



BSI Standards Publication

# General lighting — Organic light emitting diode (OLED) products and related equipment — Terms and definitions

### **National foreword**

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# TECHNICAL SPECIFICATION

# SPECIFICATION TECHNIQUE

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**General lighting – Organic light emitting diode (OLED) products and related equipment – Terms and definitions**

**Éclairage général – Produits à diodes électroluminescentes organiques (OLED) et équipements associés – Termes et définitions**

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PRODUCTS AND RELATED EQUIPMENT – TERMS AND DEFINITIONS**

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

Enquiry draft	Report on voting
34A/1874/DTS	34A/1896/RVC

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

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- replaced by a revised edition, or
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# GENERAL LIGHTING – ORGANIC LIGHT EMITTING DIODE (OLED) PRODUCTS AND RELATED EQUIPMENT – TERMS AND DEFINITIONS

## 1 Scope

This Technical Specification establishes terms and definitions specific for general lighting OLED light sources and related equipment.

## 2 Classification of terms

Terms specific for general lighting OLED light sources and related equipment are classified as follows:

- a) fundamental terms;
- b) terms related to physical properties;
- c) terms related to constructive elements;
- d) terms related to performance and specifications.

NOTE This classification is in line with IEC 62341-1-2:2014. However, the classification of terms related to the production process was removed.

## 3 Fundamental terms

### 3.1

#### **organic light emitting diode**

##### **OLED**

light emitting diode consisting of an electroluminescent zone made of organic compounds which are situated between two electrodes

Note 1 to entry: This note applies to the French language only.

### 3.2

#### **polymeric organic light emitting diode**

##### **PLED**

OLED where all the organic semiconductor materials are polymers

Note 1 to entry: This note applies to the French language only.

### 3.3

#### **small molecule organic light emitting diode**

##### **SMOLED**

OLED where all the organic semiconductor materials are small molecules

Note 1 to entry: This note applies to the French language only.

### 3.4

#### **stacked OLED**

OLED consisting of two or more emission layers and at least one charge generation layer between two emission layers

Note 1 to entry: There can be emission layers inside a stacked OLED that are not separated by a charge generation layer. However, at least one pair of emission layers is separated by a charge generation layer.

**3.5****bottom emission OLED**

OLED which emits light through the substrate side

**3.6****top emission OLED**

OLED which emits light through the encapsulation side

**3.7****transparent OLED**

OLED in which the light-emitting area is transparent in the off-state

**3.8****inverted OLED**

OLED where the substrate carries the cathode

**3.9****hybrid organic light emitting diode****hybrid OLED**

OLED that uses a hybrid OLED stack

**3.10****bendable OLED**

OLED designed for being bent into a permanent shape

**3.11****flexible OLED**

OLED designed for being repeatedly bent

**3.12****OLED tile**

smallest functional OLED light source which cannot be separated into smaller OLED lighting elements and containing at least one contact ledge with at least one positive and one negative pole for connection to the electrical power supply

**3.13****OLED panel**

independently operable unit OLED product containing one or more OLED tiles and means of connection to electrical supply such as a connector, PCB (printed circuit board), passive electronic components and optionally a frame

**3.14****OLED module**

assembly of one or more OLED panels and active electronic components

**3.15****OLED lamp**

OLED panel or OLED module with a cap

**3.16****OLED light source**

OLED tile, OLED panel, OLED module or OLED lamp



## 4 Terms related to physical properties

### 4.1

#### light output area

 $A_{LO}$ 

area of an OLED tile, panel or module designed to emit light, including active luminous areas, busbars and other mechanical structures, but excluding edges

Note 1 to entry: The light output area is expressed in m<sup>2</sup>.

### 4.2

#### active luminous area

 $A_{act}$ 

area of an OLED tile, panel or module designed to emit light and including inner non-luminous areas due to defects, but excluding layout defined busbars and other mechanical structures

Note 1 to entry: The active luminous area is expressed in m<sup>2</sup>.

### 4.3

#### aperture ratio

 $F$ 

quotient of active luminous area and light output area

$$F = \frac{A_{act}}{A_{LO}}$$

Note 1 to entry: The aperture ratio is a quantity of dimension one.

### 4.4

#### luminous current efficacy

 $r$ 

luminance divided by the applied current per unit area

Note 1 to entry: This term is sometimes incorrectly called "luminous current efficiency".

Note 2 to entry: The luminous current efficacy is expressed in cd/m<sup>2</sup>.

### 4.5

#### emission ratio

luminous flux emitted by the side with the higher luminous flux divided by the luminous flux emitted by the side with the lower luminous flux

Note 1 to entry: This term is only used with transparent OLED panels.

Note 2 to entry: The emission ratio is a quantity of dimension one.

### 4.6

#### internal quantum efficiency

 $\eta_{IQE}$ 

ratio of the number of photons generated inside an OLED to the number of electrons injected into the OLED

Note 1 to entry: An internal quantum efficiency greater than 100 % is possible if charge carriers are generated inside the OLED.

### 4.7

#### external quantum efficiency

 $\eta_{EQE}$ 

quantity describing the yield of outcoupled photons with regard to injected charge carriers (electrons)

Note 1 to entry: The external quantum efficiency can be expressed as

$$\eta_{EQE} = \eta_{IQE} * \eta_{out}$$

where  $\eta_{out}$  is the outcoupling efficiency.  $\eta_{out}$  contains optical loss modes such as surface plasmon polaritons or waveguided modes.

Note 2 to entry: The external quantum efficiency is expressed in %.

#### 4.8 outcoupling efficiency

$\eta_{out}$   
quotient of the external quantum efficiency and the internal quantum efficiency

$$\eta_{out} = \frac{\eta_{EQE}}{\eta_{IQE}}$$

#### 4.9 forward direction

F

direction of electrical current that results when the HIL/HTL side of the OLED stack (p-type region) connected to an electrode is on positive potential relative to the EIL/ETL side (n-type region) connected to the other electrode

Note 1 to entry: The forward direction is denoted by adding the subscript F to the symbol of the quantity concerned, for example forward current is denoted as  $I_F$ .

#### 4.10 reverse direction

R

direction of electrical current when the HIL/HTL side of the OLED stack is connected to an electrical contact which is on negative potential with regards to the connection of the EIL/ETL side

Note 1 to entry: The reverse direction is denoted by adding the subscript R to the symbol of the quantity concerned, for example reverse current is denoted as  $I_R$ .

#### 4.11 forward current

$I_F$

electrical current in forward direction

Note 1 to entry: The forward current is expressed in A.

#### 4.12 forward voltage

$U_F$

potential difference pertaining to the forward direction, dependent on the forward current at a given temperature

Note 1 to entry: The forward voltage is expressed in V.

[SOURCE: IEC 62504:2014, 3.13, modified — Note 2 to entry has been deleted.]

#### 4.13 reverse current

$I_R$

electrical current in reverse direction

Note 1 to entry: The reverse current is expressed in A.

**4.14****reverse voltage** $U_R$ 

potential difference pertaining to the reverse direction dependent on the reverse current

Note 1 to entry: The reverse voltage is expressed in V.

**4.15****uniformity**

physical magnitude of change present in a spatial luminance or chromaticity distribution

Note 1 to entry: This definition does not take perception into account.

**4.16****homogeneity**

perceived magnitude of change present in a spatial luminance or chromaticity distribution

**5 Terms related to constructive elements****5.1****fluorescent emitter**

emitter where only the singlet state excitons can show radiative decay and photon emission

Note 1 to entry: A fluorescent emitter is a type of emitter material. According to spin statistics in quantum chemistry, excitons formed by an electron and a hole can have two different spin multiplicities, i.e. 1 (singlet state) or 3 (triplet state). Simply spoken, 25 % of the states are singlets and 75 % are triplets. In a fluorescent emitter only the singlet state excitons can show radiative decay and photon emission. The theoretical maximum of the internal quantum efficiency is 25 %.

**5.2****phosphorescent emitter**

emitter where singlet and triplet state excitons can show radiative decay and photon emission

Note 1 to entry: A phosphorescent emitter is a type of emitter material. According to spin statistics in quantum chemistry, excitons formed by an electron and an electron hole can have two different spin multiplicities, i. e. 1 (singlet state) or 3 (triplet state). Simply spoken, 25 % of the states are singlets and 75 % are triplets. In a phosphorescent emitter singlet and triplet state excitons can show radiative decay and photon emission.

**5.3****hybrid OLED stack**

OLED stack that uses more than one kind of material and/or processing method

Note 1 to entry: A hybrid OLED stack can be as follows, for example:

- a) an OLED stack which contains fluorescent and phosphorescent emitters,
- b) an OLED stack which contains polymer and small molecule layers,
- c) an OLED stack which combines solution-processed and evaporated organic layers.

[SOURCE: IEC 62341-1-2:2014, 2.2.16, modified — The terms "hybrid organic light emitting diode" and /"hybrid OLED" were replaced with "hybrid OLED stack". The definition was modified to fit the term. List entry c) was added to the note.]

**5.4****substrate**

material to carry the OLED stack

Note 1 to entry: Most common is the use of glass, metal foils or polymer foils.

**5.5****OLED stack**

core element of an OLED to generate light, consisting of a multi-layer structure with significant lateral dimensions where each layer has a special functionality, the two

sandwiching layers at top and bottom being electrodes for connection to a power supply and at least one of these electrodes being transparent to enable light extraction

## 5.6

### **anode**

<OLED stack> electrode from where holes are injected into the organic layers

## 5.7

### **cathode**

<OLED stack> electrode from where electrons are injected into the organic layers

## 5.8

### **hole injection layer**

#### **HIL**

layer adjacent to the anode and designed to improve the hole injection

Note 1 to entry: The HIL is part of the OLED stack.

Note 2 to entry: This note applies to the French language only.

## 5.9

### **electron injection layer**

#### **EIL**

layer adjacent to the cathode and designed to improve the electron injection

Note 1 to entry: The EIL is part of the OLED stack.

Note 2 to entry: This note applies to the French language only.

## 5.10

### **hole transport layer**

#### **HTL**

layer inside the OLED stack with a relatively high mobility of holes and used to adjust the charge carrier balance in the OLED stack

Note 1 to entry: The special case of an electrically doped HTL for further conductivity increase is called p-HTL.

Note 2 to entry: This note applies to the French language only.

## 5.11

### **hole blocking layer**

#### **HBL**

layer inside the OLED stack with a relatively low mobility of holes or difference of highest occupied molecular orbital level and used to adjust the charge carrier balance in the stack

Note 1 to entry: This note applies to the French language only.

## 5.12

### **electron transport layer**

#### **ETL**

layer inside the OLED stack with a relatively high mobility of electrons and used to adjust the charge carrier balance in the stack

Note 1 to entry: The special case of an electrically doped ETL for further conductivity increase is called n-ETL.

Note 2 to entry: This note applies to the French language only.

## 5.13

### **electron blocking layer**

#### **EBL**

layer inside the OLED stack with a relatively low mobility of electrons and used to adjust the charge carrier balance in the OLED stack

Note 1 to entry: This note applies to the French language only.

#### **5.14**

##### **emissive layer**

##### **EML**

layer of an OLED stack designed for exciton formation and photon generation

Note 1 to entry: The EML can consist of several materials.

Note 2 to entry: This note applies to the French language only.

#### **5.15**

##### **charge generation layer**

##### **CGL**

layer in a stacked OLED between two single OLED structures generating electrons for one adjacent OLED unit (acting as a cathode) and holes for another adjacent OLED unit (acting as an anode)

Note 1 to entry: The CGL is not directly connected to an electrical power supply. It enables the serial connection of two or more OLED structures which are placed on top of each other.

Note 2 to entry: This note applies to the French language only.

#### **5.16**

##### **interlayer**

##### **ITL**

layer which separates other functional layers

Note 1 to entry: Two examples are interlayers to separate the fluorescent from the phosphorescent emission zone and interlayers to separate emission layers and injection layers.

Note 2 to entry: This note applies to the French language only.

#### **5.17**

##### **matrix**

<OLED stack> material in the EML which acts as host for emitter materials

#### **5.18**

##### **emitter**

<OLED stack> material in the EML which acts as phosphor, typically used as dopant in a matrix

#### **5.19**

##### **encapsulation**

enclosing structure to protect the organic layers and the electrodes from undesired substances, such as water and oxygen

#### **5.20**

##### **thin film encapsulation**

##### **TFE**

encapsulation by one or more thin layers directly coating the OLED

Note 1 to entry: This note applies to the French language only.

#### **5.21**

##### **optical outcoupling structures**

optical structures to enhance the light extraction from the OLED

[SOURCE: IEC 62341-1-2:2014, 2.4.33, modified — The phrase "to the air" has been deleted.]

**5.22****external outcoupling structures**

optical structures which are located on the outer substrate surface to enhance the light extraction

**5.23****internal outcoupling structures**

optical structures which are located between the OLED stack and the substrate to bring more light into the substrate which finally leads to a higher amount of photons extracted

**5.24****busbar**

by design non-luminous, grid-like or other patterned structure within the area of OLED segments used for the improvement of the current density distribution on transparent electrodes

**5.25****OLED cell**

small part of the light output surface of an OLED tile whose boundaries are defined by busbar structures and which cannot be independently controlled

**5.26****contact ledge**

<OLED panel> exposed area of an OLED tile designed for electrical connection to one or more electrodes

**5.27****getter**

<OLED tile> material used inside an OLED tile to absorb undesired substances that enter the OLED tile in spite of the encapsulation

**5.28****glass encapsulation**

encapsulation by glass attached to the substrate

**5.29****active luminous surface**

<OLED panel> surface of an OLED tile, panel or module which is intended to emit light, including inner non-luminous areas due to defects, but excluding layout defined busbars, edges and other mechanical structures

**5.30****light output surface**

<OLED panel> surface of an OLED tile, panel or module which emits light, including active luminous surface, busbars and any other mechanical structure but excluding the edges

**6 Terms related to performance and specifications****6.1****ageing**

<OLED light source> preconditioning of the OLED light source before initial values are taken

[SOURCE: IEC 62504:2014, 3.1, modified — The definition has been amended with references to OLED.]

## **6.2**

### **bright spot**

small area remarkably brighter than the surrounding light output area of the OLED panel

## **6.3**

### **dark spot**

small area remarkably darker than the surrounding light output area of the OLED panel

Note 1 to entry: A dark spot can be due to lower current density or an open circuit in that area.

## **6.4**

### **internal short circuit**

unintentional conductive path between OLED anode and OLED cathode localized on a small area

Note 1 to entry: An internal short circuit can look like a dark spot. It can lead to a significant heat generation in that area.

## **6.5**

### **stabilization**

<OLED light source> keeping an OLED panel switched on under specified electrical input to obtain stable conditions

## **6.6**

### **stabilization time**

<OLED light source> time that the OLED light source requires to obtain stable conditions with specified electrical input

## Bibliography

IEC 62341-1-2:2014, *Organic light emitting diode (OLED) displays – Part 1-2: Terminology and letter symbols*

IEC 62504:2014, *General lighting – Light emitting diode (LED) products and related equipment – Terms and definitions*

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