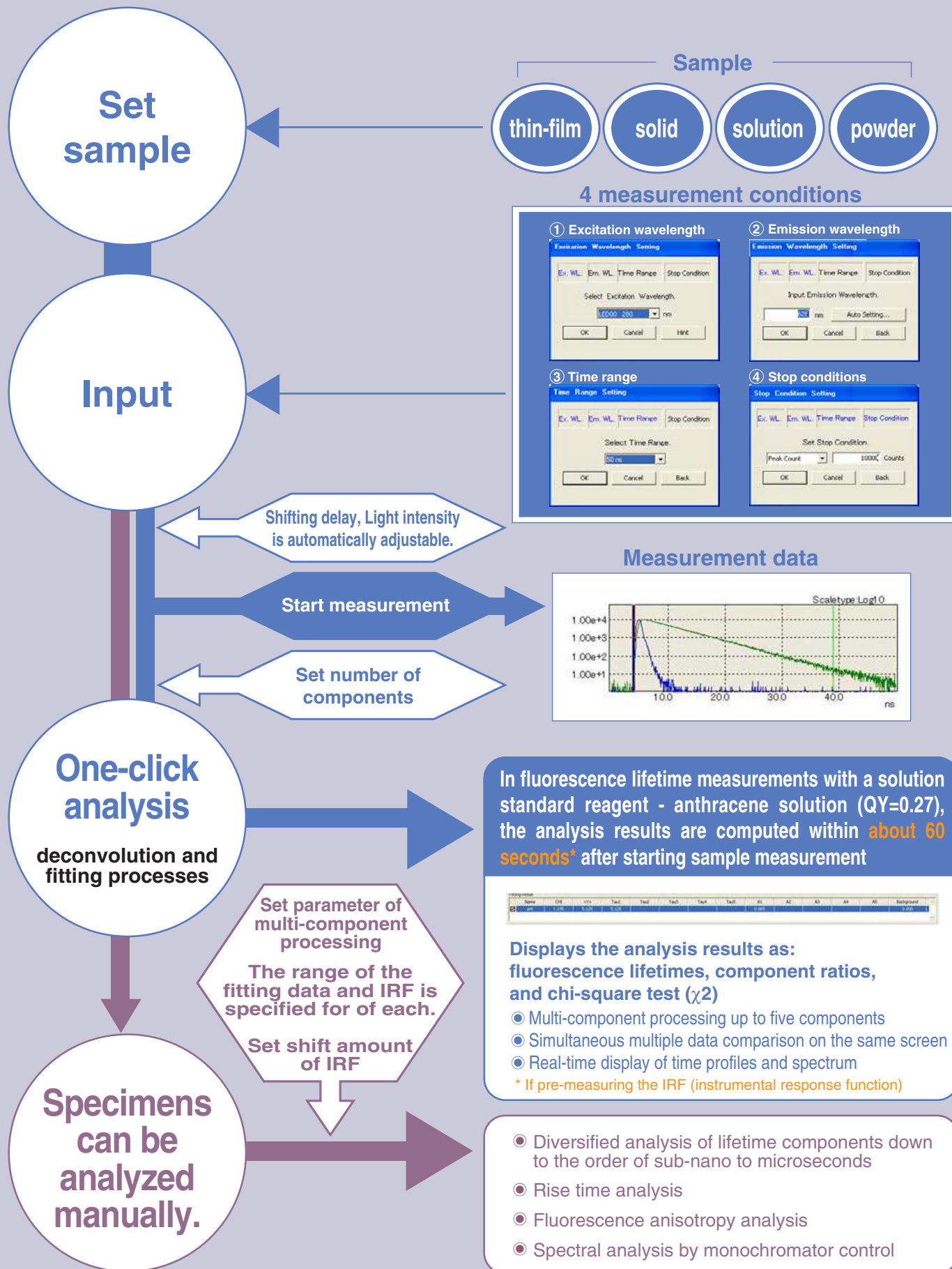
Standard	NIR
C11367-11	C11367-12
wavelength 300 nm to 800 nm	wavelength 380 nm to 1030 nm



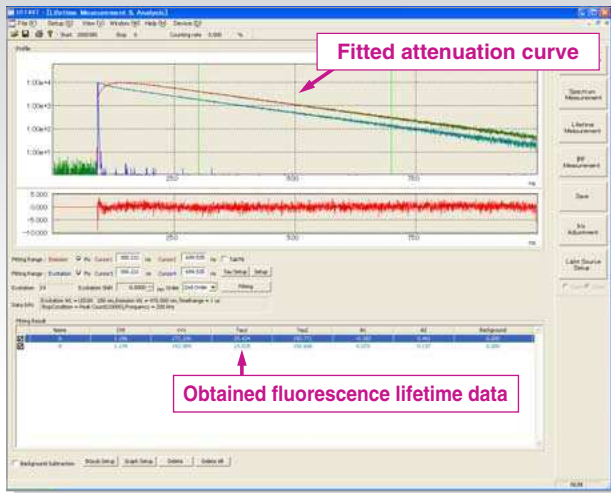
Fluorescence lifetime measurement is applicable to varied applications. Typical applications include electron movement and energy transfer reactions within or between organic metallic complex molecules, as well as fluorescence and phosphorescence lifetime measurement of materials essential for developing 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



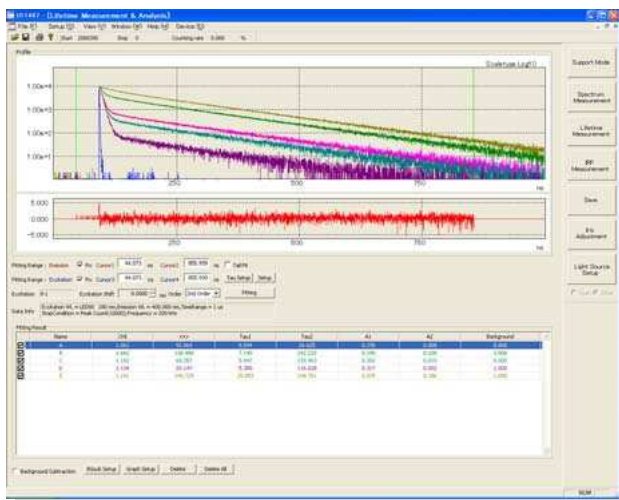


**Multi-component fluorescence lifetime analysis and comparison**



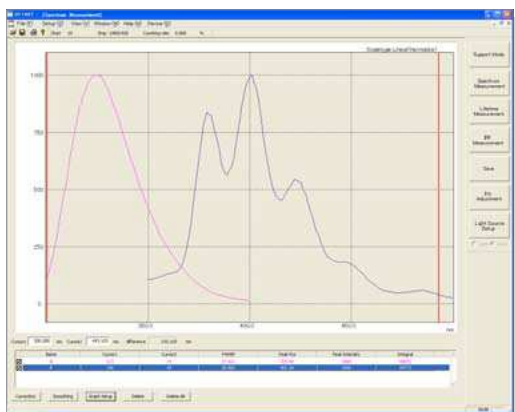
- **Multi-component analysis of up to five components**  
In fluorescence lifetime measurement, a phenomenon often occurs where the data is observed as the sum of the attenuation curves of multi-component fluorescence lifetimes. Quantaurus-Tau easily calculates the fluorescence lifetime and component 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**



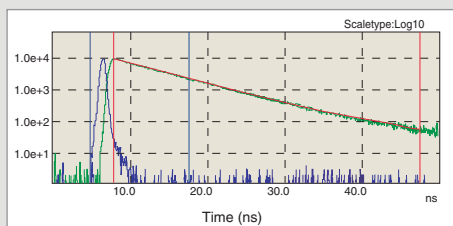
- **Multiple data analysis on the same screen**  
Calculated fluorescence lifetime values are also displayed on the same screen for easy comparison analysis.
- **Comparisons under the same fitting**  
To make comparison analysis under the same conditions, Quantaurus-Tau subjects the multiple samples 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**

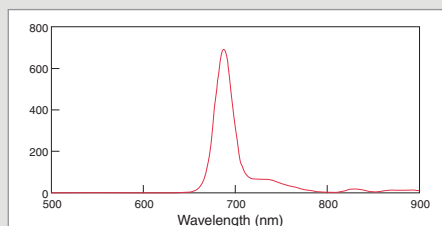
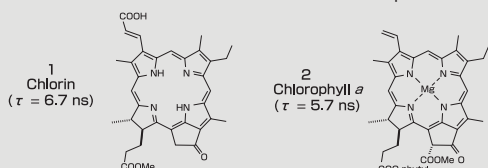


- **Time-resolved spectrum display**  
Allows time-resolved spectrum display the greatest feature offered by streak camera systems.
- **Spectrum and fluorescence decay curve display**  
Displays the full width at half maximum (FWHM), peak position and peak intensity for each profile
- **Multiple data loading and comparison on the same screen.**  
Normalized processing makes multiple data comparison easy.

### Dye measurement of dye-sensitized solar cells



Fluorescence lifetime measurement of chlorine compound THF solvent:  $\tau = 6.7$  ns

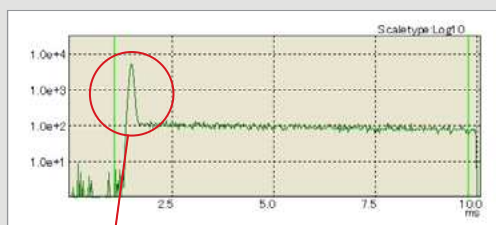


Fluorescence spectrum of chlorine compound: ex 412 nm,  $\phi = 0.26$

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<sub>2</sub>) requires certain optical parameters such as the fluorescence lifetime and quantum yield of the dye.

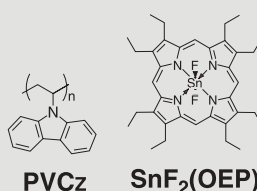
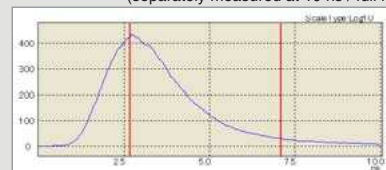
Data courtesy of Prof. Dr. Hitoshi Tamiaki, Mr. Yusuke Kinoshita  
Laboratory of Bioorganic Chemistry Institute of Science and Engineering Ritsumeikan University

### Thermally activated delayed fluorescence from organic LED material



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

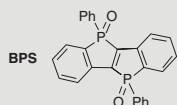
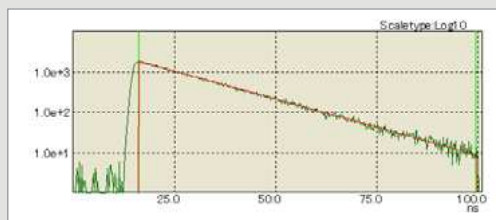
Fluorescence components (separately measured at 10 ns / full range)



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<sub>1</sub>) to a minimum singlet excitation level (S<sub>1</sub>). 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



Ladder type  $\pi$ -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  $\pi$  conjugation length as well as a high quantum yield ( $\phi = 0.98$ ). Moreover, measuring the fluorescence lifetime showed a result of  $\tau = 15.7$  ns. From this results it is clear that, compared to stilbene compounds with cross-linked sections of other elements, these are specially unique  $\pi$ -electron materials possessing an extremely small nonradiative speed constant ( $6.2 \times 10^7$  s<sup>-1</sup>) while maintaining a larger Stokes shift (4500 cm<sup>-1</sup>).

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).

## 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  $\tau$  (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 ( $\phi$ ) is expressed as the ratio of the number of photons emitted from molecules ( $PN_{em}$ ) to that absorbed by molecules ( $PN_{abs}$ ).

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

However the PL Quantum Yield  $\phi$  is also written as

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

Thus, there is a close relationship between  $\tau$  (tau) and  $\phi$  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 now available!

Newly developed Quantaurus-Tau for measuring fluorescence lifetime and Quantaurus-QY for absolute PL quantum yield with simplified and minimized operating procedure are now 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 Quantum Yield Spectrometer

**Quantaurus-QY**



## Specifications

Type number	C11367-11	C11367-12
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	
Sample holder	For solution (standard: compatible with 10 mm square cells)	
Measurement time range	2.5 ns to 50 $\mu$ s / full scale	
Phosphorescence measurement	50 $\mu$ s to 50 ms / full scale	
Polarized light measurement	Phosphorescence excitation wavelength (280 nm, 340 nm, 370 nm, 405 nm, 445 nm, 470 nm, 590 nm, 630 nm) Supports UV measurement (option: A11552-02 is required.)	
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 and spectrum analysis up to five components by exponential function fitting	

## Options

### Sample holder

- **Sample holder for solid sample measurement A11551-01**  
This is used for measurement of powder or thin film samples.
- **Dewar flask holder for low temperature measurement A11238-04**  
This is used to cool the sample solution with liquid nitrogen.
- **Sample holder for cryostat OPTISTAT DN**  
This sample holder is designed for 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.

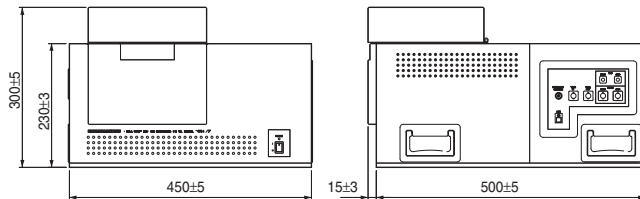


### Light source option

- **Adapter for external light source connection A11553-01**  
This is used with a xenon flash lamp for phosphorescence, YAG laser unit, or external laser.
- **Options for phosphorescence measurement C11567-01**  
These include xenon flash lamps, photon counting boards, and interference filter holders.
- **Bandpass filter  $\phi$ 25 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) C8597-02**  
YAG laser output : 30 mW, Pulse width : <1.0 ns, Repetition rate : 15 kHz
- **YAG laser trigger adapter A8598-12**  
This is a trigger adapter for the C8597-02 and allows adjusting the excitation light intensity.

### Dimensional Outlines

(unit : mm) weight : 32 kg



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