Photal
OTSUKA ELECTRONICS

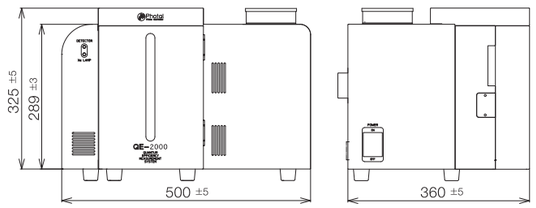
Specifications

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 *HalfMoon*							
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.)

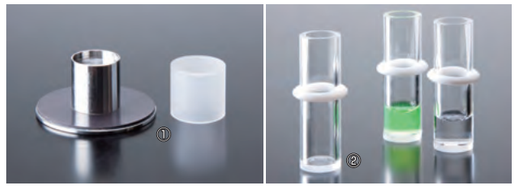
Size (mm)

Weight: ca. 28kg



Optical Equipments

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



Related Products

Quantum Efficiency Measurement System
(Separate type) QE-2100

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

- Optional temperature control function(50–300℃) enables temperature dependence 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 range is available.
- Broadband mode (300–1600nm) is available

OTSUKA ELECTRONICS

3-26-3, Shodai-Tajika, Hirakata-shi, Osaka, 573-1132, Japan
Tel. +81-72-855-8550 Fax. +81-72-855-8557

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

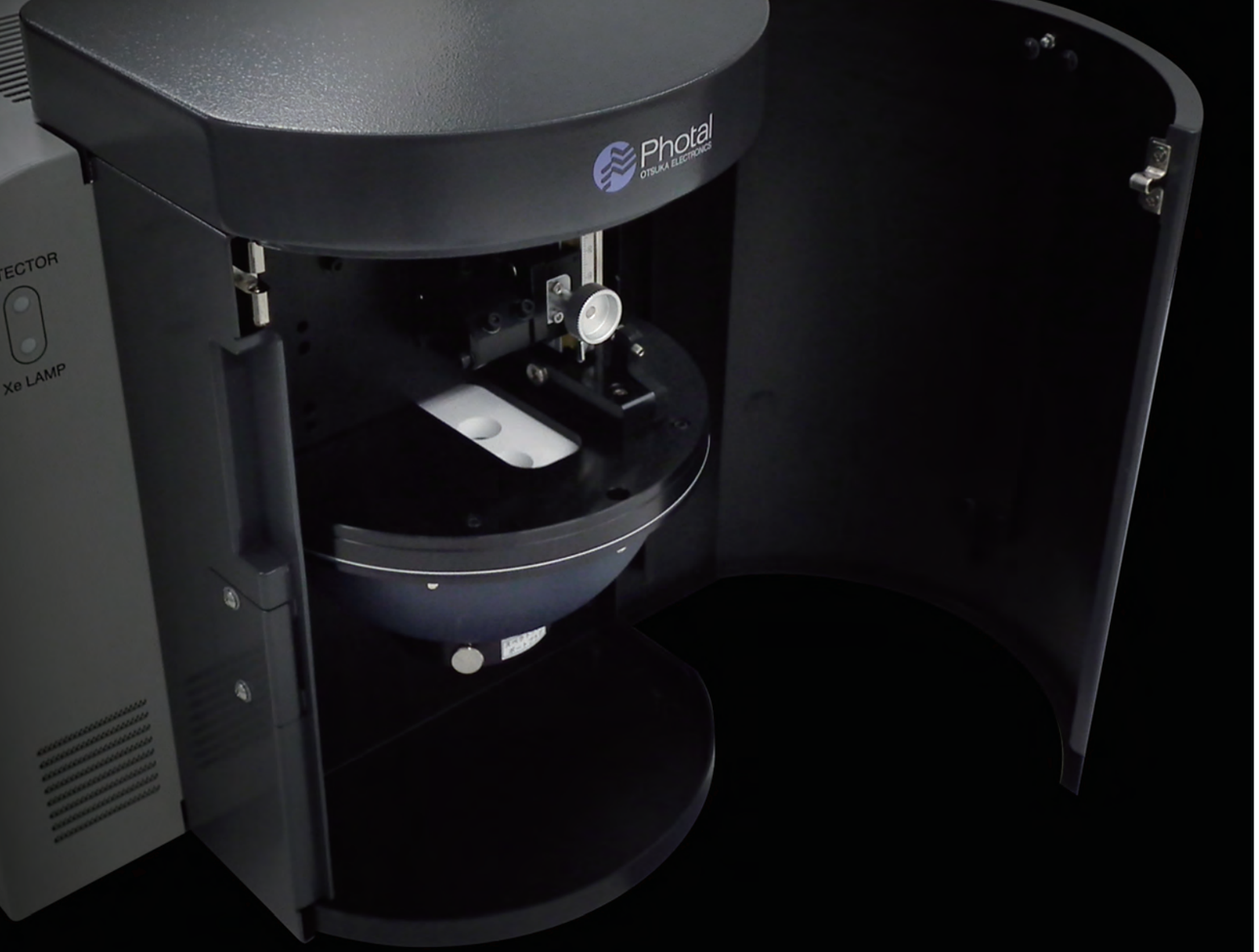
May 17. 2013

Photal
OTSUKA ELECTRONICS

Quantum Efficiency Measurement System

QE-2000

OTSUKA ELECTRONICS CO.,LTD.



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

Quantum Efficiency ▶▶▶ Can evaluate phosphor property

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

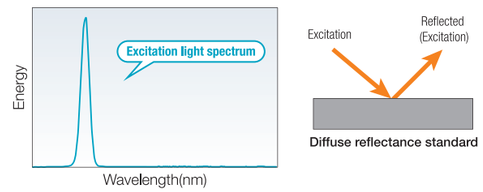
	Conventional	QE-2000	
Powder	Goniophotometric method	• Measure in integrating hemisphere	• Easy • Quick • Compact • No dark room needed
Liquid	Comparison between known sample and target sample	• Measure only target sample • Measure in integrating hemisphere	• Quick • No preparation • No known value sample needed

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

Quantum efficiency measurement process

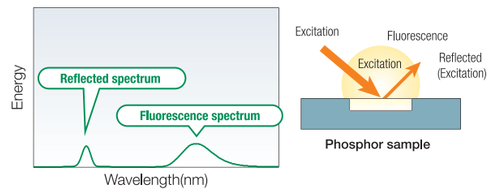
Reference measurement

Excitation light is reflected at diffuse reflectance standard

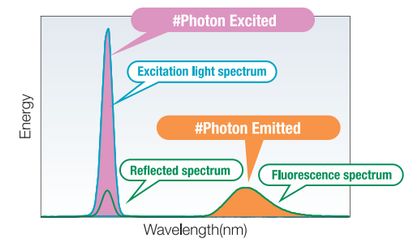


Sample measurement

Excitation light reflected at sample and fluorescent light

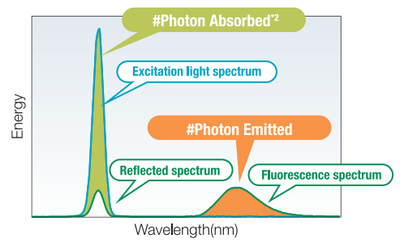


Calculate external quantum efficiency (yield)



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

Calculate internal quantum efficiency (yield)



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

*2: The number of Photon Absorbed into phosphor sample

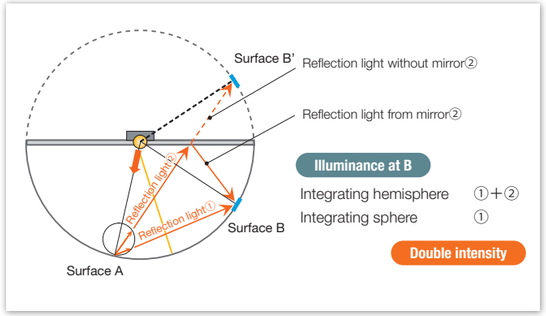
Otsuka innovative technologies to achieve high accuracy quantum efficiency (yield) measurement

Fact 1 Optimized geometry using integrating hemisphere

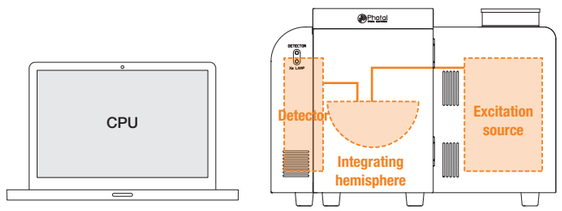
QE-2000 equips integrating hemisphere which has various unique features what others don't have.

