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Datasheet for the decision of 3 May 2017

Case Number: T 0333/13 - 3.3.10

Application Number: 05853110.4

Publication Number: 1828342

IPC: C09K11/06, H01L51/50, H05B33/22, H05B33/14

Language of the proceedings: EN

Title of invention:
PHOSPHORESCENT OLEDS WITH EXCITON BLOCKING LAYER

Patent Proprietor:
Global OLED Technology LLC

Opponent:
Merck Patent GmbH

Headword:
OLED DEVICES

Relevant legal provisions:
EPC Art. 56

Keyword:
All requests - Inventive step - (no)

Decisions cited:

Catchword:

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Case Number: T 0333/13 - 3.3.10

D E C I S I O N
of Technical Board of Appeal 3.3.10
of 3 May 2017

Appellant: (Opponent)	Merck Patent GmbH Frankfurter Strasse 250 64293 Darmstadt (DE)
Representative:	Breuning, Esther Merck Patent GmbH 64271 Darmstadt (DE)
Respondent: (Patent Proprietor)	Global OLED Technology LLC 13873 Park Center Road, Suite 330 Herndon, VA 20171 (US)
Representative:	Wibbelmann, Jobst Wuesthoff & Wuesthoff Patentanwälte PartG mbB Schweigerstrasse 2 81541 München (DE)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 2 January 2013 concerning maintenance of the European Patent No. 1828342 in amended form.**

Composition of the Board:

Chairman	P. Gryczka
Members:	C. Komenda
	C. Schmidt

Summary of Facts and Submissions

I. The appeal of the appellant (opponent) lies from the decision of the Opposition Division to maintain the European patent No. 1 828 342 in amended form according to the then pending Main Request.

II. Notice of opposition has been filed on the grounds of insufficiency of disclosure (Article 100(b) EPC), of lack of novelty and lack of inventive step (Article 100(a) EPC).

III. In its decision the opposition division referred *inter alia* to the following documents:

(3) WO 02/47457 A2,
(5) "Triplet exciton confinement and unconfinement by adjacent hole-transport layers", K Goushi et al., J. Appl. Phys. 1994, 95(12), 7798-7802 and
(13) WO 2004/062324 A1.

The opposition division found that the amendments made to the claims of the Main Request fulfilled the requirements of Article 123(2) and (3) EPC. Further, the opposition division stated that the original application contained sufficient information to enable the skilled person to carry out the invention, since the method for determining the triplet energy values referred to in claim 1 was a reliable and well known method. The claimed subject-matter was regarded as being novel over the cited prior art. A combination of the teachings of documents (3), (5) or (13) would not have led the skilled person to the subject-matter of claim 1.

IV. The wording of independent claim 1 of the main request on which the decision under appeal was based read as follows:

"*1. An OLED device comprising a cathode, an anode, and located therebetween a light emitting layer (LEL) comprising at least one hole transporting co-host and at least one electron transporting co-host, together with a phosphorescent emitter, and wherein the triplet energy of each of the co-host materials is greater than the triplet energy of the phosphorescent emitter and further containing an exciton blocking layer comprising a hole transporting material with a triplet energy greater 2.5 eV adjacent the emitting layer on the anode side, wherein the triplet energy is calculated as the difference between the ground state energy (E(gs)) of the molecule and the energy of the lowest triplet state (E(ts)) of the molecule, both given in eV, and wherein these energies are obtained using the B3LYP method as implemented in the Gaussian 98 computer program, wherein the basis set for use with the B3LYP method is defined as follows: MIDI! for all atoms for which MIDI! is defined, 6-31G* for all atoms defined in 6-31G* but not in MIDI!, and the LACV3P basis set and pseudopotential for atoms not defined in the MIDI! wherein for any remaining atoms, any published basis set and pseudopotential may be used; MIDI!, 6-31G* is used as implemented in the Gaussian98 computer code and LACV3P is used as implemented in the Jaguar 4.1 computer code, wherein the energy of each state is computed at the minimum-energy geometry for that state, wherein the difference in energy between the two states is further modified by equation (1) to give the triplet state energy (E(t)):*
E(t)=0.84(E(ts)-E(gs))+0.35 (eq. 1).*"

