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**Datasheet for the decision
of 11 June 2015**

Case Number: T 0340/13 - 3.4.03

Application Number: 01954939.3

Publication Number: 1323215

IPC: H01L33/00

Language of the proceedings: EN

Title of invention:

IMPROVED TRANSPARENT SUBSTRATE LIGHT EMITTING DIODE

Applicant:

Lumei Optoelectronics Corporation

Headword:

Relevant legal provisions:

EPC 1973 Art. 54, 56, 84

EPC Art. 52(1), 123(2)

Keyword:

Amendments - added subject-matter (yes)

Claims - clarity (no)

Novelty - (yes)

Inventive step - (no)

Decisions cited:

Catchword:



**Beschwerdekammern
Boards of Appeal
Chambres de recours**

European Patent Office
D-80298 MUNICH
GERMANY
Tel. +49 (0) 89 2399-0
Fax +49 (0) 89 2399-4465

Case Number: T 0340/13 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 11 June 2015

Appellant: Lumei Optoelectronics Corporation
(Applicant) 9650 Telstar Avenue
El Monte, CA 91731 (US)

Representative: Meissner, Bolte & Partner GbR
Widenmayerstrasse 47
80538 München (DE)

Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 26 June 2012
refusing European patent application No.
01954939.3 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman G. Eliasson
Members: S. Ward
T. Bokor

Summary of Facts and Submissions

- I. The appeal is against the decision of the Examining Division refusing European patent application No. 01 954 939 on the grounds that the claimed subject-matter did not meet the requirements of Article 123(2) EPC and did not involve an inventive step within the meaning of Articles 52(1) and 56 EPC.

At the end of the oral proceedings held before the Board the appellant requested that the decision under appeal be set aside and that a patent be granted based on the main request filed with the statement of grounds of appeal or on the 1st auxiliary request filed with the letter of 8 May 2015.

- II. The following documents cited by the Examining Division are referred to in this decision:

D1: JP 10 270754 A
D4: WO 99/57788 A2
D5: JP 11 220170 A.

- III. Claim 1 of the main request reads as follows:

*"A light emitting diode comprising a transparent substrate, a light emitting region, and a window, wherein light generated by the active region passes through the transparent substrate; characterized in that:
said light emitting diode further comprises:
a Distributed Bragg Reflector (DBR) that reflects light in a range of wavelengths arriving at a range of incident angles, the DBR forming part of the face of only the window which is not being used to exit useful*

light, such that the DBR is positioned opposite to the side from which the light exits the light emitting diode."

Claim 1 of the 1st auxiliary request reads as follows:

"A light emitting diode comprising a transparent substrate, a light emitting region, and a window, wherein light generated by the light emitting diode exits through the transparent substrate, the transparent substrate forming an outermost layer on one side of the light emitting diode; characterized in that: said light emitting diode further comprises: a Distributed Bragg Reflector (DBR) that reflects light in a range of wavelengths arriving at a range of incident angles, the DBR being formed directly on the window, such that the DBR is positioned on another side of the light emitting diode that is opposite to the one side from which the light exits the light emitting diode."

IV. The findings of the Examining Division, insofar as they are relevant to the present decision, may be summarised as follows:

The subject matter of claim 1 differed from the disclosure of D5 only in that a DBR (instead of a metal reflector) was provided. This had the technical effect that the reflection of light was tailored for a specific range of wavelengths arriving at a specific range of incident angles. The objective technical problem was to optimise the reflection characteristics of the reflector.

A DBR had already been employed for the same purpose in the similar light emitting diode depicted in Fig. 3 and described in paragraphs [0030]-[0031] of document D1, and it would be obvious to the person skilled in the art to apply this feature with corresponding effect to a light emitting diode according to D5. Hence, the subject matter of claim 1 did not involve an inventive step (Articles 52(1) and 56 EPC).

V. In a communication under Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA) the Board argued essentially as follows:

The subject-matter of claim 1 of the present main request did not meet the requirements of Article 123(2) EPC or of Article 84 EPC 1973, and moreover lacked novelty in view of document D4, which, having regard to the red LED 11 and the lower DBR 22, appeared to disclose all features of claim 1.

In relation to inventive step, it was doubtful whether a skilled person would employ the DBR 9 disclosed in Fig. 3 of document D1 as a replacement for reflector 6a of document D5, which was required to display not only high reflectivity, but also electrical conductivity.

VI. The appellant's arguments may be briefly summarised as follows:

The amended features of claim 1 of the main request were clearly, unmistakably and fully derivable from Fig. 2 and not at odds with the other parts of the disclosure. The drawings were to be regarded as an integral part of the documents disclosing the invention.

