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Paper 41
Entered: October 19, 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.

IPR2020-00813
Patent 9,859,464 B2

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

BISK, *Administrative Patent Judge*.

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

I. INTRODUCTION

Satco Products, Inc., filed a Petition requesting an *inter partes* review of claims 1, 2, 8–12, and 18–20 ("the challenged claims") of U.S. Patent No. 9,859,464 B2 (Ex. 1001, "the '464 patent"). Paper 2 ("Pet"). The owner of the '464 patent, The Regents of the University of California, filed a Preliminary Response. Paper 9 ("Prelim. Resp.").

We instituted review on October 22, 2020. Paper 10 ("Institution Dec."). Subsequent to institution, Patent Owner filed a Patent Owner Response (Paper 19 ("PO Resp.")), Petitioner filed a Reply (Paper 27 ("Reply")), and Patent Owner filed a Sur-Reply (Paper 28 ("Sur-Reply")). A transcript of the oral hearing held on September 8, 2021, has been entered into the record as Paper 40 ("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, 2–3. 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 IPRs challenging patents related to the '464 patent, including IPR2020-00579, IPR2020-00695, IPR2020-00780, IPR2021-00661, IPR2021-00662, and IPR2021-00794. Petitioner also identifies a related proceeding before the International Trade Commission

(ITC), *In the Matter of Certain Filament Light-Emitting Diodes and Products Containing Same (II)*, Inv. No. 337-TA-1172. Pet. 1.

B. The '464 Patent

The '464 patent relates to "LED Light Extraction and white LED with high luminous efficacy for optoelectronic applications, and, more specifically, relates to a textured phosphor conversion layer LED." Ex. 1001, 5:20–23. In particular, the '464 patent discloses that "[i]n conventional white LEDs, the phosphor conversion layer is typically placed directly on top of the blue GaN chip." *Id.* at 5:30–31. Because photons are converted to lower energy photons in that phosphor layer, a large fraction of them are internally reflected and reabsorbed by the chip. *Id.* at 5:35–39. This is inefficient. *Id.* To increase efficiency of the LED, the '464 patent "minimizes the internal reflection of the phosphor layer by preferential patterning the emitting surface to direct more light away from the absorbing chip structure." *Id.* at 5:58–61.

Figures 8A and 8B of the '464 patent are reproduced below.

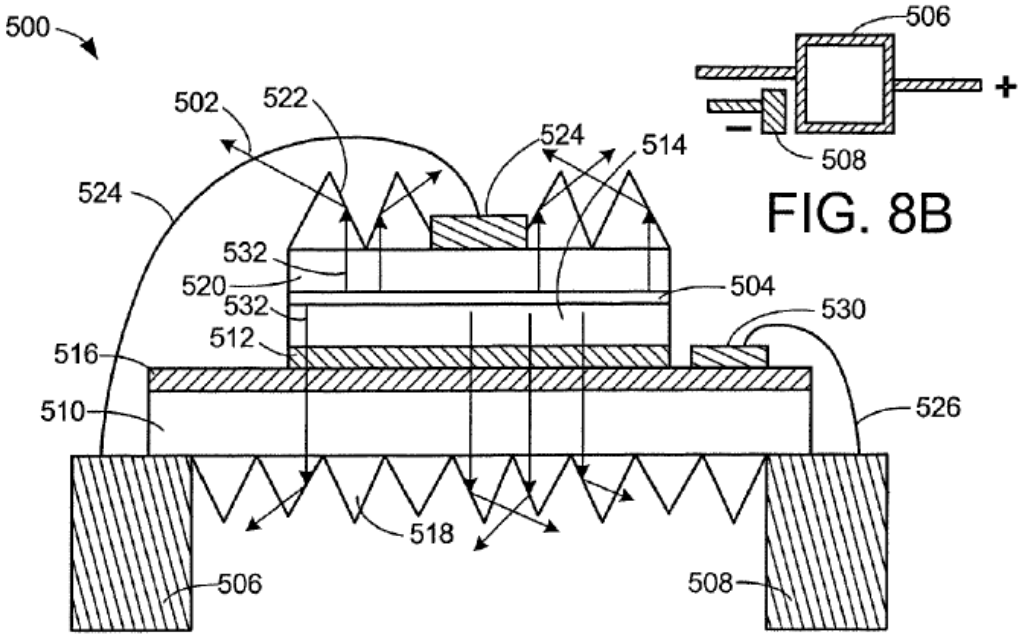


FIG. 8B

FIG. 8A

Figures 8A and 8B of the '464 patent "illustrate the dual-sided roughened phosphor layer of the present invention." *Id.* at 7:37–39. LED chip 500 contains glass plate 510, which is coated with Indium Tin Oxide (ITO) layer 516, which, in turn, is attached to deposited ITO layer 512 using epoxy as a glue. *Id.* at 10:34–39. "LED chip 500 is put on a lead frame 506," and wire bonding 524 and 526 connect bonding pads 528 and 530 of LED chip 500 with lead frame 506 and electrode 508 "to allow an electric current to flow through the lead frame 506." *Id.* at 10:46–51. Lead frame 506 "acts as a support around the edges of LED chip 500." *Id.* at 10:52–56.

C. The Challenged Claims

Petitioner challenges claims 1, 2, 8–12, and 18–20 of the '464 patent. Claims 1 and 11 are independent. Claim 1 is reproduced below:

1. A light emitting device, comprising:
   a lead frame including a transparent plate; and

> an LED chip, attached to the lead frame, for emitting light;
>
> wherein the LED chip resides on or above the transparent plate and at least some of the light emitted by the LED chip is transmitted through the transparent plate; and
>
> wherein at least a portion of the light emitted by the LED chip is extracted from a front side of the lead frame and another portion of the light emitted by the LED chip is extracted from a back side of the lead frame.

Ex. 1001, 15:23–33.

Claim 11 is substantively similar to claim 1, but claims a method. To the extent our analysis herein focuses on claim 1, it should be understood to apply equally to claim 11.

Claims 2 and 8–10 depend from claim 1, and claims 12 and 18–20 depend from claim 11.

D. Asserted Grounds of Unpatentability

Petitioner asserts the following grounds of unpatentability:

Claims Challenged	**35 U.S.C. §[1]**	**Basis**
1, 9, 11, 19	102(b)	Okamoto[2]

[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 '464 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 bases for unpatentability.

[2] Japan Patent App. Pub. No. 2000/277808A (published Oct. 6, 2000). Ex. 1008 (certified English translation).

Claims Challenged	35 U.S.C. §[1]	Basis
1, 2, 9, 11, 12, 19	103(a)	Okamoto, Shimizu[3]
8, 10, 18, 20	103(a)	Okamoto, Shimizu, Lester[4,5]
8, 10, 18, 20	103(a)	Okamoto, Shimizu, Tadatomo[6]
1, 2, 11, 12	102(b)	Miyahara[7]
2, 9, 12, 19	103(a)	Miyahara
8, 10, 18, 20	103(a)	Miyahara, Lester[8]
8, 10, 18, 20	103(a)	Miyahara, Tadatomo

[3] U.S. Patent No. 5,998,925 (issued Dec. 7, 1999). Ex. 1017.

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

[5] Petitioner refers to this ground as Okamoto, Shimizu, Lester-085, "and/or Tadatomo." Pet. 5, 59. However, the analysis provided by Petitioner only addresses the combinations of Okamoto, Shimizu, and Lester-085 or Okamoto, Shimizu, and Tadatomo and does not address a combination of Okamoto, Shimizu, Lester-085 and Tadatomo. Pet. 59–64.

[6] 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.

[7] Japan Patent App. Pub. No. 2005/035864A (published Feb. 10, 2005). Ex. 1011 (certified English translation).

[8] Petitioner refers to this ground as Miyahara, Lester-085, "and/or Tadatomo." Pet. 5, 81. However, the analysis provided by Petitioner only addresses the combinations of Miyahara and Lester-085 or Miyahara and Tadatomo and does not address a combination of Miyahara, Lester-085, and Tadatomo. Pet. 81–83.

Pet. 4–6, 30–83. Petitioner submits the Declaration of Russell D. Dupuis, Ph.D. (Ex. 1003) in support of its arguments. Patent Owner submits declarations of E. Fred Schubert, Ph.D., M.S. (Exs. 2001, 2008) in support of its arguments.

Petitioner alleges that all of the asserted references are prior art to the '464 patent under 35 U.S.C. § 102(b). Pet. 16–21. 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 15–16 (referring to Ex. 1007 ("Schubert")), 20–21 (referring to Ex. 1005 ("Krames-924") and Ex. 1016 ("Ishizaka-361")); *see* Ex. 1003 ¶¶ 64, 218 (also referring to Ex. 1028 ("Fujii") and Ex. 1029 ("Narukawa")). 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 '464 patent.

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. 13–14 (citing Ex. 1003 ¶¶ 26–28). 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. 2. 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 ¶¶ 66–67).

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 (Institution Dec. 7–8) to address any material differences between the two proposals in post-institution briefing, 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).

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. 2 ("[T]he only claim term necessary to resolve the issues in controversy, is the term 'lead frame.'"); Reply 2–13 (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. 8–11. For purposes of institution, we determined that "the transparent plate may be part of the lead frame" (*id*. at 9) and "the lead frame structure, as a whole, provides support to the LED" (*id.* at 10). 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 10–11.

Subsequent to institution, both parties agree that the transparent plate may be considered a part of the lead frame. PO Resp. 3; Reply 3; Sur-Reply 1. 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.[9] PO Resp. 4; Reply 4. According to Patent Owner, "the leads in a lead frame provide structural or mechanical 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 6), 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 determine that Patent Owner has not shown that the term "lead frame," as recited by 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

[9] Although Patent Owner contends that "the parties agree that the conductive leads must provide structural support to the LED" (PO Resp. 4), Petitioner disagrees (Reply 4).

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 identify 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. 4–5 (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. 4; Sur-Reply 2 ("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* PO Resp. 4. 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,[10] 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 ("[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. 5–8; 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. PO Resp. 7 (citing Ex. 2011 ("Basin") as 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 those two elements. PO Resp. 5–7.

[10] Each of the challenged claims requires a "lead frame including a transparent plate." Ex. 1001, 15:23–16:48.

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 themselves provide support. Instead, it seems an equally viable difference between an LED package with a lead frame and one without is 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. 7–8 (citing Ex. 2011 ¶ 36). It is possible that the relevant difference between Basin and the '464 patent—why one has a lead frame and the other does not—is not that the leads in Basin are not providing support to the LED chip, but one of the other many differences between the device in Basin and the device in the '464 patent. 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 12–13. Dr. Schubert's testimony on the issue is consistent with this understanding. 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. 2008 ¶ 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 by contrasting Basin's device with that of the '464 patent.[11] 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. 6–9 (citing Ex. 2008 ¶¶ 63–69, 75–86)) stating that "[t]he lead frame provides mechanical or structural support to the LED chip" and "[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. 2008 ¶ 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. 2008 ¶ 63); (2) "[t]he term 'lead frame' is a very

[11] 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.* ¶ 69 (citing Ex. 1017, 8:51–54; Ex. 1016 ¶ 33). However, as with Basin, Dr. Schubert does not address the many other differences between the devices of Shimizu and Ishizaka or explain why support provide by leads is the relevant factor distinguishing a lead frame package from a chip-on-board package. *Id.*

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)" (Ex. 2008 ¶ 76); and (3) "[i]n the context of the claims at issue and in light of the specification, the 464 Patent (and related patents) teach that the transparent plate, with the leads, in involved in the support of the LED chip" (*id.* ¶ 84). However, none of these statements explicitly requires 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 '464 (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 '464 Patent would understand that the lead frame recited in the claims include 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.

Both parties appear to agree that Figure 15 of the '464 patent shows an anode lead providing at least some structural support to the LED chip. PO Resp. 8 (stating that in Figure 15 "lead frame 1522 both (i) supports the LED chip and (ii) provides the electrical connection through bonding wires 1518 and 1520"); Reply 7 (showing an annotated version of Figure 15 with a portion of element 1522 labelled as "anode lead: structural support"). However, neither party directs us to, nor do we see any, disclosure in the

'464 patent that explicitly states that element 1522 is providing mechanical support to the LED chip. *See* PO Resp. 8 (citing Ex. 1001, 12:12–14[12] ("Wire bonds 1518 and 1520 are added to connect the LED structure 1502 to the lead frame 1522.")). Both parties, therefore, appear to base their understanding on the positioning of element 1522 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.

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, provides the required support.

C. Grounds Based on Okamoto

Petitioner contends that: (1) claims 1, 9, 11, and 19 are anticipated by Okamoto, (2) claims 1, 2, 9, 11, 12, and 19 are unpatentable, because their subject matter would have been obvious over the combined disclosures of Okamoto and Shimizu, (3) claims 8, 10, 18, and 20 would have been obvious over the combined disclosures of Okamoto, Shimizu, and Lester, and (4) claims 8, 10, 18, and 20 would have been obvious over the combined disclosures of Okamoto, Shimizu, and Tadatomo. Pet. 4–5, 30–64. For the reasons given below, Petitioner has shown anticipation and obviousness by a preponderance of the evidence.

[12] The Patent Owner Response actually refers to Ex. 1001, 11:54–60, but that appears to be a typo.

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.[13] *See Graham*, 383 U.S. at 17–18.

1. Overview of Okamoto

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). Figure 1 of Okamoto is reproduced below.

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

[FIG. 1]

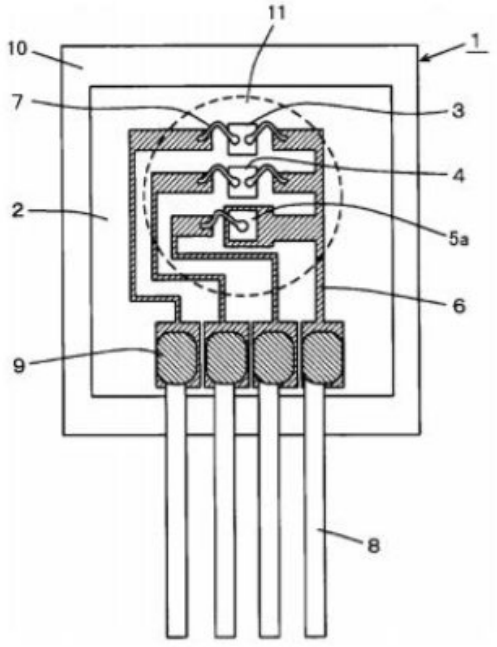


Figure 1 of Okamoto shows "a frontal view illustrating a configuration of a light source device."[14] *Id.* ¶ 26. The device includes GaN blue LED element 3, GaN green LED element 4, and GaAs red LED element 5a, all three of which are "disposed in a row on a front face of a light-transmissive glass substrate 2." *Id.* ¶ 27. The device also includes GaAs red LED element 5b (not shown). *Id.* Wiring path 6 is on glass substrate 2 and is fixed to back-side LED electrodes with a conductive epoxy resin adhesive and electrically connected to upper-side LED electrodes with gold wire 7. *Id.* ¶¶ 28–29. Lead frame 8 is attached to wiring pattern 6 with solder material 9. *Id.* ¶ 29.

Figure 6 of Okamoto is reproduced below.

[14] Petitioner refers to Okamoto's Figure 1 as showing a "lead-type" package. Pet. 42.

[FIG. 6]

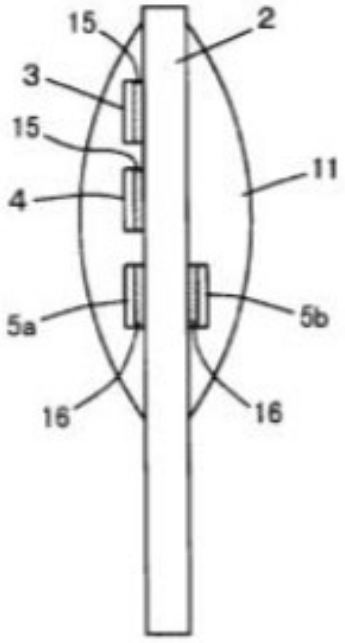
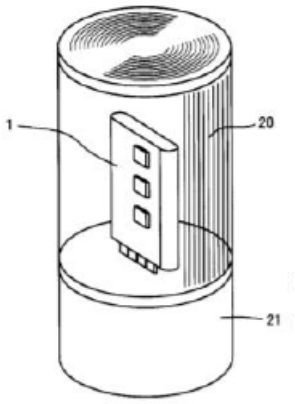


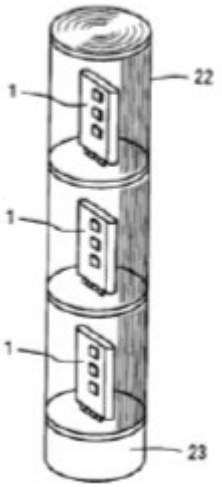
Figure 6 of Okamoto shows "a manufacturing method of the light source device 1." *Id.* ¶ 32. "LED elements 3, 4, 5a, and 5b are integrally molded with the light-transmissive substrate 10 . . . on top of the light-transmissive resin 11 together with the glass substrate 2 having the lead frame 8 attached thereto." *Id.* ¶ 34.

Figures 8 and 9 of Okamoto are reproduced below.

[FIG. 8]



[FIG. 9]



Figures 8 and 9 of Okamoto show "perspective views of signal lights having the light source 1 of FIG. 1 incorporated therein." *Id.* ¶ 41.

2. Overview of Shimizu

Shimizu is a U.S. Patent issued December 7, 1999, titled "Light Emitting Device Having a Nitride Compound Semiconductor and a Phosphor Containing a Garnet Fluorescent Material." Ex. 1017, codes (45), (54). It describes a "white light emitting diode" that uses "a semiconductor as a light emitting layer and a phosphor which absorbs a part of light emitted by the light emitting component and emits light of wavelength different from that of absorbed light." *Id.* at code (57). "[T]he phosphor contains a garnet fluorescent material activated with cerium which contains at least one element selected from the group consisting of Y, Lu, Sc, La, Gd and Sm, and at least one element selected from the group consisting of Al, Ga and In." *Id.* Shimizu describes embodiments with a "lead type light emitting diode" and a "tip type light emitting diode." *Id.* at 6:48–53. Figure 1 of Shimizu is reproduced below.

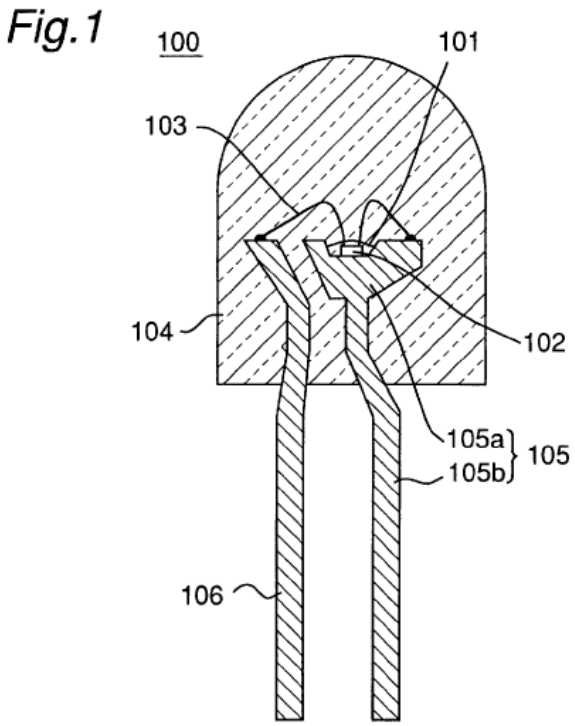


Figure 1 of Shimizu "is a schematic sectional view of a lead type light emitting diode."[15] *Id.* at 6:49–51. LED 100 has "a mount lead 105 and an inner lead 106," and "a light emitting component 102." *Id.* at 8:31–39.

[15] Petitioner refers to Shimizu's Figure 1 as showing a "lead-type" package. Pet. 19.

Figure 2 of Shimizu is reproduced below.

