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# Datasheet for the decision of 10 March 2015

**Case Number:** T 0671/10 - 3.4.03

**Application Number:** 03740528.9

**Publication Number:** 1525623

**IPC:** H01L31/101, H01L31/0352, H01L23/48

**Language of the proceedings:** EN

**Title of invention:**
SEMICONDUCTOR STRUCTURE FOR IMAGING DETECTORS

**Patent Proprietor:**
Detection Technology OY

**Opponent:**
HAMAMATSU PHOTONICS K.K.

**Headword:**

**Relevant legal provisions:**
EPC 1973 Art. 56

**Keyword:**
Inventive step - (yes)

**Decisions cited:**

**Catchword:**

Europäisches Patentamt
European Patent Office
Office européen des brevets

**Beschwerdekammern**
**Boards of Appeal**
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**Case Number: T 0671/10 - 3.4.03**

# D E C I S I O N
# of Technical Board of Appeal 3.4.03
# of 10 March 2015

| | |
|---|---|
| **Appellant:** (Patent Proprietor) | Detection Technology OY<br>Micropolis<br>91100 Ii (FI) |
| **Representative:** | Williams, David John<br>Page White & Farrer<br>Bedford House<br>John Street<br>London<br>WC1N 2BF (GB) |
| **Respondent:** (Opponent) | HAMAMATSU PHOTONICS K.K.<br>1126-1, Ichino-cho<br>Higashi-ku<br>Hamamatsu-shi<br>Shizuoka 435-8558 (JP) |
| **Representative:** | Boult Wade Tennant<br>Verulam Gardens<br>70 Gray's Inn Road<br>London WC1X 8BT (GB) |
| **Decision under appeal:** | **Decision of the Opposition Division of the European Patent Office posted on 19 November 2009 revoking European patent No. 1525623 pursuant to Article 101(3)(b) EPC.** |

**Composition of the Board:**

| | |
|---|---|
| **Chairman** | G. Eliasson |
| **Members:** | V. L. P. Frank |
| | T. Bokor |

## Summary of Facts and Submissions

I. This is an appeal by the patent proprietor against the decision of the opposition division to revoke the patent EP 1 525 623 (Article 101(3)(b) EPC).

The patent was opposed in its totality. Grounds of opposition were lack of novelty and inventive step (Articles 100(a), 54 and 56 EPC 1973).

II. At oral proceedings before the board, the appellant proprietor requested that the decision under appeal be set aside and, as sole request, that the patent be maintained in amended form on the basis of the following documents:

Description:
Columns 1,2,9,10 of the patent specification,
Columns 3-8 as filed in the oral proceedings before the board,

Claims: 1-31 of the fourth auxiliary request filed with letter dated 23 December 2010,

Drawings: Figures 1-8 of the patent specification.

The respondent opponent requested that the appeal be dismissed.

III. The independent claims of the appellant's request read as follows (the differences with respect to the claims of the main request before the opposition division are highlighted by the board):

"1. A substrate including a plurality of photodetectors, each photodetector of the

plurality having an active area (32) on a first surface of the substrate and a further active area (40) on the side of a second surface of the substrate, wherein each photodetector of the plurality is provided with an adjacent conductive via (48b) electrically isolated from the substrate, said via extending from the first surface of the substrate to the second surface of the substrate and connecting the active area to the second surface of the substrate, wherein the conductive vias comprise polysilicon, formed on the inner walls of the vias, and wherein there is provided a further conductive element from the side of the first surface of the substrate to the side of the second surface within, **and electrically isolated from**, at least one of the conductive vias, the second surface providing electrical connections (56, 64a) for the active areas and the further active areas of the plurality of photodetectors."

"18. A method of manufacturing a plurality of photodetectors comprising: providing for each of the photodetectors of the plurality an active area (32) on a first surface of a substrate; providing for each of the photodetectors a further active area (40) on the side of a second surface of the substrate; forming for each of the photodetectors an adjacent conductive via (48b) electrically isolated from the substrate, said via extending through the substrate from the first surface of the substrate to the second surface of the substrate; connecting the active areas to the conductive vias such that the active areas are connected to the second surface of the substrate; wherein the conductive vias comprise polysilicon,

the method further comprising the step of forming polysilicon on the inner walls of the vias; providing at least one further conductive element from the first surface of the substrate to the second surface within, **and electrically isolated from**, at least one of the conductive vias; and providing at the second surface electrical connections for the active areas and the further active areas of the plurality of photodetectors."

