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Datasheet for the decision of 21 November 2007

Case Number: T 1050/04 - 3.4.03

Application Number: 99124797.4

Publication Number: 1001469

IPC: H01L 31/02

Language of the proceedings: EN

Title of invention:
Forming contacts on semiconductor substrates for radiation detectors and imaging devices

Applicant:
IPL INTELLECTUAL PROPERTY LICENSING LIMITED

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (no)"

Decisions cited:
-

Catchword:
-

Case Number: T 1050/04 - 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 21 November 2007

Appellant: IPL INTELLECTUAL PROPERTY LICENSING LIMITED
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 23 March 2004 refusing European application No. 99124797.4 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. G. O'Connell
Members: G. Eliasson
U. Tronser

Summary of Facts and Submissions

I. This is an appeal against the refusal of application 99 124 797 for lack of inventive step with respect to the prior art documents

D1: JP 02 232 978 A and corresponding Abstract in English; and

D4: US 4 369 458 A.

II. The appellant applicant requests that the decision under appeal be set aside and a patent granted on the basis of claims 1 to 13 of "Set A" as a main request, or as an auxiliary request, on the basis of claims 1 to 12 of "Set B", both filed with the statement of grounds of appeal.

III. Claim 1 of the main request reads as follows:

"1. A method of manufacturing a radiation detector having a plurality of conductive detector cell contacts on a first surface of a semiconductor radiation detector substrate at positions for defining radiation detector cells and a layer of conductive material on a second surface of said substrate opposite to said first surface, said substrate being formed from cadmium zinc telluride or cadmium telluride semiconductor material for detecting X-rays, γ-rays or β-rays, and said cell contacts being suitable for flip-chip bonding with corresponding cell contacts on another substrate so as to form electrical connection therebetween, wherein said method includes steps of forming said contacts on said first surface, the method including the steps of:

a) forming a layer of passivation material directly on said first surface of said substrate with openings to said substrate surface at said contact positions;

b) applying a metal layer over said passivation layer and directly on said first surface in said openings in a single layering process; and

c) selectively removing portions of said metal layer overlaying said passivation layer using a metal etchant so as to form individual detector cell contacts from remaining metal, wherein the contacts cover the openings and also extend up and laterally beyond the openings."

IV. Claim 1 of the auxiliary request differs from that of the main request in that step c) reads as follows (insertions bold, deletions struckthrough):

"c) selectively removing portions of said metal layer overlaying said passivation layer ~~using a metal etchant~~ so as to form individual detector cell contacts from remaining metal, wherein the contacts cover the openings and also extend up and laterally beyond the openings **such that individual detector cell contacts are of the**

order of 10 μm across with spacing between adjacent cell contacts of the order of 5 μm."

V. The appellant applicant presented essentially the following arguments in support of his requests:

(a) In contrast to the claimed device, the contacts of the device of document D1 finished abruptly at the organic film/metal interface. The technical problem having regard to document D1 should thus be formulated as preventing material from seeping into the electrode/organic layer interface, thereby preventing the resistance between contacts from being reduced.

(b) Contrary to the teaching of the present invention, document D1 explicitly taught in relation to Figure 3d the direct application of an organic etchant to the semiconductor substrate.

(c) A combination of documents D1 and D4 was not realistic as the device of document D4 was for detecting *infrared* light and hence the CdTe substrate was *transparent* in this light range. Furthermore, document D4 taught using featured dielectric layers made of silicon dioxide or nitride whereas document D1 taught away from using inorganic passivation layers.

Reasons for the Decision

1. The appeal is admissible.

2. *Inventive step - main request*

2.1 Document D1 is considered closest prior art as it relates to a radiation detector for detecting X-rays and having a substrate made of CdTe. In the method of manufacturing the radiator detector, a passivation layer 21 made of an organic insulator is formed on a first surface of the substrate 11 with openings 25 exposing the substrate at the contact positions (Figures 10 and 11(a) and (b)). As shown in Figure 11(c), a first metal layer 23 is selectively formed in the openings 25 of the passivation layer to form metal contacts 23. According to the appellant applicant, the method used for depositing the first metal layer 23 is "electroless plating" which indeed is a well-known method for selective deposition of metal layers.

A second metal layer 27 is formed over the passivation layer 22 and the metal contacts 23. Contact pads 27 over the metal contacts 23 are formed by patterning the second metal layer using a photolithographic method. The resulting contact pads 27 extend laterally beyond the metal contacts 23 and thereby beyond the corresponding openings 25.

2.2 The board agrees with the opinion of the examining division that the contact pads 25 should be regarded to be suitable for flip-chip bonding, which the appellant applicant has not contested in the appeal procedure.

2.3 The method of claim 1 of the main request thus differs from that of document D1 in that (a) a metal layer is formed over the passivation layer and on the first surface exposed in the openings in a single layering process, followed by the step of selectively removing portions of the (single) metal layer using a metal etchant so as to form individual detector cell contacts from remaining metal. In the method of document D1, a first metal layer is selectively formed on the first surface exposed in the openings of the passivation layer, followed by the step depositing a second metal layer on the passivation layer and the first metal layer in the openings, and selectively removing portions of the second metal layer overlaying the passivation layer.

2.4 The appellant applicant argued that the method of document D1 had the disadvantage that since the contacts finished abruptly at the organic film/metal interface, material could seep between the electrode/organic layer interface causing a reduction of the resistance between contacts (item V(a) above).

2.4.1 This argument fails to take into account that the organic passivation layer/metal layer interface 22/23 at the contact openings is never exposed but is covered by the second metal layer 27 (see Figures 10, 11(d) and 12(f)). Therefore, the problem suggested by the appellant applicant does not occur for the device of document D1.

2.5 The appellant furthermore argued that contrary to the claimed method, document D1 in relation to Figure 3(d) taught the direct application of an etchant to the semiconductor substrate (item V(b) above).

2.5.1 Figures 3(a) to 3(d) of document D1 describe the process steps up to forming the first metal layer 3 by selective deposition in an opening 5 of an organic passivation layer 2. Figure 3d illustrates the step of forming the opening 5 in the passivation layer where the metal/semiconductor contact is to be formed. The corresponding step in the present application is illustrated in Figures 1C, 2F, and 3F where openings are etched in the passivation layer to form contact openings. Thus, the etching step referred to in Figure 3d is not contrary to the teaching of the present application.

2.6 The distinguishing features (a) and (b) referred to above have the technical effect that in the claimed method a contact is formed from a single metal layer, whereas in the method of document D1, a bi-layer metal contact is formed. The contact structure formed in the method of document D1 is useful for situations where the metal chosen for the contact layer cannot be in direct contact with the semiconductor substrate. If this is not the case, so that the first and the second metal layers could be made of the same metal, the method of document D1 requiring two separate deposition steps for forming a metal contact layer would appear to be unnecessarily complicated.

The technical problem having regard to document D1 thus relates to simplifying the method of document D1 of forming the cell contacts when the same metal can be used for first and second layers.

2.7 The board agrees with the assessment of the examining division that the skilled person seeking to simplify the method of document D1 would immediately realise that one of the metal deposition steps could be dispensed with, and would hence be faced with the problem of choosing which one of the two metal deposition steps to omit. There are several compelling reasons for omitting the metal layer deposition using electroplating. Firstly, since this step involves the use of a selective deposition process the size of the cell contact has to be the same as the metal/semiconductor contact, thus limiting the possibility of optimising the cell contact with respect to the metal/semiconductor contact on one hand and with respect to applications for flip-chip bonding on the other hand. Secondly, since the first metal deposition stage has to be selective, the options of suitable deposition processes are more limited than for blanket deposition methods. Thirdly, the interface metal contact/passivation layer would in such a process be exposed with its obvious risks of having contaminants reaching down to the semiconductor surface. Finally, as exemplified in document D4 (Figure 4), it is well-known in the art to form contacts suitable for flip-chip bonding using photolithographic patterning of a metal layer deposited on a passivation layer with openings defining the metal/semiconductor contacts. Such a conventional photolithographic patterning entails the use of a metal etchant for removing metal outside of the cell contacts.

The method resulting from omitting the step of selectively depositing the first metal layer would have all the features of claim 1 of the main request.

2.8 The appellant applicant argued that documents D1 and D4 were technically incompatible and therefore, the skilled person would not consider combining their teachings (item V(c) above).

2.8.1 Although document D1 relates to a radiation detector for detecting X-rays and document D4 for infrared radiation, flip-chip bonding is a well-established connection technique in the art of semiconductor devices and would therefore be well-known to the skilled person seeking to improve the method of document D1. Document D4 merely illustrates that it was known in the general field of radiation detectors to use flip-chip bonding for connecting the radiation detector to a control circuit.

2.9 For the above reasons, in the board's judgement, the subject matter of claim 1 of the main request does not involve an inventive step within the meaning of Article 56 EPC.

3. *Inventive step - Auxiliary request*

3.1 The method of claim 1 of the auxiliary request further specifies that individual detector cell contacts are on the order of 10 μm across with spacing between adjacent cell contacts of the order of 5 μm. Document D1 on the other hand neither discloses any dimensions of the cell contacts themselves nor the spacing between adjacent cell contacts. These features were specified in dependent claim 22 as filed.

3.2 In the examination procedure, the examining division referred to column 7, lines 5 to 8 of document D4 which disclosed similar dimensions of the cell contact structure of a radiation detector, albeit for detecting infrared radiation. It discloses cell contacts of a radiation detector for flip-chip bonding which have a surface area of five micrometers on a side and a centre-to-centre distance of 10 μm. Thus, using the terminology of claim 1, the cell contacts of the device of document D4 are on the order of 5 μm across with spacing between adjacent contacts on the order of 5 μm. Thus, the claimed dimensions of the cell contact structure lie within that a skilled person would consider for a radiation detector which is be flip-chip bonded.

3.3 For the above reasons, in the board's judgement, the subject matter of claim 1 of the auxiliary request does not involve an inventive step within the meaning of Article 56 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

Registrar Chair

S. Sánchez Chiquero R. G. O'Connell