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Datasheet for the decision of 8 November 2007

Case Number: T 0098/05 - 3.4.03

Application Number: 98102735.2

Publication Number: 0843365

IPC: H01L 33/00

Language of the proceedings: EN

Title of invention:
Light source and technique for mounting light emitting diodes

Patentee:
Agilent Technologies, Inc.

Opponent:
OSRAM Opto Semiconductors GmbH & Co. OHG,

Headword:
-

Relevant legal provisions:
EPC Art. 100(a)(c), 56, 123(2), 76(1)

Keyword:
"Added subject-matter - main request (yes)"
"Inventive step - auxiliary requests (no)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0098/05 - 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 8 November 2007

Appellant: (Opponent)	OSRAM Opto Semiconductors GmbH & Co. OHG, Wernerwerkstraße 2 D-93049 Regensburg (DE)
Representative:	Schachtner, Richard Epping Hermann Fischer Patentanwaltsgesellschaft mbH Ridlerstraße 55 D-80339 München (DE)
Respondent: (Patent Proprietor)	Agilent Technologies, Inc. - a Delaware Corporation - 5301 Stevens Creek Boulevard Santa Clara, CA 95051 (US)
Representative:	Dilg, Haeusler, Schindelmann Patentanwaltsgesellschaft mbH Nußbaumstraße 6 D-80336 München (DE)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted 25 November 2004 concerning maintenance of European patent No. 0843365 in amended form.**

Composition of the Board:

Chairman: G. Eliasson
Members: V. L. P. Frank
J. Van Moer

Summary of Facts and Submissions

I. This is an appeal by the opponent as sole appellant against the maintenance of EP 843 365 in amended form (Article 102(3) EPC).

EP 843 365 was based on European application 96 102 735, a divisional application of 96 106 644 ("parent application"), which itself was a divisional application of 93 112 376 ("grandparent application").

The opposition was based on the grounds of Article 100(a) EPC, in particular Articles 54 and 56 EPC, and Articles 100(b) and (c) EPC.

II. The sole independent claim of the patent as maintained by the opposition division and as defended by the respondent proprietor on appeal as main request reads:

"1. A light source comprising:

a substrate (17);

a light emitting diode having a light emitting junction (313) perpendicular to the substrate and having an electrically conductive layer (314, 352) at each of the two opposite end faces of the light emitting diode perpendicular to the substrate,

said opposite end face extending parallel to the light emitting junction (313),

at least one of said electrically conductive layers (314, 352) comprising a metal layer (352)

extending parallel to the light emitting junction (313) and being deposited on a reflective layer (353),

the reflective layer (353) being applied on one of said end faces of the light emitting diode and having at least one hole (354) for establishing electrical contact between the metal layer (352) and the light emitting diode (10);

means for mounting the light emitting diode on the substrate with the junction (313) perpendicular to the substrate and the electrically conductive layers (314, 352) in electrical contact with conductive areas on the substrate."

In the following only those paragraphs of the 1st to 6th auxiliary requests comprising amendments with respect to the main request will be reproduced (the amendments with respect to claim 1 of the main request are marked in bold by the board).

First auxiliary request:

" at least one of said electrically conductive layers (314, 352) comprising a metal layer (352) extending parallel to the light emitting junction (313) and being deposited on a **non-conductive** reflective layer (353)"

Second auxiliary request:

" at least one of said electrically conductive layers (314, 352) comprising a metal layer (352)

extending parallel to the light emitting junction (313) and being deposited on a reflective layer (353), **said reflective layer being formed to not establish electrical connection to the light emitting diode (10),**"

Third auxiliary request:

" at least one of said electrically conductive layers (314, 352) comprising a metal layer (352) extending parallel to the light emitting junction (313) and being deposited on a reflective layer (353), **said metal layer (352) providing an entire metallized end face,"**

and

" **solder** for mounting the light emitting diode on the substrate with the junction (313) perpendicular to the substrate and the electrically conductive layers (314, 352) in electrical contact with conductive areas on the substrate."

Fourth auxiliary request:

" at least one of said electrically conductive layers (314, 352) comprising a metal layer (352) extending parallel to the light emitting junction (313) and being deposited on a **non-conductive** reflective layer (353), **said metal layer (352) providing an entire metallized end face,"**

and

" **solder** for mounting the light emitting diode on the substrate with the junction (313) perpendicular to the substrate and the electrically conductive layers (314, 352) in electrical contact with conductive areas on the substrate."

Fifth auxiliary request:

" the reflective layer (353) **consisting of silica and** being applied on one of said end faces of the light emitting diode and having at least one hole (354) for establishing electrical contact between the metal layer (352) and the light emitting diode (10);"

Sixth auxiliary request:

" at least one of said electrically conductive layers (314, 352) comprising a metal layer (352) extending parallel to the light emitting junction (313) and being deposited on a reflective layer (353)**, said metal layer (352) providing an entire metallized end face,**

the reflective layer (353) **consisting of silica and** being applied on one of said end faces of the light emitting diode and having at least one hole (354) for establishing electrical contact between the metal layer (352) and the light emitting diode (10);

solder for mounting the light emitting diode on the substrate with the junction (313)

perpendicular to the substrate and the electrically conductive layers (314, 352) in electrical contact with conductive areas on the substrate."

III. The following prior art documents *inter alia* were cited in the opposition procedure:

D1: US 3 911 431 A

D2: US 3 877 052 A

D5: EP 0 303 272 A

IV. In the decision under appeal the opposition division found that the light source disclosed in document D1 differed from the light source of claim 1 in that in the invention the metal layers were deposited on and not inside or below the reflective layer (as in D1) and that at least one hole of the reflective layer was for establishing electrical contact between the metal layer and the light emitting device. The problem addressed by the invention was to provide an improved conductive layer/reflective layer structure with a higher reflectivity and a greater flexibility in the choice of the material of the reflective layer than in the prior art. Although document D2 disclosed the "missing feature" of claim 1 it did not deal with LEDs mounted perpendicular on a substrate but with an apparatus which coupled radiation into an optical fibre. The person skilled in the art had no incentive to modify the reflective layer disclosed in D1, as it was stated therein that the light screens already consisted of highly reflective material. The skilled person would

therefore not have modified the structure of D1 to arrive at the present invention (reasons, point 6).

V. The appellant opponent argued essentially as follows:

– The subject-matter of the opposed patent, which was a 2nd generation divisional application, extended beyond the content of both earlier applications as filed (Article 100(c) EPC). The earlier applications disclosed either "a non-conductive layer for reflection" or "a thin layer of silica to provide reflection". Claim 1 of the opposed patent by merely specifying "a reflective layer" comprised also conductive reflective layers. Conductive layers for reflection, however, could not be directly and unambiguously derived from the earlier applications.

– The claimed light source did not involve an inventive step considering *inter alia* the combination of documents D1 and D2. The light source disclosed in the embodiment shown in Figure 13 of the opposed patent differed from the one disclosed in D1 in that a silica reflective layer was provided on one of the end faces of the light emitting diode (LED) between the electrode and the body of the LED, the silica layer having at least one hole to provide electric contact to the LED. D2 however, disclosed the use of a double reflective layer in an LED for increasing the light output of the LED. The double layer was formed by a silica layer in contact with the body of the LED and a metal reflective layer which served simultaneously as electric contact. The skilled person would have applied the teaching of D2

to the LED disclosed in D1 for increasing its light output in the same manner as disclosed in D2.

VI. The respondent proprietor argued essentially as follows:

– The subject-matter claimed by the opposed patent was based on the embodiment of Figure 13 and the corresponding description. This embodiment was disclosed in each one of the earlier applications. Moreover, the feature "reflective layer" in claim 1 as maintained corresponded to the removal of the feature "silica layer" disclosed explicitly in the description. This feature, however, was not explained as being essential to the invention, was not indispensable for the function of the invention in the light of the problems it intended to solve and its removal did not require any real modification of other features of the invention.

– As to the first auxiliary request, a skilled person using his technical knowledge would have understood that the function of the silica layer could be generalized to a "non-conductive" layer. Since holes were provided in the reflective layer and an example of a non-conductive material (silica) was given, the skilled person would infer that other "non-conductive" materials might be used as long as the reflective function was maintained.

– Document D1 related to light-emitting diodes intended to be mounted with the p-n junction perpendicular to the substrate. At each end face a strip-like ohmic electrode was formed while the remaining portions of the end face were covered by a

conductive light screen. The function of the light screens was twofold, namely to provide high reflectivity and for mounting the LED on the substrate. Starting from D1, the objective problem underlying the invention was to provide a greater flexibility in the choice of the material of the reflective layer whilst maintaining the mechanical fixing of the LED through the conductive membranes to the substrate. The structure of the LED of the present invention allowed to achieve simultaneously the two conflicting aims of optimizing the mounting reliability and optimizing the light output.

– Document D2 disclosed a light emitting semiconductor apparatus for optical fibres which improved the coupling of the radiation of the LEDs into the optical fibres. However, the two-layer structure known from document D2 had no relation to the mounting of an LED to a substrate. This document was only concerned with increasing the coupling of radiation from the LED into the glass fibre. A person skilled in the art would therefore have not combined documents D1 and D2.

VII. At oral proceedings before the board, the appellant opponent requested that the decision under appeal be set aside and that the European patent No. 843 365 be revoked.

The respondent proprietor requested that the appeal be dismissed or in the alternative that the patent be maintained on the basis of the first to sixth auxiliary requests filed with the letter dated 8 October 2007.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request – Article 100(c) EPC*

2.1 Claim 1 of the opposed patent is directed to a light source comprising a light emitting diode (LED) mounted on a substrate so that the light emitting junction is perpendicular to the substrate. A reflective layer is applied to one end face of the LED and a metal layer is deposited on the reflective layer. The electric contact between the metal layer and the LED is established through at least one hole in the reflective layer (patent, Figure 13).

2.2 The appellant opponent argued that the subject-matter of the opposed patent, being a divisional application, extended beyond the content of the earlier applications as filed, since it included alternatives where the reflective layer at the end face of the LED was a conductive layer.

2.3 The claims of the parent and grandparent applications, from which the opposed patent was filed as a divisional application, specify a reflective layer only in their respective claims 9 which read: *"A light source as recited in claim 1 further comprising a **non-conductive layer for reflection** between an end of the light emitting diode (10) and a metal layer and at least one hole (354) through the **non-conductive layer** for electrical contact between the metal layer and the light emitting diode (10)"* (marking added by the board).

2.4 The description of both earlier applications corresponding to the embodiment of Figure 13, which is the support for the embodiment of claim 9, disclose that a thin layer of silica was used to provide reflection at the anode end of the LED and that holes for electrical contact were etched through the silica layer.

2.5 The respondent proprietor argued that the earlier application disclosed different manners for providing reflection and that the use of a non-conductive layer was only an example from which a generalization should be allowable. He referred, in particular, to the use of the expression "such an arrangement" instead of "this arrangement" employed when comparing the embodiment of Figure 13 with the prior art to indicate that a non-conductive layer and silica, in particular, were disclosed as mere instances of the more general concept of a reflective layer (grandparent application, column 12, lines 41 to 46).

2.6 He further referred to the "is it essential test?" for the removal of a feature, stating that the feature "non-conductive" was neither disclosed as being essential nor was it indispensable for the function of the invention, and its removal would not require modification of other features.

2.7 The board is however not persuaded that the earlier applications, ie the parent and the grandparent applications, disclose directly and unambiguously that any kind of reflective layers could be used, in particular conductive ones. The skilled person

understands that the reflective layer disclosed in the earlier applications reflects the incident light by total internal reflection. This effect occurs at the interface between an essentially transparent diode material and a non-conductive reflective layer. The feature "non-conductive material" is therefore an "essential" feature of the invention disclosed in the earlier applications that cannot be removed without changing the nature of the invention.

2.8 Since claim 1 of the opposed patent comprises both kinds of layers, conductive and non-conductive ones, it extends beyond the subject-matter disclosed in the earlier applications as filed. The main request is therefore not allowable.

3. *1st auxiliary request – Inventive step (Article 56 EPC)*

3.1 Claim 1 of this request is restricted to non-conductive reflective layers. Although this feature is not explicitly disclosed in the application as filed, the board considers that its introduction in the claim does not contravene Article 123(2) EPC, since the skilled person understands that the embodiment of Figure 13 is not limited to the use of silica only, but can be generalized to other non-conductive layers as long as they act as reflective layers, ie that they provide total internal reflection. However, as this and the further auxiliary requests fail for lack of an inventive step, this point is of secondary importance.

3.2 Document D1 discloses in the wording of claim 1 (reference signs according to Figure 2 of D1 were inserted in the claim):

A light source comprising: a substrate (11); a light emitting diode (19) having a light emitting junction (17) perpendicular to the substrate and having an electrically conductive layer (20, 21) at each of the two opposite end faces of the light emitting diode perpendicular to the substrate, said opposite end face extending parallel to the light emitting junction (17), at least one of said electrically conductive layers (20, 21) comprising a metal layer extending parallel to the light emitting junction (17); means (18, 26, 27) for mounting the light emitting diode on the substrate with the junction (17) perpendicular to the substrate and the electrically conductive layers (20, 21) in electrical contact with conductive areas (24, 25) on the substrate.

Document D1 further discloses that the electric contact between the LED's end faces 19a, 19b and the conductive portions 24, 25 on the substrate is made by means of conductive membranes 26, 27 formed of conductive paste which contact the conductive light screens 22, 23 of the LED. These light screens are highly reflective metal layers made of materials such as gold, silver, aluminium, nickel or platinum. The LED is bonded onto the substrate by an electric insulating adhesive 18, eg a transparent epoxy resin (column 2, lines 18 to 33; Figure 2). A simple and reliable mounting of the LED on the substrate is therefore made possible.

3.3 The light source of claim 1 differs therefore from the one disclosed in D1 in that

(a) the metal layer is deposited on a non-conductive reflective layer, while in D1 the reflective layer is conductive, and in that

(b) the non-conductive reflective layer is applied on one of said end faces of the light emitting diode and has at least one hole for establishing electrical contact between the metal layer and the light emitting diode.

3.4 The board considers that the objective technical problem addressed by the invention relative to D1 is to provide an LED with an electrode structure with higher reflectivity, while maintaining the ease of connection of the semiconductor element.

3.5 Document D2 discloses an LED 10 which is coated with a reflecting double layer having an aperture for transmission of optical radiation, eg to an optical fibre 17. The reflecting double layer is formed by a layer of dielectric 14, such as silica, in contact with the semiconductor and by an optically reflecting metal layer 15, 16 deposited on the dielectric. The dielectric layer has apertures for electrode contacts, through which the metal layer 15, 16 establishes contact to the semiconductor, and for the insertion of an optical fibre. As the areas of contact between the metal layer and the semiconductor are usually optically darkened by the alloying required for establishing an ohmic contact, these areas are made in the form of a plurality of tiny circular (multiple dots) contacts

through corresponding cylindrical apertures in the dielectric. This enables the non-reflecting areas of contact to be reduced, while good and reliable electrical contact is maintained (Abstract; column 1, lines 48 to 68; column 2, lines 28 to 33; column 3, line 62 to column 4, line 26; Figure 1).

D2 further discloses that the optical rays which are incident on the surface of the semiconductor at angles greater than the critical angle are reflected by the dielectric layer with an efficiency of close to 100 percent, whereas those rays which are incident on the surface at angles less than the critical angle are reflected by the metal layer with a loss of the order of 5 to 20 percent (column 4, lines 27 to 36).

3.6 The respondent proprietor argued that the skilled person would not combine the disclosures of documents D1 and D2, since both documents related to completely different technical areas. Document D1 related to mounting light emitting display devices and D2 related to the coupling of light into an optical fibre.

3.7 The board is not persuaded by this argument. The person skilled in the art, an engineer or physicist designing light emitting devices, understands that the improvement in reflectivity disclosed in document D2 is achieved by the use of a dielectric/metal reflecting double layer, as the underlying physical principles of this double layer are clearly explained in this document. For the skilled person it is evident that this improvement is independent from the intended use of the device, since it is not restricted to coupling radiation into an optical fibre, and can therefore be

applied to any other light emitting devices for which an improvement in reflectivity is sought. The use of the double reflective layer disclosed in document D2 in the LED disclosed in document D1 does not require any structural modifications other than the replacement of the layers at the end faces. The mounting and contacting of the LED can still be made in the same manner as disclosed in D1, since the outer layer of the reflecting double layer of D2 is a metal layer to which electric contact can be made in the same way as to the light screens disclosed in D1.

3.8 The board is also not persuaded by the opposition division's argument that there was no incentive to modify the reflective layers disclosed in document D1, since the skilled person is constantly trying to improve the prior art. To recognize that the reflecting properties of a metal layer with a loss of 5 to 20 percent can be improved by interposing a dielectric layer which reflects a part of the incident radiation with nearly 100 percent efficiency is considered by the board to be obvious.

3.9 The board judges therefore that the light source of claim 1 does not involve an inventive step within the meaning of Article 56 EPC.

4. *2nd to 6th auxiliary requests*

4.1 Although these requests were filed to overcome the objections raised under Article 100(c) EPC and the respondent proprietor did not argued that the features introduced involved an inventive step, the differences

with respect to claim 1 of the main request will be highlighted and discussed in the following.

4.2 Claim 1 of the 2nd auxiliary request differs from claim 1 of the main request by introducing the feature that the "reflective layer being formed to not establish electrical connection to the light emitting diode". This negative formulation essentially states that the reflective layer is non-conductive, ie that it does not establish an electrical connection. However, a non-conductive reflective layer is disclosed in document D2 and therefore the same arguments for finding claim 1 of the 1st auxiliary request not allowable apply to this request.

4.3 Claim 1 of the 3rd auxiliary request differs from claim 1 of the main request in that it specifies:

(a) that the metal layer provides an entire metallized face and
(b) that the mounting means are solder.

Feature (a) is disclosed in document D1. As acknowledged by the respondent proprietor, the conductive light screen, which is a metal layer, covers the entire end face of the LED (Figures 4 to 6).

The board considers that the mounting of LEDs on a printed circuit board by means of solder, ie feature (b), is an alternative available to the skilled person (D5; column 1, lines 9 to 21 and column 1, line 55 to column 2, line 13).

The light source of claim 1 of the 3rd auxiliary request therefore does not involve an inventive step.

4.4 Claim 1 of the 4th auxiliary request differs from claim 1 of the 3rd auxiliary request in that it requires that the reflective layer be non-conductive, ie it is a combination of the features of claims 1 of the 1st and 3rd auxiliary requests. This request fails for the reasons advanced in relation to the 1st and 3rd auxiliary requests.

4.5 Claim 1 of the 5th auxiliary request differs from claim 1 of the main request in that it requires that the reflective layer is made of silica. Document D2 discloses a reflective layer made of silica (column 2, lines 28 to 29). This request fails therefore for the reasons advanced for the main request.

4.6 Claim 1 of the 6th auxiliary request is a combination of claims 1 of the 3rd and 5th auxiliary requests. This request fails for the reasons advanced in relation to the 3rd and 5th auxiliary requests.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

Registrar Chair

S. Sánchez Chiquero G. Eliasson