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Title of invention:
SEMICONDUCTOR DEVICE

Applicant:
Flosfia Inc.

Relevant legal provisions:
EPC Art. 52(1), 56, 123(2)
RPBA 2020 Art. 13(1), 13(2)

Keyword:
Main request, auxiliary requests 1 to 5 - inventive step - (no)
Auxiliary requests 6 and 7 - amendments - extension beyond the content of the application as filed (yes)
Main request A, auxiliary requests 1A to 7A - amendment after summons - taken into account (no)

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Case Number: T 0899/21 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 14 December 2023

Appellant: (Applicant)	Flosfia Inc. 1-29, Goryoohara Nishikyo-ku Kyoto-shi Kyoto 615-8245 (JP)
Representative:	Gulde & Partner Patent- und Rechtsanwaltskanzlei mbB Wallstraße 58/59 10179 Berlin (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 17 February 2021 refusing European patent application No. 16204582.7 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	T. Häusser
Members:	M. Ley
	D. Prietzel-Funk

Summary of Facts and Submissions

I. The appeal is against the decision of the examining division to refuse European patent application No. 16 204 582 pursuant to Article 97(2) EPC.

II. The examining division cited the following documents:

D1 US 2015/325659 A1
D2 XP 055370856

and decided that the subject-matter of claim 1 according to the main request and according to the first and second auxiliary requests did not involve an inventive step (Article 56 EPC) over D1, that the subject-matter of claim 1 according to the third to fifth auxiliary requests did not involve an inventive step (Article 56 EPC) over D1 and D2, and that claim 1 according to the sixth and seventh auxiliary requests did not comply with the requirements of Article 123 (2) EPC.

III. At the oral proceedings before the board the appellant requested that the impugned decision be set aside and a European patent be granted on the basis of the main request, or of the main request A or on the basis of auxiliary requests 1, 1A, 2, 2A, 3, 3A, 4, 4A, 5, 5A, 6, 6A, 7, 7A.

The main request and auxiliary requests 1 to 7 are the requests underlying the decision under appeal and main request A and auxiliary requests 1A to 7A were filed after the summons to oral proceedings with the letter dated 13 November 2023.

IV. The wording of the independent claims is as follows (board's labelling and underlining):

Claim 1 according to the main request has the following wording:
(α) A semiconductor device, comprising:
(a) a semiconductor layer (101a, 101b) containing a crystalline oxide semiconductor with a corundum structure as a major component; and
(b) a Schottky electrode (105a) on the semiconductor layer (101a, 101b),
(a1) wherein the crystalline oxide semiconductor is α-Ga_2O_3 or a mixed crystal thereof, and
(b1) the Schottky electrode (105a) is a metal layer comprising two or more metal films comprising a metal film that contains at least one metal selected from Group 4 of the periodic table.

Claim 1 according to main request A corresponds to claim 1 of the main request, wherein feature (b1) is replaced with the following feature:
(b1-MRA) the Schottky electrode (105a) is a metal layer comprising two or more metal films comprising a metal film that consists of at least one metal selected from Group 4 of the periodic table.

Claim 1 according to auxiliary request 1 corresponds to claim 1 of the main request, wherein feature (b1) is replaced with the following feature:
(b1-AR1) the Schottky electrode (105a) is a metal layer comprising two or more metal films comprising a metal film that contains titanium.

Claim 1 according to auxiliary request 1A corresponds to claim 1 of auxiliary request 1, wherein feature (b1-AR1) is replaced with the following feature:

(b1-AR1A) the Schottky electrode (105a) is a metal layer comprising two or more metal films comprising a metal film that consists of titanium.

Claim 1 according to auxiliary request 2 corresponds to claim 1 of the main request, wherein feature (b1) is replaced with the following feature:
(b1-AR2) the Schottky electrode (105a) is a metal layer comprising two or more metal films comprising a metal film that contains at least one metal selected from the fourth period of Groups 4-9 of the periodic table.

Claim 1 according to auxiliary request 2A corresponds to claim 1 of auxiliary request 2, wherein feature (b1-AR2) is replaced with the following feature:
(b1-AR2A) the Schottky electrode (105a) is a metal layer comprising two or more metal films comprising a metal film that consists of at least one metal selected from the fourth period of Groups 4-9 of the periodic table.

Claim 1 according to auxiliary request 3 comprises features (α), (a), (b), (c), (a1), (b1-AR2) and (c1-AR3), where features (c) and (c1-AR3) are as follows:
(c) an ohmic electrode (105b) on the semiconductor layer (101a, 101b),
(c1-AR3) the ohmic electrode (105b) is a metal layer comprising two or more metal films comprising a metal film that contains at least one metal of Group 4 or 11 of the periodic table.

Claim 1 according to auxiliary request 3A corresponds to claim 1 of auxiliary request 3, wherein feature (b1-AR2) is replaced with the feature (b1-AR2A).

Claim 1 according to auxiliary request 4 comprises features (α), (a), (b), (c), (a1), (b1) and (c1-AR3).

Claim 1 according to auxiliary request 4A corresponds to claim 1 of auxiliary request 4, wherein feature (b1) is replaced with feature (b1-MRA).

Claim 1 according to the auxiliary request 5 comprises features (α), (a), (b), (c), (a1), (b1) and (c1), where feature (c1) is as follows:
(c1) the ohmic electrode (105b) is a metal layer comprising two or more metal films comprising a metal film that contains titanium and a metal film that contains gold.

Claim 1 according to auxiliary request 5A corresponds to claim 1 of auxiliary request 5, wherein feature (b1) is replaced with feature (b1-MRA).

Claim 1 according to auxiliary request 6 comprises features (α), (a), (b), (a1) and (b2), wherein feature (b2) reads as follows:
(b2) the Schottky electrode (105a) is a metal layer comprising three metal films and the intermediate metal film thereof contains titanium.

Claim 1 according to auxiliary request 6A corresponds to claim 1 of auxiliary request 6, wherein feature (b2) is replaced with the following feature:
(b2-AR6A) the Schottky electrode (105a) is a metal layer comprising three metal films and the intermediate metal film thereof consists of titanium.

Claim 1 according to auxiliary request 7 comprises features (α), (a), (b), (c) (a1), (b2) and (c1-AR3).

Claim 1 according to auxiliary request 7A corresponds to claim 1 of auxiliary request 7, wherein feature (b2) is replaced with feature (b2-AR6A).

V. The appellant's arguments can be summarized as follows:

The subject-matter of claim 1 according to the main request and according to auxiliary requests 1 to 5 involves an inventive step (Article 56 EPC), see point 2.3 below.

Claim 1 according to auxiliary requests 6 and 7 complies with the requirements of Article 123(2) EPC, see point 5.3 below.

The claims according to main request A and auxiliary requests 1A to 7A should be admitted into the appeal proceedings due to exceptional circumstances.

Reasons for the Decision

1. The invention concerns a semiconductor device particularly useful for a power device.

Gallium oxide (Ga_2O_3) is a transparent semiconductor that has a band gap as wide as 4,8 to 5,3 eV at room temperature and absorbs almost no visible light and ultraviolet light. It is accordingly a promising material for use in optical and electronic devices and transparent electronics operated particularly in a deep ultraviolet region, see paragraph [0002] of the description of the application.

Gallium oxide has five crystal structures of α, β, γ, δ, and ε, and generally the most stable structure is

β-Ga_2O_3. However, having a β-gallic structure, β-Ga_2O_3 is not always preferred to be used in semiconductor devices. Growth of a β-Ga_2O_3 thin film requires a high substrate temperature and a high degree of vacuum, causing the problem of an increase in manufacturing costs. In contrast, having a crystal structure which is the same as that of a sapphire substrate already sold for general purposes, α-Ga_2O_3 is accordingly preferred to be used in optical and electronic devices. It further has a band gap wider than that of β-Ga_2O_3 and thus is particularly useful for a power device, see paragraph [0003] of the description of the application.

According to paragraph [0004] of the description, electrode metal stacks known to be used for β-Ga_2O_3 do not function as Schottky electrodes or ohmic electrodes for α-Ga_2O_3. It is thus the object of the present invention to provide Schottky and/or ohmic electrodes for α-Ga_2O_3.

2. Auxiliary request 5 - inventive step

2.1 The board finds it appropriate to first discuss auxiliary request 5 for ease to deal with the appellant's arguments and as was also done during the oral proceedings. The wording of claim 1 of this request is repeated for convenience. Using the board's labelling the claim reads as follows:

(α) A semiconductor device, comprising:
(a) a semiconductor layer (101a, 101b) containing a crystalline oxide semiconductor with a corundum structure as a major component;
(b) a Schottky electrode (105a) on the semiconductor layer (101a, 101b); and
(c) an ohmic electrode (105b) on the semiconductor

layer (101a, 101b),
(a1) wherein the crystalline oxide semiconductor is α-Ga_2O_3 or a mixed crystal thereof,
(b1) the Schottky electrode (105a) is a metal layer comprising two or more metal films comprising a metal film that contains at least one metal selected from Group 4 of the periodic table,
and
(c1) the ohmic electrode (105b) is a metal layer comprising two or more metal films comprising a metal film that contains titanium and a metal film that contains gold.

2.2 It is undisputed that the Schottky barrier diode of paragraph [0116] and Figure 20 of document D1 discloses features (α), (a), (b), (c), (a1). Said diode has a titanium ohmic electrode 105b on the n^+-type semiconductor layer 101b and a platinum Schottky electrode 105a on the n^--type semiconductor layer 101a.

Thus, as also pointed out by the examining division and the appellant, the subject-matter of claim 1 of auxiliary request 5 differs from the diode known from D1 in that:
- the Schottky electrode is a metal layer comprising two or more metal films comprising a metal film that contains at least one metal selected from Group 4 of the periodic table
and
- the ohmic electrode is a metal layer comprising two or more metal films comprising a metal film that contains titanium and a metal film that contains gold.

In other words, the distinguishing features are features (b1) and (c1).

2.3 According to the appellant, as disclosed in the description of the application, the inventors found that a Schottky electrode including two or more metal films and a Group 4 metal has favorable semiconductor characteristics and properties (see paragraphs [0008], [0032], examples 1 to 3, 6 and 7 for Pt/Ti/Au, Ti/Au, Ti/Cu, and Fe/Ti/Cu Schottky electrodes, see paragraphs [0053], [0058], [0078] and [0079] and Figures 7 to 9 and 15A to 18 of the application), in particular favorable Schottky characteristics. A single Pt layer used in comparative example 1 showed less favorable characteristics (see Figure 10 of the application).

During oral proceedings before the board, the appellant argued that the experiments shown in figures 15A to 18 provided evidence that the presence of a Group 4 metal layer improved the thermal stability and the Schottky electrode "adhesion", see also paragraphs [0012], [0078] and [0079] of the application as originally filed. This was independent of the position of the Group 4 metal layer within the Schottky electrode. The examples concerned Ti, but the skilled person would know that the same results could be expected for the other Group 4 elements, i.e. hafnium and zirconium, because these elements had similar properties as they belonged to the same group in the periodic table.

Therefore, the objective problem associated with feature (b1) was "to provide a semiconductor device having improved semiconductor properties in terms of durability, dielectric breakdown voltage, resistance voltage, on resistance, stability, etc. without impairing the semiconductor properties of the α-Ga_2O_3 semiconductor layer".

Paragraph [0054] of D1 provided a long list of possible materials for the Schottky and ohmic electrodes. No preference or specific guidance was provided. Said paragraph listed each and every transition metal that was (naturally) available in suitable amounts, at reasonable costs and was stable (i.e. not radioactive). Said paragraph provided a generic disclosure of all transition metal elements. The skilled person would not arbitrarily select any element from this paragraph. In particular, it would not select a Group 4 metal, in particular titanium. No electrical properties of the Schottky electrodes were disclosed in D1 that could support any guidance for the selection. D1 did not deal with the optimization of Schottky electrodes, but with improvements of the crystalline semiconductor layers.

Hence, D1 did not prompt the skilled person to the claimed materials for the Schottky electrode or the ohmic electrode. The skilled person would rather select the materials of the specific examples (i.e. Mo, Al or Pt, see paragraphs [0055] and [0116]), or corresponding metals from Groups 6, 13 and 10 of the periodic table, such as Cr, In or Ni.

Moreover, as the skilled person knew that some materials were suitable and others not and as other factors such as the doping concentration had an influence on the characteristics, the skilled person would not arbitrarily try all transition metals and electrode structures mentioned in D1. This applied even more as the manufacturing of semiconductor devices was complex and time consuming and therefore optimizing the materials and structures for the specific purpose imposed huge efforts of experimentation.

Regarding feature (c1), the appellant argued that document D2 did not unambiguously disclose a multilayer ohmic electrode. The expression "Ti/Au" in the caption of Figure 3 could likewise be interpreted as an *alloy* comprising Ti and Au or a layer of *either* Ti *or* Au. More important, the resistance voltage of the SBD disclosed in D2 was only 270 V (see Figure 6 and the corresponding part of the description). During the oral proceedings, the appellant added that the presence of Ti in the ohmic electrode would also improve its adhesion. Thus, starting from D1 and aiming to further improve the performance of a semiconductor, particularly the resistance voltage (breakdown voltage), the skilled person would not be motivated to select the ohmic electrode disclosed in D2.

Paragraph [0054] of D1 could not be regarded as a proper motivation for selecting any metal for the ohmic electrode, either.

None of D1 and D2 specifically focused on optimizing the materials for the ohmic electrode (or the Schottky electrode). Therefore, the skilled person would not be motivated to combine the teaching of these documents in order to optimize the electrodes of an Schottky barrier diode.

2.4 The board does not share the appellant's view.

2.4.1 Both distinguishing features (b1) and (c1) are unrelated. The functional interaction of both features does not provide any synergistic effect so that it is appropriate to formulate a partial objective technical problem for each distinguishing feature. This was not disputed by the appellant.

2.4.2 According to the wording of feature (b1) in claim 1, the Schottky electrode comprises at least two metal films, one of the metal films contains a Group 4 metal (i.e. Ti, Zr, Hf or Rf, while Rf in fact excluded due to its short half-life of the longest-lived isotope of 48 minutes, as also argued by the appellant), which also encompasses an arrangement with said one metal film comprising 10 at% of Ti, for example.

While the board notes that e.g. paragraph [0032], third sentence of the application does not exclude the Schottky electrode being an alloy, i.e. a mixture of two or more metallic elements, the board focuses, for the sake of the argument, on the case with said "one of the metal films" *consisting of* a Group 4 metal, e.g. titanium.

It is to be noted that the wording of claim 1 does not specify the total number of metal films forming the Schottky electrode, the materials and thicknesses of the different metal films and the position of the particular metal film consisting of a Group 4 metal within the stack of metal films forming the Schottky electrode. In particular, a direct contact between the the Group 4 metal film and the semiconductor material is not required.

2.4.3 When defining the objective technical problem, an effect cannot be retained if it is not credible that the promised result is attainable throughout the entire range covered by a claim (see Case Law of the Boards of Appeal, 10th Edition, 2022, I.D.4.1).

As pointed out, distinguishing feature (b1) encompasses quite a number of possible embodiments falling within the subject-matter of claim 1. The objective technical

problem is thus to be formulated such that feature (b1) provides the solution to it for all said embodiments, i.e. over the whole breadth of claim 1.

2.4.4 The board finds it questionable whether adding a Group 4 metal film (and possibly other metal films) to the Pt metal film of D1 would provide a semiconductor device having improved characteristics in accordance with the appellant's formulation of the objective technical problem.

The Schottky characteristics of a Schottky electrode are mainly impacted by the semiconductor material itself and the metal layer in immediate electrical contact with the said semiconductor material. As the location of the metal film consisting of a Group 4 element is not specified in claim 1, it cannot be said that its mere presence would necessarily have any (beneficial or detrimental) impact on the Schottky characteristics.

2.4.5 Paragraph [0008] of the description of the application discloses that a Schottky electrode containing metal of the Group 4 of the periodic table is "excellent in semiconductor properties and excellent in Schottky characteristics without impairing the semiconductor properties of the crystalline oxide semiconductor with a corundum structure". This paragraph further states that a semiconductor device according to the invention was capable to "solve the conventional problems at once", wherein said conventional problems are those described in paragraphs [0004] and [0012] of the application for β-Ga_2O_3 semiconductor devices, i.e. not the devices of D1 and, in particular, not the device of paragraph [0116] of D1. There is however no indication that the characteristics of the Schottky diode known

from paragraph [0116] of D1, i.e. made of α-Ga_2O_3, would be further improved by using a multi-layer Schottky electrode according to feature (b1).

2.4.6 Paragraph [0012] states that the metal of Group 4 of the periodic table might provide a "better adhesion". However, the position of the metal film containing/consisting of said metal of Group 4 of the periodic table or its thickness are not specified in claim 1. The board does not agree that the mere presence of a (possibly very thin) titanium, zirconium or hafnium layer somewhere within a multi-layer stack of other metal layers of unspecified composition would necessarily improve a better adhesion or a better thermal resistance. Thus, it cannot be said that feature (b1) would provide a better adhesion, either.

Regarding paragraphs [0078] and [0079] and Figures 15A to 18, they concern the bilayer Ti/Cu and trilayer Fe/Ti/Cu Schottky electrodes according to examples 6 and 7. Figures 15A to 15C and Figures 17A to 17C show scanning internal photoemission microscopy (SIPM) images for Ti/Cu and Fe/Ti/Cu Schottky electrodes, respectively. Figures 15B and 17B and Figures 15C and 17C are performed after thermal annealing at 200°C and 300°C, respectively. Figures 16 and 18 show the respective barrier height maps. The board is of the view that these measurements merely show that it is possible to produce a Schottky electrode which is not damaged when heated at 300°C by using a Ti/Cu or Fe/Ti/Cu stack. However, it cannot be concluded from these experiments alone, as did the appellant during oral proceedings before the board, that the presence of the Ti layer would be the crucial factor for these results. When confronted to the measurements according to Figures 15a to 18 alone, one could also conclude that

the covering copper layer might produce said results. In any case, it cannot be derived from these figures that a Schottky electrode according to feature (b1) would necessarily present a better adhesion than the Pt Schottky electrode used in D1.

2.4.7 Paragraph [0031] of the description of the application states that the Schottky electrode is not particularly limited as long as the electrode contains at least one metal selected from Groups 4-9 of the periodic table. It may also contain a metal of Group 10 or 11 of the periodic table. Paragraph [0032] states that the Schottky electrode might contain one or more metal films. It is not derivable from said paragraphs that a Schottky electrode comprising feature (b1) would necessarily improve the characteristics of the device known from D1.

This observation is apparently also valid for the examples of the application using specific Schottky electrodes ([0036], Figure 3: Pt/Ti/Au, Pt/Ti/Ag, Pt/Ti/Cu; examples 1 and 2, [0053] and [0056]: Pt/Ti/Au; example 3, [0057]: Ti/Au; example 6, [0078]: Ti/Cu; example 7, [0079]: Fe covered by Ti and Cu, i.e. Fe/Ti/Cu).

Comparative example 1 (see Figure 10) merely shows that the specific arrangements of examples 1 to 3 (Figures 7 to 9, Pt/Ti/Au and Ti/Au Schottky electrodes) provide an improved current-voltage characteristic when compared to a device with a Pt Schottky electrode, see Figure 10. This was apparently also the view of the examining division, which suggested a wording of claim 1, which they considered allowable, see e.g. the minutes of oral proceedings, point 10.

The board finds it however questionable whether the same improvement would be observed for any Schottky electrode according to feature (b1).

2.4.8 In view of points 2.4.2 to 2.4.7 above, the appellant's formulation of the objective technical problem solved by feature (b1) is not accurate. Feature (b1) only solves the problem of providing an alternative Schottky electrode structure.

2.4.9 Regarding distinguishing feature (c1), the application does not disclose that the specific Ti/Au ohmic contact would have any beneficial effect on the resistance voltage (breakdown voltage) of the semiconductor device of D1. Feature (c1) only solves the problem of providing an alternative ohmic electrode structure.

2.4.10 Regarding distinguishing feature (b1), the skilled person wishing to provide an alternative Schottky electrode for the diode of paragraph [0116] of D1 would know from paragraph [0054] of D1 that metals from Group 4 of the periodic tables are suitable and from its common general knowledge or from paragraph [0082] of D1 that multilayer electrodes are known and used. It is obvious to arrange the Schottky electrode of D1 such that it is a metal layer comprising two or more metal films comprising a metal film that contains at least one metal selected from Group 4 of the periodic table (i.e. Ti, Zr or Hf).

In particular, it is obvious for the skilled person to include a Ti layer into the Schottky electrode of D1.

2.4.11 Regarding distinguishing feature (c1), paragraph [0054] of D1 already mentions Au and Ti as possible metals for ohmic electrodes. The provision of a multilayer ohmic

electrode is common in the present technical field (see e.g. D2, disclosing in Fig. 3 an α-Ga_2O_3 Schottky diode comprising a Ti/Au ohmic electrode). The skilled person would understand from D2 that a Ti/Au bi-layer electrode is meant, and not a Ti-Au alloy.

It is obvious to arrange the ohmic electrode of D1 such that it is a metal layer comprising two or more metal films comprising a metal film that contains titanium and a metal film that contains gold.

2.4.12 Hence, the subject-matter of claim 1 of auxiliary request 5 does not involve an inventive step (Articles 52(1) and 56 EPC) over the disclosure of paragraph [0116] of D1 and D2.

3. Main request, auxiliary requests 1 to 4 - inventive step

Claim 1 according to the main request comprises features (α), (a), (b), (a1) and (b1).

Claim 1 according to the auxiliary request 1 further specifies that the metal film contains titanium (i.e. that the one metal selected from Group 4 of the periodic table is titanium).

Claim 1 according to the auxiliary request 2 requires that the Schottky electrode comprises one metal layer containing one metal selected from the fourth period of Groups 4-9 of the periodic table, i.e. one metal selected from Ti, V, Cr, Mn, Fe or Co. Zr and Hf are thus excluded.

Claim 1 according to auxiliary request 3 requires an ohmic electrode being a metal layer comprising two or

more metal films comprising a metal film that contains at least one metal of Group 4 or 11 of the periodic table (e.g. Ti, Zr, Hf or Cu, Ag, Au).

Claim 1 according to auxiliary request 4 differs from claim 1 of auxiliary request 3 in that the Schottky electrode is the one according to claim 1 of auxiliary request 5.

For the reasons given for auxiliary request 5, the subject-matter of respective claim 1 of the main request and auxiliary requests 1 to 4 does not involve an inventive step (Articles 52(1) and 56 EPC), either.

4. Main request A, auxiliary requests 1A to 5A - admittance

4.1 For the appellant, the late filing appeared to be justified since the amendments occurred in direct response to an objection of the board that had never been raised before. More specifically, on page 6, second paragraph of the communication under Article 15(1) RPBA, the board questioned whether the technical effect was provided at any concentration of the respective metal in the Schottky electrode, e.g. for an arrangement with said metal film comprising 10 at% of Ti, for example.

The amendments made to claim 1 of the main request A and of auxiliary requests 1A to 5A restricted the composition of the metal film of the Schottky electrode to exclusively include the respective metal in order to address the board’s objection and to support the technical effect. Since the board’s objection had never been raised before, there was a cogent reason

justifying the late filing pursuant to Article 13(2) RPBA.

4.2 The board is not convinced that this should be followed. It has not only serious doubts whether exceptional circumstances are present, because the board did not raise any new objection, but rather gave an argument in the context of the objection under Articles 52(1) and 56 EPC already raised by the examining division against claim 1 of the main request underlying the decision under appeal.

But also, in any case, the amendments made to claim 1 of the main request A and of auxiliary requests 1A to 5A clearly do not overcome the inventive step objection raised against the main request and auxiliary requests 1 to 5.

The board therefore did not admit the main request A and auxiliary request 1A to 5A into the appeal proceedings (Article 13(1) and (2) RPBA).

5. Auxiliary requests 6 and 7 - added subject-matter

5.1 Respective claim 1 of both requests specify that the Schottky electrode (105a) is a metal layer comprising three metal films and the intermediate metal film thereof contains titanium (feature (b2)).

5.2 The examining division held that feature (b2) did not comply with the requirements of Article 123(2) EPC.

5.3 The appellant indicated paragraphs [0036], [0078], [0079], Figure 3, examples 1, 2, 6 and 7 of the application as a basis for feature (b2).

Paragraph [0036] discloses a Schottky diode including an Au layer 51, a Ti layer 52 and a Pt layer 53 and states that the metal of Group 11 of the periodic table might be Ag or Cu. Pt, Ti, and Au were merely examples for elements of Groups 10, 4 and 11, respectively. Examples 1 and 2 also disclosed three-layered Pt/Ti/Au Schottky electrode.

In the statement setting out the grounds of appeal, the appellant argued that example 6 (paragraph [0078]) and example 7 (paragraph [0079]) disclosed Ti/Ti/Au and Fe/Ti/Au Schottky electrodes, respectively, because the term "first metal layer" used in paragraphs [0078] and [0079] did not refer to the whole Schottky electrode, but to the first metal film of the Schottky electrode of example 1. During oral proceedings, the appellant then argued that examples 6 and 7 concerned in fact a Ti/Cu and Fe/Ti/Cu Schottky electrodes, respectively.

Hence, the application disclosed Pt/Ti/Au and Fe/Ti/Cu as specific examples of a three layered Schottky electrode. Paragraph [0036] disclosed a (Group 10 element)/(Group 4 element)/(Group 11 element) Schottky electrode. Ti being the most preferred element (according to paragraphs [0031], [0032] and [0036], examples 1 to 3, 6 and 7), feature (b2) is an embodiment encompassed and recommended by the application.

From these examples, the skilled person would directly and unambiguously derive feature (b2) without being presented any new technically relevant information. The wording of feature (b2) was thus an allowable intermediate generalisation.

5.4 The board does not follow this argument, but agrees with the examining division.

The board accepts that the Schottky electrode in example 6 is a Ti layer covered by a Cu layer, which is however not a structure according to feature (b2). Hence, the application as originally filed discloses a (Group 10 element)/Ti/(Group 11 element), see paragraph [0036], a Pt/Ti/Au Schottky electrode, see paragraph [0053] or a Fe/Ti/Cu Schottky electrode, see paragraph [0079].

According to feature (b2) the Schottky electrode is a metal layer comprising three metal films and the intermediate metal film of these three layers contains titanium, while the other metals can be of any composition. The total number of metal layers as well as their thicknesses is not defined in claim 1.

The disclosure of paragraphs [0036], [0053] and [0079] is not such that a skilled person would directly and unambiguously derive feature (b2) therefrom. In particular, the skilled person would not conclude that the results shown in Figure 7 (Pt/Ti/Au Schottky electrode of example 1) and figures 17A to 17C and 18 (Fe/Ti/Cu, Schottky electrode of example 7) would be applicable to any Schottky electrode according to feature (b2). In other words, the board shares the examining division's view that feature (b2) is an unallowable intermediate generalisation.

Therefore, respective claim 1 of auxiliary requests 6 and 7 contains subject-matter extending beyond the content of the application as filed, contrary to the requirements of Article 123(2) EPC.

6. Auxiliary requests 6A and 7A - admittance

6.1 The appellant only made reference to its written submissions with respect to the admittance of auxiliary requests 6A and 7A.

6.2 The board is of the view the amendments made to claim 1 of auxiliary requests 6A and 7A clearly do not overcome the objection under Article 123(2) EPC raised against auxiliary requests 6 and 7.

The board therefore did not admit auxiliary request 6A and 7A into the appeal proceedings (Article 13(1) and (2) RPBA).

7. As no admissible and allowable request is on file, the appeal must fail.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

S. Sánchez Chiquero T. Häusser

Decision electronically authenticated