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**Datasheet for the decision  
of 12 January 2023**

**Case Number:** T 3069/19 - 3.4.03

**Application Number:** 14197959.1

**Publication Number:** 2950346

**IPC:** H01L27/146, H01L31/112,  
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H01L27/148

**Language of the proceedings:** EN

**Title of invention:**

Semiconductor radiation detector with a modified internal gate structure

**Applicant:**

Aurola, Artto

**Headword:**

**Relevant legal provisions:**

EPC Art. 123(2)  
RPBA 2020 Art. 13(1), 13(2)

**Keyword:**

Amendments - extension beyond the content of the application  
as filed (yes) - intermediate generalisation

Amendment to appeal case - amendment overcomes issues raised  
(no)

Amendment after summons - exceptional circumstances (no)

**Decisions cited:**

G 0001/03, T 0191/04, T 0461/05, T 0219/09, T 0879/09,  
T 1944/10, T 2311/10

**Catchword:**



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Case Number: T 3069/19 - 3.4.03

**D E C I S I O N**  
**of Technical Board of Appeal 3.4.03**  
**of 12 January 2023**

**Appellant:** Aurola, Artto  
(Applicant) Haltijatontuntie 11 B 6  
02200 Espoo (FI)

**Representative:** Berggren Oy  
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**Decision under appeal:** **Decision of the Examining Division of the  
European Patent Office posted on 24 June 2019  
refusing European patent application No.  
14197959.1 pursuant to Article 97(2) EPC.**

**Composition of the Board:**

**Chairman** T. Häusser  
**Members:** A. Böhm-Pélissier  
T. Bokor

## **Summary of Facts and Submissions**

I. The appeal is against the decision of the examining division to refuse patent application No. 14 197 959. The refusal was based on the objections of lack of unity of the invention (Article 82 EPC), added subject-matter (Article 123(2) EPC), lack of clarity and lack of novelty (Articles 84, 52(1), 54(1) and (2) EPC).

II. Reference is made to the following **documents**:

D1 = JP 61 214465 A

D2 = US 4 518 863 A

D3 = DE 33 45 176 A1

D4 = J. Nishizawa et al: "Static Induction Transistor Image Sensors", IEEE Transactions on Electron Devices, vol. 26, no. 12, 1 December 1979, pages 1970-1977, XP055007801

D5 = US 4 639 753 A

D6 = NEESER W et al: "DEPFET - a pixel device with integrated amplification", Nuclear Instruments and Methods in Physics Research A, ELSEVIER BV NORTH-HOLLAND, NL, vol. 477, no. 1-3, 21 January 2002 (2002-01-21), pages 129-136, XP004345526

III. The appellant (applicant) **requests** that the decision under appeal be set aside, and a patent be granted on the basis of claims 1-13 of the main request filed with letter dated 12 July 2017, or one of the 1<sup>st</sup> or 2<sup>nd</sup> auxiliary requests filed with letter dated 12 December 2022 (in reply to the communication under Article 15(1) RPBA 2020) or on the basis of the 3<sup>rd</sup>

auxiliary request filed during oral proceedings before the board.

IV. The wording of **claim 1** according to the **main request** and the **1<sup>st</sup> auxiliary request** is as follows (labelling (A), (B), ... introduced by the board):

(A) A semiconductor radiation detector device, comprising:

(B) - a conductive backside layer (102) and

(C) - a bulk layer (103) of a semiconductor material, and

(D) on a surface of the bulk layer (103) opposite to the conductive backside layer (102), in the following order:

(E) - a layer (104) of semiconductor material of second conductivity type, hereinafter referred to as the modified internal gate layer,

(F) - a layer (105) of semiconductor material of first conductivity type, hereinafter referred to as the barrier layer, and

(G) - pixel dopings (111, 112, 506, 511, 512) of semiconductor material of the second conductivity type, adapted to be coupled to at least one pixel voltage in order to create pixels corresponding to pixel dopings,

(H) said pixel voltage being defined as a potential difference to a potential of the conductive backside layer (102),

(J) characterized in that in response to applying the at least one pixel voltage the semiconductor radiation detector device is adapted to:

(K) - form three-dimensional potential energy minima for signal charges in the modified internal gate layer, and

(L) - form three-dimensional potential energy saddle points for both signal and secondary charges in the barrier layer.

V. **Claim 1** according to the **2<sup>nd</sup> auxiliary request**

Feature (J) of claim 1 of the main request was modified to:

(J2) characterized in that in the semiconductor radiation detector device the barrier layer (105) in between the pixel dopings (102) and the modified internal gate layer (104) does not correspond to a base of a bipolar transistor or to a channel of a field effect transistor, and in response to applying the at least one pixel voltage the semiconductor radiation detector device is adapted to:

VI. **Claim 1** according to the **3<sup>rd</sup> auxiliary request**

The following features were added to claim 1 of the 2<sup>nd</sup> auxiliary request (features in alphabetical order):

(I) - a channel stop doping (115, 116, 515, 516) of semiconductor material of the first conductivity type surrounding the pixel dopings (115, 116, 515, 516),

(M) wherein the three-dimensional potential energy saddle points for both signal and secondary charges in the barrier layer coincides with respective pixel dopings (111, 112, 506, 511, 512).

