### Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>3610C</th>
<th>3110C</th>
<th>2460C</th>
<th>3065C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detecting wavelength</td>
<td>300–1500nm</td>
<td>300–1500nm</td>
<td>250–450nm</td>
<td>300–1500nm</td>
</tr>
<tr>
<td>Theoretical resolution per pixel</td>
<td>1.4nm</td>
<td>0.6nm</td>
<td>1.2nm</td>
<td>0.6nm</td>
</tr>
<tr>
<td>Number of (spatial) pixels</td>
<td>512x512</td>
<td>1024x1024</td>
<td>512x512</td>
<td>1024x1024</td>
</tr>
<tr>
<td>Detector</td>
<td>Electro-cooling CCD Image Sensor</td>
<td>512x512</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AD resolution</td>
<td>16bits</td>
<td>16bits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spectral sensitivity</td>
<td>Flat Field Type F=3 f=85.8mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excitation light source</td>
<td>150W Xenon Lamp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light source</td>
<td>250–800nm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bandwidth</td>
<td>FWHM 5nm / SL 0.6mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection from excitation light</td>
<td>Automatic Shutter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>Automatic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrating sphere</td>
<td>Automatic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>Specimen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>150mm Hemisphere HalfMoon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample holder</td>
<td>SUS 304, w/o Quartz Cover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For powder</td>
<td>250–800nm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For liquid (room temperature)</td>
<td>Quartz Solution Cell/open type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility</td>
<td>AC100–1200V/AC 200–230V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software</td>
<td>Quantum efficiency (yield)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantum efficiency (yield)</td>
<td>Re-Excitation correction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excitation wavelength dependency of Quantum Efficiency (yield)</td>
<td>Emission Spectra</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflectance spectra</td>
<td>Transmission / Absorption spectra</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PL excitation spectra</td>
<td>Color calculation (Chromaticity, CCT, Ra, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EEM (Excitation Emission Matrix)</td>
<td>Spectralon</td>
<td></td>
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</tr>
</tbody>
</table>

### Size (mm)

- Weight: ca. 28kg

### Optical Equipments

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

### Related Products

**Quantum Efficiency Measurement System**
- QE-2000

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 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

- May 17, 2013

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Introduction to QE-2000

The QE-2000 Quantum Efficiency Measurement System has been designed for your every need 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.

<table>
<thead>
<tr>
<th>Conventional</th>
<th>QE-2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powder</td>
<td>Gonioscopic method</td>
</tr>
<tr>
<td>Liquid</td>
<td>Comparison between known sample and target sample</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Easy
- Quick
- Compact
- No dark room needed
- Quick
- No preparation
- No known value sample needed

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

3 Key Features

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

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

- 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, ultraviolet light
- Dye sensitized solar cell
- Complex Chemistry

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)

\[
\eta_{\text{external}} = \frac{\text{Number of Photoemitted}}{\text{Number of Photons Excited}}
\]

Calculate internal quantum efficiency (yield)

\[
\eta_{\text{internal}} = \frac{\text{Number of Photons Excited}}{\text{Number of Photons Absorbed}}
\]

*2: The number of Photon Absorbed by 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

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

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).
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 right. (BAM = BaMgAl<sub>10</sub>O<sub>17</sub>: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.

**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 glass 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<sup>-6</sup> mol/L) which is equivalent with literature value.


**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.

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