**Internal distribution code:**

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

# Datasheet for the decision of 8 June 2018

**Case Number:** T 1731/13 - 3.4.03

**Application Number:** 02013075.3

**Publication Number:** 1271663

**IPC:** H01L33/00, C30B25/02, C30B29/40, H01L21/20

**Language of the proceedings:** EN

**Title of invention:**
A III nitride film and III nitride multilayer

**Applicant:**
NGK Insulators, Ltd.

**Headword:**

**Relevant legal provisions:**
EPC 1973 Art. 84, 111(1)
EPC 1973 R. 29(6)
RPBA Art. 13(1)

**Keyword:**
Claims - main request and 2nd to 11th auxiliary requests - unclear characterization by parameters - clarity (no)
Late-filed request - 1st auxiliary request - admitted (no)
Remittal to the department of first instance - (no)



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

**Decisions cited:**
T 1156/01, T 0412/02, T 0849/11

**Catchword:**


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

Europäisches Patentamt
European Patent Office
Office européen des brevets

**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
Fax +49 (0)89 2399-4465

**Case Number: T 1731/13 - 3.4.03**

# D E C I S I O N
# of Technical Board of Appeal 3.4.03
# of 8 June 2018

| | |
|---|---|
| **Appellant:** (Applicant) | NGK Insulators, Ltd.<br>2-56, Suda-Cho, Mizuho-ku<br>Nagoya City, Aichi Pref. (JP) |
| **Representative:** | TBK<br>Bavariaring 4-6<br>80336 München (DE) |
| **Decision under appeal:** | **Decision of the Examining Division of the European Patent Office posted on 6 March 2013 refusing European patent application No. 02013075.3 pursuant to Article 97(2) EPC.** |

**Composition of the Board:**

| | |
|---|---|
| **Chairman** | G. Eliasson |
| **Members:** | T. M. Häusser |
| | C. Heath |

## Summary of Facts and Submissions

I. The appeal concerns the decision of the examining division refusing the European patent application No. 02 013 075 for lack of clarity (Article 84 EPC 1973) in relation to the former main request and the former first to fourth auxiliary requests and for lack of inventive step (Article 56 EPC 1973) in relation to the former main request and the former second auxiliary request.

II. Reference is made to the following document:

D6: Koide Y et al., *Effect of AlN Buffer Layer on AlGaN/α-$Al_2O_3$ Heteroepitaxial Growth by Metalorganic Vapor Phase Epitaxy*, Japanese Journal of Applied Physics, Vol. 27, No. 7, July 1988, pp. 1156-1161.

III. At the oral proceedings before the board the appellant requested that the decision under appeal be set aside and that a patent be granted based on the main request filed with letter dated 9 March 2018, in the auxiliary based on the 1st auxiliary request filed during oral proceedings at 11:00, or the 2nd auxiliary request filed as 1st auxiliary request with letter dated 9 March 2018, or based on the 3rd - 11th auxiliary requests, filed as main Request and 1st - 8th auxiliary requests with the statement of the grounds of appeal dated 12 July 2013. Further auxiliarily, the appellant requested that the case be remitted to the department of first instance for further prosecution based on one of the above requests.

IV. The wording of respective claim 1 of the requests is as follows (board's labelling "(a)", ..., "(z)", "(aa)", ..., "(hh)"):

Main request:

"1. A III nitride multilayer comprising:
(a) a substrate (1),
(b) a III nitride underfilm (2) on the substrate (1), the underfilm (2) including Al element of 70 atomic percentages or over for all of the III elements, and
(c) an Al containing III nitride film (3) on the underfilm (2), the III nitride film (3) including Al element in lower Al content than the Al content of said III nitride underfilm by 10 atomic percentages or over, wherein
(d) a full width at half maximum in X-ray rocking curve of said III nitride film (3) is 800 seconds or below at (100) plane,
(e) a full width at half maximum in X-ray rocking curve of said III nitride film (3) is 200 seconds or below at (002) plane, and
(f) a thickness of the III nitride underfilm is within 0.5 to 3 μm,
(g) wherein the X-ray rocking curves are obtained using a Cu $K\alpha_1$ line with a wavelength of 0.15405 nm selected by a channel cut Ge (220) monochromator and a narrow slit before the III nitride multilayer."

1st auxiliary request:

"1. A method of fabricating a III nitride multilayer comprising:
(h) providing a C-faced sapphire single crystal substrate (1),
(i) nitriding a main surface of the substrate (1);

(j) making a AlN underfilm (2) on the main surface of the substrate (1) by a CVD method at a temperature of 1200°C, a pressure of 15 Torr, and a ratio of TMA:$NH_3$ = 1:450 for 120 minutes, and
(k) forming an $Al_{0.1}Ga_{0.9}N$ film (3) on the underfilm (2) by the CVD method at a temperature of 1050°C, a pressure of 100 Torr, and a ratio of TMA:TMG:$NH_3$ = 1:9:15000 for 60 minutes, wherein
(l) a surface roughness Ra in a range of 5 $\mu m^2$ of the AlN underfilm is 0.2 nm;
(m) a thickness of the AlN underfilm is 2 µm; and
(n) a thickness of the $Al_{0.1}Ga_{0.9}N$ film is 2 µm."

2nd auxiliary request:

"1. A III nitride multilayer comprising:
(o) a C-faced sapphire single crystal substrate (1) having a nitrided main surface,
(p) a AlN underfilm (2) on the main surface of the substrate (1), the underfilm (2), and
(q) an $Al_{0.1}Ga_{0.9}N$ film (3) on the underfilm (2), wherein
(r) a full width at half maximum in X-ray rocking curve of said AlN underfilm (2) is 50 seconds at (002) plane,
(s) a full width at half maximum in X-ray rocking curve of said $Al_{0.1}$ $Ga_{0.9}N$ film (3) is 450 seconds at (100) plane,
(t) a full width at half maximum in X-ray rocking curve of said $Al_{0.1}Ga_{0.1}N$ film (3) is 120 seconds at (002) plane, and
(u) a surface roughness Ra in a range of 5 $\mu m^2$ of the AlN underfilm is 0.2 nm;
(v) a thickness of the AlN underfilm is 2 µm,
(w) a thickness of the $Al_{0.1}Ga_{0.9}N$ film is 2 µm,

(x) wherein the X-ray rocking curves are obtained using a Cu $K\alpha_1$ line with a wavelength of 0.15405 nm selected by a channel cut Ge (220) monochromator and a narrow slit before the III nitride multilayer."

3rd auxiliary request:

Claim 1 of the 3rd auxiliary request differs from claim 1 of the main request in that feature (g) is deleted.

4th auxiliary request:

Claim 1 of the 4th auxiliary request differs from claim 1 of the 3rd auxiliary request in that the following feature is added:

(y) "the III nitride underfilm is made at a temperature within 1100 - 1250°C".

5th auxiliary request:

Claim 1 of the 5th auxiliary request is identical to claim 1 of the 3rd auxiliary request.

6th auxiliary request:

Claim 1 of the 6th auxiliary request is identical to claim 1 of the 4th auxiliary request.

7th auxiliary request:

Claim 1 of the 7th auxiliary request differs from claim 1 of the 3rd auxiliary request in that feature (a) is replaced by the following feature:

(z) "a C-faced sapphire single crystal substrate (1)".

8th auxiliary request:

Claim 1 of the 8th auxiliary request is identical to claim 1 of the 7th auxiliary request.

9th auxiliary request:

"1. A method of fabricating a III nitride multilayer comprising:
(aa) providing a substrate (1),
(bb) making a III nitride underfilm (2) on the substrate (1), the underfilm (2) including Al element of 70 atomic percentages or over for all of the III elements, and
(cc) forming an Al containing III nitride film (3) on the underfilm (2), the III nitride film (3) including Al element in lower Al content than the Al content of said III nitride underfilm by 10 atomic percentages or over, wherein
(dd) a full width at half maximum in X-ray rocking curve of said III nitride film (3) is set to 800 seconds or below at (100) plane,
(ee) a full width at half maximum in X-ray rocking curve of said III nitride film (3) is set to 200 seconds or below at (002) plane, and
(ff) a thickness of the III nitride underfilm is within 0.5 to 3 µm."

10th auxiliary request:

Claim 1 of the 10th auxiliary request differs from claim 1 of the 9th auxiliary request in that feature (bb) is replaced by the following feature:

(gg) "making a III nitride underfilm (2) on the substrate (1) at a temperature of 1100°C - 1250°C, the underfilm (2) including Al element of 70 atomic percentages or over for all of the III elements, and".

11th auxiliary request:

Claim 1 of the 11th auxiliary request differs from claim 1 of the 9th auxiliary request in that feature (aa) is replaced by the following feature:

(hh) "providing a C-faced sapphire single crystal substrate (1)".

V. The appellant argued essentially as follows:

(a) Main request, 2nd to 11th auxiliary requests - clarity

The definition of the invention in terms of the claimed full widths at half maximum of the X-ray rocking curves defined a structural feature, namely the crystal quality of the III nitride film. Even if it were assumed that the invention was defined in terms of a result to be achieved, such a definition was considered allowable in the present case.

Moreover, the method of measuring the X-ray rocking curve was defined in greater detail in claim 1 of the main request, in particular using feature (g). The thickness of the III nitride film was only relevant for the X-ray rocking curve if the film was very thin. As the skilled person knew that the thickness of the III nitride layer was larger than the penetration depth of the X-rays (100 Å), that thickness was not essential

and did not need to be mentioned in claim 1 of the main request.

Furthermore, claim 1 of the 2nd auxiliary request defined the details of the embodiment described in the description of the application in order to address any objections as to lack of clarity.

(b) Procedural matters

The filing of the 1st auxiliary request was a reaction to the new objection by the board communicated with the summons to the oral proceedings. There was no reason to file the request earlier as the examining division's objection that the former claims contained a "result to be achieved" was not justified. Since all conditions of the fabrication of the III nitride multilayer were specified in claim 1 of the 1st auxiliary request, it was evident that the features relating to the values of the full width at half maximum of the relevant rocking curves could be removed from the claim without violating Article 123(2) EPC.

The 1st auxiliary request should therefore be admitted into the appeal proceedings. In fact, since the issue of compliance of claim 1 of the 1st auxiliary request with Article 123(2) EPC was not dealt with by the examining division, the case should be remitted to the department of first instance so that the issue could be decided there.

## Reasons for the Decision

1. Main request, 2nd to 11th auxiliary requests - clarity

1.1 Article 84 EPC 1973 stipulates that the claims define the matter for which protection is sought and that they must, *inter alia*, be clear.

1.2 In the decision under appeal the examining division held that the respective independent claims of the requests pending at the time were not clear (see points A-1, B, C-1, and D of the Reasons). In particular, the examining division was of the opinion that the features relating to the values of the full width at half maximum (FWHM) of the relevant rocking curves were attempts to define the claimed subject-matter in terms of the *result to be achieved*, which was not allowable in the present case as it was possible to define the subject-matter in more concrete terms (see points A-1.1 and A-1.3 of the Reasons).

1.3 The board agrees with the appellant in that the features relating to the FWHM values of the relevant rocking curves are not objectionable as an attempt to define the invention by a result to be achieved. Rather, these features, i. e. features (d) and (e) of claim 1 of the main request and the corresponding features of respective claim 1 of the 2nd to 11th auxiliary requests, are an attempt to characterize the claimed product by *parameters*, namely the full widths at half maximum of the respective rocking curves. In particular, by specifying that the parameters are within certain value ranges, it is attempted to define structural features of the claimed III nitride film/underfilm by providing quantitative measures of the crystal quality of the film, as detailed below.

Whether the skilled person is enabled to perform - without undue burden - essentially all the embodiments covered by the claimed invention, i. e. achieve the

claimed crystal quality for all claimed compositions of the III nitride film/underfilm, is a different matter concerning compliance with the requirement of sufficiency of the disclosure (Article 83 EPC 1973).

1.4 However, when the invention is defined by a parameter, the requirement of clarity of the claim is only fulfilled when it is clear from the claim itself when being read by the person skilled in the art exactly how the parameter is to be determined. This implies, as a rule, that the method of measuring the parameter and the conditions of measurement having an influence on the value of the parameter have to be indicated in the claim, either expressly or - if appropriate - by way of reference to the description in accordance to Rule 29(6) EPC 1973. Such indication would only be superfluous if the skilled person knew from the outset which method and conditions to employ (see T 1156/01, Reason 2.3; T 412/02, Reasons 5.7 to 5.9; T 849/11, Reason 1.1).

1.5 In the present case the critical features relate to rocking curves measured in relation to particular crystal planes of the claimed III nitride crystal film/underfilm. In order to obtain a rocking curve, an x-ray spectrometer is used in the "ω-mode", i. e. in such a way as to record the diffraction intensity as a function of the angle of rotation ("rocking") of the specimen crystal (here: the III nitride crystal film/underfilm). The FWHM of the rocking curve provides a measure of the crystal quality, that is, the variation in lattice spacing and/or orientation of the crystallites constituting the crystal film. It contains thus contributions due to the orientation distribution and the spacing distribution of the crystallites.

The precise shape of the rocking curve and its FWHM value depend not only on the spectral characteristics of the x-ray beam, but also on the beam geometry and the actual experimental set-up of the x-ray spectrometer. The incoming beam width, which may be influenced by an aperture plate with a slit in front of the X-ray source and/or the monochromator and by the distances between the x-ray source, the monochromator and the crystal film, determines for example, which crystallites of the crystal film contribute to the rocking curve. On the other hand, an aperture plate with a slit may also be used in front of the detector to single out a given lattice spacing so that the FWHM of the rocking curve predominantly reflects the orientation distribution of the crystallites of the crystal film. This is illustrated in the top two diagrams relating to the "ω-mode" in Figure 3 of document D6, in which it is shown that rocking curves of $Al_{0.1}Ga_{0.9}N$ films with and without an AlN buffer layer have smaller FWHM values when receiving slits of 60µm, respectively 100µm, are used to limit the diffracted X-rays compared to using an open detector window.

1.6 The appellant attempted to address the issue of lack of clarity by introducing feature (g) into claim 1 of the main request. According to that feature the X-ray rocking curves are obtained using a Cu $K\alpha_1$ line with a wavelength of 0.15405 nm selected by a channel cut Ge (220) monochromator.

The board acknowledges that the spectral characteristics of the x-ray beam used for determining the rocking curves of the claimed III nitride film are thus mentioned in claim 1 of the main request.

In relation to the beam geometry it is merely mentioned in claim 1 of the main request that a "narrow slit" is used before the III nitride multilayer (see feature (g)). However, the precise value of the slit width is not specified in the claim and there is no indication at all concerning the set-up of the x-ray spectrometer, in particular concerning the presence of other aperture plates and the distances between the x-ray source, the monochromator, the crystal film and the detector.

For the reasons mentioned above these measurement conditions have an influence on the measured FWHM value of the rocking curves of the III nitride film. Moreover, these conditions are not considered to be standardized in the relevant technical field of semiconductor physics.

In view of the above claim 1 of the main request is not clear, contrary to the requirements of Article 84 EPC 1973.

1.7 Features (s) and (t) of claim 1 of the 2nd auxiliary request differ from features (d) and (e) of claim 1 of the main request in that the precise composition of the III nitride film and particular values rather than ranges of the FWHM of the rocking curves are specified. That claim also contains the additional feature (r) in which the FWHM value of the rocking curve of the claimed AlN underfilm is specified.

Features (d) and (e) of claim 1 of the main request are also contained in claim 1 of the 3rd to 8th auxiliary requests. Features (dd) and (ee) of independent method claim 1 of the 9th auxiliary request correspond to features (d) and (e) of independent device claim 1 of the main request, respectively. Features (dd) and (ee)

of claim 1 of the 9th auxiliary request are also contained in claim 1 of the 10th and 11th auxiliary requests.

However, in none of these claims there is any indication of the relevant measurement conditions concerning the beam geometry and experimental set-up of the x-ray spectrometer for determining the FWHM of the various rocking curves, either. Therefore, for same reasons as those indicated above in relation to claim 1 of the main request, the respective claim 1 of the 2nd to 11th auxiliary requests also lacks clarity, contrary to the requirements of Article 84 EPC 1973.

2. Procedural matters

2.1 The 1st auxiliary request was filed during oral proceedings before the board. It constitutes therefore an amendment to the appellant's case after it has filed its grounds of appeal and may be admitted into the proceedings and considered at the board's discretion (Article 13(1) RPBA).

In accordance with established case law, the board exercises its discretion to admit a late-filed request into the proceedings considering whether there are sound reasons for filing the request at a late stage in the proceedings and whether - *prima facie* - the request overcomes the outstanding objections under the EPC and does not give rise to new objections (Case Law of the Boards of Appeal of the EPO, 8th edition 2016, sections IV.E. 4.4.1 and 4.4.2).

2.2 The appellant argued that the filing of the 1st auxiliary request was a reaction to the new objection by the

board communicated with the summons to the oral proceedings.

The board notes that the features relating FWHM values of the rocking curves had already been objected to as being unclear during the examination proceedings and that this objection was a ground of refusal (see point 1.2 above). Hence, the appellant had reasons to file - at least on an auxiliary basis - a claim such as claim 1 of 1st auxiliary request, in which these offending features are deleted, already during the examination proceedings or at the latest with the grounds of appeal.

In the summons to oral proceedings the board had merely provided a different reasoning (compared to that of the examining division) why it regarded these same features as unclear. The board does not consider this as a new development objectively occasioning the filing of the 1st auxiliary request.

At any rate, there is no valid reason for not filing the 1st auxiliary request at least with the letter dated 9 March 2018 filed in preparation of the oral proceedings before the board, but only submitting this request as the third attempt to overcome the clarity objection during the oral proceedings.

Hence, the board is of the opinion that there are no sound reasons for filing the 1st auxiliary request at such a late stage during the appeal proceedings.

2.3 The board accepts that the deletion of the features relating FWHM values of the rocking curves overcomes the clarity objection against these features.

However, the deleted features were the only features defining the III nitride film which had originally been claimed according to original claim 1, the broadest claim of the original set of claims. Moreover, it would appear from the original description that these features were presented as essential in achieving the object of the invention of improving the crystallinity of the III nitride film (see paragraphs [0004], [0013], [0014], and [0021] of the description of the application as filed). This gives immediately rise to the question whether the deletion of the features amounts to a broadening of the claimed subject-matter which has no basis in the application as filed.

The appellant argued that, since all conditions of the fabrication of the III nitride multilayer were specified in claim 1 of the 1st auxiliary request, it was evident that the features relating to the FWHM values of the relevant rocking curves could be removed from the claim without extending beyond the original application documents.

The board is of the opinion that the fabrication of the III nitride film and underfilm using chemical vapour deposition (CVD) is a highly complex process and that various process conditions which are not specified in claim 1 of the 1st auxiliary request, such as which carrier gas and flow rates are used, the precise arrangement of the substrate in the reaction chamber, and the speed of the temperature ramping, may well have an influence on the crystal quality of the crystal films and thus on the FWHM values of the rocking curves.

Hence, the 1st auxiliary request gives rise to new objections under Article 123(2) EPC.

2.4 The appellant argued further that since the issue of compliance of claim 1 of the 1st auxiliary request with Article 123(2) EPC was not dealt with by the examining division, the case should be remitted to the department of first instance so that the issue could be decided there.

In view of the considerations mentioned above under points 2.1 to 2.4 the board is of the opinion that the 1st auxiliary request should not be admitted into the appeal proceedings. Hence, it would be inappropriate to remit the case to the examining division for consideration of that request.

Otherwise, every request filed during oral proceedings and raising new issues would have to be remitted for consideration of these issues by the first instance. This cannot be the correct approach already for the reason that necessity for remittal is a reason not to admit a request at this stage of the procedure.

2.5 In view of the above, the 1st auxiliary request is not admitted into the appeal proceedings (Article 13(1) RPBA) and the case is not remitted to the department of first instance under Article 111(1) EPC 1973.

3. Conclusion

Since the main request and the 2nd to 11th auxiliary requests are not allowable, the 1st auxiliary request is not admitted into the appeal proceedings and the case is not remitted to the department of first instance, the appeal is to be dismissed (Article 111(1) EPC 1973).

**Order**

**For these reasons it is decided that:**

The appeal is dismissed.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated