

Internal distribution code:

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

DECISION
of 25 July 2003

Case Number: T 0149/02 - 3.4.3

Application Number: 93118670.4

Publication Number: 0599224

IPC: H01L 33/00

Language of the proceedings: EN

Title of invention:

Light-emitting gallium nitride-based compound semiconductor device

Patentee:

Nichia Corporation

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 123(2), 56, 84

Keyword:

"Reformatio in peius"

"Clarity - (yes)"

Decisions cited:

T 0401/95, T 0583/95

Catchword:

The principle of prohibition of "reformatio in peius" ensures that a judicial body has no power to put a sole appellant in a worse situation than if he had not appealed. The doctrine of prohibition of reformatio in peius however, cannot be construed to apply separately to each point or issue decided, or the reasoning leading to the impugned decision.



Case Number: T 0149/02 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 25 July 2003

Appellant:
(Proprietor of the patent) Nichia Corporation
491-100, Oka,
Kaminaka-cho
Anan-shi,
Tokushima-ken (JP)

Representative:
Heusler, Wolfgang, Dipl.-Ing.
v. Bezold & Sozien
Patentanwälte
Akademiestrasse 7
D-80799 München (DE)

Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office posted
13 December 2001 maintaining the European
patent No. 0599224 in amended form.

Composition of the Board:

Chairman: R. K. Shukla
Members: M. Chomentowski
J. P. B. Seitz

Summary of Facts and Submissions

I. European patent No. EP-B-0 559 224 was granted on the basis of the European patent application No. 93 118 670.4, claiming the priority of filings of previous patent applications in Japan, in particular of the following three earliest applications referred here as

PR1: JP 335556/92 on 20 November 1992,

PR2: JP 18122/93, on 8 January 1993, and

PR3: JP 18123/93, also on 8 January 1993.

II. A first opposition was filed on 19 April 1999 on the grounds that the subject-matter of the contested patent was not new or did not involve an inventive step having regard *inter alia* to the prior art documents

D3: GB-A-2 250 635,

D4: JP-A-4 242 985, and

D8: JP-A-4 209 577,

that the contested patent did not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art and that it contained subject-matter extending beyond the content of the application as filed (Article 100(a), 100(b) and 100(c) EPC, respectively).

A second opposition was filed on 22 April 1999 on the grounds that the subject-matter of the contested patent was not new or did not involve an inventive step having regard *inter alia* to the prior art document

D12: Japanese Journal of Applied Physics, vol. 32, Part 2, No. 1A/B (15 January 1993), Tokyo, JP, pages L8 to L11; S. Nakamura et al.: "P-GaN/N-InGaN/N-GaN double-heterostructure blue-light-emitting diodes",

and that the contested patent contained subject-matter extending beyond the content of the application as filed (Article 100(a) and 100(c) EPC, respectively).

III. The patent was maintained in amended form by the Opposition Division by an interlocutory decision dated 13 December 2001 in accordance with the patent proprietor's fourth auxiliary request.

The set of claims maintained by the interlocutory decision consists of 8 claims.

IV. Independent claims 7 and 8 of the third auxiliary request which was rejected by the Opposition Division had the following wording:

Claim 7

"A light-emitting gallium nitride-based compound semiconductor device having a double-heterostructure comprising:

a light-emitting layer (18) having first and second major surfaces and formed of a low-resistivity $\text{In}_x\text{Ga}_{1-x}\text{N}$ compound semiconductor, where $0 < x < 1$,

a first clad layer (16) joined to said first major surface of said light-emitting layer and formed of an n-type gallium nitride-based compound semiconductor having a composition different from that of said semiconductor of said light-emitting layer, and

a second clad layer (20) joined to said second major surface of said light-emitting layer and formed of a low-resistivity p-type gallium nitride-based compound semiconductor having a composition different from that of said semiconductor of said light-emitting layer,

characterized in that

said light-emitting layer (18) is doped with p-type impurity and is of p-type, and

said compound semiconductor of said second clad layer (20) is represented by the formula $\text{Ga}_z\text{Al}_{1-z}\text{N}$, where $0 < z < 1$, wherein said second clad layer (20) is doped with p-type impurity comprising magnesium in a concentration of 1×10^{18} to $1 \times 10^{21} / \text{cm}^3$ and is of p-type."

It is to be noted that, although the term "low-resistivity" in respect of the light-emitting layer and the second clad layer, highlighted by the Board, is not shown in the claims attached to the contested decision, the term is included in the claims at the text locations as shown at the request of the patent

proprietor as stated in item II.3, first paragraph of the contested decision.

Claim 8 has the same precharacterizing part as claim 7, except that the value of x in $\text{In}_x\text{Ga}_{1-x}\text{N}$ compound semiconductor of the light-emitting layer is $0 < x < 0.5$, and its characterizing part has the following wording:

"said light-emitting layer (18) is doped with n-type impurity comprising silicon in a concentration of 1×10^{17} to $1 \times 10^{21} / \text{cm}^3$, and it is of n-type, and said second clad layer (20) is doped with p-type impurity comprising magnesium in a concentration of 1×10^{18} to $1 \times 10^{21} / \text{cm}^3$, and is of p-type."

The reasoning of the Opposition Division for rejecting claims 7 and 8 which is relevant to the present decision was essentially as follows:

Claim 7

The subject-matter of claim 7 is not entitled to the priority of the priority documents PR1 to PR3. Therefore, document D12 and document

D20: Japanese Journal of Applied Physics, vol. 32, No. 3A (1 March 1993), pages L338 to L341; S. Nakamura et al.: "Cd-doped InGaN films grown on GaN films"

are comprised in the state of the art according to Article 54(2) EPC.

Document D12 shows a light-emitting device (LED) having a double heterostructure comprising an n-type InGaN light-emitting layer doped with Si and a p-type second clad layer doped with Mg.

From document D20 the person skilled in the art gets the incentive to dope the light-emitting layer in a device according to document D12 with a p-type dopant (Cd), whereby Mg is already used as p-type dopant for the second clad layer of the device of document, D12, i.e., in a similar semiconductor compound, and it is then a routine option for the skilled person to anneal the light-emitting layer to render it p-type and thus to reduce its resistivity.

Concerning the material and the doping of the second clad layer, document D4 in combination with document US-A-5 247 533, which is a corresponding patent application published after the last, valid priority date of 17 May 1993 of the patent in suit, shows that the GaAlN clad layer of a double-heterostructure is Mg-doped.

Moreover, a Mg-doped InGaAlN layer is described in document D8.

Therefore, the subject-matter of claim 7 lacks an inventive step.

Claim 8

Claim 8 specifies that the p-type clad layer is doped with Mg and is thus entitled to the priority of the priority document PR2. Thus, for assessing inventive

step of its subject-matter, only the pre-published documents, such as documents D8 and D3 are relevant.

Document D3 shows in Example 3 a device with an n-type GaInN light-emitting layer doped with an n-type impurity, but without a clad layer between the light-emitting layer and the substrate. A double heterostructure with GaN-based clad layers on both surfaces of an undoped light-emitting layer is known from document D8. However, doping of the light-emitting layer for reducing the threshold current density of the device would be readily contemplated by the skilled person in view of the resulting improvement, and n-type doping of an InGaN layer is already known from document D3.

The range of doping concentration of Mg in the claim is the range normally used for practical applications and Mg-doped p-type clad layers are known from document D4.

Therefore, the subject-matter of claim 8 lacks an inventive step.

- V. The patent proprietor lodged an appeal against the decision on 8 February 2002 paying the appeal fee on the same day. A statement setting out the grounds of the appeal was filed on 15 April 2002.

A notice of appeal and a written statement setting out the grounds of appeal were also duly filed on behalf of the Opponent II, Mr Stephen Hogan.

VI. On 4 July 2002 and 1 October 2002, respectively, the opponent I, a party as of right, and the opponent II withdrew their oppositions.

VII. In response to a communication from the Board annexed to the summons to the oral proceedings the appellant (patent proprietor) filed sets of new claims forming respectively a new main request and three auxiliary requests with the letter dated 25 June 2003.

Claims 1 to 8 of the main request are identical to claims 1 to 8 as maintained by the Opposition Division.

Independent claim 9 of the *main request*, has the same precharacterizing part as the rejected claim 7 (see item II, above), except for the upper limit of x in $\text{In}_x\text{Ga}_{1-x}\text{N}$ compound semiconductor of the light-emitting layer, which is 0.5 in place of 1; its characterizing portion reads as follows:

"said light-emitting layer (18) is doped with p-type impurity comprising magnesium in a concentration of 1×10^{17} to $1 \times 10^{21} / \text{cm}^3$ and is of p-type, and

said second clad layer (20) is made of $\text{Ga}_z\text{Al}_{1-z}\text{N}$, where $0 < z < 1$, being doped with p-type impurity comprising magnesium in a concentration of 1×10^{18} to $1 \times 10^{21} / \text{cm}^3$ and is of p-type."

Independent claim 10 of the *main request* has the same precharacterizing part as claim 9, and thus as the rejected claim 8, its characterizing portion reading as follows:

"said light-emitting layer (18) is doped with n-type impurity comprising silicon in a concentration of 1×10^{17} to 1×10^{21} / cm^3 , and is of n-type, and

said second clad layer (20) is made of $\text{Ga}_z\text{Al}_{1-z}\text{N}$ where $0 < z < 1$ being doped with p-type impurity comprising magnesium in a concentration of 1×10^{18} to 1×10^{21} / cm^3 and is of p-type."

In the above, the amendments with respect to claims 7 and 8 of the third auxiliary request of the contested decision (see item II above) have been highlighted by the Board.

Claims 11 to 15 are dependent claims.

VIII. At the oral proceedings held on 25 July 2003, the appellant requested that the decision under appeal be set aside and that the patent be maintained in amended form on the basis of his main request or any of the three auxiliary requests filed with the letter dated 25 June 2003.

The appellant's arguments in support of his main request can be summarized as follows:

Both opponents having withdrawn their oppositions, the patent proprietor is the only appellant. Thus, according to the principle of "reformatio in peius" stated in the decisions G 9/92 and G 4/93, OJ EPO 1994, 875 of the Enlarged Board of Appeal, claims 1 to 8 of the request, which are identical with the claims of the fourth auxiliary request which has been found allowable

by the decision under appeal, are no longer a subject of consideration in the present appeal procedure.

In claims 9 and 10, the expression "low-resistivity" is used in the same context as in claims 1 and 2 of the fourth auxiliary request. The Opposition Division concluded in the decision under appeal that the expression "low-resistivity" in claims 1 and 2 was clear. A consideration of the issue of clarity by the Board in respect of the same expression therefore would be contrary to the principle of prohibition of "reformatio in peius".

Claim 9

The claimed light-emitting device (LED) is distinguished from the device known from document D12 *inter alia* in that,

- the light-emitting layer is doped with p-type impurity, Mg, and not with n-type impurity, Si, and it is of p-type, and not of n-type;
- the second clad layer is made of $\text{Ga}_2\text{Al}_{1-z}\text{N}$, where $0 < z < 1$, and not made of GaN.

Moreover, as can be seen from document

B: textbook "The Blue Laser Diode - GaN Based Light Emitters and Lasers", S. Nakamura et al., Springer-Verlag Berlin Heidelberg New York (1997),

cited as evidence, the low-energy electron-beam irradiation (LEEBI) treatment used in the fabrication process of document D12 cannot result in low-resistivity layers as in the claimed device, for which a different fabrication process is used.

Indeed, document D20 takes into account the device of document D12 and suggests to substitute Cd for Si in the light-emitting layer in order to obtain blue emission centers in InGaN, at about 0.5 eV above the valence band.

However, according to document

A: textbook "Semiconductors and Semimetals" (1998),
Vol. 50, pages 268 to 271, J.I. Pankove et al.,

cited as evidence, five years after the publication of document D20, Cd was not used in commercial LEDs, so that the relevance of the disclosure in document D20 regarding substituting Cd for Si as dopants in the InGaN active layer is questionable.

Concerning the argument that having substituted Cd for Si, it would be obvious to replace Cd, a p-type impurity, with another well known p-type impurity Mg, the following is to be taken into consideration:

As can be seen from document

C: Applied Physics Letters, Vol. 66, No. 9,
27 February 1995, pages 1112-1113, S. Yamasaki et al., "p-type conduction in Mg-doped $\text{Ga}_{0.91}\text{In}_{0.09}\text{N}$ grown by metalorganic vapor-phase epitaxy",

Mg provides luminescent centers at about 0.2 eV (204 meV) above the valence band of InGaN. This is shallower than the luminescent centers (0.5 eV) provided by Cd. Therefore, Mg cannot directly be considered as being equivalent to Cd.

Yet, as shown in document A, Mg is particularly successful as a luminescent center.

It is also to be noted that, as Example 1 of the patent in suit, Cd-doped InGaN shows n-type conductivity and that, in any case, there is no indication in the prior art that it was a routine measure to anneal the active layer, as mentioned by the Opposition Division.

Therefore, the subject-matter of claim 9 involves an inventive step.

Claim 10

Claim 10 is entitled to the priority from priority document PR2; in particular, the indication therein that the first and second clad layers are made of InGaAlN is to be construed as meaning also GaAlN materials, in accordance with statements about the first clad layer.

Example 3 of document D3 concerns a LED with a n-type InGaN active layer doped with oxygen, which, as Si, is a n-type dopant. Document D8 shows a double heterostructure employing non-doped InGaN. Therefore, its combination with document D3, which shows a different type of devices, does not lead in an obvious

way to the claimed LED. Indeed, as can be seen from the Reports 4 and 5 of Dr Takashi Mukai of Nichia Corporation filed by the appellant, superior results are obtained by the combination of Si-doped InGaN active layers with Mg-doped AlGaN clad layers.

Therefore, the subject-matter of claim 10 also involves an inventive step.

Reasons for the Decision

1. The appeal is admissible.
2. *Reformatio in peius* - Main request, claims 1 to 8

In connection with claims 1 to 8 of the main request, which are identical in wording to claims 1 to 8 of the patent as maintained in the interlocutory decision of the Opposition Division, the appellant patent proprietor submitted that both the opponents having withdrawn their oppositions, and consequently not being parties in the appeal proceedings, following the principle of prohibition of *reformatio in peius*, as stated in the decisions above-mentioned G 9/92 and G 4/93, claims 1 to 8 of the main request cannot be a subject of consideration in the present appeal proceedings.

The Board agrees with the appellant patent proprietor that both the opponents having withdrawn their oppositions, the only party to the appeal proceedings is the patent proprietor as the appellant.

According to the above-mentioned decisions G 9/92 and G 4/93 (see item 1 of the Headnote), if the patent proprietor is the sole appellant against an interlocutory decision maintaining a patent in amended form, the Board of appeal may not challenge the maintenance of the patent ("die Fassung des Patents" in German and "le texte du brevet" in French) as amended in accordance with the interlocutory decision.

Therefore, insofar as the claims 9 to 15 of the appellant's (patent proprietor's) main request do not change the understanding of the text as maintained, following the principle of the prohibition of *reformatio in peius*, the Board has no power to consider the validity of claims 1 to 8 of the main request.

3. Main request - claims 9 to 15

3.1 Admissibility of the amendments

In relation to claim 1 of the patent as granted, independent claims 9 and 10 are restricted in their scopes since they specify the dopant impurities for the light-emitting layer and the second clad layer and their concentrations.

Therefore, the Board is satisfied that the claims of the European patent have not been amended in such a way as to extend the protection conferred (Article 123(3) EPC).

The feature of claim 9 requiring that in the $\text{In}_x\text{Ga}_{1-x}\text{N}$ compound semiconductor of the light-emitting layer $0 < x < 0.5$, and not $0 < x < 1$, is based on claim 23,

dependent on independent claim 13, of the application as filed. The further feature of the claim, that the p-type doping impurity of the light-emitting layer comprises Mg in a concentration of 1×10^{17} to $1 \times 10^{21} / \text{cm}^3$, is based on claim 18 and, dependent on claim 13, citing Zn as the p-type impurity, together with other text locations (see e.g. claim 14, dependent on claim 13, and column 5, lines 36 to 42), citing Mg as equivalent to Zn in this respect.

In relation to claim 16 as originally filed, claims 9 and 10 have been amended so that the value of z in the semiconductor compound material $\text{Ga}_z\text{Al}_{1-z}\text{N}$ of the second clad layer is $0 < z < 1$, whereas in the original claim 16 z was $0 \leq z \leq 1$, so that in the device of claims 9 and 10 GaN is not used as a semiconductor component for the second clad layer.

Concerning the value of $z = 0$, which is excluded from claims 9 and 10, i.e. the use of AlN semiconductor compound for the second clad layer, this exclusion removes an inconsistency between the preamble of the claims, wherein the second clad layer is formed of gallium nitride-based compound semiconductor, and the characterizing portion, wherein the AlN second clad layer would contain no gallium.

Therefore, the Board is satisfied that the new claims 9 and 10 meet the requirement of Article 123(2) EPC that a European patent may not be amended in such a way that it contains subject-matter extending beyond the content of the application as filed.

3.2 Clarity

Opponent II before withdrawal of his opposition and thereby also his appeal, submitted during the appeal proceedings that the expression "low-resistivity" in claims 1 and 2 as maintained by the Opposition Division was unclear. The same expression is also used in a similar context in independent claims 9 and 10 of the main request before the Board. The proprietor appellant has submitted that since he is from now on the only appellant, applying the principle of prohibition of "reformatio in peius" in claims 9 and 10, the Board has no power to consider the clarity of the expression "low-resistivity" in claims 9 and 10, since this would indirectly challenge the decision of the Opposition Division on clarity in respect of claims 1 to 8.

3.2.1 However, the Board does not agree with the above submissions that it has no power to consider whether the expression "low-resistivity" in claims 9 and 10 meets the requirement of clarity according to Article 84 EPC.

In this connection, the above principle indeed ensures that a judicial body has no power to put a sole appellant in a worse situation than if he had not appealed, which in the present case means that the Board has no power to review the decision of the opposition division to maintain the patent as amended. The doctrine of prohibition of *reformatio in peius* however, in the Board's view cannot be construed to apply separately to each point or issue decided or the reasoning leading to the impugned decision (see, e.g. T 401/95 and T 583/95).

In appeal proceedings, in particular the opposition appeal proceedings, the devolutive effect of the appeal according to Articles 110 and 111(1) EPC together with Rule 64(b) EPC in fine means that the Board is entitled to fully consider the appellant's requests which were either refused by the first instance or filed during the appeal proceedings, and therefore to control whether they overcome the original grounds of opposition if unchanged, or whether they fulfil all the requirements of the EPC if amended.

In fact when lodging an appeal the requests filed by the appellant define the extent to which amendment or cancellation of the decision is sought and therefore determine together with the original scope of the opposition the extent to which it is challenged; i.e., the procedural frame within which the Board must decide whether the appeal is admissible and therefore examine whether said requests either overcome the original grounds of opposition, or meet the other requirements of the EPC if amended.

It means necessarily that all the statements made by the first instance in support of its final finding to maintain the patent in amended form are not binding on the Board of appeal if the same objections they purported to refute still apply to claims relating to the same subject-matter but having a larger scope, either refused by the first instance or filed during the appeal proceedings.

For these reasons both general principles of procedure, i.e. prohibition of "reformatio in peius" on the one hand, and devolutive effect of the appeal conferring to the Board the power to consider its subject-matter on the other hand, are complementary and have to be implemented in such a way that they do not exclude each other.

Moreover, it has to be borne in mind that the appellant's requests which constitute the subject-matter of the appeal, and define the extent of scrutiny required from the Board also define the limits for the body to apply the provisions of Article 114(1) EPC.

Hence, even after withdrawal of both oppositions the Board remains empowered to address ex officio the clarity of claims filed at the appeal stage.

3.2.2 However, in the case in suit, the Board remains satisfied that, although the terms "low resistivity" are not defined in the claims 9 and 10, the main request meets the clarity requirements of Article 84 EPC.

Concerning this issue of clarity of the claims, the Board agrees with the appellant that the expression is clear in the context of a GaN group compound semiconductor layer doped with a p or n-type impurity. In this connection, it follows from the patent application as filed (see, e.g. column 8, line 7) that the expression "low-resistivity" means the resistivity of a p or n-type GaN group semiconductor compound layer after it has been subjected to an annealing treatment

at a sufficiently high temperature (e.g., at or above 400°C) whereby its resistivity is lowered in relation to its resistivity in the unannealed state. Moreover, it follows from the application in suit that the resistivity is lowered by about four orders of magnitude on annealing so that the "low resistivity" state is clearly distinguished from the unannealed state of the GaN group semiconductor compound.

3.3 Claim 9 - inventive step

3.3.1 The appellant has argued that independently of whether or not claim 9 was entitled to any of the priority dates 20 November 1992 and 8 January 1993, respectively of priority documents PR1 to PR3, and considering that documents D12 and D20 published respectively on 15 January 1993 and 1 March 1993, i.e. before the validly claimed priority date of 5 March 1993, belonged to the state of the art pursuant to Article 54(2) EPC, the subject-matter of claim 9 was not rendered obvious by the cited prior art, and in particular by the above documents.

The following consideration of inventive step is therefore based on the assumption that the above documents are comprised in the state of the art according to Article 54(2) EPC.

3.3.2 It has not been disputed that the closest prior art is represented by document D12 (see in particular Figure 1 and the corresponding text).

Document D12 discloses a p-GaN / n-InGaN / n-GaN double-heterostructure blue-light-emitting diode. In the diode known from this document,

- the light-emitting layer is of n-type, and not of p-type;
- the light-emitting layer is doped with n-type impurity comprising Si of unspecified concentration and is thus not doped with p-type impurity comprising magnesium in a concentration of 1×10^{17} to 1×10^{21} / cm^3 , as in the claimed device;
- the second clad layer is made of $\text{Ga}_z\text{Al}_{1-z}\text{N}$, where $0 < z < 1$, and not made of GaN; and
- in the second clad layer, the p-type impurity comprising magnesium is specified as being doped in a concentration of 1×10^{18} to 1×10^{21} / cm^3 .

3.3.3 In document D20 (see page L338, left-hand column, last three lines of the last complete paragraph) reference numeral (11) unambiguously identifies document D12 and the InGaN/GaN DH blue light-emitting diodes fabricated using the InGaN described therein. It is further stated (see page L338, left-hand column, last paragraph to right-hand column, second paragraph) that, from the standpoint of spectral luminous efficiency, the peak wavelength of this diode is not advantageous for visible blue LEDs and that there is a need for development of other techniques in order to obtain longer-peak-wavelength blue emission centers in InGaN. Cd doping into InGaN films is described in this respect

and it is concluded (see page L340, left-hand column, four last lines of the last complete paragraph, and page L341, "Conclusions") that Cd has the effect of providing blue emissions with a peak wavelength at an energy level 0.5 eV lower than the band-gap energy of every InGaN and that, thus, the Cd-doped InGaN films are good candidates for the active layer of blue LEDs.

Starting from the device known from document D12 and taking into account the information in document D20, the person skilled in the art of blue LEDs would consider substituting Cd for Si in the light-emitting layer of the LED of document D12.

However, concerning the further necessary step of then substituting Mg for Cd, it is to be noted that the selection of Cd in document D20 is mentioned as being related to its effect as an impurity and, as convincingly shown by the appellant in his letter dated 25 June 2003 (see pages 12 and 13) with reference to document C, Mg allows the provision of luminescent center at about 0.2 eV in the band-gap, above the valence band of InGaN, i.e., shallower than the luminescent centers (0.5 eV) provided by Cd. Therefore, as luminescent center for specific wavelength emissions, Mg cannot directly be considered as being equivalent to Cd.

The further prior art documents are less relevant in this respect.

Thus, in the Board's judgement, it was not obvious to the skilled person to consider, having substituted Cd for Si, substituting Mg for Cd in the InGaN active layer,

For this reason, it is also not necessary to assess whether the further steps necessary for arriving at the claimed subject-matter, which comprise

- treating the structure under conditions equivalent to those mentioned in the patent in suit (annealing), so as to obtain a light-emitting layer of p-type and of low-resistivity, and
- substituting $\text{Ga}_z\text{Al}_{1-z}\text{N}$, where $0 < z < 1$ the p-type impurity comprising magnesium is doped in a concentration of 1×10^{18} to $1 \times 10^{21} / \text{cm}^3$ for GaN with an undetermined concentration of Mg for the second clad layer,

would have been considered as obvious by the skilled person.

Therefore, having regard to the state of the art, the subject-matter of claim 9 involves an inventive step in the sense of Article 56 EPC.

3.4 Claim 10 - inventive step

- 3.4.1 As compared to claim 8 of the third auxiliary request forming the basis of the contested decision (see item 15 of the reasons), for which the priority entitlement of PR2 was recognized, claim 10 contains

the additional feature that the second clad layer (20) is made of $Ga_zAl_{1-z}N$ where $0 < z < 1$.

With regard to the priority date of 8 January 1993 claimed from priority document PR2, the appellant has convincingly argued as follows:

Paragraph (0028) of the priority document PR2 states that the first and second clad layers, mentioned as being made of GaN, can be made of other materials "such as InGaAlN". This is however not understood in the art as meaning only materials comprising all the four components In, Ga, Al and N, but also other compositions with e.g. three components, such as GaAlN. This is what the skilled person would understand from the general statement, and this is confirmed by paragraph (0011), according to which, for the first clad layer, also mentioned in paragraph (0028), "part of Ga in the n-type GaN layer may be replaced by Al".

Therefore, the Board is satisfied that claim 10 in dispute is entitled to the priority date of 8 January 1993 of priority document PR2.

3.4.2 Consequently, documents D12 and D20, which are published after 8 January 1993, do not form part of the state of the art in the sense of Article 54(2) EPC.

Example 3 of document D3 (see pages 19 to 22; Figure 3) concerns a LED comprising in particular an intermediate n-type InGaN light-emitting layer (20), and represents the closest prior art.

However, the InGaN light-emitting layer of Example 3 of document D3 is made of $\text{In}_{0.17}\text{Ga}_{0.83}\text{N}$, i.e. a $\text{In}_x\text{Ga}_{1-x}\text{N}$ and is thus not a $\text{In}_x\text{Ga}_{1-x}\text{N}$ compound semiconductor; it is doped with oxygen, and not with silicon. Moreover, the layer (3) separating the buffer layer (2) and the substrate layer (1) from the light-emitting layer (20) is not a GaN-based first clad layer in a double heterostructure (DH) in the sense of the patent in suit, but is made of ZnO. Furthermore, the layer (21) corresponding to the second clad layer of the claimed device, is made of AlInN, and is thus not a GaN-based material. Moreover, it is doped with Zn, and not with Mg.

In document D8 (see the "Purpose"), a double heterostructure is disclosed and mentioned as being a high efficiency light emitting element with a long life.

However, it has not been disputed that, in document D8, the light-emitting layer is not doped.

As already found in the decision under appeal (see item 10 and 21 of the reasons), document D4 does not disclose a light-emitting device comprising a $\text{In}_x\text{Ga}_{1-x}\text{N}$ ($0 < x < 0.5$) layer sandwiched between two GaN-based layers of different composition; indeed, although a p-type GaAlN layer doped with Mg is disclosed in the US corresponding document (see column 3, lines 23 to 26), the adjacent light-emitting layer is made of GaN, and not of $\text{In}_x\text{Ga}_{1-x}\text{N}$ ($0 < x < 0.5$).

Thus, by combining the teaching of these documents, the skilled person would not arrive in an obvious way at the light-emitting device of claim 10.

The further prior art documents are less relevant.

Therefore, in the Board's judgement, the subject-matter of claim 10 involves an inventive step in the sense of Article 56 EPC.

3.5 Consequently, claims 9 and 10 are patentable in the sense of Article 52(1) EPC.

Claims 1 to 8 are also patentable following the principle of "reformatio in peius" and claims 11 to 15, which correspond to particular embodiments of the claims 1 to 10, are also patentable for the same reasons as the claims from which they depend.

Therefore, the patent can be maintained in amended form (Article 102(3) EPC).

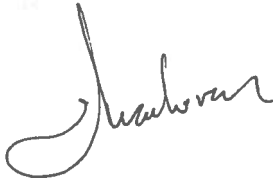
However, the description, which has been adapted with respect to the claims 1 to 8 only, has to be adapted also with respect to claims 9 to 15.

Order

For these reasons it is decided that:


1. The decision under appeal is set aside.
2. The case is remitted to the department of first instance with the order to maintain the patent on the basis of the following patent documents:
 - Claims 1 to 15 of the main request as filed with letter dated 25 June 2003;
 - Description and the figures: to be adapted to the claims.

The Registrar:



P. Martorana

The Chairman:



R. K. Shukla

