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Datasheet for the decision of 17 August 2020

Case Number: T 0623/16 - 3.4.03

Application Number: 02734378.9

Publication Number: 1390962

IPC: H01J1/62, H01J63/04, C09K11/06, H01J29/32, H05B33/14, H01J1/74

Language of the proceedings: EN

Title of invention:
HIGH EFFICIENCY MULTI-COLOR ELECTRO-PHOSPHORESCENT OLEDS

Patent Proprietor:
THE TRUSTEES OF PRINCETON UNIVERSITY
UNIVERSITY OF SOUTHERN CALIFORNIA

Opponents:
BASF SE
OSRAM GmbH

Headword:

Relevant legal provisions:
EPC 1973 Art. 83

Keyword:

Sufficiency of disclosure - (yes) - support by the description (yes) - reproducibility (yes) - completeness of disclosure - main request (no) - auxiliary request (yes)
Essential features

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

Boards of Appeal

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Case Number: T 0623/16 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 17 August 2020

Appellant: (Patent Proprietor 1)	THE TRUSTEES OF PRINCETON UNIVERSITY 5th Floor, New South Building Princeton, NJ 08544-0036 (US)
Appellant: (Patent Proprietor 2)	UNIVERSITY OF SOUTHERN CALIFORNIA 3716 South Hope Street Suite 313 Los Angeles, CA 90007-4344 (US)
Representative:	Maiwald Patent- und Rechtsanwaltsgesellschaft mbH Elisenhof Elisenstraße 3 80335 München (DE)
Former Opponent 1:	BASF SE 67056 Ludwigshafen (DE)
Representative:	Hollah, Dorothee Patentanwälte Isenbruck Bösl Hörschler PartG mbB Eastsite One Seckenheimer Landstrasse 4 68163 Mannheim (DE)
Respondent: (Opponent 2)	OSRAM GmbH Marcel-Breuer-Strasse 6 80807 München (DE)
Representative:	Epping - Hermann - Fischer Patentanwaltsgesellschaft mbH Schloßschmidstraße 5 80639 München (DE)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted on 4 January 2016 revoking European patent No. 1390962 pursuant to Article 101(3)(b) EPC1973.**

Composition of the Board:

Chairman G. Eliasson
Members: A. Böhm-Pélissier
G. Decker

Summary of Facts and Submissions

I. The appeal is against the decision of the Opposition Division revoking European patent No. EP 1 390 962 with the application No. 02 734 378.

II. Two oppositions were filed which both were based on the grounds of opposition under Articles 100 (a)-(c) EPC 1973. The patent was revoked solely according to Article 100 (b) EPC 1973, i.e. insufficiency of disclosure.

III. Reference is made to the following documents:

D40 = Experimental data provided by BASF on 4 May 2015

D41 = Experimental report filed by the patent proprietors on 16 October 2015

D41a = Annex to the experimental report, color diagram situating the devices mentioned in D41

D43 = Molecular design of hole transport materials for obtaining high durability in organic electroluminescent diodes, Chihaya Adachi et al, Appl. Phys. Lett. 66 (20), 15 May 1995, page 2697 - 2681, https://doi.org/10.1063/1.113123

D44 = High-Efficiency Organic Electroluminescent Devices Using an Organoterbium Emitter, Simone Capecchi et al, Adv. Mater. 2000, Vol. 12, No. 21, November 2, page 1591 - 1593.

IV. The **Patent Proprietors** (hereinafter: **"Appellants"**) lodged an appeal.

V. The opposition by BASF SE was withdrawn with a submission dated 16 January 2020, and thus former **Opponent 1** is no longer part of the present appeal proceedings. Former Opponent 1 had not replied to the statement of grounds of appeal.

Before the Opposition Division, former Opponent 1 filed some experimental data (D40) supporting an objection with respect to insufficiency of disclosure within the meaning of Article 83 EPC 1973. The counter experiments carried out by the Appellants are described in D41. The Opposition Division admitted these evidences.

VI. **Opponent 2** (hereinafter **"Respondent"**) filed arguments in reply to the statement of grounds of appeal and announced in a letter dated 11 March 2020 that it would not be attending the oral proceedings.

VII. In its provisional opinion expressed in a communication accompanying the summons to oral proceedings, the **Board** came to the conclusion that from the description of the impugned patent and the experimental data provided in D41 enough details were provided for carrying out the invention. However, the claim wording as granted lacked features essential for carrying out the invention over the whole range, i.e. to generate white light. The Board also indicated that it intended to remit the case to the Opposition Division for further prosecution, should any of the requests meet the requirements of Article 83 EPC 1973.

VIII. Requests

In response to the summons to oral proceedings, the **Appellants** filed New First to Third Auxiliary Requests with a letter dated 20 May 2020 and requested that:

(a) as a Main Request, the decision under appeal be set aside and that the patent be maintained based on the Claims 1 to 8 as granted;

(b) if the Board considered the New First Auxiliary Request, filed with letter dated 20 May 2020, to be compliant with the requirements of Article 83 EPC 1973, the oral proceedings be cancelled and the case be remitted to the Opposition Division on that basis for consideration of novelty and inventive step;

(c) alternatively, a patent be maintained on the basis of the New Second or New Third Auxiliary Request, filed with letter dated 20 May 2020, or of the New Fourth to Ninth Auxiliary Request (previously First to Sixth Auxiliary Requests) as filed with the statement of grounds of appeal.

The **Respondent** requested that the appeal be dismissed.

IX. In response to the Appellants' letter of 20 May 2020, the Board cancelled the oral proceedings.

X. **Claim 1** of the **Main Request** as granted reads:

An organic light emitting device, the device emitting white light and comprising an emissive region,
wherein the emissive region comprises a host material, and a plurality of emissive dopants,
wherein the emissive region is comprised of a plurality of bands and each emissive dopant is doped into a separate band within the emissive region,

wherein at least one of the emissive dopants emits light by phosphorescence,
and wherein the device color can be tuned by varying the thickness and the dopant concentrations in each band.

XI. **Claim 1** of the **New First Auxiliary Request** reads (Board's labelling (A), (C) and (D)):
An organic light emitting device, the device emitting white light and comprising an emissive region,
wherein the emissive region comprises a host material, and a plurality of emissive dopants,
wherein the emissive region is comprised of a plurality of bands and each emissive dopant is doped into a separate band within the emissive region,
(A) wherein each of the emissive dopants emits light by phosphorescence, wherein
(C) (a) the bands within the emissive region are ordered with respect to the location of the exciton formation zone, and wherein the emissive dopants are arranged
(a1) in the order of highest triplet energy, intermediate triplet energy, to lowest triplet energy, or
(a2) in the order of highest triplet energy, lowest triplet energy, to intermediate triplet energy, and/or
(D) (b) at least two of the bands comprising the emissive region are separated by an exciton blocking layer, and wherein the device color can be tuned by varying the thickness and the dopant concentrations in each band.

XII. The parties' **main arguments**, as far as relevant to the present decision, may be summarised as follows:
(a) The Respondent argued that the claims did not fulfil the requirements of Article 83 EPC 1973

because they lacked essential features, *inter alia* that each of the emissive dopants emits light by phosphorescence, i.e. none of the emissive dopants emits light by fluorescence, and that an NPD layer was essential for carrying out the invention over the whole range.

(b) The Appellants argued that an NPD layer was not essential for carrying out the invention. As support for this reasoning, they referred *inter alia to* D43 and D44.

Reasons for the Decision

1. The appeal is admissible.

2. <u>The invention as claimed</u>

2.1 Organic light emitting devices (OLEDs) utilise thin film materials that emit light when excited by electric current. Light emission from OLEDs is typically via fluorescence or phosphorescence. The emitted light is generated by excitons which are formed by the recombination of holes and electrons.

2.2 Excitons are formed as a singlet or triplet excited state by means of applying an electric current between a cathode and an anode. An advantage of phosphorescence is that all excitons both from singlet and tripled excited states may participate in luminescence.

2.3 In contrast, only a small percentage (about 25%) of excitons in fluorescent devices are capable of producing the fluorescent luminescence that is obtained

from a singlet excited state. White organic light-emitting devices (WOLEDs) are of interest because they offer low cost alternatives for backlights in flat-panel displays and find use in room or area lighting.

2.4 The invention aims to provide an efficient electroluminescent emission from an emissive material having a plurality of light-emitting dopants within the emissive region of a single organic light emitting device. The color and intensity of each of the emissive dopants can be tailored to produce white light emission from a single OLED.

2.5 This is achieved in the present invention in that each of the emissive dopants emits light by phosphorescence, none of the emissive dopants emits light by fluorescence. The order of the layers is according to the band energy of the emitting layers. Alternatively a so-called exciton blocking layer is implemented. The blocking layer may be arranged between the blue emitting (e.g. Flrpic) layer and the red emitting layer and increases the blue emission.

3. Main Request - Article 83 EPC 1973

3.1 Experiments carried out by former Opponent 1

3.1.1 Former Opponent 1 tried to reproduce with its experiments in D40 device 2 of the patent with the only difference of using a different red emitter. Former Opponent 1 was in the position of the skilled person who has selected the emitters and the host. When the device was tested, it emitted only in the orange. Changing only concentration and thicknesses did not lead to a white emitting device.

3.1.2 Document D41 was submitted by the Appellants to demonstrate that it was possible to obtain white light from the device shown in D40. The skilled person would have needed to modify concentration and thicknesses of all three layers and at the same time change the sequence of the emitting layers or introduce a blocking layer.

3.1.3 The Appellants argued that the first experiment of D40 was an accidental failure because the blue emitter simply did not emit in this arrangement contrary to device 2 of the patent which used a different red emitter. This failing device could nonetheless be tuned to emit white light.

3.1.4 The Opposition Division was of the opinion that the measures implemented by the Appellants in D41 to get white emission would not be contemplated by the skilled person based on the general technical knowledge and the information provided by the patent. In particular, the values of the thickness of the different layers were extreme, i.e as thin as 1 nm for the green emitting layer and as thick as 60 nm for the blue emitting layer in view of the values/ranges disclosed in the patent in suit (e.g. paragraph [0069]; Figure 13 and paragraph [0072] indicated smaller than 30nm).

3.1.5 Thus, it was decided that it was not possible for the skilled person to depart from the very specific example of the impugned patent and obtain white light over the whole scope of claim 1 without undue burden.

3.2 Undue burden of carrying out the invention

3.2.1 The description proposes to vary a plurality of parameters for achieving a white emitting device. Examples of these parameters are changing the emitter, the host, changing the respective concentrations of dopants and components, varying the layer thicknesses, the sequence of the layers, adding blocking layers or not, changing the number of emitting layers and their location. All these parameters are inter-related.

3.2.2 There is no indication in the claims that several parameters, such as concentration and thickness on the one hand and the addition of a blocking layer on the other hand (or other parameters), should be varied at the same time. When the skilled person makes a first experiment and obtains a device which does not emit white, they would not find an explicit guidance in the patent to decide on what to start with to yield white emission.

3.2.3 Thus, guidance has to be given in the claims as to which features are essential for carrying out the invention over the whole range in order to achieve a device emitting white light. Once the skilled person is aware that these features are crucial for carrying out the invention, changing only concentration and thicknesses is no longer an undue burden and leads - with a series of experiments undertaken without technical difficulties by a person skilled in the area of producing OLEDs - to a white emitting device.

3.3 Essential features

3.3.1 In its reply to the statement of grounds of appeal, the Respondent provided a list of technical features which

are common to all embodiments described in the description. According to its reasoning the following features are essential for carrying out the embodiments (underlining added by the Board):

(a) there is always a dopant for red light;
(b) there are exactly two or three light emitting layers;
(c) each of the emissive dopants emits light by phosphorescence, none of the emissive dopants emits light by fluorescence;
(d) there is always an NPD layer.

The Appellants proposed two alternative measures to make the failing device of D40 emitting white light:

(e) ordering the layers according to the bands or
(f) implementing a blocking layer.

3.3.2 The Board is of the opinion that the description of the impugned patent describes all these measures in detail. Therefore, the description provides enough details for carrying out the invention.

ad (a)

3.3.3 **Dopant for red light:** As to the argument of the Respondent that a dopant for red light is essential for carrying out the invention over the whole range claimed, the Board admits that all examples described in D41 use a layer emitting red light. However, the Board derives from the Figure of D41a that also other combinations not using a red emitter could lead to devices emitting white light, such as combinations with devices emitting orange or yellow light.

ad (b)

3.3.4 **Two or three light emitting layers:** As to the argument of the Respondent that in all examples there are

exactly two or three light emitting layers, the Board is of the opinion that other combinations using more than three layers appear also possible.

3.3.5 Consequently, these two features are not essential for carrying out the invention over the whole range.

3.3.6 In its provisional opinion, the Board had objected that the claim wording as granted lacked the following features essential for carrying out the invention over the whole range:

Feature (A) ("phosphorescence", item (c) above):
"*each of the dopants emits by phosphorescence*", (basis: granted claim 2).

Feature (B) ("NPD", item (d) above):
(B1)"*the device comprises an NPD layer*",
(B2) "the NPD layer is an α or β NPD for forming excitons" (basis: all device examples, e.g. paragraph [0027] and [0041] of the patent).

Feature (C) ("ordering of bands", item (e) above):
"T*he bands within the emissive region are ordered with respect to the location of the exciton formation zone, and wherein the emissive dopants are arranged (a1) in the order of highest triplet energy, intermediate triplet energy, to lowest triplet energy, or (a2) in the order of highest triplet energy, lowest triplet energy, to intermediate triplet energy*"
(basis: granted claims 4 and 5).

Feature (D) ("exciton blocking layer", item (f) above):
as alternative or additive measure to feature (C):
"*at least two of the bands comprising the emissive region are separated by an exciton blocking layer*"

(basis: granted claim 6).

ad (c)

3.4 Feature (A) "phosphorescence":

In all examples provided in the impugned patent and in D41 each of the emissive dopants emits light by phosphorescence, none by fluorescence. There was therefore no proof provided that any combination of dopants emitting by florescence and phosphorescence would provide OLEDs stably emitting white light. The Appellants have not contested this.

ad (d) As to feature (B), see section 4 below.

ad (e)

3.5 Feature (C) "ordering of bands":

The Appellants stated in their grounds of appeal on page 11 that only one measure was necessary for shifting the overall emission of the device of D40 towards white light, namely varying the order of layers. This was directly taught in the description of Device 2, in more general terms in the specification of the patent (see e.g. paragraphs [0061] and [0047]) and in the dependent claims.

ad (f)

3.6 Feature (D) "exciton blocking layer":

3.6.1 As a further or alternative measure the Appellants have proposed an exciton blocking layer. The examples of D41 with such a BCP blocking layer show the best results. The blocking layer has multiple basis in the impugned patent (paragraph [0022], [0029], [0071], [0073]). It was concluded by the Appellants that in the light of the patent's disclosure, the skilled person must readily conclude that - in particular when emission

from the blue emitter is a problem - the use of an exciton blocking layer between the blue FIrpic layer and the red layer increases the blue emission, and thereby addresses the problem of the lacking blue emission in the device prepared in D40.

3.6.2 The Board notes that many examples described in the impugned patent comprise a BCP exciton blocking layer. However, the skilled person needs to vary a plurality of parameters in order to carry out the invention according to the Main Request. The BCP layer is not in the claim wording, indicating that this feature is essential. Therefore, it is an undue burden for the skilled person to multiply the number of experiments by considering a BCP layer or not.

3.6.3 In paragraph [0058] of the impugned patent the inventive idea, the function of the BCP layer and measures necessary for carrying out the invention are described in more detail (underlining added by the Board):

"*It is believed that the BCP layer thus functions simultaneously as a hole blocking layer and as an exciton transporting layer, which is present between the phosphorescent zone of the device and the hole transporting region of the device where substantially all hole-electron recombination occurs, but where only a small fraction of the luminescence is produced as fluorescent emission. By suitably selecting the materials used in each layer, and then adjusting the layer thicknesses and the phosphorescent dopant concentrations, the emission may be tuned to produce substantially any desired color. For example, by placing the phosphorescent dopants having the lowest energy transfer efficiency in a band immediately adjacent, or proximal to the hole-electron*

recombination zone, also referred to as the exciton formation zone, of the device and placing the phosphorescent dopants having the highest energy transfer efficiency in a band distal from the hole-electron recombination zone of the device, the relative emissive contribution of each phosphorescent dopant, each producing a different color of light emission, may be controlled by adjusting the thickness of each layer and concentration of dopant in each layer, as required to generate a desired color of light emission from the electrophosphorescent OLED. It is believed that such devices are commercially practical only if they are fabricated using at least one phosphorescent dopant, because the triplet excitons that are responsible for phosphorescence have diffusion lengths of a hundred nanometers or more, whereas fluorescent, singlet excitons have diffusion lengths that seldom exceed ten nanometers. Therefore, a device using triplet excitons can achieve the brightness and efficiency necessary for a commercially useful device".

3.6.4 This passage also underlines the importance of features (A) and (C). It was demonstrated in D41 that the layer structure of OLEDs in D41, i.e. the same as that of device 2 of the impugned patent, only emits white light with such a blocking layer.

3.6.5 From the Appellants' reasoning and the passages cited above, the Board concludes that the BCP layer is essential for carrying out the invention, if the bands are not ordered in a specific manner (see above). The blocking layer confines electrically generated excitons within an emissive layer, i.e. retards the flow of holes from the FIrpic doped layer towards the cathode and thereby forces more excitons to form in the FIrpic

layer thus preventing excitons from diffusing towards the cathode after forming in the FIrpic doped layer.

3.6.6 Claim 1 of the Main Request does not comprise features (A), (C)/(D) being essential to the invention and crucial to carry out the invention over the whole range claimed. Omitting these features leads to a device failing to emit white light.

3.6.7 **To summarise**, the Main Request does not comply with the requirements of Article 83 EPC 1973, at least for the reason that the independent claim does not comprise features (A) and (C) / (D).

3.6.8 Once the skilled person is aware that features (A), (C) /(D) are crucial for carrying out the invention, changing only concentration and thicknesses is no longer an undue burden and leads - with a series of experiments undertaken without technical difficulties by a person skilled in the area of producing OLEDs - to a white emitting device.

4. New First Auxiliary Request

4.1 In their response to the Board's preliminary opinion, the Appellants concurred with the conclusions drawn by the Board in that features (C) and (D) were essential for the invention. Furthermore, feature (A) was not contested as being essential either, and was - like features (C) and (D) - also introduced into the new First to Third Auxiliary Requests.

4.2 However, the Appellants contested that feature (B) was essential, although in all examples provided in the impugned patent and in D41 an α or β NPD layer was used

for generating the excitons. The NPD layer was supposed by the Board in its preliminary opinion to be crucial for generating the excitons and achieving the emission of white light.

4.3 It is common ground that an NPD layer is present in all Device examples of the patent. This is termed as HTL (Hole Transport Layer) in all devices. There is no other layer in the devices which could perform the essential feature of a hole transporting layer.

4.4 An HTL close to the Emissive Region (EMR) is essential for forming excitons by means of recombination of holes and electrons. These excitons are essential for light emission in the EMR of the OLED. The site of exciton formation is generally referred to in the patent as Exciton Formation Region (EFR) or exciton formation zone (EFZ). There is therefore an agreement that the EFZ in combination with an HTL is crucial for the invention claimed.

4.5 The main question is whether, according to the disclosure of the invention, features (B1) and (B2) are essential for the invention, i.e. whether the NPD layer is essential for creating the excitons, or whether a teaching is provided to the skilled person that also other means could be used for providing sufficient excitons in the EFZ. The Board considers the entire specification when identifying the role of NPD layer and HTL.

4.6 As put forward by the Appellants, the impugned patent provides enough basis that not the specific material of NPD is important for the generation of excitons, but the interface of the HTL and the EMR.

4.6.1 The main arguments asserted by the Appellants in this respect can be shortly summarised as follows:

(i) example device 1 is a very specific example and is not representative for other Device examples in the impugned patent; when the invention was made almost 20 years ago the role of the NPD layer was not completely understood;

(ii) if the excitons were generated only in the NPD layer, the device would not emit in white;

(iii) the description provides the teaching that other HTLs may be used instead of an NPD layer;

(iv) the prior art also proposes alternatives for NPD layers as efficient HTLs.

4.6.2 A general explanation on the formation of excitons in the devices is given in the detailed description of the invention (paragraphs [0021] and [0022]), which provides basis that excitons are not formed in the NPD layer, but in general at an HTL interface:

"[0022] *By varying the concentration of the dopants, the location of the different color regions with respect to the HTL interface, where exciton formation generally occurs, the thicknesses of each of the layers, and by inserting an exciton blocking layer between emissive layers, the CIE coordinates of the OLEO emission can be tuned over a wide range. ...".*

4.6.3 Therefore, the EFZ is generally at the interface to the HTL, but this is not necessarily the case, as is disclosed in paragraph [0064] ("*In OLED devices, excitons form at the interface between two materials where a build up of excess charge occurs in one of the*

materials") and in Paragraph [0072] ("*The precise location of the EFZ in the WOLED is difficult to establish since it may shift depending on the several variables considered for color balancing").*

4.6.4 **D43 and D44** in the passages cited below provide evidence that it was well-known to the skilled person at the time the invention was made that the presence of an HTL is crucial for an OLED. A variety of different suitable materials is proposed in D43 and D44 and coincide with some materials proposed in the description of the impugned patent (TPD, MTDATA):

(a) In D43 14 different compounds HTM1 to HTM14 are depicted in Fig. 1 on page 2680, which are shown to be useful as material in an HTL of an OLED.

(b) D44 discloses the use of different HTL materials. The OLEDs of D44 also use triplet excitons, as in the present patent, for emission via lanthanides (page 1591, right column, lines 9 to 20). The device examples of D44 disclose the use of TPD as hole transporting layer material (page 1592, left column, last paragraph) and MTDATA (page 1593, left column, first full paragraph).

4.6.5 **To summarise**, the presence of an NPD layer is thus not essential to the present patent, neither as hole transport material, nor as exciton formation material. The Board hence concludes that it does not need to be explicitly claimed.

4.6.6 Once the skilled person is aware that features (A) and (C) / (D) are crucial for carrying out the invention, changing only concentration and thicknesses is not anymore an undue burden and leads - with a series of

routine experiments undertaken without technical difficulties by a person skilled in the area of producing OLEDs - to a white emitting device. Therefore, with the amendments made, the claims of the First Auxiliary Request fulfil the requirements of Article 83 EPC 1973.

4.7 The decision under appeal dealt solely with the question of sufficiency of disclosure (Article 83 EPC 1973). Therefore, the Board remits the case to the Opposition Division for further prosecution, as requested by the Appellants.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Opposition Division for further prosecution.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated