

Internal distribution code:

- (A) [-] Publication in OJ
- (B) [-] To Chairmen and Members
- (C) [-] To Chairmen
- (D) [X] No distribution

**Datasheet for the decision
of 29 November 2018**

Case Number: T 1451/14 - 3.4.03

Application Number: 05740465.9

Publication Number: 1756877

IPC: H01L33/00

Language of the proceedings: EN

Title of invention:

LUMINESCENT CERAMIC FOR A LIGHT EMITTING DEVICE

Applicant:

Lumileds Holding B.V.

Headword:

Relevant legal provisions:

EPC 1973 Art. 56

Keyword:

Inventive step - all requests - (no)

Decisions cited:

Catchword:



Beschwerdekammern
Boards of Appeal
Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 1451/14 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 29 November 2018

Appellant: Lumileds Holding B.V.
(Applicant) WTC Schiphol, Tower G4
Schiphol Boulevard 127
1118 BG Schiphol (NL)

Representative: Rüber, Bernhard Jakob
Lumileds Germany GmbH
Intellectual Property
Philipsstraße 8
52068 Aachen (DE)

Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 19 December
2013 refusing European patent application No.
05740465.9 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman G. Eliasson
Members: M. Papastefanou
C. Heath

Summary of Facts and Submissions

I. The appeal is against the the decision of the Examining Division refusing the European patent application No 05 740 465.9 (published as WO 2005/119797 A1) on the ground that claim 1 of the sole request before it introduced subject matter going beyond the originally filed content of the application (Article 123(2) EPC).

II. The final requests of the Appellant (Applicant) were that the decision be set aside and that a patent be granted on the basis of the Main request filed with its letter dated 26 July 2018. As an auxiliary measure, the Appellant requested that a patent be granted on the basis of one of the First or Second Auxiliary requests (titled "New First Auxiliary Request" and "New Second Auxiliary Request" respectively), both filed during the oral proceedings before the Board.

III. Reference is made to the following document:

D1: 103 49 038 A1.

IV. Independent Claim 1 of the Main request is worded as follows:

A method for manufacturing a light emitting structure, comprising:

- *a first step of manufacturing a semiconductor light emitting device (52) comprising the steps of:*
 - *providing a growth substrate (40),*
 - *providing a n-type region (42) on the growth substrate (40),*
 - *providing a p-type region (44),*

- providing a III-nitride based light emitting layer (43) disposed between the n-type region and the p-type region,
- a second step of providing a first ceramic layer (50, 50a), comprising a wavelength converting material, at a surface from which light is extracted from the light emitting device, characterized by attaching the first ceramic layer to the growth substrate (40) of the light emitting device by means of wafer bonding.

V. Claim 1 of the First Auxiliary request has the same wording as claim 1 of the Main request and in addition comprises the features of claim 2 of the Main request:

"...and wherein the second step comprises a step of pressing the semiconductor light emitting device and the first ceramic layer together at a temperature greater than room temperature and at a pressure greater than atmospheric pressure".

VI. Claim 1 of the Second Auxiliary request has the same wording as claim 1 of the First Auxiliary request with the additions that it is specified that:

- (i) the ceramic layer (50, 50a) comprises a wavelength converting material of **YAG:Ce**; and that
- (ii) the growth substrate is a **sapphire wafer** (emphasis added).

Reasons for the Decision

1. The appeal is admissible.

2. Main request

The Main request corresponds to the request underlying the decision under appeal.

2.1 The claimed invention

Claim 1 defines a method for manufacturing a light emitting structure. From the features of the manufactured structure defined in claim 1, it is understood that it corresponds to the embodiment presented in Figure 2 and described in lines 5-24 on page 7 of the application as published. This embodiment comprises a light emitting device (LED) with a growth substrate (40) on which the ceramic layer is attached (see also page 8, lines 3-6).

The claimed method comprises two steps: a first step in which the the LED is manufactured and a second step in which a (first) ceramic layer comprising a wavelength converting material is provided at a surface of the LED from which light is extracted. The method is characterised in that in this second step the ceramic layer is attached to the growth substrate of the LED by wafer bonding.

2.2 Closest prior art

2.2.1 It remained uncontested that document D1 represented the closest prior art.

D1 describes a light emitting structure comprising an LED and a ceramic layer (see paragraph [0011], for example). Regarding the light emitting layer, D1 discloses that the LED is based on a GAlN and/or GaN layer (see paragraph [0021]), which are both III-

nitride based materials.

There are three main embodiments of the light emitting structure in D1 (see paragraph [0023]). In the first, the ceramic layer is directly attached to the LED (Figures 1, 8 and paragraphs [0042], [0049]). In the second embodiment, the ceramic layer is attached to the LED with an intermediate adhesive layer (7) (Figure 2, paragraph [0043]). In the third embodiment, the ceramic layer is placed at a distance from the LED (Figure 3, first lines of paragraph [0023]).

The Board notes that in the first embodiment of the light emitting device (Figure 1), the ceramic layer is used as a substrate for growing the layers of the LED upon (paragraphs [0042] and [0049]). A presence or use of an additional growth substrate is, therefore, excluded in this embodiment. In addition, since the LED is directly formed on the ceramic layer, the problem of attaching the latter to the former does not appear.

The Board considers, thus, that the second embodiment, presented in Figure 2 of D1, is the most appropriate starting point for the skilled person. As it is described in paragraph [0043] of D1, the ceramic layer with the wavelength converting material (*Lumineszenzkonversionskörper 3*) is attached to the LED (2) by means of a joining layer (*Verbindungsschicht 7*) which comprises an adhesive (*Klebstoff 8*). The growth substrate of the LED (*Hilfssubstrat*) is removed before the ceramic layer and the LED are glued together (last sentence of paragraph [0043]).

- 2.2.2 D1 does not explicitly disclose an LED with an n-type region on the growth substrate, a p-type region and a light emitting layer disposed between the n-type and

the p-type regions.

In the Board's opinion, an LED comprising a light emitting layer placed between a p-type and an n-type region is the standard LED structure and was so before the priority date of the present application. The Board considers, therefore, these features to be implicitly disclosed in D1. The Appellant acknowledged also that these features were at least implicitly disclosed in D1, as both in the statement of grounds of appeal and its letter of 26 July 2018 none of these features were argued to be among the features distinguishing claim 1 from D1.

2.3 Differences and technical problem

2.3.1 The method of claim 1 differs from the one in D1, therefore, in that:

- the light emitting device comprises a growth substrate;
- the ceramic layer is attached to the growth substrate; and
- the ceramic layer is attached to the growth substrate using wafer bonding.

2.3.2 In the statement of grounds of appeal, the Appellant argued that the advantage of the use of wafer bonding instead of an adhesive was that "it allows fabricating multiple structures in parallel on a wafer-size scale, thus drastically simplifying the "pick-and-place" approach of manufacturing individual structures disclosed in D1" (grounds of appeal, page 3, second paragraph). The method of claim 1, thus, solved the technical problem of simplifying the manufacturing of a light emitting structure by "using wafer bonding to attach the ceramic layer to the LEDs prior to the

dicing of the light emitting structures" (grounds of appeal, page 3, fourth paragraph).

The Board does not follow this argument. Firstly, there is no mention or suggestion in the application that the wafer bonding takes place before dicing the wafer. There is no mention or suggestion of dicing of the wafer at all in the application. Both in the application and D1 the description refers to single light emitting structures and there is no hint to a parallel manufacture of more than one such structures nor to any dicing of any wafers. Secondly, in D1 there is mention of a possible use of one ceramic layer with more than one LEDs (first sentence of paragraph [0022]) which indicates that the description of D1 is not necessarily limited to attaching ceramic layers to single LEDs, as the Appellant argued.

2.3.3 As the technical effect of using wafer bonding instead of an adhesive to join the ceramic layer to the LED can be seen a more direct and robust connection of the two parts of the light emitting structure. The use of adhesive introduces an additional, third material that creates additional joints (ceramic layer to adhesive layer to LED) and increases the risk of deterioration of the connection of the ceramic layer to the LED over time, for example due to repeated variations in temperature. A deterioration of this connection would have negative effects both to the light transmission through the adhesive layer as well as to the robustness and compactness of the whole light emitting structure.

2.3.4 The skilled person starting from the embodiment of Figure 2 in D1 is faced, thus, with the technical problem of how to improve the robustness and compactness of the light emitting structure and

consequently its reliability over time.

2.4 Solution and Obviousness

2.4.1 As mentioned in the application, wafer bonding is one of the known possible ways of attaching the ceramic layer to the LED (page 5, lines 7-10). The Appellant did not contest that wafer bonding was generally known before the priority date of the present application.

2.4.2 The Board is of the opinion that the skilled person would consider the use of wafer bonding for attaching the ceramic layer to the LED in the light emitting structure of Figure 2 in D1 in an obvious way. Wafer bonding is one of the few, known alternative ways of attaching the ceramic layer to the LED. The advantages and disadvantages of each one of these alternatives are well known and form part of the common general knowledge of the skilled person.

In order to avoid the negative effects of the use of the adhesive layer between the ceramic layer and the LED (see point 2.3.3), the skilled person would opt for a way to join the ceramic layer and the LED directly (i.e. without the use of any additional material) and the selection of wafer bonding in this context would be an obvious way to go.

2.4.3 Keeping the growth substrate (*Hilfssubstrat* in D1) of the LED would be an inherent consequence of this obvious decision since the growth substrate would be necessary for carrying out the wafer bonding with the ceramic layer.

2.4.4 The Appellant argued that there were several steps the skilled person would have to take starting from D1 in

order to arrive at the claimed method: he would have to decide to keep the growth substrate, to decide to use a different way of attaching the ceramic layer to the LED and to select wafer bonding. These were steps the skilled person would not have been able to take without exercising inventive skill, therefore the subject matter of claim 1 involved an inventive step.

- 2.4.5 The Board does not agree with the Appellant in this argument. As stated previously (points 2.4.1, 2.4.3), the Board considers that the skilled person would take these steps in the inverse order: first he would take the obvious decision to use wafer bonding instead of adhesive and then the decision to keep the growth substrate would be inherent in the context of using wafer bonding.
- 2.4.6 The Board reaches, thus, the conclusion that the subject matter of claim 1 of the Main request does not involve any inventive step within the meaning of Article 56 EPC 1973 in the light of D1 and the common general knowledge of the skilled person.
- 3. First Auxiliary request ("New First Auxiliary Request")
 - 3.1 The Appellant argued that, by adding the specification of the steps comprised in the process of wafer bonding, there were additional steps distinguishing the claimed method from D1. Even if the skilled person would consider using wafer bonding in the context of D1 in an obvious way, there was nothing in D1 that would indicate the specific steps that were to be taken in carrying it out. Moreover, the LED was a sensitive structure and the skilled person would not think of applying high pressure and/or temperature to the light emitting structure of D1 since he would risk damaging

it.

- 3.2 The Board does not share the Appellant's opinion. Pressing the growth substrate and the ceramic layer (i. e. the two wafers that are to be joined by wafer bonding) together at a temperature greater than room temperature and at a pressure greater than atmospheric pressure is the standard way of carrying out wafer bonding. It is well known - and was so before the priority date of the application - that in carrying out wafer bonding, the two wafers are pressed together and are heated so that diffusion of their respective materials can occur and they can be bonded to each other. The claim defines both the temperature and the pressure ranges to be applied very broadly and the Board considers that any standard application of wafer bonding would fall under the steps specified in claim 1.
- 3.3 Considering the Appellant's argument that the LED was a sensitive structure that would risk being damaged when high pressure and/or temperature is applied on it and this would stop the skilled person from considering doing so, the Board notes that in the method described in the application, the LED structure is submitted to a temperature of 1700°C and a pressure of 300 bar (page 11, lines 23-27) during the wafer bonding step. There seems therefore to be no support for the argument that the LED risks to be damaged during the wafer bonding process.
- 3.4 The Board concludes, therefore, that claim 1 of the First Auxiliary request does not involve an inventive step within the meaning of Article 56 EPC 1973, either.

4. Second Auxiliary request ("New Second Auxiliary request")
 - 4.1 The Appellant argued that by specifying the materials of the ceramic layer and the substrate, additional distinguishing features from D1 were introduced into claim 1. Although the Appellant acknowledged that a ceramic layer comprising a wavelength converting material of YAG:Ce was also disclosed in D1 (see for example paragraph [0046]), it pointed out that a growth substrate made of sapphire was neither disclosed nor suggested in D1. Sapphire had a similar thermal expansion coefficient with the YAG:Ce ceramic and this was important when the two were bonded, since they would behave in the same way when heated, thereby avoiding any risk of cracking. Since there were even more steps distinguishing claim 1 of the Second Auxiliary request from D1 with respect to the previous requests, it could not be said that the skilled person starting from D1 would take all of them in an obvious way and the subject matter of claim 1 was inventive.
 - 4.2 The Board notes that in D1, there is no indication of any possible material(s) for the growth substrate. The skilled person, who would try to manufacture the LED structure in the context of D1 and had decided (in an obvious way) to use wafer bonding, would also have to select a suitable material for the growth substrate. This substrate would have to be transparent, so that the light generated by the LED could reach the ceramic layer without any obstacles.

It is known that sapphire is a transparent material and, as the Appellant also acknowledged, it is one of the standard materials of substrates used in LED and LED structures (and was before the priority date of the

application).

- 4.3 The Board sees, hence, the selection of sapphire, for the material of the growth substrate in the light emitting structure of D1 an obvious one, which the skilled person would make based only on his common general knowledge.
- 4.4 The conclusion of the Board is that the subject matter of claim 1 of the Second Auxiliary request does not involve any inventive step in the sense of Article 56 EPC 1973.
5. Since none of the requests on file is allowable, the appeal must fail.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

G. Eliasson

Decision electronically authenticated