IV. The following documents are cited in this decision:

D1: JP 2001-318155 and the corresponding English abstract

D3: WO 97/23897 A

D5: JP 63-157439 A and the corresponding English abstract

D5": full English translation of document D5 filed by the appellant proprietor with his letter of 23 December 2010

V. In the decision under appeal, the opposition division found in relation to the main request that:

- Document D3 was considered to be the closest prior art. The claimed substrate differed from the one disclosed in D3 in that via conductive regions (polysilicon and further conductive element) were provided. The objective technical problem was thus to realize the device of D3 with alternative materials to the metallic connection suitable for via connection of the photodetector active areas. At the priority date of the application, the

skilled person knew of polysilicon interconnects as the ones disclosed in D1, commonplace in silicon device processing, which provided advantageous electrical characteristics. Thus the skilled person was prompted to try this alternative compatible with the silicon substrate used in D3. The further conductive element was known from D5 and was applicable to silicon substrates as used in D3. The teaching of D5 of providing higher conductivity vias in silicon substrates was thus immediately transferable to the devices known from D3 and D1. It was immediately evident to the skilled person that the inner wall polysilicon vias of the tiled photodetector of D1 and the multilevel conductive layered element of the silicon substrate device of D5 provided a low resistance easily fabricated via of improved electrical properties and would thus be routinely used to replace the wire or strip via solution of D3. Both the D3 and D5 devices concerned vias in silicon semiconductor substrates. It was thus natural for the skilled person to adopt the D5 multilevel conductor via solution to replace the evidently more difficult to fabricate solution of the D3 wire or strip via. Hence the claimed substrate did not involve an inventive step over a combination of documents D3 and D5.

VI. The appellant proprietor argued essentially as follows:

- Document D3 was considered to be the closest prior art. The substrate according to claim 1 differed from the one disclosed in D3 in that:
  i) each via was adjacent to the corresponding photodetector;

ii) the conductive via comprised polysilicon, formed on the inner walls of the vias; and

iii) a further conductive element was provided within, and electrically isolated from the via.

From the decision under appeal it was clear that the opposition division did not take feature (i) into account, since only features (ii) and (iii) were discussed in their reasoning.

- The objective technical problem could thus be formulated, taking all three differences into account, as to providing additional connections using existing vias through the photodetector substrate.

- The fabrication of photodetectors had specific requirements that went beyond those for general semiconductor devices. The skilled person would for this reason not consider document D5 when looking for a solution to the above stated problem. Documents D5 and D3 were not combinable, since a vertical stacking of substrates, as illustrated in D5, was not suitable for photodetectors. The claim required a 1:1 relation between vias and photodetectors, since a via was required for each photodetector. Document D5 on the contrary had the aim of reducing the number of vias by providing a further electric connection through each via. This allowed and required the increase of the via's diameter. However, in the detector of D3 increasing the via's diameter implied reducing the photodetector's active area, as the via traversed the photodetector.

- Even if documents D3 and D5 would be combined, a photodetector according to claim 1 was not realized, since the via was not adjacent to the photodetector (feature (i)), but lied within the active area of the detector. The claimed substrate had the advantage that the diameter of the via could be freely changed without interfering with the active area of the detector and thus allowed a greater design freedom.

VII. The respondent opponent argued essentially as follows:

- Document D3 should be regarded as the closest prior art. It was contested, however, that D3 could not be combined with document D5, which was not directly concerned with photodetectors, since vias used with photodetector devices served the same purpose, had dimensions of the same order of magnitude and went through the same material as vias in general semiconductor design and manufacturing fields. The skilled person would therefore look at all areas of semiconductor design and manufacturing when looking for a solution for contacting photodetectors.

- Multilayer structures and stacked substrates, as the ones disclosed in D5, were not incompatible with photodiode devices. It was understood that the surface of the substrate directly above the photodiode's active area had to be exposed to the incident radiation. However, there were ways to assure that in multilayer structures these layers did not interfere with the photodetector's active area. Stacked substrates, on the other hand, were also not incompatible with photodetectors provided that the incident radiation was not prevented from

reaching the photodetector, eg by providing the photodetector in the uppermost substrate, while additional circuitry could be provided on the underlying substrates.

- It was also contested that the substrate according to claim 1 specified a 1:1 ratio between photodetectors and vias. Claim 1 did not preclude the possibility that each photodetector was provided with more than one adjacent via. Hence the possibility of a 1:n ratio between photodetectors and conductive vias, with $n \geq 1$, was not excluded.

- Starting from D3 the objective technical problem could be formulated as how to provide multiple electrical connections from the top surface of a photodiode substrate to a bottom surface of the substrate. The skilled person would have immediately recognized that either multiple conductive vias had to be provided or that two or more electrical connections had to be routed through a single conductive via. The second possibility was disclosed by document D5 and the skilled person would not have been prevented from applying it to the photodetector disclosed in D3.

- The argument that according to claim 1 each photodetector was provided with an **adjacent** via was for the first time presented in the oral proceedings before the board. According to Article 12(2) RPBA, however, it should have been presented with the statement of grounds of appeal. This argument took the respondent by surprise and should therefore not be considered by the board.

- Furthermore, the feature that each via was adjacent to the corresponding photodetector was in fact not a differentiating feature between the claimed substrate and the one of D3. The active area of the photodetector 3 was the area on which the radiation was incident. Hence in D3 the conductive via was also "adjacent to" the active area of the detector, since "adjacent" meant next to or adjoining, and this was also the case for the device of D3.

- Hence the skilled person would have incorporated the via structure of document D5 in the device of document D3, arriving at the claimed substrate in an obvious manner.

## Reasons for the Decision

1. The appeal is admissible.

*2. Amendments*

2.1 The feature of claims 1 and 18 that *"there is provided a further conductive element from the side of the first surface of the substrate to the side of the second surface within, and electrically isolated from, at least one of the conductive vias"* is based on [0046] of the patent (page 9, lines 26-28 of the original application). The board is thus satisfied that the requirements of Articles 123(2) and (3) EPC are fulfilled.

2.2 The description was amended to acknowledge documents D3 and D5 and to bring it into concordance with the claims.

*3. Inventive step (Article 56 EPC 1973)*

3.1 The only remaining issue in this appeal is that of inventive step.

3.2 Document D3 discloses in the words of claim 1 (references corresponding to D3 are included):

A substrate 1 including a plurality of photodetectors, each photodetector of the plurality having an active area 6 on a first surface of the substrate and a further active area 5 on the side of a second surface of the substrate, wherein each photodetector of the plurality is provided with a conductive via 31 electrically isolated from the substrate, said via extending from the first surface of the substrate to the second surface of the substrate and connecting the active area to the second surface of the substrate, the second surface providing electrical connections 10, 11 for the active areas and the further active areas of the plurality of photodetectors (cf Figs 1 and 3 with accompanying description).

In document D3 the conductive via 31 is formed in the active area 6 of the photodetector and the electrical connection within the conductive via is achieved by a conductive metallic element 30, eg a wire or a strip conductor ("Leiterbahn") (page 19, last paragraph; Fig. 3).

3.3 The appellant proprietor hence argued that the substrate of claim 1 differed from the substrate disclosed in document D3 in that:

(a) each photodetector was provided with an adjacent via;
(b) the conductive vias comprised polysilicon, formed on the inner walls of the vias; and in that
(c) there was provided a further conductive element from the side of the first surface of the substrate to the side of the second surface within, and electrically isolated from at least one of the conductive vias.

The respondent opponent argued that in document D3 the conductive via was also adjacent to the photodetector. Hence feature (a) mentioned above was not a differentiating feature.

3.4 The board however agrees with the appellant proprietor that the conductive via of document D3 cannot be considered adjacent to the photodetector, since it is clearly shown in Figure 3 of this document that the conductive via is formed within the p-doped Si region 3 belonging to the active area of the photodetector. Although it might be disputable whether in D3 the via is within or **adjacent to the active area** of the photodetector, the board sees no justification for equating the photodetector in claim 1 with its active area. Hence it is without doubt that the via in the device of D3 is not **adjacent to the photodetector**. Hence, in the view of the board, the claimed substrate differs from the substrate disclosed in D3 by the features (a) to (c) mentioned above.

3.5 The respondent opponent further objected that it was only at the oral proceedings before the board that the appellant proprietor stated that the claimed substrate differed from the disclosure of D3 by three features. Feature (a) never played a role or was even mentioned in the proceedings before the opposition division or in appeal. According to Article 12(2) RPBA the statement of grounds of appeal should contain a party's complete case. The board should therefore not take feature (a) into account when assessing inventive step.

3.6 The board considers that although Article 12(2) RPBA states that the statement of grounds of appeal shall specify expressly all the facts, arguments and evidence relied on, this cannot be interpreted in a way that no further arguments may be brought forward later in the proceedings. Such an interpretation would render in particular oral proceedings nearly pointless.

Article 13 RPBA regulates the possibility of amendments to a party's case and sets out criteria how such amendments should be dealt with. It states in particular that amendments sought to be made after oral proceedings have been arranged shall not be admitted if they raise issues which the board or the other party or parties cannot reasonably be expected to deal with without adjournment of the oral proceedings.

The board thus decides under the present circumstances to take the arguments of the appellant proprietor mentioned under point 3.3 above into account, since they are based entirely on facts that were present already in front of the opposition division and were not changed in appeal, ie the unamended features of claim 1 and the disclosure of document D3, and their

consideration does not require an adjournment of the proceedings.

3.7 The appellant proprietor argued that the objective technical problem could be formulated, taking all three differences into account, as how to provide additional electrical connections using the existing vias through the photodetector substrate.

The respondent opponent, on the other hand, argued that the objective technical problem could be formulated as how to provide multiple electrical connections from the top surface of a photodiode substrate to a lower surface of said substrate.

3.8 According to the established practice of the boards of appeal, the objective technical problem is the problem which can be seen to have been actually solved in the light of the closest prior art. Hence all three differences mentioned under point 3.3 have to be taken into account when formulating the objective technical problem, since these three features form the difference between the claimed substrate and the closest prior art, ie document D3.

The board thus considers that the objective technical problem can be formulated as how to provide additional electrical connections from the upper to the lower surface in the conventional device of D3, ie a photodetector array in which the conductive vias are provided within the photodetector.

3.9 Document D5 discloses a p-Si substrate 20 with a front and rear surface 22 and 23, respectively, and a through hole 21. Over the front and rear surface and the inner wall of the through hole extends successively a silicon

dioxide film 25, a polysilicon film 26, a further silicon dioxide film 27 and a further polysilicon film 28. The remaining through hole 21 is filled with a gold layer 29. The polysilicon films 26 and 28 provide thus two independent electrical connections from the front to the rear surface of the substrate (Figures 1 and 2 and the corresponding description).

It is the purpose of document D5 to enable a reduction of the number of through holes or vias and the fine pitch wiring on a surface of the substrate (D5", page 1, "Summary"). By reducing the number of through holes their diameter may be increased, since they can be spaced further apart (D5", page 2, "Operation").

3.10 The appellant proprietor argued that the skilled person would not consider combining the teachings of documents D3 and D5, since D5 required larger diameter vias which would reduce the active area of the photodetector of D3, reducing thus their effectivity.

3.11 The board however considers that this argument is based on an incorrect understanding of the teaching of D5. This document does not require that the diameter of the through holes should be larger, it merely states this as a possibility. By reducing the number of through holes the distance between them is increased and hence larger diameter vias may be considered (D5", page 3, lines 9-11). This is a possibility but not a requirement. Hence the board cannot recognize in the disclosure of D5 a requirement of larger through holes or vias.

3.12 Hence the argument of the appellant proprietor that the skilled person would not consider a combination of documents D3 and D5 must fail, since the board cannot

see any hindrance in combining both documents as suggested by the respondent opponent.

3.13 However, even if the skilled person would have combined the teachings of documents D3 and D5 by replacing the metal interconnect of D3 by polysilicon as in D5 and by providing in the via 31 of D3 a further electrical connection as in D5, the resulting via would still be located within the photodetector and would not be adjacent to it as required by claim 1.

3.14 By moving the via from within the photodetector to a position adjacent to it the skilled person obtains more design freedom for choosing size and shape of the via. The via's diameter may be increased without disturbing the photodetector's active area and thus without compromising its efficiency.

3.15 The board judges for these reasons that the substrate of claim 1 involves an inventive step within the meaning of Article 56 EPC 1973.

As the manufacturing method of claim 18 involves the required manufacturing steps to obtain the substrate of claim 1, in particular positioning the conductive via adjacent to each photodetector, it involves an inventive step for the same reasons as the substrate of claim 1.

4. The appellant's request is thus allowable.

**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 as amended in the following version:

Description:
Columns 1,2,9,10 of the patent specification,
Columns 3-8 as filed in the oral proceedings before the board,

Claims:
1-31 of the fourth auxiliary request filed with letter dated 23 December 2010,

Drawings: Figures 1-8 of the patent specification.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated