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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for optical properties of ceramic phosphors for white light-emitting diodes with reference materials

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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This document was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

White light-emitting diode (LED)-based solid-state lighting (SSL) has been widely used for a variety of applications as an alternative for incandescent and fluorescent lamps. Initially, 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 were commercialised for general lighting, replacing conventional luminaires and capitalising 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 material 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 optical properties of the phosphors in a well-established manner. Photoluminescence quantum efficiency is one of the key optical parameters of phosphors for use in white LEDs and has been measured extensively by using an integrating sphere-based absolute method.

ISO 20351 was developed in accordance with the demand for standardizing the test method of internal quantum efficiency of phosphors using an integrating sphere. This standard test method has the advantage of a short measurement time and being available to those with no expertise in precise optical measurement. Despite their importance in terms of the performance of ceramic phosphor products, the external quantum efficiency and absorptance are out of the scope of ISO 20351 due to insufficient understanding of the source of variation in these measurement values.

ISO 23946 was then developed to provide “integrating-sphere-free” absolute measurement methods for the external quantum efficiency, internal quantum efficiency and absorptance for ceramic phosphors for use in white LEDs using a gonio-spectrofluorometer. These goniometric measurement methods are based on basic illumination theory and can give accurate values of quantum efficiencies and absorptance for ceramic phosphors regardless of the spatial distribution of fluorescence or scattered light. While the goniometric method is theoretically rigorous, it requires large and complicated equipment as well as a long time to complete the measurement. Therefore, the application of ISO 23946 is assumed to be limited to those who intend to determine the optical properties of phosphor materials to be utilized as reference materials.

This document provides a simple measurement method for those who use a general-purpose instrument, where a phosphor material with optical properties evaluated according to the methods in ISO 23946 is used as a reference material.

In this document, measurement conditions and procedures that can affect the measurement values are described in detail, helping those who address high-performance phosphors for competitive SSL products to obtain appropriate information on their competitiveness.

This document can also be adopted for phosphors used in non-white LEDs, e.g. green, orange, pink and purple.

Guide to application of relevant ISO documents concerning test methods for optical properties of ceramic phosphors for white LEDs are presented in Annex C.