Claim 1 of the first auxiliary request addressed issues raised in the Board's preliminary opinion in relation to Articles 123(2) and 84 EPC. The transparent substrate forming an outermost layer on one side of the light emitting diode was based on Fig. 2.

In relation to the question of novelty, the substrate disclosed in document D4 was the element referred to as "GaP-Substrat 1", which did not form "an outermost layer on one side of the light emitting diode". The layers of the upper LED 10 could not reasonably be regarded as part of the substrate.

Regarding inventive step, the combination of documents suggested by the Board during oral proceedings (document D1 as closest prior art plus document D5) would not lead the skilled person to the subject-matter of claim 1 of the first auxiliary request. The problem addressed by document D5 was to increase the light output, which was limited by the low transmission of layer 6 represented in Fig. 2. The equivalent layer in the embodiment of Fig. 3(a) of document D1 was the contact layer 5, which would display a similarly low transmission. The problem was therefore to further increase the amount of light exiting the structure.

The solution of document D5 was to replace layer 6 with metal layer 6a and to adopt the inverted arrangement shown in Fig. 1. Hence, even if the skilled person were to apply the teaching of document D5 to the arrangement of Fig. 3(a) of document D1, the result would be an inverted arrangement in which contact layer 5 was replaced by a metallic reflective layer. Such an arrangement would not correspond to the subject-matter of claim 1.

Reasons for the Decision

1. The appeal is admissible.
2. *Main Request: Article 123(2) EPC and Article 84 EPC 1973*
 - 2.1 Claim 1 of the main request includes the feature: "the DBR forming part of the face of only the window which is not being used to exit useful light". The Board, however, finds no disclosure in the application as filed of the DBR forming part of the window (or the face of the window); the DBR and the window are disclosed as two separate features. In this respect, therefore, the subject-matter of claim 1 does not meet the requirements of Article 123(2) EPC.

Moreover, a DBR is a three-dimensional object having a volume, and hence the Board does not see how it could ever be reasonably described as forming part of a face, i.e. a two dimensional surface. The clarity requirements of Article 84 EPC 1973 are therefore not met.

Objections essentially corresponding to those mentioned above formed part of the Board's provisional opinion set out in the communication under Article 15(1) RPBA. During the oral proceedings the appellant offered no comments in this regard, and the Board sees no reason to change its position.

The main request cannot therefore be allowed, as claim 1 does not meet the requirements of Article 123(2) EPC and Article 84 EPC 1973.

3. *1st Auxiliary Request: Novelty*

3.1 Claim 1 of the 1st auxiliary request defines a transparent substrate "forming an outermost layer on one side of the light emitting diode". If the substrate is identified with "GaP-Substrat 1" in document D4, then the claimed feature is not disclosed.

On the other hand, if the element 1 and the layers collectively labelled 10 in Fig. 2 of document D4 could reasonably be regarded as forming a composite substrate on which LED 20 is formed, then the cited feature would have to be considered as being disclosed.

In semiconductor technology the term "substrate" often refers to a structure comprising a single layer, but is also routinely used to refer to a structure having multiple layers, and it can well be imagined that cases may arise in which it is unclear whether one or more layers should properly be regarded as being part of the substrate or part of a device deposited on the substrate, or where such a distinction is essentially arbitrary.

The Board is satisfied that the device of document D4 does not represent such a case. The invention of document D4 relates to a bicolour light emitting semiconductor device in which a key idea is to deposit two active devices (first and second LEDs 10 and 20, having different wavelengths) on the same substrate. According to the normal terminology used in the field, the layers of the LED 10 do not form part of a composite substrate on which the LED 20 is formed, but form a separate active device, itself deposited on substrate 1.

It is therefore not disclosed in document D4 that the substrate 1 forms an outermost layer on one side of the light emitting diode, and hence the subject-matter of claim 1 of the 1st auxiliary request is new within the meaning of Articles 52(1) EPC and 54 EPC 1973.

4. *1st Auxiliary Request: Inventive step*

4.1 Document D5 was identified in the contested decision as the closest prior art. For the reasons set out in the communication under Article 15(1) RPBA, and further explained to the appellant during oral proceedings, the Board does not regard this document as a suitable starting point for the discussion of inventive step, and document D4 also is not considered suitable. The closest prior art is in fact seen as the second working example of document D1 (Figs. 3(a) to 5, and paragraphs [0030] to [0041]).

As best seen in Fig. 3(a), this example discloses a light emitting diode comprising a transparent substrate 1, a light emitting region 3, a window 5 and a Distributed Bragg Reflector (DBR) 9 that reflects light in a range of wavelengths arriving at a range of incident angles (true of any DBR).

Hence, claim 1 of the 1st auxiliary request differs in that:

- *"light generated by the light emitting diode exits through the transparent substrate, the transparent substrate forming an outermost layer on one side of the light emitting diode"; and*

- *"the DBR being formed directly on the window, such that the DBR is positioned on another side of the light emitting diode that is opposite to the one side from which the light exits the light emitting diode."*

4.2 In other words, Fig. 3(a) of document D1 discloses an arrangement essentially according to Fig. 1 of the present application, whereas what is presently claimed is the arrangement of Fig. 2 (hereinafter referred to as the "inverted" arrangement). Compared to an LED having no reflector, both of these arrangements can be seen as solving the problem alluded to in the description of the present application (see page 1, lines 19-22) of reducing light loss.

4.3 However, the application does not disclose any specific advantage of the arrangement of Fig. 2 over that of Fig. 1, and gives no indication that these two arrangements represent anything other than alternative possibilities for solving the above problem. Since the Board does not see any clear advantage offered by the claimed inverted arrangement in comparison with the non-inverted arrangement of the closest prior art, the problem is regarded as providing an alternative arrangement for reducing light loss in an LED.

4.4 Fig. 1 of document D5 discloses such an alternative arrangement, namely to use the light transmitted through a transparent (sapphire) substrate, and to locate the reflecting layer on the window side to provide light recycling and prevent loss. This would immediately suggest to the skilled person that a solution to the posed problem could be found in relocating the reflective layer of document D1 to the position proposed in Fig. 1 of document D5.

The layer 6a in document D5 is made of a highly reflective metal (paragraph [0009]), this being necessary as it serves a dual function as both a reflecting layer and a (conductive) current diffusion layer. In the arrangements of document D1 the reflecting films have no such dual function and no specific conductive properties are required; hence either a metallic film or a dielectric film may be used. The skilled person would therefore understand that an inverted arrangement could be implemented for the devices of document D1 by an appropriate relocation either of the metallic mirror 8 of Fig. 1 or of the DBR 9 of Fig. 3(a) depending on requirements, the second option leading directly to the distinguishing features noted above.

- 4.5 The Board does not believe that the skilled person would be deterred by any concomitant adaptations required in switching to an inverted design, for example in terms of electrode placement or device mounting; it would be well within the capacity of a person skilled in LED design to effect such modifications.

In view of these considerations, the Board concludes that it would be obvious for the skilled person to arrive at the claimed subject-matter on the basis of documents D1 and D5.

- 4.6 The appellant's counter-arguments are not found persuasive. The initial steps of the appellant's approach amount to the following:
- a) noting that document D5 identifies a problem in the prior art (represented by Fig. 2) of insufficient light output due to the low optical

transmission displayed by layer 6, which is made of an unspecified electrically conducting material;

- b) arguing that the equivalent layer in document D1 is the GaN contact layer 5, and asserting that this layer would also display a low optical transmission, resulting in a correspondingly poor light output; and
- c) concluding that the objective problem is to further increase the amount of light exiting the structure.

Firstly, this argument is based on pure speculation, in that no evidence has been adduced that GaN would have the same or similar transmission properties as those of the (unspecified) electrically conducting material of document D5.

Secondly, and more fundamentally, it represents an impermissible attempt to confect a problem based purely on the contents of prior art documents, without any reference to the subject-matter claimed.

Within the context of the problem-solution approach it is well-established that the objective problem is formulated on the basis of the technical effect achieved by the features distinguishing the claim from the closest prior art. Moreover, the objective problem should be plausibly solved by the invention over the whole breadth of the claim.

In the present case, the claimed subject-matter is distinguished from the closest prior art by the feature referred to above as the inverted arrangement, and hence, to accept the problem formulated by the appellant (i.e. increasing the amount of light exiting

the structure), it would need to be plausible that an LED with an inverted arrangement would invariably produce a greater light output than an otherwise identical LED having a non-inverted arrangement.

There is not so much as a hint in the description of the present application that this is the case, nor can the Board see any reason to believe it to be so. The appellant's arguments are therefore considered to be based on a wrong application of the problem-solution approach which leads to an incorrect formulation of the objective problem. Consequently they do not persuade the Board.

- 4.7 The Board judges that claim 1 of the 1st auxiliary request does not involve an inventive step within the meaning of Articles 52(1) EPC and 56 EPC 1973. The 1st auxiliary request therefore cannot be allowed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

G. Eliasson

Decision electronically authenticated