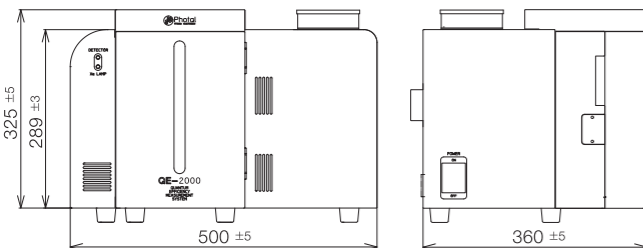


Specifications

Model no.	3683C		311C		2580C		3095C	
Detecting wavelength	360–830nm		360–1100nm		250–800nm		300–950nm	
Theoretical resolution per pixel	1.0nm	0.5nm	1.6nm	0.8nm	1.2nm	0.6nm	1.4nm	0.7nm
Number of channel pixel	512ch	1024ch	512ch	1024ch	512ch	1024ch	512ch	1024ch
Detector	Electro-cooling CCD Image Sensor 512 ch							
AD resolution	16bits							
Spectrometer optics	Flat Field Type F=3 f=85.8mm							
Excitation light source								
Light source	150W Xenon Lamp							
Excitation wavelength	250–800nm							
Band width	FWHM 5nm / Slit 0.6mm							
Protection from excitation light	Automatic Shutter							
Control	Automatic							
Integrating sphere								
Material	Spectralon							
Size	∅ 150mm Hemisphere <i>HalfMoon</i>							
Sample holder								
For powder	SUS 304, w/o Quartz Cover							
For liquid (room temperature)	Quartz Solution Cell(open type)							
Utility								
Supply voltage	AC100–120V/AC 200–230V							
Software								
	Quantum efficiency (yield) Excitation wavelength dependency of Quantum Efficiency (yield) Reflectance spectra PL excitation spectra EEM (Excitation Emission Matrix)				Re-Excitation vcorrection Emission Spectra Transmittance / Absorption spectra Color calculation (Chromaticity, CCT, Ra, etc.)			

Size (mm) Weight: ca. 28kg



Related Products

Quantum Efficiency Measurement System (Separate type) QE-2100

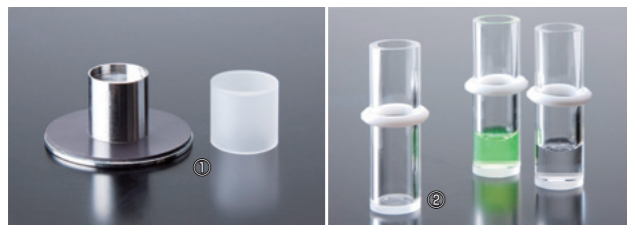


Each component separately configured makes upgrading easier for user's application in addition to standard functions

- Optional temperature control function(50–300°C) enables temperature dependency analysis of quantum efficiency(yield)
- Flexible geometry configuration by application for various sample needs
- Detector can be used for total luminous flux and goniophotometer measurement
- Other wavelength ranges are available
- Broadband model (300–1600nm) is available

Optical Equipments

- Auto Sampler
- Sample Cell
 - ① for Powder : SUS 304 w/t Quartz cover
 - ② for Film : Sample Holder for film sample



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July 19, 2013

OTSUKA ELECTRONICS

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<http://www.photal.co.jp/>

Quantum Efficiency Measurement System

QE-2000



OTSUKA ELECTRONICS CO.,LTD.



**No Absolute Test,
No Accuracy**

Quantum Efficiency Measurement System | QE-2000

3 Key Features

Accurate

- Instant absolute quantum efficiency (yield) measurement
- Re-excitation eliminating function
- Optically optimized geometry using integrating hemisphere
- Low stray light array spectrometer for detector

Easy

- User friendly software
- Easy cell loading and unloading
- Compact
- Excitation wavelength is selectable by user's choice
- Automatic measurement after choosing wavelength and intervals.

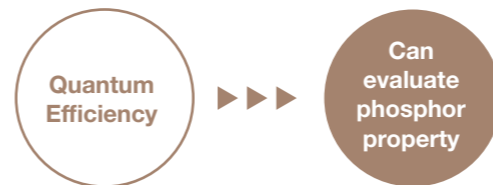
Multi Functions

- Versatile samples; powder, liquid, solid and film
- Various analysis functions
 - Quantum efficiency (yield)
 - Excitation wavelength dependency
 - Emission spectrum
 - PL excitation spectrum
 - EEM (Excitation Emission Matrix)

Applications

- ▶ LED and OLED Materials
- ▶ Thin film state sample such as Remote Phosphor
- ▶ Quantum dot, fluorescent probe, biotechnology, clathrate
- ▶ Dye sensitized solar cell
- ▶ Complex Chemistry

Introduction to **QE-2000**



The QE-2000 Quantum Efficiency Measurement System has been designed for your every needs of quantum efficiency (yield) measurement. You will be guided by user-friendly software from cell loading to measure and analysis in a short time.

Using high precision detector, QE-2000 gives accurate results by calculating absolute quantum efficiency (yield) from photons emitted and photons excited

	Conventional	QE-2000
Powder	Goniophotometric method	<ul style="list-style-type: none"> • Measure in integrating hemisphere
Liquid	Comparison between known sample and target sample	<ul style="list-style-type: none"> • Measure only target sample • Measure in integrating hemisphere

- Easy
- Quick
- Compact
- No dark room needed

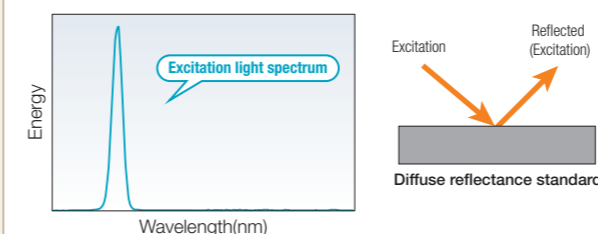
- Quick
- No preparation
- No known value sample needed

*1: Calibrated by national standard light source based upon Japan Calibration Service System (JCSS)

Quantum efficiency measurement process

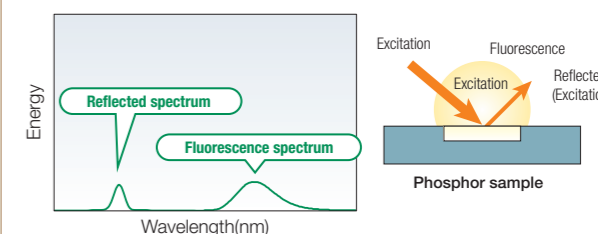
Reference measurement

Excitation light is reflected at diffuse reflectance standard

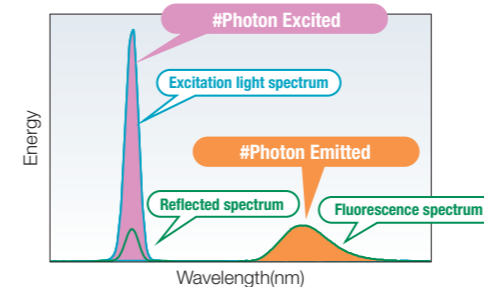


Sample measurement

Excitation light reflected at sample and fluorescent light

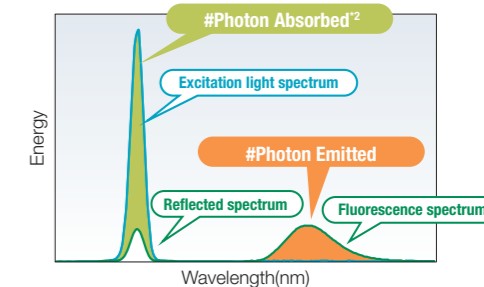


Calculate external quantum efficiency (yield)



$$\eta_{\text{external}} = \frac{\text{\#Photon Emitted}}{\text{\#Photon Excited}}$$

Calculate internal quantum efficiency (yield)



$$\eta_{\text{internal}} = \frac{\text{\#Photon Emitted}}{\text{\#Photon Absorbed}^2}$$

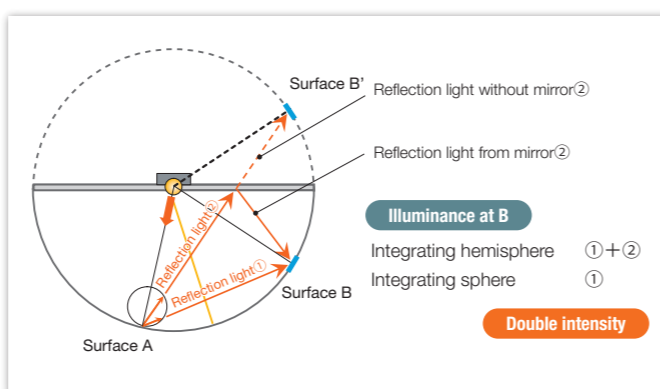
*2: The number of Photon Absorbed into phosphor sample

Otsuka innovative technologies to achieve high accuracy quantum efficiency (yield) measurement

Fact 1 Optimized geometry using integrating hemisphere

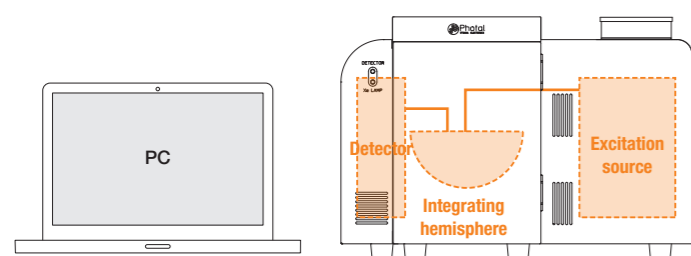
QE-2000 equips integrating hemisphere which has various unique features what others don't have.

- Optimized geometry enables non-emissive part locating outside making self-absorption effect minimized
- Mirror surface to achieve approx. double illuminance than existing integrating (full)sphere
- Easy cell loading and unloading to reduce the risk of damaging inside of sphere

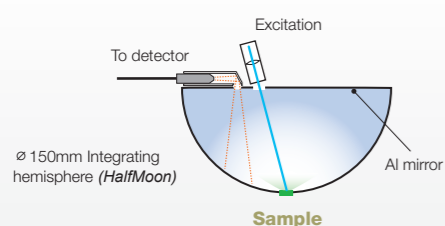


Japan Patent No.: 4216314, US Patent No.: 7283222

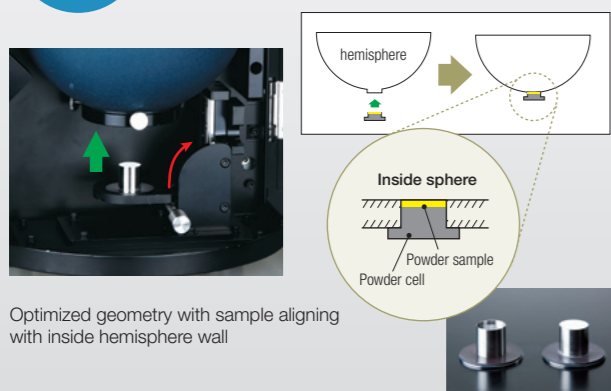
Optics



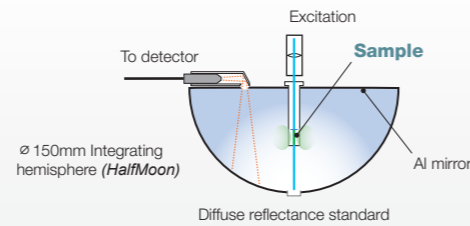
■ Powder, Solid sample



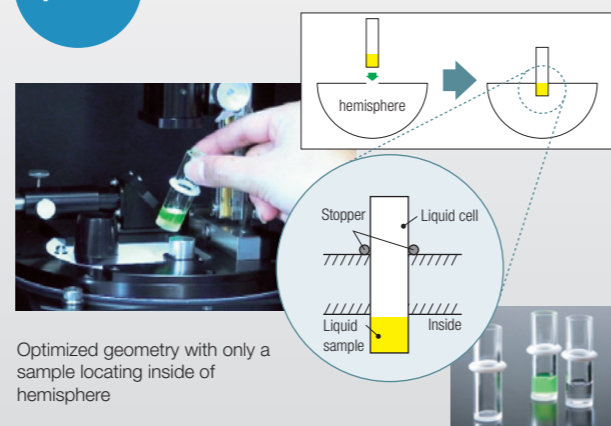
Easy Operation Easy cell loading and unloading Up / Down lever



■ Liquid sample



Easy Operation Cell being loaded and unloaded on hemisphere

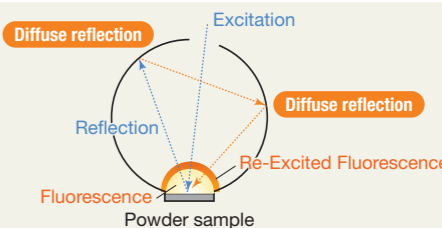


Fact 2 Re-excitation eliminating function for "True property"

True property cannot be obtained under the condition of re-excitation emission being included because apparatus property is included. Making use of advantage of integrating hemisphere, QE-2000 enables accurate measurement using re-excitation eliminating functions.

What is re-excitation?

Excitation light reflected by phosphor sample will be diffuse reflected in the sphere. And this reflected excitation light will go to sample again.



■ Powder

Japan Patent No.: 3287775
Japan Patent No.: 4631080, US Patent No.: 8119996, Korea Patent No.: 10-1034716

- 1. Measure reference (Excitation)**
To detector: Excitation
Diffuse reflectance standard
Excitation light spectrum
- 2. Measure fluorescence spectrum**
To detector: Excitation
Powder sample
Excitation reflection spectrum
Fluorescence spectrum
- 3. Measure Re-Excited fluorescence spectrum**
To detector: Excitation
Powder sample
Re-Excited fluorescence spectrum

Calculate internal quantum efficiency (yield)

#Photon Absorbed
#Photon Emitted - #Photon Re-Excited Fluorescence
Wavelength(nm)
Energy

$$\eta(in) = \frac{\text{\#Photon Emitted} - \text{\#Photon Re-Excited Fluorescence}}{\text{\#Photon Absorbed}}$$

■ Solution

US Patent No.: 8422018
US Patent No.: 8415639

- 1. Measure reference (Excitation)**
To detector: Excitation
Diffuse reflectance standard
Solvent
Excitation light spectrum
- 2. Measure sample**
Measure transmission excitation and fluorescence
To detector: Excitation
Standard reflection plate
Solution sample
Transmission excitation spectrum
- 3. Measure sample**
Measure fluorescence without re-excitation (Transmitted excitation light goes through the bottom hole).
To detector: Excitation
Solution sample
Fluorescence spectrum

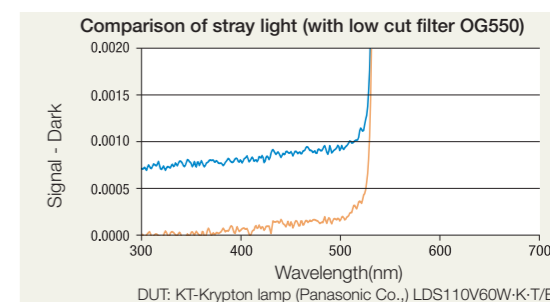
Calculate internal quantum efficiency (yield)

#Photon Absorbed
#Photon Emitted
Wavelength(nm)
Energy

$$\eta(in) = \frac{\text{\#Photon Emitted}}{\text{\#Photon Absorbed}}$$

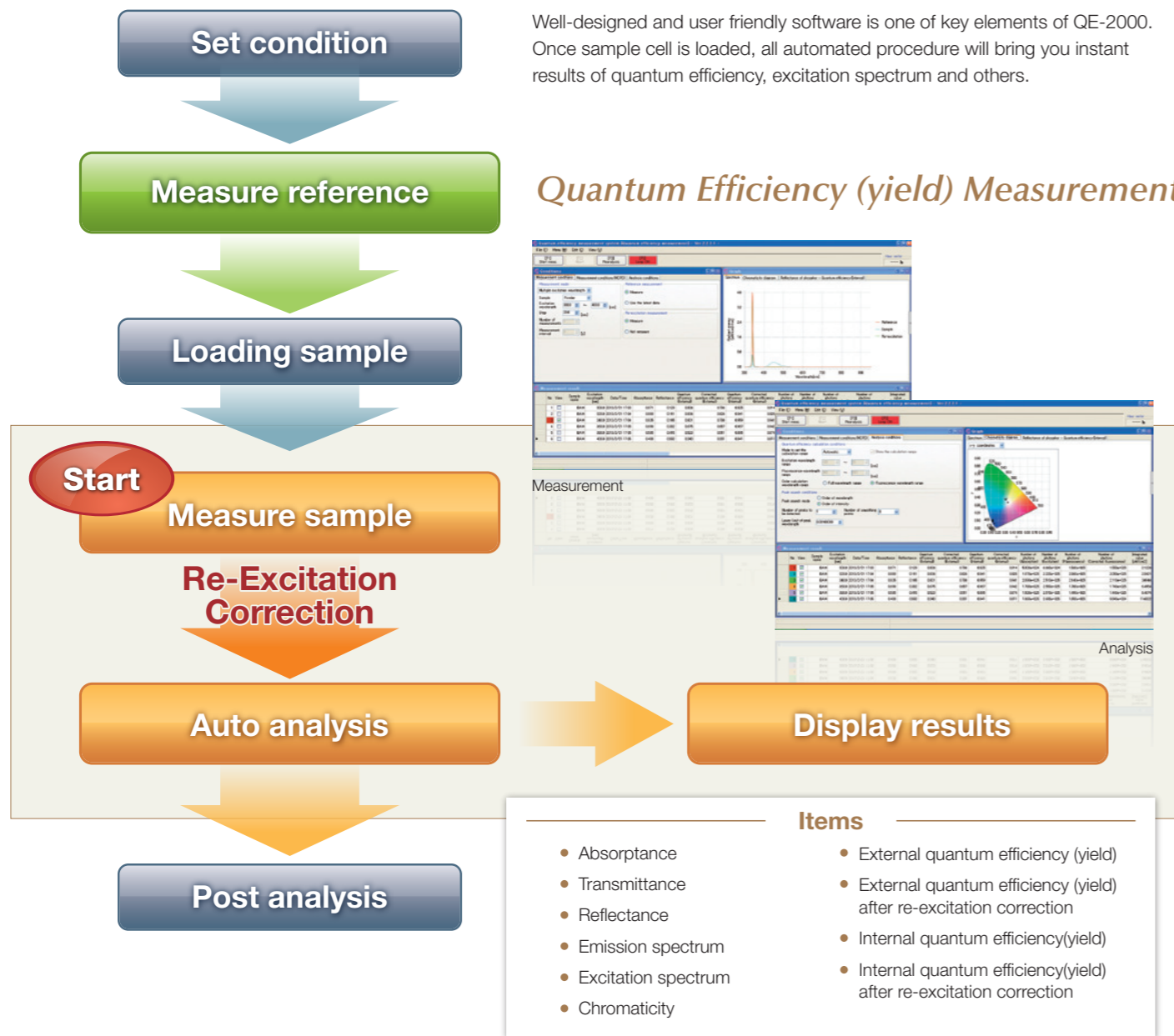
Fact 3 Low stray light array spectrometer for reducing stray light in UV region

Instead of existing detector which gave significant amount of stray light, Otsuka newly invented a stray light eliminating solution. It is clearly seen that the array spectrometer used for QE-2000 has stray light 1/5 of the existing model (orange-colored spectrum).



Japan Pat.No:5150939

Operation simplicity, high accuracy, fully automated from start to end



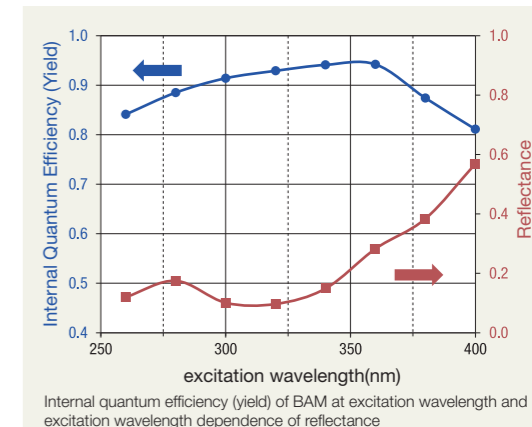
Powder application

Multi excitation of BAM

The quantum efficiency (yield) depends on excitation wavelength. The relationship between quantum efficiency (yield) of BAM and excitation wavelength is shown on the right. (BAM = BaMgAl₁₀O₁₇:Eu)

- Blue(left): Internal quantum efficiency (yield) after re-excitation correction
- Red(right): Reflectance at each excitation wavelength

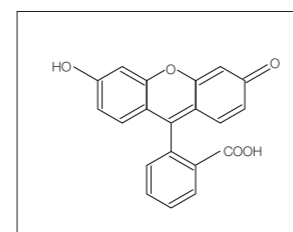
In case of BAM from above study, the closer to visual range the excitation wavelength is, the lower absorbance becomes, in another word the higher reflectance.



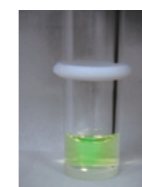
Solution application

Excitation spectrum of Fluorescein

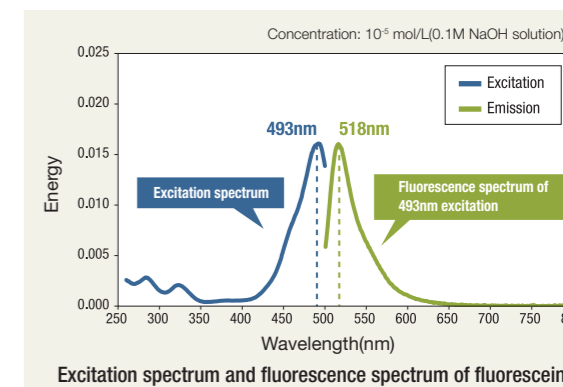
The excitation spectrum is the spectrum showing at which wavelength fluorescence intensity becomes max. Excitation spectrum of fluorescein (blue) and emission spectrum at 493nm excitation where fluorescence intensity becomes maximized (green).



Fluorescein structure

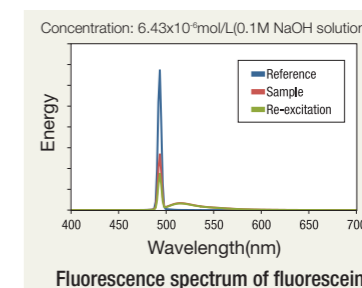


Excitation at 493nm hit from the top gives green beam in the center.



Internal quantum efficiency (yield) of fluorescein

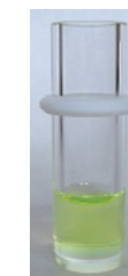
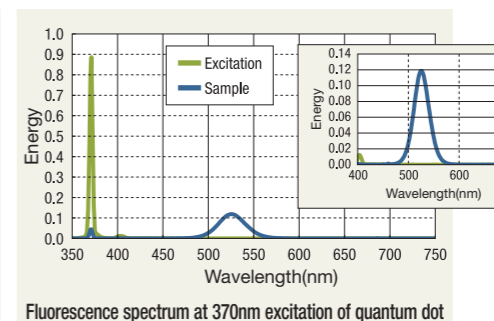
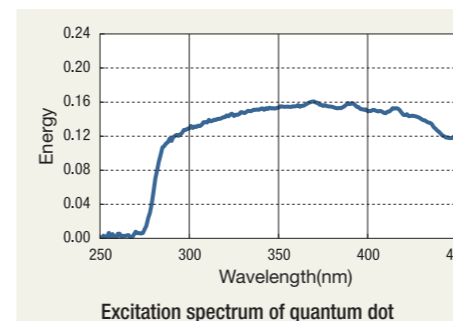
Fluorescence spectrum (including excitation) of fluorescein solution at 493nm excitation wavelength is shown on right. The internal quantum efficiency (yield) was calculated as 0.903(Concentration: 6.43x10⁻⁶ mol/L) which is equivalent with literature value.



1) G. Weber and F. W. J. Teale, *Trans Faraday Soc* **53**, 646(1957)

Internal quantum efficiency (yield) of quantum dot

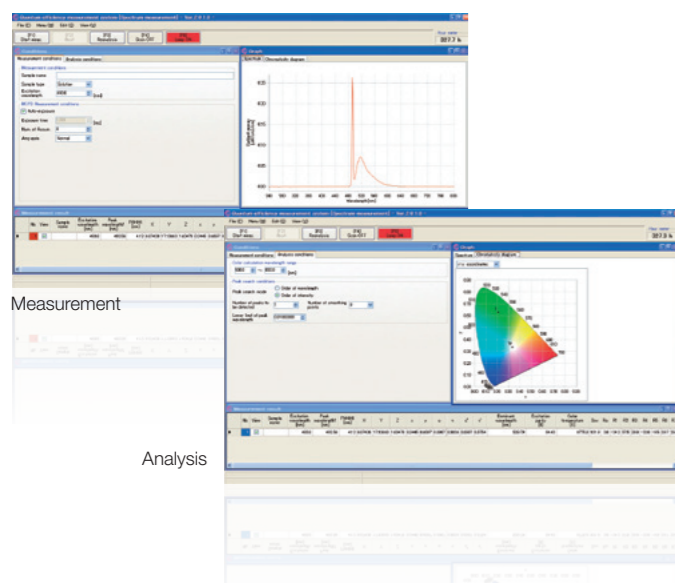
Quantum dot is a new material which works in choosing optical property by changing its chemical structure. Excitation spectrum and fluorescence spectrum at 370nm excitation wavelength of quantum dot are shown as below.



Quantum dot

Sample : provided from Nanosquare Inc

Fluorescence spectrum



Multi excitation spectra

