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# Datasheet for the decision of 17 January 2019

**Case Number:** T 1155/15 - 3.4.02

**Application Number:** 04785662.0

**Publication Number:** 1633673

**IPC:** H01L21/00, B81C1/00

**Language of the proceedings:** EN

**Title of invention:**
MICROELECTROMECHANICAL SYSTEMS HAVING TRENCH ISOLATED CONTACTS, AND METHODS FOR FABRICATING SAME

**Applicant:**
ROBERT BOSCH GMBH

**Relevant legal provisions:**
EPC 1973 Art. 54(1), 56, 84

**Keyword:**
Conciseness in the number of independent claims (yes, amended claims)
Novelty and inventive step (yes, amended claims)

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**Case Number: T 1155/15 - 3.4.02**

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

| | |
|---|---|
| **Appellant:** (Applicant) | ROBERT BOSCH GMBH<br>Postfach 30 02 20<br>70442 Stuttgart (DE) |
| **Decision under appeal:** | **Decision of the Examining Division of the European Patent Office posted on 27 November 2014 refusing European patent application No. 04785662.0 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. 04785662.0 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 1 464 615 A2
D2: DE 199 61 578 A1
D3: "Sputtered silicon carbide thin films as protective coating for MEMS applications", N. Ledermann *et al.*; Surface and Coatings Technology, Vol. 125 (2000); pages 246 to 250.

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 D2 (Article 56 EPC).

In an *obiter dictum* of the decision the examining division also expressed its view that

- independent claims 1 and 9 then on file did not satisfy the requirements of conciseness of Article 84 in combination with Rule 43(2) EPC, and in particular under consideration of Rule 43(2)(c) EPC, and

- the subject-matter of independent claims 9 and 17 and of dependent claims 2 to 7, 10 to 15, and 18 to 25 then on file did not involve an inventive step (Article 56 EPC).

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

A1: US 2002 001 6058 A1
A2: DE 100 05 555 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 6, 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 6 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 1/26 to 26/26 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) and an electrical contact (24), both overlying a substrate (14), 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 (20, 20b, 20c, 20d), wherein the electrical contact (24) and the mechanical structures (20a, 20b, 20c, 20d) are both disposed on the first sacrificial layer (30);

depositing a second sacrificial layer (32) over the mechanical structures (20a, 20b, 20c, 20d) and at least a portion of the electrical contact (24), directly covering the mechanical structures (20a, 20b, 20c, 20d) and the portion of the electrical contact (24);

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 (38a) 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), wherein a portion (40) of the second sacrificial layer (32) remains between the chamber (26) and the contact via (38a) so that the contact via (38a) is disposed outside 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) and the contact via (38a);

forming a trench (46a, 46b) in the first and the second encapsulation layer (28a, 28b) around the contact via (38a); and

depositing an insulating material in the trench (46a, 46b) to electrically isolate the electrical contact (24)."

The claims of the appellant's request also include dependent claims 2 to 6 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 independent claims 1 and 9 as originally filed and on the passage on page 11, lines 24 and 25, 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 4I and resulting in the device represented in Fig. 3. Dependent claims 2 to 6 are based on dependent claims 2, 3, and 5 to 7 as originally filed, respectively.

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 D2 and A2) 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. *Clarity and conciseness - Article 84 EPC 1973*

In an *obiter dictum* of the decision under appeal the examining division expressed its view that independent claims 1 and 9 then on file did not satisfy the requirements of conciseness of Article 84 in combination with Rule 43(2) EPC, and in particular under consideration of Rule 43(2)(c) EPC, i.e. of Article 84 in combination with Rule 29(2) EPC 1973, and in particular under consideration of Rule 29(2)(c) EPC 1973, applicable in the present case. The then independent claims 1 and 9 were directed to different combinations of features of the method disclosed in the description of the application, and the present claims contain one single independent claim 1 encompassing, among other features, the features of independent claims 1 and 9 underlying the decision under appeal. Consequently, the present claims overcome the objection of lack of conciseness mentioned by the examining division in its decision.

In addition, the claims as presently amended are clear within the meaning of Article 84 EPC 1973.

Therefore, the present claims satisfy the requirements of Article 84 EPC 1973.

4. *Novelty and inventive step*

4.1 Novelty

4.1.1 Document D2, on which the examining division's finding of lack of inventive step was based, discloses a method of manufacture of 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) and an electrical contact (see in Fig. 34 the electrical contact between contact pad 36 and the electric element in Fig. 34 corresponding to the conductive element 14 of Fig. 3) both overlying a substrate (substrate 10 in Fig. 4), the mechanical structures residing in a sealed chamber of the device (see Fig. 34). In addition, the method disclosed in document D2 comprises the following steps:

- providing (see Fig. 34 together with Fig. 4) the substrate with a first sacrificial layer (layer 12 in Fig. 3), an electrical contact (the electrical contact constituted in Fig. 4 by the portion of silicon layer 16 disposed over the electric element of Fig. 34 corresponding to the electric element 14 of Fig. 3 and 4) and the mechanical structures, the electrical contact and the mechanical structures being 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 covering the mechanical structures, and filling the cavity formed within the first sacrificial layer (see Fig. 6 and 7);

- depositing a first encapsulation layer (layer 32 in Fig. 8) over the second sacrificial layer and over the electrical contact (see Fig. 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 portion of the first encapsulation layer overlying the electrical contact; and

- patterning the first and the second encapsulation layers and the electrical contact (see Fig. 32 to 34) so as to form an isolation trench around a patterned portion of the electrical contact (portion 36 in Fig. 33 and 34, together with column 8, line 68 to column 9, line 28).

The method of present claim 1 differs from the method disclosed in document D2 in several respects. In particular,

a) while in document D2 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 D2 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; and

c) while in document D2 the second sacrificial layer is also deposited over the electrical contact (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 at least a portion of the electrical contact, and an opening is then 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 then covered by the second encapsulation layer, wherein a portion of the second sacrificial layer remains between the chamber and the contact via so that the contact via is disposed outside the chamber, and a trench in the first and second encapsulation layers is subsequently formed around the contact via to electrically isolate the electrical contact as claimed.

4.1.2 Document A2 discloses a method of manufacture of an electromechanical device (Fig. 1g and abstract) having mechanical structures (mechanical structures 7) overlying a substrate (substrate 1) and residing within a sealed chamber (chamber 16), the device also comprising an electrical contact (electrical contact 3). 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 over the second sacrificial layer a first encapsulation layer (structured layer 10 and 14 in Fig. 1f) having vents (vents 11 and 15 in Fig. 1f), 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 A2 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 all the steps involving the formation of the trenched contact via for electrical connection of the electrical contact from the side of the device comprising the encapsulation layers.

4.1.3 The remaining documents on file are less relevant for the issue of novelty. In particular,

- Document D1 (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 its priority date of 30 March 2004 was valid. However, the issue of priority has not to be dealt with in the present case, because document D1 is not novelty-destroying for the following reasons. The document 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 D1, 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 this reason the method of claim 1 is new over the disclosure of document D1.

- Document D3 is directed to properties of thin films used as protective coatings in electromechanical devices (abstract), and the document is silent as to the manufacture of the devices.

- Document A1 discloses the manufacture of an electrochemical device (paragraph [0014] together with Fig. 1 and the corresponding disclosure) comprising mechanical structures (mechanical structures 1020, 1030 and 1040) arranged within a sealed chamber (chamber 1130 and 1140), and an electrical contact (contact 1050, see paragraph [0044]). The method of claim 1 differs from the method of document A1, among other features, in that one single sacrificial layer (layer 3010 in Fig. 3) is used in the formation of the chamber (see abstract, and Fig. 3 to 6 together with the corresponding description, in particular paragraphs [0040] and [0047] to [0049]), and in that the electrical contact within the device is not electrically connected to the outside by portions of the encapsulation layers of the device surrounded by an isolation trench as claimed, but by means of a conductive plug subsequently formed in the encapsulation layers sealing the chamber (plug 1120 in Fig. 1 and paragraph [0044]).

4.1.4 Therefore, the subject-matter of claim 1, and also that of dependent claims 2 to 6, is new over the documents on file (Article 54(1) EPC 1973).

4.2 Inventive step

The closest state of the art is constituted by the method disclosed in document D2.

As regards the distinguishing feature a) identified in point 4.1.1 and the corresponding technical effect, i.e. the simplification of the manufacturing method disclosed in document D2, the board notes that document A2 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 A2, Fig. 1e and 1f and the corresponding disclosure).

However, none of the documents on file teaches or suggests the combination of distinguishing features b) and c) mentioned in point 4.1.1 above, nor the resulting technical effect, i.e. the manufacture of an electromechanical device comprising within the device an electrical contact directly connected to the side of the device comprising the encapsulation layers by a contact via constituted by a portion of the first encapsulation semiconductor layer deposited within an opening of a remaining portion of the second sacrificial layer and overlaid by a portion of the second encapsulation semiconductor layer, the contact via being disposed outside the chamber of the device by interposition of the mentioned portion of the second sacrificial layer and being electrically isolated by an insulating material deposited in a trench formed around the contact via and surrounding the mentioned portions of the first and the second encapsulation layers. In particular:

- In document A1 the electrical contact (electrical contact 1050 in Fig. 1) within the electrochemical device is directly connected to the outside by a conductive plug subsequently formed in the encapsulation layers sealing the chamber and in direct

physical contact with the electrical contact (plug 1120 in Fig. 1, and paragraph [0044]).

- In document A2 the electrical contact (electrical contact 3 in Fig. 1g) of the electromechanical device is arranged within a portion of the first sacrificial layer so as to directly emerge to the lateral side of the device and provide an electrical connection on this side, and not on the side of the device comprising the encapsulation layers.

- Document D3 is silent as to the provision of electrical contacts in electromechanical devices.

- Document D1 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, it is 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 6.

5. 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 6 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 1/26 to 26/26 as published.

The Registrar: The Chairman:

M. Kiehl R. Bekkering

Decision electronically authenticated