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Datasheet for the decision of 4 June 2024

Case Number: T 1587/21 - 3.4.02

Application Number: 06790291.6

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Language of the proceedings: EN

Title of invention:
METHOD AND SYSTEM FOR INSPECTING INDIRECT BANDGAP SEMICONDUCTOR STRUCTURE

Patent Proprietor:
BT Imaging Pty Limited

Opponent:
Vos, Derk

Relevant legal provisions:
EPC Art. 56
RPBA 2020 Art. 12(4)

Keyword:
Inventive step (main request: no, auxiliary request 1: yes)

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Case Number: T 1587/21 - 3.4.02

D E C I S I O N
of Technical Board of Appeal 3.4.02
of 4 June 2024

Appellant: (Patent Proprietor)	BT Imaging Pty Limited 18 Bulletin Place Sydney, NSW 2000 (AU)
Representative:	Sonnenberg Harrison Partnerschaft mbB Herzogspitalstraße 10a 80331 München (DE)
Appellant: (Opponent)	Vos, Derk Maiwald GmbH Elisenhof Elisenstraße 3 80335 München (DE)
Representative:	Maiwald GmbH Elisenhof Elisenstraße 3 80335 München (DE)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 14 July 2021 concerning maintenance of the European Patent No. 1946079 in amended form.**

Composition of the Board:

Chair	R. Bekkering
Members:	F. J. Narganes-Quijano
	C. Almberg

Summary of Facts and Submissions

I. Both the patent proprietor and the opponent lodged an appeal against the interlocutory decision of the opposition division finding European patent No. 1946079 as amended according to auxiliary request 1 to meet the requirements of the EPC.

The opposition filed by the opponent against the patent as a whole was based on the grounds for opposition of added subject-matter (Article 100(c) EPC), insufficiency of disclosure (Article 100(b) EPC), and lack of novelty and of inventive step (Article 100(a) together with Articles 52(1), 54 and 56 EPC).

II. Among the documents cited during the first-instance proceedings, the following documents were considered by the parties during the appeal proceedings:

D1: "A Real-Time Photoluminescence Imaging System", G. Livescu *et al.*; Journal of Electronic Materials, Vol. 19, 1990; pages 937 to 942

D2: "Effective excess carrier lifetimes exceeding 100 milliseconds in float zone silicon determined from photoluminescence", T. Trupke *et al.*; 19th EPVSC, Paris, amended version of February 2005; pages 1 to 4

D3: "Photographic surveying of minority carrier diffusion length in polycrystalline silicon solar cells by electroluminescence", T. Fuyuki *et al.*; Applied Physics Letters, Vol. 86, 2005; pages 262108-1 to 262108-3

D4: "Luminescence imaging - a well-established technique to study material- and device-

related problems", M. Baeumler *et al.*; Materials Science and Engineering, Vol. B66, 1999; pages 131 to 140

D6: "Photoluminescence microscopy investigation of lattice defects in epitaxial heterostructures", Z. M. Wang *et al.*; Journal of Crystal Growth, Vol. 126, 1993; pages 205 to 215

D9: "Photoluminescence: A surprisingly sensitive lifetime technique", T. Trupke *et al.*; Conference Record of the Thirty-First IEEE Photovoltaic Specialist Conference, January 2005; pages 903 to 906

D10: "Defect mapping in full-size multi-crystalline Si wafers", S. Ostapenko *et al.*; The European Physical Journal - Applied Physics, Vol. 27, 2004; pages 55 to 58.

III. In its decision the opposition division held in respect of the requests then on file *inter alia* as follows:

- Main request (patent as granted): The grounds for opposition under Articles 100(b) and (c) EPC did not prejudice the maintenance of the patent as granted, and the subject-matter of independent claim 10 was not obvious, in particular over document D1 in combination with document D2 and the common general knowledge, but the subject-matter of claim 1 was obvious in view of document D9 in combination with document D1 and the common general knowledge (Article 56 EPC).

- Auxiliary request 1: The patent as amended met the requirements of the EPC; in particular, the subject-matter of independent claims 1 and 10 involved an inventive step in view of documents D1, D2, D9 and the common general knowledge (Article 56 EPC).

IV. With its statement of grounds of appeal the patent proprietor filed, *inter alia*, a copy of the patent as amended according to auxiliary request 1 underlying the decision under appeal, a copy of the claims of auxiliary requests 2 to 6 filed with the letter dated 9 April 2021, and the following document

A1: "Photoluminescence imaging of silicon wafers", T. Trupke *et al.*; Applied Physics Letters Vol. 89 (2006); pages 044107-1 to 044107-3.

V. In its statement of grounds of appeal the opponent presented a copy of a table from "Wikipedia" and a copy of an illustration from a website of the University of Freiburg (page 5).

VI. With the letter of reply dated 28 March 2022 the patent proprietor filed document:

A2: "Spectral Identification of Lighting Type and Character", C. D. Elvidge *et al.*; Sensors Vol. 10 (2010); pages 3961 to 3988.

VII. Oral proceedings were held on 4 June 2024.

The proprietor requested that the appealed decision be set aside and that the opposition be rejected, i.e. that the patent be maintained as granted (main request). As their auxiliary request 1, the proprietor requested that the opponent's appeal be dismissed, i.e. that the patent be maintained in amended form according to the claims found allowable in the appealed decision. In the further alternative, the proprietor requested that the case be remitted to the opposition division for consideration of the patent's maintenance according to the claims of one of auxiliary requests 2 to 6 filed

with letter dated 9 April 2021. In the still further alternative, the proprietor requested that the patent be maintained in amended form according to the claims of one of auxiliary requests 2 to 6 filed with letter dated 9 April 2021.

The opponent requested that the appealed decision be set aside and that the patent be revoked.

At the end of the oral proceedings the chair announced the decision of the board.

VIII. Claim 1 as granted (main request) - with the feature labelling "M1" to "M1.7" in square brackets indicating the feature labelling adopted during the proceedings being inserted therein by the board - reads as follows:

"*[M1]* A method of inspecting an indirect bandgap semiconductor structure (140), said method comprising the steps of:

[M1.1] generating light from a light source (110) comprising a laser, laser diode or light emitting diode having a wavelength emission peak suitable for inducing photoluminescence in said indirect bandgap semiconductor structure (140);

[M1.2] short-pass filtering said generated light to reduce long wavelength light of said generated light above said wavelength emission peak being received by an image capture device (130);

[M1.3] collimating said generated light;

[M1.4] substantially uniformly and simultaneously illuminating a large area including up to an entire surface of said indirect bandgap semiconductor structure (140) with said collimated, short-pass filtered light;

[M1.5] simultaneously capturing photoluminescence induced from said indirect bandgap semiconductor structure (140) by said illumination using the image capture device (130) capable of capturing simultaneously said induced photoluminescence; and

[M1.6] image processing images of said captured photoluminescence to quantify spatially resolved, specified electronic properties of said indirect bandgap semiconductor structure (140) using the spatial variation of said photoluminescence induced in said large area;

[M1.7] wherein the indirect bandgap semiconductor structure (140) comprises a bare or partially processed wafer, or a wafer that has undergone any number of processing steps to form a photovoltaic device such as a solar cell."

Claim 1 of auxiliary request 1 differs from claim 1 of the main request in that features M1.2 and M1.3 are interchanged and M1.2 is replaced by the following feature M1.2' (with a deletion and additions being respectively indicated by strike-through and underlining by the board):

[M1.2'] short-pass filtering said ~~generated~~ collimated light using one or more dielectric filters or dielectric mirrors to reduce long wavelength light of said generated light above said wavelength emission peak being received by an image capture device (130);

Independent claim 10 of auxiliary request 1 reads - with the feature labelling "M10" to "M10.6" in square brackets inserted therein, and with a deletion and additions when compared with granted claim 10 being respectively indicated by strike-through and underlining by the board - as follows:

"*[M10]* A system (100) for inspecting an indirect bandgap semiconductor structure (140), said system (100) comprising:

[M10.1] a light source (110) comprising a laser, laser diode or light emitting diode for generating light having a wavelength emission peak suitable for inducing photoluminescence in said indirect bandgap semiconductor structure (140);

[M10.2] an image capture device (130) for capturing photoluminescence induced from said indirect bandgap semiconductor structure (140) by said illumination;

[M10.3] a short-pass filter unit (114) comprising one or more dielectric filters or dielectric mirrors disposed between said light source (110) and said indirect bandgap semiconductor structure (140), the short-pass filter unit (114) being adapted to reduce long wavelength light of said generated light above said wavelength emission peak being received by the image capture device (130);

[M10.4] a collimator (112) disposed between said light source (110) and said ~~indirect bandgap semiconductor structure (140)~~ short-pass filter unit (114), said collimated, short-pass filtered light substantially uniformly and simultaneously illuminating a large area including up to an entire surface of said indirect bandgap semiconductor structure (140); and

[M10.5] an image processor (150) for processing images of said captured photoluminescence to quantify spatially resolved, specified electronic properties of said indirect bandgap semiconductor structure (140) using the spatial variation of said photoluminescence induced in said large area;

[M10.6] wherein the indirect bandgap semiconductor structure (140) comprises a bare or partially processed wafer, or a wafer that has undergone any number of

processing steps to form a photovoltaic device such as a solar cell."

Reasons for the Decision

1. The appeal of the patent proprietor and the appeal of the opponent are admissible.

2. *New evidence submitted during the appeal proceedings - Article 12 (4) RPBA*

In its statement of grounds of appeal the opponent presented a copy of a table from "Wikipedia" and a copy of an illustration from a website of the University of Freiburg. The patent proprietor requested that the mentioned copy of a table and of an illustration presented by the opponent be disregarded.

The board notes that the mentioned table and the mentioned illustration only disclose respectively the wavelengths of argon ion lasers and the band gap energy of different semiconductors, that this information constituted common general knowledge in the technical field under consideration, and that this evidence was submitted by the opponent only in support of some of the arguments relating to the content of documents already considered during the proceedings. For these reasons, the board found appropriate in the exercise of its discretion under Article 12 (4) RPBA to consider this evidence.

Documents A1 and A2 are two scientific articles respectively submitted by the patent proprietor with

the statement of grounds of appeal and with their reply to the statement of grounds of appeal of the opponent only in support of the use of mega-pixel cameras and of the spectrum of emission wavelengths of mercury lamps, respectively. For reasons analogous to those given in the previous paragraph, the board also found appropriate in the exercise of its discretion under Article 12 (4) RPBA to consider documents A1 and A2.

3. *Main request (patent as granted) - Claim 1 - Inventive step - Document D9 in combination with D1 and the common general knowledge*

3.1 The opposition division concluded in its decision that

- the method of claim 1 as granted differed from the method disclosed in document D9 in features M1.3, M1.5 and M1.6,

- feature M1.3 and features M1.5 and M1.6 were directed to solve different objective technical problems, namely the provision of a homogeneous light distribution on a region of the sample surface and achieving a more comprehensive inspection of the sample, respectively, and

- the subject-matter of claim 1 was obvious in view of document D9 representing the closest prior art in combination with D1 and the common general knowledge.

The patent proprietor contested the opposition division's view in this respect.

3.2 In the statement of grounds of appeal the patent proprietor did not agree with the opposition division's assessment relating to the determination of two objective technical problems, but expressly declined to submit arguments in support of this view. In these

circumstances, the board sees no reason to depart from the opposition division's view in this respect.

3.3 Feature M1.3

In its decision the opposition division held that feature M1.3 was obvious in view of the common general knowledge. In particular, it was standard practice in the art to use collimators to solve the objective technical problem formulated in respect of feature M1.3, and in particular for controlling the divergence of a light beam.

The patent proprietor submitted no argument in reply to the opposition division's view in this respect, and the board sees no reason to depart from the opposition division's conclusion that feature M1.3 was obvious in view of the common general knowledge.

3.4 Features M1.5 and M1.6

3.4.1 The patent proprietor submitted that the objective technical problem of achieving a more comprehensive inspection of the sample was to be assumed to pertain to inspection with spatial resolution, and that document D9 did not pertain to spatial resolution and the skilled person would not have viewed the lack of spatial resolution as a technical problem to be solved in document D9.

The board notes, however, that the objective technical problem formulated by the opposition division does - contrary to the patent proprietor's view - not involve the concept of spatial resolution, and as a matter of fact it should not involve it because otherwise the objective technical problem would - contrary to an

objective assessment of inventive step according to the problem-solution approach - already contain an element of the claimed solution (see combination of features M1.5 and M1.6, in particular the features "simultaneously", "to quantify spatially resolved", and "spatial variation"). It is also noted that, as submitted by the opponent, there is no need for document D9 as closest prior art to expressly address the objective technical problem and that, in any case, document D9 already points to the possible inaccuracies in not taking into account the spatial inhomogeneous characteristics of the sample (see page 903, right column, section "Theory", first paragraph, lines 5 to 10 after equation (1)).

Therefore, the board sees no reason to depart from the opposition division's formulation of the objective technical problem solved by features M1.5 and M1.6.

3.4.2 The patent proprietor submitted that document D1 was directed to III-V direct bandgap semiconductors which substantially differed in several respects - manufacture, characteristics such as the photoluminescence quantum efficiency (patent specification, paragraph [0027]), etc. - from the silicon samples considered in document D9, and that direct and indirect bandgap semiconductors constituted two areas of technical interest that did not overlap with each other. Therefore, a skilled person working in the technical field of document D9 and seeking to inspect indirect bandgap semiconductors and in particular the silicon samples of document D9 would not have considered the specific technical field of direct bandgap semiconductors, and in particular document D1, to solve the objective technical problem.

The opponent essentially submitted that the skilled person working in this technical field would not have confined the search for a solution to the objective technical problem to indirect bandgap semiconductors and that document D1 was not limited to the direct bandgap semiconductor materials considered in the specific examples.

The board notes that document D1 discloses a photoluminescence imaging inspection method specifically applied - as submitted by the patent proprietor - to the inspection of GaAs/AlGaAs, InGaAs/InP and InGaAs/InP wafers (abstract, and page 938, right column, second paragraph) which are direct bandgap semiconductor structures. However, this application of the method is disclosed in document D1 only as a specific example (abstract, last sentence), and the inspection method is not disclosed in the document as being restricted to this specific example or - as submitted by the patent proprietor - to a specific class of materials such as III-V direct bandgap semiconductors, but as being generally applicable to "optical and electro-optical materials" (abstract, penultimate sentence) and, more particularly, to "large wafers of semiconductor materials and structures" (page 942, section 3, lines 1 to 5). In addition, the board is not convinced by the patent proprietor's argument that the skilled person, when starting with document D9, would have confined its considerations to silicon wafers or to the specific class of semiconductors to which silicon belongs, i.e. to the class of indirect bandgap semiconductor materials. In particular, the fact that document D9 is specifically directed to measuring the effective excess carrier lifetime in silicon wafers would not have dissuaded the skilled person when confronted with the

objective technical problem from consulting document D1 because the measurement of carrier lifetimes in a silicon wafer is encompassed by the inspection of the wafer and, in addition, document D1 discloses the photoluminescence inspection of wafers, without it being restricted to the inspection of a predetermined feature of the wafer (see, in particular, document D1, section "1." on page 937, left column, lines 1 to 20).

Therefore, the board cannot follow the patent proprietor's argument that the skilled person would not have considered document D1 when seeking for a solution to the objective technical problem.

3.4.3 The patent proprietor also submitted that in document D9 it was necessary to illuminate a large area and detect photoluminescence from the whole area of the silicon wafer with a single element photodiode because the authors were interested in measuring carrier lifetimes in the silicon wafer at very low injection levels (Fig. 2), so that the photoluminescence signal intensity was very low at these injection levels and the method of document D9 required signal averaging times of around 80 seconds to an hour (paragraph bridging pages 904 and 905). In contrast thereto, the photoluminescence imaging set-up of document D1 was used with materials with a photoluminescence emission having an intensity orders of magnitude higher than that of silicon, it involved a laser source having a power different from that required for indirect bandgap semiconductors, and it did not ensure a uniform and simultaneous illumination of the wafer as it was the case of feature M1.4 of claim 1. Therefore, replacing the single photodiode used in document D9 by an imaging detector or by a camera as disclosed in document D1, for instance by a MxN pixel camera, in particular by a

one-megapixel camera such as that disclosed in (post-published) document A1 (page 044107-1, right column, third paragraph), would increase the required acquisition time, in particular by a factor of MxN in the case of a MxN pixel camera. In addition, the imaging detector would require imaging optics (D1, Fig. 3), and only a small fraction of the isotropically emitted photoluminescence would be collected by the imaging optics, thus introducing an additional factor in the measurement time when compared with document D9 where a large area photodiode could be placed in direct contact with the sample. Therefore, the skilled person would have understood that the photoluminescence inspection method of document D1, while suitable for inspecting III-V semiconductors, would not have been practical for the inspection of indirect bandgap materials such as silicon, and there was no hint or prompt in document D1 to indirect bandgap semiconductors. Furthermore, document D9 failed to specify technical details, such as the location of the long and short pass filters. Therefore, the skilled person could, but would not have considered the combination of document D9 with document D1 and would rather have turned to scanning beam techniques such as those disclosed in documents D2, D3 and D10.

The board notes, however, that the photoluminescence intensity of indirect bandgap semiconductors depends - as submitted by the opponent - on the specific semiconductor material, the dopants present in the material, temperature, etc., and that in the event that the skilled person would encounter problems associated with a relatively low photoluminescence emission intensity and/or with relatively long detection times when applying the method of document D1 to the method of document D9, the person skilled in the technical

field under consideration would, on the basis of the common general knowledge in this field, have considered selecting the appropriate technical means disclosed in document D1, such as the collecting and imaging optics having the appropriate characteristics and/or the image capturing device having the appropriate high-sensitivity and/or the light source having the appropriate high power to enable applying the imaging technique disclosed in document D1 to the inspection method of document D9. It is also noted in this respect that claim 1 only requires a light source having a wavelength emission peak suitable for inducing photoluminescence (feature M1.1), an image capturing device capable of simultaneously capturing the induced photoluminescence (feature M1.5) and an image processor for processing the images of the captured photoluminescence (features M1.6), and that claim 1 does not - as submitted by the opponent - require any specific feature of these components that would solve or at least alleviate the problems mentioned by the patent proprietor. In particular, the claim does not exclude the provision of the technical means mentioned above or even carrying out the method with long detection times. More particularly, the board is unable to identify in features M1.5 and M1.6 and in the remaining claimed features any technical feature that would go beyond the mere application of the imaging method disclosed in document D1 to the inspection method of document D9. Furthermore, the problem of the uniform illumination of the sample is already acknowledged in document D1 and - as submitted by the opponent - also solved, at least to a predetermined degree (Fig. 4 and 6), in the document (page 940, right column, last paragraph) and, in any case, feature M1.4 of claim 1 only requires a substantial uniform and simultaneous illumination of the sample.

In addition, in the board's view document D9 contains sufficient technical details enabling the skilled person to implement the method disclosed therein. In particular, the skilled person would have understood the sentence "[a] combination of long and short pass filters was used to reduce the fraction of incident LED light that is transmitted by the sample and detected by the PL sensor" (emphasis added by the board) on page 904 of document D9, left column, first paragraph, penultimate sentence, in the sense that the filters are located between the light source and the sample.

Therefore, the board considers that the skilled person not only could, but would have considered the application of the teaching of document D1 to the method of document D9 in order to solve the objective technical problem formulated in respect of features M1.5 and M1.6.

In addition, the application of the teaching of document D1 to the method of document D9 would - as held by the opposition division in its decision - have resulted in the claimed features M1.5 and M1.6.

3.5 In view of these considerations and the reasons given by the opposition division in its decision, the board is of the opinion that the method defined in claim 1 as granted does not involve an inventive step in view of document D9 as closest prior art in combination with document D1 and the common general knowledge (Article 56 EPC).

3.6 The board concludes that, as held by the opposition division in its decision, the ground for opposition of lack of inventive step (Article 100(a) together with

Articles 52(1) and 56 EPC) prejudices the maintenance of the patent as granted.

4. *Auxiliary request 1 - Inventive step*

4.1 Claim 1 - Document D9 as closest prior art

4.1.1 Claim 1 of auxiliary request 1 differs in substance from claim 1 as granted in that features M1.2 and M1.3 have been interchanged and in that the expression "short-pass filtering said generated light" of feature M1.2 has been replaced by "short-pass filtering said collimated light using one or more dielectric filters or dielectric mirrors".

The step of short-pass filtering the light from the light source is disclosed in document D9 (see point 3.4.3 above, third paragraph), and the step of collimating the light D9 does, as already concluded in point 3.3 above, not involve an inventive step. In the decision under appeal the opposition division considered that the objective technical problem solved by the additional feature of first collimating the generated light and then using "one or more dielectric filters or dielectric mirrors" for short-pass filtering the collimated light was to increase sensitivity of the system and concluded that the method of claim 1 involved an inventive step over document D9 in combination with document D1 and the common general knowledge.

4.1.2 The opponent contested the opposition division's view in this respect and submitted on the basis of a series of technical considerations involving the short-pass filters disclosed in document D9, the dielectric mirror disclosed in Fig. 3 of document D1, and the angle

dependent characteristics of interference-based filters requiring the use of a collimator to reduce beam divergence that the objective technical problem solved by the amended features of claim 1 was to be seen in obtaining a position-independent or uniform filtering effect of the excitation light. The opponent submitted that the skilled person would have considered the use of collimation optics such as that disclosed in document D4 (Fig. 1, together with page 2, section 2.2, first paragraph) which contained a reference (reference [7]) to the optical set-up of document D6 (Fig. 1, together with page 206, left column, second paragraph).

The board notes, however, that the objective technical problem submitted by the opponent in respect of claim 1 is not based on document D9 as closest prior art, but on document D9 together with the filtering characteristics of the dielectric mirror disclosed in Fig. 3 of document D1. However, document D1 is - as submitted by the patent proprietor - silent as to the filtering characteristics (if any) of the dielectric mirror represented in Fig. 3 of D1. In addition, the opponent is already assuming a combination of document D9 as closest prior art with document D1 (see point 3 above) and then applying anew the problem-solution approach with respect to the combination of documents D9 and D1 as closest prior art. This approach, however, is not consistent with the problem-solution approach.

In addition, in the inspection methods of both document D1 and document D9 (see D1, page 904, left column, first paragraph, lines 4 to 7, and D9, diverging lens in Fig. 3 of document D1, together with the "uniform illumination of the wafer by the exciting laser beam" mentioned on page 940, right column) the excitation light is simultaneously projected on a broad section of

the surface of the sample to be inspected. Furthermore, the optical set-up disclosed in document D4 by reference to document D6 constitutes - as submitted by the patent proprietor - a confocal-type photoluminescence microscopy arrangement in which the diverging excitation light from a mercury lamp emitting in a broad spectrum of wavelengths (document A2, Fig. 11) is primarily collimated for the purpose of projecting the collimated light on the microscope objective and focusing the excitation light in a relatively small region of the sample (see Fig. 1 of each of documents D4 and D6). In this context, the board is of the opinion that the skilled person would have had no incentive to, first, consult document D4 and/or D6 and, second, to consider extracting from document D4 and/or D6 a teaching that would have led the skilled person to consider modifying the combination of document D9 with document D1 addressed in point 3.4 above so as to arrive at the claimed method.

4.1.3 The opponent also submitted that it was common general knowledge, and in fact routine, to collimate the light emitted by a light source in order to compensate the divergence of the emitted light, and that it was also common general knowledge to filter the collimated light and also to use dielectric filters and/or dielectric mirrors appropriately arranged for filtering the light, in particular to obtain a uniform filtering effect and/or to increase the sensitivity of a system.

However, in the absence of evidence in support of this chain of considerations each involving the common general knowledge, the board cannot follow the opponent's argument in this respect. In particular, none of documents D4 and D6 referred to in point 4.1.2

above can be considered as illustrating the mentioned common general knowledge because these documents are scientific articles and, in addition, as already mentioned in point 4.1.2 above, last paragraph, they only concern a specific confocal-type photoluminescence microscopy arrangement. Therefore, the opponent's arguments are - as submitted by the patent proprietor - insufficient to conclude that the specific arrangement defined in claim 1 was obvious in view of the common general knowledge.

4.1.4 In view of these considerations, the board is of the opinion that the method of claim 1 of auxiliary request 1 does not result in an obvious way from document D9 as closest prior art in combination with document D1 and under consideration of the common general knowledge and/or of documents D4 and D6 (Article 56 EPC).

4.2 Independent claim 10 - Document D9 as closest prior art

Independent claim 10 of auxiliary request 1 is directed to a system for inspecting an indirect bandgap semiconductor structure and comprising a series of means the structural and functional features of which are essentially in one-to-one correspondence with the method steps of the method defined in claim 1 of auxiliary request 1.

In the board's opinion the system defined in independent claim 10 involves an inventive step over document D9 as closest prior art at least for reasons analogous to those given in point 4.1 above in respect of the additional features of claim 1 (collimating the generated light and then short-pass filtering the "collimated light using one or more dielectric filters or dielectric mirrors") which are also present in

independent claim 10 (a short-pass filter "comprising one or more dielectric filters or dielectric mirrors" and a collimator "disposed between said light source (110) and said short-pass filter unit") (Article 56 EPC).

4.3 Independent claim 10 - Document D1 as closest prior art in combination with D2 and the common general knowledge

4.3.1 In its decision the opposition division held that the system defined in independent claim 10 of auxiliary request 1 was new over document D1 in features M10.3 and M10.4 and also in the reference to the suitability of the claimed system for the inspection of indirect bandgap semiconductor structures.

The opponent contested the opposition division's view in this respect and submitted that the system of document D1 was suitable for the claimed purpose. In particular, the argon ion laser used for excitation in document D1 (Fig. 3) had emission wavelengths ranging from 350 up to 1100 nm (*cf.* table from "Wikipedia" on page 5 of the opponent's statement of grounds of appeal) and, in addition, there was an overlap of the bandgap energy of indirect bandgap semiconductors with that of at least some of the III-V and II-VI direct bandgap semiconductors (*cf.* illustration from a website of the University of Freiburg on page 5 of the opponent's statement of grounds of appeal).

The board first notes that the system of independent claim 10 is - as submitted by the opponent - only required to be suitable for the inspection of indirect bandgap semiconductor structures, but that this suitability - and more particularly the corresponding suitability explicitly required for the different

components of the system, see in particular features M10.1, M10.2 and M10.5 - implicitly involves predetermined restrictions to the components of the system. In addition, the system of document D1 is, as held by the opposition division in its decision, not suitable for the mentioned purpose. As already noted in point 3.4.2 above, third paragraph, document D1 specifically discloses the applicability of the inspection method disclosed therein to GaAs/AlGaAs, InGaAs/InP and InGaAs/InP wafer structures, which are direct bandgap semiconductor structures, and also a system (Fig. 3) specifically conceived for the inspection of these structures, and the document also discloses the application of the method "for quick inspection of optical and electro-optical materials" (abstract) and "for semiconductor wafers" (page 937, left column, line 4). However, this general reference to samples and structures other than the specific direct bandgap semiconductor wafer structures mentioned in document D1 does not imply *per se* that the system disclosed in document D1 would also be suitable for inspecting each of the specific structures that may fall within the expressions "optical and electro-optical materials" and "semiconductor wafers", and in particular for the inspection of indirect bandgap semiconductor structures. More particularly, under the assumption - contested by the patent proprietor - that the Argon ion laser of the system of Fig. 3 of document D1 would, as submitted by the opponent, be suitable for photo-exciting an indirect semiconductor, the board notes that document D1 only discloses a Vidicon camera for visible light and a lead sulphide camera for infrared light (page 938, right column, last paragraph) and that these two cameras are not suitable for detecting and imaging the photoluminescence emitted by an indirect

semiconductor. In addition, the CCD cameras mentioned by the opponent as being readily available at the priority date of the patent in suit and suitable for detecting and imaging the photoluminescence emitted by an indirect semiconductor are not disclosed in document D1.

Therefore, the suitability of the system - and, more specifically, of the different components of the system - disclosed in document D1 for the inspection of indirect bandgap semiconductor structures is not directly and unambiguously derivable from the disclosure of document D1 and, therefore, it constitutes a distinguishing feature of the claimed system over the system of document D1.

The board concludes that the system of independent claim 10 differs from the system disclosed in document D1 in

- the suitability of the system for the inspection of indirect bandgap semiconductor structures and
- features M10.3 and M10.4.

4.3.2 The opponent submitted that, when starting with document D1 as the closest prior art, the claimed system was rendered obvious by document D2 and the common general knowledge.

Document D2 discloses photoluminescence measurements on silicon wafers (title, abstract, and Fig. 3) involving the use of a short-pass filter between the light source and the wafer (page 3, left column, second paragraph).

In its decision the opposition division held in respect of independent claim 10 as granted that the features of the claim corresponding to features M10.3 and M10.4 of

claim 10 of auxiliary request 1 (i.e. features M10.3 and M10.4 without the additional feature "comprising one or more dielectric filters or dielectric mirrors" incorporated into claim 10 of auxiliary request 1 and without the requirement that the collimator is disposed before the short-pass filter, see point VIII above) were obvious, in particular in view of document D2 and the common general knowledge, but that the skilled person would have had no incentive in rendering the resulting system suitable for the inspection of indirect bandgap semiconductor structures.

The question arises as to why the skilled person would have considered modifying the system of document D1 or selecting specific ones of the different technical means notionally encompassed by the components of the system disclosed in document D1 (camera, etc.) in such a way that the system would become suitable for the purpose mentioned in claim 1. The board notes that the opponent submitted no argument in this respect, and the board does not see why the skilled person, even under consideration of document D2 and of the common general knowledge, would - and not merely could - have considered selecting, modifying or adapting the components of the system of document D1 so that it would be specifically suitable for the purpose indicated in independent claim 10. In particular, the board sees no reason why the skilled person, without previous knowledge of the claimed invention, would have considered - as submitted by the opponent - replacing the Vidicon and/or the lead sulphide cameras disclosed in document D1 by a CCD camera suitable for detecting photoluminescence from an indirect bandgap semiconductor. Therefore, the skilled person had - as held by the opposition division in its decision - no incentive in rendering the system of document D1

suitable for inspecting indirect bandgap semiconductor structures, and already for this reason the system defined in independent claim 10 was not obvious in view of document D1 as closest prior art.

In addition, as regards features M10.3 and M10.4, the additional features relating to the short-pass filter unit "comprising one or more dielectric filters or dielectric mirrors" and the collimator being "disposed between said light source (110) and said short-pass filter unit" of independent claim 10 of auxiliary request 1 are in the board's opinion not obvious for reasons analogous to those given in points 4.1.2 and 4.1.3 above in respect of the additional features of claim 1 of auxiliary request 1.

4.3.3 The board concludes that the system of independent claim 10 of auxiliary request 1 involves an inventive step over document D1 in combination with document D2 and the common general knowledge (Article 56 EPC).

4.4 Claim 1 - Document D1 as closest prior art in combination with document D2 and the common general knowledge or in combination with document D9 and the common general knowledge

4.4.1 As regards the combination of document D1 with document D2 and the common general knowledge, the first question to be addressed is why the skilled person would, when starting with document D1 as closest prior art, have considered applying the method of document D1 to the inspection of indirect bandgap semiconductor structures as required by claim 1 of auxiliary request 1. In the board's view considerations analogous to those set forth in points 4.3.1 and 4.3.2 above in respect of independent claim 10 also apply to this question and,

in addition, to the features of claim 1 (features M1.3 and M1.2') corresponding to features M10.3 and M10.4 of independent claim 10.

Therefore, the method of claim 1 of auxiliary request 1 involves an inventive step in view of document D1 as closest prior art in combination with document D2 and the common general knowledge (Article 56 EPC).

4.4.2 As regards the combination of document D1 with document D9 and the common general knowledge, the first question to be addressed is why the skilled person would, when starting with document D1 as closest prior art, have considered the combination of the method of inspection of optical and electro-optical materials and, in particular, of direct bandgap semiconductor structures of document D1 with the disclosure of document D9 relating to the inspection of silicon wafers. In view of the considerations in point 4.3.1 above the board sees no reason why the skilled person would have considered this specific combination. In any case, the method of claim 1 would still differ from the mentioned combination of document D1 with document D9 in the sequence of steps consisting in first collimating the light from the light source and then short-pass filtering the collimated light using one or more dielectric filters or dielectric mirrors (features M1.3 and M1.2'), and this sequence of steps is not obvious in view of the common general knowledge - in particular, under consideration of documents D4 and D6 - for reasons analogous to those already given in points 4.1.2 and 4.1.3 above.

Therefore, the method of claim 1 of auxiliary request 1 involves an inventive step in view of document D1 as

closest prior art in combination with document D9 and the common general knowledge (Article 56 EPC).

4.5 The board concludes that the subject-matter of independent claims 1 and 10 and therefore also that of dependent claims 2 to 9 and 11 to 21 of auxiliary request 1 involves an inventive step (Article 56 EPC).

In addition, the board sees no reason to depart from the opposition division's conclusion that the patent as amended according to auxiliary request 1 complies with the remaining requirements of the EPC.

Order

For these reasons it is decided that:

The appeal of the patent proprietor and the appeal of the opponent are dismissed.

The Registrar: The Chair:

D.Meyfarth R. Bekkering

Decision electronically authenticated