- 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

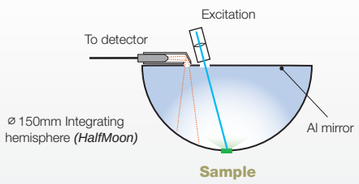
Japan Patent No.: 4216314, US Patent No.: 7283222



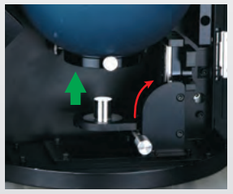
Optics

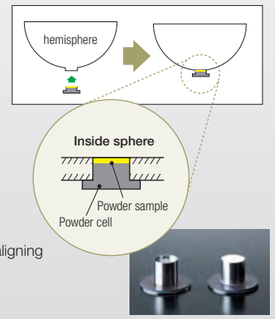


Powder, Solid sample



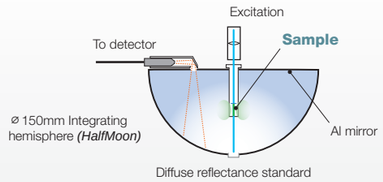
Easy Operation Easy cell loading and unloading Up / Down lever



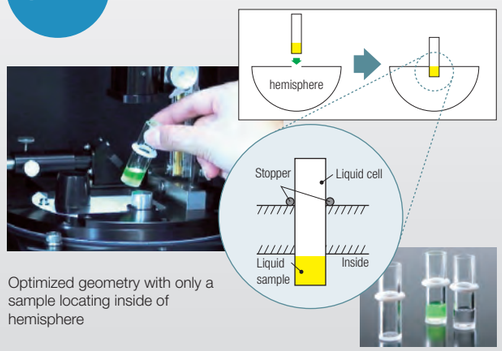


Optimized geometry with sample aligning with inside hemisphere wall

Liquid sample



Easy Operation Cell being loaded and unloaded on hemisphere



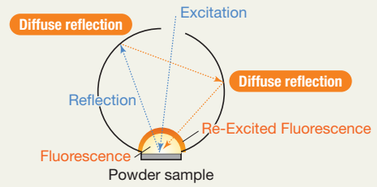
Optimized geometry with only a sample locating inside of hemisphere

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.

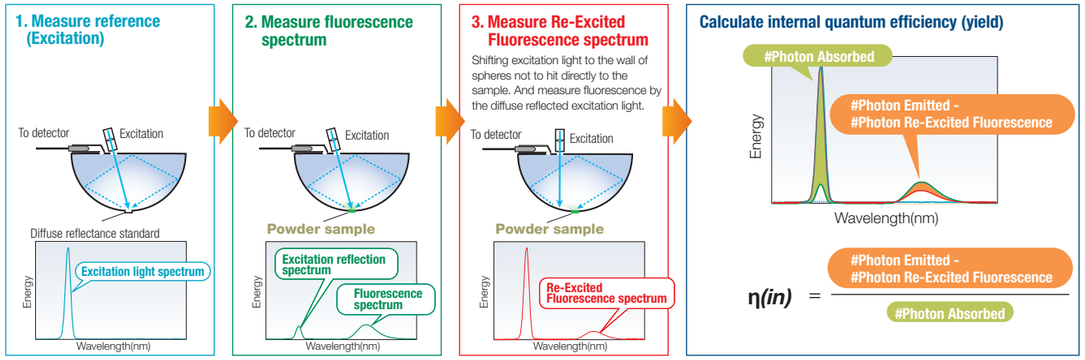
What is re-excitation?

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



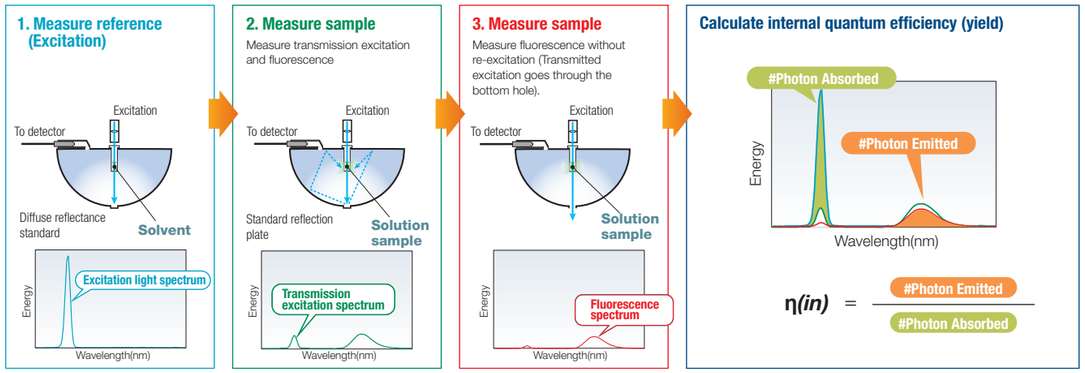
Powder

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



Solution

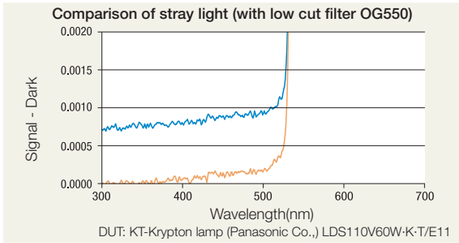
US Patent No.: 8422018
US Patent No.: 8415639



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

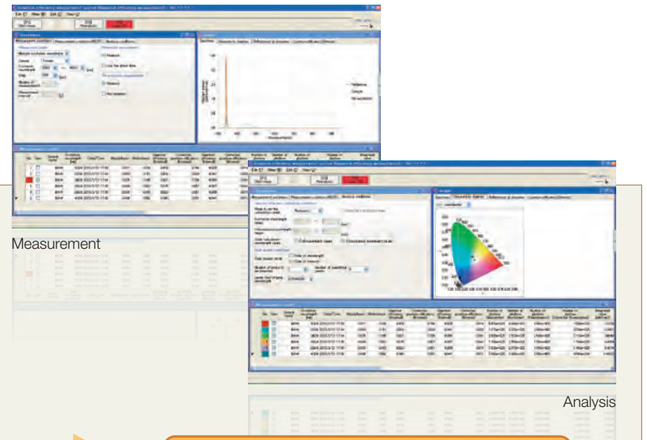


Operation simplicity, high accuracy, fully automated from start to end

Set condition → Measure reference → Loading sample → Start → Measure sample → Re-Excitation Correction → Auto analysis → Display results → Post analysis

Well-designed and user friendly software is one of key elements of QE-2000. Once sample cell is loaded, all automated procedure will bring you instant results of quantum efficiency, excitation spectrum and others.

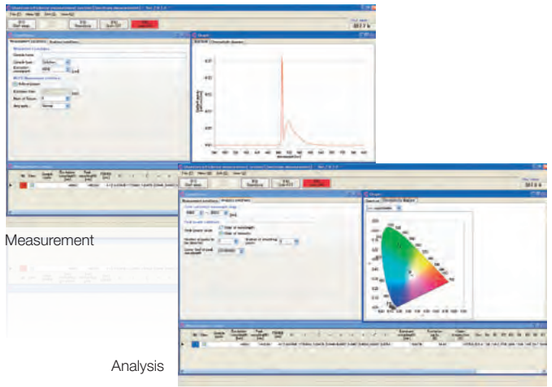
Quantum Efficiency (yield) Measurement



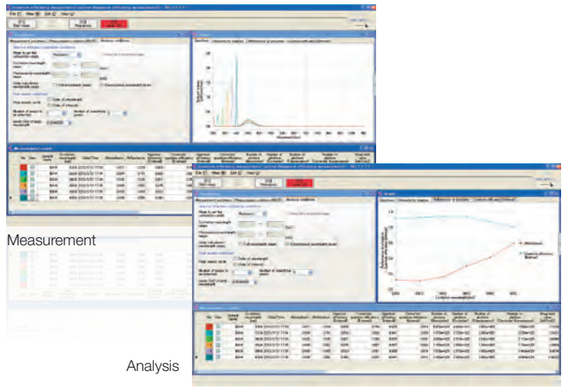
Items

- Absorptance
- Transmittance
- Reflectance
- Emission spectrum
- Excitation spectrum
- Chromaticity
- External quantum efficiency (yield)
- External quantum efficiency (yield) after re-excitation correction
- Internal quantum efficiency(yield)
- Internal quantum efficiency(yield) after re-excitation correction

Fluorescence spectrum



Multi excitation spectra



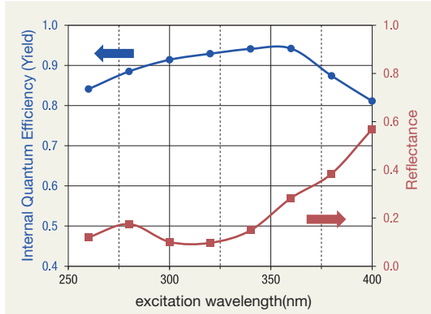
Powder application

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 right. (BAM = $BaMgAl_{10}O_{17}$: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 absorptance becomes, in another word the higher reflectance.

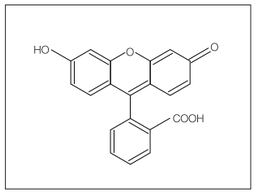


Internal quantum efficiency (yield) of BAM at excitation wavelength and excitation wavelength dependence of reflectance

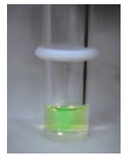
Solution application

Excitation spectrum of Fluorescein

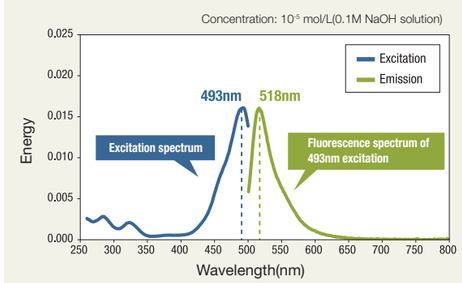
The excitation spectrum is the spectrum showing at which wavelength fluorescence intensity becomes max. Excitation spectrum of fluorescein (blue) and emission spectrum at 493nm excitation where fluorescence intensity becomes maximized (green).



Fluorescein structure



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

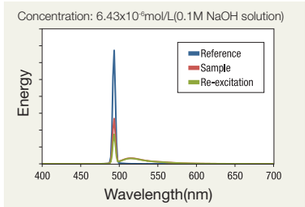


Excitation spectrum and fluorescence spectrum of fluorescein

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: 6.43×10^{-6} mol/L) which is equivalent with literature value.

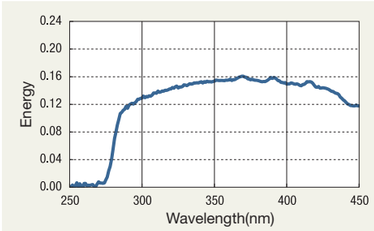
1) G. Weber and F. W. J. Teale, *Trans Faraday Soc* **53**, 646(1957)



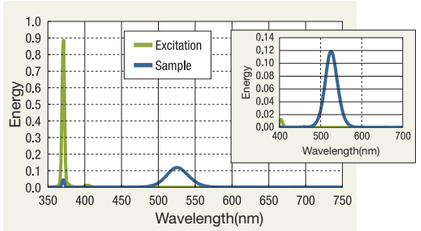
Fluorescence spectrum of fluorescein

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.



Excitation spectrum of quantum dot



Fluorescence spectrum at 370nm excitation of quantum dot

Quantum dot

Sample : provided from Nanosquare Inc