Application Note
FP-0017

Internal Quantum Efficiency Measurement of Phosphor Powders

Introduction

Some white LEDs consist of two types of materials: a luminescent diode that emits a blue light in the near-UV region, and a phosphor that emits visible light from the absorption to the near-UV region. Determining a phosphor's internal quantum efficiency is an important parameter in evaluating the emission efficiency of a white LED. A molecule's efficiency to fluoresce is described by its quantum yield and the internal quantum efficiency is defined as the ratio of the number of photons emitted by the sample to the number of photons absorbed by the sample.

FP-8500 3D Fluorescence High-Speed Measurement System

This application note illustrates the measurement reproducibility of the internal quantum efficiency of two phosphor powders from the evaluation of a white LED.

Keywords

FP-8500, ESC-842 Calibrated WI light source, ISF-834 Integrating sphere, Phosphors, Materials, Fluorescence, Quantum yield, FWQE-880 Quantum Yield Calculation program

Experimental

Measurement Conditions			
Excitation Wavelength	455 nm	Scanning Speed	500 nm/min
Emission Bandwidth	5 nm	Excitation Bandwidth	5 nm
Response	0.1 sec	Sensitivity	355 V

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To calculate the internal quantum efficiency, both the sample spectrum and incident light spectrum must be measured. The incident light spectrum is the emission spectrum of the excitation light scattered by a $BaSO_4$ reflectance standard, shown in Figure 1. A calibrated light source is then used for spectral correction of the measured spectrum.

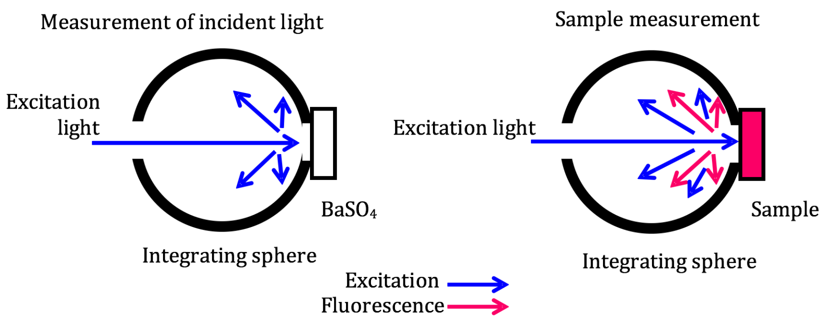

Figure 1. Measurement of the incident light (left) and sample fluorescence and excitation scattered light using the integrating sphere.

Results

To confirm reproducibility, five repeat measurements were made for each sample (by refilling the sample cell) and are shown in Figure 2 and 3. High reproducibility was obtained for both phosphor measurements as indicated by the difference between the maximum and minimum values of the internal quantum efficiency (within 1.5% with a coefficient of variance of 0.6%), shown in Table 1 and 2.

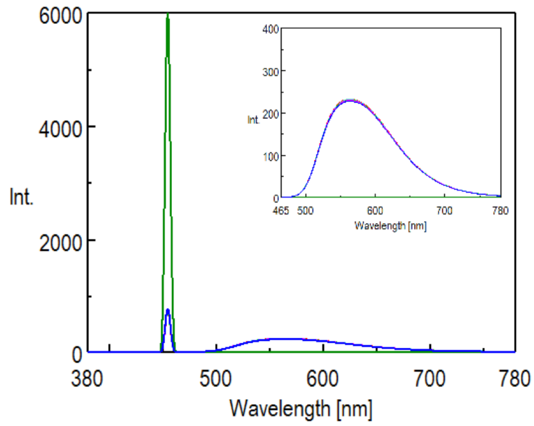

Figure 2. Incident light spectrum (black), fluorescence spectrum of yellow phosphor sample 1 (red), sample 2 (blue), sample 3 (green), sample 4 (pink), and sample 5 (light blue). Inset: zoomed in fluorescence spectrum around 550 nm peak.

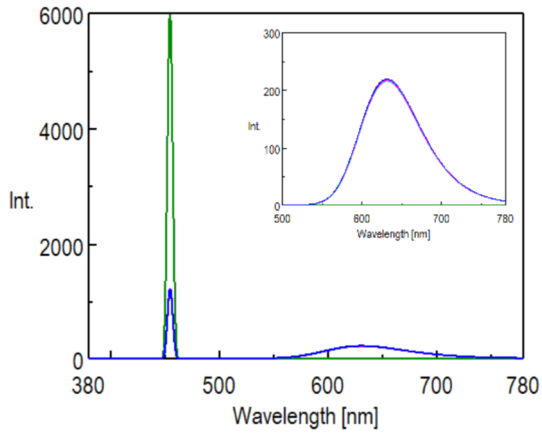

Figure 3. Incident light spectrum (black), fluorescence spectrum of red phosphor sample 1 (red), sample 2 (blue), sample 3 (green), sample 4 (pink), and sample 5 (light blue). Inset: zoomed in fluorescence spectrum around 550 nm peak.

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Table 1. Calculated results of the internal quantum efficiency of the yellow phosphor.

Number of Measurement	Sample Absorption Rate (%)	External Quantum Efficiency (%)	Internal Quantum Efficiency (%)
1	87.6	80.7	92.1
2	87.4	80.3	91.9
3	87.3	79.9	91.6
4	87.2	79.7	91.4
5	87.1	79.0	90.7
Average	87.3	79.9	91.5
SD	0.19	0.64	0.54
C.V.	0.22	0.80	0.59

Table 2. Calculated results of the internal quantum efficiency of the yellow phosphor.

Number of Measurement	Sample Absorption Rate (%)	External Quantum Efficiency (%)	Internal Quantum Efficiency (%)
1	78.2	65.8	84.1
2	77.6	64.9	83.6
3	77.9	65.9	84.6
4	77.8	65.4	84.1
5	77.9	66.1	84.9
Average	77.9	65.6	84.3
SD	0.22	0.48	0.50
C.V.	0.28	0.73	0.60

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