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# Datasheet for the decision of 16 September 2011

**Case Number:** T 0284/08 - 3.4.03

**Application Number:** 06001230.9

**Publication Number:** 1804308

**IPC:** H01L 51/52

**Language of the proceedings:** EN

**Title of invention:**
An organic light emitting device with a plurality of organic electroluminescent units stacked upon each other

**Applicant:**
Novaled AG

**Opponent:**
-

**Headword:**
-

**Relevant legal provisions:**
EPC Art. 123(2)

**Relevant legal provisions (EPC 1973):**
EPC Art. 56

**Keyword:**
"Inventive step (yes) - after amendements"
"Added subject-matter (no)"

**Decisions cited:**
-

**Catchword:**
-

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**Case Number:** T 0284/08 - 3.4.03

# D E C I S I O N
**of the Technical Board of Appeal 3.4.03**
**of 16 September 2011**

**Appellant**: Novaled AG
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D-01307 Dresden (DE)

**Representative**: Bittner, Thomas L.
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**Decision under appeal:** **Decision of the Examining Division of the European Patent Office posted 14 September 2007 refusing European patent application No. 06001230.9 pursuant to Article 97(1) EPC 1973.**

**Composition of the Board:**

**Chairman:** G. Eliasson
**Members:** T. Häusser
P. Mühlens

## Summary of Facts and Submissions

I. The appeal concerns the decision of the examining division refusing European patent application No. 06 001 230 for impermissible extension of subject-matter (main request) and lack of inventive step (first and second auxiliary request) having regard to the following document:

D2: EP 1 478 025 A2.

II. The appellant requests as a main request that the decision be set aside and a patent be granted on the basis of the following documents:

- claims 1 to 7 as filed with the letter dated 12 November 2010.
- description pages 1, 2, and 8 to 10 as originally filed; pages 3 and 3a as filed with the letter dated 25 August 2006, pages 5 to 7 as filed with the letter dated 8 March 2007, and pages 4 and 11 as filed with the letter dated 12 November 2010;
- drawings sheets 1/2 and 2/2 as originally filed.

The appellant also requests oral proceedings on an auxiliary basis.

III. The wording of claim 1 reads as follows:

"1. An organic light emitting device comprising:

- an anode (2);
- a cathode (4); and
- a plurality of organic electroluminescent units (3.1, ..., 3.m; m = 2, 3, ...) provided upon each

other in a stack or an inverted stack between said anode (2) and said cathode (4) each of the organic electroluminescent units (3.1, ..., 3.m) comprising two doped transporting-layers, namely a p-type doped hole-transporting layer (p-HTL) and a n-type doped electron-transporting layer (n-ETL), and an electroluminescent zone (EML) formed between the p-HTL and the n-ETL;

wherein:

– for the first organic electroluminescent unit (3.1), the p-HTL is in direct contact with the anode (2);

– for the $m^{th}$ organic electroluminescent unit (3.m), the n-ETL is in direct contact with the cathode (4);

– for all of said organic electroluminescent units (3.1, ..., 3.m), within the stack or the inverted stack adjacent doped transporting layers provided in two adjacent organic electroluminescent units and adjacent to each other are in direct contact, thereby forming a p-n-junction between an adjacent p-HTL provided in one of the two adjacent organic electroluminescent units and an adjacent n-ETL provided in the other one of the two adjacent organic electroluminescent units; and

– for all of said organic electroluminescent units (3.1, ..., 3.m), the organic electroluminescent unit is provided as a unit selected from the following group of units:

  – p-HTL / EML / n-ETL,

  – p-HTL / EBL / EML / n-ETL,

  – p-HTL / HIL / EML / n-ETL,

  – p-HTL / EML / HBL / n-ETL,

– p-HTL / EML / EIL / n-ETL, and

– p-HTL / EBL / EML / HBL / n-ETL,

where HIL is a hole injection layer, EIL is an electron injection layer, HBL is a hole blocking layer, and EBL is an electron blocking layer."

IV. The appellant argued essentially as follows:

The closest state of the art was document D2 which disclosed light emitting devices having the following structure:

cathode ¦ electroluminescent unit ¦ connecting unit ¦ electroluminescent unit ¦ connecting unit ¦ ... ¦ connecting unit ¦ electroluminescent unit ¦ anode,

where the connecting unit consisted of a combination of doped layers, namely a p-type doped hole-transporting layer and an n-type doped electron-transporting layer. Furthermore, even in the simplest case the electroluminescent unit comprised an undoped hole-transporting layer.

The objective technical problem was to provide a simplified structure for stacked organic light emitting devices. This problem was solved by an organic light emitting device according to claim 1, which is free of an additional undoped hole-transporting layer.

Whereas it was stated in paragraph [0069] of D2 that the light-emitting layer and the electron-transporting layer may be collapsed into a single layer, no such collapsing design was disclosed or proposed for the hole-transporting layer. Rather, each of the

electroluminescent units was considered in D2 as a fully functional organic light emitting device for which the hole-transporting layer was considered necessary. These units were stacked in D2 using the connecting units.

Consequently, there was no disclosure or stimulation in D2 leading the skilled person in obvious ways to the device of claim 1.

## Reasons for the Decision

1. Admissibility

The appeal is admissible.

2. Amendments

Claim 1 is based on claim 1 as originally filed and on the description and drawings as originally filed (page 5, lines 15 to 17; page 6, lines 18 to 22; page 8, lines 16 to 23; page 9, lines 13 to 16 and 23 to 26; Figures 1 and 2).

Dependent claims 2 to 7 are based on original claims 3 to 8, respectively. The description has been brought into conformity with the amended claims and supplemented with an indication of the relevant content of the prior art. Furthermore, a general statement in the description has been deleted.

Accordingly, the board is satisfied that the amendments comply with the requirements of Article 123(2) EPC.

3. Novelty

3.1 Document D2 discloses (page 3, lines 43 to 47) a cascaded organic light-emitting device (OLED) comprising an anode 110, a cathode 140 and a plurality of organic electroluminescent (EL) units 120.1 to 120.N. The EL units are cascaded serially to each other between the anode 110 and the cathode 140 (Figure 1, reference signs 110, 140, and 120.1 to 120.N).

Furthermore, it is stated in document D2 (paragraphs [0002] and [0022]) that there are many organic EL multilayer structures known that can be used in the device and a list of several of such structures is provided, the preferred structure of the first, $N^{th}$, and intermediate EL unit being HIL/HTL/LEL/ETL, HTL/LEL/ETL/EIL, and HTL/LEL/ETL, respectively, where "HTL", "ETL", "LEL", "HIL", and "EIL" means hole-transporting layer, electron-transporting layer, light-emitting layer, hole-injecting layer, and electron-injecting layer, respectively. The LEL includes a luminescent or fluorescent material where electroluminescence is produced as a result of electron-hole pair recombination (paragraph [0058]).

A multitude of connecting units (130.1 to 130.(N-1)) are disposed between any two adjacent organic EL units (page 3, lines 49-50) comprising preferably an n-type doped organic layer adjacent to the ETL of the EL unit towards the anode side and a p-type doped organic layer adjacent to the HTL of the EL unit towards the cathode side, the two layers of a connecting unit forming a p-n junction (page 5, lines 2-9, and claim 1, d)). The host

material of the n-type doped organic layer of a connecting unit preferably supports electron transport, whereas the host material of the p-type doped organic layer of a connecting unit preferably supports hole transport (page 5, lines 32-36).

3.2 In the wording of claim 1 (except for the qualification in bold), document D2 discloses an organic light emitting device (OLED) comprising:

– an anode (110);

– a cathode (140); and

– a plurality of organic electroluminescent units (EL unit 120.1 and n-type doped organic layer of connecting unit 130.1; p-type doped organic layer of connecting unit 130.1 and EL unit 120.2 and n-type doped organic layer of connecting unit 130.2; ... ; p-type doped organic layer of connecting unit 130.(N-2) and EL unit 120.(N-1) and n-type doped organic layer of connecting unit 130.(N-1); p-type doped organic layer of connecting unit 130.(N-1) and EL unit 120.N) provided upon each other in a stack between said anode (110) and said cathode (140), wherein each of the organic electroluminescent units, **except the first and the last of these units,** comprises two doped transporting-layers, namely a p-type doped hole-transporting layer(p-type doped organic layer of connecting unit 130.1 to 130.(N-2)), subsequently named "p-HTL", and a n-type doped electron-transporting layer (n-type doped organic layer of connecting unit 130.2 to 130.(N-1)), subsequently named "n-ETL", and an electroluminescent zone (LEL including luminescent

or fluorescent material) formed between the p-HTL and the n-ETL;

wherein:

– for all of said organic electroluminescent units within the stack adjacent doped transporting layers provided in two adjacent organic electroluminescent units and adjacent to each other are in direct contact, thereby forming a p-n-junction between an adjacent p-HTL provided in one of the two adjacent organic electroluminescent units (p-type doped organic layer of connecting unit 130.1 to 130.(N-1)) and an adjacent n-ETL provided in the other one of the two adjacent organic electroluminescent units (n-type doped organic layer of connecting unit 130.1 to 130.(N-1)).

3.3 Document D2 also discloses in paragraphs [0055]-[0057] and [0064]-[0065] suitable materials for the HTL and ETL, respectively. However, it is neither described that the HTL could be p-type doped, nor that the ETL could be n-type doped. Furthermore, in the preferred embodiment referred to above (see point 3.1), each of the EL units comprises an HTL and an ETL. Even in the other disclosed alternatives (see in particular paragraphs [0022] and [0069]), each of the EL units comprises at least an undoped HTL. Hence, at least the following feature of claim 1 is not disclosed in document D2:

(i) for all of said organic electroluminescent units, the organic electroluminescent unit is provided as a unit selected from the following group of units:

- p-HTL / EML / n-ETL,

- p-HTL / EBL / EML / n-ETL,
- p-HTL / HIL / EML / n-ETL,
- p-HTL / EML / HBL / n-ETL,
- p-HTL / EML / EIL / n-ETL, and
- p-HTL / EBL / EML / HBL / n-ETL,

where HIL is a hole injection layer, EIL is an electron injection layer, HBL is a hole blocking layer, and EBL is an electron blocking layer.

3.4 For these reasons the subject-matter of claim 1 is new over document D2.

The remaining prior art documents on file are not closer to the subject-matter of claim 1 than document D2. Claims 2 to 7 are dependent on claim 1 providing further limitations.

Accordingly, the subject-matter of claims 1 to 7 is new (Article 52(1) EPC and Article 54(1), (2) EPC 1973).

4. Inventive step

4.1 The closest state of the art is regarded to be document D2 discussed above, in particular the device comprising the preferred layers referred to above under point 3.1. The subject-matter of claim 1 differs from the device of document D2 at least in comprising feature (i) (see point 3.3).

4.2 Feature (i) has the effect of obviating the need to manufacture certain layers, namely the HTL and the ETL, at all, thus simplifying the manufacturing process (see also the description, page 3, paragraph 4 and page 4, first paragraph).

The objective technical problem can therefore be regarded as to allow the manufacturing process to be simplified.

4.3 In the decision under appeal a reference was made to paragraph [0069] of document D2 which stated that the ETL and the light-emitting layer could optionally be collapsed into a single layer that served the function of supporting both light emission and electron transportation, and that it was known in the art that light-emitting dopants might be added to the HTL, which then would serve as a host. The examining division was of the opinion that the skilled person would, when starting from any of the structures disclosed in paragraph [0022], use this teaching to arrive at the claimed subject-matter.

However, in the board's view, adding light-emitting dopants to the HTL would not *simplify* the manufacturing process as it would require an additional manufacturing step, thus increasing the complexity of the manufacturing process.

Furthermore, the location of the electron-hole recombination zone depends on the mobilities of the electrons and holes in the various layers. If a device were to be considered in which the LEL and ETL were not only collapsed into a single layer, but light-emitting dopants were also added to the HTL, then the mobilities of the collapsed layer and the doped HTL would have to be carefully adjusted such that recombination would take place in both layers; otherwise the light-emitting dopants in one of the layers would serve no purpose.

Moreover, since the host would be different in the two layers, generally different light-emitting dopants would have to be used for the two layers in order to ensure that the band gap of the light-emitting dopant was smaller than that in the host material - a necessary condition for efficient energy transfer from the host to the light-emitting dopant molecule (see document D2, paragraph [0059]). Therefore, the complexity of the manufacturing process would be further increased.

The board is therefore of the opinion that it would not be obvious for the skilled person, a semiconductor physicist, when starting from the device representing the closest state of the art and attempting to solve the posed problem, to arrive at a device comprising feature (i).

The above considerations lead to the same conclusion, even if the skilled person were to consider replacing the preferred structures of the EL units (see point 3.1) by another structure listed in paragraph [0022] of document D2.

4.4 The other document on file discloses no teaching that would lead the skilled person to the subject-matter of claim 1.

4.5 The subject-matter of claim 1 is therefore not considered to be obvious.

The subject-matter of claims 2 to 7 is not considered obvious either as these claims are dependent on claim 1.

Accordingly, the subject-matter of claims 1 to 7 involves an inventive step (Article 52(1) EPC and Article 56 EPC 1973).

5. Other requirements of the EPC and conclusions

In order to comply with the requirements of Article 84 EPC 1973, the description has been brought into conformity with the amended claims and a general statement in the description has been deleted. Furthermore, the description has been supplemented with an indication of the relevant content of the prior art to comply with the requirements Rule 27(1)(b) EPC 1973. These requirements of the EPC are therefore also satisfied.

In view of the above the appellant's main request is allowable.

The holding of oral proceedings - the appellant's auxiliary request - is therefore not necessary.

## Order

## For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a European patent in the following version:
   - claims 1 to 7 as filed with the letter dated 12 November 2010.
   - description pages 1, 2, and 8 to 10 as originally filed; pages 3 and 3a as filed with the letter dated 25 August 2006, pages 5 to 7 as filed with the letter dated 8 March 2007, and pages 4 and 11 as filed with the letter dated 12 November 2010;
   - drawings sheets 1/2 to 2/2 as originally filed.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson