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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test methods for optical properties of ceramic phosphors for white light-emitting diodes using a gonio-spectrofluorometer

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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. 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 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.

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 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, however, 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.

This document provides the absolute measurement methods of external quantum efficiency and absorptance as well as internal quantum efficiency and related optical properties for ceramic phosphors for use in white LEDs using a gonio-spectrofluorometer. This equipment is regarded as one of the variations of a gonio-reflectometer commonly used to evaluate optical properties of material surfaces.

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

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

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1 Scope

This document specifies a method for use of a gonio-spectrofluorometer to measure internal quantum efficiency, external quantum efficiency, absorptance, luminescent radiance factor and relative fluorescence spectrum of ceramic phosphor powders which are used in white light-emitting diodes (LEDs) and emit visible light when excited by UV or blue light.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 20351, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Absolute measurement of internal quantum efficiency of phosphors for white light emitting diodes using an integrating sphere*

CIE S 017/E, *International Lighting Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20351 and CIE S 017/E and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
gonio-spectrofluorometer
apparatus measuring the observation angle dependence of the spectral distribution of fluorescent light or scattered light emitted by a sample irradiated on its surface by a monochromatic light

3.2
in-plane
<optical radiation> emitted or reflected, with a propagation vector located in a plane of incidence

3.3
out-of-plane
<optical radiation> emitted or reflected, with a propagation vector not located in a plane of incidence

4 Spherical coordinate system

The coordinate system used in gonio-spectrofluorometry shall be a spherical coordinate system (r, θ, ϕ). In a gonio-spectrofluorometer, the plane including the sample surface shall be taken as the horizontal plane and the centre of the surface of the sample shall be taken as the origin. The radial distance r