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Datasheet for the decision of 15 January 2015

Case Number: T 1680/10 - 3.4.03

Application Number: 98302581.8

Publication Number: 0898308

IPC: H01L21/768

Language of the proceedings: EN

Title of invention:
A method for forming a metal interconnection in a semiconductor device

Applicant:
Samsung Electronics Co., Ltd.

Headword:

Relevant legal provisions:
EPC 1973 Art. 84, 111(1), 113(2)
EPC 1973 R. 71(2)
EPC Art. 123(2)
RPBA Art. 15

Keyword:
Amendments - added subject-matter (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 1680/10 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 15 January 2015

Appellant: (Applicant)	Samsung Electronics Co., Ltd. 129, Samsung-ro Yeongtong-gu Suwon-si, Gyeonggi-do, 443-742 (KR)
Representative:	Zijlstra, Robert Wiebo Johan Elkington and Fife LLP Prospect House 8 Pembroke Road Sevenoaks, Kent TN13 1XR (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 10 March 2010 refusing European patent application No. 98302581.8 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	G. Eliasson
Members:	S. Ward
	T. Bokor

Summary of Facts and Submissions

I. The appeal is against the decision of the Examining Division refusing European patent application No. 98 302 581 on the grounds that the claimed subject-matter of the main request and the first and second auxiliary requests did not meet the requirements of Articles 84 and 123(2) EPC.

II. The appellant requested in writing that the decision under appeal be set aside and that a patent be granted on the basis of claims 1–26 of the main request or alternatively on the basis of claims 1–24 of the first auxiliary request, both filed with the statement of the grounds of appeal. The appellant further requested remittal to the Examining Division, depending on the substantive findings of the Board, for further possible amendments.

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

"A method for forming a metal interconnection, comprising the steps of:

a) forming an interdielectric layer on a semiconductor substrate (201);

b) forming an interdielectric layer pattern (205) having a recessed region by etching a predetermined region of the interdielectric layer;

c) forming a TiN barrier layer (209) on the entire surface of the resultant structure where the interdielectric layer pattern (205) is formed;

d) selectively forming a further layer (213) on a non-recessed region leaving exposed the TiN barrier layer (209) in the recessed region, said further layer increasing the formation time of Cu

and Al nuclei on the further layer in a selective MOCVD process, the further layer being selected from aluminum oxide, tantalum oxide, titanium oxide, aluminum nitride and SiC;

e) *selectively forming a metal liner (218) on a surface of the exposed barrier metal layer (209) by means of said selective MOCVD process, said metal liner comprising a double liner (215; 217) comprising a first Cu liner (215) and a second Al liner (217) stacked on said first Cu liner (215);*

f) *forming an Al or Al alloy metal layer (219) at a temperature below the reflow temperature of the metal layer on the entire surface of the resultant structure; and*

g) *forming a planarized metal alloy layer (219a) by reflowing the Al or Al alloy metal layer by annealing at 350-500°C to mix the metal liner with the Al or Al alloy metal layer and to completely fill said recessed region."*

Claim 1 of the first auxiliary request reads as follows (differences with respect to claim 1 of the main request in bold):

"A method for forming a metal interconnection, comprising the steps of:

a) *forming an interdielectric layer on a semiconductor substrate (201);*

b) *forming an interdielectric layer pattern (205) having a recessed region by etching a predetermined region of the interdielectric layer;*

c) *forming a TiN barrier layer (209) on the entire surface of the resultant structure where the interdielectric layer pattern (205) is formed;*

d) *selectively forming a further layer (213) on a non-recessed region leaving exposed the TiN*

barrier layer (209) in the recessed region, said further layer increasing the formation time of Cu and Al nuclei on the further layer in a selective MOCVD process, the further layer being selected from aluminum oxide, tantalum oxide, titanium oxide, aluminum nitride and SiC;

e) selectively forming a metal liner (218) on a surface of the exposed barrier metal layer (209) by means of said selective MOCVD process, said metal liner comprising a double liner (215; 217) comprising a first Cu liner (215) and a second Al liner (217) stacked on said first Cu liner (215); ***wherein the selective MOCVD process using for forming the Cu liner is performed at a temperature corresponding to a surface limited region of copper using a precursor containing Cu;***

f) forming an Al or Al alloy metal layer (219) ***through a combination of CVD and sputtering process*** *at a temperature below the reflow temperature of the* ***Cu*** *metal layer on the entire surface of the resultant structure; and*

g) forming a planarized metal alloy layer (219a) by reflowing the Al or Al alloy metal layer by annealing at 350-500°C to mix the ***Cu*** *metal liner with the Al or Al alloy metal layer and to completely fill said recessed region."*

III. The Examining Division argued essentially as follows:

In relation to Article 123(2) EPC, the following features of claim 1 of the main request extended beyond the original disclosure:

(i) "said anti-nucleation layer increasing the formation time of metal nuclei on the anti-nucleation layer in a selective MOCVD process";

(ii) "by means of said selective MOCVD process";

(iii) "forming a metal layer at a temperature below the reflow temperature of the metal layer on the entire surface of the resultant structure"; and

(iv) "forming a planarized metal alloy layer by reflowing the metal layer by annealing at a predetermined temperature to mix the metal liner with the metal layer and to completely fill said recessed region".

The portions of the application cited in support of these amended features by the applicant related to specific disclosures which could not be considered to be an allowable basis in the sense of Article 123(2) EPC for the more general added features in the context of claim 1.

In relation to Article 84 EPC, the feature "anti-nucleation layer" used in claim 1 suggested the prevention of any nucleation on the surface of the layer which was inconsistent with the formation of a metal layer in step (f) which requires nucleation.

Furthermore, claim 1 of the main request attempted to define the subject-matter in terms of the result to be achieved. Claim 1 did not define any materials for the anti-nucleation layer, barrier metal layer and metal liner and no process parameters. The reflow of a metal layer into a recess also depended on a large number of interdependent parameters. Hence the skilled person would have to carry out undue experimentation in order to achieve the results specified in claim 1.

Claim 1 of the first auxiliary request and claim 1 of the second auxiliary request also failed to meet the requirements of Articles 84 and 123(2) EPC.

IV. The appellant's arguments may be briefly summarised as follows:

The amendments made to claim 1 of the main request, a basis for which could be clearly found in the application as filed, overcame the added matter and clarity objections of the contested decision as each method step had been limited to the materials disclosed in the detailed description of the claimed embodiment.

Moreover, it was not necessary to further specify how the anti-nucleation layer was formed or to give further details of the selective MOCVD deposition steps, as the skilled person would understand how to carry out these steps. The skilled person would also know how to form an Al or Al alloy layer below the reflow temperature, and it was not necessary to limit the formation of this layer to a combination of CVD and sputtering.

As claim 1 had been limited to specific materials, specific reflow conditions (350-500°C) and specific deposition methods, it could no longer be said that the claim defined the subject matter in terms of the result to be achieved.

V. In a communication pursuant to Article 15(1) RPBA issued together with a summons to attend oral proceedings, the Board's preliminary opinion was that in relation to the claims of the main request filed with the grounds of appeal, a number of objections still arose under Article 84 EPC 1973 and Article 123(2) EPC. However, the Board took the view that these

objections could be overcome by relatively minor amendments, and that if these amendments were carried out, the case would most likely be remitted to the department of first instance under Article 111(1) EPC 1973 to allow other matters (*inter alia* novelty and inventive step) to be considered before two instances.

The appellant did not file any further written submissions and chose not to be represented at oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

As announced in advance, the duly summoned appellant did not attend the oral proceedings. According to Rule 71(2) EPC 1973, the proceedings could however continue without the appellant. In accordance with Article 15(3) RPBA, the board relied for its decision only on the appellant's written submissions. The board was in a position to decide at the conclusion of the oral proceedings, since the case was ready for decision (Article 15(5) and (6) RPBA), and the voluntary absence of the appellant was not a reason for delaying a decision (Article 15(3) RPBA).

