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# Datasheet for the decision of 11 May 2017

**Case Number:** T 1774/12 - 3.4.03

**Application Number:** 04822037.0

**Publication Number:** 1741127

**IPC:** H01L31/107

**Language of the proceedings:** EN

**Title of invention:**
PLANAR AVALANCHE PHOTODIODE

**Applicant:**
Picometrix, LLC

**Headword:**

**Relevant legal provisions:**
EPC 1973 Art. 84
EPC Art. 123(2)
RPBA Art. 13(3)

**Keyword:**
Claims - clarity - main request and auxiliary request I (no)
Amendments - added subject-matter - auxiliary request II (yes)
Late-filed auxiliary request - admitted (no)

**Decisions cited:**

**Catchword:**

Europäisches Patentamt
European Patent Office
Office européen des brevets

**Beschwerdekammern**
**Boards of Appeal**
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**Case Number: T 1774/12 - 3.4.03**

# D E C I S I O N
# of Technical Board of Appeal 3.4.03
# of 11 May 2017

| | |
|---|---|
| **Appellant:** (Applicant) | Picometrix, LLC<br>2925 Boardwalk<br>Ann Arbor, MI 48104 (US) |
| **Representative:** | Patent- und Rechtsanwälte<br>Dr. Solf & Zapf<br>Candidplatz 15<br>81543 München (DE) |
| **Decision under appeal:** | **Decision of the Examining Division of the European Patent Office posted on 28 March 2012 refusing European patent application No. 04822037.0 pursuant to Article 97(2) EPC.** |

**Composition of the Board:**

| | |
|---|---|
| **Chairman** | G. Eliasson |
| **Members:** | M. Papastefanou |
| | T. Karamanli |

## Summary of Facts and Submissions

I. The appeal is against the decision of the examining division refusing European patent application No. 04 822 037 (published as WO 2005/114712) on the grounds of lack of clarity (Article 84 EPC) and lack of novelty (Article 54(1) and (2) EPC) with regard to main request and auxiliary request 1, and unallowable added subject matter within the meaning of Article 123(2) EPC with regard to auxiliary request 2.

II. From the documents referred to during the first-instance examination proceedings, the following document is cited in this decision:

D1: US 2003/226952 A1.

III. The applicant (appellant) appealed against this decision and with the statement of grounds of appeal submitted claims of a Main Request and of Auxiliary Requests I and II which corresponded to those requests underlying the decision under appeal.

IV. In a communication pursuant to Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA), which was annexed to the summons to oral proceedings, the board communicated its preliminary, non-binding opinion, according to which it shared the conclusions of the examining division regarding lack of clarity of claim 1 of the Main Request and Auxiliary Request I and unallowable added subject matter in claim 1 of Auxiliary request II.

V. In a letter dated 8 May 2017 and received two days before the oral proceedings the appellant presented

arguments supporting the clarity of claim 1 of the Main Request and Auxiliary Request I. It did not present any comment on the further objections raised in the board's communication.

VI. Oral proceedings were held before the board on 11 May 2017.

The appellant submitted amended claims 1 to 12 of a new Auxiliary Request III.

The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims of the Main Request filed with the statement of the grounds of appeal or, as an auxiliary measure, of one of Auxiliary Requests I or II, both requests filed with the statement of grounds of appeal, or Auxiliary Request III filed during the oral proceedings.

VII. In its submissions, the appellant referred to the first communication pursuant to Article 94(3) EPC of the examining division dated 9 July 2009.

In section 4, entitled "Conclusion", the examining division indicated that: *"The subject-matter of independent claim 1 restricted to the embodiment shown in figure 11 of the present application seems to be allowable if in the independent claim the remaining diode structure could be clearly distinguished from the planar avalanche photodetector structure known from document D1.*
*The applicant is therefore invited to file new claims which take account of the above comments."*

In the same communication, in point 1.1 (pages 1 and 2), the examining decision objected, among others, that the subject-matter of claims 1 and 13 was not new with regard to document D1.

