IEC TS 62876-4-1

Edition 1.0 2025-02

TECHNICAL SPECIFICATION

Nanomanufacturing – Reliability assessment – Part 4-1: Nanophotonic products – Optical stability test of quantum dot enabled light conversion films: Temperature, humidity and light exposure

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 07.120

ISBN 978-2-8327-0165-2

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms, definitions and abbreviated terms 8
3.1 Terms and definitions 8
3.2 Abbreviated terms 8
4 General requirements 8
4.1 Q-LCF 8
4.2 Tests 9
4.2.1 General 9
4.2.2 Quantity of specimens 10
4.2.3 Equipment specifications 10
4.2.4 Test methods 10
4.2.5 Caution 11
4.3 Measurements 11
4.3.1 General 11
4.3.2 General testing conditions 12
4.3.3 Measurement instrument specifications 12
4.3.4 Conditioning 12
4.3.5 Data collection 12
4.3.6 Measurement methods of Q-LCFs in simulated direct-lit BLU 13
4.3.7 Measurement methods of width of invalid edge 13
4.3.8 Pass or fail criteria 14
5 Test methods 14
5.1 T1 – High temperature and blue light exposure 14
5.1.1 Purpose 14
5.1.2 Temperature and light 14
5.1.3 Data logging 14
5.1.4 Output 15
5.1.5 Required equipment 15
5.2 T2 – Damp heat and blue light exposure 15
5.2.1 Purpose 15
5.2.2 Temperature, humidity and light 15
5.2.3 Data logging 15
5.2.4 Output 16
5.2.5 Required equipment 16
5.3 T3 – Damp heat 16
5.3.1 Purpose 16
5.3.2 Procedure 16
5.3.3 Temperature and humidity 16
5.3.4 Data logging 16
5.3.5 Output 16
5.3.6 Required equipment 16
5.4 T4 – Low temperature 16
5.4.1 Purpose 16

5.4.2 Temperature 16
5.4.3 Data logging 16
5.4.4 Output 17
5.4.5 Required equipment 17
5.5 T5 – Thermal cycling 17
5.5.1 Purpose 17
5.5.2 Temperature 17
5.5.3 Data logging 17
5.5.4 Output 17
5.5.5 Required equipment 17
6 Report 18
Annex A (informative) Case study of Q-LCF reliability assessment 19
A.1 Test sample 19
A.2 Test method 19
A.3 Test results 19
Bibliography 24

Figure 1 – Overview of stresses that Q-LCF are exposed to in service environments 9
Figure 2 – General reliability test procedure 9
Figure 3 – Example of measurement setup for invalid edge 13
Figure 4 – Lighting assembly 15
Figure A.1 – Trend plots of Q-LCFs during accelerated aging tests 23

Table 1 – Summary of stresses utilized in this document 10
Table 2 – Summary overview of relevant test methods and main control parameters 11
Table 3 – Pass or fail criteria 14
Table A.1 – Test results of Q-LCF accelerated aging tests 19

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

NANOMANUFACTURING – RELIABILITY ASSESSMENT –

Part 4-1: Nanophotonic products – Optical stability test of quantum dot enabled light conversion films: Temperature, humidity and light exposure

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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TS 62876-4-1 has been prepared by IEC technical committee 113: Nanotechnology for electrotechnical products and systems. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
113/866/DTS	113/886/RVDTS

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

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62876 series, published under the general title *Nanomanufacturing – Reliability assessment*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

Quantum dots (QDs), as luminescent nanomaterials, exhibit broad absorption spectra and narrow emission spectra. Using the same excitation source to excite QDs of different particle size, it is possible to emit spectra with different peak wavelengths. Based on the above characteristics, QDs are used in display products, which can greatly improve the display colour gamut.

Nowadays, as a typical product of quantum dot technology application, quantum dot enabled light conversion film (Q-LCF) is widely used in the display field. Under normal working conditions, Q-LCF in a backlight module will be continuously irradiated by high-energy excitation light (such as blue light) to emit converted light. Under the combined action of water vapour and oxygen from the environment, the optical properties of the QDs in Q-LCF will slowly deteriorate. In order to ensure the quality and stability of Q-LCF products, it is essential to scientifically design a reliability test standard to evaluate product quality. Reliability assessment can be used, for example, to authorize advancement to the next step in product development, or to authorize progress payments, or to proceed with delivery and acceptance of products.

This document provides reliability test and evaluation criteria for Q-LCF. In this document, Q-LCFs are used as the test objects. Accelerated aging tests containing stress factors of temperature, humidity, light are imposed on the test objects to obtain performance shift data and change trend.

NANOMANUFACTURING – RELIABILITY ASSESSMENT –

Part 4-1: Nanophotonic products – Optical stability test of quantum dot enabled light conversion films: Temperature, humidity and light exposure

1 Scope

This part of IEC 62876, which is a Technical Specification, establishes a general reliability testing programme to verify the reliability of the performance of quantum dots nanomaterials, and quantum dot enabled light conversion films (Q-LCFs).

The Q-LCF is used as subassemblies for the fabrication of nano-enabled photoelectrical display devices, mainly liquid crystal display (LCD) currently, with other components.

This testing programme defines standardized aging conditions, methodologies and data assessment for Q-LCF product.

The results of these tests define a stability under standardized aging conditions for quantitative evaluation of the reliability of the Q-LCF.

The procedures specified in this document were designed for Q-LCF but can be extended to serve as a guideline for other kinds of light conversion films or related subassemblies as well.

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.

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-78:2012, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC TS 62565-4-4:2025, *Nanomanufacturing – Product specifications – Part 4-4: Nanophotonic products – Blank detail specifications: Quantum dot enabled light conversion films*

IEC 62595-2-1:2016, *Display lighting unit – Part 2-1: Electro-optical measuring methods of LED backlight unit*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*