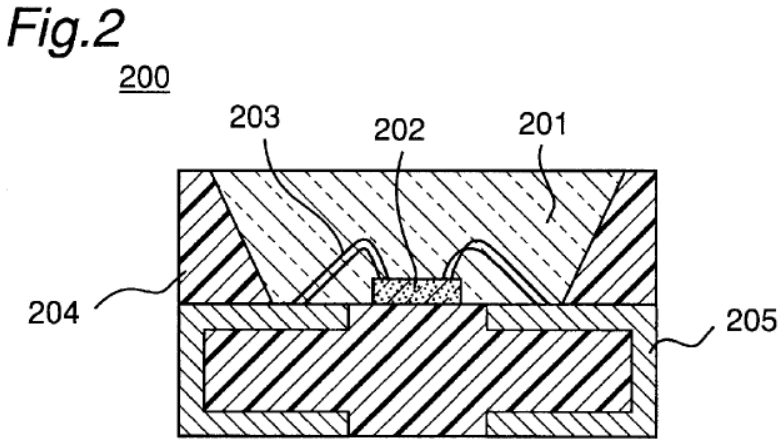


Figure 2 of Shimizu "is a schematic sectional view of a tip type light emitting diode."[16] *Id.* at 6:52–54. LED 202 is installed in a recess of casing 204, which "is filled with a coating material which contains a specified phosphor to form a coating 201." *Id.* at 8:51–54. Electrodes of LED 202 are "connected to metal terminals 205 installed on the casing 204 by means of conductive wires 203." *Id.* at 8:54–59. "[B]ecause the phosphor is used by blending with a resin[,] which makes the . . . coating material 201 (detailed later), color tone of the light emitting diode can be adjusted including white and incandescent lamp color by controlling the mixing proportion with the resin or the quantity used in filling . . . the recess of the casing 204 in accordance to the wavelength of light emitted by the gallium nitride light emitting component [202]." *Id.* at 10:36–44.

[16] Petitioner refers to Shimizu's Figure 2 as showing a "chip-type" package. Pet. 19.

3. Independent Claims 1 and 11

Petitioner asserts that claims 1 and 11 are anticipated by Okamoto and would have been obvious over Okamoto and Shimizu. Pet. 30–52.

a. Anticipation by Okamoto

Petitioner points to Okamoto's glass substrate 2 as disclosing the claimed "transparent plate" and Okamoto's lead frame 8 and wiring pattern 6 as disclosing the claimed "lead frame." Pet. 31–32 (citing Ex. 1008, Figs. 1, 6, ¶¶ 27, 29, 34, 37; Ex. 1003 ¶ 116). In the Reply, Petitioner explains that "[u]nder the Board's construction," Okamoto discloses the recited lead frame because "the transparent plate is part of the lead frame." Reply 17.

Petitioner further contends that Okamoto's lead frame 8 and glass substrate 2 "form a support structure" for LED 3. Pet. 37. According to Petitioner, Figures 1, 6, and 8 of Okamoto show "the blue LED chip is mounted on the transparent plate, and the portion of the leads that stick out of the plate-containing package are used to mount the package within a larger device." *Id.* (citing Ex. 1008, Figs. 1, 6, 8, ¶¶ 32, 34, 37). Petitioner also provides testimony from Dr. Dupuis supporting these assertions. Ex. 1003 ¶¶ 120–121.

We agree that Okamoto shows the claimed lead frame, as a whole, providing support to the LED chip as required by claims 1 and 13. As shown in Okamoto's Figure 1, reproduced above, "lead frame 8 is attached to the wiring pattern 6 drawn around an end of the glass substrate 2 with a solder material 9." Ex. 1008 ¶ 29. According to Patent Owner, Okamoto's transparent plate "supports the lead frame," (PO Resp. 10) and as agreed upon by the parties, the claimed lead frame *includes* the transparent plate.

Okamoto also discloses that the LED chip is on transparent glass substrate 2. *Id.* ¶ 27 (stating that LED elements "are disposed in a row on a front face of a light-transmissive glass substrate 2."). Based on this disclosure, we find Okamoto teaches or suggests a lead frame that includes a transparent plate supporting an LED chip.

Okamoto's Figure 8, reproduced above, shows Okamoto's device installed in an upright, vertical position. Petitioner points to this figure as showing that Okamoto's leads, in addition to the lead frame as a whole, provide support to the LED chip. Pet. 33; Reply 17–20. Patent Owner disagrees stating that "[i]t is not clear whether light source device 1 or the component identified by Petitioner as the lead frame are above, rest upon, or are embedded into the lower portion 21" and "[i]t is far more reasonable to conclude that the larger, more substantial light-transmissive molded body 10 holds the device in place." PO Resp. 10–11.

Under our adopted construction, because we find that Okamoto's Figure 1 discloses the transparent plate portion of the lead frame supporting an LED chip, it is unnecessary that Okamoto's Figure 8 also include evidence of the leads themselves providing support. However, we agree with Petitioner that Figure 8 includes additional evidence that Okamoto's leads provide at least some support to the LED chip. Neither party quantifies the amount of support that must be given by the lead frame to the LED chip. It is apparently enough that *any* amount of support is provided by the lead frame.[17] Whether or not lower portion 21 provides a portion of the

[17] This issue was explicitly discussed in the hearing for related cases IPR2020-00579 and -00695, which both parties agree involve patents requiring the same construction of "lead frame" as the '464 patent. *See* Tr.

support for the LED chip, we find Figure 8 suggests that lead frame 8 provides at least some support as well. Indeed, Okamoto explicitly refers to its leads as a "lead frame," which both parties agree a person of ordinary skill in the art would understand provides support to the LED chip.[18] *See, e.g.*, PO Resp. 3; Reply 3.

Accordingly, on the complete record, we find that Okamoto teaches each limitation as recited in claims 1 and 11.

b. Obviousness over Okamoto and Shimizu

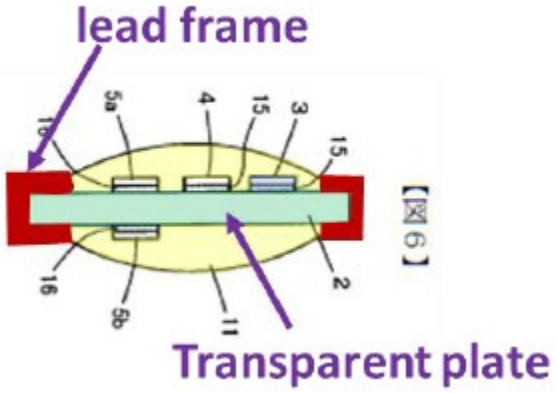
For this ground, Petitioner relies on Okamoto for most of the limitations recited in claims 1 and 11. Pet. 43–52. Petitioner explains that under the "traditional" construction of "lead frame," which does not include a transparent plate, "the transparent plate is located *in* the conductive structure that connects the LED chip to an outside circuit, but the transparent

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35:5–6 (Patent Owner stating that "my understanding is that lead frame is being construed consistently across all four of the patents."); IPR2020-00579, Paper 36, 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.").

[18] Patent Owner's expert, Dr. Schubert, testifies that "Okamoto actually describes a chip-on-board package design and incorrectly uses the term 'lead frame' as understood by a person of ordinary skill in the art in the context of the '464 Patent." Ex. 2008 ¶ 91. However, Dr. Schubert does not further explain or point to any evidence supporting this contention. *Id.*

plate is not part of that conductive structure." [19] Pet. 39–40. Based on this construction, Petitioner concedes that Okamoto's device has a "lead frame *on* its transparent plate, rather than the transparent plate being *in* the lead frame." *Id.* at 40 (citing Ex. 1008 ¶¶ 34, 36). Thus, Petitioner turns to Shimizu as showing a transparent plate *in* a lead frame. *Id.* at 41–42 (citing Ex. 1017, Fig. 2). To demonstrate the results of combining Okamoto and Shimizu, Petitioner creates a modified version of Okamoto's Figure 6, as reproduced below.



Pet. 43. Petitioner explains that the modified version of Okamoto's figure shows that "it would have been simple for a POSITA to replace Okamoto's 'lead-type' lead frame with a 'chip-type' lead frame, such as Shimizu's, such

[19] As discussed above, we do not adopt the "traditional" construction of "lead frame." Moreover, because Petitioner and its expert make clear that this statement is dependent on using the "traditional" construction of "lead frame" (*see, e.g.,* Ex. 1003 ¶¶ 142–143), this statement does not impact the other portions of Dr. Dupuis's testimony in which he explains that Okamoto does show a lead frame under a construction, like the one adopted here, that includes a transparent plate. Ex. 1003 ¶¶ 115–124.

that the two halves of the lead frame (highlighted *Red*) surround either side of Okamoto's glass plate (highlighted *Green*)." *Id.* at 43.

To explain that a person of ordinary skill in the art would have been motivated to combine Shimizu's chip-type package with Okamoto, Petitioner points to Okamoto's vertically oriented embodiment. *Id.* at 40 (citing Ex. 1008, Figs. 8–9). Because this embodiment includes "four legs of the lead frame extending from the base of the light," Petitioner asserts that "this type of lead frame is cumbersome to implement in some applications." *Id.* at 41 (citing Ex. 1003 ¶¶ 148–149). According to Petitioner, a person of ordinary skill would find Shimizu's "chip-type" package "useful in combination with the LED arrangement shown by Okamoto to facilitate less cumbersome interconnections and alternative packages and device orientations, such as where a lower-profile package is needed." *Id.* at 42 (citing Ex. 1003 ¶¶ 148–155; Ex. 1017, Fig. 2).

Patent Owner argues that the combination of Okamoto and Shimizu does not properly show the recited "lead frame." PO Resp. 15–19. This argument, however, relies on Patent Owner's proposed construction of the term "lead frame" that requires at least one of the leads included in the lead frame to provide support to the LED chip. *See id.* at 13 ("Shimizu describes the 'metal terminals 205 installed on the casing 204' indicating that the metal terminals are not providing structural support to the casing 204."), 14 ("[I]t was also well-known that [thin metal traces] would be too thin to provide structural support to either the LED chip or the substrate."). As discussed above, however, we do not construe the term lead frame to require that any particular element, including any leads, provide independent support for the LED, but that the lead frame, as a whole, supports the LED.

As shown in Petitioner's modified Figure 6, the LED sits on the transparent plate, which in turn, sits in between the leads. *See* Pet. 43. Thus, we find that the lead frame of this modified device, consisting of the leads and the transparent plate, provides support to the LED.

Patent Owner also contends that modifying Okamoto using Shimizu's Figure 2 embodiment would not result in the modified Figure 6 depicted by Petitioner because extending wiring patterns 6 to wrap around the edge of substrate 2 would result in wiring patterns only on the left side of Petitioner's modified figure. PO Resp. 15–16 (citing Ex. 2008 ¶¶ 98–111). According to Patent Owner, the modified LED has electrical terminals on two sides of the device and cannot be plugged into a receptacle as indicated in Okamoto's Figure 8. *Id.* at 16.

Petitioner contends that this argument does not address the actual obviousness contention made in the Petition. Reply 14. Instead, Petitioner states that "Petitioner did not argue that a POSITA would extend Okamoto's wiring 'around one edge of substrate 2,'" but "argued that a POSITA would use a different, but commonly-known lead frame arrangement, disclosed in Shimizu, with Okamoto's LED and transparent glass plate." *Id.* (citing Pet. 43). We agree that the Petition does not contend that Okamoto's modified device would be plugged into a receptacle as in Figure 8. *See* Pet. 40–41 (noting that the arrangement of Okamoto's device in Figure 8 "is cumbersome to implement in some applications" and a person of ordinary skill in the art "would know that alternative LED packages existed."); Ex 1003 ¶¶ 148–149. Moreover, Petitioner's modification is not limited to physically extending wires such that they only wrap around the left side of substrate 2. *See* Pet. 43; *MCM Portfolio LLC v. Hewlett-Packard Co.*, 812

F.3d 1284, 1294 (Fed. Cir. 2015) ("The test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference." (quoting *In re Keller*, 642 F.2d 413, 425 (CCPA 1981)); *In re ICON Health & Fitness, Inc.*, 496 F.3d 1374, 1382 (Fed. Cir. 2007) ("[W]e do not ignore the modifications that one skilled in the art would make to a device borrowed from the prior art."); *In re Sneed*, 710 F.2d 1544, 1550 (Fed. Cir. 1983) ("[I]t is not necessary that the inventions of the references be physically combinable to render obvious the invention under review.").

Patent Owner also asserts that "Petitioner fails to explain how its proposed modification of wrapping the wiring pattern 6 around the ends of the substrate results in a lower-profile." PO Resp. 13. According to Patent Owner, "Okamoto already provides the alleged lower-profile benefits of Shimizu, as seen by comparing figure 2 of each reference." *Id.* at 14. Dr. Dupuis supports Petitioner's contention by stating that a person of ordinary skill in the art would know to use a "chip-type" package instead of a "lead-type" package in applications where a lower profile is needed. Ex. 1003 ¶¶ 149–150 (citing Ex. 1017, 8:31–67; Ex. 1016 Fig. 1, 33–35; Ex. 1022 Figs. 1–3, 6–8, 13, ¶¶ 2–14). According to Patent Owner, Figure 2 of Okamoto "already provides the alleged lower-profile benefits of Shimizu." PO Resp. 18. Okamoto, however, states that Figure 2 is "a planar view of the light source device of" Figure 1. Ex. 1008 ¶ 43. And Figure 1 of Okamoto, reproduced above, clearly shows protruding lead frame 8. *Id.* at Fig. 1, ¶ 29. Figure 2 of Okamoto, however, does not show lead frame 8. *See id.* at Fig. 2. Thus, we do not agree with Patent Owner that Figure 2 of Okamoto shows a package with a lower profile. Instead, the record supports

Petitioner's position that the modified device created using the disclosures of Okamoto and Shimizu has a lower profile (leads wrapped around substrate 2 as opposed to protruding as shown by Okamoto Figures 1 and 8). *See* Pet 42–43; Ex. 1003 ¶¶ 148–155.

Patent Owner argues that "Petitioner ignores Dr. Schubert's explanation that Shimizu was directed towards general illumination, while Okamoto is directed towards a signaling light source" so a person of ordinary skill would not combine the two references. Sur-Reply 16 (citing Ex. 1044, 93:15–96:13). Because we do not see this argument in Patent Owner's Response Brief, nor do we see anything in Dr. Schubert's declaration to support such an argument, we do not agree that Petitioner improperly failed to respond to an argument. *See* PO Resp. 12–21; Ex. 2008 ¶¶ 112–120. Moreover, we find that both Shimizu and Okamoto disclose methods of creating white light using an LED and, therefore, the evidence supports a finding that both references are relevant to a consideration of obviousness. *See In re Oetiker*, 977 F.2d 1443, 1447 (Fed. Cir. 1992) ("In order to rely on a reference as a basis for rejection of the applicant's invention, the reference must either be in the field of the applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the inventor was concerned.").

In sum, on the complete record, we find that the combination of Okamoto and Shimizu teaches each limitation of claims 1 and 11, and we find that an ordinarily skilled artisan would have had reasons, with rational underpinning, to combine Okamoto and Shimizu.

4. Claims 2 and 12

Petitioner asserts that claims 2 and 12 would have been obvious over Okamoto and Shimizu. Pet. 52–58. Claim 2 depends from claim 1, and claim 12 depends from claim 11. Both recite "further comprising a phosphor for converting a wavelength of the light." Ex. 1001, 15:34–35, 16:22–23.

Patent Owner argues that a person of ordinary skill in the art would not have been motivated to combine Okamoto and Shimizu because the person of ordinary skill would have understood that "Okamoto was capable of generating white light using the dispersant of Okamoto's embodiment, without the need for a phosphor, if white light was the desired output." PO Resp. 17 (citing Ex. 2001 ¶¶ 86–90). According to Patent Owner, "[t]his is particularly true given that Shimizu recognizes even its improved phosphors were subject to degradation." *Id.* (citing Ex. 1017, 3:51–58); Sur-Reply 16–17. Patent Owner contends that a person of ordinary skill in the art "starting with Okamoto who desired white light would be motivated to adjust the parameters of Okamoto's embodiment to obtain it, rather than first modifying the multicolored LEDs of Okamoto, then adding a phosphor and having to address the concern of phosphor degradation," which modification would cause Okamoto to lose "the capability of emitting a single-color light (R, G, or B)." PO Resp. 20–21 (citing Ex. 2008 ¶¶ 112–120); Sur-Reply 17.

Even if, as Patent Owner contends, a person of ordinary skill in the art would have understood that "white light can be created by combining the three primary colors of light" (PO Resp. 19), we are not persuaded that a person of ordinary skill in the art would have lacked a motivation to use one of the three disclosed LEDs (the blue LED) with phosphor to create white

light as disclosed by Shimizu. Ex. 1017, 4:50–67. Petitioner provides evidence that "it was common well before the priority date of the '464 patent to use appropriate phosphors in combination with blue LEDs to create white light." Pet. 54–55 (citing Ex. 1007, 246, 248; Ex. 1003 ¶¶ 190–195; Ex. 1006); Ex. 1044, 100:23–103:10 (Dr. Schubert acknowledging that using Shimizu's phosphor technique was well known and commonly used to create white light at the relevant time).

In response, Patent Owner provides testimony from Dr. Schubert that a person of ordinary skill in the art would not have been motivated to combine Shimizu's technique because "Shimizu discloses that its own improved phosphors deteriorate over time . . . causing color shifts and decreased luminance." *Id.* ¶ 119 (citing Shimizu 3:22–62).

Nothing in Shimizu or Dr. Schubert's testimony, however, overcomes the guidance from *KSR* that "if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 401 (2007). We find that the record evidence shows a person of ordinary skill in the art would naturally look to Shimizu's well-known and commonly used technique of using phosphor to create white light instead of combining the lights of Okamoto. *See ICON*, 496 F.3d at 1380 ("One skilled in the art would naturally look to prior art addressing the same problem as the invention at hand."). Moreover, even though Shimizu itself acknowledges there are some potential problems with using its phosphor technique, these issues would not discourage one of ordinary skill in the art from using that technique, which Shimizu itself prefers. Ex. 1017

1:31–3:21; *see Optivus Tech., Inc. v. Ion Beam Applications S.A.*, 469 F.3d 978, 989–90 (Fed. Cir. 2006) (finding that one of ordinary skill in the art would still be motivated to combine two references even though a direct combination would result in a "death ray" instead of a cancer treatment device).

In sum, on the complete record, we find that the combination of Okamoto and Shimizu teaches each limitation of claims 2 and 12, and we find that an ordinarily skilled artisan would have had reason, with rational underpinning, to combine Okamoto and Shimizu.

5. Claims 9 and 19

Petitioner asserts that claims 9 and 19 are anticipated by Okamoto and would have been obvious over Okamoto and Shimizu. Pet. 30–52. Claim 9 depends from claim 1, and claim 19 depends from claim 11. Both recite "wherein the LED chip includes a transparent substrate positioned adjacent the transparent plate." *Id.* at 16:4–5, 16:43–44.

The Petition relies for this limitation on Okamoto's disclosure of its LED chip including a "transparent substrate, such as one made from sapphire" that is mounted to the glass plate. Pet. 38, 51–52 (citing Ex. 1008 ¶¶ 31–32; Ex. 1003 ¶¶ 137, 181–182). We credit Dr. Dupuis's uncontroverted testimony and find that Okamoto teaches the additional limitation of claims 9 and 19.

In sum, on the complete record, we find that Okamoto teaches each limitation as recited in claims 9 and 19. Thus, we determine that claims 9 and 19 are anticipated by Okamoto and would have been obvious over the combination of Okamoto and Shimizu.

6. Overview of Lester

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.

7. Overview of Tadatomo

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. Tadatomo reports that a patterned sapphire substrate "is very effective in reducing the dislocation density and for increasing the extraction efficiency due to the multiple scattering of the emission light at the GaN/ patterned sapphire interface." *Id.* at 243.

8. Claims 8, 10, 18, and 20

Petitioner asserts that claims 8, 10, 18, and 20 would have been obvious over the combined teachings of Okamoto, Shimizu, and Lester, or Okamoto, Shimizu, and Tadatomo. Pet. 59–81. Claim 8 depends from

claim 1, and claim 10 depends from claim 9. Claim 18 depends from claim 11, and claim 20 depends from claim 19. Claims 8 and 18 recite "wherein one or more surfaces of the LED chip are roughened, textured or patterned to increase the light extraction from the LED chip." Ex. 1001, 16:1–3, 16:7–9. Claims 10 and 20 recite "wherein the transparent substrate is a roughened, textured, or patterned, to increase extraction of the light from the LED chip." *Id.* at 16:40–42, 16:46–48.

According to Petitioner, a person of ordinary skill in the art "would have been motivated to and would have found it obvious to use conventional sapphire substrate roughening and/or texturing with Okamoto's GaN LEDs as shown by Lester and Tadatomo" "so as to enhance light extraction." Pet. 59 (citing Ex. 1003 ¶¶ 64, 83, 88–91; Ex. 1007, 122–23). Petitioner also asserts that a person of ordinary skill in the art "would reasonably expect to succeed in implementing these enhancements because these features were well-known and within [their] skillset." *Id.* at 62 (citing Ex. 1003 ¶ 220; Ex. 1007, 122–23; Ex. 1030, 7:12–13, Fig. 3; Ex. 1019; Ex. 1020; Ex. 1005, 924; Ex. 1028, 857).

Patent Owner argues that a person of ordinary skill in the art would not have combined Lester or Tadatomo with Okamoto because of "an important difference between these [two] references." PO Resp. 21. Specifically, according to Patent Owner, both Lester and Tadatomo disclose devices in which "light is only extracted from one side of the LED," but Okamoto has an LED package "where light is intended to be emitted from both sides." *Id.* at 21–22. 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 22–23 (citing Ex. 1003 ¶¶ 121–129).

Petitioner disputes that this difference is relevant stating that "the fact that Okamoto teaches emitting light omnidirectionally means that at least some light will be emitted through the substrate interface," and because "Lester/Tadatomo teach how to reduce internal reflection at a substrate interface," they "teach techniques that would reduce internal reflections at [Okamoto's] interface." Reply 23–24 (citing Pet. 59–64). Dr. Dupuis testifies that a person of ordinary skill in the art would have known about surface roughening and would have wanted to increase performance by implementing these techniques with Okamoto's GaN LED. Ex. 1003 ¶ 218 (citing Ex. 1030, Fig. 3, 7:12–13; Ex. 1020, 247; Ex. 1007, 122; Ex. 1005, Fig. 8, 7:46–59, 2:65–3:20; Ex. 1019, 3:10–4:26; Ex. 1028, 857; Ex. 1029, L1084).

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 Okamoto's device and would have been motivated to combine these teachings to increase performance of the LED device.

On the one hand, Dr. Schubert testifies that "[c]ombining Okamoto with Lester and Tadatomo still reflects light . . . into the active/absorbing layer of the LED chip, falling short of the invention claimed by the '464 patent." Ex. 2008 ¶ 127 (quoting Ex. 1001, 8:18–47). In addition, Dr. Schubert states that "the '464 Patent teaches that it extracts light *through* the roughened surfaces, not *away from* the roughened surfaces, as taught by Lester." *Id.* ¶ 128 (quoting Ex. 1019, 10:66–11:7) (emphasis added).

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 "would not understand that feature of contrasting disclosures (Okamoto on one hand, and Lester and Tadatomo on the other hand) could be combined." *Id.* ¶ 126.

On the other hand, Dr. Dupuis points to objective evidence that supports his conclusions. For example, Dr. Dupuis points (Ex. 1003 ¶ 218) to Krames, a patent issued July 14, 1998, that describes an LED device "wherein the top and back surfaces . . . are textured" to "improve the extraction of first-pass light." Ex. 1005, Fig. 8, 2:65–3:4, 7:46–48. Similarly, Fujii, titled "Increase in the Extraction Efficiency of GaN-Based Light-Emitting Diodes via Surface Roughening," published in 2003, states:

> In conclusion, an anisotropic etching method has been applied to a GaN-based LED for the purpose of increasing extraction efficiency. LED output test results have indicated that, presumably due to the decrease in light propagation in the GaN film, there is a relationship between a roughened appearance and extraction efficiency. Although total integrated optical power has not been measured, the extraction efficiency from a top surface was increased twofold to threefold compared to that of an LED before roughening. It is notable that the technique mentioned in this paper is simple and does not require complicated processes, implying that it will be suitable for manufacturing of GaN-based LEDs with surface roughening.

Ex. 1028, 857; *see also* Ex. 1029 (Narukawa), L1084. This is objective evidence that a person of ordinary skill in the art at the relevant time would have understood that applying Lester's or Tadatomo's techniques to an LED device, no matter the configuration of light emission, would improve

efficiency of light extraction. In addition, Dr. Dupuis refers (Ex. 1003 ¶ 218) to a 2003 textbook by Dr. Schubert stating generally that "[o]ther efficient ways to increase the light extraction efficiency include the use of *roughened* or *textured semiconductor surfaces*." Ex. 1007, 122. And Dr. Schubert confirms this understanding in his deposition. Ex. 1044, 87:21–91:6.

On balance, the record evidence supports Petitioner's position and we find that (1) the combination of Okamoto, Shimizu, and Lester or Okamoto, Shimizu, and Tadatomo teaches each limitation of claims 8, 10, 18, and 20, (2) an ordinarily skilled artisan would have had reasons, with rational underpinning, to combine the references, and (3) the ordinarily skilled artisan would have had a reasonable expectation of success.

D. Grounds Based on Miyahara

Petitioner contends that: (1) claims 1, 2, 11, and 12 of the '464 patent are unpatentable because their subject matter is anticipated by Miyahara; (2) claims 2, 9, 12, and 19 would have been obvious over Miyahara; (3) claims 8, 10, 18, and 20 would have been obvious over Miyahara and Lester; and (4) claims 8, 10, 18, and 20 would have been obvious over Tadatomo. Pet. 4–5, 64–83. For the reasons that follow, we determine that Petitioner establishes these grounds of unpatentability by a preponderance of the evidence.

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.

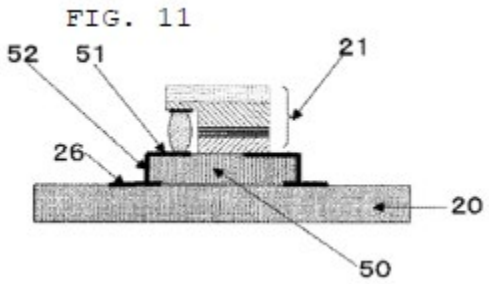


Figure 11 of Miyahara is "a cross-sectional diagram[] showing the substrate for mounting a light-emitting element." *Id.* ¶ 19. Light-emitting element 21 is mounted on submount 50, which in turn is mounted on the substrate for mounting a light-emitting element 20. *Id.* ¶ 31. Substrate 20 and light-emitting 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. Independent Claims 1 and 11

Petitioner contends that independent claims 1 and 11 are anticipated by Miyahara. Pet. 64–78. 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. 67–68 (citing Ex. 1011 Fig. 11, ¶¶ 31, 121).

Patent Owner argues that Miyahara fails to disclose "that the leads provide support to the LED chip." PO Resp. 24. 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. 24–26. 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.* at 25. Patent Owner adds that "a POSITA would understand even a thick film metallization would not provide structural support in Figure 11." *Id.*

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. 27. We also noted that "Patent Owner appears to agree that submount 50 supports the LED." *Id.* (citing Prelim. Resp. 24). 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. 26 (citing Ex. 2008 ¶¶ 130–136).

Because, as discussed above, we do not agree with Patent Owner's assertion that the leads of the lead frame are required to provide 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 1 and 11. In fact, Dr. Schubert agrees that "[i]n Figure 11, substrate 20 and submount 50 provide the structural support to the LED chip." Ex. 2008 ¶ 134.

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 of claims 1 and 11 by Miyahara.

3. Claims 2 and 12

Petitioner asserts that claims 2 and 12 are anticipated by and would have been obvious over Miyahara. Pet. 75–78. Claim 2 depends from claim 1, and claim 12 depends from claim 11. Both recite "further comprising a phosphor for converting a wavelength of the light." Ex. 1001, 15:34–35, 16:22–23.

Petitioner relies on Miyahara as disclosing "that phosphors may be used with any of its embodiments to convert light into any desired color, including white light." Pet. 75 (citing Ex. 1011 ¶¶ 2, 9, 23). According to Petitioner, a person of ordinary skill in the art "would have understood—particularly because of Miyahara's teaching that phosphors may be used on any of its embodiments to convert light into white light—that the LED chip of Fig. 11 may be sealed with a resin that included phosphor for the purpose of converting emitted light from blue to white." *Id.* at 77.

Patent Owner relies on the same argument, that Miyahara does not disclose a lead frame, as for claims 1 and 11. For the stated reasons, we do not agree with Patent Owner's proposed construction of "lead frame." Accordingly, after review of the testimonial evidence, and the disclosure of Miyahara, we determine that the record provides substantial evidence supporting Petitioner's assertions of anticipation by Miyahara and obviousness over Miyahara of claims 1 and 11.

4. Claims 9 and 19

Petitioner asserts that claims 9 and 19 would have been obvious over Miyahara. Pet. 78–81. Claim 9 depends from claim 1, and claim 19

depends from claim 11. Both recite "wherein the LED chip includes a transparent substrate positioned adjacent the transparent plate." Ex. 1001, 16:4–5, 16:43–44.

In the Petition, based on its proposed construction of "lead frame"—where the transparent plate was not a part of the lead frame—Petitioner asserted that Figure 11 of Miyahara discloses a transparent substrate above the LED and "adjacent (but not immediately adjacent)" transparent submount 50. Pet. 78. Petitioner thus asserted that a person of ordinary skill in the art would have known that the arrangement of the LED chip in Figure 11 could be used in a different orientation such as shown in Figure 7 of Miyahara where the LED substrate is located below instead of on top of the device (a "flip-chip" orientation) resulting in the transparent substrate being immediately adjacent to transparent submount 50. *Id.* at 79–80.

Subsequently, based on the claim construction we adopted in the Institution Decision, and continue to maintain here, Petitioner explains that this modification of orientation is no longer necessary. Reply 27–28. Instead, Figures 7 and 11 of Miyahara expressly disclose lead frames that include a transparent substrate/submount (e.g., submount 50), and the transparent substrate/submount is immediately adjacent transparent plate 20. *Id.* (citing Ex. 1011, Figs. 7, 11). We agree that Figures 7 and 11 of Miyahara show a transparent substrate/submount adjacent transparent plate 20 as recited in claims 9 and 19.

Patent Owner argues that Petitioner has not properly shown that Miyahara discloses a lead frame. Sur-Reply 20–21. Because we do not adopt Patent Owner's proposed construction of "lead frame," as discussed

above, we find that Miyahara discloses a lead frame which includes transparent plate 20.

Accordingly, having reviewed Petitioner's contentions, the testimonial evidence, and the disclosure of Miyahara, we determine that the record provides substantial evidence supporting Petitioner's assertions of obviousness of claims 9 and 19 over Miyahara.

5. Claims 8, 10, 18, and 20

Petitioner asserts that claims 8, 10, 18, and 20 would have been obvious over the combined disclosures of Miyahara and Lester or Miyahara and Tadatomo. Pet. 81–83. Claim 8 depends from claim 1, and claim 10 depends from claim 9. Claim 18 depends from claim 11, and claim 20 depends from claim 19. Claims 8 and 18 recite "wherein one or more surfaces of the LED chip are roughened, textured or patterned to increase the light extraction from the LED chip." Ex. 1001, 16:1–3, 16:7–9. Claims 10 and 20 recite "wherein the transparent substrate is a roughened, textured, or patterned, to increase extraction of the light from the LED chip." *Id.* at 16:40–42, 16:46–48.

Petitioner relies on the same portions of Lester and Tadatomo as in the grounds based on Okamoto and Shimizu. Pet. 81–83. According to Petitioner, a person of ordinary skill in the art "would have been motivated to and would have found it obvious to use roughened/patterned substrates in Okamoto's GaN LEDs to increase light extraction, as expressly taught by Lester-085 and/or Tadatomo," and "would have also been motivated to and found it obvious to use conventional sapphire substrate roughening and/or texturing with Miyahara's GaN LEDs." *Id.* at 81–82 (citing Ex. 1003 ¶ 292).

Patent Owner also relies on the same argument made for the ground based on Okamoto and Shimizu that a person of ordinary skill in the art would not have combined Lester or Tadatomo with Miyahara because of the differences in the devices in those references. PO Resp. 29. For the same reasons as discussed above, 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 Miyahara's device and would have been motivated to combine these teachings to increase performance of the LED device. Ex. 1003 ¶¶ 291–302.

IV. CONCLUSION[20]

Based on the full record, we determine that Petitioner shows by a preponderance of the evidence that claims 1, 2, 8–12, and 18–20 of the '464 patent are unpatentable.

Claim(s)	**35 U.S.C. §**	**Reference(s)/Basis**	**Claims Shown Unpatentable**	**Claims Not Shown Unpatentable**
1, 9, 11, 19	102(b)	Okamoto	1, 9, 11, 19	
1, 2, 9, 11, 12, 19	103(a)	Okamoto, Shimizu	1, 2, 9, 11, 12, 19	

[20] 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).

8, 10, 18, 20	103(a)	Okamoto, Shimizu, Lester	8, 10, 18, 20	
8, 10, 18, 20	103(a)	Okamoto, Shimizu, Tadatomo	8, 10, 18, 20	
1, 2, 11, 12	102	Miyahara	1, 2, 11, 12	
2, 9, 12, 19	103(a)	Miyahara	2, 9, 12, 19	
8, 10, 18, 20	103(a)	Miyahara, Lester, Tadatomo	8, 10, 18, 20	
8, 10, 18, 20	103(a)	Miyahara, Tadatomo	8, 10, 18, 20	
Overall Outcome			1, 2, 8–12, 18–20	

V. ORDER

Accordingly, it is:

ORDERED that, pursuant to 35 U.S.C. § 314(a), Petitioner has shown by a preponderance of the evidence that claims 1, 2, 8–12, and 18–20 of the '464 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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