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Paper 41
Entered: September 15, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SATCO PRODUCTS, INC.,
Petitioner,

v.

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA,
Patent Owner.

IPR2020-00579
Patent 7,781,789 B2

Before JENNIFER S. BISK, CHRISTOPHER L. CRUMBLEY, and STEVEN M. AMUNDSON, *Administrative Patent Judges*.

CRUMBLEY, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

Satco Products, Inc. ("Petitioner"), filed a Petition requesting an *inter partes* review of claims 1, 3, 5, 9, 12, 13, 15, 18, 28, 29, 31, 33, 37, 40, 41, 43, 47, and 56 of U.S. Patent No. 7,781,789 B2 (Ex. 1001, "the '789 patent"). Paper 1 ("Pet"). The owner of the '789 patent, The Regents of the University of California ("Patent Owner"), filed a Preliminary Response. Paper 7 ("Prelim. Resp.").

We instituted review on September 16, 2020. Paper 8 ("Institution Dec."). Subsequent to institution, Patent Owner filed a Patent Owner Response (Paper 16 ("PO Resp.")), Petitioner filed a Reply (Paper 21 ("Reply")), and Patent Owner filed a Sur-Reply (Paper 28 ("Sur-Reply")). A transcript of the oral hearing held on June 14, 2021, has been entered into the record as Paper 36 ("Tr.").

This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a). For the reasons that follow, Petitioner has demonstrated by a preponderance of the evidence that the challenged claims are unpatentable.

II. BACKGROUND

A. Related Matters

The parties identify several related district court cases, including *Satco Products, Inc. v. The Regents of the University of California*, 2:19-cv-06444, in the Eastern District of New York ("the Satco Litigation"). Pet. 1–2; Paper 3, 2. In the Satco Litigation, Petitioner filed a complaint seeking a declaratory judgment of non-infringement. Pet. 4. In addition, there are several other pending petitions for IPR challenging patents related to the '789 patent, including IPR2020-00695, IPR2020-00780, IPR2020-00813, IPR2021-00661, IPR2021-00662, and IPR2021-00794.

B. The '789 patent

The '789 patent, entitled "Transparent Mirrorless Light Emitting Diode," describes an "(Al, Ga, In)N light emitting diode (LED) in which multi-directional light can be extracted from one or more surfaces of the LED." Ex. 1001, 5:15–17. In particular, the '789 patent discloses that "[i]n conventional LEDs, in order to increase the light output power from the front side of the LED, the emitting light is reflected by the mirror on the backside of the sapphire substrate or the mirror coating on the lead frame." *Id.* at 6:31–34. Because the energy of the photons in the emitted light is close to the band-gap energy of the emitting layer of the LED, reflected light may be re-absorbed by the emitting layer. *Id.* at 6:37–40. This reduces the efficiency and output power of the LED. *Id.* at 6:40–42. To increase efficiency of the LED, the '789 patent "minimizes internal reflections within the LED by eliminating mirrors and/or mirrored surfaces, in order to minimize re-absorption of the LED's light." *Id.* at 5:36–38. To achieve this, all layers of the LED, except the emitting layer, may be transparent for the emission wavelength of the LED. *Id*. at 5:34–35.

Figures 4A and 4B of the '789 patent are reproduced below.

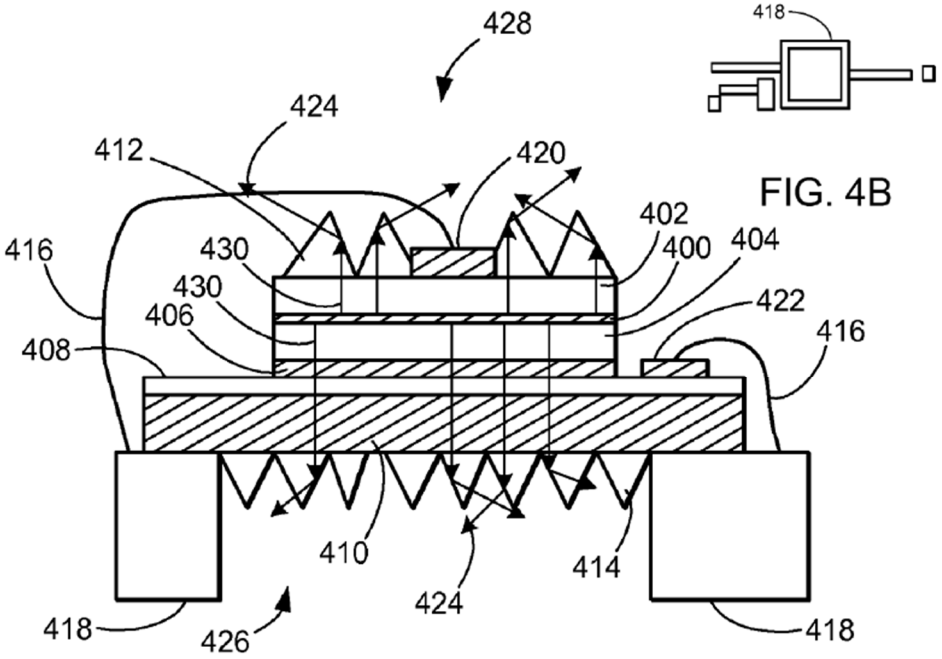


FIG. 4A

Figures 4A and 4B of the ’789 patent are schematic illustrations of an LED that emits light from multiple sides of the LED as described in the patent. *Id.* at 7:15–19. The LED chip comprises emitting layer 400, n-type GaN layer 402, p-type GaN layer 404, and glass plate 410. *Id.* at 7:45–48. “The LED is attached and wire bonded 416 to a lead frame 418 via the LED’s bonding pads 420, 422.” *Id.* at 7:50–51. Because lead frame 418 “supports the LED at the edges of the glass 410 leaving the emitting surface of the glass 410 and LED unobstructed,” the ’789 patent states that the LED “is designed to effectively extract light 424 from both sides of the LED, because the frame 418 does not obstruct the surfaces 412 and 414, i.e., the back side 426 of the LED as well as the front side 428 of the LED.” *Id.* at 8:2–9.

C. The Challenged Claims

Petitioner challenges claims 1, 3, 5, 9, 12, 13, 15, 18, 28, 29, 31, 33, 37, 40, 41, 43, 47, and 56 of the '789 patent. Claims 1, 28, 29, and 56 are independent. Claims 1 and 28 are representative:

> 1. An opto-electronic device, comprising:
>
> a light emitting diode (LED) that emits light out of the LED from multiple sides of the LED, wherein all layers of the LED are transparent for an emission wavelength except for an emitting layer.
>
> 28. An opto-electronic device, comprising:
>
> a light emitting diode (LED) that emits light out of the LED from multiple sides of the LED, wherein the LED resides on a transparent plate in a lead frame that allows the light to be extracted from two or more sides of the LED.

Ex. 1001, 14:28–32, 15:40–45.

Claims 29 and 56 are substantively similar to claims 1 and 28, respectively, but claim methods of making the opto-electronic devices of claims 1 and 28. To the extent our analysis herein focuses on claims 1 and 28, it should be understood to apply equally to claims 29 and 56. The parties do not provide separate analyses for the device and method claims.

Claims 3, 5, 9, 12, 13, 15, and 18 depend directly or indirectly from claim 1, while claims 31, 33, 37, 40, 41, 43, and 47 depend from directly or indirectly from claim 29. The additional limitations of the dependent claims are mirrored across each set (i.e., the additional limitations of claims 3 and 31 are the same, claims 5 and 33 are the same, etc.).

D. Asserted Grounds of Unpatentability

Petitioner asserts the following grounds of unpatentability:

Claims Challenged	35 U.S.C. §[1]	Basis
1, 9, 29, 37	102(b)	Nishida[2]
12, 13, 15, 40, 41, 43	103(a)	Nishida, Admitted Prior Art[3] ("APA")
3, 5, 31, 33	103(a)	Nishida, APA, Lester,[4] Tadatomo[5]
3, 5, 31, 33	103(a)	Nishida, Krames,[6] Tadatomo
12, 13, 15, 18, 40, 41, 43, 47	103(a)	Nishida, Basin[7]

[1] The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) ("AIA"), included revisions to 35 U.S.C. § 102 and § 103 that became effective on March 16, 2013. Because the '789 patent issued from an application that was a continuation of an application filed before March 16, 2013, we apply the pre-AIA version of the statutory basis for unpatentability.

[2] Nishida, T. et al., "Highly Transparent Structure for Nitride Ultraviolet Light Emitting Diodes." 42 JPN. J. APPL. PHYS. 2273–2277, Apr. 2003 (Ex. 1004).

[3] Petitioner identifies three figures of the '789 patent (Ex. 1001, Figs. 1–3) and their accompanying written description (*id*. at 6:27–7:13) as "Admitted Prior Art." Pet. 6.

[4] U.S. Patent No. 6,091,085 to Lester, issued July 18, 2000 (Ex. 1019).

[5] Tadatomo, K. et al. "High Output Power Near-Ultraviolet and Violet Light-Emitting Diodes Fabricated on Patterned Sapphire Substrates Using Metalorganic Vapor Phase Epitaxy," Proceedings of SPIE – the International Society for Optical Engineering, vol. 5187, Third International Conference on Solid State Lighting, (26 January 2004): 243–249. Bellingham, WA:SPIE, c2004 (Ex. 1020).

[6] U.S. Patent No. 5,779,924 to Krames et al., issued July 4, 1998 (Ex. 1005).

[7] U.S. Published Patent Appl. No. 2006/0105484 A1 to Basin et al., published May 18, 2006 (Ex. 1006).

Claims Challenged	35 U.S.C. §[1]	Basis
28, 56	102(b)	Okamoto[8]
28, 56	103(a)	Okamoto, Ishizaka[9]
28, 56	102(b)	Miyahara[10]

Pet. 4–5. Petitioner submits the Declaration of Russell D. Dupuis, Ph.D. (Ex. 1003) in support of its arguments. Patent Owner submits the declarations of E. Fred Schubert, Ph.D., M.S. (Exs. 2001 and 2006) in support of its arguments.

Petitioner alleges that each of the asserted references except Basin are prior art to the '789 patent under 35 U.S.C. § 102(b), whereas Basin is prior art under § 102(a) and (e). Pet. 14–17. Petitioner also refers to several references not asserted as part of any ground and alleges that they are also prior art under § 102(b). *Id.* at 15 (referring to Ex. 1005 ("Krames-924")), 16–17 (referring to Ex. 1016 ("Ishizaka-361")). Patent Owner does not challenge the prior-art status of any reference. *See generally* PO Resp.; Sur-Reply. We find that the references are prior art to the '789 patent.

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[8]Japan Patent App. Pub. No. 2000/277808A, published Oct. 6, 2000 (Ex. 1008) (certified English translation). The original Japanese-language document is in the record as Exhibit 1009. Citations herein are to the English translation, the accuracy of which has not been challenged.

[9] U.S. Published Patent Appl. 2003/0151361 A1 to Ishizaka, published Aug. 14, 2003 (Ex. 1016).

[10] Japan Patent App. Pub. No. 2005/035864A to Miyahara, published Feb. 10, 2005 (Ex. 1011) (certified English translation). The original Japanese-language document is in the record as Exhibit 1012. Citations herein are to the English translation, the accuracy of which has not been challenged at this stage of the proceedings.

III. ANALYSIS

A. Level of Skill in the Art

The level of skill in the art is a factual determination that provides a primary guarantee of objectivity in an obviousness analysis. *See Al-Site Corp. v. VSI Int'l, Inc.*, 174 F.3d 1308, 1323 (Fed. Cir. 1999) (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966)). The level of skill in the art also informs the claim-construction analysis. *See Teva Pharm. USA, Inc. v. Sandoz, Inc.*, 574 U.S. 318, 332 (2015) (explaining that claim construction seeks the meaning "a skilled artisan would ascribe" to the claim term "in the context of the specific patent claim" (emphasis omitted)).

Petitioner asserts that a person of ordinary skill in the art "would have been knowledgeable regarding conventional designs and fabrication techniques pertaining to LEDs, including LED package designs, and would have had at least 2 years of experience in LED design and fabrication as well as at least a master's degree in a relevant field (e.g., chemical engineering, materials engineering, or electrical engineering), or alternatively would have an equivalent combination of advanced education and practical experience." Pet. 10 (citing Ex. 1003 ¶¶ 23–25). Patent Owner contends that the person of ordinary skill "would have had at least a B.S. degree in mechanical or electrical engineering or a related field, and three years of experience in designing semiconductor LED packages." Prelim. Resp. 3; Ex. 2006 ¶ 73. Patent Owner adds that "a higher level of education or skill might make up for less experience (for example, an M.S. in any of the above fields and two years of practical experience would qualify one as a [person of ordinary skill in the art] (POSITA)." *Id.* (citing Ex. 2001 ¶ 67); Ex. 2006 ¶ 73.

Both parties appear to be in general agreement regarding the level of skill, and neither party contends that any differences between their proposals would have any effect on our analysis of Petitioner's challenges. Although we encouraged the parties to address any material differences between the two proposals in post-institution briefing (*see* Institution Dec. 8), neither party addressed the issue. *See generally* PO Resp.; Reply; Sur-Reply. We, therefore, adopt a level of ordinary skill that encompasses a person with a degree in mechanical or electrical engineering or a related field and the equivalent of several years of experience in designing semiconductor LED packages.

B. Claim Construction

For petitions filed on or after November 13, 2018, such as the one in this case, we interpret claims in the same manner used in a civil action under 35 U.S.C. § 282(b), "including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent." 37 C.F.R. § 42.100(b) (2021). Only terms that are in controversy need to be construed, and then only to the extent necessary to resolve the controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). In our Institution Decision, we noted the parties' dispute over the meaning of the term "lead frame" and provided a preliminary construction, but held that the term "transparent" (which had been briefed only by Petitioner) did not require construction. Institution Dec. 9–12.

Based on post-institution briefing, we determine that only the construction of "lead frame" is necessary to resolve the issues in

controversy. *See* PO Resp. 3 ("[T]he only claim term necessary to resolve the issues in controversy, is the term 'lead frame.'"); Reply 4–11 (addressing only the construction of "lead frame").

In the Institution Decision, we noted two issues to be resolved regarding the construction of "lead frame": (1) whether the transparent plate may be considered a part of the lead frame; and (2) whether specific components (e.g. leads) of the lead frame must provide support to the LED chip. Institution Dec. 9–12. For purposes of institution, we determined that "the transparent plate may be a part of the lead frame" (*id*. at 11) and "the lead frame structure, as a whole, provides support to the LED" (*id.* at 11–12). We then adopted a construction proposed by ITC Staff in a related Investigation—"a support structure for providing an interface to a semiconductor die." *Id.* at 12. The ITC later adopted this construction. *See* Ex. 3002, 11–14.[11]

Subsequent to institution, both parties agree that the transparent plate may be considered a part of the lead frame. PO Resp. 4; Reply 4; Sur-Reply 2. The parties also agree that the lead frame provides support to the LED chip. *Id.*

The parties, however, continue to disagree whether the leads themselves must provide support to the LED chip.[12] PO Resp. 4; Reply 6.

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[11] The parties forwarded a copy of the ITC's Markman Order in 337-TA-1220, dated June 15, 2021, to notify us of the decision. We have entered the order as Board Exhibit 3002.

[12] Although Patent Owner contends that "the parties agree that the conductive leads must provide structural support to the LED" (PO Resp. 5), Petitioner disagrees (Reply 5–6).

According to Patent Owner, "the leads in a lead frame provide mechanical or structural support to the LED chip" by either "directly support[ing] the LED chip (in the absence of a transparent plate) or indirectly support[ing] the LED chip through the transparent plate (in the presence of a transparent plate)." PO Resp. 7. Although Petitioner understood Patent Owner's argument to be "that a lead frame has at least two leads and all leads must provide structural support" (Reply 7), in the Sur-Reply, Patent Owner clarifies that its position is that "some or all of the leads" provide structural support. Sur-Reply 3.

As detailed below, we disagree with Patent Owner that the term "lead frame," as recited in the challenged claims, requires that any component lead provide support to the LED chip. Instead, we maintain our construction from the Institution Decision that "lead frame" in this context means a support structure for providing an interface to a semiconductor die, where the lead frame structure, as a whole, provides the support to the semiconductor die.

Patent Owner provides several arguments in support of its proposed construction requiring at least one lead to provide structural support to the LED chip. First, Patent Owner contends that the plain meaning of the term "lead frame" requires that the leads must form "the structural frame supporting the LED chip." Sur-Reply 4. According to Patent Owner, "[o]n its face, the meaning is clear" that "'lead frame' is a frame formed by leads." *Id*. We do not find this conclusory statement helpful in determining whether the leads in a lead frame are required to provide structural support to the LED chip. Patent Owner does not provide any evidence, intrinsic or extrinsic, that the plain meaning of the term "lead frame" requires that any

leads provide direct or indirect support to the LED chip. In fact, Patent Owner refers to several dictionary definitions of the term "lead frame," none of which makes any reference to support. PO Resp. 5 (citing Ex. 1023, 4 ("Lead Frame. The metallic portion of a component package that is used to interconnect with semiconductor die by wire bonding and to provide output terminal leads."); Ex. 1024, 4 ("lead frame— . . . 2. The metal part of a solid-state device package that achieves electrical connection between the die and other parts of the system of which the IC is a component. . . .); Ex. 1026, 3 ("lead frame the metallic portion of the device package that makes electrical connections from the die to other circuitry").

Second, Patent Owner argues that a person of ordinary skill in the art would have understood the term "lead" to have a different meaning than the term "lead frame," and "the role of the conductive material in providing structural support is part of what distinguishes a 'lead frame' from 'leads.'" PO Resp. 5; Sur-Reply 3 ("The very fact that lead and lead frame are separate terms indicates that the leads in a lead frame have some distinct or separate function."). Patent Owner, however, does not point to any evidence, intrinsic or extrinsic, that it is the leads' role in providing structural support that distinguishes the two terms. *See id.* Moreover, because we construe the term "lead frame" to potentially include other components, in addition to leads, the two terms already have different meanings. Thus, we are not persuaded that the absence of a role in supporting the LED chip renders the term "lead frame" indistinguishable from the term "leads."

Third, Patent Owner argues that because under some circumstances not relevant to the claims at issue,[13] it is possible that the lead frame includes only the leads, the leads necessarily provide support even in the presence of other, optional, components. Sur-Reply 2–3 ("[T]he fact that a transparent plate is allowed, but not required, indicates that the leads provide support whether or not a transparent plate is present."). Again, Patent Owner does not provide any evidence to support this conclusion. *See id.* We also do not follow the logic of the argument. Patent Owner itself allows that the support given by leads may change in the presence of a transparent plate. *See* PO Resp. 7 ("The leads either directly support the LED chip (in the absence of a transparent plate) or indirectly support the LED chip through the transparent plate (in the presence of a transparent plate).").

Fourth, Patent Owner argues that if the leads provide no structural support, then the term "lead frame" is essentially meaningless. PO Resp. 6–8; Sur-Reply 3–4. According to Patent Owner, all LED chips require both structural support and leads, but not all LED packages include lead frames. *Id.* (citing Ex. 1006 ("Basin") showing what Patent Owner refers to as a "chip on board package" that does not include a lead frame). Patent Owner, thus, concludes that the term "lead frame" must require something more than simply the combination of structural support and leads. PO Resp. 6–8.

Even accepting the premise that all LED chips require both structural support and leads, but not all LED packages include lead frames, it is unclear why the differentiating factor for lead frames must be that the leads

[13] Each of the challenged claims that recites a lead frame requires a "transparent plate in the lead frame." Ex. 1001, 14:29–16:63.

themselves provide support. Instead, it seems equally viable that the difference between an LED package with a lead frame and one without resides in the manner in which the leads are connected to each other and to any other potential components of the package. For example, Basin, which Patent Owner points to as a "chip on board package" that purportedly does not have a lead frame, shows a circuit board supporting both the LED chip and the leads themselves. PO Resp. 8 (citing Ex. 1006 ¶ 36). It is possible that the relevant difference between Basin and the '789 patent—why one has a lead frame and the other does not—is that the leads in Basin are not providing support to the LED chip, as asserted by Patent Owner. However, there are other differences between the device in Basin and the device in the '789 patent, which also could be the basis for such difference. In other words, we see no evidence supporting a presumption that the reason Basin lacks a lead frame is that the leads do not provide support to the LED chip. And, as Petitioner points out, Basin itself does not use the term "lead frame" or provide any other clarification of what the term means. *See* Reply 11.

Dr. Schubert's testimony on the issue does not support such a presumption. First, Dr. Schubert states that "structural support *from the lead frame, itself*—and not from a substrate (as discussed below)—is what fundamentally distinguishes the lead frame packaging design from other packaging designs as in surface mounted packaging/ chip-on-board packaging designs." Ex. 2006 ¶ 63. Nothing in this statement requires any particular portion of the lead frame, including the leads, to provide the structural support. Later, Dr. Schubert states that in a lead frame package "the leads provide support to the LED chip." *Id.* ¶ 68. However, the only evidence that Dr. Schubert relies upon for this conclusion is the contrast

between Basin's device and that of the '789 patent.[14] Because, as above, we see no evidence that the only difference between those two devices is whether or not the leads provide support to the LED chip, we do not find Dr. Schubert's conclusion persuasive. We, therefore, agree with Petitioner that Basin does not support Patent Owner's proposed construction.

Patent Owner also relies on testimony from Dr. Schubert (PO Resp. 7 (citing Ex. 2006 ¶¶ 63–69, 75–86)) stating that "[t]he leads either directly support the LED chip (in the absence of a transparent plate) or indirectly support the LED chip through the transparent plate (in the presence of a transparent plate)." Ex. 2006 ¶ 86. However, Dr. Schubert does not cite to any evidence, intrinsic or extrinsic, supporting this statement. *Id.* In fact, earlier in the same section of his testimony, Dr. Schubert states that (1) "[a] lead frame in the context of LEDs is understood by those of skill in the art as a support structure for an LED chip that comprises at least two conductive leads, an anode lead and cathode lead that are structurally stable and do not require support from another component" (Ex. 2006 ¶ 63); (2) "[t]he term 'lead frame' is a very commonly used term in the field of LEDs" that "refers to a frame (support structure) for LEDs that includes leads (electrodes) for making electrical connections between an LED and other structures (e.g., an LED driver or power supply)" (*id.* ¶ 76); and (3) "[i]n the context of the

[14] Dr. Schubert also refers to the devices of Shimizu and Ishizaka, which are similar to the device in Basin in that they allegedly use chip-on-board packaging instead of a lead frame. *Id.* at 69 (citing Ex. 1017, 8:51–54; Ex. 1016 ¶ 33). However, as with Basin, Dr. Schubert does not address the other differences between the devices of Shimizu and Ishizaka or explain why support provided by leads is the relevant factor distinguishing a lead frame package from a chip-on-board package. *Id.*

claims at issue and in light of the specification, the '789 Patent (and related patents) teach that the transparent plate, with the leads is involved in the support of the LED chip" (*id.* ¶ 84).

However, all of these statements support a finding that the *lead frame* supports the LED chip, but they do not require that any *leads* support the LED chip. Dr. Schubert does not explain the logical step between the requirement of the lead frame providing support and the leads of the lead frame providing support except to state that "[i]n the context of the claims at issue and in light of the specification, the '789 (and related patents) teach that the transparent plate, with the leads, is involved in the support of the LED chip" and "[t]herefore, in my opinion a POSITA reading the '789 patent would understand that the lead frame recited in the claims include[s] a transparent plate, where both the transparent plate and conductive leads provide [structural] support to the LED." *Id.* ¶¶ 84–85. Because this conclusion is not supported by intrinsic or extrinsic evidence, we are not persuaded that Dr. Schubert's testimony provides significant support to Patent Owner's proposed construction.

Figure 11A of the '789 patent is reproduced below.

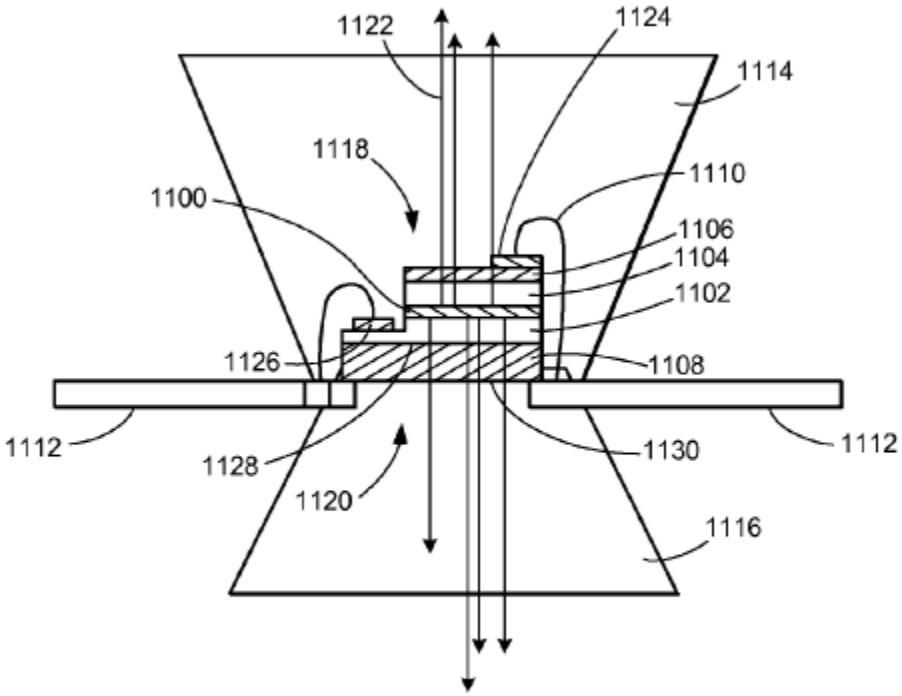


FIG. 11A

Figure 11A shows an LED including emitting layer 1100 and sapphire substrate 1108. Ex. 1001, 9:66–10:32. "The LED is attached and wire bonded 1110 to a lead frame 1112." *Id.* at 10:2–3.

Both parties appear to agree that Figure 11A of the '789 patent shows an anode lead providing at least some structural support to the LED chip. PO Resp. 9 (stating that in Figure 11A "lead frame 1112 both (i) supports the LED chip and (ii) provides the electrical connection through bonding wires 1110"); Reply 8 (showing an annotated version of Figure 11A with a portion of element 1112 labelled as "anode lead: structural support"). However, neither party directs us to, nor do we see any, disclosure in the '789 patent that explicitly states that element 1112 is providing mechanical support to the LED chip. *See* PO Resp. 9 (citing Ex. 1001, 9:66–10:5 ("The LED is attached and wire bonded 1110 to a lead frame 1112.")). Both

parties, therefore, appear to base their understanding on the positioning of element 1112 in the figure—below the LED chip. Although this disclosure is evidence that the leads of a lead frame *can* provide support to the LED chip, Patent Owner has not persuaded us that any of the leads in the lead frame are *required* to provide such support.

We note that, regardless of the role of the leads in the construction, neither party quantifies the amount of support required to be provided to the LED chip. *See* Tr. 12:24–25 (Petitioner's counsel stating "[i]t is unclear, from the patent, what the actual amount of support is required."); 46:7–10 (Patent Owner's counsel stating "[a]nd I know Your Honor asked earlier how much support leads provide, and I don't think that that's necessarily an issue that needs to be resolved because, as we'll see in the prior art, the leads in those particular references are not providing any physical support."); *see also* Tr. 49:10–11 (Patent Owner's counsel stating "I don't know that there's evidence that goes directly to the question of what support means in the abstract."). Our construction, therefore, does not require any particular amount of support to be provided to the LED chip by the lead frame. It is enough that the lead frame provides *any* amount of support to the LED chip.

Accordingly, we maintain our construction from the Institution Decision that the term "lead frame," as recited by the challenged claims, means a support structure for providing an interface to a semiconductor die, where the lead frame structure, as a whole, supports the LED.

C. Grounds Based on Nishida

Petitioner asserts several grounds of unpatentability based on Nishida: (1) that claims 1, 9, 29, and 37 are anticipated by Nishida; (2) that claims 12, 13, 15, 40, 41, and 43 would have been obvious over Nishida in view of

admitted prior art ("APA"); (3) that claims 3, 5, 31, and 33 would have been obvious over the combined disclosures of Nishida, APA, Lester, and Tadatomo; (4) that claims 3, 5, 31, and 33 would have been obvious over the combined disclosures of Nishida, Krames, and Tadatomo; and (5) that claims 12, 13, 15, 18, 40, 41, 43, and 47 would have been obvious over the combined disclosures of Nishida and Basin. Pet. 4–5, 25–56.

In order to find a claim anticipated, we must find not only that all elements of a claim are disclosed within the four corners of a single prior-art reference, but that the elements are "arranged as in the claim." *Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1369 (Fed. Cir. 2008).

A claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are "such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." We resolve the question of obviousness on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations.[15] *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

For the reasons given below, Petitioner has demonstrated unpatentability on each ground by a preponderance of the evidence. We

[15] The record does not include allegations or evidence of objective indicia of nonobviousness.

begin with an overview of the disclosure of Nishida, and then turn to an analysis of each of the grounds.

1. Overview of Nishida

Nishida, published in April of 2003, reports the merits of nitride semiconductor ultraviolet light-emitting diodes having a transparent structure. Ex. 1004, Abstract. The LED of Nishida is constructed using "sapphire substrates, AlN-template layers, AlGaN alloy buffer layers, and p-type contact layers . . . all of which are transparent to the emission." *Id*. Nishida achieves transparency by using AlGaN instead of binary GaN, resulting in what it terms a "GaN-free" structure. *Id*. at 2273. Figure 1 of Nishida is a schematic showing the structure of the GaN-free UV-LED:

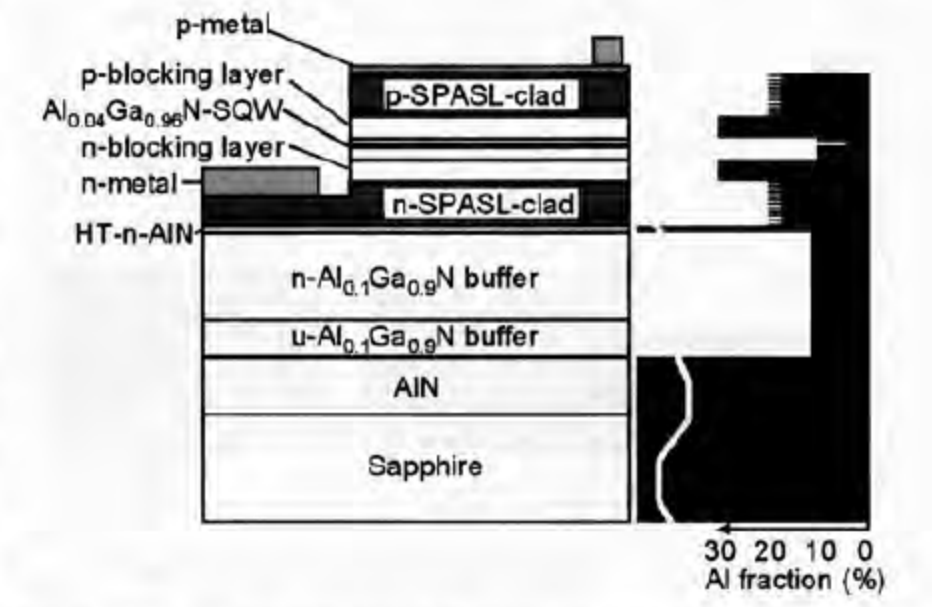
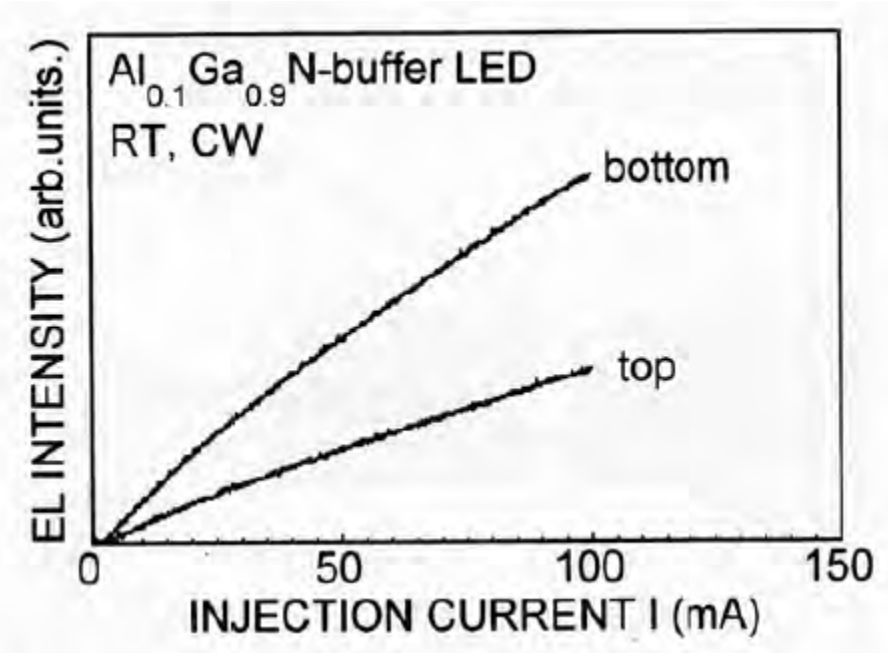


Fig. 1. The schematic drawing of the structure of the GaN-free UV-LED.

Figure 1 of Nishida depicts an LED having an active emitting layer of $Al_{0.04}Ga_{0.96}N$-SQW, sandwiched between two blocking layers (labeled p-blocking layer and n-blocking layer) and cladding layers (labeled p-SPASL-clad and N-SPASL-clad). *Id*. at 2273–74.

Nishida reports the results of experiments performed to confirm the transparency of its layers. For example, Figure 4 of Nishida shows the light transmitted through its LED wafers at various wavelengths, as compared to a GaN-buffer LED. *Id*. at 2274, Fig. 4. Nishida concludes that "most of the probe light passed through the GaN-free LED wafer, which confirms the transparency of the GaN-free LED structure." *Id*. at 2275. Nishida also reports the emissions from both the top and the bottom of its LED in Figure 9:



As shown in Figure 9, light is emitted from both the top and bottom surfaces of Nishida's LED, with the bottom-side emission approximately two times higher than the top-side emission. *Id*. at 2276, Fig. 9. Nishida states that this is due to the difference between the light transmission of the top and bottom surfaces of the LED structure, because the top surface comprises p-type semitransparent ohmic contact metal. *Id*. at 2276.

2. Anticipation by Nishida

Petitioner contends that Nishida anticipates claims 1, 9, 29, and 37, and sets forth where each of the limitations are allegedly disclosed in the reference. Pet. 25–36. For example, with respect to claim 1, Petitioner contends that Nishida discloses an LED that emits light from multiple sides, because Figure 9 of Nishida indicates that its LED emits light from at least the top and bottom sides of the device. Pet. 27–30 (citing Ex. 1004, Fig. 9, 2276; Ex. 1003 ¶¶ 100–103). Petitioner also contends that Nishida discloses that all layers of its LED are transparent for an emission wavelength, except for its emitting layer. *Id.* at 31–35. Specifically, Petitioner notes Nishida's experimental confirmation of the transparency of its GaN-free LED structure. *Id*. (citing Ex. 1004, 2274–75).

Petitioner provides the same analysis for claim 29, which is identical to claim 1 except directed to a method. Pet. 35–36. Claims 9 and 37 additionally require that the LED includes one or more transparent contact layers, and Petitioner directs us to Nishida's disclosure that its p-type contact layers are transparent to the LED's emissions. *Id*. at 35 (citing Ex. 1004, 2273), 36.

In the Institution Decision, we found Petitioner's evidence and arguments sufficient to support its anticipation challenge. Inst. Dec. 15–16. Specifically, we concluded that Petitioner had sufficiently supported its contention that all layers of Nishida's LED, other than an emitting layer, were transparent. *Id*. We noted that Nishida characterizes its p-metal layer as a "p-type *semitransparent* ohmic contact metal" and that Figure 9 of Nishida shows that the top of the LED emits light despite the presence of its p-metal layer at the surface. *Id.* at 16 (citing Ex. 1004, 2276). Patent Owner

has not argued that the '789 patent requires any particular degree of transparency, and did not proffer a construction of "transparent" at all.

As for the n-metal of Nishida, we noted that it is unclear whether it would be properly characterized as a "layer" of Nishida's LED at all. *Id*. at 16. In our preliminary view, the n-metal, which covers only a portion of the layer below it, appeared more similar to the bonding pads disclosed in the '789 patent, as opposed to a layer of the LED itself. *Id.* (citing Ex. 1001, Fig. 4A (showing bonding pad 422)). And Patent Owner appeared to acknowledge this interpretation in its Preliminary Response, noting that "at best . . . the n-metal in Figure 1 of Nishida corresponds to the bonding pads of the '789 patent." Prelim. Resp. 12.

In its Response following institution, Patent Owner continues to dispute whether all layers other than the emitting layer of Nishida's LED are transparent. PO Resp. 10–12. We note that Patent Owner does not take issue with any other claim limitation as set forth by Petitioner, or our analysis regarding these claim elements in the Institution Decision. We maintain our findings as to these elements as supported by a preponderance of the evidence on the full record developed at trial, and turn to the only claim limitation in dispute.

Patent Owner first argues that our Institution Decision erred by making findings regarding Nishida that were not set forth in the Petition. PO Resp. 10–11. In particular, Patent Owner alleges that the Petition did not address the transparency of Nishida's p-metal and n-metal; nor did Petitioner argue that these metals were not "layers" of the LED. *Id*. Patent Owner argues that this is gap-filling of Petitioner's arguments, contrary to the instructions from the Supreme Court that an *inter partes* review must

proceed "in accordance with or in conformance to the petition." *Id.* (quoting *SAS Inst., Inc. v. Iancu*, 584 U.S. __, 138 S. Ct. 1348, 1356 (2018)).

The primary case Patent Owner relies on for its gap-filling argument is *Sirona Dental Systems GmbH v. Institut Straumann AG*, 892 F.3d 1349, 1356 (Fed. Cir. 2018), in which the court stated that it "would not be proper for the Board to deviate from the grounds in the petition and raise its own obviousness theory." *Id*. But ultimately, the court concluded that the Board did not deviate from the Petitioner's proposed grounds: "[t]he Board did not change theories simply because the petition did not use the exact words" relied upon in the decision. *Id*. (citing *Rambus Inc. v. Rea,* 731 F.3d 1248, 1255 (Fed. Cir. 2013) ("[T]he Board is not required to 'recite and agree with the examiner's rejection *in haec verba*' in order to ensure that the PTO has provided adequate notice."). Furthermore, because the patent owner had "notice and opportunity to address the portions of [the prior art] relied on by the Board, the Board's reliance on these portions . . . did not violate the APA and is not inconsistent with *SAS.*" *Id.*

The portions of our Institution Decision are even less objectionable under *SAS* than the situation addressed in *Sirona*. First, that case involved a theory allegedly raised for the first time in the Board's final written decision. *Id*. at 1355. Here, by contrast, Patent Owner filed two substantive briefs since the allegedly new theories were first raised, and thus had full notice and opportunity to respond to them with argument and evidence. But more importantly, the portions of the Institution Decision to which Patent Owner objects are simply not new theories or grounds of unpatentability. The unpatentability theory discussed in the Institution Decision is exactly the one set forth in the Petition: that Nishida anticipates the challenged claims,

because all of the layers of Nishida's LED except for an emitting layer are transparent to the emission wavelength. Pet. 31–35. Our discussion of whether the bonding pads should be considered layers, and whether they are transparent, was an analysis of Nishida's disclosure in response to Patent Owner's counterargument first raised in the Preliminary Response. Prelim. Resp. 9–13. Reviewing the disclosure of the prior art to determine whether the Patent Owner's arguments were correct cannot be fairly characterized as the Board raising a new theory of unpatentability.

Turning to the merits of Patent Owner's counterarguments, we first note that Patent Owner does not contest Petitioner's assertion that the p-metal of Nishida is transparent. *See* PO Resp. 10–12 (focusing only on n-metal); Sur-Reply 7–9 (same). And as set forth in the Petition, Nishida discloses that "[t]o produce a transparent device structure at the emission wavelength, we used . . . p-type contact layers . . . which are transparent to the emission." Pet. 35 (citing Ex. 1004, 2273). We need not determine whether Nishida's p-metal is properly considered a layer of the LED, as even if it is, it satisfies the transparency claim limitation.

As for Nishida's n-metal, Patent Owner cites Dr. Schubert's testimony that the n-metal is Ti/Al, which would be understood as not transparent. PO Resp. 12 (citing Ex. 2006 ¶¶ 88–93). And Patent Owner contends that Nishida does not distinguish between its p-metal and n-metal in such a way that would support a conclusion that the former is a layer of the LED, while the latter is not. *Id*. at 11. Citing the disclosure of the '789 patent, Patent Owner observes that the patentee did not expressly state that the bonding pads are not a layer of the invention, and they could have been made from transparent materials. Sur-Reply 7.

Petitioner responds that we were correct to hold that the n-metal of Nishida is a bonding pad, not a "layer" of the LED. Reply 12. Petitioner directs us to the deposition testimony of Dr. Schubert, who agreed that if a "small percentage" of the top surface of an LED is occupied by a bonding pad, it would not be considered a "layer of the LED," whereas a bonding pad that occupies a "large percentage" would. Ex. 1044, 53:2–13. Dr. Schubert also testified that he generally understood claim 1's requirement that "all layers of the LED are transparent" to refer to the embodiments of the '789 patent where the bonding pads take up a small amount of the surface. *Id*. at 53:15–54:6. And Petitioner points out the similarities between Figure 1 of Nishida and Figure 11A of the '789 patent, both of which show a small n-metal or n-side ohmic contact/bonding pad. Reply 13.

Based on our review of the record and the parties' arguments, we agree with Petitioner that a person of ordinary skill in the art would have considered Nishida's n-type metal to be a bonding pad or contact electrode, not a layer of the LED as that term is used in the '789 patent. This usage is consistent with both the disclosure of Nishida and the '789 patent's written description. It is also in keeping with Dr. Schubert's testimony that a bonding pad that occupies a small percentage of the surface of an LED would not be considered a layer.

In addition, we note that Patent Owner's characterization of Nishida—that its n-metal is both non-transparent and a layer of the LED—is contrary to both the purpose and the experimental results reported in the reference. As discussed above, the purpose of Nishida is to provide an LED having a "transparent structure." Ex. 1004, Abstract. To achieve this, the LED is constructed using "sapphire substrates, AlN-template layers, AlGaN alloy

buffer layers, and p-type contact layers . . . all of which are transparent to the emission." *Id*. It is telling that the n-type metal is not listed as a layer of the LED in this list. And it would be contrary to the purpose of Nishida if the LED were constructed to have a layer of n-metal that was not transparent to the emission. Furthermore, this would be inconsistent with the results reported in Nishida, which show that light is emitted from both surfaces of the LED. *Id*. at 2276, Fig. 9. Tellingly, Nishida discusses that the light emitted from the top if its LED is less than the light from the bottom, due to the presence of the p-type electrode. *Id*. The presence or absence of the n-type metal bonding pad is not mentioned as relevant to the light emission at all. *Id*.

For all these reasons, we find that all layers of the Nishida LED, other than the emitting layer, are transparent for an emission wavelength. As noted above, we also find all other limitations of claims 1, 9, 29, and 37 are disclosed by Nishida. We, therefore, conclude that Petitioner has carried its burden to prove that Nishida anticipates these claims.

3. Obviousness over Nishida and APA

Petitioner contends that Nishida, in combination with admitted prior art described in the '789 patent, would have rendered the subject matter of claims 12, 13, 15, 40, 41, and 43 obvious. Pet. 36–41. Claims 12, 13, and 15 add the requirement of a "shaped optical element" to the opto-electronic device of claim 1: Claim 12 requires that the LED is embedded in a shaped optical element; claim 13 requires that the shaped optical element is a molding; and claim 15 requires that the shaped optical element is comprised of transparent materials. Ex. 1001, 14:61–64, 15:1–2. Claims 40, 41, and

43 add the same limitations to the method claim of claim 29. *Id*. at 16:11–14, 17–18.

Although Nishida discloses the structure of its LED, Petitioner observes that it does not disclose various implementation details. Pet. 36. But Petitioner contends that such implementation details were conventional at the time of the invention, and that a person of ordinary skill would have found it obvious to apply conventional chip-shaping and packaging techniques to Nishida's transparent LED. *Id*. at 36–37. According to Petitioner, the disclosure of the '789 patent itself provides details about the techniques that were conventional at the time of the invention, and it would have been obvious to apply those techniques to the LED disclosed in Nishida. *Id*. at 37.

In particular, Petitioner directs us to Figures 1–3 of the '789 patent, which are labeled as "prior art," and the accompanying disclosure in the written description of the patent. Pet. 37–40; *see* Ex. 1001, 6:28–7:13, Figs. 1–3. For example, Figure 1 of the '789 patent shows "a conventional LED" that is die-bonded on lead frame 106 with clear epoxy molding 108. *Id*. at 6:43–47. And in Figure 2, the "conventional LED" is a flip-chip LED that is die-bonded onto lead frame 208 and embedded in clear epoxy molding 210. *Id*. at 6:58–63. Petitioner contends that this admitted prior art shows "that LEDs may be conventionally embedded in clear epoxy moldings." Pet. 37. And a person of ordinary skill in the art allegedly would have had reason to do so as "a simple way to protect the LED from damage while also providing desirable light extraction effects." *Id.* at 40 (citing Ex. 1003 ¶¶ 125–132). Applying conventional moldings to the LED of Nishida,

Petitioner sets forth how the combined disclosures teach or suggest each element of claims 12, 13, 15, 40, 41, and 43.[16] *Id.* at 38–41.

Patent Owner argues that a person of ordinary skill in the art would not have combined Nishida with the conventional moldings described in the '789 patent because the conventional techniques described therein are for use with "conventional LEDs where light is emitted out of the LED only through the front (top) of the LED." PO Resp. 13 (quoting Ex. 1002, 177). Nishida, by contrast, "describes an LED where the light is extracted from both the top and bottom surfaces." *Id*. According to Patent Owner, the packaging described in the APA reflects light so that it is emitted from only one side of the device, contrary to the purposes of Nishida's LED. *Id*. (citing Ex. 2006 ¶¶ 94–103). "Without the lead frames of Figures 1 & 2 [depicting the APA] to provide an electrical connection for the chip of Nishida, one cannot simply assume that the clear epoxy moldings of the APA could still be used with Nishida." *Id*.

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[16] On August 18, 2020, the Director of the Patent & Trademark Office issued a Memorandum addressing the use of "applicant admitted prior art" as the basis for an *inter partes* review challenge. *See* USPTO Memorandum, Treatment of Statements of the Applicant in the Challenged Patent in Inter Partes Reviews Under § 311 (August 18, 2020), *available at* https://www.uspto.gov/sites/default/files/documents/signed_aapa_guidance_memo.pdf. That Memorandum concludes that one permissible use of admitted prior art in an *inter partes* review is to "supply missing claim limitations that were generally known in the art prior to the invention." *Id*. at 10. Petitioner's citation to the description of a "conventional LED" in the '789 patent falls within this category. Notably, Patent Owner did not object to Petitioner's citation to "APA," or our reliance on it in the Institution Decision. PO Resp. 12–14. The '789 patent clearly denotes these disclosures as "Prior Art," and we see no obstacle under 35 U.S.C. § 311 to Petitioner relying on admitted prior art in this manner.

Petitioner responds that while certain aspects of the prior-art devices in Figures 1–3 may be incompatible with an LED that emits light from both sides, those are not the features that it proposes combining with Nishida. Reply 16. Though Patent Owner's arguments focus on the presence of a reflective lead frame in these LEDs, Petitioner argues that its combination relies only on the application of the "conventional technique of embedding an LED in a clear epoxy molding to enhance light extraction and prevent damage." *Id*. And Dr. Dupuis testifies that epoxy moldings such as the ones shown in Figures 1 and 2 are a "well-known and conventional technique for encapsulating an LED in a protective cover," and notes that Nishida states that its LEDs can be improved using "appropriate chip-shape design and by packaging technology." Ex. 1003 ¶ 124 (citing Ex. 1004, 2276).

Based on our review of the record and the parties' arguments, we find that Petitioner has provided substantial evidence that clear epoxy coatings were a well-known technique for use with LEDs. Furthermore, given the "simple bare-chip geometry" of Nishida's LEDs (Ex. 1004, 2276), we find that a person of ordinary skill in the art would have had reason to apply the known technique of epoxy coatings to protect the LEDs and enhance their performance. We do not find persuasive Patent Owner's arguments that the features of the LEDs described in the APA, because they emit light from only one side of the device, would have been inapplicable to LEDs such as Nishida. These arguments misrepresent Petitioner's proposed combination, and focus on features of the APA other than the conventional clear epoxy coating technique that could be applied to all types of LEDs. Notably, neither Patent Owner nor Dr. Schubert gives any reason why a clear epoxy coating would not protect Nishida's LED the same way it protects the APA

devices; nor do they provide any supported reason why a clear epoxy coating would prevent Nishida's LED from functioning.

For these reasons, Petitioner has proven by a preponderance of the evidence that a person of ordinary skill in the art would have combined Nishida with the APA's molding technique, and how such a combination would teach all elements of claims 12, 13, 15, 40, 41, and 43. We conclude that these claims would have been obvious to a person of ordinary skill in the art.

4. Obviousness over Nishida, APA, Lester, and/or Tadatomo

Petitioner asserts that claims 3, 5, 31, and 33 would have been obvious over the combined teachings of Nishida, the APA, Lester, and/or Tadatomo. Pet. 41–46. Claim 3 depends from claim 1 and requires that one or more layers of the LED are "shaped, patterned, textured or roughened to increase the light extraction," and claim 5 further specifies that it is the substrate that is shaped, patterned, textured, or roughened. Ex. 1001, 14:36–38, 42–44. Claims 31 and 33 add the same limitations to method claim 29. *Id*. at 15:53–55, 59–61.

Lester is a U.S. Patent, issued July 18, 2000, titled "GaN LEDs with Improved Output Coupling Efficiency." Ex. 1019, codes (45), (54). It describes "[a]n LED having a higher light coupling efficiency than prior art devices, particularly those based on GaN." *Id.* at code (57). Lester discloses improving "the coupling efficiency of a GaN-based LED by disrupting the waveguide . . . by altering the surface of the interface between the sapphire/GaN layer and/or the surface of the GaN layer." *Id.* at 3:20–24. One method of altering the surface "involves roughening the sapphire/GaN interface," which "can be accomplished by any of a number of techniques,"

including "polishing it with relatively coarse grinding grit." *Id.* at 3:25–28, 3:65–4:1.

Tadatomo is an article titled "High Output Power Near-ultraviolet and Violet Light-emitting Diodes Fabricated on Patterned Sapphire Substrates Using Metalorganic Vapor Phase Epitaxy." Ex. 1020, 243. It discusses improving the performance and reliability of LEDs by using a patterned sapphire substrate. *Id.* at 243–44.

According to Petitioner, a person of ordinary skill in the art "would have also been motivated to roughen exterior layers of the Nishida LED to enhance light extraction," as taught in the admitted prior art, Lester, and Tadatomo. Pet. 41–43 (citing Ex. 1003 ¶¶ 136–139; Ex. 1001, Fig. 3, 7:1–13; Ex. 1019, 3:10–4:26; Ex. 1020, Abstract, Figs. 2, 7, 247–48). Petitioner observes that Nishida states that "further extraction enhancement is expected by appropriate chip shape design" (Ex. 1004, 2267), that the '789 patent depicts a "conventional LED" with a roughened n-GaN layer that enhances extraction of LED emissions (Ex. 1001 7:1–13), and that Tadatomo discloses extraction enhancement through use of a patterned sapphire substrate (Ex. 1020, 247–48). Petitioner contends that when the person of ordinary skill combined the prior art in the manner proposed, the resulting opto-electronic device would meet all elements of claims 3, 5, 31, and 33.[17]

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[17] Petitioner also asserts that claim 3 (and, presumably, claim 5) is a product-by-process claim because "shaped, patterned, textured or roughened" are processing steps and, therefore, do not limit the claim for purposes of validity. Pet. 44. We noted in our Institution Decision that we saw no persuasive reason why "shaped," "roughened," textured," and "patterned" should not be understood as adjectives, and Petitioner did not maintain its argument during trial. *See* Reply 16–20. Nevertheless, because Petitioner

Patent Owner argues that a person of ordinary skill in the art would not have combined Lester or Tadatomo with Nishida because the combination "fails to account for a fundamental difference in the LEDs at issue." PO Resp. 14. Specifically, according to Patent Owner, both Lester and Tadatomo disclose the application of their techniques to GaN-based LEDs, but Nishida's LED is expressly "GaN-free." *Id.* at 14–15. Patent Owner argues that Petitioner does not provide sufficient analysis of how the techniques of Lester or Tadatomo would affect the growth of Nishida's GaN-free layers. *Id*. at 15. And Patent Owner points out that Lester uses its techniques to address the high index of refraction of GaN, but Petitioner provides no evidence that Nishida's LED would have a similar problem. *Id*.

Patent Owner also argues that Petitioner ignores the "fundamental difference" between Nishida and Lester's or Tadatomo's LEDs "which emit light from only one side." *Id*. at 16. According to Patent Owner, "[w]hether the total amount of light emitted would be increased, stay the same, or decreased, is a complex question based upon the specific device design" and "[i]t is overly simplistic to say what worked for one LED would work for another." *Id.* at 17 (quoting Ex. 2006 ¶¶ 104–115).

Petitioner disputes that these differences are relevant, or would prevent combination of the prior-art disclosures. Taking Patent Owner's second argument first, Petitioner responds that Lester and Tadatomo both teach the principle that "reducing internal reflections at a material interface improves light extraction," and a person of ordinary skill in the art would

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has sufficiently established that the prior art meets these limitations, we need not resolve at this juncture whether they should be given patentable weight.

have "immediately recognized that such techniques were useful for improving Nishida." Reply 18–19 (citing Pet. 41–44, 46–48). Dr. Dupuis testifies that a person of ordinary skill in the art would have known about surface roughening and would have used this technique on exterior sapphire layers of an LED to enhance light extraction. Ex. 1003 ¶ 138 (citing Ex. 1019, 3:10–4:26; Ex. 1020, Abstract, Figs. 2–7, 247–48).

Addressing Patent Owner's other argument, Petitioner contends that the characterization of Nishida's LED as "GaN-free" is "misleading," as Nishida only uses that term to distinguish its use of AlGaN buffer layers (which are transparent to the emission wavelengths) from GaN (which is not). Reply 19 (citing Ex. 1004, 2273; Ex. 1003 ¶¶ 46–47). And according to Petitioner, both Lester and Tadatomo expressly disclose that their surface-roughening techniques are applicable to AlGaN LEDs. *Id*. at 20 (citing Ex. 1019, 6:33–37; Ex. 1020, 243).

We find that substantial evidence supports Petitioner's contention that a person of ordinary skill in the art would have reasonably expected the roughening techniques disclosed by Lester and Tadatomo to work with Nishida's LED and would have been motivated to combine these teachings to increase performance of the LED device. We do not find there to be a relevant distinction between Lester's or Tadatomo's GaN-based LEDs and the AlGaN LEDs disclosed in Nishida that would prevent the person of ordinary skill from applying the former's surface-roughening techniques to the latter. The record does not support Patent Owner's argument that there is a "fundamental difference" between these LEDs that would make their teachings incompatible. While Dr. Schubert notes that Lester and Tadatomo use GaN while Nishida uses AlGaN, he does not explain in his testimony

why this distinction would make a difference when it comes to surface roughening. *See* Ex. 2006 ¶¶ 104–115. And Patent Owner's argument is contradicted by objective evidence in the prior art that surface-roughening techniques are applicable to AlGaN LEDs such as the ones disclosed by Nishida. Ex. 1019, 6:33–37; Ex. 1020, 243.

Turning to Patent Owner's argument that the direction of light emitted makes the prior art incompatible, we note that Dr. Schubert testifies that "[c]ombining Nishida . . . with the APA, Lester, and Tadatomo still reflects light . . . into the active/absorbing layer of Nishida, falling short of the invention claimed by the '789 Patent." Ex. 2006 ¶ 114 (quoting Ex. 1001, 5:34–49). In addition, Dr. Schubert states that "the '789 Patent teaches that it extracts light *through* the roughened surfaces, not *away from* the roughened surfaces, as taught by Lester." *Id.* ¶ 115. However, the claims at issue do not prohibit any light from being reflected into the LED chip. Instead they require that the amount of light extracted from the LED chip is increased. Moreover, Dr. Schubert does not refer to objective evidence to support his conclusion that "without more" a person of ordinary skill in the art "would not understand that feature of contrasting disclosures (Nishida on one hand, and the APA, Lester, and Tadatomo on the other hand) could be combined." *Id.* ¶ 113. As discussed during Dr. Schubert's deposition, a person of ordinary skill in the art would have wanted to minimize internal reflections in LEDs, and would have known that techniques such as those described in Lester and Tadatomo would have reduced internal reflections. Ex. 1044, 87:21–91:6.

On balance, the record evidence supports Petitioner's position and we find that the combination of Nishida, the APA, and Lester or Tadatomo

teaches each limitation of claims 3, 5, 31, and 33, and that an ordinarily skilled artisan would have had reasons, with rational underpinning, to combine the references, and the skilled artisan would have had a reasonable expectation of success.

5. Obviousness over Nishida, Krames, and Tadatomo

Petitioner also challenges claims 3, 5, 31, and 33 as having been obvious over the combined disclosures of Nishida, Krames, and Tadatomo. Pet. 46–50. Like the secondary references in the ground above, Petitioner cites to Krames as disclosing chip-shaping methods that enhance light extraction from an LED by patterning or texturing. *Id*. at 46 (citing Ex. 1005, 2:65–3:20). The primary difference between Krames and the previously cited texturing references is that Krames shows, for example in its Figure 8, an embodiment in which both "the top and back surfaces of a transparent substrate device are textured." Ex. 1005, Fig. 8, 7:46–54. Petitioner concedes, however, that Krames does not disclose texturing a sapphire substrate. Pet. 48. For this, Petitioner again relies on Tadatomo. *Id*. (citing Ex. 1020, Abstract, 247–48). Petitioner contends that a person of ordinary skill in the art would have applied the techniques of Krames and Tadatomo to the LED of Nishida, with the goal of improving light extraction. *Id*. Petitioner sets forth how each limitation of claims 3, 5, 31, and 33 would be taught by such a combination. *Id.* at 49–50.

Because we have determined claims 3, 5, 31, and 33 to be unpatentable over the combined disclosures of Nishida, the APA, and Lester or Tadatomo as discussed above, we need not consider whether the claims are also unpatentable over the combination proposed in this ground.

6. Obviousness over Nishida and Basin

Petitioner's final ground of unpatentability based on Nishida challenges claims 12, 13, 15, 18, 40, 41, 43, and 47, and contends that these claims would have been obvious over the combined disclosures of Nishida and Basin. Other than claims 18 and 47, all of these claims were summarized above. Claim 18 depends from claim 12 and further recites a phosphor layer located on top of the shaped optical element, within the shaped optical element, or near a surface of the shaped optical element. Ex. 1001, 15:7–10. Claim 47 adds the same limitation to method claim 40. *Id*. at 16:25–28.

Basin discloses techniques for forming a lens on a surface-mounted LED, in which a mold is filled with an optically transparent material such as silicone, after which the material is cured to form a hardened lens. Ex. 1006 ¶¶ 5–6. According to Basin, this hardened lens not only can be used to create a desired emission pattern for light, but it also encapsulates the LED and protects it. *Id*. ¶ 33. Basin also discloses that phosphors may be used to cause the LED to emit light of a desired wavelength; the phosphor may be coated on the LED die, or may instead overly the clear silicone shell. *Id*. ¶¶ 39, 43. When the phosphor overlies the clear silicone shell, the LED die emits UV light, which is converted by the phosphor to produce a white light. *Id*. ¶ 43.

Petitioner asserts that the person of ordinary skill would have been motivated to use the UV-LED of Nishida in the phosphor-coated silicone shell of Basin, because Nishida suggests that its bare chip could be improved with appropriate packaging. Pet. 52 (citing Ex. 1003 ¶¶ 163–66, Ex. 1004, 2267). Petitioner also notes that Basin teaches its packaging enhances light

extraction and durability while also permitting the LED to emit white light. *Id*. Once combined in this manner, Petitioner sets forth how each element of claims 12, 13, 15, 18, 40, 41, 43, and 47 would be taught by the combined disclosures. *Id*. at 53–56.

Patent Owner contends that Petitioner relies on Basin for substantially identical teachings as those in the APA, and its counterarguments are similar as well. PO Resp. 19–20. Patent Owner notes that Basin pertains to "surface mounted LEDs," and Figure 5 of the reference shows a lens that covers only the top side of an LED. *Id*. (citing Ex. 1006 ¶ 3, Fig. 5). Patent Owner repeats its argument that "there is simply no reason why a [person of ordinary skill in the art] would take the LED of Nishida, which is designed to emit light from both sides, and use it with the packaging of Basin, which only permits light extraction from one side." *Id*. at 20 (citing Ex. 2006 ¶¶ 124–128).

We are no more persuaded by Patent Owner's arguments here than we were in the ground above involving the APA combination. Basin teaches that its silicone shell can be used to create a desired emission pattern while also protecting the LED and incorporating phosphors to achieve a desired color of light. Ex. 1006 ¶ 33. Those features are the focus of Petitioner's analysis, and the features that are proposed to be applied to Nishida's LED. Nothing in the record supports the conclusion that these features are incompatible with Nishida's LED merely because it emits light from more than one side. The distinctions Patent Owner and its expert focus on, that allegedly would prevent combination of the prior-art teachings, are not features relied upon by Petitioner. *See* PO Resp. 19 ("Basin . . . is intended for 'surface mounted LEDs'"); Ex. 2006 ¶ 126 (Basin teaches that "the LED

chip is mounted to a circuit board on one side . . . so light does not emit through the back side.").

We have reviewed Petitioner's rationale for combining the references, as well as its analysis of how the limitations of each of claims 12, 13, 15, 18, 40, 41, 43, and 47 would be taught by the combination, and find them supported by a preponderance of the evidence. We therefore conclude that these claims would have been obvious to a person having ordinary skill in the art.

D. Anticipation by Miyahara

Petitioner contends that claims 28 and 56 are anticipated by Miyahara. Pet. 74–82. For the reasons that follow, we determine that Petitioner establishes by a preponderance of the evidence that these claims are anticipated Miyahara.

1. Overview of Miyahara

Miyahara is a Japanese Patent Application published on February 10, 2005, titled "Substrate for Mounting Light-emitting Element." Ex. 1011, codes (43), (54). Figure 11 of Miyahara is reproduced below.

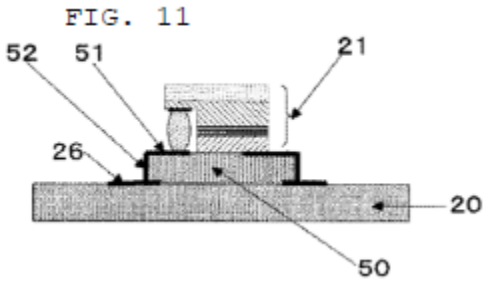


Figure 11 of Miyahara is "a cross-sectional diagram[] showing the substrate for mounting a light-emitting element." *Id.* ¶ 19. Light-emitting element 21 is mounted on submount 50, which in turn is mounted on the substrate for

mounting a light-emitting element 20. *Id.* ¶ 31. Substrate 20 and light-emitting element 21 are electrically connected by the use of electrical circuit 52 to connect electrical circuit 51 with surface electrical circuit 26. *Id.* Submount 50 includes "an optically transparent sintered body." *Id.* ¶ 34.

2. Unpatentability of Claims 28 and 56

Petitioner contends that independent claims 28 and 56 are anticipated by Miyahara. Pet. 74–82. Petitioner asserts that Miyahara's submount 50 is a transparent plate "surrounded by 'thick-film metallization' on its top, side, and bottom surfaces . . . in order to electrically connect LED (21) to power," which combine to teach the lead frame limitation. Pet. 79 (citing Ex. 1011 ¶¶ 31, 121, Fig. 11). Petitioner also notes that Figure 7 of Miyahara shows light (22, 23) emitted from the top and bottom of the LED, and relies on Miyahara as disclosing that "light is emitted and extracted from both the top and bottom sides of the LED . . . because plate 20 is transparent." *Id.* at 77–79 (citing Ex. 1011 ¶¶ 5, 6, 17–20, 24, Fig. 7).

Patent Owner argues that Miyahara fails to disclose "that the leads provide support to the LED chip." PO Resp. 30. In particular, Patent Owner argues that Miyahara's elements 26, 51, and 52 (1) do not constitute "a single structural element, but instead an electrical circuit formed by several elements," and (2) may be formed by thick film metallization as discussed by Petitioner, but also may be formed by sintering or thin film metallization, or a combination of these techniques. PO Resp. 31–32. According to Patent Owner, a person of ordinary skill in the art "would not consider a thick film metallization to be providing structural support in Miyahara, [and] they would know that a thin film metallization could not possibly provide structural support." *Id*. Patent Owner adds that "even if a thick film

metallization could provide support in certain circumstances, a POSITA would understand it is not doing so in Figure 11." *Id.* at 32.

In our Institution Decision, we explained that because "we do not agree with Patent Owner that every element of the lead frame must support the LED, we see no significance in the fact that elements 26, 51, and 52 may be separate or how they are formed." Institution Dec. 32. We also noted that "Patent Owner appears to agree that submount 50 supports the LED." *Id.* (citing Prelim. Resp. 29). In the Response, Patent Owner explains that the Institution Decision's "conclusion was based on the erroneous belief that the leads did not have to provide structural support," and "[w]ith that requirement in mind, the fact that they may be separate elements formed at separate times illustrates that they are not providing structural support." PO Resp. 32.

Because, as discussed above, we do not agree with Patent Owner's assertion that the leads of the lead frame must support to the LED chip, we continue to agree with Petitioner that the combined elements of 26, 51, and 52 of Miyahara disclose a lead frame as recited by claims 28 and 56. In fact, Dr. Schubert agrees that "[i]n Figure 11, substrate 20 and submount 50 provide the structural support to the LED chip." Ex. 2006 ¶ 153. Because submount 50 is part of the lead frame and provides support to the LED chip, we need not address Patent Owner's argument that the thick film metallization of elements 26, 51, and 52 do not also support the chip.

We have reviewed Petitioner's contentions, the testimonial evidence, and the disclosure of Miyahara, and determine that the record provides substantial evidence supporting Petitioner's assertions of anticipation by Miyahara of claims 28 and 56.

E. Grounds Based on Okamoto

Petitioner also contends that claims 28 and 56 are either anticipated by Okamoto, or obvious over the combined disclosures of Okamoto and Ishizaka. Pet. 4–5, 56–74. Okamoto is a Japanese Patent Application published October 6, 2000, titled "Light Source Device and Manufacturing Method of the Same." Ex. 1008, codes (43), (54). Okamoto describes providing a light source device with "LED elements 3 and 4 having light distribution characteristics for emitting in all directions" on a "light-transmissive substrate 2." *Id.* at code (57). Petitioner argues that Okamoto's LED anticipates claims 28 and 56, arguing that "because the transparent plate is part of the lead frame," it discloses a transparent plate in a lead frame as required by the challenged claims. Reply 22. Alternatively, if Okamoto does not disclose the claimed transparent plate in the lead frame, Petitioner relies on the disclosure of Ishikara, which teaches a chip-type package having electrodes which surround and allegedly support a substrate for the LED. Pet. 67–69

Because we have found claims 28 and 56 anticipated by Miyahara, we need not address these grounds of unpatentability based on Okamoto.

IV. CONCLUSION[18]

Based on the full record, we determine that Petitioner shows by a preponderance of the evidence that claims 1, 3, 5, 9, 12, 13, 15, 18, 28, 29, 31, 33, 37, 40, 41, 43, 47, and 56 of the '789 patent are unpatentable.

Claim(s)	35 U.S.C. §	Reference(s)	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 9, 29, 37	102(b)	Nishida	1, 9, 29, 37	
12, 13, 15, 40, 41, 43	103(a)	Nishida, APA	12, 13, 15, 40, 41, 43	
3, 5, 31, 33	103(a)	Nishida, APA, Lester, Tadatomo	3, 5, 31, 33	
3, 5, 31, 33	103(a)	Nishida, Krames, Tadatomo[19]		
12, 13, 15, 18, 40, 41, 43, 47	103(a)	Nishida, Basin	12, 13, 15, 18, 40, 41, 43, 47	
28, 56	102(b)	Okamoto[20]		
28, 56	103(a)	Okamoto, Ishizaka		

[18] Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

[19] As discussed above, we do not reach this ground of unpatentability.

[20] As discussed above, we do not reach either ground of unpatentability based on Okamoto.

Claim(s)	35 U.S.C. §	Reference(s)	Claims Shown Unpatentable	Claims Not Shown Unpatentable
28, 56	102(b)	Miyahara	28, 56	
Overall Outcome			1, 3, 5, 9, 12, 13, 15, 18, 28, 29, 31, 33, 37, 40, 41, 43, 47, 56	

V. ORDER

For the reasons given, it is:

ORDERED that, pursuant to 35 U.S.C. § 314(a), Petitioner has shown by a preponderance of the evidence that claims 1, 3, 5, 9, 12, 13, 15, 18, 28, 29, 31, 33, 37, 40, 41, 43, 47, and 56 of the '789 patent are unpatentable; and

FURTHER ORDERED that parties to the proceeding seeking judicial review of this Final Written Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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