

Internal distribution code:

- (A) [-] Publication in OJ
(B) [-] To Chairmen and Members
(C) [-] To Chairmen
(D) [X] No distribution

**Datasheet for the decision
of 6 March 2015**

Case Number: T 2017/14 - 3.2.07

Application Number: 10177935.3

Publication Number: 2264215

IPC: C23C14/34, H01L21/28,
H01L21/285, H01L21/768,
C22C9/01, C22C9/02

Language of the proceedings: EN

Title of invention:

Copper alloy sputtering target, process for producing the same
and semiconductor element wiring

Applicant:

JX Nippon Mining & Metals Corporation

Headword:

Relevant legal provisions:

EPC Art. 56
RPBA Art. 13(1), 13(3)

Keyword:

Inventive step -
main request and first and second auxiliary requests (no)
Late-filed third auxiliary request - admitted (no)

Decisions cited:

G 0009/91, T 1705/07, T 1067/08

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 2017/14 - 3.2.07

D E C I S I O N
of Technical Board of Appeal 3.2.07
of 6 March 2015

Appellant: JX Nippon Mining & Metals Corporation
(Applicant) 6-3, Otemachi 2-chome
Chiyoda-ku
Tokyo 100-8164 (JP)

Representative: Hoarton, Lloyd Douglas Charles
Forresters
Skygarden
Erika-Mann-Strasse 11
80636 München (DE)

Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 21 May 2014
refusing European patent application No.
10177935.3 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman H. Meinders
Members: G. Patton
O. Loizou

Summary of Facts and Submissions

- I. The applicant (appellant) lodged an appeal against the decision of the Examining Division to refuse European patent application No. 10 177 935.3.
- II. The following documents considered in the impugned decision are referred to:

D1: US-A-6 066 892
D3: US-A-2001/0034126
- III. According to the impugned decision, the subject-matter of claim 1 of the then main and auxiliary requests was lacking inventive step starting from D1 as closest prior art and using the common general knowledge of the skilled person (Article 56 EPC).
- IV. With the statement of grounds of appeal the appellant maintained the above mentioned requests.
- V. In the annex to the summons to oral proceedings the Board presented its preliminary non-binding opinion with respect to the requests on file, in that the subject-matter of claims 1 of the main and auxiliary requests was regarded as lacking inventive step. Additionally, lack of clarity objections were also raised.
- VI. In reaction, the appellant filed on 23 February 2015 a second auxiliary request.
- VII. Oral proceedings took place on 6 March 2015 during which the matter was discussed with the appellant in particular regarding, *inter alia*, inventive step of the claims of the main and second auxiliary requests in

view of D1 as closest prior art and using the common general knowledge of the skilled person. Both requests were deliberated separately.

After hearing the negative result of the deliberation on the second auxiliary request, which applied a *fortiori* also to the first auxiliary request, the appellant filed a third auxiliary request.

The admissibility of the third auxiliary request was discussed with the appellant in view of Articles 13(1), 13(3) and 12(4) RPBA.

The Board announced its decision at the end of the oral proceedings.

VIII. The appellant requests that the decision under appeal be set aside and that a patent be granted on the basis of the set of claims of its main request or the first auxiliary request, as filed with its statement of grounds of appeal and alternatively on the basis of the set of claims of the second auxiliary request filed with its letter of 23 February 2015, or of the set of claims of the third auxiliary request filed at the oral proceedings held on 6 March 2015.

IX. Independent claim 1 of the **main request** reads as follows:

"A copper alloy sputtering target containing 0.01 to (less than) 0.5wt% of Al characterised in that the target contains either Mn or Si or both in a total amount of 0.25wtppm or less, and that the average crystal grain size of the target is 100µm or less, and the average grain size variation is within ±20%."

Independent claim 1 of the **first auxiliary request** reads as follows (in bold the amendments as compared to claim 1 of the main request; emphasis added by the Board):

"A copper alloy sputtering target containing 0.01 to (less than) 0.5wt% of Al characterised in that the target contains either Mn or Si or both in a total amount of 0.25wtppm or less, and that the average crystal grain size of the target is 100µm or less, and the average grain size variation is within ±20%, **wherein the inevitable impurities excluding gas components are 10wtppm or less, and wherein Na and K are respectively 0.05wtppm or less; U and Th are respectively 1wtppb or less; oxygen is 5wtppm or less; nitrogen is 2wtppm or less; and carbon is 2wtppm or less.**"

Independent claim 1 of the **second auxiliary request** reads as follows (in bold the amendments as compared to claim 1 of the main request; emphasis added by the Board):

