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Paper 28
Entered: January 21, 2015

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

OSRAM GMBH,
Petitioner,

v.

E. FRED SCHUBERT,
Patent Owner.

Case IPR2013-00459
Patent 6,294,475 B1

Before JENNIFER S. BISK, GREGG I. ANDERSON, and
MATTHEW R. CLEMENTS, *Administrative Patent Judges.*

ANDERSON, *Administrative Patent Judge.*

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. BACKGROUND

A. Introduction

On July 19, 2013, OSRAM GmbH ("Petitioner") filed a petition requesting *inter partes* review of claims 1, 2, 4, 11–14, and 16 of U.S. Patent No. 6,294,475 B1 (Ex. 1001, "the '475 patent"). Paper 3 ("Pet."). We instituted trial on all challenged claims 1, 2, 4, 11–14, and 16 of the '475 patent on certain grounds of unpatentability alleged in the Petition. Paper 11 ("Dec. Inst.").

After institution of trial, E. Fred Schubert ("Patent Owner") filed a Patent Owner Response. Paper 18 ("PO Resp."). Petitioner filed a Reply. Paper 21 ("Pet. Reply"). An oral hearing was held on October 15, 2014. The transcript of the hearing has been entered into the record. Paper 27 ("Tr.").

We have jurisdiction under 35 U.S.C. § 6(c). This final written decision is issued pursuant to 35 U.S.C. § 318(a). We have considered all the evidence of record, including arguments made at the oral hearing. We conclude that Petitioner has failed to show by a preponderance of the evidence that claims 1, 2, 4, 11–14, and 16 of the '475 patent are unpatentable.

B. Related Proceedings

The '475 Patent is involved in co-pending cases captioned *E. Fred Schubert v. OSRAM GmbH.*, Case No. 12-cv-923-GMS (D. Del) and *E. Fred Schubert v. Koninklijke Philips Electronics N.V.*, Case No. 12-cv-924-GMS (D. Del). Pet. 1.

C. The ’475 Patent

The ’475 Patent relates to a method for processing a III-Nitride epitaxial layer system on a substrate. Ex. 1001, Abstract. III-Nitride epitaxial layer systems include gallium nitride (“GaN”). *Id.* III-Nitrides are used for producing light-emitting devices including light-emitting diodes (“LEDs”) and lasers. *Id.* at 1:24–27.

GaN has a hexagonal crystalline structure (“HCP”) where the top surface is the c-plane or <0001>.[1] Ex. 1001, 3:9–17. The layer of atoms that lies parallel to a basal plane is the c-plane of the crystal. Ex. 1003 ¶ 31. GaN may be grown on a c-plane sapphire substrate. Ex. 1001, 3:9–17.

The ’475 Patent discloses that the c-plane of GaN was impervious to all of the chemicals with which etching had been attempted. *Id.* at 3:21–23. The ’475 patent describes that by employing an initial processing step, non-c-planes could be etched crystallographically by molten potassium hydroxide (“KOH”). *Id.* at 3:19–21.

The ’475 Patent discloses a two-step process to achieve crystallographic etching on non-c-plane surfaces. Ex. 1001, 2:17–23; 3:52–64. The process is disclosed in Figure 3, which is reproduced below.

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[1] According to the testimony of Professor James R. Shealy (“Shealy Declaration,” Ex. 2002), the various brackets associated with the four Miller indices are interpreted as follows: parentheses ( ) denote a specific plane; curly brackets { } denote a set of planes with equivalent symmetry; square brackets [ ] denote a specific crystal direction; and angle brackets < > denote a set of crystal directions normal to planes with equivalent symmetry. Ex. 2002 ¶ 36.

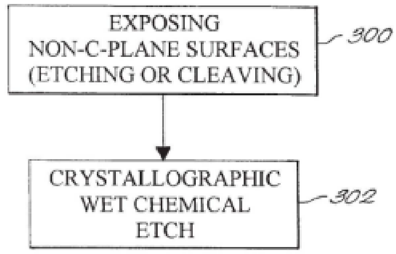

FIG. 3

Figure 3 shows at first block 300 an exposing step, which step removes material to expose the non-c-plane surfaces of a GaN epitaxial layer system. Ex. 1001, 3:52–59. The exposing step uses a known method, such as reactive ion etching in chlorine-based plasma, photoelectrochemical (“PEC”) etching in a KOH solution, or cleaving. *Id.* Crystallographic etching step 302 includes immersing the epitaxial layer system in a wet chemical etch, such as phosphoric acid, molten KOH, KOH dissolved in ethylene glycol, sodium hydroxide dissolved in ethylene glycol, tetraethyl ammonium hydroxide, or tetramethyl ammonium hydroxide. *Id.* at 2:27–33. Step 302 produces a smooth crystallographic surface. *Id.* at 3:59–62.

Figures 9A–9C show how the process is used to make a laser diode. Figures 9A–9C are reproduced below.

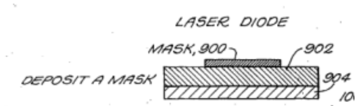

FIG. 9A

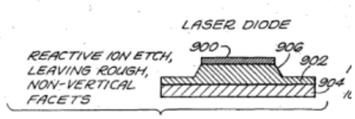

FIG. 9B

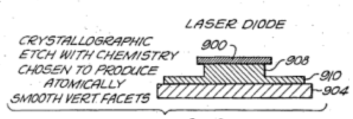

FIG. 9C

As shown in Figures 9A–9C, mask 900 is deposited initially on III-Nitride device structure 902, which is configured on sapphire substrate 904. Ex. 1001, 5:3–5, Fig. 9A. A reactive ion etch is performed, leaving rough, non-vertical facets 906 in the structure. *Id.* at 5:5–6, Fig. 9B. Then a crystallographic etch produces atomically smooth vertical facets 908, 910. *Id.* at 5:6–7, Fig. 9C.

D. Illustrative Claims

Claims 1, 11, and 13 are the three independent claims of the challenged claims that illustrate the claimed subject matter. Claims 1, 11, and 13 are reproduced below:

> 1. A method of processing a III-Nitride epitaxial layer system provided on a substrate, comprising:
>
> exposing non-c-plane surfaces of said III-Nitride epitaxial layer system; and
>
> crystallographically etching said epitaxial layer system in order to obtain crystallographic plane surfaces.
>
> 11. A method of processing a III-Nitride epitaxial layer system comprising:
>
> providing a III-Nitride epitaxial layer system on a substrate; and
>
> wet chemical crystallographic etching said epitaxial system along non-c-plane crystal directions.
>
> 13. A method of processing a III-Nitride epitaxial layer system comprising:
>
> providing a III-Nitride epitaxial layer system on a substrate; and
>
> crystallographically etching said epitaxial layer system by immersing said epitaxial layer system into a liquid chemical.

E. Prior Art References Supporting Unpatentability

Reference	Description	Publication Date	Exhibit No.
Akasaki	Japanese Published Application H10-41585	Feb. 13, 1998	Ex. 1005
Akasaki[2]	Translation of Akasaki	Feb. 13, 1998	Ex. 1006
Sonobe	Japanese Published Application No. H8-255952	Oct. 1, 1996	Ex. 1008
Sonobe[3]	Translation of Sonobe	Oct. 1, 1996	Ex. 1009

F. The Pending Grounds of Unpatentability

Claims	Grounds	Reference[s]
1, 2, 4, 11–14, and 16	§ 102(a)	Akasaki
1, 2, 4, 11–14, and 16	§ 102(b)	Sonobe

II. ANALYSIS

A. Claim Construction

1. Principals of Law

We interpret claims of an unexpired patent using the broadest reasonable construction in light of the specification of the patent in which they appear. *See* 37 C.F.R. § 42.100(b); Office Patent Trial Practice Guide, 77 Fed. Reg. 48,756, 48,766 (Aug. 14, 2012).

[2] All references in this decision to "Akasaki" are to the English translation (Ex. 1006) of the Japanese Published Application.
[3] All references in this decision to "Sonobe" are to the English translation (Ex. 1009) of the Japanese Published Application.

2. “substrate”

The term “substrate” is recited in all three independent claims 1, 11, and 13. Substrate appears in the preamble of claim 1 and as part of claimed steps of claims 11 and 13. For example, claim 11 recites: “providing a III-Nitride epitaxial layer system on a substrate.” As used in claim 1, “substrate” does not provide antecedent basis for any ensuing claim terms and is not a limitation. *See*, e.g., *C.R. Bard, Inc. v. M3 Sys., Inc.*, 157 F.3d 1340, 1350 (Fed.Cir. 1998).

Patent Owner argued in its Preliminary Response that “substrate” had a meaning to the person of ordinary skill as the substrate upon which epitaxial layers are supported. Prelim. Resp. 7–11 (citing Ex. 2002[4] ¶¶ 19–25). We adopted Patent Owner’s proposed construction in the Decision to Institute. Dec. Inst. 9–10.

Neither party objects to the construction of “substrate” from the Decision to Institute. The ’475 patent does not define the term “substrate.” On this record, we are not presented with any reason to change our construction of “substrate” from the Decision to Institute and we find that “substrate” has its ordinary and customary meaning as would be understood by one with ordinary skill. Accordingly, “substrate” means “support material for epitaxial layers.” *Id.*

3. “epitaxial layer system”

The term “epitaxial layer system” is recited in all three independent claims. For example, claim 1 recites: “exposing non-c-plane surfaces of said III-Nitride epitaxial layer system.”

[4] Dr. Shealy’s Declaration, Exhibit 2002, was created for and submitted in the related district court action between the parties.

Neither party objects to our construction of “epitaxial layer system” from the Decision to Institute. Dec. Inst. 10–11. The *McGraw-Hill Dictionary of Scientific & Technical Terms* 690 (5th ed. 1994) defines “epitaxial layer” as “[a] semiconductor layer having the same crystalline orientation as the substrate on which it is grown.” Ex. 1028. The Specification is consistent with the dictionary definition. *See* Ex. 1001, 3:15–17. On this record, we are not presented with any reason to change our construction of “epitaxial layer system” substrate” from the Decision to Institute and thus we construe “epitaxial layer system” as “at least one semiconductor layer having a crystalline relationship to the substrate on which it is grown.” *See* Dec. Inst. 10–11.

4. “non-c-plane”

The term “non-c-plane” is recited in independent claims 1 and 11, but not claim 13. For example, claim 1 recites: “exposing non-c-plane surfaces of said III-Nitride epitaxial layer system.”

Neither party objects to our construction of “non-c-plane” from the Decision to Institute. Dec. Inst. 13–14. According to the testimony from the Declaration of Dr. Christian M. Wetzel, Petitioner’s witness (“Wetzel Declaration,” Exhibit 1003), a person of ordinary skill with knowledge of the GaN crystal structure would have understood non-c-plane as something other than two c-planes, which are a positive c-plane (0001) (on the top surface) and a negative c-plane (000$\bar{1}$) on the bottom surface). Ex. 1003 ¶ 62. The file history of the ’475 patent also describes non-c-planes as passing “vertically through the c[-]plane.” Ex. 1002, 116–117. The ’475 patent describes the c-plane as the “top surface of the GaN crystal.” Ex. 1001, 3:21–23. The ’475 patent also uses the Miller indices nomenclature {0001} in describing the c-plane. *Id.* at 4:6–8. Dr. Shealy testifies that, in the case of GaN, the nomenclature {0001} limits the designated plane to the positive c-plane. Ex. 2002 ¶ 48.

We are not presented with any reason to change our construction of "epitaxial layer system" substrate" from the Decision to Institute and thus construe "non-c-plane" as "a plane other than the positive c-plane (0001)." Dec. Inst. 13–14.

5. "crystallographic etching/crystallographically etching"

The terms "crystallographic etching" or "crystallographically etching" are recited in all three independent claims. For example, claim 1 recites: "crystallographically etching said epitaxial layer system."

In the Decision to Institute, we construed "crystallographic etching/crystallographically etching" as "etching that proceeds in directions dictated by the crystallographic planes of the material being etched." Dec. Inst. 11–12. Both parties cited Donnelly (Exhibit 1019) as describing the interaction between an etchant and "III-IV material" as "differential crystallographic etching, i.e., etching that proceeds in directions dictated by the crystallographic planes of the material being etched at a rate which strongly depends on the particular plane." *See* Pet. 14–15 (citing Ex. 1019, 3:7–12); Prelim. Resp. 14.

In its Response, Patent Owner states it is "essentially in agreement with the Board's construction." PO Resp. 15. Nonetheless, Patent Owner proposes a different construction as follows: "***etching*** (removal of material) ***that proceeds in directions dictated by the crystallographic planes of the material being etched*** at a rate which depends on the particular plane (defect-revealing etching is not crystallographic etching)." *Id.* (Board construction from Decision to Institute in bold and italics). Patent Owner's construction offers additional clarifications to our construction from the Decision to Institute. *Id.* at 15–18.

Petitioner contends that the '475 patent discloses in Figure 2 "etching that proceeds in directions dictated by the crystallographic planes of GaN at defect sites." Pet. Reply 2. Petitioner contends that "crystallographic etching" includes what is shown in Figure 2, the etching of defects. *Id.* at 3. Thus, Petitioner argues that "crystallographic etching" does not require "pristine crystal" and etching of defect pits which include the crystal symmetry of GaN are encompassed by "crystallographic etching." *Id.* at 4.

The '475 patent does not explicitly define "crystallographic etching." Patent Owner's clarifications are extraneous limitations unnecessary for the purpose of making sense of the claim. *See*, *e.g.*, *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994). Neither do we accept Petitioner's proposal that defect etching should be specifically included in our construction because defect etching could be, but is not necessarily, "crystallographic etching."

On this record, we are not presented with any reason to change our construction of "crystallographic etching" from the Decision to Institute and construe "crystallographic etching/crystallographically etching" as "etching that proceeds in directions dictated by the crystallographic planes of the material being etched." Dec. Inst. 11–12.

6. "crystallographic plane surfaces"

We have not previously considered nor provided a construction for "crystallographic plane surfaces." The term "crystallographic plane surfaces" is present in claim 1, which recites "crystallographically etching said epitaxial layer system in order to obtain *crystallographic plane surfaces*."

When asked for a construction of "crystallographic plane surfaces" at final hearing, Petitioner stated the term means "the smooth surfaces that are crystallographic planes that are yielded in the -- in both Akasaki and in Sonobe." Tr. 8:12–15. Patent Owner, in response to the same question, said, "a crystallographic plane surface is one that is, first of all, produced by crystallographic etching. And it refers to, in that particular plane, a smooth plane surface that reflects the intrinsic planes in the crystal." Tr. 31:16–20. The language of claim 1 requires that "crystallographic plane surfaces" result from crystallographic etching.

We thus construe "crystallographic plane surfaces" to mean "a smooth plane surface resulting from crystallographic etching."

B. Issues for Review

1. Summary of Remaining Issues

We instituted trial on claims 1, 2, 4, 11–14, and 16 on two grounds. Based on the information provided in the Petition, we determined that Petitioner had demonstrated a reasonable likelihood of showing that the claims were anticipated under 35 U.S.C. § 102(a) by Akasaki, and under 35 U.S.C. § 102(b) by Sonobe. Dec. Inst. 23.

Patent Owner does not dispute that the vertical dry etch used in both Akasaki and Sonobe exposed non-c-planes of GaN. PO Resp. 3. Patent Owner states the critical issue is whether the wet etching of Akasaki and Sonobe discloses, expressly or inherently, crystallographic etching of the subject epitaxial layer system. *Id*. at 3, 12; Tr. 53:1–4. Petitioner agrees that the critical issue in this case is whether Akasaki and Sonobe disclose crystallographic etching under the broadest reasonable claim interpretation. Pet. Reply 1; Tr. 5:4–8.

We have reviewed the Petition, Petitioner's evidence, Patent Owner's Response and its evidence and have determined that the record supports that both Akasaki and Sonobe disclose the dry etching and wet etching of a GaN epitaxial layer as claimed in claims 1, 11, and 13 of the '475 patent. Therefore, the only issue before us is whether or not either Akasaki or Sonobe disclose "crystallographic etching"[5] as we have construed the terms.

2. Anticipation by Akasaki

Petitioner contends that claims 1, 2, 4, 11–14, and 16 of the '475 Patent are anticipated under 35 U.S.C. § 102(a) by Akasaki. Pet. 18–25. To support this position, Petitioner presents the Wetzel Declaration. Ex. 1003 ¶¶ 72–76. In light of the arguments and evidence submitted by both parties, for the reasons discussed below, Petitioner has not shown by a preponderance of the evidence that claims 1, 2, 4, 11–14, and 16 of the '475 patent are anticipated by Akasaki.

a. Akasaki Overview

Akasaki is directed to a method of manufacturing a group III nitride semiconductor. Ex. 1006, Title. According to Akasaki, there were "known blue light-emitting diodes (LEDs) and blue laser diodes (LDs), formed from individual layers made of a gallium nitride compound semiconductor (AlGaInN) on a sapphire substrate." *Id.* ¶ 2.

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[5] Hereafter we will refer to "crystallographic etching" understanding that "crystallographically etching" is encompassed by that reference.

In an embodiment of Akasaki, "a p layer and a n layer are formed from a group III nitride semiconductor on the substrate, where the individual layers are formed from group III nitride semiconductors on the substrate." *Id.* ¶ 4. Each layer is dry-etched in order to form end faces of a resonator. *Id.* After dry etching, the end faces that have been dry-etched are wet-etched through an etching solution. *Id.* The result of the wet etching is that the damage caused to the end faces of the resonator by dry etching is removed, improving the degree of mirror surfacing of the end faces. *Id.*

Figure 2 of Akasaki is reproduced below:

[FIG. 2]

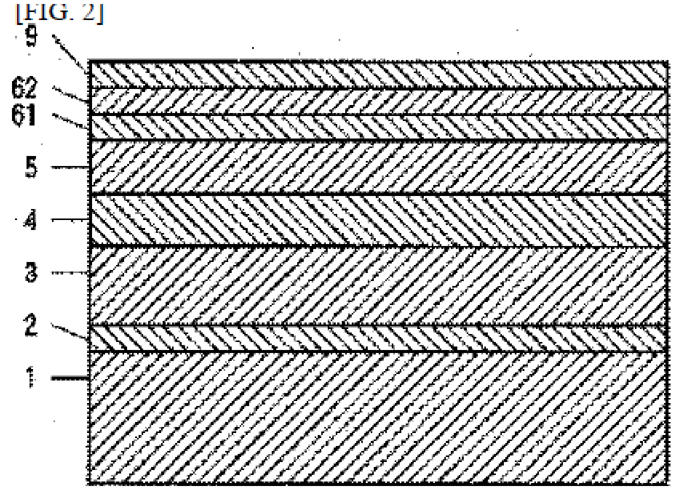

Figure 2 illustrates the first manufacturing step of the method of the present invention. Substrate 1 is sapphire. *Id.* ¶ 7. Individual layers are formed sequentially on substrate 1. *Id.* ¶ 8. An n conductivity-type clad layer 4 is made from aluminum gallium nitride ($Al_{0.08}Ga_{0.92}N$). *Id.* ¶ 11. Layer 5 is an active layer of $Al_{0.08}Ga_{0.92}N$. *Id.* ¶ 12. Layer 61 is a p conductivity-type clad layer of magnesium-doped $Al_{0.08}Ga_{0.92}N$. *Id.* ¶ 13. Contact layer 62 is formed from magnesium doped GaN. *Id.* ¶ 14.

Figure 7 of Akasaki is reproduced below:

[FIG. 7]

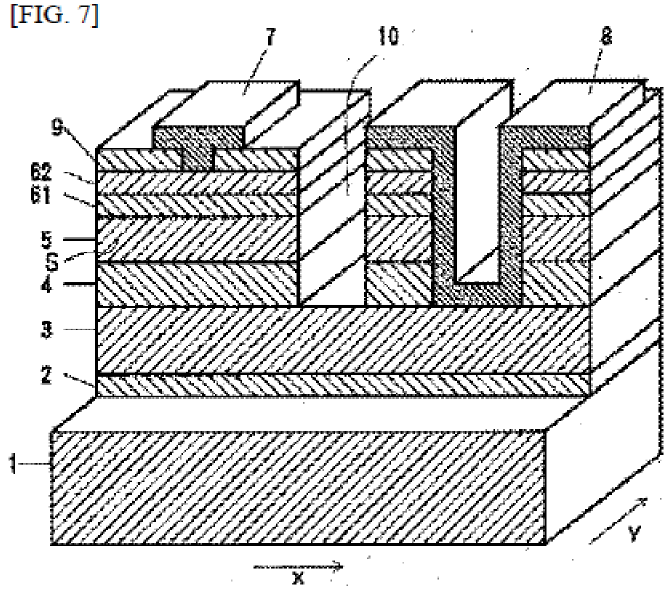

FIG. 7 is a perspective cross section of a structure for a laser diode after the dry etching and wet etching steps. Resonator end faces S, with "high levels of squareness relative to the substrate 1 and with high levels of parallel between the end faces were obtained in the active layer 5." Ex. 1006 ¶ 21.

b. Whether Akasaki Discloses "crystallographic etching"

All three independent claims recite either "crystallographic etching" or "crystallographically etching." Akasaki discloses performing "wet etching of the end faces that had been dry-etched." Ex. 1006 ¶ 0021. Relying on Dr. Wetzel's Declaration, Petitioner alleges that the wet etching of Akasaki is "crystallographic," as recited in claim 1. Pet. 20 (citing Ex. 1003 ¶¶ 74–75).

Akasaki further specifies the result obtained by wet etching is a resonator end face S with "high levels of squareness" and "high levels of parallel between the end faces." Ex. 1006 ¶ 21; *see* Fig. 7. The wet etching results in "improving the degree of mirror surfacing." *Id.* ¶ 5, Fig. 1. Petitioner cites to the preceding language regarding wet etching as additional support for contending Akasaki discloses "crystallographically etching" the epitaxial layer system. Pet. 20–21.

Patent Owner argues neither Akasaki nor Sonobe discloses "crystallographic etching." PO Resp. 3, 23–30. Patent Owner further notes that neither reference mentions "crystallographic etching" nor identifies any specific crystal plane. *Id.* Thus, Patent Owner contends there is no express disclosure of "crystallographic etching." *Id.* at 4, 23–30. Patent Owner also argues there is no inherent disclosure of the limitation. *Id.* at 4, 30–60.

In illustrating its primary argument, that defect etching shown in Akasaki and Sonobe is not "crystallographic etching," Patent Owner labels the GaN epitaxial layer of the etched material as layer B. PO Resp. 4–5. Conversely, layer A is denominated as the layer of damage and contamination left after the dry etch. *Id.* Patent Owner cites to the Declaration of Professor James R. Shealy ("Shealy Declaration," Ex. 2014) as evidence that reactive ion beam etching is known to create a layer of amorphous damage, i.e., Material A. *Id.* at 5–6, *see* Ex. 2014 ¶ 79.

Patent Owner argues the '475 patent distinguishes between defect etching and crystallographic etching. PO Resp. 17. Specifically, Patent Owner states defect etching is known to etch pits at defect sites. *Id.* (citing Ex. 1001, 3:33–35). By contrast, the '475 patent discloses that "non-c planes can be crystallographically etched by molten KOH." *Id*. (citing Ex. 1001, 3:18–21). As a result, Patent Owner contends one of ordinary skill in the art would distinguish crystallographic etching from defect-revealing etching. *Id.* (citing Ex. 2014 ¶ 36).

As to Akasaki specifically, Patent Owner notes that the dry etching step produces defects "due to the end faces being damaged by the ions." PO Resp. 24 (citing Ex. 1006 ¶ 3). The damage is removed by wet etching, "thus improving the degree of mirror surfacing of the end faces." *Id.* (citing Ex. 1006 ¶ 5). Patent Owner concludes that Akasaki does nothing through the wet etching step other than remove damage. *Id.* at 26. Patent Owner cites to Dr. Shealy for his conclusion that the "high levels of squareness relative to the substrate" and the "high levels of parallel between the end faces" in Akasaki were produced by the vertical dry etching. *Id.* (citing Ex. 2014 ¶¶ 53–55). Thus Patent Owner argues Akasaki does not expressly disclose "crystallographically etching." *Id.*

Patent Owner makes several additional arguments that neither Akasaki nor Sonobe expressly or inherently disclose "crystallographic etching." PO Resp. 30–60. The arguments include: neither discloses aligning the mask with an appropriate crystal plane (PO Resp. 31–38); etching damage and contaminants is not "crystallographic etching" (PO Resp. 38–44); no etching beyond the defect layer is disclosed (PO Resp. 44–45); there is insufficient information on reagents or conditions to conclude "crystallographic etching" takes place (PO Resp. 46–47); "crystallographic etching" cannot be inferred from Akasaki's laser performance data (PO Resp. 47–54); Akasaki's and Sonobe's drawings are not evidence of "crystallographic etching" (PO Resp. 54–56); and descriptions of etching results are not evidence of "crystallographic etching" (PO Resp. 56–59).

In its Reply, Petitioner argues Figure 2 of the '475 patent, which shows defect pits, discloses etching that proceeds in directions dictated by the crystallographic planes of GaN. Pet. Reply 2. Petitioner notes that the discovery of the ’475 patent is that etching proceeds in directions dictated by the crystallographic planes, i.e., crystallographic etching. *Id.*

Petitioner concludes that the “broadest reasonable construction of ‘crystallographic etching’ must include the Figure 2 embodiment.” *Id.* at 3. Petitioner notes that other references of record disclose etch pits in GaN that are “hexagonal pyramids, which reflect the crystal symmetry of GaN.” Pet. Reply 4 (citing Ex. 1011, Abstract). Further, this prior art disclosure, according to Petitioner, identifies the non-c-plane crystal facets of the pyramids. *Id.* (citing Reply Declaration of Dr. Christian M. Wetzel, “Wetzel Reply Declaration,” Ex. 1041 ¶¶ 17–18).

Petitioner relies on Akasaki and Sonobe as expressly, or at a minimum inherently, disclosing “crystallographic etching.” Tr. 55:14–16. However, neither the Petition nor any evidence provided in its Reply identifies any basis for concluding that “crystallographic etching” is expressly disclosed. Indeed, Dr. Wetzel does not state any facts that support a conclusion that the references etch the gallium nitride layer, the so called B layer. *See* Ex. 1041, 160–180.

We are not persuaded that Figure 2 of the ’475 patent discloses an “embodiment” that includes defect etching as “crystallographic etching,” as we have construed that term above in section II.A.5. The ’475 patent does differentiate defect etching from “crystallographic etching.” *See* Ex. 1001, 3:17–31. For example the ’475 patent acknowledges that “[M]olten KOH is known to form pits at dislocations in the c-plane of GaN.” *Id.* at 3:18–19. Further, exposing a defect pit that has planar surfaces by wet etching is not “etching that proceeds in directions *dictated by the crystallographic planes* of the material being etched.” Dec. Inst. 11–12.

Petitioner points to Figure 2 as showing that the faces produced in the defect pits are "two or more competing etch planes." Pet. Reply 2–3 (citing Ex. 1001, 3:40–44; *see also* Ex. 1041 ¶¶ 7–9). However, this disclosure does not support the position that Figure 2 is an example of "crystallographic etching." "Crystallographic etching" is directed to creating a "crystallographic plane surface" (see claim 1) and not multiple "competing etch planes." Dr. Shealy also testifies that Figure 2 shows "many, many crystal planes" and is not "crystallographic etching." Deposition of James R. Shealy, Ex. 1040, 48:13–22. Dr. Wetzel's Reply Declaration does not dictate a different result. Ex. 1041 ¶¶ 7–9.

As discussed above, Petitioner argues Akasaki expressly, or at least inherently, discloses "crystallographic etching." Petitioner argues the smooth mirror faces which result from the wet etching in Akasaki are evidence that "crystallographic etching" necessarily results. Tr. 59:14–18; *see* Ex. 1006 ¶ 4. However, Akasaki states clearly that the wet etch step removes damage caused by the dry etch, "thus improving the degree of mirror surfacing of the end faces." Ex. 1006 ¶ 5. Smooth surfaces alone do not necessarily imply "crystallographic etching" because the smooth surface may result from only the removal of damage caused by the dry etch.

Petitioner has produced no evidence that would lead us to conclude that the wet etch in Akasaki goes beyond the damage produced by the dry etch—i.e., the amorphous layer (Patent Owner's Layer A)—to actually etch the epitaxial layer system (Patent Owner's Layer B). "Crystallographic etching" might possibly then occur, but Petitioner has not shown that it necessarily occurs.

c. Summary of Akasaki

Petitioner has not shown by a preponderance of the evidence that Akasaki expressly or inherently discloses "crystallographic etching." Independent claims 1, 11, and 13 all recite "crystallographic etching" or "crystallographically etching." The remaining dependent claims 2, 4, 12, 14, and 16 necessarily require the limitation. Petitioner has failed to show by a preponderance of the evidence that claims 1, 2, 4, 11–14, and 16 of the '475 patent are anticipated by Akasaki.

2. Anticipation by Sonobe

Petitioner contends that claims 1, 2, 4, 11–14, and 16 of the '475 Patent are anticipated under 35 U.S.C. § 102(b) by Sonobe. Pet. 25–31. To support this position, Petitioner relies, in part, on the testimony of Dr. Wetzel. Ex. 1003 ¶¶ 77–80. In light of the arguments and evidence submitted by both parties, for the reasons discussed below, Petitioner has not shown by a preponderance of the evidence that claims 1, 2, 4, 11–14, and 16 of the '475 patent are anticipated by Sonobe.

a. Sonobe Overview

Sonobe discloses a "Method of Manufacturing Semiconductor Light-Emitting Element." Ex. 1009, Title. Sonobe's method is directed to etching of a gallium nitride group semiconductor layer by first dry etching the semiconductor layer and then carrying out wet etching. *Id.* at Abstract. The result of the method is a light emitting-diode which is etched vertically so that light is emitted from the side surface exposed by etching. *Id.* ¶¶ 1, 3.

Figure 2(d) is reproduced below.

[Figure 2]

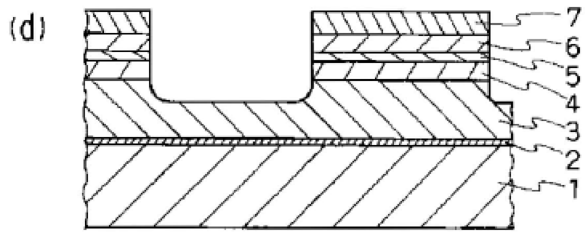

Figure 2(d) is a cross section of the laminate layers of the semiconductor during one step of the manufacturing process. As shown in Figure 2(d), the laminate layers include substrate 1, low temperature buffer layer 2, high temperature buffer layer 3, n-type cladded layer 4, activated layer 5, p-type cladded layer 6, and cap layer 7. Ex. 1009 ¶ 21. Dry etching of the laminated semiconductor layers using reactive ion etching is performed. *Id.* ¶ 24. Wet etching is performed using an etching solution. *Id.* As a result, the etched surface is not damaged, and the perpendicularity of the lateral surface of the semiconductor, which had been etched relative to the surface of the semiconductor layer, is maintained as indicated in Figure 2(d). *Id.*

b. Whether Sonobe Discloses "crystallographic etching"

Sonobe discloses that, after dry etching, wet etching is performed. Ex. 1009 ¶ 16. Petitioner argues this portion of Sonobe[6] meets the "crystallographically etching" limitation of claim 1 and forms crystallographic plane surfaces. Pet. 27 (citing Ex. 1003 ¶¶ 79–80). Sonobe also discloses perpendicular lateral semiconductor surfaces, which Petitioner

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[6] Petitioner mistakenly cites to Ex. 1010 (Certification of the Translation of Sonobe) instead of Ex. 1009 (Sonobe Translation).

interprets as "crystallographic plane surfaces" from wet etching. Pet. 27 (citing Ex. 1009 ¶¶ 24, 31).

Patent Owner's arguments described above in the discussion of Akasaki apply generally to both Akasaki and Sonobe. Specific to Sonobe, Patent Owner contends Sonobe does not purport to disclose crystallographic etching at all, but instead discloses using the wet etch to "clean" the surface after dry etching. PO Resp. 5, 27–30; *see* Ex. 1009 ¶¶ 11, 15.

Further, Patent Owner offers evidence that "crystallographic etching" proceeds at different rates depending on the particular plane involved. *Id.* at 6 (citing Ex. 2014 ¶ 60). Etching at different rates for different crystallographic planes is anisotropic. *Id.* (citing Ex. 2014 ¶ 60). Etching that proceeds equally in all directions is called isotropic etching. *Id.* (citing Ex. 2014 ¶ 60). Patent Owner's expert concludes that Sonobe describes isotropic etching based, in part on descriptions of a "round part." *Id.* (citing Ex. 2014 ¶ 60).

Patent Owner further notes that the "perpendicularity of the lateral surface of the semiconductor" is created by Sonobe in the first instance by dry etching and "is maintained" after wet etching. PO Resp. 27 (citing Ex. 1009 ¶ 24). Patent Owner argues that Sonobe describes dry etching as resulting in "approximately 90 to 95% of the entire etching amount." *Id.* at 27 (citing Ex. 1009 ¶ 25).

Petitioner's arguments in response include those made in regard to Akasaki. As to Sonobe specifically, Petitioner argues that the etching that is "carried out evenly" on the sidewalls to maintain "[t]he perpendicularity of the lateral surface" is "crystallographic etching." Pet. Reply 11 (citing Ex. 1009 ¶ 24; *see also* Ex. 1041 ¶ 46).

We are not persuaded that Sonobe discloses "crystallographic etching" for the same reasons we discuss above with respect to Akasaki, i.e., defect etching as disclosed in Sonobe, or cleaning, is not "crystallographic etching." In addition, the evidence establishes that crystallographic etching is anisotropic. Ex. 2014 ¶ 60. As discussed below, Sonobe discloses isotropic etching.

As Petitioner's witness, Dr. Wetzel, testified, "[I]t is clear that the term 'crystallographic' is being used [in the '475 patent] to describe a preferential, or anisotropic, etch." Ex. 1003 ¶ 59. Sonobe specifically states the wet etching step is "*isometric etching* and etching is carried out evenly both on the lateral surface of the laminated semiconductor layer and on the exposed surface." Ex. 1009 ¶ 18 (emphasis added). As already noted, Patent Owner's expert, Dr. Shealy, concluded that Sonobe disclosed isotropic etching. Ex. 2014 ¶ 60. Professor Shealy also testifies that "crystallographic etching" is anisotropic. *Id.* At the final hearing, Petitioner also agreed that "crystallographic etching" must be anisotropic. Tr. 19:2–7. On this record, we determine that Sonobe discloses isotropic etching and not crystallographic etching.

Petitioner does not specify how Sonobe might inherently disclose "crystallographic etching." Accordingly, our analysis is based on Petitioner's arguments that Sonobe expressly discloses "crystallographic etching."

c. Summary of Sonobe

Petitioner has not shown by a preponderance of the evidence that Sonobe expressly or inherently discloses "crystallographic etching." Independent claims 1, 11, and 13 all recite "crystallographic etching" or "crystallographically etching." The remaining dependent claims 2, 4, 12, 14, and 16 necessarily require the limitation. Petitioner has failed to show by a preponderance of the evidence that claims 1, 2, 4, 11–14, and 16 of the '475 patent are anticipated by Sonobe.

III. ORDER

For the reasons given, it is

ORDERED that claims 1, 2, 4, 11–14, and 16 of U.S. Patent No. 6,294,475 have not been shown by a preponderance of the evidence to be unpatentable; and

FURTHER ORDERED that, because this is a final written decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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