VII. The appellant **argued** essentially as follows:

(a) Main request to 3<sup>rd</sup> auxiliary request - added subject matter

The application as a whole - and in particular the figures - disclosed the amendments in claim 1 of the requests, i.e. features (I), (J2), (K), (L) and (M). The definition of the layer structure (features (A) to (H)) implied the sufficient definition of the minima and the saddle points (features (K) and (L)). The description as a whole supported the teaching. The special structure of the modified internal gate layer (MIG), such as doping and other structural features, made the formation of the saddle points possible. An angled arrangement was not realistic. The structure also worked without doped channel stop regions, these were disclosed to be optional. The channel stops could also be floating and needed not be biased, though this was preferred. Therefore, the channel stops or the channel stop voltage did not need to be claimed. For the invention to work, the doping needed to be properly distributed, both in depth and laterally, in addition to the proper amount of doping. The doping profile was crucial and the dopings in the MIG layer defined effectively the saddle point. The saddle points were formed near the pixel edges and therefore required a specific pixel structure, i.e. suitable pixel boundaries.

(b) 1<sup>st</sup> to 3<sup>rd</sup> auxiliary request - admission

These requests should be admitted into the proceedings because they addressed new objections raised by the board in its communication under Article 15(1) RPBA 2020. The amendments were a reaction to the issues raised. The applicant had repeatedly been surprised by the examining division's new arguments, while consistently trying

to overcome the objections. The appellant had only at the hearing arrived in a situation where it was able to address well-founded objections.

Feature (J2): This negative feature was necessary for distinguishing the invention over the prior art and it was the only realistic possibility to distinguish the subject-matter of claim 1 over D1 to D6 and in particular over D5 and D6. Feature (J2) was clearly limiting with respect to these documents. All embodiments in the application were according to the negative feature and the skilled person would clearly deduce this negative feature from the totality of the figures.

Features (I) and (M): Basis for these features was provided by all the embodiments and the corresponding figures. The absence of the channel stops and the location of the saddle points were not objected to earlier. Therefore, the objection could not have been anticipated.

## **Reasons for the Decision**

### **1. The invention as claimed**

- 1.1 The present invention concerns a phototransistor and in particular the way in which the differently doped semiconductor regions are arranged with respect to each other in the transistor and how their electric potentials are arranged.
- 1.2 In general signal charges are collected by heavily doped regions (electrodes) that are throughout at the same potential, i.e. there is no undulating potential profile present in these doped regions. The stated aim



of the invention is to reduce the influence of leakage current and surface charges on the generated signal and to maximise the performance (page 1, lines 7 to 11, page 5, lines 12 to 16, page 11, last paragraph of the description).

- 1.3 As a solution, the present invention proposes isolating the charges by means of pixel dopings, a barrier layer and a modified internal gate layer (MIG), wherein three-dimensional potential energy saddle points for both signal and secondary charges are formed in the barrier layer and three-dimensional potential minima for signal charges are formed in the MIG layer. This provides very low sense node capacitance and enables non-destructive read-out of the signal charges.

**2. Main request - Article 123(2) EPC**

- 2.1 According to established case law (T 219/09, point 3.1 of the Reasons; T 1944/10, point 3.2 of the Reasons), it is normally not allowable to base an amended claim on the extraction of isolated features from a set of features originally disclosed only in combination, e.g. a specific embodiment in the description or drawings of the original application. Amended subject-matter that amounts to a generalisation of a particular embodiment disclosed in the original application but is still more specific than the original definition of the invention in general terms (claim 1) is called an "intermediate generalisation" (see e.g. T 191/04, point 2.2 of the Reasons; T 2311/10, points 2.3 and 2.4 of the Reasons) and sometimes an "intermediate restriction" (T 461/05, point 2.3 of the Reasons; T 879/09, point 2.1.2 of the Reasons; see "Case law of the Boards of Appeal of the European Patent Office", 10<sup>th</sup> edition 2022, II.E.1.9).

2.2 The board agrees with the examining division (section 3.1 of the communication dated 4 January 2019 referred to in the decision under appeal) that the amendments (in particular features (K) and (L)) filed with the letter dated 12 July 2017 introduces subject-matter which extends beyond the content of the application as filed due to an intermediate generalisation, contrary to Article 123(2) EPC:

2.3 Features (K) and (L) are taken from the embodiment of Figs. 1 to 3.

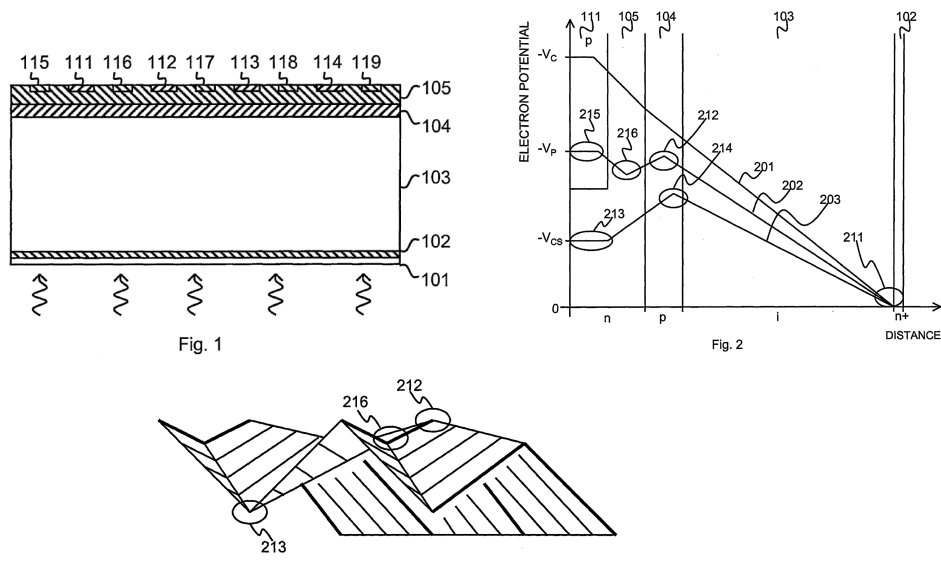


Fig. 1

Fig. 2

Fig. 3

### Application

2.4 Figs. 2 to 3 are explicitly described as showing the resulting signals of the device disclosed in Fig. 1 (page 10, lines 3 to 7; page 11, lines 4 to 8). Consequently, generalizing a potential energy behaviour without the context of the layer structure of Fig. 1 (doping types of layers 111 - 119, 105, 104, 103, 102, channel stop implants, channel stop voltage  $V_{cs}$ , the voltage potentials applied, the exact location and orientation of the potential energy function, etc.) amounts to an inadmissible intermediate generalisation.

2.5 Isolating a specific (functional) feature (forming saddle point/minima in the three-dimensional potential energy distribution) from the context of a specific embodiment (Figs. 1 to 3) requires a basis in the application as originally filed. For instance it has to be explicitly or implicitly disclosed that the features being in relation to the isolated feature are optional or do not influence said isolated feature. Figs. 1 to 3 and the corresponding description however disclose that the potential behavior is a direct result of the structure and that a change in the structure or biasing voltage influences the energy potential characteristic of Fig. 2. The channel stop implants are optional according to the description, page 9, lines 19 to 25. However, the channel stops are necessary to create points 212 and 216 discussed according to Fig. 2 and referred to in claim 1 (minima, saddle points).

2.6 As submitted by the appellant

- (i) layer form and layer thickness,
- (ii) kind (p, n), type (B, Sb or P), amount, structure and structure size of the doping,
- (iii) pixel stop structure and size,
- (iv) channel stop structure and size,
- (v) biasing voltages ( $|V_C| > |V_P| > |V_{CS}|$ )

are all interrelated and require very complex parameter setting and simulations, which can take several years to optimize until the desired potential structure with saddle point and minima is achieved. Given this interrelationship of structural features and potentials, the complex interweaving of parameters leading to the potential behavior shown in Fig. 2 cannot be generalized and simplified to the (functional) features to form "three-dimensional potential energy minima for signal charges in the

modified internal gate layer" and "three-dimensional potential energy saddle points for both signal and secondary charges in the barrier layer" in the context of the preamble of claim 1 in which only five layers/ pixel regions are defined (102-105, 111-112).

2.7 Amended claim 1 refers to minima for signal charges in the MIG layer 104 (maxima 212 being minima for holes) and saddle points (216 in Fig. 2) in the barrier layer 105. Points 213 to 214 and 216 are formed by a specific structure (Fig. 1) and by potentials  $V_C$ ,  $V_P$  and  $V_{CS}$  with specific interrelation to each other ( $|V_C| > |V_P| > |V_{CS}|$ ). Therefore, it would be necessary to introduce the specific context of the embodiment shown in Figs. 1 to 3 into claim 1. However, claim 1 lacks the following features:

- (a) pixel structure: the saddle point is formed by a pixel structure with defined edges (pixel structure shown in Figs. 1 and 2);
- (b) channel stops: structure and biasing applied;
- (c) location/alignment of saddle points/minima: the potential energy saddle points (216) for signal/secondary charges are formed in the barrier layer 105 along a line (curve 202) extending perpendicularly from a pixel doping to the backside layer (having a pixel voltage  $V_P$  between the pixel and the biased backside layer); the potential energy minima (212) for signal charges are formed in the MIG layer 104 along a line extending (curve 202) perpendicularly from a pixel doping to the biased backside layer;
- (d) the potentials  $V_P$ ,  $V_C$  and  $V_{CS}$  forming the minima/saddle point have to fulfil the condition  $|V_C| > |V_P| > |V_{CS}|$ .

2.8 Furthermore, claim 1 is not even limited to minima/saddle points lying on a conceptual line perpendicular to the surface of the device starting at the pixel locations, but any angle of the conceptual line is covered by the wording of the claim. Even though, according to the appellant, the creation of minima/saddle points on an oblique conceptual line would require considerable effort, this would nevertheless appear technically possible and is not excluded by the wording of claim 1. However, there is no disclosure of this option in the application as filed.

2.9 Therefore, features (K) and (L) in their broad meaning, i.e. in the context of only features (A) to (H) and (J), are not directly and unambiguously derivable from the application as filed, in particular Figs. 1 to 3 and page 8, line 31 to page 11, line 37 and cannot be isolated from this context without amounting to an inadmissible intermediate generalisation. Consequently, the subject-matter of claim 1 of the main request extends beyond the content of the application as filed and the requirements of Article 123(2) EPC are not met.

3. **Admission of 1<sup>st</sup> to 3<sup>rd</sup> auxiliary request - Articles 13(1) and (2) RPBA 2020**

3.1 **Cogent reasons and exceptional circumstances**

3.1.1 Any amendment to a party's appeal case made after notification of a summons to oral proceedings shall, in principle, not be taken into account unless there are exceptional circumstances, which have been justified with cogent reasons by the party concerned (Article 13(2) RPBA 2020). The board shall exercise its discretion in view of, *inter alia*, the current state of the proceedings, the suitability of the amendment to

resolve the issues which were raised by the Board, whether the amendment is detrimental to procedural economy, and, in the case of an amendment to a patent application, whether the party has demonstrated that any such amendment, *prima facie*, overcomes the issues raised by the Board and does not give rise to new objections (Article 13(1) RPBA 2020).

3.1.2 The objection of an intermediate generalisation was discussed by the examining division in the impugned decision and was maintained by the board in its communication under Article 15(1) RPBA 2020. Since the board did not raise any new objection with respect to Article 123(2) EPC (intermediate generalisation), it cannot accept that the arguments of the appellant would identify exceptional circumstances within the meaning of Article 13(2) RPBA 2020.

### **3.2 Article 123(2) EPC**

3.2.1 Furthermore, the board *prima facie* has doubts whether the 1<sup>st</sup> to 3<sup>rd</sup> auxiliary request comply with the requirements of Article 123(2) EPC:

3.2.2 For the 1<sup>st</sup> auxiliary request the reasoning of section 2. above applies directly because claim 1 of this request is identical to claim 1 of the main request.

3.2.3 The amendments made to claim 1 of the 2<sup>nd</sup> and 3<sup>rd</sup> auxiliary requests *prima facie* do not overcome the objection under Article 123(2) EPC against claim 1 of the main request since the specific context of the embodiment shown in Figs. 1 to 3 is still not specified. Furthermore, the appellant could not indicate any specific basis for features (I), (J2) and (M). In particular, the negative feature (J2) has no

literal, implicit or explicit basis in the application. The feature that the barrier layer does not correspond to a base of a bipolar transistor or to a channel of a field effect transistor cannot be deduced from the mere absence of such transistors in the drawings of the application.

The conditions for a disclaimer according to G 1/03 (headnote) are not fulfilled, either, because none of D1 to D6 is a document under Article 54(3) and (4) EPC or one that could be regarded as an accidental anticipation under Article 54(2) EPC. The negative feature also does not relate to subject-matter which is excluded from patentability for non-technical reasons.

Consequently, the subject-matter of claim 1 of the 1<sup>st</sup> to 3<sup>rd</sup> auxiliary request *prima facie* does not fulfill the requirements of Article 123(2) EPC.

### **3.3 Conclusion**

In view of the above the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> auxiliary requests are not admitted into the proceedings under Article 13(1) and (2) RPBA 2020.

### **4. Summary**

Since claim 1 of the main request was amended in such a way that it contains subject-matter which extends beyond the content of the application as filed and the 1<sup>st</sup> to 3<sup>rd</sup> auxiliary requests were not admitted into the proceedings the examining division's decision refusing the application is confirmed. Consequently the appeal has to be dismissed (Articles 97(2) and 111(1) EPC).

**Order**

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

The appeal is dismissed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

T. Häusser

Decision electronically authenticated