V. With its statement of grounds for appeal the appellant brought forward its argumentation as to why the subject-matter of the claims was not disclosed in a manner sufficiently clear for it to be carried out by a skilled person and why it was not novel. In support of inventive step he filed *inter alia* documents

(16) "Ergebnisse von quantenchemischen Untersuchungen an organischen Elektrolumineszenzvorrichtungen, durchgeführt unter der Anleitung von Dr. Christof Pflumm" and
(17) US 2002/0101154 A1.

In its discussion of inventive step the appellant started from either of documents (3), (13) or (17) as the closest state of the art. Since some of the claimed devices did not exhibit improved properties when compared to those of the prior art the claimed devices could only represent obvious alternatives to those of the prior art. Consequently, the subject-matter of all claims was not based on an inventive step.

VI. In its reply to the statement of grounds for appeal dated 7 October 2013 the respondent (patent proprietor) filed the auxiliary requests I to III.

(a) The wording of claim 1 of the auxiliary request I is based on the wording of claim 1 of the main request, which has additionally been characterized in that "the triplet energies of the materials of the exciton blocking layer exceed that of the phosphorescent emitter".

(b) The wording of claim 1 of the auxiliary request II is based on the wording of claim 1 of the main request, wherein the phosphorescent emitter was

further characterized in that it was a "green or blue" phosphorescent emitter.

(c) The wording of claim 1 of the auxiliary request III is based on the wording of claim 1 of the main request, which additionally contained both restrictions introduced into claim 1 of the auxiliary requests I and II.

VII. With regard to inventive step the respondent argued that only document (5) could represent the closest state of the art, since the documents (3), (13) and (17) related to technical problems other than that of the patent in suit. Further the experiments of the appellant presented as document (16) did not demonstrate the absence of any improvement over the disclosure of document (5). Further, it was not obvious from the cited prior art that the claimed combination of features led to OLED devices having an improved efficiency.

VIII. The appellant (opponent) requested that the decision under appeal be set aside and that the European patent No. 1828342 be revoked.

The respondent (patent proprietor) requested that the appeal be dismissed, i.e. that the patent be maintained as upheld by the Opposition Division, or, as an auxiliary measure, that the patent be maintained on the basis of any of the auxiliary requests I, II or III, all auxiliary requests filed with letter dated 7 October 2013.

IX. At the end of the oral proceedings held on 3 May 2017 before the Board the decision was announced.

Reasons for the Decision

1. The appeal is admissible.

2. The appellant has objected to the claimed subject-matter as not being disclosed in a manner sufficiently clear for it to be carried out by a skilled person. Further he raised an objection against novelty of the claimed subject-matter. In view of the negative decision on inventive step for all requests (see below) a decision on these issues appears superfluous.

Main request - Inventive step (Article 56 EPC)

3. The patent in suit is directed to an OLED device comprising a cathode, an anode, and located therebetween a light emitting layer (LEL). According to the respondent and the opposition division the closest state of the art was represented by document (5). The appellant, however, regarded either of documents (3), (13), or the newly filed document (17) as a starting point for the assessment of inventive step.

3.1 Document (3) relates to an OLED device comprising an anode, a cathode and a LEL positioned therebetween. The LEL is composed of a mixed host-system comprising an organic small molecule hole transporting co-host material, such as N,N'-diphenyl-N,N'-bis-alpha-naphthylbenzidine (NPD), an organic small molecule electron transporting co-host material, such as tris-(8-hydroxyquinoline)aluminium (ALq_3), and a phosphorescent emitter, such as 2,3,7,8,12,13,17,18-octaethyl-21*H*,23*H*-porphine platinum II (PtOEP), as emitter (see claims 1 and 5). As calculated according

to the method described in claim 1 of the patent in suit the triplet energies are 2.42 eV for NPD, 2.09 eV for ALq_3 and 2.08 eV for PtOEP. Thus, the triplet energies for the co-host materials (NPD and ALq_3) are higher than that of the phosphorescent emitter (PtOEP). According to one embodiment the OLED may additionally comprise a hole transporting layer which may also function as an exciton blocking layer (page 9, lines 29 to 33).

3.2 Document (13) relates to an organic electroluminescent device (OLED) having improved luminous efficiency and durability (page 3, last paragraph). The OLED contains a light emitting layer comprising a green or blue phosphorescent emitter together with a hole transporting co-host and an electron transporting co-host, wherein the triplet energy of each of the co-host materials is greater than the triplet energy of the green or blue phosphorescent emitter (claim 1). Example 5 discloses an OLED device which has a hole transporting layer adjacent to the LEL on the anode side. This layer comprises N,N'-diphenyl-N,N'-di(o-tolyl)benzidine (TPD) as hole transporting material. The light emitting layer deposited thereon comprises a hole transporting co-host, identified as A-10, an electron transporting co-host, identified as ET-1, and a blue emitting phosphorescent compound, identified as G-2. The triplet energies of these compounds were calculated as being 3.12 eV for A-10, 2.98 eV ET-1 and 2.66 eV for the phosphorescent emitter G-2. Therefore, the co-host materials of the OLED disclosed in Example 5 have triplet energies greater than the triplet energy of the phosphorescent emitter, as required according to the patent in suit. The TPD containing hole transporting layer adjacent to the light emitting layer, which corresponds to the exciton blocking layer,

has a triplet energy of 2.49 eV. According to the patent in suit, however, the lower limiting value for the triplet energy of the hole transporting layer is 2.5 eV.

3.3 Document (5) is a scientific article that relates to a study determining the influences on exciton confinement and unconfinement by adjacent hole transport layers. In particular, the study concluded that there has to be a wide gap of the triplet energy of the hole transporting host material for obtaining high exciton confinement within the light emitting layer. Further, the triplet energy of the hole transport layers has to be higher than that of the phosphorescent emitter in order to obtain high efficiency (see page 7801, paragraphs V and VI). However, the light emitting layer of document (5) comprises only one single co-host.

3.4 Since the OLED disclosed in document (5) uses a single host system for the light emitting layer, whereas the OLED of the patent in suit is based on a light emitting layer comprising at least one electron transporting co-host and one electron transporting co-host, the skilled person would not have considered starting from a structurally different system, when he was looking for improving an OLED comprising a mixed co-host system. Therefore, the Board concludes that document (5) is less suitable as a starting point for the discussion of inventive step than documents (3) or (13), which both use a mixed co-host system as in the OLED according to the patent in suit.

3.5 According to the appellant the teaching of the newly filed document (17) was similar to that of documents (3) or (13), which have both already been part of the opposition proceedings. Since the teaching of document

(17) is apparently not closer to the subject-matter of the patent in suit than documents (3) or (13), the Board sees no need to discuss inventive step starting from document (17) as the closest state of the art.

3.6 It was accepted that the teachings of documents (3) and (13) are very similar. Therefore, the Board concludes that either of documents (3) or (13) is suitable to represent the closest state of the art for the discussion of inventive step. In the following discussion the Board will, however, refer only to document (13) as the closest state of the art.

4. According to the respondent the problem to be solved starting from document (13) as the closest state of the art was to provide an OLED device having an improved luminous efficiency at a lower voltage.

5. As a solution to this technical problem the patent in suit proposes the OLED according to claim 1, wherein the exciton blocking layer comprising a hole transporting material is characterized in that it has a triplet energy greater 2.5 eV.

6. Although the appellant raised doubts as to whether the examples of the patent specification are suitable to demonstrate that the claimed improvement is achieved over the whole range claimed, the Board accepts to the benefit of the respondent, that the problem mentioned in paragraph 4. *supra* has been successfully solved.

7. Thus, it remains to be determined, whether the solution offered by the patent in suit was obvious from the prior art.

7.1 In this respect the appellant referred to document (5). This document teaches that in order to confine the excitons in the light emitting layer the hole transporting material of the HTL has to have a triplet energy greater than that of the phosphorescent emitter (see paragraph 3.3 *supra*). Document (5) teaches that the hole transporting material NPD was a stable material, but with its triplet energy below 2.5 eV it was found insufficient in confining the excitons in the light emitting layer. However, the compound 1,1-bis-[(di-tolylamino)phenyl]cyclohexane (TAPC) having a calculated triplet energy of 2.97 eV provided the highest exciton confinement and the highest luminous efficiency of the OLEDs. Document (5), therefore, leads the skilled person to select hole transporting materials having high triplet energies for use in the HTLs in order to increase the luminous efficiency of the OLEDs. In view of the finding in document (5) that the triplet energy of the hole transporting material in the HTL has to be only greater than that of the phosphorescent emitter in order to confine the excitons in the light emitting layer, the absolute limiting value of 2.5 eV as defined in claim 1 of the patent in suit appears to be arbitrarily selected and does as such not contribute to the solution. Therefore, the skilled man was led to the subject-matter of the patent in suit without having to exercise any inventive skill.

7.2 The respondent brought forward that from the teaching of document (5) the skilled person would have expected only a small increase in the luminous yield when using TAPC instead of NPD, since the exciton confinement for the various hole transporting materials exemplified in document (5) resulted in an increase of the quantum efficiency of only between 8% for NPD and 14% for TAPC. Therefore, the skilled person would have had no

incentive to deviate from NPD as hole transporting material, since the durability of NPD was much higher than for other hole transporting materials.

7.3 However, it has to be stated that the problem to be solved was to increase the luminous yield. The degree of improvement is of no relevance as long as document (5) teaches to use hole transporting materials having high triplet energy levels, such as TAPC. The stability of the hole transporting material is in this respect of no relevance, since the stability of the OLED devices was not part of the technical problem as stated in paragraph 4. *supra*. Therefore, this argument of the respondent cannot succeed.

8. Consequently, the Board comes to the conclusion that the subject-matter of the claims according to the main request is not based on an inventive step as stipulated in Article 56 EPC.

Auxiliary requests I to III

9. The appellant did not raise any objections to the amendments made. In view of the negative conclusion on inventive step for all auxiliary requests (see below), the Board sees no reason to further investigate into this matter.

10. Claim 1 of the auxiliary requests I, II and III was based on the wording of claim 1 of the main request. The claimed subject-matter was further characterized in that "the triplet energies of the materials of the exciton blocking layer exceed that of the phosphorescent emitter" (auxiliary request I) and that the phosphorescent emitter was a "green or blue" phosphorescent emitter (auxiliary request II). The

claim 1 of auxiliary request III contained both of these restrictions (see paragraph VI a) to c), *supra*).

11. Since all of these further restricting features were already disclosed in the closest prior art, document (13) (see paragraph 3.2 *supra*), the arguments and conclusions as brought forward in the discussion of inventive step with regard to the main request (see paragraphs 3. to 8. *supra*) apply *mutatis mutandis* also to the discussion on inventive step for the auxiliary requests I to III. Consequently, the subject-matter of claim 1 of these requests also is regarded as not involving an inventive step (Article 56 EPC).

Order

For these reasons it is decided that:

12. The decision under appeal is set aside.

13. The patent is revoked.

The Registrar: The Chairman:

M. Schalow P. Gryczka

Decision electronically authenticated