
**Fine ceramics (advanced ceramics,
advanced technical ceramics) —
Absolute measurement of internal
quantum efficiency of phosphors for
white light emitting diodes using an
integrating sphere**

Sample *Céramiques fines (céramiques avancées, céramiques techniques
avancées) — Mesurage absolu du rendement quantique interne des
luminophores des diodes électroluminescentes blanches en utilisant
une sphère intégrante*

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Foreword

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Introduction

White light-emitting diode (LED) based solid-state lighting (SSL) has been widely used for a variety of applications as alternatives for incandescent and fluorescent lamps. In the beginning, white LEDs (comprising blue LEDs and yellow phosphors) became popular as backlight sources for small-size liquid-crystal displays (LCDs) used in mobile phones and digital cameras. These were followed by white LEDs (consisting of blue LEDs combined with green and red phosphors) applied to backlight sources for large-area LCDs. Subsequently, LED lamps have been commercialized for general lighting, replacing conventional luminaires and capitalizing on their advantages, such as compactness, high luminous efficiency, high brightness below 0 °C or higher ambient temperatures, long life, and controllability of light intensity and colour temperature.

The optical performance of a phosphor for use in a white LED is one of the most important factors influencing the performance of the white LED. Accordingly, it is of great importance, not only for researchers and manufacturers of phosphors for use in white LEDs but also for researchers and manufacturers of white LED devices, to evaluate the optical properties of the phosphors in a well-established manner. However, standard measurement methods of studying the optical properties of luminescent powder materials commercially used for white LEDs have never been developed.

Photoluminescence quantum efficiency is one of the key parameters of phosphors for use in white LEDs and has been measured extensively by using an integrating sphere-based absolute method. This method was originally developed to determine the photoluminescence quantum efficiency for fluorophore-doped organic thin films and solutions, and has also been applied to phosphor powders. However, those who measure the quantum efficiency of phosphor materials have frequently noted that the measured quantum efficiency may deviate beyond their tolerance level, depending on the measurement equipment, the geometrical configuration of the integrating sphere and the arrangement of the sample cell, even if the measurement procedure is common in principle. This document provides the absolute measurement method of internal quantum efficiency of phosphors for use in white LEDs with reduced deviation of measured values. In this document, measurement equipment and procedures, which can be the sources of the deviation, are described in detail, helping those who address the high performance phosphors for competitive SSL products to obtain the proper information on their competitiveness.