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Datasheet for the decision of 17 January 2019

Case Number: T 1169/15 - 3.4.02

Application Number: 04785661.2

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Language of the proceedings: EN

Title of invention:
MICROELECTROMECHANICAL SYSTEMS, AND METHODS FOR ENCAPSULATING AND FABRICATING SAME

Applicant:
ROBERT BOSCH GMBH

Relevant legal provisions:
EPC 1973 Art. 54(1), 56

Keyword:
Novelty and inventive step (yes, amended claims)

This datasheet is not part of the Decision.
It can be changed at any time and without notice.

Beschwerdekammern

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Case Number: T 1169/15 - 3.4.02

D E C I S I O N
of Technical Board of Appeal 3.4.02
of 17 January 2019

Appellant: ROBERT BOSCH GMBH
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted on 27 November 2014 refusing European patent application No. 04785661.2 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman R. Bekkering
Members: F. J. Narganes-Quijano
T. Karamanli

Summary of Facts and Submissions

I. The appellant (applicant) lodged an appeal against the decision of the examining division refusing European patent application No. 04785661.2 filed on 30 March 2004 and claiming priority from an US application, filed on 4 June 2003.

II. During the examination proceedings reference was made to the following documents:

D1: EP 1 460 038 A2
D2: EP 1 464 615 A2
D3: DE 100 05 555 A1
D4: "An integrated wafer-scale packaging process for MEMS", T. W. Kenny *et al.*; Proceedings of the IMECE (2002), ASME International Mechanical Engineering Congress & Exposition, 2002, New Orleans (US); pages 51 to 54.

In its decision the examining division held that the subject-matter of claim 1 of the request then on file did not involve an inventive step in view of the disclosure of document D3 (Article 56 EPC).

In an *obiter dictum* of the decision the examining division also expressed its view that the subject-matter of independent claim 11 and dependent claims 2 to 10 and 12 to 16 of the request then on file did not involve an inventive step.

III. In a communication annexed to summons to oral proceedings the board introduced the following document into the proceedings:

A1: DE 199 61 578 A1,

and presented a preliminary assessment of the appellant's appeal case.

IV. Oral proceedings were held on 17 January 2019.

During the oral proceedings the appellant submitted amended claims 1 to 13, and amended pages 1 to 3, 3a, and 4 to 28 of the description according to a new sole request.

The appellant requested that the decision under appeal be set aside and a patent be granted in the following version:

- Claims: Nos. 1 to 13 filed at the oral proceedings of 17 January 2019.
- Description: Pages 1 to 3, 3a, and 4 to 28 filed at the oral proceedings of 17 January 2019.
- Drawings: Sheets 1/22 to 22/22 as published.

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

V. Claim 1 of the appellant's request reads as follows:

"A method of manufacturing an electromechanical device having mechanical structures (20a, 20b, 20c, 20d), an electrical contact (24) and field regions (22a, 22b), all overlying a substrate (14), wherein the mechanical structures (20a, 20b, 20c, 20d) and the electrical contact (24) are disposed between the field regions (22a, 22b), wherein the field regions (22a, 22b) are comprised of silicon, germanium, silicon/germanium, silicon carbide or gallium arsenide, and wherein the

mechanical structures (20a, 20b, 20c, 20d) reside in a sealed chamber (26), the method comprising:

providing a substrate (14) with a first sacrificial layer (30), an electrical contact (24) and mechanical structures (20a, 20b, 20c, 20d), wherein the electrical contact (24) and the mechanical structures (20a, 20b, 20c, 20d) are disposed between field regions (22a, 22b), wherein the electrical contact (24), the mechanical structures (20a, 20b, 20c, 20d) and the field regions (22a, 22b) are all disposed on the first sacrificial layer (30);

depositing a second sacrificial layer (32) over the mechanical structures (20a, 20b, 20c, 20d), the electrical contact (24) and a portion of each of the field regions (22a, 22b), directly covering the mechanical structures (20a, 20b, 20c, 20d), the electrical contact (24) and the portions of the field regions (22a, 22b);

forming an opening (34) into the second sacrificial layer (32), wherein the opening (34) is positioned in a portion of the second sacrificial layer (32) which covers the electrical contact (24);

depositing a first encapsulation layer (28a) over the second sacrificial layer (32) filling up the opening (34) for forming a contact via (38) wherein the first encapsulation layer (28a) consists of a semiconductor material;

forming at least one vent (36) through the first encapsulation layer (28a) to allow removal of at least a portion of the first and second sacrificial layer (30, 32);

removing at least a portion of the first and second sacrificial layer (30, 32) to form the chamber (26);

sealing the chamber (26) by depositing a second encapsulation layer (28b) on the first encapsulation layer (28a), wherein the second encapsulation layer

(28b) consists of a semiconductor material and covers the vent (36)."

The claims of the appellant's request also include dependent claims 2 to 13 all referring back to claim 1.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments - Article 123(2) EPC*

Claim 1 is based on claim 1 as originally filed and on the passages on page 11, second and penultimate paragraphs, of the description as originally filed, together with the process steps of the method disclosed in the description as originally filed with reference to Fig. 4A to 4G and resulting in the device represented in Fig. 3. Dependent claims 2 to 11 are based on dependent claims 2, 3, 5 to 7, 9 to 12, and 4 as originally filed, respectively, and dependent claims 12 and 13 are based on Fig. 4E and 4F together with the corresponding description, see in particular page 16, second paragraph, of the description as originally filed.

The amendments to the description relate to the adaption of some of its passages to the invention as defined in the present claims (Article 84 and Rule 27(1)(c) EPC 1973), and to the acknowledgement of the pertinent state of the art (documents D3 and A1) in the introductory part of the description (Rule 27(1)(b) EPC 1973).

Therefore, the application as amended according to the present request of the appellant complies with the requirements of Article 123(2) EPC.

3. *Novelty and inventive step*

3.1 Novelty

3.1.1 Document D3, on which the examining division's finding of lack of inventive step was based, discloses a method of manufacturing an electromechanical device (Fig. 1g and abstract) having mechanical structures (mechanical structures 7) and field regions (field regions 5, see column 2, lines 59 to 64) overlying a substrate (substrate 1), the mechanical structures being disposed between the field regions (Fig. 1g) and residing within a sealed chamber (chamber 16), the device also comprising an electrical contact (electrical contact 3 in Fig. 1g). The method involves depositing a second sacrificial layer (layer 8 in Fig. 1b) over the mechanical structures formed on a first sacrificial layer (layer 2 and 4 in Fig. 1a and 1b) disposed on the substrate, forming a first encapsulation layer (structured layer 10 and 14 in Fig. 1f) having vents (vents 11 and 15 in Fig. 1f) over the second sacrificial layer, removing the second sacrificial layer and portions of the first sacrificial layer so as to form the chamber (Fig. 1f), and sealing the chamber by depositing a second encapsulation layer (layer 17 in Fig. 1g).

Claim 1 differs from the method of document D3 in several respects. In particular, the electrical contact (electrical contact 3 in Fig. 1g) of the device of document A2 is formed in a lateral portion of the first

sacrificial layer (layer 2 and 4 in Fig. 1g) that is not affected by the steps of formation of the chamber mentioned above (Fig. 1g), the electrical contact being arranged for direct electrical connection from the lateral side of the device. Thus, the method of claim 1 is novel over the method of document A2 at least in that the device comprises an electrical contact disposed between the field regions, and in all the steps involving the formation of an electrical connection, and in particular of the contact via, for electrically connecting the electrical contact on the side of the device comprising the encapsulation layers.

3.1.2 Document A1 discloses a method of manufacturing an electromechanical device (abstract, Fig. 34 and column 5, lines 38 to 40, together with the manufacturing method disclosed with reference to Fig. 1 to 16 and 32 to 34) having mechanical structures (see Fig. 34, and mechanical structures 26 in Fig. 4), an electrical contact (see in Fig. 34 the electrical contact between contact pad 36 and the conductive element in Fig. 34 corresponding to the conductive element 14 of Fig. 3) and field regions (the field regions constituted by the sections of the layer of Fig. 34 corresponding to layer 16 shown in Fig. 12 and positioned at both sides of the electric contact and the mechanical structures of Fig. 34), all overlying a substrate (substrate 10 in Fig. 4), wherein the mechanical structures and the electrical contact are disposed between the field regions (Fig. 34) made of silicon (column 5, line 68 to column 6, line 5), and the mechanical structures reside in a sealed chamber of the device (see Fig. 34). The method comprises the following steps:

- providing (see Fig. 34 together with Fig. 4) the substrate with a first sacrificial layer (layer 12 in

Fig. 3), the mechanical structures and a silicon layer (layer 16 in Fig. 4), the mechanical structures being disposed between sections of the silicon layer, wherein the silicon layer and the mechanical structures are disposed on the first sacrificial layer (see Fig. 4);

- forming a cavity in a portion of the first sacrificial layer below the mechanical structures (Fig. 5);
- depositing a second sacrificial layer (layer 30 in Fig. 6) over and directly covering the mechanical structures, and filling the cavity formed within the first sacrificial layer (see Fig. 6);
- depositing a first encapsulation layer (layer 32 in Fig. 8) over the second sacrificial layer and over the silicon layer (see Fig. 8 and 32);
- forming vents through the first encapsulation layer (column 7, lines 43 to 48);
- removing the second sacrificial layer through the vents to form the chamber (see Fig. 9 and 10);
- sealing the chamber by depositing a second encapsulation layer (layer 34 in Fig. 11, 32 and 34; see also column 9, lines 23 to 28) on the first encapsulation layer so as to cover the vents and the first encapsulation layer; and
- patterning the silicon layer together with the first and the second encapsulation layers (see Fig. 32 to 34) so as to form a trenched electrical contact within the silicon layer (portion 36 in Fig. 33 and 34, together with column 8, line 68 to column 9, line 28), wherein the electrical contact and the mechanical structures are disposed between sections of the silicon layer that constitute field regions within the meaning of claim 1.

The method of present claim 1 differs from the method disclosed in document A1 in several respects. In particular,

a) while in document A1 the formation of the chamber requires two different steps, namely forming a cavity within the first sacrificial layer (Fig. 4 and 5) and, at a later stage (Fig. 9 and 10), removing all the material of the second sacrificial layer filling up the mentioned cavity and the interspaces between the mechanical structures, in claim 1 the chamber is formed in a single step by removing at least a portion of the first and the second sacrificial layers;

b) while in document A1 the first and the second encapsulation layers are respectively made of polysilicon and a metal (sentence bridging columns 6 and 7, and column 8, lines 52 to 63), in claim 1 both the first and the second encapsulation layers are made of a semiconductor material;

c) while in document A1 the electrical contact and the field regions are formed by patterning the silicon layer at a final stage of the method, i.e. after deposition of the first and the second encapsulation layers, in claim 1 the electrical contact and the field regions are formed as distinct components on the first sacrificial layer at a stage of the method prior to the deposition of the second sacrificial layer; and

d) while in document A1 the second sacrificial layer is also deposited over the silicon layer (Fig. 6) but then partially removed so that the second sacrificial layer only covers the mechanical structures (Fig. 7), in claim 1 the second sacrificial layer is deposited over and covering the electrical contact and a portion of the field regions, and then an opening is formed into the second sacrificial layer in a portion of the layer covering the electrical contact, this opening being subsequently filled up by the material of

the first encapsulation layer for forming a contact via, and the contact via being subsequently covered by the second encapsulation layer.

3.1.3 The remaining documents on file are less pertinent for the issue of novelty. In particular:

- Document D1 (a European patent application filed on 18 March 2004, published on 22 September 2004 and claiming priority from an US application, filed on 20 March 2003) and document D2 (a European patent application filed on 30 March 2004, published on 6 October 2004 and claiming priority from an US application, filed on 31 March 2003) could constitute state of the art within the meaning of Article 54(3) EPC together with Article 54(4) EPC 1973 for the present application, if the respective claimed priority date was valid. However, the issue of priority has not to be dealt with in the present case, because neither document D1 nor document D2 are novelty-destroying for the following reasons. Document D1 discloses an electromechanical device comprising mechanical structures residing within a sealed chamber (Fig. 2 and 3, together with the corresponding description), and the document discloses that the mechanical structures can be constituted by a portion of electrode arrays (column 7, lines 40 to 49). However, document D1 does not disclose a contact via formed as claimed for the electrical connection of an electric component within the device. Document D2 discloses the manufacture of an electrochemical device comprising mechanical structures encapsulated within a sealed chamber (Fig. 2E and the corresponding description); in the method of document D2, however, the formation of the chamber involves the removal in one step of only one sacrificial layer (layer 205 in Fig. 2B and paragraph [0058]). Already

for these reasons the method of claim 1 is new over the disclosure of documents D1 and D2.

- Document D4 discloses an electromechanical device comprising a mechanical structure in a chamber of the device, the mechanical structure being disposed between field regions made of silicon (see Fig. 1 and Fig. (E) on page 52, together with the abstract). The device, however, does not comprise an electrical contact overlying the substrate of the device and disposed between the field regions, but only an electrical contact on a portion of the field regions and electrically connected to the side of the device comprising two encapsulation layers, by a portion of the first encapsulation layer and an aluminium pad (see Fig. (E) on page 52).

3.1.4 Therefore, the subject-matter of claim 1, and also that of dependent claims 2 to 13, is new over the documents on file (Article 54(1) EPC 1973).

3.2 Inventive step

The closest state of the art is constituted by the method disclosed in document A1.

As regards the distinguishing feature a) identified in point 3.1.2 and the corresponding technical effect, i.e. the simplification of the manufacturing method disclosed in document A1, the board notes that document D3 already teaches the formation of the chamber by removing in one single step the portions of the first and the second sacrificial layers required for forming the chamber (see document D3, Fig. 1e and 1f and the corresponding disclosure).

However, none of the documents on file teaches or suggests the combination of distinguishing features b), c) and d) mentioned in point 3.1.2 above. In particular, while in document A1 the electrical contact and the field regions are formed by patterning the silicon layer together with the first and the second encapsulation layers after the chamber has been sealed with the two encapsulation layers, claim 1 requires the formation of the electrical contact and the field regions as distinct components on the first sacrificial layer at a stage prior to the deposition of the second sacrificial layer and the subsequent steps of forming and sealing the chamber. Furthermore, the claim specifies the steps required for ensuring the electrical connection of the electrical contact with the side of the device comprising the encapsulation layers. None of the documents on file suggests modifying the manufacturing method of document A1 as claimed. In particular:

- documents D3 and D4 are silent as to the formation of an electrical contact disposed between field regions as claimed and electrically connected to the side of the device comprising the encapsulation layers, and
- documents D1 and D2 could only constitute state of the art within the meaning of Article 54(3) EPC and thus, in accordance with Article 56, second sentence, EPC 1973), they are not to be considered in deciding whether there has been an inventive step.

Therefore, the method of claim 1 involves an inventive step over the available documents of the state of the art (Article 56 EPC 1973). The same conclusion applies to dependent claims 2 to 13.

4. The board concludes that the application documents amended according to the present request of the appellant meet the requirements of the EPC and that the request for grant 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 grant a patent in the following version:
    - Claims: Nos. 1 to 13 filed at the oral proceedings of 17 January 2019.
    - Description: Pages 1 to 3, 3a, and 4 to 28 filed at the oral proceedings of 17 January 2019.
    - Drawings: Sheets 1/22 to 22/22 as published.

The Registrar: The Chairman:

M. Kiehl R. Bekkering

Decision electronically authenticated