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GB/T 42977-2023

Nanotechnology - Nano-enabled optoelectrical display - Optical reliability assessment for quantum dot enabled light conversion film

纳米技术 纳米光电显示 量子点光转换膜的光学可靠性测定

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1 Scope

GB/T 42977-2023 gives the method for assessing the optical reliability of quantum dot light conversion films. The film is what makes a quantum dot television's colour: blue LEDs pump red and green emitting dots, and the resulting gamut is far wider than a phosphor can produce. The weakness is that the dots degrade under exactly the conditions the film works in - blue flux, heat and any oxygen or moisture that reaches them - and they do so unevenly, so the display shifts colour rather than simply dimming. The standard sets the instruments and equipment, the optical reliability test conditions, the test samples, the test operating procedure, the optical performance test method and data processing, the reliability judgment indicators, the measurement uncertainty and the test report, with an informative annex giving a report template. It took effect on 1 April 2024.

This document provides a method for measuring the optical reliability and reliability judgment indicators of quantum dot enabled light conversion film (Q-LCF). This document is applicable to the optical reliability measurement of quantum dot enabled light conversion film for liquid crystal display devices; other film materials with light conversion function shall use this standard as a reference.

2 Normative references

The contents of the following documents constitute essential clauses of this document through normative references in the text. Among them, for dated references, only the version corresponding to that date applies to this document; for undated references, the latest version (including all amendments) applies to this document.

GB/T 2423.1 Environmental testing for electric and electronic products - Part

3 Terms and definitions

The terms and definitions as defined in GB/T 42976-2023, as well as the following terms and definitions, apply to this document.

3.1 Optical reliability The ability of a product to achieve specified optical performance under specified conditions and within a specified time. [Source: GB/T 33721-2017, 3.2, modified]

3.2 Invalid edge The edge area where the quantum dot enabled light conversion film fails due to obvious optical performance degradation.

4.1 Reliability test platform equipment

4.1.1 Overview The optical reliability test of the quantum dot enabled light conversion film is divided into illumination test and storage test, according to the conditions of accelerated aging test with or without light irradiation. The illumination test is carried out on the illumination test platform; the storage test is carried out on the storage test platform.

4.1.2 Illumination test platform

4.1.2.1 Structure The structure of the illumination test platform is as shown in Figure 1, which consists of a brightness enhancement film, a sample stage, a backlight system. The brightness enhancement film, the sample stage, the backlight system are stacked from top to bottom and have the same normal line.

4.2.3 Hot-cold shock test chamber. Temperature range is -40 °C ~ 100 °C; temperature accuracy is <= 1 °C; the use of the test chamber shall comply with the requirements of GB/T 2423.22.

4.2.4 Constant temperature and humidity test chamber. Temperature range is 0 °C ~ 100 °C; temperature accuracy is <= 1 °C; the maximum humidity test range covers at least 98% relative humidity, at a relative humidity accuracy of <= 5%; the use of the test chamber shall comply with the requirements of GB/T 2423.3.

4.2.5 Room temperature test chamber. It shall be a dark chamber; the illumination inside the chamber is <=

0.1 lx. The atmospheric pressure and temperature inside the chamber are consistent with those in the storage room. The temperature is required to be constant at 23 °C ± 2 °C and the relative humidity is 50% ± 10%.

4.3 Optical performance test platform The optical performance test platform shall meet the requirements of GB/T 42976-2023.

4.4 Film ruler The film ruler, which has a measuring range of 100 mm or larger and a minimum scale of <=

0.1 mm.

4.5 Optical microscope The optical microscope shall have its own light source and the test accuracy shall be <=

0.1 mm.

5 Optical reliability test conditions

5.1 Test type and cycle The optical reliability test of quantum dot enabled light conversion film can be divided into constant condition aging test and periodic cycle test. The test cycle of the constant condition aging test is set according to the accelerated aging test conditions and reached an agreement with the user. The conventional constant condition aging test cycle should be 1000 h. The periodic cycle aging test is usually a cold and hot shock test, which should be carried out 100 cycles.

Note. Only one type of aging test condition is tested for a single sample. If other aging tests are added, the initial sample that has not undergone reliability tests needs to be taken.

5.2 Accelerated aging test conditions

5.2.1 Constant temperature aging test The constant temperature aging test determines the optical reliability of the quantum dot enabled light conversion film, by setting a single acceleration factor of temperature. It is divided into low temperature test and high temperature test. The low temperature test is carried out in a low temperature test chamber (4.2.2). The temperature in the chamber shall be set to -40 °C. The high temperature test is carried out in a high temperature test chamber (4.2.1). The conventional high temperature test temperature shall be set to 65 °C. The test conditions can also be negotiated with the user.

5.2.2 Constant temperature and humidity aging test The constant temperature and humidity aging test determines the optical reliability of the quantum dot enabled light conversion film, by setting a double acceleration factor of temperature and humidity. The constant temperature and humidity aging test is carried out in a constant temperature and humidity test chamber (4.2.4). The conventional constant temperature and humidity test temperature should be set to 60 °C; the humidity shall be set to 90% relative humidity. It should not

exceed 65 °C and 95% relative humidity. The test conditions can also be negotiated with the user.

5.2.3 Cold-hot shock aging test The cold-hot shock aging test determines the optical reliability of the quantum dot enabled light conversion film, by setting the temperature acceleration factor. It is carried out in a thermal shock test chamber (4.2.3). The low temperature condition should be set to -40 °C; the high temperature test condition should be set to 85 °C; the transition temperature in the cycle should be set to 25 °C. The maintenance time of a single cycle of high and low temperature test should be 30 minutes; the single heating/cooling time should be less than 5 minutes. The test conditions can also be negotiated with the user.

5.2.4 Light aging test The light aging test can be divided into high temperature light aging test and constant temperature and humidity light aging test. The light test platform (4.1.2) is placed in an appropriate test chamber (4.2) for the test. The temperature conditions of the high temperature light aging test are set according to 5.2.1; the temperature and humidity conditions of the constant temperature and humidity light aging test are set according to 5.2.2.The lighting conditions are set according to the average irradiance on the surface directly exposed to light of the test sample, which should be selected from Table 1. The temperature of the light aging test condition should be 40 °C; the humidity shall be 85% relative humidity; the light intensity should be the light source component 1 in Table 1.

6 Test samples

Quantum dot enabled light conversion film test samples shall be selected from products

8.1.2 Test nodes During the optical reliability test, the changes in optical performance shall be recorded. The test nodes shall be 0 h, 24 h, 72 h, 168 h, 336 h, 504 h, 1000 h, 2000 h, 3000 h. The test node setting can also be negotiated with the user.

8.2 Test method

8.2.1 Optical performance test Based on the contents of Chapter 8 and Chapter 9 of GB/T 42976-2023, test brightness L, chromaticity coordinates (x, y), light conversion efficiency LCE.

8.2.2 Invalid edge test

8.2.2.1 Overview After the quantum dot enabled light conversion film has been subjected to the accelerated aging test, the maximum invalid edge can be tested as one aspect of optical reliability evaluation. The invalid edge test method can be divided into the optical microscope test method and the film ruler test method.

8.2.2.2 Optical microscope to measure the maximum invalid edge The optical microscope test steps are as follows: