NSAI Standards

Irish Standard
I.S. EN 62607-3-1:2014

Nanomanufacturing - Key control characteristics - Part 3-1: Luminescent nanomaterials - Quantum efficiency

I.S. EN 62607-3-1:2014

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NSAI
1 Swift Square,
Northwood, Santry
Dublin 9

T +353 1 807 3800
F +353 1 807 3838
E standards@nsai.ie
W NSAI.ie

Sales:
T +353 1 857 6730
F +353 1 857 6729
W standards.ie

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 62607-3-1

August 2014

ICS 07.030

English Version

Nanomanufacturing - Key control characteristics - Part 3-1: Luminescent nanomaterials - Quantum efficiency (IEC 62607-3-1:2014)

Nanofabrication - Caractéristiques de contrôle clé Partie 3-1: Nanomatériaux luminescents - Rendement quantique (CEI 62607-3-1:2014)

Nanofertigung - Schlüsselmerkmale - Teil 3-1: Lumineszierende Nanomaterialien - Quanteneffizienz (IEC 62607-3-1:2014)

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Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

The text of document 113/214/FDIS, future edition 1 of IEC 62607-3-1, prepared by TC 113 "Nanotechnology standardization for electrical and electronic products and systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62607-3-1:2014.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2015-03-26
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2017-06-26

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Annex ZA
(normative)
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The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
CIE S 017/E	2011	ILV: International Lighting Vocabulary	-	-

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IEC 62607-3-1

Edition 1.0 2014-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Nanomanufacturing – Key control characteristics
Part 3-1: Luminescent nanomaterials – Quantum efficiency

Nanofabrication – Caractéristiques de contrôle clé
Partie 3-1: Nanomatériaux luminescents – Rendement quantique

IEC 62607-3-1:2014-05(en-fr)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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IEC 62607-3-1

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INTERNATIONAL STANDARD

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colour inside

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62607-3-1 has been prepared by IEC technical committee 113: Nanotechnology standardization for electrical and electronic products and systems.

The text of this standard is based on the following documents:

FDIS	Report on voting
113/214/FDIS	113/219/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 625607 series, published under the general title *Nanomanufacturing – Key control characteristics,* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

One of the principal drivers of solid-state lighting (SSL) is the potential efficiency of the illumination devices to convert electricity into light. Incandescent and fluorescent lighting devices are only about 5 % to 30 % efficient, with incandescent lighting having the lowest efficiency. Since a significant portion of all electricity consumed is used in providing lighting, increasing the efficiency of lighting devices will have a huge impact on the world's energy consumption. The luminous efficiency of SSL devices is a critical measurement of their overall efficiency, and standard methods to perform these measurements have been established and were essential to producing reliable product information for manufacturers and consumers. The same is true of the luminescent materials on which these light-emitting diode (LED) manufacturers rely; however, no such standard currently exists. This standard provides SSL manufacturers a universal means for comparing luminescent nanomaterials from different suppliers, and potentially for luminescent materials for LEDs in general.

The most common SSL devices are composed of a blue light-emitting diode (LED) and a luminescent material. The blue LED optically excites the luminophore, which will radiate light of the appropriate colour or colours to yield the desired white spectrum. This device, termed a phosphor-converted light emitting diode (or pc-LED), converts the electricity indirectly into white light by first creating blue light and then converting the blue light into broad-band visible radiation. Currently, quantum dots (QDs) or nanophosphors are one option for the photoluminescent material that converts the blue LED wavelength to broad spectrum visible light. QDs and nanophosphors are of interest in this application for several reasons including their greater colour flexibility, narrowband emission spectrum, broadband absorption, near-infinite flocculation time, reduced bleaching, and lower scattering compared to conventional phosphors which are typically larger than 5 μm. QD-enabled pc-LEDs have been shown to have the best possible combination of colour rendering, correlated colour temperature, and luminous efficiency of any other pc-LED on the market.

A critical measurement parameter for luminescent materials used in the lighting industry is quantum efficiency, which is defined in this standard as the number of photons emitted into free space by a luminescent nanoparticle divided by the number of photons absorbed by the nanoparticle. Suppliers of QDs and luminescent nanomaterials typically measure only relative quantum efficiency (or alternatively, quantum yield) in the solution phase due to the ease of such measurements and the applicability of such measurements to biomedical imaging (a widespread use of QDs in R&D). These measurements are often taken at low concentrations where effects such as nanoparticle agglomeration and re-absorption are minimized. However, in end-use applications, the actual concentration of luminescent nanomaterials may be significantly different. For example, concentrated luminescent nanoparticle formulations (in either solid or liquid state) may be required to achieve a desired luminous flux and correlated colour temperature in a SSL device. This standard codifies that method for the first time, and establishes an absolute quantum efficiency test method for both solid (e.g., luminescent nanoparticles embedded in polymer matrices, coated on glass optics, applied directly to light emitted diodes, and other form factors) and solution samples (e.g., colloidal suspensions of luminescent nanoparticles), enabling suppliers and purchasers to compare the performance of one material to another, both in their raw (solution) phase as well as their technologically relevant (solid) phase of matter.

NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS

Part 3-1: Luminescent nanomaterials – Quantum efficiency

1 Scope

This part of IEC 62607 describes the procedures to be followed and precautions to be observed when performing reproducible measurements of the quantum efficiency of luminescent nanomaterials. Luminescent nanomaterials covered by this method include nano-objects such as quantum dots, nanophosphors, nanoparticles, nanofibers, nanocrystals, nanoplates, and structures containing these materials. The nanomaterials may be dispersed in either a liquid state (e.g., colloidal dispersion of quantum dots) or solid-state (e.g., nanofibers containing luminescent nanoparticles). This standard covers both relative measurements of liquid state luminescent nanomaterials and absolute measurements of both solid and liquid state nanomaterials.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CIE 017/E:2011, *International Lighting Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in CIE 017/E:2011 as well as the following terms and definitions apply.

NOTE See also ISO TS 80004-2 (in preparation).

3.1
absorbance
negative base 10 logarithm of the ratio of the intensity of light (I) that has passed through and transmitted by a sample to the incident intensity (I_o) at a specified wavelength

Note 1 to entry: Expressed mathematically, absorbance = $-\log(I/I_o)$. Proper corrections are required for other losses (e.g., reflection and scattering) for this equation to be correct.

3.2
absorptance
ratio of the radiant or luminous flux in a given spectral interval that is absorbed by a medium to that of the incident light source

Note 1 to entry: The sum of the hemispherical reflectance, the hemispherical transmittance, and the absorptance is one.

3.3
absorption
process by which matter removes photons from incident light and converts it to another form of energy such as heat