"A copper alloy sputtering target **consisting of Cu, containing** 0.01 to (less than) 0.5wt% of Al, ~~characterised in that the target contains either~~ Mn ~~and~~ Si ~~or both~~ in a total amount of 0.25wtppm or less, **wherein the inevitable impurities excluding gas components are 10wtppm or less, one or more selected from among Sb, Zr, Ti, Cr, Ag, Au, Cd, In and As are in a total amount of 0.3wtppm or less, Na and K are respectively 0.05wtppm or less; U and Th are respectively 1wtppb or less; oxygen is 5wtppm or less; nitrogen is 2wtppm or less; and carbon is 2wtppm or less, and wherein that** the average crystal grain size

of the target is 100µm or less, and the average grain size variation is within ±20%."

Independent claim 1 of the **third auxiliary request** reads as follows:

"A method of manufacturing a copper alloy sputtering target comprising the steps of:
preparing a single phase mother alloy of Cu and Sn within the solid solubility limit and having a melting point of 800°C or higher,
melting the mother alloy with molten copper or an alloy to form an ingot containing 0.01 to less than 0.5wt% of Sn and either Mn or Si or both in a total amount of 0.25 wtppm or less, and
processing the ingot to form a sputtering target."

The other independent claims of the requests are not relevant for the present decision.

X. The arguments of the appellant are essentially as follows:

Main request

D1 does not disclose the following features of claim 1:

- a sputtering target;
- controlled Mn and Si contents; and
- the microstructural features regarding the average grain size and its variation.

They should therefore all be regarded as distinguishing features over D1.

Even if it could be admitted as being generally known that the finer the crystal grain structure of the sputtering target, the more uniform the sputtered film,

this cannot be said as belonging to the skilled person's common general knowledge for use in forming a seed layer of a semiconductor wiring. Inventive step for the subject-matter of claim 1 should therefore be acknowledged.

First and second auxiliary request

The impurity limits in claim 1 of the first and second auxiliary requests are not disclosed in the closest prior art D1. In fact, the oxygen and impurity contents in the copper alloy known from D1 are above the claimed limits.

The skilled person would have no incentive to improve the sputtering target of D1 as it does not disclose any sputtering target, nor would he see any reason to reduce the impurities contents to the claimed low levels. In view of the generally used industrial pure copper, the skilled person will assess the oxygen and impurity contents in the copper alloy of D1 to be above the claimed limits. Consequently, inventive step should be acknowledged.

Third auxiliary request

The third auxiliary request should be admitted in the procedure since its subject-matter was searched.

Reasons for the Decision

1. Main request

1.1 Disclosure of D1

1.1.1 D1 discloses a metallisation structure having a copper alloy seed layer (60) comprising copper and less than 10 at.% of an alloying element selected from the group consisting of magnesium, aluminium, boron and tellurium. When the alloying element of the copper alloy layer is aluminium, the amount thereof is 0.05 to 0.3 at.% (0.02 to 0.13 wt.%). D1 additionally describes that the copper alloy seed layer is deposited via sputtering (column 5, lines 15-23; column 7, lines 10-21; claims 1 and 6) (cf. also statement of grounds of appeal, page 3, third paragraph).

1.1.2 As correctly put forward by the appellant, D1 does not disclose a sputtering target **as such** with this composition.

However, as discussed during the oral proceedings, the Board cannot follow the appellant's view that a sputtering target should be considered as a distinguishing feature of claim 1 over the disclosure of D1. As a matter of fact, D1, column 5, line 16, explicitly discloses that the copper alloy seed layer (60) is **sputter deposited**. As a result, a sputtering target is disclosed in D1, at least implicitly, for obtaining the copper alloy seed layer (see also column 1, line 50 to column 2, line 27 and figure 1 for the conventional practice in the present technical field).

1.1.3 The appellant considers that D3, from which D1 is a continuation-in-part, teaches to form thin films from

different angles, namely a copper target and an alloy target. Since D1 does not disclose a sputtering target with the composition of the copper alloy seed layer, the appellant concludes that two targets are also used in D1. A sputtering target with the claimed composition would therefore not be known from D1 (statement of grounds of appeal, page 3, third to fifth paragraphs).

It is not clear to the Board, however, which part of D3 the appellant uses to support its view. Further, the Board is of the opinion that the disclosure of D3 cannot be transferred to D1; the latter has to be interpreted in light of its own disclosure. D1 mentions co-sputtering using **a** copper alloy sputtering target, i.e. a single target (column 2, line 65 to column 3, line 2), but this passage refers to the prior art of D1 and is the only reference to co-sputtering. There is no hint in D1 at the use of two different sputtering targets at the same time. Consequently, using his common general knowledge, the skilled person will unambiguously and directly derive that in D1 a single target is to be used in forming the copper alloy seed layer (60).

- 1.1.4 The Board considers that the aspects of the sputtering target used in D1 can be inferred from the characteristics of the copper alloy seed layer (60) described therein (cf. also statement of grounds of appeal, page 2, first three paragraphs of "Inventive Step").

Therefore, the microstructural features of the sputtering target used in D1 are indeed unknown and, hence, the Board concurs with the Examining Division and the appellant that the claimed average crystal grain size of the target being 100µm or less, and the

- average grain size variation being within $\pm 20\%$ are distinguishing features over the disclosure of D1 (impugned decision, page 3, last four paragraphs).
- 1.1.5 The Board further shares the Examining Division's finding that D1 implicitly provides a sputtering target having the composition of the copper alloy seed layer (60), i.e. a copper alloy containing 0.05 to 0.3 at.% (0.02 to 0.13 wt.%) Al (impugned decision, point 1, second paragraph).
- 1.1.6 As put forward by the appellant, D1 does not disclose Mn and Si as alloying elements nor any respective limits. It is silent on the need to control the concentration of these elements. Hence, the skilled person will unambiguously and directly derive that the Mn and Si contents in the sputtering target used in D1 are to be at impurity levels.
- 1.1.7 The Board concurs with the Examining Division, impugned decision, page 3, fourth paragraph, that the feature of claim 1: "the target contains either Mn or Si or both in a total amount of 0.25 wt. ppm or less", allows the claim to encompass copper alloys having infinitesimal amounts, possibly no amounts, of Mn and Si, i.e. down to impurity levels.
- 1.1.8 The appellant holds the view that contrary to this, Mn and Si are **not impurities** in the composition of the claimed sputtering target since their contents are **controlled** by using mother alloys in which Mn and Si are added together with high purity copper of a purity level of 6N or higher, further combined with process conditions (statement of grounds of appeal, page 4, first paragraph; examples 1-10 according to the invention, page 9, lines 16-20 of the application as

originally filed). As argued during the oral proceedings, this would be further clarified from the measures taken in the manufacturing process disclosed, page 6, lines 16-18, and page 8, lines 10-11, of the application as originally filed.

The Board cannot, however, share this view since the reference to the examples according to the invention given in the description does not provide any limitation on the interpretation of the claims, which concern product claims with Mn and Si contents covering impurity levels.

Further, contrary to the appellant's view, there is no indication in the application as originally filed on how to control these elements. As a matter of fact, the passages and even the examples mentioned by the appellant do not disclose such measures, e.g. addition of Mn and Si, and clearly deal with Mn and Si as impurities.

Therefore, since the Mn and Si contents are at impurity levels in both the sputtering target of claim 1 and that of D1, the claimed upper limits cannot be regarded as distinguishing features over the disclosure of D1.

- 1.1.9 Even if it were to be assumed that the sputtering target for obtaining the copper alloy seed layer (60) in D1 was at a purity level equivalent to a 4N grade, as argued by the appellant, which appears to the Board to be a mere allegation, the ASTM standard for oxygen-free electrolytic copper-refinery shapes filed by the appellant with its letter dated 23 February 2015, page 2, table 1, still does not enable to show that the Mn and/or Si contents in D1 would inevitably fall above the claimed limit.

1.1.10 The appellant considers that in view of the impurity level of the copper seed layer (62) in D1, the same impurity level of 1 at.% (less than 10,000 at. ppm) will also apply to the copper alloy seed layer (60). Since this disclosed limit is much higher than the claimed limit of 0.25 wt. ppm, the Mn and Si claimed contents should be regarded as distinguishing features over the disclosure of D1 (statement of grounds of appeal, page 3, last paragraph).

The Board cannot share the appellant's view since, as discussed during the oral proceedings, the 1 at.% limit applies exclusively to the copper seed layer (62). As a matter of fact, the passage mentioned by the appellant, column 5, lines 59-66, further mentions that "the 1% impurity or doping level does not apply to the alloying elements discussed here." There is no disclosure in D1 with respect to transferring this impurity level to the copper alloy seed layer (60), the contrary being even explicitly disclosed.

1.1.11 Therefore, in view of the above, the features of claim 1 that "the target contains either Mn or Si or both in a total amount of 0.25 wt. ppm or less" are not considered as being distinguishing features over D1, contrary to the appellant's view.

1.2 Distinguishing features

Consequently, the only distinguishing features of claim 1 over D1 are (see point 1.1.4 above; impugned decision, page 3, last four paragraphs):

the average crystal grain size of the target is 100µm or less, and the average grain size variation is within ±20%.

1.3 Technical effect

The technical effect of the distinguishing features is regarded as to enable to sputter uniform films (see application as originally filed, page 7, lines 22-28; statement of grounds of appeal, page 2, "Inventive step", sixth paragraph).

1.4 Problem to be solved

Hence, the objective technical problem to be solved is regarded as to modify the sputtering target of D1 in order to obtain uniform films (impugned decision, page 3, last paragraph).

1.5 Inventiveness

1.5.1 The Board shares the appellant's view that "it is known that, the finer the crystal grain structure of the sputtering target, the more uniform the sputtered film" (statement of grounds of appeal, page 4, second paragraph).

As a result, following this common general knowledge the skilled person will immediately come to the conclusion of reducing the average grain size of the sputtering target as well as its variation for solving the above mentioned objective technical problem. By doing so, he will arrive at the claimed subject-matter in an obvious manner. As a consequence, the Board cannot find fault in the reasoning and conclusion provided by the Examining Division with respect to the

lack of inventive step of the subject-matter of claim 1, that the skilled person starting from D1 and using his common general knowledge will arrive at the claimed subject-matter in an obvious manner (Article 56 EPC) (impugned decision, point 1, as from page 3, fifth paragraph).

- 1.5.2 The appellant contests, however, that this knowledge would belong to the common general knowledge of the person skilled in the art of forming seed layers for semiconductor wiring. Therefore, he would not think of applying it **for use** in forming a seed layer of a semiconductor wiring like in D1.

The Board cannot follow the appellant's argument since the intended use of the sputtered film cannot make the above mentioned common general knowledge "not known" by the skilled person. When faced with the problem to be solved defined above he will apply that knowledge to provide a sputtering target suitable for deposition of uniform films (impugned decision, page 3, last paragraph) or to solve the even more general problem defined by the appellant itself to provide a sputtering target with improved sputtering characteristics (statement of grounds of appeal, page 2, seventh paragraph).

2. **First and second auxiliary requests**

- 2.1 During the oral proceedings, the discussion focused on the second auxiliary request. In case the subject-matter of claim 1 of the second auxiliary request would lack inventive step, so would the subject-matter of claim 1 of the first auxiliary request. This was not disputed by the appellant.

- 2.2 With respect to claim 1 of the main request claim 1 of the second auxiliary request (see point IX above):
- a) - closes off the copper alloy sputtering target composition ("containing" replaced by "consisting of");
 - b) - specifies "Mn and Si in a total amount of 0.3wtppm or less" instead of "either Mn or Si or both in a total amount of 0.25wtppm or less"; and
 - c) - sets further upper limits for impurities: "the inevitable impurities excluding gas components are 10wtppm or less, one or more selected from among Sb, Zr, Ti, Cr, Ag, Au, Cd, In and As are in a total amount of 0.3wtppm or less, Na and K are respectively 0.05wtppm or less; U and Th are respectively 1wtppb or less; oxygen is 5wtppm or less; nitrogen is 2wtppm or less; and carbon is 2wtppm or less".
- 2.3 As argued by the appellant, the first two amendments a) and b) aim at overcoming lack of clarity objections raised in the annex to the summons to oral proceedings. They are not there to distinguish the claimed subject-matter further from the disclosure of D1 in view of the discussion for the main request under point 1.1 above.
- 2.4 As discussed during the oral proceedings, the claimed limits for impurities specified in the last amendment c) are indeed not explicitly disclosed in the closest prior art D1.
- 2.5 With its written submissions the appellant argues that the oxygen and impurity contents in oxygen free high conductivity copper (OFHC) and electrolytic cathode copper "generally used as industrial pure copper" are higher than the claimed limits. This would apply to the copper alloy known from D1.

The Board considers, however, contrary to the appellant's view, that these claimed upper limits for impurities do not enable to distinguish the claimed sputtering target from that of D1. The reasons are the same as those given above for the Mn and Si contents (see point 1.1.8 above): claimed upper limits for impurities cannot be regarded as distinguishing features over such impurities as present in the copper alloy as disclosed in D1. That the oxygen and impurity contents in D1 are inevitably above the claimed limits amounts to a mere allegation.

As a consequence, the reasoning and conclusion given above for the main request with respect to the lack of inventive step continue to apply against claim 1 of the second auxiliary request, *a fortiori* against claim 1 of the first auxiliary request (Article 56 EPC).

2.6 Holding the view that above feature c) regarding the impurity levels should be regarded as a distinguishing feature, the appellant considers that the skilled person would have no incentive to improve the sputtering target of D1 in that sense as D1 does not disclose a sputtering target as such, nor would he see any reason to reduce its impurity contents to such claimed low levels. Consequently, inventive step should be acknowledged.

2.7 Even if the claimed levels of impurities were to be considered as distinguishing features, these arguments can still not convince the Board for the reasons discussed during the oral proceedings that it belongs to the common general knowledge of the skilled person that impurities negatively affect the performance of semiconductor elements (application, page 1, lines 25-29; page 6, line 31 to page 7, line 9). Hence, faced

with the problem of avoiding negative effects on the semiconductors, the skilled person will immediately think of reducing to the lowest possible levels the impurity contents of the sputtering target for producing copper alloy wiring for semiconductors. The skilled person is indeed aware that the sputtering target is a source for the impurities that will be included in the film to be produced. Therefore, even if the claimed levels of impurities were to be considered as distinguishing features, they could still not justify an inventive step for the subject-matter of claims 1 of the first and second auxiliary requests (Article 56 EPC).

2.8 As already mentioned above, the appellant is of the opinion that, in view of the oxygen free high conductivity copper (OFHC) and electrolytic cathode copper "generally used as industrial pure copper", the skilled person will envisage the oxygen and impurity contents in the copper alloy of D1 to be above the claimed limits.

2.9 The Board cannot follow this appellant's argument for the reason that it relates to what is generally accepted in industry, not to what the skilled person would do when faced with the above problem of avoiding negative effects of impurities on semiconductors.

3. **Third auxiliary request**

3.1 The appellant filed the third auxiliary request during the oral proceedings before the Board. Due to this late-filing the admission of the request in the procedure is subject to the discretionary power of the Board in accordance with Articles 13(1), (3) RPBA.

- 3.2 The third auxiliary request, which comprises only method claims, reverts to the alternative of the copper alloy sputtering target comprising "Sn", which had been deleted from the claims by the appellant after having received the search report, i.e. before the very first communication of the Examining Division (see appellant's letter of 16 September 2011 in the examination proceedings). As a consequence, this "Sn" alternative has never been dealt with by the Examining Division and is clearly not part of the impugned decision. In fact, it appears from the file that the appellant has constantly focused in examination and appeal proceedings on the alternative of the copper alloy sputtering target comprising "Al" (aluminium). Hence, the Board was confronted with this new subject-matter for the very first time at the oral proceedings, without having any finding of the Examining Division on it.
- 3.3 The appeal proceedings, which are largely determined by the factual and legal scope of the preceding proceedings, are, however, not about bringing an entirely fresh case to the Board. This means that an appellant is not at liberty to bring about the shifting of its case to the appeal proceedings as it pleases, and so compel the Board either to give a first ruling on the critical issues or to remit the case to the Examining Division. Conceding such freedom to an appellant would run counter to orderly and efficient appeal proceedings, contrary to Article 13(1) RPBA. In effect, it would allow a kind of "forum shopping" which would jeopardise the proper distribution of functions between the departments of first instance and the boards of appeal and would be absolutely unacceptable for procedural economy generally (G 9/91, OJ EPO 1993, 408, point 6; T 1705/07, not published, point 8.4 of

the reasons; T 1067/08, not published, points 7.1 to 7.2).

- 3.4 Further, in view of the change in the subject-matter as filed during the oral proceedings, which has never been dealt with before, the Board cannot reasonably be expected to deal with it without adjournment of the oral proceedings, either for it to examine in substance or to remit it to the Examining Division for further prosecution, contrary to Article 13(3) RPBA.
- 3.5 For these reasons, the board has decided to exercise its power under Articles 13(1), (3) RPBA not to admit the third auxiliary request in the appeal proceedings.
- 3.6 The appellant argues that the subject-matter of the third auxiliary request was searched (see European Search Report of 7 February 2011), which was not the case for the earlier application 04 712 732.9 from which this divisional application originates. Consequently, the appellant considers itself entitled to file such a searched subject-matter.
- 3.7 The Board cannot share the appellant's view since the mere fact that the subject-matter was searched does not change the fact that the Board is confronted with it for the first time at such a late stage in the proceedings, which, for the reasons given above under points 3.3 and 3.4, cannot be accepted, in applying the principles of Articles 13(1) and 13(3) RPBA.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



G. Nachtigall

H. Meinders

Decision electronically authenticated