VIII. Independent claim 1 of the Main Request reads as follows (emphasis by the board):

*A planar avalanche photodiode (10, 110) comprising:*
*a first semiconductor layer (28);*
*a first contact layer (26), the first contact layer (26) being on the first semiconductor layer (28);*
*a second semiconductor layer (16) having a diffusion region (14) or an edged mini-mesa structure (32) of a semiconductor layer on the second semiconductor layer (16), the diffusion region (14) and the mini-mesa structure (32) having a smaller area than the second semiconductor layer (16);*
*a semiconductor multiplication layer (24) positioned between the first and second semiconductor layers (28, 16);*
*a semiconductor absorption layer (20) positioned between the semiconductor multiplication layer (24) and the second semiconductor layer (16);*
*a second contact layer (12);*
*wherein the diffusion region (14) is positioned adjacent to the second contact layer (12);*
*a charge control layer (22), the charge control layer being located between the semiconductor absorption layer (20) and the semiconductor multiplication layer (24), the charge control layer (22) having substantially uniform thickness and an area larger than the diffusion region (14); and*
***wherein the photodiode (10) has a low capacitance and a low field near the edges of the absorption and multiplication layers (20, 24).***

IX. Claim 1 of Auxiliary Request I reads as follows (emphasis by the board):

*A planar avalanche photodiode (10, 110) comprising:*
*a first semiconductor layer (28);*
*a first contact layer (26), the first contact layer (26) being on the first semiconductor layer (28);*
*a second semiconductor layer (16) having a diffusion region (14) or a mesa structure (32) of a semiconductor layer on the second semiconductor layer (16), the diffusion region (14) or the mesa structure (32) having a smaller area than the second semiconductor layer (16);*
*a semiconductor multiplication layer (24) positioned between the first and second semiconductor layers (28, 16);*
*a semiconductor absorption layer (20) positioned between the semiconductor multiplication layer (24) and the second semiconductor layer (16);*
*a second contact layer (12);*
*wherein the diffusion region (14) is positioned adjacent to the second contact layer (12);*
*a charge control layer (22), the charge control layer being located between the semiconductor absorption layer (20) and the semiconductor multiplication layer (24), the charge control layer (22) having substantially uniform thickness and an area larger than the diffusion region (14); and*
***wherein the electric field near the edges of the absorption layer (20) is negligible.***

X. Claim 1 of Auxiliary Request II reads as follows (emphasis by the board):

*A planar avalanche photodiode (10, 110) comprising:*

*a first semiconductor layer (28);*
*a second contact layer (26), the second contact layer (26) being on the first semiconductor layer (28);*
*a second semiconductor layer (16) having a diffusion region (14) having a smaller area than the second semiconductor layer (16) or a mini-mesa structure (32) of a semiconductor layer on the second semiconductor layer (16);*
*a semiconductor multiplication layer (24) positioned between the first and second semiconductor layers (28, 16);*
*a semiconductor absorption layer (20) positioned between the semiconductor multiplication layer (24) and the second semiconductor layer (16);*
*a first contact layer (12);*
*wherein the diffusion region (14) is positioned adjacent to the first contact layer (12);*
*a charge control layer (22), the charge control layer being located between the semiconductor absorption layer (20) and the semiconductor multiplication layer (24); and*
***wherein the electric field near the edges of the absorption layer (20) is zero.***

XI. Claim 1 of Auxiliary Request III reads as follows:

*A planar avalanche photodiode (410) comprising:*
*a first contact layer (12);*
*a first semiconductor layer (28) defining a second contact layer;*
*a second semiconductor layer (16) with a diffusion region (14),*
*the diffusion region (14) having a smaller area than the second semiconductor layer (16) and being positioned adjacent to the first contact layer (12);*

*a semiconductor multiplication layer (24) positioned between the first and second contact layers; and a semiconductor absorption layer (20) positioned between the semiconductor multiplication layer (24) and the second semiconductor layer (16), wherein the diffusion region (14) has a p-doped hole concentration extending into the semiconductor absorption layer (20) in a decreasing manner to create a pseudo field, enhance electron transport, and decrease hole collection time.*

## Reasons for the Decision

1. Main Request (Article 84 EPC 1973)

1.1 In the last feature of claim 1 it is defined that the photodiode (10) has a **low capacitance** and a **low field** near the edges of the absorption and multiplication layers (20, 24) (emphasis by the board). The terms "low field" and "low capacitance" are relative terms and they have no specific meaning as to the values of the field and the capacitance near the edges of the layers. The skilled person would not be in a position to know which values for the capacitance and the field are to be considered as low. This feature is, hence, unclear.

1.2 The applicant argued that, in case some terms in the claims were not clear, the skilled person would look into the description and the drawings of the application to find clear definitions for them. From Figures 3 and 4, it was clear that low capacitance meant capacitance less than 0.25 pF. In the same way, it was clear from Figures 5 and 7 that low field meant less than 600 kV/cm for the multiplication layer (Figure 5) and less than 10 kV/cm for the absorption

layer (Figure 7). The person skilled in the field of semiconductors would thus be in a position to define clearly the terms in the claim.

1.3 The board is not convinced by these arguments. According to Article 84 EPC 1973, the claims must be clear in themselves and there should be no need to refer to the description to find clear definitions of the claimed features. The specific values of the capacitance and the electric field that are presented in Figures 3, 4, 5 and 7 of the application were results of measurements carried out in specific embodiments of the claimed photodiode. A specific embodiment implies a particular selection of materials for the layers and a particular set of dimensions and dopant concentrations for each layer and there is no indication about material(s), dimensions or dopant concentrations in claim 1, which provides a general definition of the photodiode of the invention. Therefore, even if reference to the Figures were made, the presented values could not be considered as being generally applicable as thresholds for the low capacitance and the low field of claim 1.

1.4 The conclusion is that claim 1 of the Main Request does not meet the requirement of clarity under Article 84 EPC 1973.

2. Auxiliary Request I (Article 84 EPC 1973)

2.1 In the last feature of claim 1 of Auxiliary Request I, it is defined that the electric field near the edges of the absorption layer is **negligible** (emphasis by the board). The term "negligible" has no specific meaning with regards to the value of the electrical field in this context and, therefore, it is not clear for the

skilled person which values for the electric field should be considered as being "negligible". Hence, this feature is unclear.

2.2 The appellant argued again that from Figure 7 of the application the skilled person would understand that any value of the electrical field under 10KV/cm is to be considered as negligible in the context of the application. The skilled person would be in a position to define clearly what was meant by negligible field.

2.3 The board does not agree with the appellant. Apart from the fact that the claim must be clear in itself, the values presented in Figure 7 cannot be seen as generally applicable values for defining the term "negligible" for the same reasons as for the Main request, see paragraph 1.3 above.

2.4 The conclusion is that claim 1 of Auxiliary Request I does not meet the requirement of clarity under Article 84 EPC 1973.

3. Auxiliary Request II (Article 123(2) EPC)

3.1 In claim 1 of Auxiliary Request II it is defined that the electric field near the edges of the absorption layer is **zero** (emphasis by the board). As a basis for this feature the appellant pointed to paragraph [0040] of the description as well as Figure 7 of the application as published.

3.2 The Board notes that the passage in paragraph [0040] of the description, which the applicant referred to, states that the electric field at the edge the absorption layer is *negligible* and that there is no mention of any specific numeric value for the electric

field. In Figure 7, it appears that the value of the electric field drops to a value close to zero as the distance from the centre of the absorption region increases. The scale in the y-axis, however, is rather large and, hence, it is not directly and unambiguously derivable that the value of the electric field indeed becomes zero. Moreover, reading the application as a whole, the skilled person would understand that the particular structure and order of the layers in the photodiode provide for a low field at the top side of the photodiode and consequently for relatively low values of the electric field at the edge of the absorption layer, see for example paragraphs [0036], [0039], [0040] or [0048] and Figure 8. From these explanations, it is not directly and unambiguously derivable for the skilled person, however, that the value of the electric field actually drops to zero at the edge of the absorption layer.

3.3 The appellant did not provide any additional arguments on this matter during the oral proceedings before the board.

3.4 The conclusion is that claim 1 of Auxiliary Request II does not comply with Article 123(2) EPC.

4. Auxiliary Request III, Admission

4.1 According to Article 13(1) RPBA, any amendment to a party's case after it has filed its grounds of appeal may be admitted and considered at the board's discretion. The discretion is to be exercised in view of inter alia the complexity of the new subject-matter submitted, the current state of the proceedings and the need for procedural economy. According to Article 13(3) RPBA, amendments sought to be made after oral

proceedings have been arranged shall not be admitted if they raise issues which the board cannot be reasonably be expected to deal with without adjournment of the oral proceedings.

4.2 The amended claims according to Auxiliary Request III were filed for the first time during the oral proceedings before the board. Hence, they constitute amendments to the appellant's case within the meaning of Article 13(1) RPBA and consequently may be admitted and considered at the board's discretion. Furthermore, the board's discretion is limited pursuant to Article 13(3) RPBA.

4.3 The appellant argued that all the features of the higher ranking requests, which had been objected under Article 84 EPC 1973 and Article 123(2) EPC were absent from the claims of this request. Moreover, claim 1 was based on subject-matter which could be considered allowable as had been indicated by the examining division in its first communication (see paragraph VII above). The appellant further explained that the subject-matter of claim 1 was essentially a combination of original claims 1 and 13 with minor amendments. However, there were no additional features taken from the description and thus no additional search would be necessary.

4.4 The board notes that, in its first communication, the examining division had concluded in point 1.1 that the subject-matter of both claims 1 and 13 was not new with respect to document D1. Furthermore, the passage in the examining division's communication, which the appellant referred to, implies that further amendments would have been necessary beyond a mere combination of claims 1 and 13 in order to arrive at an allowable claim.

4.5 The appellant further argued that the examining division had interpreted the teaching of D1 wrongly and offered to explain the disclosure of D1 in detail, if this was considered to be necessary.

4.6 From the file of the first-instance proceedings, it can be asserted that, in reaction to the first communication by the examining division, the applicant deleted claim 13 and the subject-matter it contained from the requests subsequently filed during the examination proceedings. The examining division was thereby prevented from giving a reasoned decision on the subject-matter of original claim 13 alone or in combination with, for example, original claim 1, in particular on its objection of lack of novelty in view of document D1. By filing for the first time in appeal proceedings a set of claims, of which claim 1 essentially comprises a combination of original claims 1 and 13, the appellant has presented the board with subject-matter on which no formal decision was taken by the department of first instance. This means that if the board decided to admit Auxiliary Request III, it would be compelled either to give a first ruling on the issue of novelty in view of document D1, a task incompatible with its primary role, namely the examination of the contested decision, or to remit the case to the department of first instance, which would considerably delay the proceedings and thus go against procedural economy.

4.7 In addition, during the appeal proceedings the appellant had not filed any requests with claims related to the subject-matter of original claim 13 nor had it indicated any errors in the examining division's interpretation of D1 until the submission of Auxiliary

Request III during the oral proceedings before the board, i. e. at a very late stage of the appeal proceedings. The board, therefore, could not reasonably have been expected to deal with any of these issues for the first time during the oral proceedings and it was thus not in a position to deal with them without adjourning the oral proceedings or remitting the case to the department of first instance.

4.8 Consequently, Auxiliary Request III was not admitted into the appeal proceedings in accordance with Article 13(1) and (3) RPBA.

5. Since none of the appellant's request is allowable, the appeal has to be dismissed.

**Order**

**For these reasons it is decided that:**

The appeal is dismissed.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated