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Paper 68
Entered: February 11, 2014

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NICHIA CORPORATION
Petitioner

v.

EMCORE CORPORATION
Patent Owner

Case IPR2012-00005
Patent 6,653,215

Before KEVIN F. TURNER, STEPHEN C. SIU, and JONI Y. CHANG, *Administrative Patent Judges*.

CHANG, *Administrative Patent Judge*

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

I. INTRODUCTION

Nichia Corporation ("Nichia") filed a petition on September 16, 2012, requesting an *inter partes* review of claims 1-17 of U.S. Patent No. 6,653,215 ("the '215 patent"). Paper 2 ("Pet."). The patent owner, Emcore Corporation ("Emcore") did not file a preliminary response. Upon review of Nichia's petition, the Board instituted this trial on February 12, 2013.

During the trial, Emcore filed a patent owner response (Paper 24 ("PO Resp.")), and Nichia filed a reply to the patent owner response (Paper 38 ("Pet. Reply")). Emcore also filed a motion to amend claims (Paper 26); Nichia filed an opposition to Emcore's motion to amend claims (Paper 40); and Emcore then filed a reply (Paper 43) to Nichia's opposition. Oral hearing was held on November 6, 2013.[1]

We have jurisdiction under 35 U.S.C. § 6(c). This final written decision is entered pursuant to 35 U.S.C. § 318(a). We hold that claims 1-17 of the '215 patent are unpatentable under 35 U.S.C. § 103(a). Emcore's motion to amend claims is denied.

A. Related Proceeding

Nichia indicates that the '215 patent is asserted in the litigation styled *Emcore Corp. v. Nichia Corp.*, Case No. 2-12-cv-11758 (E.D. Mich). Pet. 1.

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[1] A transcript of the oral hearing is included in the record as Paper 66.

B. Real Party-in-Interest

Emcore asserts that Nichia[2] failed to identify all real parties-in-interest in the petition, as required by 35 U.S.C. § 312(a)(2). PO Resp. 1. In support of that assertion, Emcore alleges that Nichia represented to the district court, in a motion to stay, that both Nichia Corporation and Nichia America Corporation ("NAC") filed the petition. *Id*. at 2 (citing Ex. 2017, 1). Emcore takes the position that the petition was "filed at the behest of both Nichia Corporation and NAC," and that Nichia "is acting in the interest of NAC." *Id*. at 3. Emcore submits that NAC is a subsidiary of Nichia, and as co-defendants in the district court litigation, both Nichia and NAC used the same expert witness and counsel, and asserted the same prior art and claim for a declaratory judgment. *Id*. at 3-4.

Nichia disagrees and argues that a clerical error was made inadvertently in the motion to stay, and it has notified the district court of the clerical error. Pet. Reply 15. As support, Nichia has submitted a copy of the Notice Correcting Corporate Names (Ex. 1036) that was filed in the district court. *Id*. Nichia also asserts that NAC had no control over the decision to file a petition, drafting the petition, or the content of the petition. *Id*. at 14. Nichia further maintains that NAC did not fund the petition. *Id*.

We are not persuaded by Emcore's argument, as it is based on a clerical error made in a Nichia's court filing, and speculations. Whether a party that is not named in an *inter partes* review is a "real party-in-interest"

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[2] In the instant proceeding, the term "Nichia" refers to Nichia Corporation, and does not include Nichia America Corporation.

is a "highly fact-dependent question," taking into account various factors such as whether the non-party "exercised or could have exercised control over a party's participation in a proceeding" and the degree to which a non-party funds directs and controls the proceeding. Office Patent Trial Practice Guide, 77 Fed. Reg. 48756, 48759-60 (Aug. 14, 2012).

Upon review of the parties' arguments and evidence, we determine that Emcore did not demonstrate adequately that Nichia failed to identify all real parties-in-interest. The petition identifies Nichia Corporation as the real party-in-interest. Pet. 1. Nichia's motion to stay (Ex. 2017) and the Notice Correcting Corporate Names (Ex. 1036) reveal that: (1) the motion to stay used the shorthand "Nichia" to refer to both Nichia Corporation and NAC; (2) the motion to stay inadvertently stated that "Nichia filed a Petition for *inter partes* review . . ."; and (3) the motion to stay should have used "Nichia Corporation" rather than "Nichia." Ex. 2017, 1-2; Ex. 1036, 2. The evidence before us clearly shows that the motion to stay filed in the district court contains a clerical error, especially in light of the fact that in the instant proceeding, we use the term "Nichia" to refer only to Nichia Corporation (*see, e.g.*, Decision on Institution, Paper 13 at 2). Therefore, the evidence does not establish that NAC is a real party-in-interest to this proceeding. Moreover, the mere fact that Nichia and NAC, as co-defendants, shared the same counsel and expert witness, and had similar litigation strategy is not sufficient to prove that NAC exercised, or could have exercised, control over Nichia's action in the instant proceeding. Nor does being a subsidiary of Nichia establish that NAC has the ability to control Nichia's conduct in this proceeding, in the absence of any evidence of contractual obligations of the parties. For the foregoing reasons, Emcore fails to demonstrate that Nichia did not identify all real parties-in-interest in the petition.

C. The '215 Patent

The '215 patent is directed to a method of forming a contact on an n-type III-V semiconductor by depositing four layers of metal and annealing the resulting stack. Ex. 1001, Abs. Figure 3 is a sectional view of a contact, and is reproduced below (with labels added, *see* Ex. 1001, 4:32-36):

FIG. 3

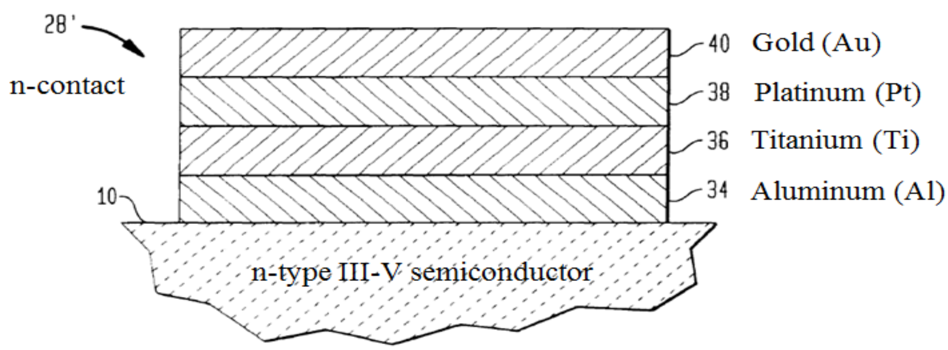

Figure 3 shows a contact formed in accordance with the claimed method.

Claim 1, reproduced below, is the sole independent claim:

> A method of forming a contact on an n-type III-V semiconductor comprising the steps of:
>
> (a) depositing Al on the n-type III-V semiconductor to provide a base layer; then
>
> (b) depositing Ti on said base layer to provide a first barrier layer; then
>
> (c) depositing Pt on said first barrier layer to provide a second barrier layer; then
>
> (d) depositing Au on said second barrier layer to provide

a top layer, whereby said base layer, said first barrier layer, said second barrier layer, and said top layer form a stack on the n-type semiconductor; and then

(e) annealing said n-type III-V semiconductor with said stack thereon.

D. Prior Art Relied Upon

Nichia relies upon the following prior art references:

Fujimoto	U.S. 6,242,761	Jun. 5, 2001	(Ex. 1007)
Nakamura	U.S. 5,563,422	Oct. 8, 1996	(Ex. 1013)
Kawamura	JP H06-37036	Feb. 10, 1994	(Ex. 1014 & 1015)
Kidoguchi	JP10-256645	Sept. 25, 1998	(Ex. 1016 & 1017)[3]
Shibata	JP H08-274372	Oct. 18, 1996	(Ex. 1018 & 1019)[4]

Admitted Prior Art – the background section of ’215 patent (Ex. 1001, 1:15-2:9) and the background section of provisional application 60/238,221 (“the ’221 provisional application”) (Ex. 1004, 1-2[5]).

Murarka, et al., “Investigation of the Ti-Pt Diffusion Barrier for Gold Beam Leads on Aluminum,” 125 Iss.1 J. Electrochem. Soc. 1561978 (Ex.1008).

Vendenberg, et al., “An in situ x-ray study of gold/barrier-metal interactions with InGaAsP/InP layers,”55(10) J. Appl, Phys. 3676 (15 May 1984) (Ex.1009).

Lepselter, “Beam-Lead Technology,” 45, The Bell System Technical Journal 233 (1966) (Ex.1020).

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[3] The exhibits provide the specified Japanese patent application and a certified English translation thereof, where we cite to the English translation.

[4] *Ibid.*

[5] All references to the page numbers of the ’221 provisional application refer to the original page numbers, and not the exhibit page numbers.

Terry, et al., "Metallization Systems for Silicon Integrated Circuits," 57, No. 9 Proc. IEEE 1580 (1969) (Ex. 1021).

Hoff, et al., "Ohmic contacts to semiconducting diamond using a Ti/Pt/Au trilayer metallization scheme," 5 (1996) Diamond and Related Materials 1450 (Ex. 1022).

Durbha, et al., "Thermal Stability of Ohmic Contacts to n-$In_xGa_{1-x}N$," 395 Mat. Res. Soc. Symp. Proc. 825(1996) (Ex. 1023).

E. Ground of Unpatentability

The Board instituted the instant trial based on the ground that claims 1-17 of the '215 patent are unpatentable under 35 U.S.C. § 103(a) over Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art.

II. ANALYSIS

A. Claim Construction

We begin our analysis by determining the meaning of the claims. In an *inter partes* review, claim terms in an unexpired patent are given their broadest reasonable construction in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b). Under the broadest reasonable construction standard, claim terms are given their ordinary and customary meaning as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *In re Translogic Tech. Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). An inventor may rebut that presumption by providing a definition of the term in the specification with reasonable clarity, deliberateness, and precision. *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994). In absence of such a definition, limitations are not to be read from the specification into the claims. *In re Van Geuns*, 988 F.2d 1181, 1184 (Fed. Cir. 1993).

1. *"III-V semiconductor" (claim 1); "n-type" as used with semiconductor (claim 1); "pure nitride semiconductor" or "pure nitride compound semiconductor" (claim 12)*

In its petition, Nichia notes that the '215 patent expressly defines these semiconductor claim terms in the specification. Pet. 10-11 (citing Ex. 1001, 5:5-8; 5:14-17; 5:5-12). Upon review of the cited portions of the specification, we observe that the definitions are set forth in the specification with reasonable clarity, deliberateness, and precision. Therefore, we adopt the definitions as the broadest reasonable constructions for the semiconductor claim terms set forth in the table below.

Terms	**Definitions**
III-V semiconductor	A semiconductor according to the stoichiometric formula $Al_a In_b Ga_c N_x As_y P_z$ where (a+b+c) is about 1 and (x+y+z) is also about 1. Ex. 1001, 5:5-8.
"n-type" as used with semiconductor	A semiconductor having n-type conductivity, i.e., a semiconductor in which electrons are the majority carriers. *Id*. at 5:14-17.
Pure nitride semiconductor or pure nitride compound semiconductor	A nitride semiconductor in which x [in the stoichiometric formula $Al_a In_b Ga_c N_x As_y P_z$] is about 1.0. *Id*. at 5:10-12.

2. "annealing" (claim 1)

The claim term "annealing" is recited in claim 1 in the following limitation: "annealing said n-type III-V semiconductor with said stack thereon."

Nichia submits that the claim term "annealing" means "heating to temperatures between 400-900 ºC and for a duration sufficient to cause a desired change in the properties of the contact stack." Pet. 14 (internal quotation marks omitted). We observe that Nichia's construction would import improperly a limitation—"temperatures between 400-900 ºC"—from the specification into the claims. *Van Geuns*, 988 F.2d at 1184. Moreover, Nichia's proposed construction is inconsistent with the specification and the ordinary and customary meaning of the term. For instance, in the background section of the '215 patent discussing prior art methods of forming a contact, there is no indication that the annealing step includes such a temperature-range requirement. Ex. 1001, 1:59-2:10. Therefore, we do not adopt Nichia's proposed construction as the broadest reasonable interpretation for the claim term "annealing."

Emcore urges that the claim term "annealing" should be construed as "heating the semiconductor sufficiently to form a contact with low resistance." PO Resp. 24. In support of its proposed construction, Emcore maintains that "the specification does not require simply any change to occur," but "it requires a specific and beneficial change, i.e., the resulting contact should have a *low resistance and reliable bonding*." PO Resp. 25 (citing Ex. 1001, 4:26-27) (emphasis added). Emcore further argues that "the method disclosed by the '215 patent emphasizes that it discloses a particular method where annealing a contact with an Al base layer results in a contact with low resistance and reliable boding." PO Resp. 26 (citing Ex. 1011, 4-5). According to Emcore, those statements "distinguishing the claimed invention from the prior art go to the heart of the full understanding of what the inventors actually invented." *Id*. (internal citations omitted).

We do not agree with Emcore that its proposed construction is the broadest reasonable interpretation of the claim term "annealing," as it would import improperly a limitation—"sufficiently to form a contact with low resistance"—from the specification into the claims. *Gemstar-TV Guide Int'l, Inc. v. ITC*, 383 F.3d 1352, 1366 (Fed. Cir. 2004) (rejecting expressly the contention that claims must be construed as limited to an embodiment disclosed in the patent).

We also are not persuaded by Emcore's arguments. They fail to recognize that it is "a bedrock principle of patent law that the claims of a patent define the invention to which the patentee is entitled the right to exclude." *Phillips v. AWH Corp*., 415 F.3d 1303, 1312 (Fed. Cir. 2005) (citations and quotation marks omitted); *see also Markman v. Westview Instruments, Inc*., 52 F.3d 967, 980 (Fed. Cir. 1995) (en banc) ("The written description part of the specification itself does not delimit the right to exclude. That is the function and purpose of claims.").

Emcore has not alleged that the inventors of the '215 patent acted as their own lexicographer and provided a special definition in the specification for the claim term "annealing" that is different from its recognized meaning to one with ordinary skill in the art. The claim language used by Emcore is broad. There is no requirement as to the resistivity of the contact or a specific and beneficial change, as urged by Emcore. One with ordinary skill in the art may use "annealing" to form a contact that does not have a low resistance contact or to form other semiconductor structures.

In support of Emcore's position, Dr. Mark S. Goorsky testifies that Emcore's proposed construction is correct, because "[w]hen the '215 patent uses the term 'annealing,' it means specifically a 'contact anneal.'" Ex. 2001 ¶ 61 (citing Ex. 1002 ¶ 31). However, Dr. Goorsky relies on Nichia's expert testimony that does not support Emcore's proposed construction, as it does not discuss Emcore's proposed construction, nor contact resistivity. Ex. 1002 ¶ 31. Neither expert's testimony (Ex. 2001 ¶ 61; Ex. 1002 ¶ 31) explains sufficiently why the term "annealing" should be limited specifically to "heating the semiconductor sufficiently to form a contact with low resistance." As Emcore notes (PO Resp. 25-26), the contacts disclosed in the prior art, including those that are formed with annealing, may or may not produce a low contact resistance. Therefore, Emcore's proposed construction would be inconsistent with the claim term's ordinary and customary meaning as would be understood by one of ordinary skill in the art.

Moreover, Emcore, in its patent owner response, does not explain the meaning of the term "low resistance." PO Resp. 24-26. Upon inquiry at the final oral hearing, counsel of Emcore stated that he agrees with the definition proffered by Nichia's expert, Dr. E. Fred Schubert. Trial Tr. (Paper 66), 34:17-23. Dr. Schubert testifies:

> In 1999-2000, a contact resistance of 10^{-5} Ωcm^2 would simply have reflected the approximate dividing line between a desirable contact and an undesirable contact. Higher than 10^{-5} Ωcm^2 would have been considered a poor contact resistance, while below 10^{-5} Ωcm^2 would have been considered a good contact resistance (for example, Schroder, "Semiconductor Material and Device Characterization," Ex. 1025, p. 125 stated in 1990 that high-quality contacts were on the order of 10^{-6} Ωcm^2). The 1997 review article by Baca, *et al.* surveyed *contacts for n-type III-V semiconductors, and found none that exceeded 10^{-5} Ωcm^2, with most contacts substantially below that value* (Baca, *et al.*, Ex. 1024, p. 604, Table 1).

Ex. 1002 ¶ 55 (emphasis added).

Although that definition of "low resistance" is also consistent with the specification of the '215 patent (Ex. 1001, 4:43-46), Emcore's proposed construction would render the limitation recited in claim 15—"a contact resistance of less than about 10^{-5} ohm-cm^2"—insignificant, if not wholly superfluous. Emcore's proposed construction also would render claim 15, that depends from claim 1, an improper dependent claim under 35 U.S.C. § 112, ¶ 4. Emcore does not explain adequately as to why the term "annealing" recited in independent claim 1 should be construed to require a limitation recited in a dependent claim 15. *Phillips*, 415 F.3d at 1314-15 (stating "the presence of a dependent claim that adds a particular limitation gives rise to a presumption that the limitation in question is not present in the independent claim."); *see also Curtiss-Wright Flow Control Corp. v. Velan, Inc.*, 438 F.3d 1374, 1380 (Fed. Cir. 2006) ("In the most specific sense, 'claim differentiation' refers to the presumption that an independent claim should not be construed as requiring a limitation added by a dependent claim.").

In determining the ordinary and customary meaning of the claim term, it is appropriate to consult a general dictionary definition of the word for guidance. *Comaper Corp. v. Antec, Inc.*, 596 F.3d 1343, 1348 (Fed. Cir. 2010). The ordinary meaning of the word "anneal" includes "to heat (glass, earthenware, metals, etc.) to remove or prevent internal stress."[6]

Consistent with the usage in the prior art and in the specification of the '215 patent, we construe "annealing" as heating the semiconductor structure sufficiently to cause a change in some property of the semiconductor structure. *See e.g.*, Ex. 1001, 1:59-61 ("When the electrode is annealed it becomes transparent so that light emitted within the [light-emitting diodes ("LED")] can pass out of the device through the electrode."); 2:12-15 ("[W]here a gold layer is provided on a contact containing titanium and aluminum, the gold layer can change during annealing."); 4:47-49 ("Where the first barrier layer includes Ti, there can be some diffusion of Ti into the Al-containing base layer during annealing.").

3. "base layer" (claim 1)

Claim 1 recites "depositing Al on the n-type III-V semiconductor to provide a base layer." Emcore submits that the claim term "base layer" should be construed as "[t]he first-deposited metal layer used to form a low-resistance, ohmic contact to the semiconductor." PO Resp. 26-27.

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[6] RANDOM HOUSE WEBSTER'S COLLEGE DICTIONARY (2nd ed. 1999).

We disagree that Emcore's proposed construction is the broadest reasonable interpretation of the claim term "base layer," as it would import improperly a limitation—"a low-resistance, ohmic contact to the semiconductor"—from the specification into the claims.

In support of its position, Emcore cites to Nichia's expert testimony (Ex. 1002 ¶ 20), and the testimony of its expert (Ex. 2001 ¶¶ 62-63), who also cites to Nichia's expert testimony for support of his opinion. However, Nichia's expert testimony does not support Emcore's proposed construction or the opinion of Emcore's expert. As Nichia explains, the portion of Nichia's expert testimony relied upon by Emcore and its expert does not discuss the term "base layer," but rather explains "the function of an ohmic contact layer." Pet. Reply 1; Ex. 1002 ¶ 20.

Further, the background section of the '215 patent (Admitted Prior Art) provides the following:

> In *most semiconductor devices*, the contacts should exhibit "ohmic" characteristics. That is, the electrical voltage loss at the boundary between the contact and the semiconductor material should be substantially proportional to the current, and should be independent of the direction of current flow, so that the contact acts as a conventional electrical resistor. Also, *the contact desirably has low resistance.* For example, a light emitting diode with low resistance ohmic contacts can convert electrical power into light more efficiently than a similar diode with high resistance contacts. The contacts *typically* are connected to metallic leads as, for example, by wire-bonding processes. The contacts should include metals which are [compatible] with these processes.

Ex. 1001, 1:33-46 (emphases added).

As noted in the specification, the goal of forming a low-resistance, ohmic contact is desirable, but not all semiconductor devices have such desirable characteristics. *See also* Ex. 1001, 2:11-20 ("Despite these and other efforts in the art, still further improvements would be desirable."). In light of the specification, we construe the term "base layer" broadly, but reasonably, as "the first-deposited metal layer used to form a contact to the semiconductor."

4. "barrier layer" (claim 1)

Claim 1 recites "depositing Ti on said base layer to provide a first barrier layer" and "depositing Pt on said first barrier layer to provide a second barrier layer." Emcore asserts that the broadest reasonable interpretation of the claim term "barrier layer" is "[a] layer provided to prevent undesirable reactions between the top layer and the base layer." PO Resp. 27 (citing Ex. 1001, 2:53-65; Ex. 1002 ¶ 25).

Upon review of the specification, we observe that Emcore's proposed construction is consistent with the specification and the understanding of one with ordinary skill in the art. Ex. 1001, 2:53-65 ("[I]t is believed that the barrier layers such as Ti and Pt layers above the Al-containing base layer prevent undesirable reactions between Al and the metal of the top layers Au during annealing and/or during service."); Ex. 1002 ¶ 25 ("Barrier layers have the purpose of preventing the diffusion, intermixing, undesirable forms of alloying, and chemical reaction between the first and last deposited metal."). However, the claims require more than one barrier layer.

Therefore, in the light of the claims and specification, we construe the claim term "barrier layer" broadly, but reasonably, as "a layer provided in between two layers to prevent undesirable reactions between the two layers."

B. Obviousness Over Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art

Nichia asserts that claims 1-17 are unpatentable under 35 U.S.C. § 103(a) over Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art. Pet. 39. In support of its asserted ground of unpatentability, Nichia provides explanations as to how each limitation is met by the combination of cited prior art references and rationales for combining the prior art references. Pet. 34-47. Nichia also relies upon a declaration of Dr. Schubert. Ex. 1002.

Upon review of Nichia's contentions and supporting evidence, as well as Emcore's patent owner response and supporting evidence, we determine that Nichia has demonstrated, by a preponderance of the evidence, that claims 1-17 of the '215 patent are unpatentable over Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art.

1. Principles of Law

In an obviousness analysis, it is not necessary to find precise teachings in the prior art directed to the specific subject matter claimed because inferences and creative steps that a person of ordinary skill in the art would employ can be taken into account. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007). A basis to combine teachings need not be stated expressly in any prior art reference. *In re Kahn*, 441 F.3d 977, 987-88 (Fed. Cir. 2006). There need only be an articulated reasoning with rational underpinnings to support a motivation to combine teachings. *Id.* at 988. The level of ordinary skill in the art is reflected by the prior art of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001); *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995); *In re Oelrich*, 579 F.2d 86, 91 (CCPA 1978).

2. <u>Prior Art</u>

a. Kidoguchi

Kidoguchi describes a method of forming a semiconductor light emitting device. Ex. 1017 ¶ 01. Figure 1 of Kidoguchi is reproduced below:

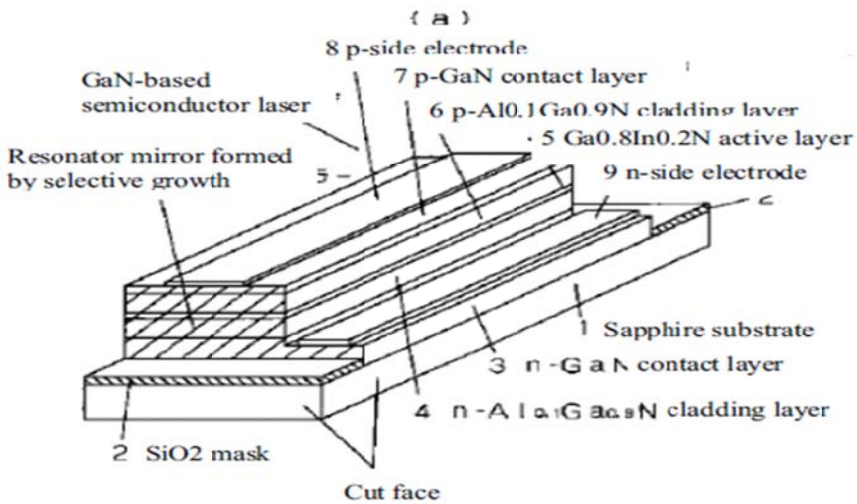

Figure 1 of Kidoguchi depicts the structure of a GaN-based semiconductor laser device formed in accordance with Kidoguchi's invention.

In particular, Kidoguchi discloses forming a GaN-based semiconductor laser device using GaN. Ex. 1017 ¶ 16. Kidoguchi also discloses forming an n-GaN contact having an electrode that is formed using Ti, Al, and Au, with Au as the outermost layer (i.e., the top layer). *Id*. at ¶ 31. Kidoguchi acknowledges the problem of high contact resistivity and loss of reliability when Au diffuses into the n-type GaN contact layer. *Id*. Kidoguchi teaches a method of suppressing the Au diffusion to decrease the contact resistance. *Id.* at ¶ 32. Kidoguchi's method includes the steps of using Al as the n-GaN contact metal (i.e., the base layer), inserting a Pt layer (i.e., a barrier layer) under the Au layer to suppress the diffusion of Au, and inserting a Ti layer (i.e., a barrier layer) to suppress the diffusion of Pt—to form an Al/Ti/Pt/Au n-side electrode on a GaN semiconductor. *Id*. at ¶¶ 32-33, Fig. 14.

b. Fujimoto

Fujimoto discloses a method of forming GaN semiconductor light emitting devices. Ex. 1007, 1:7-12. Figure 6 of Fujimoto is reproduced below.

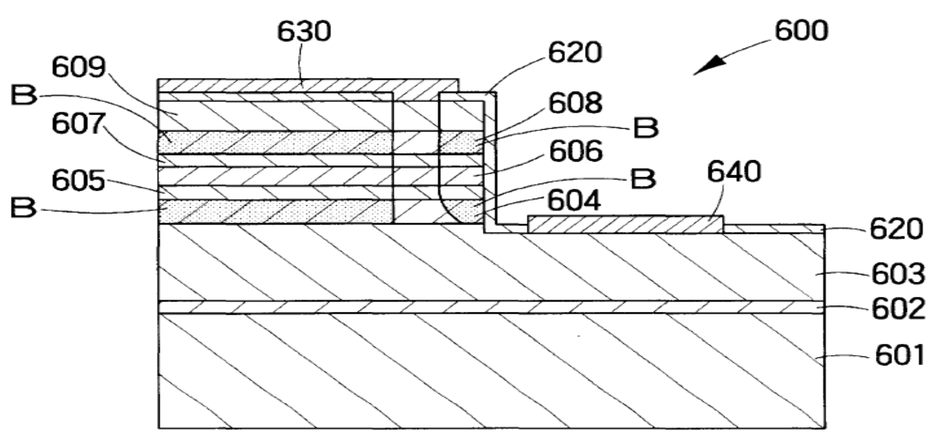

Figure 6 of Fujimoto illustrates a light emitting device formed according to an embodiment of Fujimoto.

As shown in Figure 6 of Fujimoto, semiconductor device 600 has n-side electrode 640 on the n-type GaN semiconductor. Fujimoto discloses forming the electrode with an Al/Pt/Au multi-layered structure and annealing the electrode on the GaN semiconductor at a temperature around 400 ºC. *Id*. at 16:41-46. Fujimoto further teaches interposing one or more Ti layers to the three-layered electrode. *Id*. at 20:13-16.

c. Shibata

Shibata discloses a method of forming a semiconductor light emitting device. Ex. 1019, Abs. Figure 1 of Shibata is reproduced below (emphasis added).

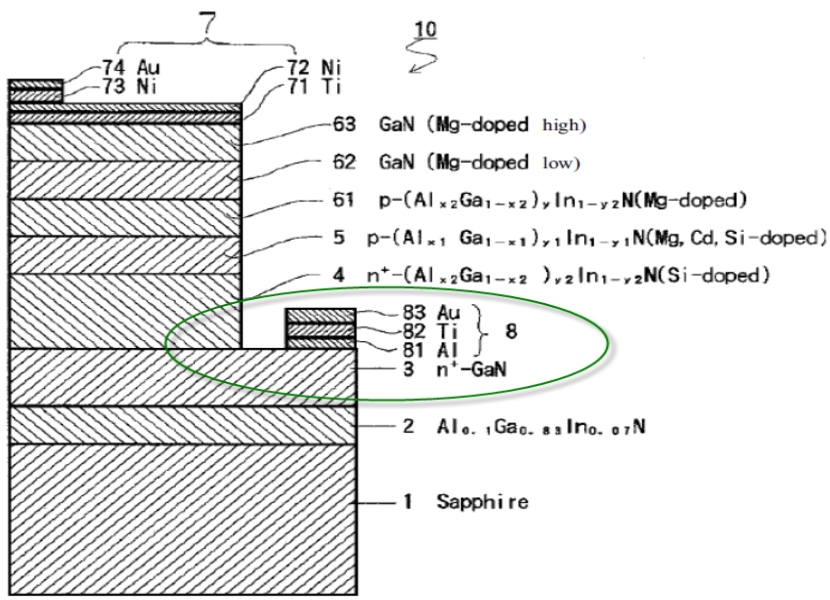

Figure 1 of Shibata shows a cross section of a light emitting device.

As illustrated in Figure 1 of Shibata, light emitting semiconductor device 10 has electrode 8 comprised of an Al/Ti/Au structure formed on n-type GaN semiconductor 3. *Id*. at ¶¶ 11-13, 26. Shibata also describes annealing the structure at 600 ºC for one minute to form a device with a contact resistance of 10^{-5} ohm-cm^2 or less. *Id*. at ¶ 27. According to Shibata, the resulting device was observed to have sufficient bonding strength and good ohmic contact. *Id*. Shibata also notes other advantages of its invention—extended life of the light emitting device and improved stability of emission. *Id*.

d. Nakamura

Nakamura discloses a method of forming a GaN semiconductor device. Ex. 1013, 1:7-19; 4:43-47. Nakamura notes that, at the time of its invention in the 1994 timeframe, it was known in the art to use Al as a material for an n-electrode of a GaN semiconductor light emitting device. *Id.* at 2:17-19. Nakamura also acknowledges that Al could degrade by an annealing. *Id*. at 2:21-24. Nonetheless, Nakamura describes a method that would overcome that problem by forming a Ti/Al/Au electrode and annealing the structure to establish an ohmic contact to an n-type GaN semiconductor. *Id*. at 2:46-51; 3:19-26; 11:3-14. Nakamura states that annealing at a temperature of 400 ºC or more, for 0.01 to 30 minutes is preferable. *Id*. at 11:15-18.

e. Admitted Prior Art

The Admitted Prior Art includes the background section of the ’221 provisional application (Ex. 1004, 1-2) and the background section of the ’215 patent (Ex. 1001, 1:15-2:9). In particular, the background section of the ’215 patent states that, in most semiconductor devices, the contacts should exhibit low "ohmic" characteristics and low contact resistance. Ex. 1001, 1:33-40. It also notes that a light emitting diode with low-resistance ohmic contacts can convert electrical power into light more efficiently than a similar diode with high-resistance contacts. *Id*. at 1:40-43. According to the background section of the '215 patent, it was known at the time of the invention to form contacts for n-type GaN by annealing a Ti and Al structure. *Id*. at 1:64-2:4. The background section of the '221 provisional application states that "[t]ypical low work function metal/metal stack with yield low contact resistance to n-GaN on annealing is Al, Ti/Al." Ex. 1004, 1 (emphasis added). It also recognizes that, for the purposes of achieving low contact resistance, "most metallization schemes to n-GaN use Ti, Ti/Al or Al followed by Ni/Au," and "[a]nnealing of the metallization is carried out at temperatures between 400-900 C for minimum contact resistance." *Id*. at 2 (emphasis added).

3. <u>Claims 1 and 11-14</u>

In its patent owner response, Emcore counters that Nichia fails to meet its burden of demonstrating claim 1 of the '215 patent is unpatentable over the combination of Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art. PO Resp. 32. In particular, Emcore argues that the primary reference Kidoguchi does not describe an Al base layer and barrier layers, as recited in claim 1. Emcore further asserts that the cited prior art references teach away from the claimed invention.

a. Forming Al/Ti/Pt/Au electrode on an n-type GaN semiconductor

Claim 1 requires forming an Al/Ti/Pt/Au structure on an n-type III-V semiconductor. Claims 11 and 12 directly depend from claim 1. Claim 11 further recites "wherein said n-type semiconductor is a nitride compound semiconductor." Claim 12 further recites "wherein said n-type semiconductor is a pure nitride compound semiconductor." Claim 13 depends from claim 11 and further recites "wherein said n-type semiconductor is a gallium nitride based semiconductor." Claim 14 depends from claim 11 and further recites "wherein said n-type semiconductor is GaN." We determine that an *n-type GaN semiconductor* meets the "n-type semiconductor" limitations recited in claims 1 and 11-14.

According to Nichia, Kidoguchi describes an Al/Ti/Pt/Au electrode formed on an n-type GaN semiconductor, as required by claims 1 and 11-14. Pet. 35. Indeed, Figure 14(a) of Kidoguchi shows a contact formed on an n-type GaN semiconductor with layers Mo/Ti/Pt/Au. Kidoguchi discloses that Al can be substituted for Mo because Al is used conventionally for the n-electrode. Ex. 1017 ¶¶ 31-33.

Emcore, however, argues that Kidoguchi does not show an Al base layer. PO Resp. 32-33, 38, 40. Specifically, Emcore alleges that Nichia's English-language translation of Kidoguchi has an error—"conventionally, *Ti and Al are used for the n-side electrode*, but the outermost surface needs to be Au . . . ." (Ex. 1017 ¶ 31, emphasis added). PO Resp. 40. According to Emcore, a proper English-language translation of that sentence—"[a] conventional n-side electrode employs Ti and Al . . ."—shows that the reference merely discloses Ti/Al/Au as the electrode, and it does not disclose Al as the base layer. PO Resp. 5, 40 (citing Ex. 2011; Ex. 2001 ¶¶ 89-90).

We are not persuaded by Emcore's argument, as it narrowly focus on one sentence and fails to consider Kidoguchi's disclosure as a whole. The alleged translation error also is of no moment. Even based on the English-language translation submitted by Emcore (Ex. 2011), Kidoguchi's disclosure as a whole discloses an embodiment that includes an Al base layer. Ex. 2011 ¶¶ 32-33 ("As illustrated in Figure 14, Mo (molybdenum) is employed as a contact metal for n-GaN. . . . Other metals, however, can be employed instead. For instance, W, Ta, Ti and Al may be employed [as a contact metal for n-GaN]." Emphasis added.). Therefore, Kidoguchi describes an Al base layer formed on an n-type GaN semiconductor, as required by claims 1 and 11-14.

Emcore also argues that Kidoguchi is "a fundamentally flawed lead reference for n-type contacts to GaN and other type III-V semiconductors," because Kidoguchi's primary teaching is a Mo base layer, "which was known not to form a low-resistance, ohmic contact," and Kidoguchi does not explain how other examples of base layer metals could be used to form a low-resistance, ohmic contact. PO Resp. 7-8, 38-39, 41-42.

We are not persuaded by that argument, as it is not commensurate with the scope of claims 1 and 11-14. *See In re Self*, 671 F.2d 1344, 1348 (CCPA 1982) (It is well established that limitations not appearing in the claims cannot be relied upon for patentability.). As discussed above in the claim construction section, we decline to import the limitation—

"a low-resistance, ohmic contact to the semiconductor"—from the specification into the claim term "base layer." Additionally, Emcore does not identify any limitation of claims 1 and 11-14, that expressly requires "a low-resistance, ohmic contact." In fact, the preamble of the sole independent claim, claim 1, merely requires "*forming a contact* on an n-type III-V semiconductor" and not "forming a *low-resistance, ohmic* contact on an n-type III-V semiconductor," as urged by Emcore.

Emcore's argument also fails to recognize that Kidoguchi's disclosure is not limited to the Mo base layer, but also includes the teaching of using Al as the base layer (Ex. 2011 ¶ 33). A prior art reference must be considered for everything it teaches by way of technology and is not limited to the particular invention it is describing and attempting to protect. *EWP Corp. v. Reliance Universal Inc.*, 755 F.2d 898, 907 (Fed. Cir. 1985).

Emcore further asserts that the state of the art at the time of the invention taught that Al was an unsuitable base layer for low-resistance, ohmic contact to n-type GaN. PO Resp. 8, 42. In support of its position, Emcore argues that one with ordinary skill in the art would not have used Al as the base layer in light of Kidoguchi's disclosure, because "its use of Mo as a base layer demonstrates that the intention of [Kidoguchi] was not to create to low-resistance ohmic contact." *Id*. at 8-9, 43.

Emcore's argument is unavailing, as it is not supported by the express teaching of Kidoguchi—Al is used as the base layer on an n-type III-V semiconductor. Ex. 2011 ¶ 33. Moreover, the prior art on record shows that, at the time of the '215 patent's invention, it was known in the art to use

Al as a base layer to form a contact to an n-type III-V semiconductor. *See, e.g.*, Ex. 1004, 1 ("Typical low work function metals/metal stack which yield low contact resistance to n-GaN on annealing is Al, Ti/Al."); Ex. 1007, 16:41-45 (The n-side electrode having a three-layered structure including an Al layer, Pt layer and Au layer, is formed on the n-type GaN contact layer.); Ex. 1019 ¶¶ 11-13, 26 (Light emitting diode 10 has an electrode 8 comprised of an Al/Ti/Au structure formed on an n-type GaN semiconductor.).

For the foregoing reasons, Nichia has demonstrated, by a preponderance of evidence, that the combination of Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art would have rendered obvious to one with ordinary skill in the art the claim invention, including the "Al" limitation as recited in claims 1 and 11-14.

b. Barrier layers

Claim 1 recites "depositing Ti on said base layer to provide a first barrier layer" and then "depositing Pt on said first barrier layer to provide a second barrier layer." As we discussed above in the claim construction section, we construe the claim term "barrier layer" as "a layer provided in between two layers to prevent undesirable reactions between the two layers."

Emcore argues that Kidoguchi does not disclose the barrier layers of claim 1, because there is no need for barrier layers between a Mo layer and an Au layer. PO Resp. 39-40, 42-43. In particular, Emcore maintains that "Mo is a refractory metal" and "is a candidate for a barrier layer." *Id*. at 39.

Emcore's argument is inapposite, because it again fails to recognize that Kidoguchi discloses an embodiment that does not use Mo as the base layer, but rather uses an Al base layer. Ex. 2011 ¶¶ 31-33. Moreover, Kidoguchi discloses inserting a Pt layer between the Au top layer and the Al base layer to inhibit excess *Au diffusions* (i.e., preventing undesirable reactions between Au and Al) and to prevent "increases in the contact resistance." Ex. 2011 ¶ 32. Kidoguchi's method also includes a step of inserting a Ti layer between the Pt barrier layer and the Al base layer to suppress *Pt diffusions* (i.e., preventing undesirable reactions between Pt and Al). Ex. 2011 ¶ 32. Given those disclosures of Kidoguchi, we determine that one with ordinary skill in the art at the time of the invention would have appreciated that Kidoguchi's Pt and Ti layers each are barrier layers.

For the foregoing reasons, Nichia has demonstrated, by a preponderance of evidence, that the combination of Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art would have rendered obvious to one with ordinary skill in the art the claim invention, including the "barrier layers" limitation as recited in claims 1 and 11-14.

c. Annealing

Claim 1 recites "annealing said n-type III-V semiconductor with said stack thereon." Nichia acknowledges that Kidoguchi does not disclose expressly an annealing step. Pet. 35-36. Nevertheless, according to Nichia, annealing a semiconductor with an electrode was known in the art at the time of the invention, to lower the contact resistance of Al contacts to n-type III-V semiconductors. Pet. 39-42. In particular, Nichia cites the following prior art references as support: Fujimoto, Shibata, Nakamura, and the Admitted Prior Art. *Id*. For instance, Nichia notes that Fujimoto describes annealing an Al/Pt/Au electrode formed on an n-type GaN semiconductor, and that Shibata describes annealing an Al/Ti/Au electrode form on an n-type GaN semiconductor. Pet. 41 (citing Ex. 1007, 16:45-46; Ex. 1019, ¶ 0026-27). As Nichia explains, the Admitted Prior Art states that "annealing of contacts containing Aluminum, Titanium and Gold on n-type GaN (a III-V semiconductor) was known." *Id*. at 40 (citing Ex. 1001, 1:64-2:9). Given the collective teachings of Fujimoto, Shibata, Nakamura, and the Admitted Prior Art, Nichia contends that it would have been obvious to one with ordinary skill in the art at the time of the invention, to anneal Kidoguchi's contact as taught by those prior art disclosures to achieve the desired contact resistance. *Id.* at 41.

Emcore alleges that the cited references teach away from annealing an Al base layer. PO Resp. 43-44. In particular, Emcore argues that "Al was well-known to have problems forming an ohmic contact to n-type GaN and degraded upon annealing." PO Resp. 42. Emcore and its expert attempt to substantiate Emcore's "teaching away" argument by referring to portions of the cited references, e.g., Nakamura, Fujimoto, Shibata, Foresi,[7] and the Admitted Prior Art. PO Resp. 5-6, 33, 42-44, 47-50; Ex. 2001 ¶¶ 99-100.

Nichia counters that the portion of the Admitted Prior art relied upon by Emcore as teaching away from annealing an Al base layer is actually "a warning toward using a diffusion barrier" layer. Pet. Reply 9. Nichia also

[7] Foresi, et al., "Metal contacts to gallium nitride," 62(22) Appl. Phys. Lett. 2859 (31 May 1993) (Ex. 1027).

submits that Emcore fails to recognize that the references "selected Al as a base layer and annealed the contact—despite the alleged fact that the art taught away from using Al as early as 1993." *Id.* at 9-10. Nichia maintains that Nakamura and Foresi are from the early development of GaN-based light emitting devices, but "there was an intense research drive to improve contacts to GaN" between the early and late 1990s. *Id*. at 11. We agree.

"A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the [inventor]." *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994). A reference does not teach away, however, if it merely expresses a general preference for an alternative invention but does not "criticize, discredit, or otherwise discourage" investigation into the invention claimed. *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004).

We are not persuaded by Emcore's arguments and supporting evidence. Instead, we agree with Nichia that a person with ordinary skill in the art, at the time the '215 patent's invention was made, would not have been dissuaded from annealing a contact with an Al base layer. Emcore and its expert erroneously rely upon references, e.g., Nakamura and Foresi, from the early development of GaN-based light emitting semiconductor devices, and fail to discuss meaningfully the state of the art at the time the '215 patent's invention was made. They also narrowly focus on a selected portion of each cited reference, and fail to consider the references in their entirety.

Although the cited references acknowledge the problems associated with annealing an electrode, Emcore and its expert fail to appreciate that the problems noted by the cited references are those that are to be solved by the inventions disclosed in the cited references. For instance, Emcore and its expert focus on a portion in the background section of Fujimoto, and then conclude that Fujimoto teaches away from annealing an Al base layer. PO Resp. 5-6; Ex. 2001 ¶¶ 99-100 (citing Ex. 1007, 2:13-35).

Fujimoto notes that some scientists including Fujimoto's inventors observed difficulties of using Al electrodes. Ex. 1007, 2:20-24. Emcore and its expert, however, fail to take into account that Fujimoto further discloses a method that solves the alleged "annealing" problem. More importantly, Fujimoto teaches annealing a multi-layered electrode—that includes an Al base layer—at a certain temperature range, to form a nitride compound semiconductor light emitting device having a *low contact resistance and good wire bonding*. *Id*. at 2:56-58; 3:53-57. Fujimoto's method includes steps of forming an Al/Pt/Au electrode, and annealing the electrode on the n-type GaN semiconductor at a temperature around 400 ºC. *Id*. at 16:41-46. Fujimoto further teaches inserting one or more Ti barrier layers between the Al and Au layers. *Id*. at 20:13-16. According to Fujimoto, its invention prevents deterioration of electrodes and the light emitting device itself, and significantly improves the reliability of the device. *Id*. at 3:59-62. In light of Fujimoto's disclosure, in its entirety, one with ordinary skill in the art would have understood that the alleged "annealing" problem could have been prevented by using Fujimoto's method of making a nitride compound semiconductor light emitting device. Therefore, we do not discern that Fujimoto criticizes, discredits, or otherwise discourages annealing an Al base layer.

Emcore and its expert also take the position that Shibata "advises that annealing may cause the contact's top layer to be 'dysfunctional as a bonding pad.'" PO Resp. 5-6 (citing to Ex. 1019 ¶ 28); Ex. 2001 ¶ 45. However, Emcore and its expert fail to consider paragraph 28 of Shibata, as a whole, which discusses the *optimal thicknesses* of the aluminum layer and titanium barrier layer. In fact, Shibata warns against using a titanium barrier layer with a thickness of 1,000 Å or less. Ex. 1019 ¶ 28 ("The optimal thickness of the titanium [barrier] layer 82 is 1,000 Å – 1 μm. If it is 1,000 Å or less, aluminum and gold would react with one another in the [annealing], rendering the layer 83 dysfunctional as a bonding pad."). The purported "annealing" problem is caused by using a barrier layer with a thickness of 1,000 Å or less.

Contrary to Emcore's argument and its expert testimony (PO Resp. 17-19; Ex. 2001 ¶¶ 44-47), Shibata clearly discloses annealing an Al/Ti/Au electrode—that includes an Al base layer—on an n-type GaN semiconductor at 600 °C for one minute to form a light emitting diode with low contact resistance and good ohmic contact. Ex. 1019 ¶ 27. Emcore and its expert (Ex. 2001 ¶ 46) again attempt to substantiate Emcore's position by pointing out a translation or clerical error—"[i]n the above light emitting diode 10, the contact resistance of the aluminum layer 81 relative to the high carrier concentration n+ layer 3 was 10^{-5} Ωcm or less" (Ex. 1019 ¶ 27, emphasis added). However, one with ordinary skill in the art would have known that "10^{-5} Ωcm" should have been "10^{-5} Ω cm^2" because the unit of measurement for contact resistance is Ω cm^2.

Emcore and its expert further allege that others failed to reproduce the result disclosed in Shibata. PO Resp. 17-19; Ex. 2001 ¶¶ 44-47. Specifically, they direct our attention to the following text in the background section of Fujimoto:

> As a countermeasure against this problem, insertion of Ti as a barrier metal is disclosed in Japanese Patent Laid-Open Publication No 8-274372. However, the Inventors have experimentally found that this approach certainly made wire bonding possible, but invited an increase in contact resistance of the electrode.

Ex. 1007, 2:29-35.

Emcore and its expert, however, did not provide any experimental data regarding the alleged experiment conducted by Fujimoto, e.g., the thicknesses of the metal layers, annealing temperature and time, and contact resistance. Instead, they rely on a vague and ambiguous sentence in the background of Fujimoto.

More importantly, Emcore and its expert ignore the fact that others in the art had reproduced low contact resistance, similar to the results disclosed in Shibata. Notably, Luther[8] reported on a study of Al and Ti/Al contacts to n-type GaN that achieved a low contact resistivity of 8×10^{-6} Ω cm^2 and

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[8] Luther, et al., "Investigation of the mechanism for Ohmic contact information in Al and Ti/Al contacts to n-type GaN," Appl. Phys. Letters. 70 (1) (6 Jan. 1997) (Ex. 1030, "Luther").

good thermal stability. Ex. 1030, 57 ("Al contacts on *n*-GaN (7 x 10^{17} cm^{-3}) annealed in forming gas at 600 °C reached a minimum contact resistivity of 8 x 10^{-6} Ω cm^2 and had much better thermal stability than reported by previous researchers."); *id*. ("[M]any researchers have made Ohmic contacts to *n*-GaN with low contact resistivities . . . ."). Luther's report provides detailed explanation and experimental data, including specific contact resistance as a function of annealing time (Fig. 1) and specific contact resistance as a function of annealing temperature (Fig. 2), e.g., annealing Al contacts to n-GaN between 400 and 600 ºC. *Id*. at 57-59.

Given that Shibata and Luther show that others have achieved low contact resistance and good thermal stability by annealing Al contacts to n-type GaN, the testimony of Emcore's expert—that one of ordinary skill in the art would not have understood Shibata as teaching a low resistance ohmic contact to n-type GaN (Ex. 2001 ¶ 47)—is entitled little weight. *See Velander v. Garner*, 348 F.3d 1359, 1371 (Fed. Cir. 2003) ("In giving more weight to prior publications than to subsequent conclusory statements by experts, the Board acted well with [its] discretion.").

In light of Shibata's disclosure, as a whole, one with ordinary skill in the art at the time of the invention would have understood that (1) using a barrier layer that has an optimal thickness would prevent the purported "annealing" problem, and (2) annealing an Al/Ti/Au electrode on an n-type GaN semiconductor under certain conditions would achieve low contact resistance and good ohmic contact. Therefore, we do not discern that

Shibata criticizes, discredits or otherwise discourages annealing an Al base layer on an n-type GaN semiconductor.

For the foregoing reasons, Nichia has demonstrated, by a preponderance of evidence, that the combination of Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art would have rendered obvious to one with ordinary skill in the art the claim invention, including the annealing limitation as recited in claims 1 and 11-14.

4. Claims 2-10 and 15-17

a. Thickness of each layer in the Al/Ti/Pt/Au stack

Dependent claims 6-10 and 16-17 require the metal layers to have certain thickness ranges. For instance, claim 6 depends from claim 1, and further recites "wherein said first barrier layer is at least about 300 Å thick." Claim 8 depends from claim 6, and further recites "wherein said deposited Al is between about 190 Å to about 210 Å thick."

Nichia relies upon Shibata and Fujimoto to meet the claimed ranges. Pet. 44-47. In particular, Shibata discloses that a Ti barrier layer that has a thickness of 1,000 Å to 1μm, which falls within the claimed range (at least about 300 Å) of claim 6. Ex. 1019 ¶ 07. Fujimoto discloses a first barrier layer that has a thickness of 50 nm (500 Å), which is close to the claimed range (about 390 Å to about 410 Å) of claim 7. Ex. 1007, 16:42-44; 19:31. Shibata also describes an Al base layer having a thickness of between 100 Å and 1000 Å, which encompasses the claimed range (about 190 Å to about 210 Å) of claim 8. Ex. 1019 ¶ 28. Fujimoto discloses a Pt barrier layer that has a thickness of 500 Å, which falls within the claimed range (about 490 Å to about 510 Å thick) of claim 9. Ex. 1007, 16:42-44; 18:34-35. Additionally, Shibata discloses an Au top layer having a thickness of 0.5 to 3 μm (5,000 to 30,000 Å), which overlaps the claimed range (at least about 6000 Å) of claim 10. Ex. 1019 ¶ 0028. Shibata further discloses an Al base layer having a thickness of 100 Å and 1000 Å, which encompasses the claim range (about 200 Å) of claim 16, and the claim range (less than about 500 Å) of claim 17.

Notwithstanding that the prior art thicknesses do not fall within all of the claimed ranges, Nichia contends that claims 6-10 and 16-17 are obvious over Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art. Pet. 44-47. According to Nichia, a person with ordinary skill in the art would have optimized the thickness of each layer to prevent undesirable diffusion, and to achieve the desired contact resistance and wire bonding properties. *Id*. Notably, as Nichia observes, Kidoguchi provides that the function of a barrier layer is to prevent excessive diffusion of Au and Pt, and to lower the contact resistance (Ex. 1017 ¶ 32). Pet. 44-45. That function depends on the thickness of the layers. *Id*.

Emcore counters that Nichia's asserted ground of unpatentability is based on impermissible hindsight. In particular, Emcore alleges that "a barrier layer's ability to prevent diffusion is not solely dependent on the thickness of the barrier layer." PO Resp. 56 (citing Ex. 2001 ¶¶ 109-111). Emcore contends that "there are many rules and relationship[s] that must be considered" including "how the barrier layer relates to the other layers in the resulting contact." *Id*. Emcore argues that this relationship between the layers for a GaN semiconductor is present only in the ’215 patent. *Id*. at 56-57 (citing Ex. 1001, 4:36-40 (“The Al thickness decides the thickness of the other layers. As Al thickness increases, it is necessary to increase the thickness of the Ti and Pt layers to avoid diffusion of Al into Au and diffusion of Au into Al.”).

We are not persuaded by Emcore’s arguments and expert’s testimony. Rather, we determine that one with ordinary skill in the art at the time of the ’215 patent’s invention would have recognized that, in light of the cited prior art references, the thickness of each metal layer in an electrode is a result effective variable. In that regard, it is well established that “discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art.” *In re Boesch*, 617 F.2d 272, 276 (CCPA 1980); *In re Antonie*, 559 F.2d 618, 620 (CCPA 1977).

Emcore’s argument and its expert testimony (Ex. 2001 ¶¶ 110-111) are based on the erroneous premise that the prior art must provide the exact method of optimization, as the one disclosed in the ’215 patent, for the variable to be result-effective. However, as our reviewing court noted, “the prior art need not provide the exact method of optimization for the variable to be result-effective.” *In re Applied Materials, Inc.*, 692 F.3d 1289, 1297 (Fed. Cir. 2012). “A recognition in the prior art that a property is affected by the variable is sufficient to find the variable result-effective.” *Id*.

On the record before us, the prior art shows that the thickness of each barrier layer affects the reduction of metal diffusions between the layers. Notably, Shibata discloses that if the titanium barrier layer is less than a certain thickness, aluminum and gold will react with one another in the annealing step, rendering the Au layer dysfunctional as a bonding pad. Ex. 1019 ¶ 28. Kidoguchi also teaches that the function of the barrier layers is to prevent diffusion of Pt and Au. Ex. 2011 ¶ 32. Moreover, Fujimoto discloses that the Pt layer prevents the top and base layers "from mixing, and maintains them operative for their intended" purposes. Ex. 1007, 18:43-45.

Shibata further recognizes that the thickness of the Al base layer affects the reaction between the Au top layer and the Al base layer, and also affects whether an ohmic contact would be achieved. Ex. 1019 ¶ 28. Shibata teaches that the thickness of the Au top layer affects the length of time for forming the layer, the bonding performance, and the cost of making the device. *Id*. Given those prior art teachings, one with ordinary skill in the art would have appreciated that the thickness of each metal layer in the electrode is a result-effective variable.

We also have reviewed the parties' supporting evidence, and we credit the testimony of Nichia's expert over the testimony of Emcore's expert. *Yorkey v. Diab*, 601 F.3d 1279, 1284 (Fed. Cir. 2010) (finding Board has discretion to give more weight to one item of evidence over another "unless no reasonable trier of fact could have done so"). We find the explanations proffered by Nichia's expert to be more consistent with the prior art teachings discussed above. In particular, Nichia's expert, Dr. Schubert, testifies that "the prior art references indicate that the barrier layers are effective, which would have motivated a person of ordinary skill to use those thicknesses." Ex. 1002 ¶ 69 (citations omitted) (citing Ex. 1019 ¶ 28;

Ex. 1007, 18:43-45); *see also* Ex. 1002 ¶¶ 44-50. Dr. Schubert further testifies that one of ordinary skill in the art would have the skill set to optimize the thickness of the Al base layer to sufficiently form an ohmic contact with the underlying semiconductor. Ex. 1002 ¶¶ 44-45, 50-51, 71. Additionally, Dr. Schubert declares that one with ordinary skill in the art would have used the thickness described in Shibata (Ex. 1019 ¶¶ 0009, 0012, 0027) to facilitate wire bonding. Ex. 1002 ¶ 69.

Emcore's expert, Dr. Goorsky, narrowly focuses on one sentence in Dr. Schubert's declaration and concludes that Dr. Schubert's testimony is misleading. Ex. 2001 ¶ 109 (citing Ex. 1002 ¶ 50). Dr. Goorsky does not explain meaningfully why the prior art cited by Dr. Schubert in his testimony does not support his statement, e.g., "the prior art has many examples of first barrier (Ti) layers thicker than 300 Å, for example Murarka, et al., p. 158, Table I and Vandenberg, et al., p. 3677, Table I" (Ex. 1002 ¶ 48); and "[t]he interactions between the metals on either side of the Ti and Pt barriers were known, for example, from Murarka, *et al.*" (Ex. 1002 ¶ 50).

Accordingly, Nichia has demonstrated, by a preponderance of evidence, that it would have been obvious to one with ordinary skill in the art to optimize the thickness of each metal layer in the electrode stack to prevent undesirable diffusion, and to achieve the desire contact resistance and wire bonding properties.

b. Annealing temperature and time; contact resistance

Dependent claims 2-5 recite certain annealing conditions, e.g., time and temperature. For instance, claim 2 depends from claim 1, and further recites "wherein said annealing step is performed at about 400-600 °C," and claim 3 depends from claim 2, and further recites "wherein said annealing step is performed for between about 1 minute and about 10 minutes."

Claim 15 depends from claim 1 and is the only claim that imposes a limitation requiring a contact resistance—"wherein said Al/Ti/Pt/Au contact has a contact resistance of less than about 10^{-5} ohm-cm^2."

Nichia relies upon Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art to meet the claimed ranges. Pet. 43-44, 46. In particular, Fujimoto discloses an annealing temperature of around 400 ºC, which is within the claimed range (400-600 ºC) of claim 2. Ex. 1007, 16:45-46. Shibata discloses an annealing step that performs at 600 ºC for one minute, which is within the claimed range (about one minute to about 10 minutes) of claim 3. Ex. 1019 ¶ 27. Nakamura discloses an annealing step that performs at 400 ºC or more for 0.01 to 30 minutes, which encompasses the claimed value (about three minutes) of claim 4. Ex. 1013, 11:14-18. Nakamura also discloses an annealing temperature of 500 ºC, as recited in claim 5. *Id*. at 11:65-12:1.

Notwithstanding that the prior art thicknesses do not fall within all of the claimed ranges, Nichia contends that claims 2-5 and 15 would have been obvious over Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art. Pet. 43-44, 46. According to Nichia, one with ordinary skill in the art would have optimized the annealing temperature and time to achieve a contact resistance of about 10^{-5} ohm-cm^2 or lower in light of the prior art. Pet. 43, 46. As support, Nichia submits a declaration of Dr. Schubert (Ex. 1002), and directs our attention to the '215 patent, which provides that "[m]oderate temperatures of 400-600 C are sufficient for low contact resistances of 10^{-5} Ωcm^2 or lower." Pet. 46 (citing Ex. 1001, 4:43-46) (internal quotation marks omitted).

Dr. Schubert testifies that the annealing temperature and time would have been optimized readily to achieve the desired contact resistance. Ex. 1002 ¶¶ 52-54, 67. Specifically, Dr. Schubert observes that annealing Kidoguchi's contact as suggested by Nakamura, Fujimoto, Shibata, and the background section of the '221 provisional application would have achieved a contact resistance of 10^{-5} Ωcm^2. *Id*. ¶¶ 55, 70.

Emcore disagrees and argues that the cited prior art references do not disclose a method of obtaining a contact resistance of 10^{-5} Ωcm^2 or lower using an Al base layer. PO Resp. 58. As to claims 2-5, Emcore relies upon the arguments directed to independent claim 1, and proffers no additional arguments. *Id*. at 55.

We are not persuaded by Emcore's argument. Rather, we agree with Nichia that one with ordinary skill in the art at the time of the '215 patent's invention would have optimized the annealing temperature and time to achieve the desired contact resistance of 10^{-5} Ω cm^2. As discussed above, Shibata clearly discloses annealing an Al/Ti/Au electrode—that includes an Al base layer—on an n-type GaN semiconductor at 600 °C for one minute to form a light emitting diode with good ohmic contact and low contact resistance of 10^{-5} Ω cm^2 or lower. Ex. 1019 ¶ 27.

It is well established that "discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art." *Boesch*, 617 F.2d at 276; *Antonie*, 559 F.2d at 620. In that regard, a "recognition in the prior art that a property is affected by the variable is sufficient to find the variable result-effective." *Applied Materials*, 692 F.3d at 1297. The prior art of record shows that the annealing conditions of an Al base layer to an n-type GaN semiconductor are result-effective variables, as they are recognized by the prior art to achieve good ohmic contact and low contact resistance. Notably, the Admitted Prior Art expressly states that "[a]nnealing of the metallization is carried out at [a] temperature between 400-900 C for minimum contact resistance." Ex. 1004, 2. Shibata also recognizes that annealing an n-type GaN semiconductor with an electrode having a base Al layer at 600 C for one minute would yield a light emitting diode with good ohmic contact and low contact resistance of 10^{-5} Ω cm^2. Ex. 1019 ¶ 27; *see also* Ex. 1030, Figs 1-2 (showing specific contact resistance as a function of annealing time and temperature). Therefore, the annealing temperature, annealing time, and contact resistance are result-effective variables.

Accordingly, Nichia has demonstrated, by a preponderance of evidence, that it would have been obvious to one with ordinary skill in the art to optimize the annealing temperature, annealing time, and contact resistance to achieve the desired contact resistance and good ohmic contact.

5. Secondary Considerations of Nonobviousness

Factual inquiries for an obviousness determination include secondary considerations based on evaluation and crediting of objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966). Notwithstanding what the teachings of the prior art would have suggested to one with ordinary skill in the art at the time of the ’215 patent’s invention, the totality of the evidence submitted, including objective evidence of nonobviousness, may lead to a conclusion that the claimed invention would not have been obvious to one with ordinary skill in the art. *In re Piasecki*, 745 F.2d 1468, 1471-1472 (Fed. Cir. 1984). Secondary considerations may include any of the following: long-felt but unsolved needs, failure of others, unexpected results, commercial success, copying, licensing, and praise. Here, Emcore argues that its claimed method “overcame the failure of others and achieved the unexpected result of making a contact with Al base layer that has surprisingly low resistance of 10^{-5} ohm-cm^2 or better.” PO Resp. 52 (citing Ex. 2001 ¶ 105).

Failure of Others

Emcore asserts that many others “tried and failed to make a suitable ohmic contact using Al as a base layer to n-type GaN.” *Id*. at 52; *see id*. at 14-20. In support of that assertion, Emcore submits that the research “by Nichia and Dr. Nakamura in 1993 led them to conclude that aluminum ‘can hardly establish an ohmic contact with the n-type gallium nitride-based III-V Group compound semiconductor layer, and [tend] to degrade by [an] annealing treatment, losing the electrical conductivity,'" and Nakamura (Ex. 1013) concluded that "Al led to poor wire bonding with top wire." *Id*. at 52-53 (citing Ex. 1013, 2:20-25). Emcore further maintains that Foresi "revealed that using Al as a base layer to n-type GaN resulted in contacts with poor contact resistance and that the contact resistance of Al-based contact increased upon annealing." *Id*. at 53 (citing Ex. 1027). Emcore also relies upon its expert testimony (Ex. 2001 ¶¶ 35-52). *Id*. at 14-20.

Nichia disagrees and responds that there were others who had used Al as a base layer to n-type GaN successfully before the '215 patent, e.g., Shibata, Fujimoto, and Luther. Pet. Reply 9-10, 13. Nichia also argues that nonobviousness cannot be established unless the claimed invention is the first to solve the problem that caused the failure. *Id*. (citing *Graham*, 383 U.S. at 36.). We agree.

Emcore's argument and supporting evidence (Ex. 2001 ¶¶ 35-52) narrowly focus on the early development of GaN-based light emitting semiconductor devices, e.g., the research conducted by Nichia and Dr. Nakamura in 1993, and Foresi published in 1993. As to the 2000 timeframe, Emcore and its expert merely rely upon the background of the '221 provisional application (the Admitted Prior Art), which provides:

> Annealing of the metallization is carried out at temperatures between 400-900 C for minimum contact resistance. However, this annealing is accompanied by degradation in the surface morphology, *due to metallurgical reactions between the metal layers* in the stack. This causes difficulty in subsequent *wire bonding* in devices and results in potential device failure during service.

PO Resp. 20; Ex. 2001 ¶ 52; Ex. 1004, 2 (emphasis added). As noted by Nichia, the portion of the '221 provisional application relied upon by Emcore and its expert is "a warning toward using a diffusion barrier" layer. Pet. Reply 9. That purported "failure" is similar to the aforementioned problem noted in Shibata to warn against using a Ti barrier layer that has a thickness less than the optimal range (Ex. 1019 ¶ 28). As discussed above, Shibata and Fujimoto disclose methods of solving the aforementioned problems associated with annealing an Al base layer. Notably, Shibata discloses an ohmic contact using Al as a base layer to n-type GaN that has a low contact resistance of 10^{-5} Ω cm^2 or less. Furthermore, others in the art have formed Al contacts to n-type GaN and achieved low contact resistance (e.g., 8 x 10^{-6} Ω cm^2) and good thermal stability (Ex. 1030). The inventors of the '215 patent, therefore, are not the first to solve the problem of using Al as a base layer to n-type GaN, and they are not the first to achieve a low contact resistance of 10^{-5} Ω cm^2 or less.

For the foregoing reasons, the objective evidence, as to failure of others, proffered by Emcore is insufficient to establish nonobviousness.

Unexpected Results

Emcore argues that the claimed method of the '215 patent "achieved an unprecedented combination of low contact resistance, good thermal stability and excellent wire bonding for an Al-based contact to n-type GaN" and "generated unexpected benefit of using Al as a base layer to increase the efficiency of LED." PO Resp. 50-51, 53. Emcore takes the position that the inventors of the '215 patent have "achieved the unexpected result of making a contact with Al base layer that has surprisingly low resistance of 10^{-5} Ωcm^2 or better." *Id*. at 52. To support its position, Emcore relies upon its expert's testimony. *Id*. at 54 (citing Ex. 2001 ¶¶ 105-108).

To be of relevance, evidence of nonobviousness must be commensurate in scope with the claimed invention. *In re Tiffin*, 448 F.2d 791, 792 (CCPA 1971) (evidence of success for cups is not commensurate in scope with containers). In order to be accorded substantial weight, there must be a nexus between the merits of the claimed invention and the evidence of secondary considerations. *GPA*, 57 F.3d at 1580. "Nexus" is a legally and factually sufficient connection between the objective evidence and the claimed invention, such that the objective evidence should be considered in determining nonobviousness. *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1392 (Fed. Cir. 1988). The burden of showing that there is a nexus lies with the patent owner. *In re Paulsen*, 30 F.3d 1475, 1482 (Fed. Cir. 1994); *Demaco Corp.*, 851 F.2d at 1392.

We are not persuaded by Emcore's argument and evidence, as they fail to establish a nexus between the merits of the claimed invention and the asserted unexpected results.

Claims 1-14 and 16-17 do not recite a contact resistance, much less a low contact resistance of 10^{-5} Ωcm^2. According to Emcore and Dr. Goorsky, the claimed feature to which the asserted unexpected results links is the use of *Al as a base layer*. PO Resp. 50-55; Ex. 2001 ¶¶ 105-108.

Contrary to Emcore's argument and expert testimony, the inventors of the '215 patent are not the first in the art to use an Al base layer on an n-type GaN semiconductor. As discussed above, at the time of the '215 patent's invention, others in the art had achieved similar results with an Al base layer. *See, e.g.*, Ex. 1019; Ex. 1030. Where the offered secondary consideration actually results from something other than what is both claimed and novel in the claim, there is no nexus to the merits of the claimed invention. *Tokai Corp. v. Easton Enters., Inc.*, 632 F.3d 1358, 1369 (Fed. Cir. 2011) ("If commercial success is due to an element in the prior art, no nexus exists."); *see also Ormco Corp. v. AlignTechnology, Inc.*, 463 F.3d 1299, 1312, 1313 (Fed. Cir. 2006) ("[I]f the feature that creates the commercial success was known in the prior art, the success is not pertinent." Reasoning that success that is due "'partially' to claimed features" and to unclaimed features and/or other features already in the art lacks the requisite nexus to show unobviousness.) (citations omitted). In the absence of an established nexus with the claimed invention, secondary consideration factors are entitled little weight, and generally have no bearing on the legal issue of obviousness. *See In re Vamco Machine & Tool, Inc.*, 752 F.2d 1564, 1577 (Fed. Cir. 1985). Accordingly, Emcore's objective evidence is accorded little weight.

Further, Emcore and its expert testimony fail to make a showing of unexpected results—a showing that the claimed invention exhibits some superior property or advantage that one of ordinary skill in the art would have found surprising or unexpected. *See In re Soni*, 54 F.3d 746, 750 (Fed.

Cir. 1995). As we discussed above, Shibata discloses *annealing an Al base layer* at 600 °C and for one minute to form a light emitting diode. Ex. 1019 ¶ 27. More importantly, Shibata discloses the same "unexpected results" as asserted by Emcore and its expert testimony (PO Resp. 50-53; Ex. 2001 ¶¶ 105-108)—a light emitting diode that has good thermal stability, good ohmic contact, good wire bonding, as well as low contact resistance of 10^{-5} $\Omega\ cm^2$ or lower. Ex. 1019 ¶ 27. Notably also, Luther discloses *annealing Al contacts* to achieve ohmic contacts, low contact resistivity of $8 \times 10^{-6}\ \Omega\ cm^2$, and good thermal stability. Ex. 1030, 57 ("Al contacts on *n*-GaN (7×10^{17} cm^{-3}) annealed in forming gas at 600 °C reached a minimum contact resistivity of $8 \times 10^{-6}\ \Omega\ cm^2$ and had much better thermal stability than reported by previous researchers."); *id*. ("[M]any researchers have made Ohmic contacts to *n*-GaN with low contact resistivities . . . ."). Given those prior art disclosures, one with ordinary skill in the art would not have found an n-type Al contact with a contact resistivity of a $10^{-5}\ \Omega\ cm^2$ surprising or unexpected.

Emcore further asserts that the claimed method is praised by Nichia. PO Resp. 54-55 (citing Ex. 2001 ¶ 55). Emcore directs our attention to Yoneda,[9] in which Nichia allegedly stated that "it is preferable to use an Al/Ti/Pt/Au or Al/Ti/Au because it efficiently reflects light and, therefore, increases the light extraction efficiency of an LED." *Id*. at 53-54 (citing Ex. 2001 ¶¶ 105-108; Ex. 2004 ¶¶ 138-139). Dr. Goorsky also relies upon

[9] Yoneda, Pub. No. US 2012/0273823 (Nov. 1, 2012) (Ex. 2004).

Yoneda as evidence that "there is a strong relation (or nexus) between the merits of the claimed invention of the '215 patent (e.g. claim 1) and these secondary considerations of nonobviousness." Ex. 2001 ¶ 106 (citing Ex. 2004 ¶¶ 136-139). Although Yoneda expresses a preference of using an Al/Ti/Pt/Au or Al/Ti/Au electrode (Ex. 2004 ¶¶ 137-139), such evidence is not sufficient to establish a nexus between Emcore's claimed method and the alleged unexpected result. Emcore and Dr. Goorsky's testimony do not show sufficiently that Yoneda is referring specifically to the claimed method of the '215 patent. As discussed above, it was known in the art at the time of '215 patent's invention to use an Al/It/Pt/Au electrode. Yoneda could have been referring to other prior art teachings, including Kidoguchi (Ex. 1017 ¶¶ 31-32) and Kawamura (Ex. 1015 ¶ 15) which disclose using an Al/Ti/Pt/Au electrode on an n-type semiconductor. Emcore and its expert testimony do not provide sufficient explanation how a preference of using an Al/Ti/Pt/Au electrode is linked to Emcore's claimed method specifically. Therefore, the mere fact that Yoneda prefers an Al/Ti/Pt/Au electrode does not support a showing of unexpected result, nor establishes a nexus between the merits of the claimed invention and the asserted unexpected results.

Emcore further asserts that the claimed method is used by Nichia. PO Resp. 54-55 (citing Ex. 2001 ¶ 55). Dr. Goorsky declares that "Nichia's 219 series products have used the contact of the claimed invention from at least 2011 to the present." Ex. 2001 ¶ 55 (citing Exs. 2012, 2013). Even assuming that Nichia uses an Al base layer in its products, that does not add sufficiently to the record to warrant a conclusion of nonobviousness, because, as we indicated previously, an Al base layer was known in the art at the time of the ’215 patent’s invention. *See In re Baxter Travenol Labs*, 952 F.2d 388, 392 (Fed. Cir. 1991) (finding the prior art possessed the function relied upon by the patent applicant to establish unexpected results and, therefore, was not a basis for rebutting a prima facie finding of obviousness.); *J.T. Eaton & Co., Inc. v. Atlantic Paste & Glue Co.*, 106 F.3d 1563, 1571 (Fed. Cir. 1997) (“[T]he asserted commercial success of the product must be due to the merits of the claimed invention beyond what was readily available in the prior art.”).

Dr. Eliashevich, one of the named inventor of the ’215 patent, also testifies that “the contact of claim 1 was incorporated into hundreds of thousands of LEDs that were sold.” Ex. 2025 ¶ 18; Ex. 2002 ¶ 18. However, Dr. Eliashevich’s testimony is not sufficient to support nonobviousness of claim 1, because Dr. Eliashevich’s testimony does not establish adequately that the sales of hundreds of thousands of LEDs constitutes commercial success when considered in relation to overall market share. Dr. Eliashevich does not provide any data pertaining to overall market share, and there is no indication that LED sales number represents a substantial quantity in the overall market share. *See In re Baxter Travenol*, 952 F.2d at 392 (“Information solely on numbers of units sold is insufficient to establish commercial success.”).

After weighing the evidence of obviousness and nonobviousness of record, on balance, we conclude that the strong evidence of obviousness outweighs the weak evidence of nonobviousness. For the foregoing reasons, we determine that Nichia has demonstrated that claims 1-17 are unpatentable under 35 U.S.C. § 103(a) over Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art.

C. Motion to Amend

Emcore filed a motion to amend claims. Paper 26, "Mot. A." Emcore requests to cancel claims 2-5, 7-9, 12, 16, and17 of the '215 patent, and replace the cancelled claims with proposed new claims 18-27. *Id*. at 1. For the reasons stated below, Emcore's motion to amend claims is *denied.*

An *inter partes* review is more adjudicatory than examinational, in nature. *See Abbott Labs v. Cordis Corp*., 710 F.3d 1318, 1326 (Fed. Cir. 2013). A motion to amend claims in an *inter partes* review is not itself an amendment. As the moving party, Emcore bears the burden of proof to establish that it is entitled to the relief requested. 37 C.F.R. § 42.20(c). In sum, Emcore's proposed substitute claims are not entered automatically, but only upon Emcore having demonstrated the patentability of those substitute claims.

1. <u>A reasonable number of substitute claims</u>

In a motion to amend, a patent owner may, for each challenged claim, propose a reasonable number of substitute claims. 35 U.S.C. § 316(d)(1). The presumption is that only one substitute claim would be needed to replace each challenged claim, although the presumption may be rebutted by a demonstration of need. 37 C.F.R. § 42.121(a)(3). Absent special circumstances, a challenged claim can be replaced by only one claim, and a motion to amend should, for each proposed substitute claim, specifically identify the challenged claim that it is intended to replace. Each proposed claim should be traceable to an original challenged claim as a proposed substitute for that claim.

Here, Emcore's motion to amend claims indicates that all of the proposed claims are new claims. Mot. A. 1-3. Emcore generally identifies the challenged claims, as a group, to be cancelled and identifies the proposed new claims, as a group. *Id*. Emcore fails to demonstrate which proposed new claim is replacing which specific challenged claim. None of the proposed new claims are traceable to any challenged claims. In other words, the motion fails to identify the challenged claim that a specific proposed substitute claim is intended to replace. Without such indication, the Board does not have adequate information to determine the reasonableness of the number of substitute claims for each original claim. Furthermore, Emcore improperly proposes an independent substitute claim, claim 22, without cancelling an independent challenged claim.

For the foregoing reasons, Emcore's motion to amend fails to present a reasonable number of substitute claims in violation of 37 C.F.R. § 42.121(a)(3).

2. <u>Claim listing</u>

A motion to amend claims must include a claim listing that clearly identifies the changes, so that new limitations and deletions of limitations can be identified easily and quickly. 37 C.F.R. § 42.121(b). However, Emcore's motion to amend presents a claim listing that contains inaccurate information. More specifically, Emcore's claim listing identifies only one limitation, as a new limitation, without identifying other new limitations and deletions of limitations. Mot. A. 1-3. For instance, Emcore fails to identify the limitation in proposed claim 18—"wherein the top layer prevents cratering of the semiconductor during bonding"—as a new limitation, and fails to identify the limitation in claim 2—"wherein said annealing step is performed at about 400-600 ºC"—as a deletion. *Id*. The inaccuracy in the claim listing causes unnecessary delay. The burden should not be placed on the Board to sort through Emcore's patent claims and proposed claims to determine which limitations are added and which limitations are eliminated.

Without proper identification of all of the changes, Emcore's motion to amend claims fails to comply with 37 C.F.R. § 42.121(b).

3. <u>Claim construction</u>

Claim construction is an important step in a patentability determination. *Oakley, Inc. v. Sunglass Hut Int'l,* 316 F.3d 1331, 1339 (Fed. Cir. 2003); *Medichem, S.A. v. Rolabo, S.L.*, 353 F.3d 928, 933 (Fed. Cir. 2003) ("Both anticipation under § 102 and obviousness under § 103 are two-step inquiries. The first step in both analyses is a proper construction of the claims. . . . The second step in the analyses requires a comparison of the properly construed claim to the prior art.") (internal citations omitted).
A motion to amend claims must identify how the proposed substitute claims are to be construed, especially when the proposed substitute claims introduce new claim terms.

Here, Emcore's proposed substitute claims introduce several new claim terms including "*cratering* of the semiconductor during *bonding*" (*see* proposed new claim 18, emphasis added), and "the top layer has a *surface morphology* which permits *reliable bonding*" (*see* proposed new claim 20, emphasis added). Mot. A. 1-3. Although Emcore proffers constructions for claim terms, "annealing," "base layer," and "barrier layer" that are recited in the challenged claims, Emcore does not provide any constructions for the new claim terms recited in its proposed substitute claims. *Id*. at 3-4. For example, the claim term "reliable bonding" is a relative term, Emcore does not provide any explanation as to how one with ordinary skill in the art would have determined whether a bonding is reliable or not, or identify whether the specification sets forth a special definition.

Without a proper construction of the new claim terms, Emcore's motion does not provide adequate information for the Board to determine whether Emcore has demonstrated the patentability of its proposed substitute claims, and thus, Emcore fails to meet its burden of proof under 37 C.F.R. § 42.20(c).

4. <u>The Amendment Must Respond to a Ground of Unpatentability</u>

Pursuant to 35 U.S.C. § 316(a)(9) and taking into account the statutory considerations under 35 U.S.C. § 316(b)—"the effect of any such regulation on the economy, the integrity of the patent system, the efficient administration of the Office, and the ability of the Office to timely complete proceedings instituted"—the Office promulgated 37 C.F.R. § 42.121 to set forth the standards and procedures for allowing a patent owner, in an *inter* *partes* review, to move to amend the patent "to cancel a challenged claim or propose a reasonable number of substitute claims." As set forth in 37 C.F.R. § 42.121(a)(2), a motion to amend may be denied where the amendment does not respond to a ground of unpatentability involved in the trial.

In Emcore's motion, all of the features of original challenged claims 2-5, 7-9, 12, 16, and 17 are being removed, including the temperature range that is said to produce the asserted "unexpected result" of low contact resistances of 10^{-5} ohm-cm^2. Mot. A. 1-3. For instance, none of Emcore's proposed substitute claims recites the temperature ranges, annealing time ranges, and base layer thickness ranges recited in those challenged claims, e.g., "said annealing step is performed at about 400-600 ºC" (claim 2); "said annealing step is performed for between about 1 minute and about 10 minutes" (claim 3); and "said base layer is about 20 nm thick" (claim 16). *Id*. at 1-3.

Emcore does not explain adequately why the removal of all those limitations is responsive to a ground of unpatentability. Emcore fails to appreciate that a patent owner may not seek to broaden a challenged claim in any respect, in the name of responding to a ground of unpatentability. A proposed substitute claim is not responsive to a ground of unpatentability of a challenged claim if it removes any feature of the challenged claim being replaced, and even more so, as here, if all of the features of the challenged claim are being removed.

By eliminating the features of the challenged claims being replaced, Emcore's motion to amend claims fails to comply with 37 C.F.R. § 42.121(a)(2).

5. Written Description Support

A motion to amend claims must identify clearly the written description support for each proposed substitute claim. 37 C.F.R. § 42.121(b)(1). The written description test is whether the original disclosure of the application relied upon reasonably conveys to a person of ordinary skill in the art that the inventor had possession of the claimed subject matter as of the filing date. *Ariad Pharms., Inc. v. Eli Lilly & Co.,* 598 F.3d 1336, 1351 (Fed. Cir. 2010) (en banc). Therefore, the written description support must be shown in the original disclosure of the application that issued as the patent.

Here, Emcore fails to provide any citation to the original disclosure of the application, Application No. 09/971,965 ("the '965 application") that issued as the '215 patent. More specifically, Emcore's motion to amend does not cite to the originally-filed specification of the '965 application for the actual claim language of each proposed substitute claim. Although Emcore cites to the '215 patent, that alone is insufficient. For instance, Emcore provides a citation, without any explanation, to the patent claims that may or may not be a part of the original disclosure—"Proposed claim 21: *See, e.g.* existing claims 6, 14, and 15." Mot. A. 5. Such a vague statement is inadequate to determine the written description support for Emcore's proposed substitute claims. The burden should not be placed on the Board to sort through Emcore's patent and the original disclosure of the '965 application to determine whether each proposed substitute claim is supported in the original disclosure of the '965 application.

For the foregoing reasons, Emcore's motion to amend fails to set forth the written description support for each proposed substitute claim, in violation of 37 C.F.R. § 42.121(b)(1).

6. Patentability over Prior Art

An *inter partes* review is neither a patent examination proceeding nor a patent reexamination proceeding. The proposed substitute claims, in a motion to amend, are not entered automatically and then subjected to examination. Rather, the proposed substitute claims will be added directly to the patent, without examination, if the patent owner's motion to amend claims is granted. The patent owner is not rebutting a rejection in an Office Action, as though this proceeding is a patent examination or a reexamination. Instead, the patent owner bears the burden of proof in demonstrating patentability of the proposed substitute claims over the prior art in general, and thus entitlement to add these proposed substitute claims to its patent.

A mere conclusory statement (*see, e.g.*, Ex. 2001 ¶ 112) that one or more added claim features are not described in any prior art or would not have been suggested or rendered obvious by the prior art is facially inadequate. It also is insufficient for Emcore simply to explain why the proposed substitute claims are patentable in consideration of the ground of unpatentability on which the Board instituted review. Mot. A. 11-15.

Emcore's motion to amend does not discuss all of the references on record, e.g., Kawamura (Ex. 1015). Further, relying on its expert testimony on the validity of claim 1—a claim that does not recite any of the new features added in the proposed substitute claims—is inapposite. Mot. A. 6 (citing Ex. 2001 ¶¶ 67-104). In fact, with respect to the proposed substitute claims, Dr. Goorsky merely testifies:

> I have analyzed the claims set forth in Emcore's Motion to Amend. In light of the foregoing, it is my opinion that those claims are valid and nonobvious over the prior art of Ground 4 [—the ground of unpatentability on which the Board instituted review].

Ex. 2001 ¶ 112.

Dr. Goorsky's declaration does not discuss each new feature added in the proposed substitute claims. Neither Emcore's motion, nor Dr. Goorsky's testimony, discusses the level of ordinary skill in the art, explaining the basic knowledge and skill set already possessed by one of ordinary skill in the art, with respect to the new claim features. Limiting the discussion to the references relied upon in the instituted ground of unpatentability does not provide a meaningful analysis.

Without having discussed sufficiently the prior art references on the record, the level of ordinary skill in the art, and what was known previously regarding the new claim features, Emcore fails to demonstrate the patentability of the proposed substitute claims.

7. Conclusion

For the foregoing reasons, Emcore has not, in its motion, set forth a prima facie case for the relief requested or satisfied its burden of proof. Consequently, consideration of Nichia's opposition and Emcore's reply is unnecessary.

D. Nichia's Motion to Exclude

Nichia seeks to exclude: (1) Emcore's evidence related to the commercial success of Nichia's 219 products (Ex. 2001 ¶ 55; Ex. 2012; Ex. 2013); (2) Dr. Goorsky's statements regarding the relevance of unexamined Japanese Patent Applications (Ex. 2001 ¶ 89); and (3) Dr. Ivan Eliashevich's supplemental declaration (Ex. 2025 ¶ 6) and the file history of the '215 patent (Ex. 2026, 5-28). Paper 46 ("Mot."). As the movant, Nichia has the burden of proof to establish that it is entitled to the requested relief. 37 C.F.R. § 42.20(c).

With regard to Emcore's evidence related to the commercial success of Nichia's 219 products (Ex. 2001 ¶ 55; Ex. 2012; Ex. 2013), Nichia argues that Emcore has not shown that Nichia's 219 products embody any claim of the '215 patent, and that any evidence of commercial success of Nichia's 219 products are irrelevant. Mot. 3. Pursuant to Rules 802 and 603 of the Federal Rules of Evidence, Nichia alleges that Dr. Goorsky's underlying test results are inadmissible hearsay, and the underlying test results are statements that were not made under oath. Mot. 3-4. As to Dr. Goorsky's statements regarding the relevance of unexamined Japanese Patent

Applications, Nichia asserts that Dr. Goorsky, who has no legal expertise in Japanese patent applications, is "not qualified to offer expert opinions about the impact of Japanese patent procedures on the level of scrutiny to which Japanese patent applications are subjected." Mot. 5-6. Nichia further asserts that Dr. Eliashevich's supplemental declaration (Ex. 2025 ¶ 6) and the file history of the '215 patent (Ex. 2026, 5-28) are improper papers because they attempt to correct deficiencies in Emcore's Motion to Amend. Mot. 7-8.

Even without excluding Emcore's evidence, we have determined that Nichia has demonstrated, by a preponderance of the evidence, that claims 1-17 of the '215 patent are unpatentable.

Accordingly, Nichia's motion to exclude is *dismissed* as moot.

E. Emcore's Motion to Exclude

Emcore seeks to exclude the following: (1) certain portions of Dr. Schubert's second declaration (Ex. 1035) filed in support of Nichia's opposition to Emcore's motion to amend; and (2) Nichia's document filed in the related district court litigation (Ex. 1036). Paper 49 ("PO Mot."). As the movant, Emcore has the burden of proof to establish that it is entitled to the requested relief. 37 C.F.R. § 42.20(c). For the reasons set forth below, Emcore fails to meet its burden, and therefore, Emcore's motion to exclude is *denied*.

Testimony on Patent Law and Sufficiency of the Evidence

Emcore alleges that certain portions of Dr. Schubert's second declaration (Ex. 1035 ¶¶ 14-16, 17-19, 33, 39, 44, 47, 51) should be excluded because Dr. Schubert testified to the ultimate issue of patent law. PO Mot. 1, 6-9. Emcore also asserts that certain portions of Dr. Schubert's second declaration (Ex. 1035 ¶¶ 33, 39, 44, 47, 51) should be excluded, as Dr. Schubert did not read at least one reference and ignored teachings of other references. PO Mot. 9-12. Nichia relies upon Dr. Schubert's second declaration in its opposition (Paper 40) to Emcore's motion to amend claims (Paper 26).

We are not persuaded by Emcore's arguments. There is a strong public policy for making all information filed in a non-jury, quasi-judicial administrative proceeding available to the public, especially in an *inter partes* review which determines the patentability of claims in an issued patent. It is better to have a complete record of the evidence submitted by the parties than to exclude particular pieces.

We recognize that expert testimony on the ultimate "legal conclusion of obviousness is neither necessary nor controlling." *Avia Grp. Int'l, Inc. v. L.A. Gear Cal., Inc.*, 853 F.2d 1557, 1564 (Fed. Cir. 1988). It is within the Board's discretion to assign the appropriate weight to be accorded to evidence. In its motion, Emcore has not explained adequately why the Board should exclude expert testimony on patent law or testimony that does not have adequate support, instead of giving it little or no weight. *See, e.g.*, *Donnelly Garment Co. v. NLRB*, 123 F.2d 215, 224 (8th Cir. 1942) ("One who is capable of ruling accurately upon the admissibility of evidence is equally capable of sifting it accurately after it has been received . . . ."). Moreover, Emcore may not challenge, in a motion to exclude, the sufficiency of the evidence. *See* Office Patent Trial Practice Guide, 77 Fed. Reg. 48765, 48767 (Aug. 14, 2012). The Board is capable of taking into account the baselessness of a witness's testimony, if any, when weighing all of the testimony of the witness.

For the foregoing reasons, we decline to exclude any portion of Dr. Schubert's second declaration (Ex. 1035).

Nichia District Court Filing (Ex. 1036)

Emcore seeks to exclude the Notice Correcting Corporate Names (Ex. 1036) that was filed in the district court litigation, because it is irrelevant, potentially prejudicial, and inadmissible hearsay. PO Mot. 12-15. We are not persuaded by Emcore's arguments.

As discussed previously, Emcore, in its patent owner response, alleged that Nichia failed to identify all real parties-in-interest in its petition. PO Resp. 1. As support, Emcore submitted a copy of Nichia's motion to stay (Ex. 2017) to show that Nichia represented to the district court that both Nichia Corporation and NAC filed the petition in the instant proceeding. *Id.* at 2 (citing Ex. 2017, 1). In response to Emcore's allegation, Nichia countered that its motion to stay contained a clerical error, and filed a copy of the Notice Correcting Corporate Name (Ex. 1036)—to establish that Nichia has notified the district court of the clerical error made in its motion to stay.

Upon review of the parties' evidence (Ex. 2017; Ex. 1036), we determine that there is little, if any, prejudice to Emcore. The Notice Correcting Corporate Name (Ex. 1036) is merely a paper filed in the district court to notify the district court of a clerical error. A complete record of the evidence submitted by the parties is necessary to preserve the file history of this proceeding. Contrary to Emcore's argument, the notice is not hearsay, because it a public document and was submitted merely to show that Nichia has notified the district court of the clerical error. Furthermore, it is relevant to the real party-in-interest issue raised by Emcore.

For the foregoing reason, we decline to exclude Nichia's Notice Correcting Corporate Name (Ex. 1036).

No New Arguments or Sur-reply

While a motion to exclude may raise issues related to admissibility of evidence, it is not an opportunity for submitting new arguments or a sur-reply. Here, Emcore, in its motion to exclude, introduces new arguments that should have presented in its patent owner response, and arguments that amount to an improper sur-reply. PO Mot. 7-13.

Notably, for the first time, Emcore specifically presents, in its motion to exclude, an argument regarding the *commercial success* of its claimed method, and identifies specific portions of the evidence that support that argument. *Id*. at 7-9. Although Emcore submits arguments for secondary considerations of nonobviousness concerning failure of others and unexpected results of its claimed method, no "commercial success" argument was presented in Emcore's patent owner response. PO Resp. 50-55. The term "commercial success" does not appear even in Emcore's patent owner response. *Id*. It is unreasonable for Emcore to contend that Nichia's expert fails to consider Emcore's "commercial success" argument and evidence. In fact, Emcore itself fails to present that argument and supporting evidence in its patent owner response.

In its motion to exclude, Emcore alleges that it presented, in its patent owner response, evidence of secondary considerations of nonobviousness that includes: (1) "Nichia's use of the '215 patent resulted in a *commercial success* of Nichia's 219 products;" and (2) Dr. Eliashevich's testimony that the contact of the '215 patent "was incorporated into '*hundreds of thousands of LEDs that were sold*.'" PO Mot. 7 (citing to Ex. 2001 ¶ 55; Ex. 2025 ¶ 18) (emphases added). However, Emcore did not cite to Dr. Eliashevich's declaration (Ex. 2025; Ex. 2002), nor provide any specific explanation as to the commercial success of its claimed method in the "Secondary Considerations" section of its patent owner response. PO Resp. 50-55. In fact, the entire patent owner response does not cite to the particular paragraph (Ex. 2025 ¶ 18; Ex. 2002 ¶ 18) of Dr. Eliashevich's declaration that is said to be supporting Emcore's alleged "commercial success" argument.

Emcore also fails to present the portion of Dr. Goorsky's declaration (Ex. 2001 ¶ 55) that purportedly supports its "commercial success" argument, in an unambiguous manner. Emcore cites, in a *footnote*, to Dr. Goorsky's declaration (Ex. 2001 ¶ 55), which merely repeats the same vague and general statements made in Emcore's patent owner response. PO Resp. 54. The purported analysis on Nichia's 219 products (Exs. 2012 and 2013) is not cited in Emcore's patent owner response, but in a *footnote* of Dr. Goorsky's declaration (Ex. 2001 ¶ 55). Citing evidence in a footnote and incorporating by reference other evidence within an expert declaration creates confusion, and violates the page limit. *Cf. Globespanvirata, Inc. v. Tex. Instruments, Inc.*, 2005 WL 3077915, *1 (D. N.J. 2005) (Defendants provided cursory statements in motion and sought to make its case through incorporation of expert declaration and a claim chart. Incorporation by reference of argument not in motion was held to be a violation of local rules governing page limitations and was not permitted by the court).

All arguments supporting the patentability of Emcore's patent claims should have been made in the patent owner response, in a reasonably unambiguous manner, to give Nichia a fair opportunity to reply and avoid inefficiency, cost, and unnecessary delays. Otherwise, it is prejudicial to Nichia, circumvents the Board's rules, and impacts the Board's ability to complete the proceeding timely. *See, e.g.,* 35 U.S.C. § 316(b).

The patent owner response itself must identify and explain specific portions of the evidence that support arguments for the patentability of the patent claims. The Board may give no weight to the evidence where a patent owner has failed to state its relevance or to identify specific portions of the evidence that support the patent owner's arguments. Emcore should not expect the Board to search the record and piece together what may support Emcore's arguments. *Cf.*, *DeSilva v. DiLeonardi*, 181 F.3d 865, 866-67 (7th Cir 1999) ("A brief must make all arguments accessible to the judges, rather than ask them to play archaeologist with the record.").

III. CONCLUSION

Nichia has met its burden of proof, by a preponderance of the evidence, in showing that claims 1-17 of the ’215 patent are unpatentable under 35 U.S.C. § 103(a) over Kidoguchi, Nakamura, Fujimoto, Shibata, and the Admitted Prior Art.

Emcore has not met its burden that its proposed substitute claims are patentable.

IV. ORDER

In consideration of the foregoing, it is

ORDERED that claims 1-17 of the ’215 patent are *cancelled*;

FURTHER ORDERED that Emcore’s Motion to Amend Claims is *denied*;

FURTHER ORDERED that Nichia’s Motion to Exclude Evidence is *dismissed*; and

FURTHER ORDERED that Emcore’s Motion to Exclude Evidence is *denied*.

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