Internal distribution code:

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

Datasheet for the decision of 17 July 2025

Case Number: T 1294/23 - 3.4.03

Application Number: 15183241.7

Publication Number: 2996141

IPC: H01L21/66

Language of the proceedings: EN

Title of invention:
METHOD OF EVALUATING METAL CONTAMINATION IN BORON-DOPED P-TYPE SILICON WAFER, DEVICE FOR EVALUATING METAL CONTAMINATION IN BORON-DOPED P-TYPE SILICON WAFER, AND METHOD OF MANUFACTURING BORON-DOPED P-TYPE SILICON WAFER

Applicant:
Sumco Corporation

Relevant legal provisions:
EPC Art. 83
RPBA Art. 13(1)
RPBA 2020 Art. 13(2)

Keyword:
Sufficiency of disclosure - (no)
Amendment after notification of Art. 15(1) RPBA communication - exceptional circumstances (no) - taken into account (no)

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

Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0

Case Number: T 1294/23 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 17 July 2025

Appellant: Sumco Corporation
(Applicant) 1-2-1 Shibaura,
Minato-ku, Tokyo 105-8634 (JP)

Representative: Godemeyer Blum Lenze Patentanwälte
Partnerschaft mbB - werkpatent
An den Gärten 7
51491 Overath (DE)

Decision under appeal: **Decision of the Examining Division of the European Patent Office posted on 3 January 2023 refusing European patent application No. 15183241.7 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman T. Häusser
Members: M. Ley
E. Mille

Summary of Facts and Submissions

I. The appeal is against the decision of the examining division refusing European patent application No. 15 183 241 pursuant to Article 97(2) EPC.

The following documents *inter alia* were cited in the decision under appeal:

D1 K. Kurita et al., "Identification and Quantification of Transition Metal Impurities in Czochralski Silicon Wafers using Microwave Photoconductive Decay Lifetime Measurements", Jpn. J. Appl. Phys., vol. 37, 1998, pages 5861 to 5865

D4 M. L. Polignano et al., "Cobalt Contamination in Silicon", Solid State Phenomena, vols. 108 - 109, 2005, pages 571 to 576

D5 N. Pic et al., "Influence of cobalt contamination in the measurement of diffusion length of p-type CZ silicon wafers", Proceedings of SPIE - The International Society for Optical Engineering, 2002.

II. The examining division decided *inter alia* that the subject-matter of claim 1 according to the main request and according to the first and second auxiliary requests underlying the decision lacked an inventive step (Article 56 EPC) over D5.

III. The appellant requests that the impugned decision be set aside and a patent be granted on the basis of one of a main request or first to sixth auxiliary requests.

The main request and the first to third auxiliary requests were filed as first to fourth auxiliary requests with the statement setting out the grounds of appeal. The fourth and fifth auxiliary requests were filed with the letter dated 12 June 2025. The sixth auxiliary request was filed during the oral proceedings before the board.

IV. Claim 1 of the **main request** has the following wording (feature labelling (a) to (c) added by the board):

A method of evaluating metal contamination of metals bonding to boron by means of electrostatic forces in a boron-doped p-type silicon wafer, which comprises:
(a) measuring over time by a microwave photoconductive decay method a recombination lifetime following irradiation with light of a silicon wafer being evaluated and obtaining information on change over time of the recombination lifetime; and
(b) comparing the information on change over time of the recombination lifetime that has been obtained with reference information on change over time that has been obtained by calculation or actual measurement of a recombination lifetime of an Fe-contaminated boron-doped p-type silicon wafer **(c)** to determine whether or not metal contamination of metals bonding to boron by means of electrostatic forces other than Fe is present in the silicon wafer being evaluated.

Claim 2 of the **main request** has the following wording:

The method of evaluating metal contamination in a boron-doped p-type silicon wafer according to claim 1, which further comprises, when it is determined that metal contamination other than Fe is present in the silicon wafer being evaluated, conducting at least

either (1) or (2) below:
(1) obtaining a concentration of metal contamination other than Fe from a recombination lifetime obtained by a first measurement following irradiation with light that is included in the information on change over time of the recombination lifetime and from a recombination lifetime obtained by a second measurement conducted within a prescribed period during which it is estimated that re-pairing of Fe and boron will not advance substantially following the first measurement; and
(2) obtaining a concentration of metal contamination other than Fe from a recombination lifetime obtained by a first measurement following irradiation with light that is included in the information on change over time of the recombination lifetime and from a recombination lifetime obtained by a third measurement conducted after a prescribed period, during which it is estimated that re-pairing of Fe and boron will advance substantially, has elapsed following the first measurement.

V. Claim 1 according to the **first auxiliary request** is directed to (additions with respect to claim 1 of the main request underlined by the board) a method of evaluating metal contamination of metals <u>other than Fe</u> bonding to boron by means of electrostatic forces in a <u>Fe-contaminated</u> boron-doped p-type silicon wafer, which comprises features (a) to (c).

The wording of claim 2 of the **first auxiliary request** is identical to the wording of claim 2 of the main request.

VI. Claim 1 of the **second** and **third auxiliary requests** has the following wording:

A method of evaluating metal contamination of Co in a Fe-contaminated boron-doped p-type silicon wafer, which comprises:

measuring over time by a microwave photoconductive decay method a recombination lifetime following irradiation with light of a silicon wafer being evaluated and obtaining information on change over time of the recombination lifetime; and

comparing the information on change over time of the recombination lifetime that has been obtained with reference information on change over time that has been obtained by calculation or actual measurement of a recombination lifetime of an Fe-contaminated boron-doped p-type silicon wafer to determine whether or not metal contamination of Co is present in the silicon wafer being evaluated.

Claim 2 of the **second** and **third auxiliary requests** has the following wording:

The method of evaluating metal contamination in a boron-doped p-type silicon wafer according to claim 1, which further comprises, when it is determined that metal contamination of Co is present in the silicon wafer being evaluated, conducting (1) below:
(1) obtaining a concentration of metal contamination of Co from a recombination lifetime obtained by a first measurement following irradiation with light that is included in the information on change over time of the recombination lifetime and from a recombination lifetime obtained by a second measurement conducted within a prescribed period during which it is estimated that re-pairing of Fe and boron will not advance substantially following the first measurement.

VII. Claim 1 according to the **fourth auxiliary request** is identical to claim 1 of the main request.

Claim 2 according to the **fourth auxiliary request** has the following wording:

The method of evaluating metal contamination in a boron-doped p-type silicon wafer according to claim 1, which further comprises, when it is determined that metal contamination other than Fe is present in the silicon wafer being evaluated, conducting at least either (1) or (2) below:
(1) obtaining a concentration of metal contamination other than Fe from a recombination lifetime obtained by a first measurement within 10 minutes following irradiation with light that is included in the information on change over time of the recombination lifetime and from a recombination lifetime obtained by a second measurement conducted after 30 minutes have elapsed but before more than 2 hours have elapsed following irradiation with light during which it is estimated that re-pairing of Fe and boron will not advance substantially following the first measurement; and
(2) obtaining a concentration of metal contamination other than Fe from a recombination lifetime obtained by a first measurement within 10 minutes following irradiation with light that is included in the information on change over time of the recombination lifetime and from a recombination lifetime obtained by a third measurement conducted after 2 hours have elapsed following irradiation with light, during which it is estimated that re-pairing of Fe and boron will advance substantially, has elapsed following the first measurement.

VIII. Claim 1 according to the **fifth auxiliary request** corresponds to claim 2 of the fourth auxiliary request.

IX. Claim 1 according to the **sixth auxiliary request** has the following wording:

A method of evaluating metal contamination of metals bonding to boron by means of electrostatic forces in a Fe-contaminated boron-doped p-type silicon wafer, wherein the metal contamination comprises contamination by Co, which comprises:
measuring over time by a microwave photoconductive decay method a recombination lifetime following irradiation with light of a silicon wafer being evaluated and obtaining information on change over time of the recombination lifetime; and
comparing the information on change over time of the recombination lifetime that has been obtained with reference information on change over time that has been obtained by calculation or actual measurement of a recombination lifetime of an Fe-contaminated boron-doped p-type silicon wafer to determine whether or not metal contamination of metals bonding to boron by means of electrostatic forces other than Fe is present in the silicon wafer being evaluated,
the method further comprises, when it is determined that metal contamination of Co is present in the silicon wafer being evaluated, conducting (1) below:

(1) obtaining a concentration of metal contamination of Co from a recombination lifetime obtained by a first measurement within 10 minutes following irradiation with light that is included in the information on change over time of the recombination lifetime and from a recombination lifetime obtained by a second measurement conducted after 30 minutes have elapsed but

before more than 2 hours have elapsed following irradiation with light during which it is estimated that re-pairing of Fe and boron will not advance substantially following the first measurement.

X. The appellant mainly argued that the patent application as a whole provided sufficient information for the skilled person to carry out the invention so that the requirements of Article 83 EPC were met.

The sixth auxiliary request filed during the oral proceedings before the board should be admitted into the appeal proceedings as a reaction to the objection under Article 83 EPC raised for the first time in the board's communication under Article 15(1) RPBA and the discussion during oral proceedings.

Reasons for the Decision

1. In the following, the board uses the numbering of the paragraphs according to the A1 publication of the patent application, which differs from the one used in the application documents as originally filed.

2. The invention relates to a method of evaluating metal contamination in a boron-doped p-type silicon wafer, see paragraph [0001] of the application.

According to the application, microwave photoconductance decay (μ-PCD) and surface photovoltage (SPV) methods are used to evaluate Fe as a contaminant in silicon wafers, see paragraph [0003] of the application. As also explained in paragraph [0008] of the application, in boron-doped p-type silicon wafers, Fe bonds to boron by means of electrostatic forces and

forms Fe-B pairs. These pairs can be dissociated by irradiation with light. The µ-PCD method using the measured recombination lifetimes before and after the dissociation of Fe-B pairs, is known as a method of measuring the Fe concentration in boron-doped p-type silicon wafers.

The application aims at providing a method of evaluating metal contamination of metals bonding to boron by means of electrostatic forces in a boron-doped p-type silicon wafer. These metals might be metals other than Fe (e.g. Co, Cu, ...) and might possibly be present in a boron-doped p-type wafer that may or may not comprise in addition Fe as a contaminant.

The method consists of identifying such metal other than Fe by measuring over time by the µ-PCD method a recombination lifetime τ following irradiation with light of a silicon wafer being evaluated and comparing the results with reference information on change over time that has been obtained by calculation or actual measurement of a recombination lifetime of an Fe-contaminated boron-doped p-type silicon.

This is allegedly possible because the rate of re-pairing with boron (called "pairing time constant" in D5, see Figure 4) following irradiation with light depends on the type of metal. Hence, the change over time of the recombination lifetime measured after irradiating with light a silicon wafer contaminated with metal other than Fe differs from that of a silicon wafer contaminated with Fe, see paragraphs [0008] to [0010] of the application.

In case a metal other than Fe is found and identified,

its concentration is determined, in accordance with e.g. claim 2 of the main request, by performing two measurements of the recombination lifetime, the first one (τ_1) being performed following irradiation with light, the second one (τ_2) conducted within a prescribed period according to alternatives (1) or (2).

In summary, the claimed method allegedly makes it possible to determine whether or not contamination by metal other than Fe is present and to measure the concentration of the contamination by that metal, see paragraphs [0036], [0056] and the first sentence of paragraph [0061] of the application, see also the statement setting out the grounds of appeal, page 3, second paragraph.

3. Main request - sufficiency of disclosure

3.1 Claims 1 and 2 of the main request are identical to claims 1 and 2 of the main request underlying the impugned decision.

The patent application does not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art, contrary to what is required by Article 83 EPC.

3.2 According to features (a) and (b), the recombination lifetime is measured over time using a μ-PCD method for a boron doped p-type silicon wafer to obtain "information on change over time of the recombination lifetime", see e.g. the curves shown in Figure 3 of the application for "Lot 1" and "Lot 2". This obtained information is then compared to reference information corresponding to an Fe-contaminated boron-doped p-type

silicon wafer. Such reference information is shown e.g. in Figure 2 of the application.

It is undisputed that the skilled person has the knowledge to perform such measurements, the µ-PCD method being a well-known technique in the field of semiconductor technology.

3.3 As also pointed out by the appellant (see e.g. the statement setting out the grounds of appeal, paragraph bridging pages 5 and 6 and section 3.3, second paragraph), the wording of feature (b) of claim 1 leaves it open whether the comparing step is performed by technical means (e.g. a computer) or by a human operator merely comparing raw measurement data, possibly using a display or a plotter. In other words, the comparing step does not necessarily involve complex data processing e.g. performed by a computer in order to determine whether or not metal contamination of metals bonding to boron by means of electrostatic forces other than Fe is present in the silicon wafer being evaluated.

3.4 In the board's view, the application is silent about how a comparison between the information obtained for a silicon wafer to be evaluated and reference information would allow the skilled person to conclude that a metal contamination of metals bonding to boron by means of electrostatic forces other than Fe are indeed present.

For example, the skilled person confronted with the curves shown in Figures 2 and 3 of the application might conclude that the recombination lifetimes of the silicon wafers to be evaluated (see Figure 3) is affected in a different way than for the Fe-contaminated reference wafer. However, the skilled

person would not be in a position to conclude that metals (e.g. Co or Cu or any other metal) bonding to B by means of electrostatic forces other than Fe would be necessarily present. The difference in recombination lifetimes could also result from recombination centres of other types (surface damage, oxygen, carbon, defects, etc.).

The board notes that in the case of the application the presence of Co is previously known by use of an inductively coupled plasma mass spectrometer (ICP-MS) and its concentration is measured by a deep-level transient spectroscopy (DLTS) method, see paragraphs [0065] and [0066] of the application. In other words, the measurements by these techniques allow to conclude that "metals bonding to boron by means of electrostatic forces other than Fe" are indeed present, and not the comparing step according to feature (b).

In other words, confronted with a boron-doped p-type silicon wafer, the skilled person would conclude from the measurements according to feature (a) and the comparison according to feature (b) at most that said silicon wafer comprises ingredients (e.g. metal contamination or others) affecting the recombination lifetime in a different way than Fe contamination. The application as a whole does not disclose any teaching which would allow the skilled person to identity said ingredients, in particular when said silicon wafer comprises a contamination with several metallic elements (Fe, Co, Cu, etc.).

3.5 In the case of alternative (1), the board understands that the second measurement is performed at a moment when re-pairing of Fe and boron has not yet substantially advanced. According to the application,

alternative (1) relating to the second measurement is suitable in the case of contamination with a metal having a rate of re-pairing with B that is substantially faster than that of Fe, see paragraphs [0047] to [0051]. In the case of alternative (2), the board understands that the third measurement is performed at a moment after a period of repairing of Fe and boron. According to the application, alternative (2) relating to the third measurement is suitable in the case of contamination with a metal having a rate of re-pairing with B that is substantially slower than that of Fe, see paragraphs [0047] to [0051].

The board hence understands that, for both alternatives (1) and (2) of claim 2, the first measurement (providing τ_1) is performed after irradiation with light and the second/third measurement (providing τ_2) performed later at a moment when re-pairing of Fe and boron has not yet substantially advanced (in the case of the second measurement)/has substantially advanced (in the case of the third measurement).

In the case of the example of Figure 2, the second measurement might be performed 30 to 120 min after irradiation, see paragraph [0049], and the third measurement might be performed more than 120 min after irradiation, see paragraph [0051]. Accordingly, the first measurement could be formed up to 30 min after irradiation in the case of Figure 2, see also the last sentence of paragraph [0054].

The application as a whole provides only <u>one</u> alleged way of obtaining the metal concentration according to alternatives (1) and (2) from two measurements of the recombination lifetime. According to paragraphs [0019], [0053], [0054] and claim 6 of the main request, the

concentration M of the metal contamination other than Fe (in atoms/cm^3) is allegedly obtained by the formula $M = k (1/\tau_2 - 1/\tau_1)$, where k is a coefficient (specific to the metal element), see paragraph [0054].

3.6 However, the board is convinced that it is not possible to obtain the concentration of metal contamination from the first and second/third measurements as defined in claim 2 using the formula cited above.

3.6.1 First, the coefficient k is different for each metal element. As an example, paragraphs [0055] and [0071] of the application indicate the value of 6×10^8 for cobalt.

However, as pointed out before, after performing method steps (a) and (b) of claim 1, a skilled person is not in a position to identify the metal element (other than Fe) in the silicon wafer and is therefore not in a position to select the adequate value of coefficient k by merely performing the method steps of claims 1 and 2, i.e. when confronted e.g. to the measurements of Figure 2 of the application.

3.6.2 Even assuming that the skilled person is aware of the exact metal element of the metal contamination causing the measured recombination lifetime change over time, it is not possible to derive its concentration using the formula of e.g. claim 6, because it is left open when exactly the first measurement is to be performed. For example in the case of Figure 2 of the application (cobalt contamination with $k = 6 \times 10^8$), measuring τ_1 at 1 min or at 20 min after irradiation would produce two very different values of the concentration.

Even assuming that the first measurement is performed

within the first 10 minutes after irradiation and e.g. the second measurements 30 min to 120 min after irradiation, the value calculated using said formula might still strongly depend on the time moments selected to perform said measurements so that it cannot be said that said formula would allow to obtain an accurate value of the contaminant concentration.

3.6.3 Moreover, according to Figure 3 of the application, in case of "Lot 2" (Co contaminant concentration of 4.12 x 10^{10} atoms/cm^3 as measured by the DLTS method, see paragraph [0066]), the recombination lifetime measured immediately after irradiation is smaller than the recombination lifetime measured after 35 min, i.e $\tau_1 < \tau_2$ so that $1/\tau_1 > 1/\tau_2$.

Using the said formula, $M = k\ (1/\tau_2 - 1/\tau_1)$, a negative number for contaminant concentration would be obtained, which does not make sense, as also acknowledged by the appellant. This implies that either said formula or the measurements shown Figure 3 are erroneous or that the formula is not applicable to the example of Co. The board notes that in case of Fe (Figure 2 of the application), one finds $\tau_1 > \tau_2$ so that the formula would generate a positive value for the concentration of Fe contaminant.

3.6.4 The board also notes that the measured recombination lifetimes τ_1, τ_2 measured e.g. about 2 min and 35 min after irradiation (as done in Figure 3 of the application for "Lot 2") depend on the wafer resistivity due the boron dopant concentration in the silicon wafer (10 Ωcm in the case of Figure 3, see paragraph [0064] of the application). This is also confirmed by equations (1) and (a) in paragraphs [0042] and [0043] of the application, which show the time

dependence of the repairing of Fe-B on the boron concentration N_B.
However, this implies that the coefficient k must also depend on the wafer resistivity. In other words, a value k of e.g. 6×10^8 for Co cannot be used for any boron-doped p-type silicon wafer, contrary to what is stated e.g. in paragraph [0071] of the application.

3.6.5 An additional issue is that, in the formula of claim 6, concentration M is expressed in atoms per cm^3 (see also paragraph [0019]) and the recombination lifetimes are expressed in seconds. A skilled person would understand that the coefficient k must therefore have a physical unit, namely s/cm^3, in order to render the formula dimensionally consistent.

This is in contradiction to the fact that, according to paragraphs [0047] and [0063] of the application, k is a dimensionless coefficient ($k = 6 \times 10^8$ for cobalt), as explicitly confirmed in the appellant's letter dated 12 June 2025, page 4, third-to-last paragraph, first sentence ("As already mentioned in our previous submission k does not have any dimension").

3.7 The appellant's arguments provided in support of sufficiency of disclosure were not found convincing by the board and will be addressed in the following paragraphs.

3.7.1 In the statement setting out the grounds of appeal, the appellant stated that claim 1 described the determination of the metal contamination of metals other than Fe in an iron-contaminated boron-doped p-type silicon wafer, see section 3.1, second paragraph.

In its letter dated 12 June 2025, the appellant argued

that the invention described a method in which during the bulk production of wafers it was easily and quickly possible to identify those wafers which had a higher metal contamination other than Fe by a contact-free technique. It was not necessary to identify the contaminating metals, because the raw materials were always analysed before they were used for wafer production. Therefore, the metals which were possible impurities were known beforehand.

Moreover, the measurement was carried out on wafers which had already been tested for other types of defects so that the change of the recombination lifetime could only result from the presence of contaminating metals.

The appellant also added that it was known from the state of the art, for example from D5, that Co had replaced Ti for the silicide front-end process step of preparing wafers. Co was applied as barrier metal on the top of the silicon layer of a semiconductor device and the metal reacted with Si atoms.

The board is not persuaded by these arguments.

As pointed out above, the claimed method defined in claims 1 and 2 clearly requires that the metal other than iron in question is identified by method steps (a) and (b) of claim 1 and that its concentration is obtained by two recombination lifetime measurements according to alternatives (1) and (2) of claim 2, the only way to determine said concentration being the equation claimed in dependent claim 6 and mentioned multiple times in the description.

The claimed method is neither limited to a quality

measurement during a silicon wafer production nor does it include any other known techniques (such as ICP-MS, DLTS, etc.) to identify contaminating metal elements or any other possible recombination centres.

The wafer to be evaluated in the claimed method is not more than a boron-doped p-type silicon wafer that may or may not contain iron and/or any other metal contaminants and/or other recombination centres. As such wafers do not necessarily have any device structures manufactured thereon, it cannot reasonably be said that they would always contain iron or cobalt, contrary to what the appellant alleged.

3.7.2 The appellant referred to paragraphs [0052] to [0055] and Figures 2 and 3 of the application, from which the skilled person would derive that Co was present and how its concentration was determined.

Paragraph [0048] of the application described how the determination of the metal concentration took place. The core point was that a difference in recombination lifetime was measured compared to a non-contaminated wafer. The higher this difference was the more contamination was present. The time points or time range of measurements of the first, second and third measurements were described in paragraphs [0054], [0016] and [0017] of the application.

The board is not convinced by this argumentation.

There is no indication in the application as a whole that the measurements as defined in claim 2 were compared to a non-contaminated wafer or a reference wafer with a known contamination so that the concentration would be derived for the wafer to be

evaluated. The application as a whole makes it clear that the measurements are to be used in the formula provided e.g. in paragraphs [0019] or [0053] of the application and which is also specified in dependent claim 6.

As pointed out before, the board has several reasons to conclude that said formula cannot provide an accurate estimation of the concentration of a contaminant.

3.7.3 Regarding the formula used in claim 6, the appellant argued that the coefficient k did not have any dimension and was specific for any metal. This could be seen for example from document D4 in the experimental results. M in the formula denoted the "concentration grade of the contamination". It did not describe an absolute amount of concentration, but a relative amount of contamination, see also the last sentence of paragraph [0056]. After the measurement it was clear if the evaluated wafer fulfilled the quality requirements or included a metal contamination which was too high so that the wafer could not be further used. The claimed method thus constituted a quality check made at the end of a production process.

In other words, the measurements made according to claim 2 were compared to a known standard (e.g. containing Co). The manufacturing a reference information wafer containing Co was disclosed in paragraph [0066] of the application. As a consequence, the units atoms/cm^3 for M was removed from claims 5 and 4 of auxiliary requests 4 and 5, respectively.

According to the appellant, the formula used in the application might contain errors (possibly due to a mistranslation from the original Japanese text). For

example, the issue with the sign might be resolved by supposing that the formula could read $M = k (1/\tau_1 - 1/\tau_2)$, the formula not being applicable to the measurement of "reference information" shown in Figure 2 for iron.

The appellant added during the oral proceedings the argument that it was known to the skilled person how to measure the concentration of a contaminant, as shown in paragraph [0008] of the application or document D1, page 5865, left-hand column.

The board cannot agree with the appellant.

Throughout the application, it is described that the claimed method aims at measuring an absolute concentration of a metal contamination other than Fe expressed in atoms/cm^3 (see paragraphs [0019], [0053], [0054] and claim 7 as originally filed), and not a relative amount which had to be compared to a reference wafer containing an known amount of the same metal.

This absolute concentration is to be obtained from the measurements according to claim 2 and the formula provided in paragraphs in paragraphs [0019] and [0053] of the application. There is no indication in the application that the method known for a Fe-contaminated silicon wafer mentioned in paragraph [0008] could also be used for a silicon wafer to be evaluated as discussed in section 3.7.1 above, last paragraph.

The board is not aware of any passages in the original Japanese application that would suggest that there was a mistranslation. On the contrary, the same mathematical formula to calculate M in atoms/cm^3 is used.

It is also noted that the disclosure of paragraphs [0066] to [0071] of the application does not concern the manufacturing of a reference wafer, as alleged by the appellant, but serves to experimentally calculate a value for coefficient k for cobalt in a silicon wafer of a resistivity of 10 Ωcm, which is to be used in the formula of dependent claim 6, see paragraph [0071].

With respect D1, the passage indicated by the appellant on page 5865 reads "After the identification of iron, its concentration can be determined using the correlation curve of the relationship between the measured recombination lifetime and iron-boron pairs concentration measured by DLTS (see Fig. 8)". In other words, other measurements techniques are used to determine the concentration of known metal contaminants. This is in accordance of what is explained in section 2.1 of D1.

The same conclusion has to be drawn when considering document D4. The appellant did not indicate a specific paragraph. The board notes that the section on "Experimental results" on page 573 uses a mathematical formula to calculate the cobalt concentration in silicon, which seems similar to the one mentioned in the present application. However, the formula uses the lifetime measured before any dissociation by light ("before activation") and has a coefficient "k" which has a unit (namely $s \cdot cm^{-3}$), contrary to the present application.

Hence, documents D1 or D4 do not provide evidence that a method using two recombination lifetime measurements as defined in claim 2 was known to the skilled person, even irrespective of the fact that both documents are

publications in scientific journals rather than extracts from textbooks, which are normally taken as evidence of the skilled person's common general knowledge.

4. First to fifth auxiliary requests - sufficiency of disclosure

4.1 The first auxiliary request corresponds to the first auxiliary request underlying the decision under appeal.

While claim 1 now requires that the silicon wafer to be evaluated is Fe contaminated, the application does not explain how to identify any metals other than Fe (such as Co, Cu, etc.) and determine their concentrations using the claimed method steps.

Therefore, the board considers the first auxiliary request 1 unallowable under Article 83 EPC for the reasons already provided.

4.2 The second auxiliary request corresponds to the second auxiliary request underlying the decision under appeal.

The third auxiliary request corresponds to the second auxiliary request with claim 7 deleted.

While claim 1 now requires that the silicon wafer to be evaluated is Fe contaminated, the same wafer does not necessarily contain Co and may or may not contain other metals such as Cu.

For the reasons already given, the application does not explain how to identify Co and determine its concentration using the claimed method steps.

Therefore, both auxiliary requests are unallowable under Articles 83 EPC for the reasons provided above.

4.3 The fourth and fifth auxiliary request were filed with the appellant's letter dated 12 June 2025.

According these requests it is claimed in very broad terms when the first, second and third measurements are to take place. It has already been concluded in the context of the main request that specifying the times of the first, second and third measurements in these broad terms is not sufficient for overcoming the objection under Article 83 EPC.

Therefore, both auxiliary requests are unallowable under Article 83 EPC for the reasons provided above.

The question of their admittance under Article 13(2) RPBA can be left open.

5. Sixth auxiliary request - admittance

5.1 The appellant justified the late filing of the sixth auxiliary request during the oral proceedings before the board by the fact that the objection under Article 83 EPC was raised for the first time by the board in the communication pursuant to Article 15(1) RPBA. Moreover, the deletion of claim 6 should be seen as a reaction to the discussions during the oral proceedings on the issues with the formula used to calculate the metal concentration.

The sixth auxiliary request corresponded to a combination of the subject-matter of the second and fifth auxiliary requests. It did not introduce new or complex matters.

5.2 During the oral proceedings, the board decided not to admit the sixth auxiliary request into the appeal proceedings (Article 13(1) and (2) RPBA) in view of the following considerations.

5.2.1 The board's communication pursuant to Article 15(1) RPBA had been issued about five months prior to the oral proceedings before the board. Section 5.4.2 of the communication provides the board's preliminary view that there are issues with the calculation of the metal concentration according to claim 2 and the formula used in the description (paragraph [0053]) and claim 6 of the main request.

It would have been possible to react to this by filing the sixth auxiliary request, e.g. with the letter dated 12 June 2025. The board is not convinced that there were exceptional circumstances that justified to wait until the end of the discussions on the first to fifth auxiliary requests and file the sixth auxiliary request only at that time.

5.2.2 As claim 1 of the sixth auxiliary request is essentially not more than a combination of the subject-matter of claim 1 of the second and fifth auxiliary request, then the board is not persuaded that the sixth auxiliary request would overcome the objection raised by the board against the higher ranking requests.

5.2.3 During the oral proceedings before the board, the appellant explained that claim 1 of the sixth auxiliary request related to a method of evaluating silicon wafer that was contaminated with iron and cobalt and of determining the cobalt concentration by performing two measurements of the recombination lifetime.

Using this reading of claim 1, the board then notes that the step of "comparing the information on change over time of the recombination lifetime ... with reference information ... to determine whether or not metal contamination of metals bonding to boron by means of electrostatic forces other than Fe is present in the silicon wafer being evaluated" cannot refer to an evaluation if cobalt is present or not, because, according to the appellant, it is already known that the silicon wafer to be evaluated is contaminated with cobalt. Said comparing step therefore seems to concern a third metal (other than Fe and Co).

For the reasons as already given for the higher ranking requests, the application does not disclose to the skilled person a method allowing to determine the Co concentration using two recombination lifetime measurements in a wafer additionally contaminated with Fe and a further unknown metal and possibly comprising other recombination centres. In other words, even accepting that in the claimed method a Fe and Co contaminated silicon wafer is to be evaluated, the sixth auxiliary request does not overcome the objection raised by the board against the higher ranking requests.

6. As not allowable and admissible request is on file, the appeal must fail (Articles 97(2) and 111(1) EPC).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

B. Atienza Vivancos T. Häusser

Decision electronically authenticated