2. Main Request: Article 123(2) EPC

2.1 Claim 1 of the main request (under point (d)) includes a statement setting out the effect of the further layer (i.e. the anti-nucleation layer) as follows:

- *"said further layer increasing the formation time of Cu and Al nuclei on the further layer in a selective MOCVD process".*

This feature does not appear in independent claim 2 as originally filed (the principal basis for claim 1 of the main request), but is said in the statement of grounds of appeal to be "found on page 5 line 3-6". The passage in question reads as follows:

- *"This is because the time required for forming metal nuclei on the anti-nucleation layer being an insulating layer is several tens through several hundreds times longer than the time required for forming metal nuclei on the barrier metal layer being a metal layer."*

While the range "several tens through several hundreds" is not defined with precision, it is not entirely devoid of technical meaning or limiting effect. For example, neither a range in single figures nor a range in thousands or above is disclosed in the application as filed, but either would fall within the ambit of present claim 1.

Furthermore, it is not stated in the application that merely forming the anti-nucleation layer from the materials recited in claim 1 would guarantee that the time required for forming metal nuclei on the anti-nucleation layer (compared with the time required for forming metal nuclei on the barrier metal layer) would always be within the range of several tens through several hundreds, nor has this been argued by the appellant.

The Board therefore takes the view that there is no basis in the application as originally filed for including in claim 1 the effect of the further (anti-nucleation) layer, while at the same time omitting the disclosed range of "several tens through several hundreds".

2.2 Claim 1 of the main request (under point (e)) defines a metal liner "comprising a double liner (215; 217) comprising a first Cu liner (215) and a second Al liner (217) stacked on said first liner (215)".

This formulation allows the possibility that the metal liner may include more than two liners, or may include components other than liners. The basis for this feature (which does not appear in independent claim 2 as originally filed) is said in the statement of grounds of appeal to be "found on page 18 lines 12-16". The passage in question reads as follows:

- *"Meanwhile, the metal liner 218 may be a single metal liner, i.e., a copper liner, as in the first embodiment, or a double metal liner obtained by sequentially forming a first metal liner 215 and a second metal liner 217. Here, it is preferable that the first and second metal liners 215 and 217 are formed of the copper liner and an aluminum liner, respectively."*

A similar statement may be found, for example, in claim 49 as originally filed. The original disclosure therefore provides a basis for a metal liner which may *be* a double metal liner, but no basis can be found in the application as filed for the feature of claim 1 that the metal liner may *comprise* a double metal liner,

i.e. that it may include a double metal liner plus other features.

2.3 Claim 1 of the main request (under point (f)) defines forming an Al or Al alloy metal layer. The basis for this feature (which does not appear in independent claim 2 as originally filed) is said in the statement of grounds of appeal to be "found on page 19 lines 9-12". The passage in question reads as follows:

- *"FIG. 8 is a sectional view illustrating a step of forming the metal layer 219. In detail, the metal layer 219, i.e., an aluminum layer or an aluminum alloy layer, is formed on the entire surface of the resultant structure where the metal liner 218 is formed, through a combination of CVD and sputtering process."*

A similar disclosure may be found on page 7, lines 21-23 and in claims 60 and 61 as originally filed. However, in each case the metal layer is disclosed as being formed "through a combination of CVD and sputtering process". The Board finds no basis in the application as filed for the omission of the quoted feature in claim 1 of the main request.

2.4 Since the Board judges that the features of claim 1 of the main request referred to under points 2.1, 2.2 and 2.3, above, extend beyond the content of the application as originally filed, claim 1 of the main request does not comply with the requirements of Article 123(2) EPC.

3. First Auxiliary Request: Article 123(2) EPC

3.1 The feature "through a combination of CVD and sputtering process" has been included in claim 1 of the first auxiliary request, and hence the objection set out under point 2.3, above, has been overcome.

However, the objections raised under points 2.1 and 2.2, above, apply *mutatis mutandis* to claim 1 of the first auxiliary request, which does not therefore comply with the requirements of Article 123(2) EPC.

4. Conclusion

4.1 The Board can only decide upon the European patent application in the text submitted to it, or agreed, by the applicant-appellant (Article 113(2) EPC 1973). In the present case, although the Board expressed the opinion in the communication pursuant to Article 15(1) RPBA that the objections set out above (and other minor problems) could be easily overcome by amendment, the appellant has neither filed amendments nor challenged the Board's analysis.

Having been found not to meet the requirements of Article 123(2) EPC, neither the main request nor the first auxiliary request submitted by the appellant can be allowed. Under such circumstances there is no reason to remit the case to the Examining Division.

Order

For these reasons it is decided that:

1. The appeal is dismissed.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated