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**Datasheet for the decision
of 12 November 2015**

Case Number: T 0021/11 - 3.4.01

Application Number: 06001027.9

Publication Number: 1657553

IPC: G01P15/08

Language of the proceedings: EN

Title of invention:

Method of manufacturing an external force detection sensor

Applicant:

MURATA MANUFACTURING CO., LTD.

Headword:

Relevant legal provisions:

EPC Art. 123(2)
EPC 1973 Art. 76(1), 84, 54(1), 54(2), 56

Keyword:

Amendments - added subject-matter (no)
Novelty - (yes)
Inventive step - (yes)

Decisions cited:

Catchword:



**Beschwerdekammern
Boards of Appeal
Chambres de recours**

European Patent Office
D-80298 MUNICH
GERMANY
Tel. +49 (0) 89 2399-0
Fax +49 (0) 89 2399-4465

Case Number: T 0021/11 - 3.4.01

D E C I S I O N
of Technical Board of Appeal 3.4.01
of 12 November 2015

Appellant: MURATA MANUFACTURING CO., LTD.
(Applicant) 10-1, Higashikotari 1-chome
Nagaokakyo-shi, Kyoto 617-8555 (JP)

Representative: Zimmermann, Tankred Klaus
Schoppe, Zimmermann, Stöckeler
Zinkler, Schenk & Partner mbB
Patentanwälte
Radlkoferstrasse 2
81373 München (DE)

Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 17 August 2010
refusing European patent application No.
06001027.9 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman G. Assi
Members: T. Zinke
F. Blumer

Summary of Facts and Submissions

- I. The appeal filed on 27 October 2010 lies from the decision of the examining division, posted on 17 August 2010, refusing European patent application No. 06 001 027.9, published with publication No. 1 657 553. This European patent application is a divisional application from the earlier European patent application No. 00 108 261.9, published with publication No. 1 046 917. The appeal fee was paid on 27 October 2010. The statement setting out the grounds of appeal was concurrently filed with the notice of appeal.
- II. In its decision the examining division refused the then pending sole request due to a plurality of independent claims in the same category (Rule 29(2) EPC 1973 in combination with Article 84 EPC 1973) and due to lack of novelty of the subject-matter of claim 1 with regard to the teaching of document D1 (DE-A-197 15 194).
- III. With the notice of appeal and the concurrently filed statement setting out the grounds of appeal the appellant (applicant) requested to set aside the decision and to grant a patent on the basis of the claims underlying the decision (main request) or on the basis of claims according to a first to a seventh auxiliary request as filed together with the notice of appeal.

In this regard, the appellant provided counter-arguments with regard to the objections under Rule 29(2) EPC 1973 and lack of novelty of the main request. Further, the appellant discussed the basis for the amendments as made for the first to seventh auxiliary request as well as inventive step of these requests.

IV. By summons of 2 June 2015 the appellant was summonsed to oral proceedings due to take place on 12 November 2015. A communication under Article 15(1) RPBA was issued on 7 September 2015 drawing attention to the issues to be discussed during oral proceedings.

In particular, the Board introduced documents D3 (DE-A-196 10 782), D4 (US-A-6,008,138), D5 (S. Franssila, J. Kiihamäki, J. Karttunen: *"Etching through silicon wafer in inductively coupled plasma"*, *Microsystem Technology* 6 (2000), published April 2000, pages 141-144, Springer Verlag 2000, presented at the Third International Workshop on High Aspect Ratio Microstructure Technology HARMST '99 in June 1999) and D6 (G. Hwang, K. Giapis: *"On the origin of the notching effect during etching in uniform high density plasmas"*, *J. Vac. Sci. Technol. B* 15(1), Jan/Feb 1997, pages 70-87) into the proceedings.

With regard to the main request, the Board discussed issues of clarity and support by the description (Article 84 EPC 1973), number of independent claims in the same category (Rule 29(2) EPC 1973), amendments (Article 123(2) EPC), priority (Article 87 EPC 1973), novelty (Article 54(1) and (2) EPC 1973) and inventive step (Article 56 EPC 1973).

Concerning the auxiliary requests, the Board pointed to issues under Article 123(2) EPC, Article 84 EPC 1973, Rule 29(2) EPC 1973 and Article 56 EPC 1973 that should be discussed during oral proceedings.

V. With letter of 6 October 2015, the appellant withdrew all requests then on file and filed revised claim sets for a new main request and a new auxiliary request, respectively.

Further, the appellant provided arguments with regard to the issues raised by the Board.

VI. Oral proceedings took place on 12 November 2015 as scheduled. The appellant withdrew its requests then on file and requested, as a final sole request, that the decision under appeal be set aside and a patent be granted on the basis of claims 1 to 4 as filed during the oral proceedings.

VII. Claim 1 of the sole request on file reads as follows:

*"1. A method of manufacturing an external force detection sensor, the method comprising:
forming a recessed part (16; 28) on a back surface side (3b) of an element substrate (3) to form a membrane (17) on a front side (3a),
providing an etching stop layer (18) comprising an electrically conductive material on a top surface (16a) of the recessed part (16) of said element substrate (3),
joining the back surface side of said element substrate (3) with a support substrate (2), and
forming a sensor element by dry etching of the membrane (17) of said element substrate (3),
wherein the element substrate (3) is formed of a silicon material, and the support substrate (2) is formed of a glass material, and wherein the element substrate (3) is anodically joined with the support substrate (2)."*

Reasons for the Decision

1. The appeal is admissible.
2. *Amendments (Article 123(2) EPC, Article 76 EPC 1973)*

With regard to claim 1, reference is made to the combination of claims 1 and 4 of the present divisional application and the combination of claims 2 and 9 of the earlier application.

A further amendment was made by replacing the original feature "*forming a membrane (17)*" with "*to form a membrane (17)*". This wording was originally disclosed, for instance, on page 13, 5th paragraph of the divisional application and the earlier application. Further, the appellant replaced the wording "*face side*" with "*front side*". This amendment is based, for instance, on Figure 1A of both the divisional application and the earlier application, wherein the "*back surface 3b*" is opposed to side 3a, which for clarity reasons should be thus named "*front side*" rather than "*face side*".

Dependent claims 2 to 4 correspond to claims 2, 6 and 7 of the divisional application and to claims 3, 11 and 12 of the earlier application. Dependent claim 4 is restricted to the aluminum alternative.

Hence, the Board is satisfied that the amendments are allowable according to Article 123(2) EPC and Article 76 EPC 1973.

3. *Clarity and support by the description (Article 84 EPC 1973)*

With the amendments made, the Board is satisfied that the requirements of Article 84 EPC 1973 are respected.

4. *Priority (Article 87 EPC 1973) and prior art to be considered*

4.1 The subject-matter of the claims of the single request on file is disclosed in the application JP-A-11129899, which is the document from which the first priority, i.e. 19 April 1999, is claimed.

4.2 Hence, documents D4 and D5, both having a later publication date, do not belong to the prior art (Article 54(2) EPC 1973) that has to be considered.

4.3 With regard to the prior art that is cited in the application (cf. Figures 7A to 7E and page 3, 2nd paragraph to page 4, 1st full paragraph), the appellant declared during oral proceedings that this disclosure had to be considered as "*internal prior art*" that was not published before the priority dates of the present application.

5. *Novelty (Article 54(1) and (2) EPC 1973)*

5.1 Document D1 discloses a method to manufacture a semiconductor device with dry etching, but does not disclose that an element substrate is anodically joined with a support substrate.

5.2 In document D2 (Z. Xiao et al: "*Laterally capacity sensed accelerometer fabricated with the anodic bonding and the high aspect ratio etching*", 5th International

Conference on Solid-State and Integrated Circuit Technology, 1998, Proceedings, Beijing, China, 21-23 October, Piscataway, NJ, USA, IEEE, US, pages 921-924, ISBN: 0-7803-4306-9), a laterally capacity sensed accelerometer fabricated with anodic bonding is disclosed, but there is no disclosure of an etching stop layer comprising an electrically conductive material on a top surface of a recessed part of an element substrate.

- 5.3 Document D3 discloses a method for manufacturing micromechanical structures with dry etching, but does not disclose that a back surface side of an element substrate is anodically joined with a support substrate.
- 5.4 The authors of document D6 discuss the origin of the notching effect during etching of polysilicon on insulator structures in uniform high density plasma. Document D6, however, does not disclose an etching stop layer comprising an electrically conductive material. Moreover, it does not disclose an external force detection sensor comprising an element substrate anodically joined with a support substrate.
- 5.5 Consequently, the subject-matter of claim 1 is novel with regard to the disclosures of documents D1, D2, D3 and D6.

6. *Inventive step (Article 56 EPC 1973)*

- 6.1 According to the Board document D2 should be considered as closest prior art, since it discloses a method of manufacturing an external force detection sensor with most of the claimed features. Contrary to document D1, which discloses only a temporary support substrate and

document D3, which does not disclose any support substrate at all, document D2 with its anodically bonded support substrate seems to be the most promising starting point for a person skilled in the art to build a stable external force detection sensor.

- 6.2 As discussed above, the distinguishing feature of the claimed invention as compared to document D2 is the electrically conductive etching stop layer on a top surface of a recessed part of an element substrate.
- 6.3 The application is silent with regard to the technical effect of such an etching stop layer at this location. According to the Board's analysis, however, the technical effect of said etching stop layer could be seen in the protection of the top surface of the recess (which later becomes the bottom side of the moving element of the sensor) against etching, after the through holes are etched.
- 6.4 None of the documents on file discusses this technical effect.
- 6.4.1 Document D2 (page 921, right column, lines 8 to 10) discloses that the support substrate itself acts as an etching stop layer: *"The bottom glass wafer also acts as an etching stop layer to eliminate the micro-loading effect"*. Evidently, this etching stop layer cannot prevent etching of the recess top surface side.
- 6.4.2 Document D3 (column 2, lines 27 to 44) discloses an etching stop layer located at the top surface side of a recess. The etching stop layer is made from a thin metal layer (*"dünne Metallschicht"* in column 2, lines 27 to 31). However, with regard to the technical effect of this etching stop layer, in column 3, lines 24 to 32

it is described that the etching stop layer should ensure that the etching does not effect a sacrificial layer, which could result in a back-cutting of the micromechanical structures (*"Die Metallschicht 4 wird somit als Ätzstop verwendet. Es wird so sichergestellt, daß durch den Ätzprozeß keinerlei Ätzung der Opferschicht 5 erfolgt, die eventuell eine Hinterschneidung der mikromechanischen Strukturen und einen Verlust an Strukturgenauigkeit zur Folge hat."*).

In the claimed method, however, no sacrificial layer is involved. Hence, the person skilled in the art gets no hint from this disclosure that an etching stop layer made from a metal could achieve the technical effect of providing a protection for the bottom side of the membrane.

6.4.3 Document D1 (column 14, lines 16 to 35) discloses the use of a metal as an etching stop layer in order to avoid that a cooling medium can penetrate an etching chamber via through-etched holes. This, however, is not an issue in the claimed method of the present application due to the anodically joined support substrate and since there is no cooling medium below the membrane.

6.4.4 The authors of document D6 do not mention a metal layer as an etching stop layer. Even in section *"V. IS REDUCTION OF NOTCHING POSSIBLE?"*, after they have attributed the notching effect to charging of the insulator material, they do not propose the use of a metal, but discuss changing plasma characteristics or modifying chemistry of etching and/or scattering dynamics.

6.5 Consequently, the person skilled in the art gets no hint to use an etching stop layer comprising an electrically conductive material on a top surface of a recessed part in order to improve the method as disclosed in document D2 for protecting the back surface of the membrane. Hence, the subject-matter of claim 1 is based on an inventive step.

In conclusion, the claims of the appellant's request are allowable.

7. *Adaptation of the description*

With respect to the necessary adaptation of the description to the present claims, the appellant, during the oral proceedings before the Board, expressed its preference for a remittal of the case to the examining division. The Board has no reason to disagree.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the examining division with the order to grant a patent on the basis of claims 1 to 4 as filed during the oral proceedings before the Board and a description to be adapted thereto.

The Registrar:

The Chairman:



G. Nachtigall

G. Assi

Decision electronically authenticated