

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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WOLFSPEED, INC. and IDEAL INDUSTRIES LIGHTING, LLC d/b/a  
CREE LIGHTING

,  
Petitioner,

v.

CAO LIGHTING, INC.,  
Patent Owner.

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IPR2022-00848  
Patent 6,634,770 C3

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Before GRACE KARAFFA OBERMANN, CHRISTOPHER M. KAISER,  
and BRIAN D. RANGE, *Administrative Patent Judges*.

RANGE, *Administrative Patent Judge*.

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

## I. INTRODUCTION

Wolfspeed, Inc. and IDEAL Industries Lighting, LLC d/b/a Cree Lighting (“Cree”) (collectively, “Petitioners”) filed a Petition requesting *inter partes* review of claims 18, 22, 25, 26, 28–30, 32–36, 40–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91 (the “Challenged Claims”) of U.S. Patent No. 6,634,770 C3 (Ex. 1001, “the ’770 patent”). Paper 1 (“Pet.”). We instituted *inter partes* review of the challenged claims on all asserted grounds. Paper 10 (“Dec”). After institution, Patent Owner filed a Patent Owner Response (Paper 31, “Resp.”), Petitioner filed a Reply (Paper 42, “Reply”), and Patent Owner filed a Sur-Reply (Paper 46, “Sur-Reply”). An oral hearing was held on July 18, 2023, and a transcript of the hearing is included in the record (Paper 59, “Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This decision is issued pursuant to 35 U.S.C. § 318(a). For the reasons that follow, we determine that Petitioner has shown, by a preponderance of the evidence, that claims 21, 22, 25, 26, 28–30, 32–36, 40, 42–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 71–73, 77, 78, 81, 82, 85, 86, and 88–91 of the ’770 patent are unpatentable. We determine that Petitioner has not shown, by a preponderance of the evidence, that claim 41 is unpatentable.

## II. BACKGROUND

### A. *Related Matters*

The parties indicate that the ’770 patent is the subject of the following district court proceedings: *CAO Lighting, Inc. v. Cree, Inc. et al.*,<sup>1</sup> No. 1:21-

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<sup>1</sup> Petitioner states that “Cree, Inc., a named defendant in the Underlying Litigation, is now Wolfspeed, Inc.” Pet. 115 n.3.

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cv-00634 (M.D.N.C.) (“the parallel district court litigation”). Pet. 115; Paper 4, 1. Patent Owner also identifies the following proceedings as related matters: *CAO Group v. GE Lighting et al.*, 2-11-cv-00426 (District of Utah), *CAO Lighting, Inc. v. GE Lighting, Inc.*, No. 1:20-cv-00681 (D. Del.), *Inter Partes* Reexamination Control No. 95/000,678, *inter partes* Reexamination Control No. 95/002,242, and *Ex Parte* Reexamination Control No. 90/012,959. Paper 4, 1.

### *B. The '770 Patent*

The '770 patent originally issued with claims 1–17. Ex. 1001, 9:52–12:20. Claims 1–6, 8, 10–15, and 17 were disclaimed during a first reexamination. *Id.* at Dec. 3, 2013, *Inter Partes* Reexamination Certificate (“IPRC”) 1:12–13. Claims 7, 9, and 16 were cancelled in a third reexamination, and claims 18–96 were added. *Id.* at Sept. 8, 2014, *Ex Parte* Reexamination Certificate (“EPRC”) 1:26–8:41.

The '770 patent is titled “Light Source Using Semiconductor Devices Mounted on a Heat Sink.” *Id.* at code (54). According to the '770 patent, “[p]rior art semiconductor light sources have not been successfully and economically used to illuminate physical spaces.” *Id.* at 1:19–21. The '770 patent states “[t]ypical prior art LED modules lack high light intensity due to the size of the LED chips used.” *Id.* at 1:23–25. In view of this, the '770 patent states there is a need “in the prior art for a semiconductor light source for use in illuminating a space with single color light in the visible range and which can efficiently dissipate the heat that they produce.” *Id.* at 1:46–49.

We reproduce Figure 1 of the '770 patent below.

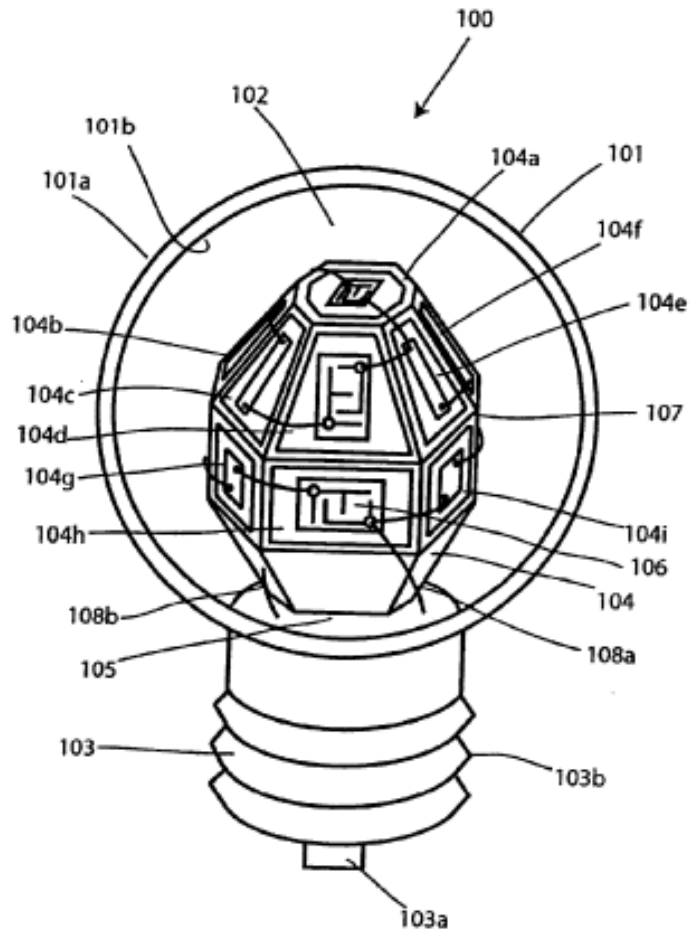


**Fig. 1**

Figure 1 shows a semiconductor light source that uses a high power chip or array arrangement. *Id.* at 1:65–67. Semiconductor light source 100 includes enclosure 101 having interior volume 102. *Id.* at 2:49–52, 3:9. Enclosure 101 may be mounted to support 105. *Id.* at 3:15. Semiconductor light source 100 further includes base 103, which “may be configured as a fitting or connector for use in a desired light socket.” *Id.* at 3:15–18. Heat sink 104 is further located within interior volume 102. *Id.* at 3:22–23. The ’770 patent describes heat sink 104 as having “a generally flat or planar top 104a, and a plurality of generally flat or planar panels or compartment 104b, 104c, 104d, 104e, 104f, 104g, 104h, 104i, etc. each of which may host a single or an

array of semiconductor devices capable of producing light.” *Id.* at 3:24–29. In addition, at least one semiconductor device 106 is mounted on heat sink 104. *Id.* at 3:37–38. The ’770 patent describes the use of “high power” LEDs by stating that “[h]igh power’ LED’s means that the light output from each LED module is greater than 40 milliwatts.” *Id.* at 4:6–7.

We reproduce Figure 3d of the ’770 patent below.

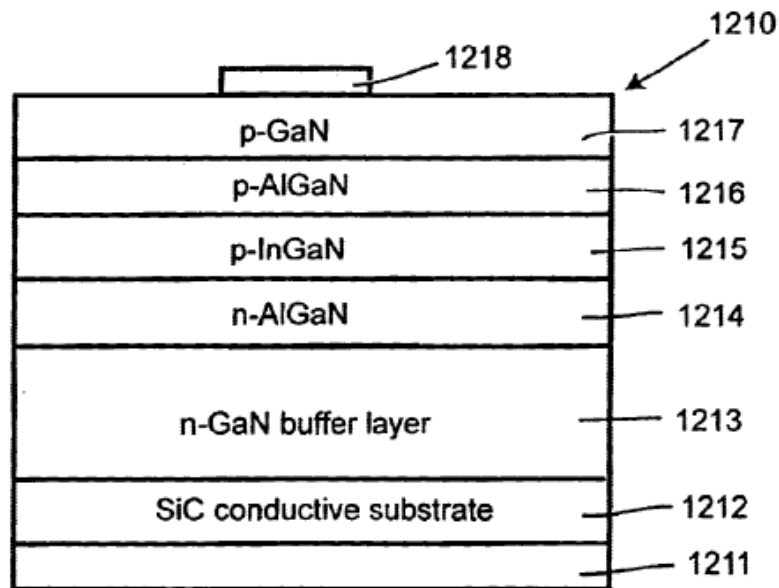


**Fig. 3d**

Figure 3d illustrates an LED structure on a sapphire substrate. *Id.* at 2:9–10. The structure includes electrically conductive substrate 1212, buffer layer 1213, cladding layer 1214, active layer 1215 where energy is converted to light, cladding layer 1216, and contact layer 1217. *Id.* at 5:11–20.

### *C. Illustrative Claims*

Petitioner challenges claims 18, 22, 25, 26, 28–30, 32–36, 40–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91. Pet. 11. Claim 18 depends from claim 9, which was cancelled during reexamination. Ex. 1001, EPRC 1:28. Claim 9 depended from claim 1,

which was also disclaimed. *Id.* at 10:52, EPRC 1:27. The remaining challenged claims directly or indirectly depend from claim 18. EPRC 1:51–8:22. Therefore, we treat claim 18 as the sole independent claim. To reflect claim 18’s full scope, we reproduce claims 1, 9, and 18 below.

1. A semiconductor light source for emitting light to illuminate a space used by humans, the semiconductor light source comprising:

an enclosure, said enclosure being fabricated from a material substantially transparent to white light,

a base to which said enclosure is mounted,

an interior volume within said enclosure,

a secondary heat sink located in said interior volume, said secondary heat sink being capable of drawing heat from one or more semiconductor devices,

a plurality of primary heat sinks mounted on said secondary heat sink, each of said primary heat sinks being smaller than said secondary heat sink,

a semiconductor chip capable of emitting light mounted on one of said primary heat sinks, said semiconductor chip being capable of emitting monochromatic light, said semiconductor chip being selected from the group consisting of light emitting diodes, light emitting diode arrays, laser chips, and VCSEL chips,

said chip including a substrate on which epitaxial layers are grown,

a buffer layer located on said substrate, said buffer layer serving to mitigate differences in material properties between said substrate and other epitaxial layers,

a first cladding layer serving to confine electron movement within the chip, said first cladding layer being adjacent said buffer layer,

an active layer, said active layer emitting light when electrons jump to a valance state,

a second cladding layer, said second cladding layer positioned so that said active layer lies between cladding layers, and

a contact layer on which an electron may be mounted for powering said chip, and

a coating for converting monochromatic light emitted by said chip to white light.

9. A device as recited in claim 1 wherein said substrate is electrically conductive.

18. The semiconductor light source as recited in claim 9 wherein:

said semiconductor chip is a light emitting diode (LED) chip configured to output light at greater than about 40 milliwatts,

said LED chip is surface mounted on said one of said primary heat sinks, and

said LED chip is configured to emit monochromatic visible light.

Ex. 1001, 9:52–10:21, 10:52–53, 32.

*D. Asserted Grounds of Unpatentability*

Petitioner, supported by the declaration of Michael S. Lebby, Ph.D. (Ex. 1006), asserts the following two grounds of unpatentability (Pet. 13):<sup>2</sup>

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<sup>2</sup> The relevant sections of the Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112–29, took effect on March 16, 2013. The application that issued as the ’770 patent was filed before this date. *See* Ex. 1001, code (22). For the purposes of this Decision, pre-AIA statutes apply.

| Claims Challenged                                                                                              | 35 U.S.C. § | References/Basis                                               |
|----------------------------------------------------------------------------------------------------------------|-------------|----------------------------------------------------------------|
| 18, 22, 25, 26, 28–30, 32–36, 40–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, 88–91 | 103(a)      | Begemann, <sup>3</sup> Krames, <sup>4</sup> Allen <sup>5</sup> |
| 18, 22, 25, 26, 28–30, 32–36, 40–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, 88–91 | 103(a)      | Begemann, Sugiura <sup>6</sup> , Allen, Krames                 |

### III. ANALYSIS

#### A. Patent Owner’s Motion to Exclude Exhibit 1028

Patent Owner moves to exclude the Declaration of Michael R. Krames, Exhibit 1028 (“the Krames declaration”). Paper 52, *passim* (“PO Mot.”); *see also* Paper 57 (“Patent Owner Reply in Support of Motion to Exclude”) (“PO Reply”). Petitioner opposes the motion. Paper 53 (“Pet. Opp.”). Patent Owner argues that the Petition is based on the contention that the Krames reference teaches that its LED chip achieves “[a] power output of over 170 mW ... at a drive current of 1.5 A dc.” PO Mot. 3–4 (quoting Pet. 52–53). Patent Owner responded to the Petition, in part, by showing, via expert declarations, that use of the Krames chip at 170 mW with a drive

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<sup>3</sup> WO 00/17569, published March 30, 2000, Ex. 1007 (“Begemann”).

<sup>4</sup> Krames et al., *High-brightness AlGaInN light-emitting diodes*, Proc. SPIE 3938, LIGHT-EMITTING DIODES: RESEARCH, MANUFACTURING, AND APPLICATIONS IV (2000), Ex. 1008 (“Krames”). The publication status of the Krames reference is disputed, and we address that dispute in Section III.E, *infra*.

<sup>5</sup> WO 99/57945, published November 11, 1999, Ex. 1011 (“Allen”).

<sup>6</sup> US 6,015,979, issued January 18, 2000, Ex. 1010 (“Sugiura”).

current of 1.5 A dc “would cause the LEDs and the Begemann device to burn up.” PO Mot. 5 (citing Resp. 33).

Petitioner filed the Krames declaration in support of its Reply. PO Mot. 5; *see also* Reply; Ex. 1028. The Krames declaration states that a person of ordinary skill in the art (“POSITA”) would not have “entertained” a drive current of 1.5 amps in product development, and would instead use lower amperage. PO Mot. 6 (citing Ex. 1028 ¶ 22).

Patent Owner argues that the Krames declaration does not properly address the Patent Owner Response in accordance with 37 C.F.R. § 42.23(b). PO Mot. 9–10. Patent Owner argues that the declaration instead changes “the starting point from Cree’s own Petition.” *Id.* Patent Owner further argues that the Krames declaration is irrelevant, because it does not relate to whether or not a person of ordinary skill in the art “would have been motivated to combine the 1.5/170 milliwatt LED chip from the Krames article with the LED light of Begemann” with “a reasonable expectation of success.” *Id.* at 10–11. Patent Owner also seeks to exclude the declaration pursuant to Federal Rule of Evidence 403 because unfair prejudice outweighs probative value, and under Federal Rule of Evidence 702(d) because Dr. Krames does not apply his principles and methods to the facts of the case. *Id.* at 11–12.

Patent Owner’s argument is unpersuasive because the Krames declaration addresses the Patent Owner Response and is relevant to the issues at hand. We start with an important observation: claim 18 (the only independent claim at issue) is an apparatus claim; the claim is directed to a “semiconductor light source.” Ex. 1001, 9:52, EPRC 1:32. One requirement of this apparatus is that it comprise “a semiconductor chip” (*id.* at 9:66) where “said semiconductor chip is a light emitting diode (LED) chip

configured to output light at greater than about 40 milliwatts.” Ex. 1001, EPRC, 1:34–36. As we explain when addressing claim construction, *infra*, we adopt Patent Owner’s proposed construction (Resp. 14) of “said semiconductor chip is a light emitting diode (LED) chip configured to output light at greater than about 40 milliwatts” as referring to “a semiconductor LED chip *capable of* emitting light greater than about 40 milliwatts.” *See* Section III.D, *infra* (emphasis added).

Because of these recitations, Petitioner bears the burden of establishing that the prior art teaches or suggests a semiconductor LED chip “capable of emitting light greater than about 40 milliwatts.” As explained herein, we determine that in the Petition, Petitioner met this burden by establishing by a preponderance of the evidence that the Krames reference teaches an LED chip that has this capability. Pet. 53 (quoting Ex. 1008, 10). Notably, claim 18 does *not* require actual operation of anything at greater than 40 milliwatts because claim 21 is not a method claim. Petitioner never had a burden of establishing a method of running the Krames reference’s LED at this power output within a semiconductor light source.

Petitioner’s unpatentability grounds are not based upon Krames alone. Pet. 13. Claim 18 is directed to a greater lightbulb structure and also a structure related to the semiconductor chip for the semiconductor light source. Ex. 1001, 9:52–10:21, EPRC 1:32–40. Petitioner relies on Begemann as teaching semiconductor light source aspects aside from structure of the chip. *See, e.g.*, Pet. 31–42. Petitioner relies on Krames as teaching semiconductor chip structure. *See, e.g.*, Pet. 42–54.

Because Petitioner’s unpatentability ground relies on both Krames and Begemann, Petitioner also bears the burden of establishing by a preponderance of the evidence that a person of ordinary skill in the art would

have used Krames's semiconductor chip as the chip in Begemann's lightbulb structure. To meet this burden, Petitioner establishes that Begemann teaches use of an LED chip but does not teach a specific chip. Pet. 27–28 (citing, e.g., Ex. 1007, 2:3–5; 4:30–32). Petitioner also establishes that Krames teaches an appropriate chip that has the same goal as Begemann. *Id.* at 28 (citing, e.g., Ex. 1008, 6; Ex. 1007, 2:3–5). We determine that Petitioner's evidence, absent rebuttal evidence, is sufficient to establish that a person of ordinary skill in the art would have had a “high expectation of success” in mounting Krames's chips as LEDs 4 of Figure 3 of Begemann. *Id.* (citing Ex. 1006 ¶ 86).

Against this backdrop, Patent Owner argues that a person of ordinary skill in the art would *not* have combined Krames's LEDs with Begemann's device. Resp. 30–35. Of particular relevance here, Patent Owner argues that a person of ordinary skill in the art “would not have expected Begemann's heat dissipating structure to be able to handle the heat generated by Krames' higher-powered LEDs.” *Id.* 31–32.

In Reply, Petitioner uses the Krames declaration (Ex. 1028) to argue, for example, that a person of ordinary skill in the art would have used a lower amperage than the 1.5 A dc that Patent Owner's Response focuses on. Reply 6 (citing Ex. 1028 ¶ 22). This use of the Krames declaration is timely because it responds to an argument Patent Owner makes in the Patent Owner Response. 37 C.F.R. § 42.23(b) (“A reply may only respond to arguments raised in ... patent owner response.”).

As to relevancy and whether the Krames declaration is applicable to the facts of this case, the issues at hand are (1) whether or not a person having ordinary skill would have had reason to use the Krames LED with Begemann with a reasonable expectation of success and (2) whether or not

the Krames LED is capable of outputting light at greater than about 40 milliwatts. Again, we emphasize that claim 18 does not recite a method where the LED within the recited semiconductor light source actually outputs greater than about 40 milliwatts.

The Krames declaration is relevant to the facts of this case because the declaration has bearing on whether or not a person of ordinary skill in the art would have combined the Krames reference's LED with Begemann's lightbulb design. *See, e.g.*, Ex. 1028 ¶ 22. Patent Owner argues that evidence must be relevant to motivation to combine "an LED chip from the Krames article (operating at 1.5 amps to produce 170 milliwatts of output)" but claim 21 has no "operating at 1.5 amps to produce 170 milliwatts of output" requirement. What is relevant is that Krames discloses a single chip that has the capability of outputting more or less light depending on operating conditions. Pet. Opp. 3; *see also* Ex. 1008, 8 (providing that Figure 12 of the Krames reference is described as illustrating "[l]ight output vs. current characteristic of a blue ... 1x1 mm<sup>2</sup> AlGaInN LED in a power package, compared to a conventional AlGaInN LED in a 5 mm lamp a package"). Because claim 18 does not require actually running the recited LED at any particular wattage or amperage, it is appropriate for the Krames declaration to rebut Patent Owner's argument that a person of ordinary skill would not have considered using the Krames LED with Begemann at high amperage by explaining that a person of ordinary skill in the art would have considered using the exact same Krames LED with Begemann at a low amperage instead and that this lower amperage would not generate excessive heat. The fact that the Krames LED is configured to run at the high amperage if desired for a different application does not negate the rationale for combining the Krames LED to run at a lower amperage.

With respect to prejudice outweighing probative value, the probative value is high because the Krames declaration directly bears on a key issue: reason to combine with reasonable expectation of success. Also, the prejudice is minimal because Patent Owner could have, in the Patent Owner Response, addressed the general issue of whether a person having ordinary skill in the art would have had reason to combine Begemann's teachings with the Krames reference LED under *any* operating conditions.

In the Reply Brief, Patent Owner argues that the statement of material facts in Patent Owner's motion should be considered admitted because Petitioner did not specifically deny them. PO Reply 2. As explained above, Petitioner refutes Patent Owner's framing of the motion to exclude in relevant respects. Also, 37 C.F.R. § 42.23(a) states, with our emphasis added, that "[a]ny material fact not specifically denied *may* be considered admitted." In the interest of justice, we decline to consider the statement of material facts admitted; *see also* 37. C.F.R. § 42.5(b) ("The Board may waive or suspend a requirement of parts 1, 41, and 42.").<sup>7</sup>

Thus, for the reasons explained above, we deny Patent Owner's motion to exclude Exhibit 1028.

*B. Petitioner's Motion to Exclude Exhibits 2017 and 2030*

Petitioner seeks to exclude Exhibit 2017 as hearsay. Paper 51, 1 ("Pet. Mot."); *see also* Paper 56 (Petitioner's Reply in support of Motion to Exclude). Exhibit 2017 is entitled "SOLID STATE LIGHTING CATALOG," and Patent Owner states that the catalog is from 2015. Resp.

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<sup>7</sup> The parties also dispute whether or not Patent Owner's motion to exclude is procedurally proper. Pet. Opp. 9; PO Reply 4–5. We need not address this issue because we deny the motion to exclude for the reasons we explain here.

48. Patent Owner argues that the catalog shows “expansion and breadth of its patented Dynasty LED lamp business.” *Id.* Patent Owner argues that Exhibit 2017 is an admissible business record. Paper 54, 2–4 (“PO Opp.”).

As explained herein, we ultimately determine that Petitioner meets its burden of establishing by a preponderance of the evidence that claims 18, 22, 25, 26, 28–30, 32–36, 40–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91 of the ’770 patent are unpatentable even if we fully consider Exhibit 2017. Moreover, we determine that Petitioner does not meet its burden of establishing that claim 41 of the ’770 is unpatentable, and our determination would be the same even if we do not consider Exhibits 2017. As such, we dismiss Petitioner’s Motion to Exclude as moot.

### C. *Level of Ordinary Skill in the Art*

In order to determine whether an invention would have been obvious at the time the application was filed, we consider the level of ordinary skill in the pertinent art at the critical time. *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966). The resolution of this question is important because it allows us to “maintain[] objectivity in the obviousness inquiry.” *Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714, 718 (Fed. Cir. 1991). In assessing the level of ordinary skill in the art, various factors may be considered, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field.” *In re GPAC, Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (quotation omitted). Generally, it is easier to establish obviousness under a higher level of ordinary skill in the art. *Innovation Toys, LLC v. MGA Entm’t, Inc.*, 637 F.3d 1314, 1323 (Fed. Cir. 2011) (“A less sophisticated level of skill

generally favors a determination of nonobviousness . . . while a higher level of skill favors the reverse.”).

Petitioner proposes a level of ordinary skill in the art as follows:

As of the ’770 Patent’s claimed priority date (August 24, 2001), a POSITA would have had at least a bachelor’s degree in an engineering discipline with coursework in semiconductors and/or optoelectronics, and three or more years of experience working in the semiconductor and/or optoelectronics fields. Less work experience may be compensated by a higher level of education with the foregoing coursework.

Pet. 19–20 (citing Ex. 1006 ¶ 34). Patent Owner provides a different description of the level of ordinary skill in the art:

The POSITA for the ’770 Patent would have at least a bachelor of science degree in electrical engineering, physics, materials science, or a similar area of study, so as to understand the basic principles of light and LED design and operation. Ex. 2018 at ¶19. The POSITA would also have experience related to LED lighting products, LED chip technology and applications, and/or LED packaging techniques for a period of at least one year. *Id.* In addition, the POSITA would understand, generally, how to implement LED chips and packages in the design and/or application of general-purpose lighting products for use in residential and commercial (or industrial) buildings and structures as well as outdoor spaces used by humans (such as roads, streets, parking lots, pathways, etc.). *Id.*

Resp. 15–16.

We agree with Patent Owner that the challenged claims relate to light fixtures, LED packaging, and LED chip layer structure and that the ’770 patent claims reflect “a hybrid of the light bulb art and semiconductor art.”

Resp. 16. The prior art of record, for example, Begemann, likewise reflects “a hybrid of the light bulb art and semiconductor art.” *Id.* (quoting Pet. 28).

Petitioner’s expert, Dr. Lebby, agreed that a person having ordinary skill in

the art would need to be “familiar with thermal issues.” Ex. 2015, 26:15–28:16.

While Petitioner’s proposed description of a person having ordinary skill in the art could, in some instances, be sufficient to qualify a person as having ordinary skill, Patent Owner’s proposal is a more complete and accurate description of the level of skill commensurate with the scope of the challenged ’770 patent claims. Patent Owner’s description appears consistent with the prior art and patent specification before us and is supported by witness testimony. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (prior art itself may reflect an appropriate level of skill). For the purpose of this Decision, we adopt Patent Owner’s description. We further note that the outcome of our decision would be the same under either party’s asserted skill level.

#### *D. Claim Construction*

In an *inter partes* review proceeding based on a petition filed on or after November 13, 2018, a patent claim shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b). 37 C.F.R. § 42.100(b) (as amended Oct. 11, 2018). This rule adopts the same claim construction standard used by Article III federal courts, which follow *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc), and its progeny. Under this standard, the words of a claim are generally given their “ordinary and customary meaning,” which is the meaning the term would have to a person of ordinary skill at the time of the invention, in the context of the entire patent including the specification. *See Phillips*, 415 F.3d at 1312–13.

Petitioner contends that “[t]he terms in the Challenged Claims should receive their ordinary and customary meaning as understood by a POSITA

in the context of the patent specification and prosecution history.” Pet. 19 (citing Ex. 1006 ¶ 69).

Patent Owner argues the U.S. District Court for the District of Delaware held, with respect to related U.S. Patent 6,465,961, construed “a light emitting diode (LED) chip configured to output light at greater than about 40 milliwatts” as “at least one LED chip is capable of emitting light greater than about 40 milliwatts.” Resp. 14 (citing Ex. 1024, 15–18).

Petitioner responds that the phrase “needs no construction” and that Petitioner’s grounds meet this construction. Reply 1.

We note that the language of claim 18 does not precisely match the language the District Court considered, it is substantively the same. The record supports a construction very similar to the construction the District Court adopts, and we reference the District Court’s reasoning. Ex. 1024, 15–18. We, thus, construe claim 18’s recitation that “said semiconductor chip is a light emitting diode (LED) chip configured to output light at greater than about 40 milliwatts” as referring to “a semiconductor LED chip that is capable of emitting light greater than about 40 milliwatts.”

It is unnecessary to construe any other claim terms in this Decision because none of the parties’ disputes turn on the meaning of other terms. *See, e.g., Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

*E. Prior Art Status of the Krames Reference*

Patent Owner argues that Petitioner fails to demonstrate that the Krames reference is prior art. Resp. 18–25. A reference may qualify as prior art if, for example, it is a printed publication. 35 U.S.C. § 102(a)(1); *see also* 35 U.S.C. § 103 (referring back to Section 102 when referencing prior art). Whether a reference qualifies as a “printed publication” is a legal conclusion

based on underlying factual determinations. *Suffolk Techs., LLC v. AOL Inc.*, 752 F.3d 1358, 1364 (Fed. Cir. 2014) (citation omitted). The determination of whether a document is a “printed publication” under 35 U.S.C. § 102(b) “involves a case-by-case inquiry into the facts and circumstances surrounding the reference’s disclosure to members of the public.” *In re Klopfenstein*, 380 F.3d 1345, 1350 (Fed. Cir. 2004). “Because there are many ways in which a reference may be disseminated to the interested public, ‘public accessibility’ has been called the touchstone in determining whether a reference constitutes a ‘printed publication’ bar under 35 U.S.C. § 102(b).” *Blue Calypso, LLC v. Groupon, Inc.*, 815 F.3d 1331, 1348 (Fed. Cir. 2016) (quoting *In re Hall*, 781 F.2d 897, 898–99 (Fed. Cir. 1986)). “A reference will be considered publicly accessible if it was ‘disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art exercising reasonable diligence, can locate it.’” *Id.* (quoting *Kyocera Wireless Corp. v. Int’l Trade Comm’n*, 545 F.3d 1340, 1350 (Fed. Cir. 2008)).

The ’770 patent was filed on August 24, 2001, and does not claim any earlier priority date. Ex. 1001, (22). We find that the record supports the following facts, and we determine that these facts, cumulatively, support that the Krames reference is prior art because it was a printed publication at least as of June 29, 2000:

1. The Krames reference, on its face, indicates that it is an “Invited Paper.” Ex. 1008, 1.
2. The face of the Krames reference bears these indicia: “In *Light-Emitting Diodes: Research, Manufacturing, and Applications IV*, H. Walter

Yao, Ian T. Ferguson, E. Fred Schubert, Editors, Proceedings of SPIE<sup>8</sup> Vol. 3938 (2000) • 0277-786X/00/\$15.00.” *Id.* These indicia suggests that the Krames reference was published in the SPIE Proceedings volume (“the Proceedings”) and the Proceedings were available to the public for fifteen dollars.

3. Rachel J. Watters is a librarian and “Head of Resource Sharing for the University of Wisconsin-Madison’s General Library System” located in Madison, Wisconsin. Ex. 1020, 1. Ms. Watters worked as a librarian with the University of Wisconsin library system since 1998. *Id.* Ms. Watters has a master’s degree in Library and Information Studies. *Id.*

4. When the University of Wisconsin-Madison Libraries received a volume, it was checked in, added to library holdings records, and made available to readers as soon as possible and, at most, within 2 to 3 weeks. *Id.* at 1–2.

5. The University of Wisconsin-Madison Libraries catalogued the Proceedings as of June 29, 2000. *Id.* at 2; *see also id.* at Exhibit B, 27<sup>9</sup> (library record indicating June 29, 2000 “Receiving date” for the Proceedings).

6. The Kurt Wendt Library at the University of Wisconsin-Madison owns the Proceedings of SPIE, 3938 that the Krames reference appears in. *Id.* at 2; *see also id.* at Ex. A (copy of excerpt of the Kurt Wendt Library’s copy of the Proceedings).

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<sup>8</sup> SPIE refers to “The International Society for Optical Engineering” or “The Society of Photo-Optical Instrumentation Engineers.” Ex. 1020, Ex. A, 6, 8.

<sup>9</sup> Reference is made to the page number of Exhibit 1020: page 27 of 28.

7. The Proceedings, on their face, indicate that papers from the Proceedings were presented at “26-27 January 2000 San Jose, California.” Ex. 1020, Exhibit A, 6.
8. Dr. Lebby attended this January 2000 conference. Ex. 1006 ¶ 75. Dr. Lebby also confirms that “proceedings from this conference were distributed to all members of SPIE as well as to libraries which had a subscription to the *Proceedings of SPIE*, so it was widely available to and accessible by those with skill in the art.” *Id.*<sup>10</sup>
9. The Proceedings indicate that papers included in the Proceedings volume “were selected by the conference program committee to be presented in oral or poster format.” Ex. 1020, Exhibit A, 7.
10. The Proceedings indicate a 2000 copyright date and further indicate that the volume was publicly available from the Copyright Clearance Center for fifteen dollars per article. *Id.*
11. The excerpt of the library’s Proceedings volume has a sticker in the upper left corner: “TK 7871.89 L53 2000.” *Id.* at 6. The sticker suggests the volume was catalogued by the library in 2000. The table of contents page also bears hand writing that repeats similar indicia including “2000.” *Id.* at 8–9.
12. The library catalog record of the University of Wisconsin-Madison indicates that the Proceedings volume “was properly catalogued and could be found by or requested by a person of skill in the art of the subject matter of the foregoing article exercising reasonable diligence.” Ex. 1020, 3.

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<sup>10</sup> We note that Dr. Lebby does not directly state *when* the Proceedings were widely available. *See* Sur-Reply 14.

13. Members of the interested public could locate the Proceedings volume on June 29, 2000, the date it was catalogued, “by searching the public library catalog or requesting a search through [Wisconsin TechSearch] WTS.” *Id.*

The facts above are evidence of the Krames reference’s publication as of June 29, 2000, because the facts tend to make the Krames reference’s publication as of June 29, 2000, more probable than it would be without the evidence. *See* Fed. R. Evid. 401(a) (defining evidence as relevant “if it has any tendency to make a fact more or less probable than it would be without the evidence”). The evidence is sufficient to support publication.

Meanwhile, no evidence of record suggests that Krames was *not* a printed publication as of June 29, 2000. Thus, a preponderance of the evidence supports Krames’s prior art status.

Patent Owner argues that Ms. Watters “never establishes a firm date when Krames was purportedly available to the relevant public.” Resp. 21. Patent Owner bases this argument by taking a tortured reading of Ms. Watters’s statement that “[m]embers of the interested public could locate a copy of [the Proceedings] on or after June 29, 2000, the date it was catalogued.” *Id.* (quoting Ex. 1020, 3); *see also* Sur-Reply 12–13. The best understanding of Ms. Watters’s statement, in view of the context of Ms. Watters explaining the library’s cataloguing process, is that a member of the interested public had two options: the person could choose to locate the Proceedings on June 29, 2000, or the person could choose to locate the Proceedings after June 29, 2000. Thus, the statement supports public availability as of June 29, 2000.

Patent Owner also argues that Exhibits A and B to the Watters declaration also do not establish when the Proceedings were available. Resp.

21–22. The Exhibits, however, serve to corroborate Ms. Watters’s credible testimony as to when the Proceedings were available.

Patent Owner also argues that a person of ordinary skill in the art would not have been able to find the Krames article and argues that a prior, non-precedential board decision, *Salesforce.com, Inc. v. WSOU Investments, LLC*, IPR2022-00357, Paper 12 (PTAB July 13, 2022), is analogous. Resp. 20–21. But the *Salesforce* decision is distinguishable. The *Salesforce* patent claims related to, for example, interfacing two network environments via a message gateway and content reformatted in a vectorized format.

*Salesforce.com, Inc.*, IPR2022-00357 at 3. Given this context, the panel determined that Petitioner did not establish a reasonable likelihood the Fox article was publicly accessible before the critical date because the MARC record was only “keyed to the title of the entire conference proceedings.” *Id.* at 14. Because the conference proceedings were entitled “Proceedings of the 2002 International Conference on International Computing,” the panel reasonably determined that a person having ordinary skill in the art would not have, with reasonable diligence, known to look in these proceedings to find information relevant to the claimed subject matter. *Id.* In *Salesforce*, the topic of the proceedings was very broad compared to the subject matter of the claims at issue.

In contrast, a person of ordinary skill in the art could have reasonably located the Krames article based on the title of the Proceedings. As a starting point, there is no dispute that Begemann is prior art. Begemann teaches an LED lamp fixture that makes use of LED chips, but it does not give very many details about the design of those chips. Ex. 1007, 1:1–14, 2:22–23, 5:13-18, Figs. 2, 3A, 3B. A person having ordinary skill in the art at the relevant time (August 24, 2001) would have sought out more information

about what different kinds of light emitting diodes could be manufactured for application with Begemann. *See* Section III.F.4.a, *infra*. As such, a person having ordinary skill in the art would have been very interested in a recent (2000) publication from a known technical society entitled “Light-Emitting Diodes: Research, Manufacturing, and Applications IV.” Ex. 1008, 1; *see also* Ex. 1020, Exhibit A, 6. The evidence supports that the Proceeding’s title was indexed such that a person of ordinary skill could find it, and this would have been sufficient to lead a person having ordinary skill in the art to the Krames article. Ex. 1020, 2–3; *see also* Reply 2–3.

Patent Owner also notes that the barcode on the back of Proceedings volume (Ex. 1020, Exhibit A, 24) has a different number than the barcode the ExLibris system states (Ex. 1020, Exhibit B, 26). Resp. 27. Patent Owner does not provide evidence explaining the import of this distinction. It is possible, for example, that the book has different barcodes for different purposes (for example, one for the manufacturer and another assigned to the library). Given that other indicia do not indicate any conflict or controversy regarding publication date, the evidence supports Ms. Watters’s testimony establishing June 29, 2000, library indexing. Ex. 1020, 2–3.

Patent Owner further argues that Exhibit B has some unexplained features related to page number and volume availability. Resp. 23. Again, Patent Owner lacks evidence regarding the import of these observations.

Patent Owner argues that Ms. Watters does not provide evidence that she personally knew about publication of the Krames article. Resp. 24–25; Sur-Reply 11. This does not undermine Ms. Watters’s credible testimony regarding her library’s systems and when, based on the library’s records, Krames was publicly available (indexed by the library in a useful fashion).

To summarize, the record provides sufficient evidence supporting that Krames published by June 29, 2000. The record provides no evidence to the contrary. The weight of the evidence supports Krames's June 29, 2000, publication. As such, Petitioner has established by a preponderance of the evidence that Krames is a printed publication.

*F. Obviousness Analysis*

1. Obviousness: Legal Standard

A patent 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.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved 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 ordinary skill in the art; and (4) when in evidence, objective evidence of nonobviousness.. *Graham*, 383 U.S. at 17–18.

2. Objective Indicia of Non-Obviousness

Patent Owner argues that commercial success and the combination of long-felt need, failure of others in the industry, and industry skepticism weigh in favor of patentability. Resp. 46–52. Petitioner argues that Patent Owner fails to show that commercial products embody and are coextensive with the challenged claims. Reply 19–21. For objective indicia of nonobviousness to be accorded substantial weight, its proponent must establish a nexus between the evidence and the merits of the claimed invention. *Lectrosonics, Inc. v. Zacom, Inc.*, IPR2018–01129, Paper 33 at 32 (PTAB Jan. 24, 2020) (precedential); *see also Fox Factory Inc. v. SRAM*,

*LLC*, 944 F.3d 1366, 1373 (Fed. Cir. 2019) (to establish objective indicia of non-obviousness, Patent Owner bears the burden of tying the objective evidence that embodies the claimed features).

Here, as to commercial success and industry praise, Patent Owner argues that Cree’s “Embodying Products” meet the limitations of claim 18 of the ’770 patent. Resp. 47. Then, Patent Owner argues that “Cree’s Lighting Products segment” has been commercially successful. *Id.* at 48. Patent Owner also argues that Cree received praise “for its LED light bulbs.” *Id.* Patent Owner does not establish, however, that the “Embodying Products” are the same as “Cree’s Lighting Products segment” or “its LED light bulbs.”

Just to the contrary, Patent Owner provides, for example, sales figures for lighting products “including the embodying products” (and, presumably, including other products as well). Ex. 2019 ¶ 46. Patent Owner’s witness, Ms. Kindler, admits to assessing only revenues associated “with [Patent Owner’s] Embodying Products as part of its Lighting Products segment.” *Id.* Although Patent Owner provides evidence that Cree states that its “Lighting Products segment ‘primarily consist[ed] of LED lighting systems and lamps,’ which would include the Embodying Products,” the record is unclear what other products the “Lighting Products segment” includes. *Id.* In sum, the evidence fails to persuasively connect patented features to commercial success or praise.

Patent Owner also argues that “there is a nexus between the industry’s LED lighting products eventually introduced and the [’770 patent].” Resp. 47. Patent Owner does not argue, however, that “the industry’s LED lighting products” enjoyed commercial success, praise, or indicia supporting non-obviousness.

Patent Owner argues that its 2015 catalog shows “expansion and breadth” of its patented Dynasty LED lamp business. Resp. 48 (citing Ex. 2017). The catalog establishes what Patent Owner offered for sale and how Patent Owner advertised Dynasty LED lamps. But the catalog does not persuasively establish commercial success or success relative to any competitors in the market.

Patent Owner further argues that Patent Owner’s “Dynasty LED lamps” are covered by the ’770 patent and had “notable examples of installation” at two stores. Resp. 48 (citing Ex. 2019 ¶¶ 30–31, 48). These examples, at best, provide very limited evidence of some commercial success.

With regard to long-felt but unmet need, Patent Owner argues that others in the industry failed to develop “a monochromatic general illumination light source that uses a semiconductor LED chip while also dissipating heat” and cites problems others in the industry had in developing such a light both before and after filing of the ’770 patent. Resp. 48–52. The record, however, suggests that the ’770 patent did not solve particular industry problems. Rather, Patent Owner’s witness testified, for example, that he purchased an off-the-shelf LED as a prototype, that attaching heat sinks was well known, and that phosphor coatings for white light were well known. Reply 21 (citing Ex. 1030, 291:20–295:6 (testimony of ’770 inventor)).<sup>11</sup>

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<sup>11</sup> Petitioner also argues that attaching heat sinks and adding phosphor coatings was well known. Reply 21. Petitioner cites the Ex. 1030 trial transcript at 126:25–127:6 and 134:17–21 for testimony supporting this argument, but these pages appear to be omitted from the present record. Nonetheless, the prior art discussed herein (for example, Begemann,

In sum, the evidence of objective indicia of non-obviousness is weak and, therefore, has little influence on our obviousness conclusions in either direction. All of our obviousness determinations, as we discuss *infra*, are made after considering all evidence in the record, including all evidence relating to objective indicia of non-obviousness.

### 3. Overview of the Asserted Art

#### a. *Begemann (Exhibit 1007)*

Begemann describes “a LED lamp comprising a gear column, a lamp cap which is connected to an end of the gear column and a substrate which is connected to the other end of the gear column and which is provided with a number of LEDs.” Ex. 1007, 1:1–3.

We reproduce Begemann’s Figure 2 below.

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Krames, and Allen) establishes that heat sinks and phosphor coatings were known in the art.

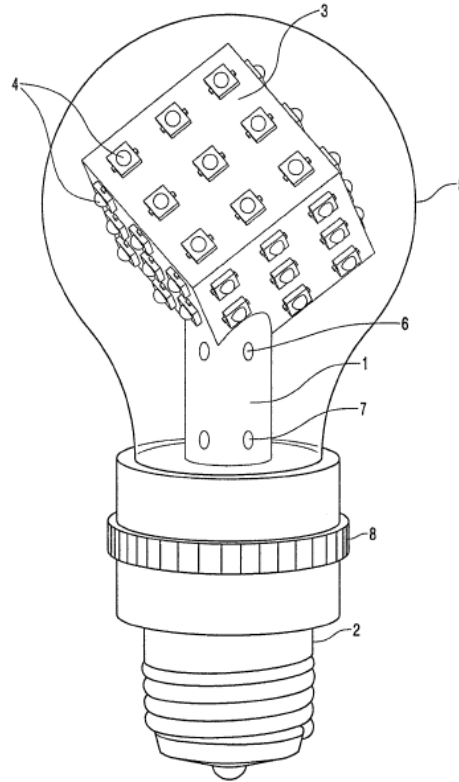


FIG. 2

Figure 2 depicts an embodiment of a LED lamp. *Id.* at 4:11. LED lamp includes gear column 1, metal lamp cap 2, metal substrate 3 having LEDs 4, envelope 5, and outlet holes 6 and inlet holes 7 for air flow. *Id.* at 5:13–16. Begemann describes substrate 6 as cube-shaped and states that each one of the faces has a number of LEDs 4. *Id.* at 5:17–18, 21–22. Begemann explains that multiple-chip LEDs are used in this embodiment, “which each have three light points (green, red and blue) per LED or four light points (green, red, yellow, blue) per LED” and “[t]hese colors are mixed so as to obtain white light in the secondary optical system of each of the LEDs.” *Id.* at 5:22–25.

We reproduce Begemann’s Figure 3A below.

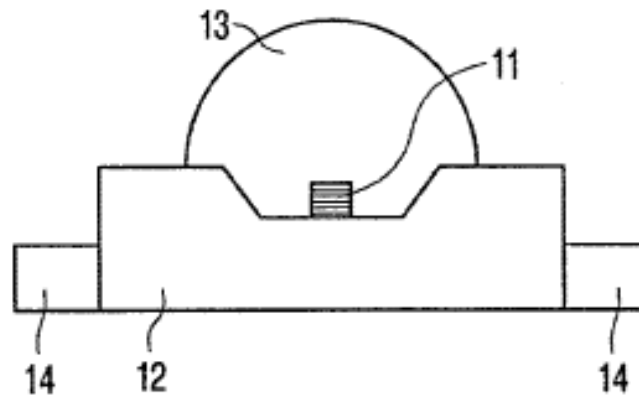


**FIG. 3A**

Figure 3A shows an LED that includes single-chip LEDs, which each has only one light point 11 per LED. *Id.* at 6:3–5. Begemann explains that “[l]ight point (11) is provided with a primary optical system(13), by means of which the radiation characteristic of the LED can be influenced.” *Id.* at 6:6–8.

b. *Krames (Exhibit 1008)*

Krames is a paper titled “High-brightness AlGaInN light-emitting diodes.” Ex. 1008, 1. Specifically, Krames describes AlGaInN LEDs grown via organometallic vapor phase epitaxy (“OMVPE”). *Id.* Krames describes a light output versus current characteristic for a blue (wavelength of about 470 nm) 1 x 1 mm<sup>2</sup> AlGaInN LED. *Id.* at 10. Krames explains that a power output over 170 mW is obtained at a drive current of 1.5 A DC. *Id.*

Krames’s Figure 3 is reproduced below.

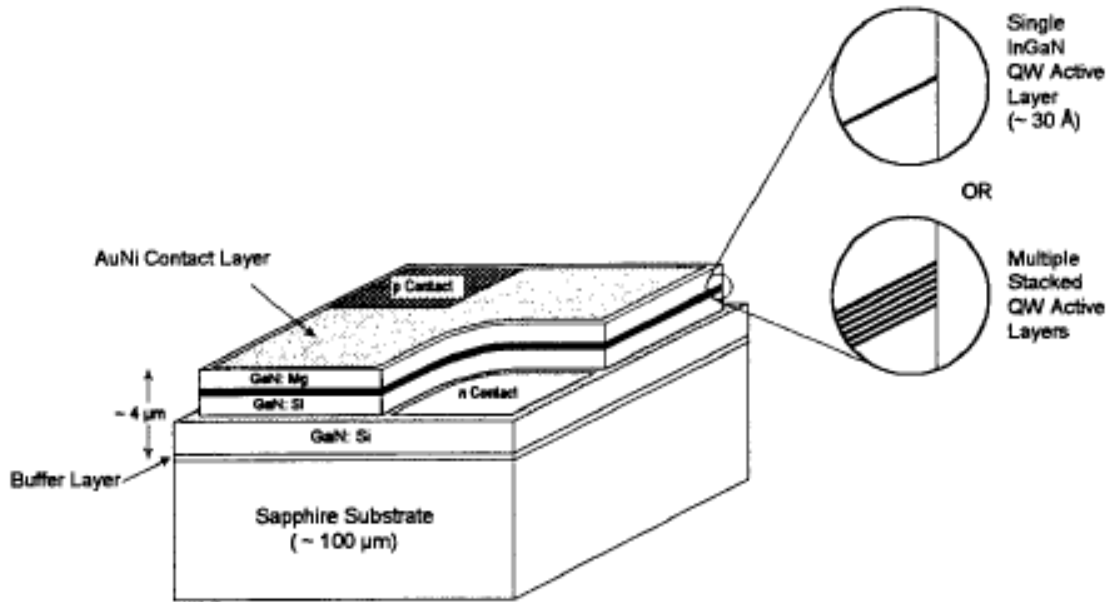


**Fig. 3. Typical AlGaInN LED structure.**

Figure 3 depicts a typical AlGaInN LED structure. *Id.* at 4. Krames discloses that “[t]he two most common substrates used for OMVPE growth of AlGaInN are sapphire and SiC.” *Id.* Krames explains that “[s]apphire is insulating and therefore both p and n Ohmic contacts must be formed on the top surface of the LED chip.” *Id.* The n-type contact is formed by mesa etching the AlGaInN LED structure to expose n-type GaN layers beneath the active region and then applying an ohmic n-contact metallization (e.g., Ti/Al) to the n-type GaN. *Id.* Krames states that the p-type contact is formed “by depositing a semi-transparent Ni/Au Ohmic contact metallization across the GaN:Mg surface.” *Id.*

c. *Allen (Exhibit 1011)*

Allen describes a lamp that includes one or more monolithic LED devices that each has an array of LED dies. Ex. 1011 code (57). Allen states that the “[t]he array of LED dies may comprise a mixture of RGB sub-dies or ‘white dies’ or a mixture of both types of dies” and that “[w]hite dies may

be, for example, blue dies with phosphorescent coating to produce a wideband spectrum.” *Id.* at 4:9–12.

We reproduce Allen Figures 6A and 6B below.

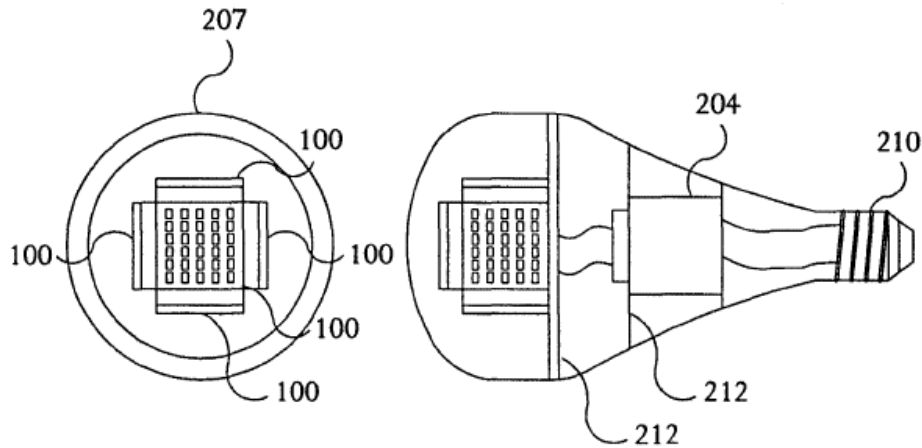


FIG. 6A

FIG. 6B

Figure 6A depicts a top view of an “A-type” screw-in hemispherical lamp configuration. *Id.* at 3:17–18. Figure 6B shows a side view of the hemispherical lamp. *Id.* at 3:19–20. The lamp includes monolithic LED device 100, lamp housing 207, mounting brackets 212, voltage converter 204, and base 210. *Id.* at 6:10–12. Allen states that voltage converter 204 “may be a transformer, such as step-down transformer, series resistor, or other type of voltage converter employed in the art to convert from a supply voltage such as an AC or DC supply followed by a bridge rectifier circuit.” *Id.* at 6:16–18.

d. *Sugiura (Ex. 1010)*

Sugiura describes “a nitride-based semiconductor element such as a semiconductor laser, a light-emitting diode, an electronic device, or the like.” Ex. 1010, 1:6–8. Sugiura’s Figure 7 is reproduced below.

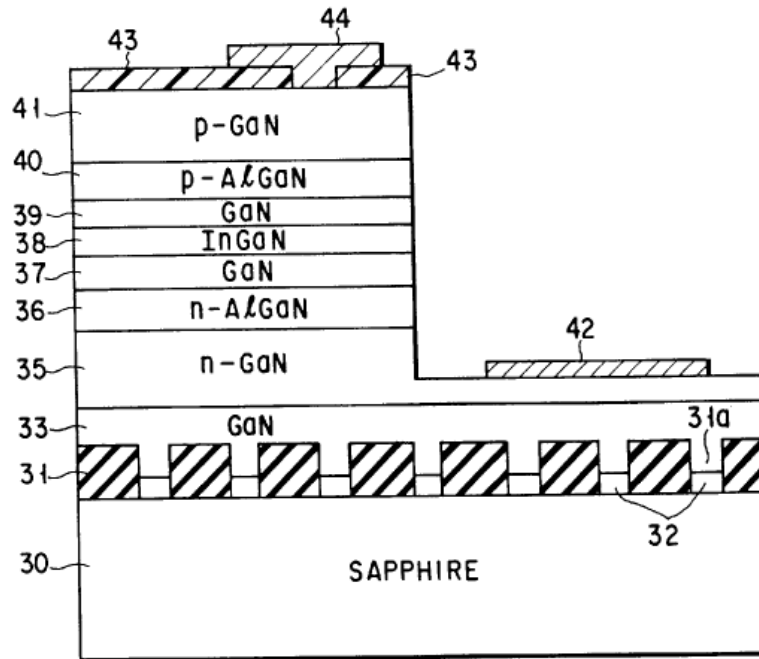


FIG. 7

Figure 7 illustrates a sectional view of a nitride-based semiconductor laser. *Id.* at 9:1–3. The nitride-based semiconductor laser includes sapphire substrate 30, mask 31 having grooves 31a, low-temperature GaN buffer layer 32, undoped underlying GaN layer 33, n-type GaN contact layer 35, n-type AlGaIn current injection layer 36, n-type GaN optical guide layer 37, InGaIn active layer 38, p-side GaN optical guide layer 39, p-type AlGaIn current injection layer 40, and p-type GaN contact layer 41. *Id.* at 12:24–36. Sugiura states that “[a]lthough this embodiment has been described above with reference to the case it is applied to a laser, . . . the present invention can be applied not only to a nitride-based semiconductor laser but also to a light-emitting diode.” *Id.* at 14:58–61.

4. Ground One: Unpatentability over Begemann, Krames, and Allen

Petitioner asserts that claims 18, 22, 25, 26, 28–30, 32–36, 40–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91

are unpatentable under 35 U.S.C. § 103(a) as obvious over Begemann, Krames, and Allen, citing the Declaration of Dr. Michael S. Lebby for support. Pet. 31–98 (citing Ex. 1006). Below, we first address Petitioner’s argued reasons to combine the references’ teachings. We then address independent claim 18. Next, we address disputed recitations of dependent claims. Finally, we address the remaining dependent claims collectively.

a. *Combining the teachings of Begemann, Krames, and Allen*

We first address the combination of Begemenan and Krames. Pet. 27–28. Begemann teaches that “[c]ustomary incandescent lamps can only be replaced by LED lamps which are provided with LEDs having ... a high luminous flux.” Ex. 1007, 2:3–5. Begemann discloses LEDs mounted to surfaces within the interior of its bulb and as part of an LED package. *Id.* at Figs. 2, 3A. Begemann does not, however, disclose what specific LED chip should be used with its device. Pet. 28. A person having ordinary skill in the art would have naturally searched LED chip references to determine what existing chips could be combined with Begemann’s disclosure.

Krames teaches an LED chip that a person of ordinary skill in the art would have recognized as useful in Begemann’s LED package. Krames notes that “by increasing the chip size and providing low-thermal-resistance power packages capable of dissipating several Watts, LEDs should be able to compete more favorably with conventional lighting technologies in many applications.” Ex. 1008, 6. Krames thus has a goal similar to that of Begemann. Ex. 1007, 2:3–5. A person of ordinary skill in the art would have had a reasonable expectation of success in mounting the LED chips Krames teaches into the Figure 3 apparatus of Begemann. Ex. 1006 ¶ 93.

Patent Owner argues that a person of ordinary skill in the art would have recognized that Begemann’s heat sink is inadequate to handle the heat

of Begemann’s suggested RGB LEDs. Resp. 31–32. This argument does not squarely respond to the ground of challenge. Petitioner’s unpatentability grounds are based upon combining Begemann’s teachings with Krames’s LED and Allen’s phosphor coating. Moreover, Begemann teaching a heat sink along with teaching its LEDs suggests, by a preponderance of the evidence, that Begemann’s heat sinks are adequate for Begemann’s LEDs. *See, e.g.*, Ex. 1007, Fig. 2, 2:17–19, 5:17–18.

Patent Owner argues that a person having ordinary skill in the art would not have combined the Krames LED with the Begemann device because Begemann’s structure would not be able to handle the heat of the Krames “higher-powered LEDs.” Resp. 31–33. This argument does not persuasively undermine Petitioner’s evidence because it is premised on the Krames LED chips being driven at 1.5 amperes and producing 390 lumens. Reply 5 (citing Ex. 2021 ¶¶ 48–64 (Patent Owner witness, Mr. McCreary, considering heat based on these conditions); Ex. 2022 ¶¶ 86–109 (Patent Owner witness, Mr. York, referring to Mr. McCreary’s modeling)). A preponderance of the evidence supports that a person of ordinary skill in the art would have utilized the Krames LED chip in conjunction with Begemann at a lower drive current and with lower lumens. *See, e.g.*, Ex. 1034, 107:6-25 (Patent Owner’s witness, Mr. York, testifying that the practical drive current for the Krames chip was somewhere around 350 milliamps); Ex. 1028 ¶¶ 22, 28 (Petitioner’s witness, Dr. Krames, testifying that an output of 136 lumens would be a reasonable output and a drive current near 350 mA would be reasonable).

Patent Owner argues that it focused on a drive current of 1.5 amps because Petitioner relied on this amperage in the Petition. Sur-Reply 15–16. This argument is unpersuasive because it reflects a misunderstanding of the

scope of claim 18 and how the Petition addresses claim 18. Claim 18 recites “said semiconductor chip ... configured to output light at greater than about 40 milliwatts.” Ex. 1001, EPRC 1:34–36. Patent Owner agrees that claim 18’s “configured to” language requires that the chip be “capable of” outputting light at greater than about 40 milliwatts. Resp. 14–15. The claim does not require a chip that, when placed in the bulb, actually operates at more than about 40 milliwatts. Thus, to show that the Krames chip meets this claim language, Petitioner explained that “Krames teaches its LED chip achieves ‘[a] power output of over 170 mW ... at a drive current of 1.5 A dc.’” Pet. 53 (quoting Ex. 1008, 10). In other words, Petitioner proved the *capability* of the Krames chip.

Petitioner never, however, insisted that a person of skill in the art would run the Krames chip within Begemann at such a high power output. Rather, Petitioner’s reason to combine is that Begemann teaches use of LED chips with high luminous flux, and Krames teaches such a chip. Pet. 27–28. When Patent Owner attempted to refute this reason to combine by arguing that the Krames chip would overheat at 170 mW and 1.5 A dc, Petitioner appropriately responded by establishing that the Krames chip could operate at a variety of power and amperage conditions. Reply 4–7; *see also Rembrandt Diagnostics, LP, v. Alere, Inc.*, 76 F.4th 1376, 1382–84 (Fed. Cir. 2023) (holding that Board did not err by considering Petitioner arguments responsive to Patent Owner assertions regarding motivation to successfully combine). Figure 12 of Krames illustrates possible operating conditions for the Krames chip, and we reproduce that figure below.

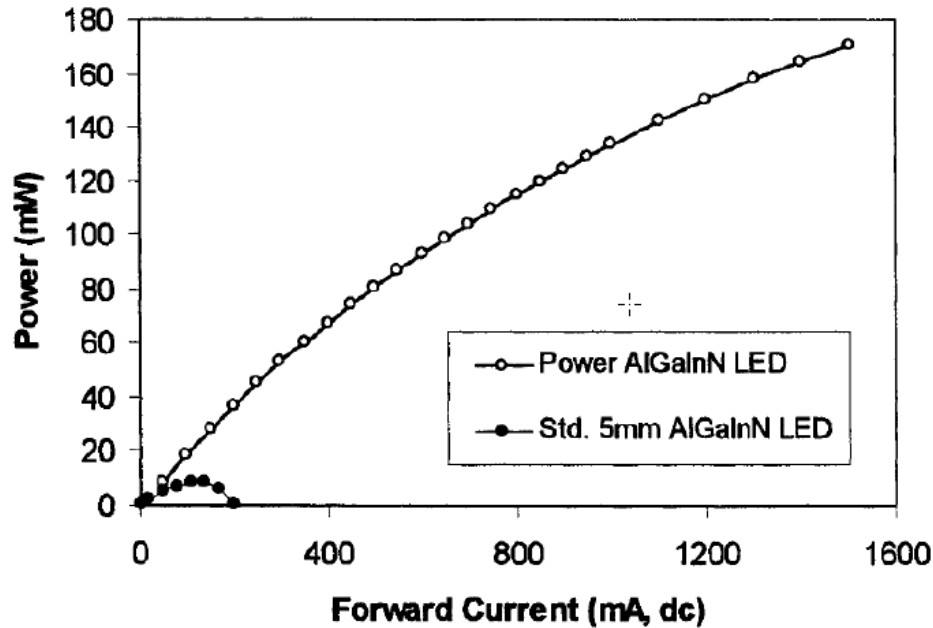


Fig. 12. Light output vs. current characteristic of a blue ( $\lambda_p \sim 470$  nm),  $1 \times 1$  mm<sup>2</sup> AlGaInN LED in a power package, compared to a conventional AlGaInN LED in a 5 mm lamp package.

Ex. 1008, 9. Krames Figure 12 depicts a graph comparing the light output versus current characteristics of the Krames LED chip versus a conventional LED. *Id.*

Krames Figure 12 illustrates that the Krames chip can operate at amperages much lower than 1.5 A. Indeed, Krames indicates “excellent reliability performance” at 350 mA. *Id.* at 10; *see also* Ex. 1028 ¶ 22. The preponderance of the evidence also establishes that, at lower amperage, a person of ordinary skill in the art would have recognized that any heat issues would have been manageable. *See* Reply 6–7 (citing Ex. 1028 ¶¶ 22–23; Ex. 1008, 9).

Patent Owner also argues that a person having ordinary skill in the art would not have utilized the Krames LED with Begemann because the Krames LED is less energy efficient than an incandescent light bulb and less efficient than the Begemann RGB LEDs. Resp. 33–35. Krames, however, teaches, at 350 mA, “the best performance in terms of power conversion

efficiency” and “excellent reliability performance.” Reply 6 (quoting Ex. 1008, 7); *see also* Ex. 1008, 9 (teaching excellent reliability performance at 350 mA). Petitioner persuasively argues that the combination of Begemann and Krames could output 136 lumens which exceeds the light output of many commercial bulbs (while dissipating resulting heat). Reply 9–10 (citing Ex. 1028 ¶¶ 27–29). Also, Krames teaches that its LEDs “should be able to compete more favorably with conventional lighting technologies in many applications.” Ex. 1008, 6; *see also id.* at 10 (explaining that the Krames chip offers advantages where “high flux density is important” and may offer unique advantages in “traffic signaling”), 11 (noting “long-life of solid-state emitters”).

A person having ordinary skill in the art would have recognized potential advantages of using the Krames LED chip and would have been able to weigh the advantages against any disadvantages. The existence of advantages and disadvantages does not make the combination of Begemann and Krames less obvious in view of Begemann suggesting use of LED chips and Krames providing an appropriate LED chip that provides at least some advantages. *See Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006) (“a given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine”). In sum, the preponderance of the evidence, as explained above, supports that a person of ordinary skill in the art would have had reason to combine the teachings of Begemann and Krames with a reasonable expectation of success.

With respect to Allen, Begemann teaches a “white LED” for at least one embodiment. Pet. 29 (quoting Ex. 1007, 3:6–9). Krames teaches conversion of blue light into white “via phosphors” and Allen teaches that

“blue dies with phosphorescent coating” may be used. Ex. 1008, 11; Ex. 1011, 4:11–12; Ex. 1006 ¶¶ 88–90. A preponderance of the evidence supports Petitioner’s position that a person of skill in the art would have combined the teachings of Begemann, Allen, and Krames to reach claim 1’s recited coating.

Patent Owner argues that Petitioner’s proposed obviousness combination is inconsistent because it “argues for the purported obviousness of replacing Begemann’s LEDs with Krames’ LED chips” but “also argues for the purported obviousness of replacing Begemann’s LEDs with Allen’s chips.” Resp. 26. Patent Owner further argues that neither the Krames chip nor the Allen chip alone teach all recitations of claim 18. *Id.* at 26–28. This argument is unpersuasive because the Petition is reasonably clear that ground one asserts the Begemann with the Krames chip and Allen’s phosphor coating. *See* Pet. 26–28 (explaining why it would be obvious to use the Krames chip with Begemann), 29–31 (explaining why it would have been obvious to modify the Krames chip by using a coating of phosphors). When Petitioner maps claim 18 to the asserted art, Petitioner refers to Begemann for the greater lightbulb structure and Krames for the chip. *Id.* at 31–54. For claim 18, Petitioner refers to Allen *only* for the phosphor coating. *Id.* at 51.<sup>12</sup> Petitioner does not rely on only the chip of Krames or only the chip of Allen to meet claim 18, and, as we further address below, Petitioner accounts for each recitation of claim 18.

To summarize, the preponderance of the evidence establishes that a person of ordinary skill in the art would have had good reason to combine

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<sup>12</sup> When addressing dependent claims, Petitioner also refers to Allen for certain aspects of the bulb structure. *See, e.g.,* Pet. 61–74, 76–77.

implement the Krames chip in the Begemann device while also making use of a phosphor coating as Allen teaches and that a person of ordinary skill in the art would have had a reasonable expectation of success in combining the references' teachings in this manner.

b. *Independent Claim 18*

Claim 18 depends from cancelled claims 1 and 9. The preamble of claim 1 recites, "A semiconductor light source for emitting light to illuminate a space used by humans, the semiconductor light source comprising." Petitioner argues that Begemann discloses this recitation. Pet. 31–32. The preponderance of the evidence supports that Begemann teaches or suggests this recitation. Ex. 1007, 1:1, 6:23–24, Fig. 2; Ex. 1006 ¶ 91.

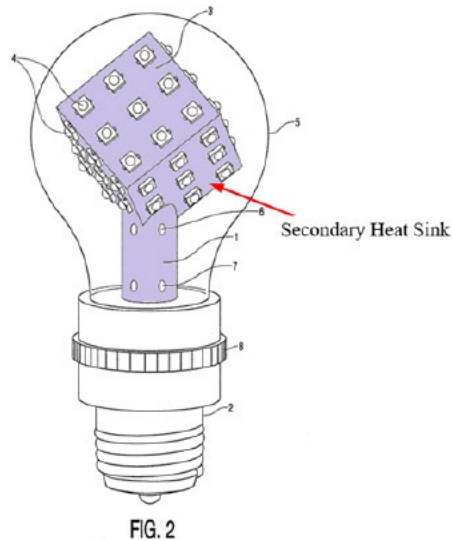
Claim 1 next recites "an enclosure, said enclosure being fabricated from a material substantially transparent to white light." Petitioner argues that Begemann teaches this recitation. Pet. 32–33. The preponderance of the evidence supports that Begemann teaches or suggests this recitation. Begemann states, for example, that "during operation of the LED lamp shown, white light is obtained" and that the Begemann device has an "envelope ... made of glass [or] synthetic resin." Ex. 1007, 2:23–24, 5:26; *see also id.* at Fig. 2; Ex. 1006 ¶ 92.

Claim 1 next recites "a base to which said enclosure is mounted." Petitioner asserts that Begemann lamp cap 2 and the structure surrounding adjusting ring 8 of Begemann Figure 2 is such a base. Pet. 33–34. The preponderance of the evidence supports that Begemann teaches or suggests this recitation. Ex. 1007, Fig. 2; Ex. 1006 ¶ 93.

Claim 1 next recites "an interior volume within said enclosure." As Petitioner asserts, the preponderance of the evidence supports that

Begemann teaches or suggests this recitation. Pet. 34–35, Ex. 1007, Fig. 2; Ex. 1006 ¶ 94.

Claim 1 next recites “a secondary heat sink located in said interior volume.” Petitioner identifies such a sink by annotating Figure 2. Pet. 35–36. We reproduce that annotated figure below.



Pet. 35–36 (reproducing Ex. 1007, Fig. 2). Begemann Figure 2 is a view of a second embodiment of Begemann’s LED lamp. Ex. 1007, 4:11. Petitioner annotates the Figure to “Secondary Heat Sink” areas. The preponderance of the evidence supports that Begemann teaches or suggests this recitation. Begemann teaches, for example, that substrate 3 is “made of a metal or metal alloy, thereby enabling a good heat conduction” and that “[t]he outer surface of the gear column (1) of the LED lamp is made of a metal or a metal alloy ... enable[ing] good heat conduction.” *Id.* at 4:28–29, 5:1–3; *see also* Ex. 1006 ¶ 95.

Claim 1 recites “said secondary heat sink being capable of drawing heat from one or more semiconductor devices.” For the reasons we address

above, the preponderance of the evidence supports that Begemann teaches or suggests this recitation. Pet. 37.

Claim 1 recites “a plurality of primary heat sinks mounted on said secondary heat sink.” Petitioner asserts that the MC-PCP elements 12 of Begemann Figure 3A are primary heat sinks. Pet. 37–39. The preponderance of the evidence supports that Begemann teaches or suggests this recitation. Begemann teaches, for example, that the MC-PCB elements are “responsible for good heat transfer.” Ex. 1007, 6:5–6, Fig. 3A; *see also* Ex. 1006 ¶¶ 97–98.

Claim 1 recites “each of said primary heat sinks being smaller than said secondary heat sink.” Petitioner asserts that Begemann teaches this recitation as illustrated, for example by Begemann Figure 2. Pet. 39–40. The preponderance of the evidence supports that Begemann teaches or suggests this recitation. Ex. 1007, Figs. 2, 3A; Ex. 1006 ¶ 99.

Claim 1 recites “a semiconductor chip capable of emitting light mounted on one of said primary heat sinks.” Petitioner asserts that Begemann Figure 3A depicts such a chip. Pet. 40–41. The preponderance of the evidence supports that Begemann teaches or suggests this recitation. Ex. 1007, 6:3–5, Fig. 3A; Ex. 1006 ¶ 100.

Claim 1 recites “said semiconductor chip being capable of emitting monochromatic light.” Petitioner argues that Begemann teaches this recitation. Pet. 41–42. The preponderance of the evidence supports that Begemann teaches or suggests this recitation. Begemann teaches that its “single chip LEDs” have “only one light point per LED.” Ex. 1007, 4:32–

34.<sup>13</sup> Begemann explains, for example, that its green, red, yellow, blue light points may be mixed to obtain white light. *Id.* at 5:17–26. Petitioner’s witness, Dr. Lebby, testifies that these statements indicate the LED is monochromatic. Ex. 1006 ¶ 101. Moreover, as we explain herein, Petitioner persuasively explains why it would have been obvious to use a phosphor coating in conjunction with Begemann to achieve monochromatic white light.

Claim 1 recites “said semiconductor chip being selected from the group consisting of light emitting diodes, light emitting diode arrays, laser chips, and VCSEL chips.” The preponderance of the evidence supports that Begemann teaches or suggests this recitation. As Petitioner asserts, Begemann teaches that its chips are LEDs. Pet. 42; Ex. 1007, 6:4–5, Fig. 3A; Ex. 1006 ¶ 102.

Claim 1 recites “said chip including a substrate on which epitaxial layers are grown.” Petitioner asserts that Krames discloses this limitation by showing a “sapphire substrate” on which epitaxial layers have grown. Pet. 42–43. The preponderance of the evidence supports that Begemann teaches or suggests this recitation. Ex. 1008, 4 (“the two most common substrates used for OMVPE growth of AlGaInN are sapphire and SiC”), Fig. 3; Ex. 1006 ¶¶ 103–104.

Claim 1 recites “a buffer layer located on said substrate.” Petitioner asserts that Krames discloses this limitation. Pet. 43–44. The preponderance of the evidence supports that Krames teaches or suggests this recitation. Krames Figure 3 shows a “buffer layer” located on a “sapphire substrate.”

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<sup>13</sup> Petitioner mistakenly cites 3:32–35 (Pet. 40), but the quote is easily located on the next page.

Ex. 1008, Fig. 3; Ex. 1006 ¶ 105. Also, as we explain *supra*, Petitioner adequately establishes that it would have been obvious to combine Krames' LED chip with Begemann.

Claim 1 recites "said buffer layer serving to mitigate differences in material properties between said substrate and other epitaxial layers." Petitioner argues that Krames's buffer layers would serve this function. Pet. 44–46. The preponderance of the evidence supports that Krames teaches or suggests this recitation. Ex. 1008, Fig. 3; Ex. 1006 ¶¶ 106–107; Ex. 1014, 353 (reference Krames cites explaining that mismatch between substrate and film makes film difficult to grow).

Claim 1 recites "a first cladding layer serving to confine electron movement within the chip." Petitioner asserts that Krames discloses a cladding layer that serves to perform the recited function. Pet. 46. The preponderance of the evidence supports that Krames teaches or suggests this recitation. Ex. 1008, 5, Fig. 3; Ex. 1006 ¶ 108.

Claim 1 recites "said first cladding layer being adjacent said buffer layer." Petitioner asserts that Krames Figure 3 discloses this recitation. Pet. 47. The preponderance of the evidence supports that Krames teaches or suggests this recitation. Ex. 1008, Fig. 3; Ex. 1006 ¶ 109.

Claim 1 recites "an active layer." Petitioner asserts that Krames teaches this layer as "either the single InGaN QW active layer or the multiple stacked QW active layers" of Krames Figure 3. Pet. 47–48. The preponderance of the evidence supports that Krames teaches or suggests this recitation. Ex. 1008, Fig. 3; Ex. 1006 ¶ 110.

Claim 1 recites "said active layer emitting light when electrons jump to a valance state." Petitioner asserts that Krames's active layer will meet

this function. Pet. 48–49. The preponderance of the evidence supports that Krames teaches or suggests this recitation. Ex. 1006 ¶ 111.

Claim 1 recites “a second cladding layer.” Petitioner asserts that Krames discloses this limitation. Pet. 49–50. The preponderance of the evidence supports that Krames teaches or suggests this recitation. Ex. 1008, 5, Fig. 3; Ex. 1006 ¶ 112.

Claim 1 recites “said second cladding layer positioned so that said active layer lies between cladding layers.” Petitioner asserts that Krames Figure 3 discloses this recitation. Pet. 50. The preponderance of the evidence supports that Krames teaches or suggests this recitation. Ex. 1008, Fig. 3; Ex. 1006 ¶ 113.

Claim 1 recites “a contact layer on which an electron [sic, electrode] may be mounted for powering said chip.” Petitioner asserts that Krames Figure 3 discloses this recitation. Pet. 50–51. The preponderance of the evidence supports that Krames teaches or suggests this recitation. Ex. 1008, Fig. 3; Ex. 1006 ¶¶ 114–115.

Claim 1 recites “a coating for converting monochromatic light emitted by said chip to white light.” Petitioner asserts that Allen teaches this recitation and that, additionally, Krames teaches conversion of blue light “into white via phosphors.” Pet. 51–52. The preponderance of the evidence supports that Allen and Krames teaches or suggests this recitation. *See* Ex. 1011, 4:11–12 (Allen stating that “[w]hite dies may be, for example, blue dies with phosphorescent coating to produce a wideband spectrum”); Ex. 1008, 11 (Krames explaining “conversion of blue light into white via phosphors”); Ex. 1006 ¶¶ 116–117. Also, as we explain *supra*, the preponderance evidence supports that a person having ordinary skill in the

art would have had reason to combine the teachings of Allen with Krames and Begemann.

We next address elements of claim 9 which depend from claim 1. Claim 9 recites “[a] device as recited in claim 1 wherein said substrate is electrically conductive.” Petitioner asserts that Krames teaches an electrically conductive SiC substrate. Pet. 52.

Patent Owner argues that Petitioner relies on Figure 3 of Krames as teaching a sapphire substrate but never establishes that a sapphire substrate is a conductive substrate. Resp. 28; *see also* Surreply 21. Patent Owner’s argument is unpersuasive because it does not squarely address the Petition. While Petitioner relies on Krames Figure 3 for some elements, Petitioner also relies on Krames teaching that the substrate can be “sapphire (as depicted) or SiC.” Pet. 23 (*citing* Ex. 1008, 4); Reply 10–11. Petitioner further explains that Krames teaches OMVPE growth for “the two most common substrates ... sapphire and SiC.” Pet 43; *see also* Ex. 1006 ¶¶ 103–104. In other words, Krames reasonably suggests that the Figure 3 substrate, instead of being sapphire, could be SiC. Petitioner explains that sapphire or SiC could be used for growing an epitaxial layer (Pet. 42) and explains that, between these two choices that Krames offers, Krames teaches that the SiC option is conductive (*id.* at 52).

Krames further teaches that sapphire is less expensive but is “insulating” which poses “design challenges.” *Id.* Krames, thus, provides evidences that SiC substrate is conductive. Dr. Lebby’s testimony further supports this position. *Id.* at 52 (*citing* Ex. 1006 ¶ 118). As such, the preponderance of the evidence supports that Krames teaches it would have been obvious to use a SiC layer and that such a layer would have both been conductive and would have permitted growing an epitaxial layer.

We next address elements of claim 18. Claim 18 depends from claim 9. Claim 18 recites “[t]he semiconductor light source as recited in claim 9 wherein: said semiconductor chip is a light emitting diode (LED) chip configured to output light at greater than about 40 milliwatts.” The preponderance of the evidence supports that Krames teaches or suggests this recitation. Ex. 1008, 10; Ex. 1006 ¶ 119. Importantly, this claim language requires a semiconductor chip *capable* of the recited output, and Patent Owner does not persuasively dispute that the Krames chip is *capable* of meeting this recitation.

Claim 18 recites “said LED chip is surface mounted on said one of said primary heat sinks.” Petitioner asserts that Begemann Figure 3A depicts LED chips (elements 11) surface mounted on the primary heat sink. Pet. 53–54. The preponderance of the evidence supports that Begemann teaches or suggests this recitation. Ex. 1007, Fig. 3A; Ex. 1006 ¶ 120.

Claim 18 also recites “said LED chip is configured to emit monochromatic visible light.” Petitioner asserts that Krames discloses the limitation. Pet. 54. The preponderance of the evidence supports that Krames teaches or suggests this recitation. Ex. 1008, 5; Ex. 1006 ¶ 121.

To summarize, Petitioner has shown by a preponderance of the evidence that the combined teachings of Begemann, Krames, and Allen teach or reasonably suggest all of the elements of claim 18 in the manner claim 18 (and the claims that claim 18 depends from) recites. Thus, we are persuaded that Petitioner has established by a preponderance of the evidence that the combination of Begemann, Krames, and Allen renders claim 18 obvious.

c. *Dependent Claim 29*

Claim 29 recites, “[t]he semiconductor light source as recited in claim 28 wherein: said opening defined in said dome-shaped enclosure is large enough for said heat sink to pass through said opening.” Ex. 1001, EPRC 2:21–25. The “opening” of claim 29 is defined in claim 28 which refers to “said enclosure [referring back to the enclosure of claim 1] is shaped as a dome that defines an opening.” *Id.* at 2:18–20.

Petitioner reproduces Figure 6B of Allen to illustrate that the opening of Allen is large enough for Allen’s heat sink to pass through. Pet. 62–63. Petitioner further argues that a person having ordinary skill in the art would incorporate this aspect of Allen “to achieve an LED lamp with improved performance and manufacturability that could replace conventional incandescent lamps. Pet. 30–31 (citing Ex. 1006 ¶ 90).

Patent Owner argues that Petitioner relies only on Begemann as providing a heat sink and that “Cree provides absolutely no explanation why a POSITA would have been motivated to use or combine Allen’s enclosure with Begemann.” Resp. 35–36. This argument does not persuasively undermine Petitioner’s position. Petitioner provides a rationale for combining the teachings of Allen and Begemann, and the rationale is supported by sufficient evidence, namely the declaration of Dr. Lebby. Pet. 30–31 (citing Ex. 1006 ¶ 90); *see also* Reply 13–15. Patent Owner provides no evidence that would undermine or weigh against Petitioner’s stated reasons to combine.

Patent Owner further argues that a person having ordinary skill in the art would understand that Allen’s “dome-shaped enclosure” would not function for its intended purpose with Begemann’s lightbulb because it “does not fit the geometry of Begemann’s light bulb.” Resp. 36 (citing

Ex. 1007, Figs. 1–2; Ex. 1011, Figs. 6A–6B). This argument is unpersuasive because it does not squarely address Petitioner’s contentions; Petitioner’s combination relies on using Allen’s bulb shape having Allen’s opening rather than relying on Begemann’s lightbulb shape. *See* Reply 13–15.

Thus, Petitioner has shown by a preponderance of the evidence that the combined teachings of Begemann, Krames, and Allen teach or reasonably suggest all of the elements of claim 29 in the manner claim 29 recites. Ex. 1006 ¶ 90; Ex. 1011, Fig. 6B. Thus, we are persuaded that Petitioner has established by a preponderance of the evidence that the combination of Begemann, Krames, and Allen renders claim 29 obvious.

d. *Dependent Claim 32*

Claim 32 recites, “[T]he semiconductor light source as recited in claim 18 wherein: the semiconductor light source further comprises an AC/DC converter, said AC/DC converter is configured to convert AC power into DC power that is usable by said LED chip, and said AC/DC converter is positioned outside said interior volume.” Ex. 1001, EPRC 2:37–44.

Petitioner argues that Allen teaches the recited voltage converter. Pet. 65 (citing Ex. 1011, 6:15–18). Petitioner further argues that Allen teaches that voltage converter 204 is located outside of the interior volume. *Id.* at 65–67 (citing Ex. 1011, 6:15–18, Fig. 6B). Petitioner also provides evidence, namely testimony from Dr. Lebby, supporting that a person of ordinary skill in the art would have been motivated to put circuitry outside of the interior volume to avoid obscuring emitted light. *Id.* at 66–67 (citing Ex. 1006 ¶ 139).

Patent Owner argues that Allen’s voltage converter 204 is not “outside said interior volume” as claim 32 recites. Resp. 37–38. Patent Owner argues that Petitioner “incorrectly limits the interior volume within the enclosure to

only the space to the left of the leftmost “support 212.” *Id.* at 37. This argument is unpersuasive because the preponderance of the evidence supports Petitioner.

As Petitioner argues, claim 1 (which claim 32 ultimately depends from) states that the recited “enclosure” is “fabricated from a material substantially transparent to white light.” Reply 16. Allen’s structure to the right of the leftmost “support 212” (where the converter 204 is located) is opaque: “[t]he mounting 212 supporting the five monolithic LED devices 100 is preferably transparent or translucent, whereas *the mounting 212 that supports the voltage converter 204 is preferably opaque.*” Ex. 1011, 9:32–34 (emphasis added). Allen continues: “the parts of the bulb housing 207 forming the globular front face 206 and form the side up to the mounting support for the power supply is likely to be transparent or frosted, whereas the remaining parts of the housing 207 forming the base 210 are preferably opaque.” *Id.* at 9:34–10:2.

Patent Owner argues that the entire enclosure need not be opaque. Sur-Reply 24–25. This argument does not squarely address Petitioner’s position. The preponderance of the evidence supports that Allen’s enclosure for the LEDs is the transparent portion to the left of support 212 while the opaque portion is a base rather than being part of that same enclosure. The opaque portion to the right of support 212 is separated from the transparent portion to the right of support 212 and, thus, does not enclose the same components and is not the same enclosure. Ex. 1011, Fig. 6B.

Patent Owner also argues that Petitioner’s alleged reason to combine Allen with Begemann “to avoid the emitted light from being obscured by such circuitry or structures” would not be a concern. Resp. 38. Patent Owner argues that Begemann does not identify this problem and places components

in its interior volume. *Id.* This argument is unpersuasive because Allen discloses a workable and advantage design; a person having ordinary skill in the art would have understood that Begemann would benefit from having electronic components outside the interior lighting volume for the same reason Allen benefits from this design. *KSR Int'l. Co.*, 550 U.S. at 417 (“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”); *see also* Ex. 1006 ¶ 148.

Petitioner has shown by a preponderance of the evidence that the combined teachings of Begemann, Krames, and Allen teach or reasonably suggest all of the elements of claim 32 in the manner claim 32 recites. Ex. 1006 ¶ 148; Ex. 1011, 9:32–10:2, Fig. 6B. We are persuaded Petitioner has established by a preponderance of the evidence that the combination of Begemann, Krames, and Allen renders claim 32 obvious.

e. *Dependent Claim 34*

Claim 34 recites:

The semiconductor light source as recited in claim 32 wherein:  
the semiconductor light source further comprises a positive lead wire and a negative lead wire configured to provide power from said AC/DC converter to said LED chip, and  
said positive lead wire and said negative lead wire run from said AC/DC converter, through an interior of said base, into said interior volume, and over an exterior surface of said secondary heat sink.

Ex. 1001, EPRC 2:48–57. Petitioner argues that Allen Figure 6B illustrates positive and negative lead wires. Pet. 68 (citing Ex. 1011, Figs. 6A, 6B; Ex. 1006 ¶ 141). Petitioner argues that it would have been obvious to include

Allen's AC/DC converter in Begemann's base and to connect those wires as recited in order to power the LEDs. *Id.* at 68–70 (citing Ex. 1006 ¶ 142).

Patent Owner argues that the identified structures do not “run from said AC/DC converter, through an interior of said base.” Resp. 39. We disagree. As we explain with regard to claim 32, Allen's structure to the right of leftmost “support 212” is the recited base. Reply 16–17. Figure 6B shows the wires running through this base.

Patent Owner also argues that Petitioner does not provide a reason why a person having ordinary skill in the art would combine Allen's voltage converter 204 and lead wires with Begemann's device or place Allen's voltage converter 204 within Begemann's base. Resp. 39–40. Petitioner, when addressing claim 33, provides a persuasive reason why a person of ordinary skill in the art would use Allen's voltage converter and position it in the base. Pet. 67 (“A POSITA would have been motivated and found it obvious to put circuitry or other electronic structures in Begemann's base to avoid the emitted light from being obscured by such circuitry or structures”). Patent Owner does not present evidence persuasively undermining this reasoning or evidence. A preponderance of the evidence supports Petitioner's position. Ex. 1011, Fig. 6B, 6:15–18; Ex. 1006 ¶ 140. We are persuaded Petitioner has established by a preponderance of the evidence that the combination of Begemann, Krames, and Allen renders claim 34 obvious.

f. *Dependent Claim 36*

Claim 36 recites: “[t]he semiconductor light source as recited in claim 18 wherein: said coating is directly applied to a face of said LED chip.” Ex. 1001, EPRC 2:63-65. Petitioner argues that Allen teaches “[w]hite dies may be, for example, blue dies with phosphorescent coating to produce a wideband spectrum.” Pet. 70 (citing Ex. 1011, 4:11–12). Petitioner also

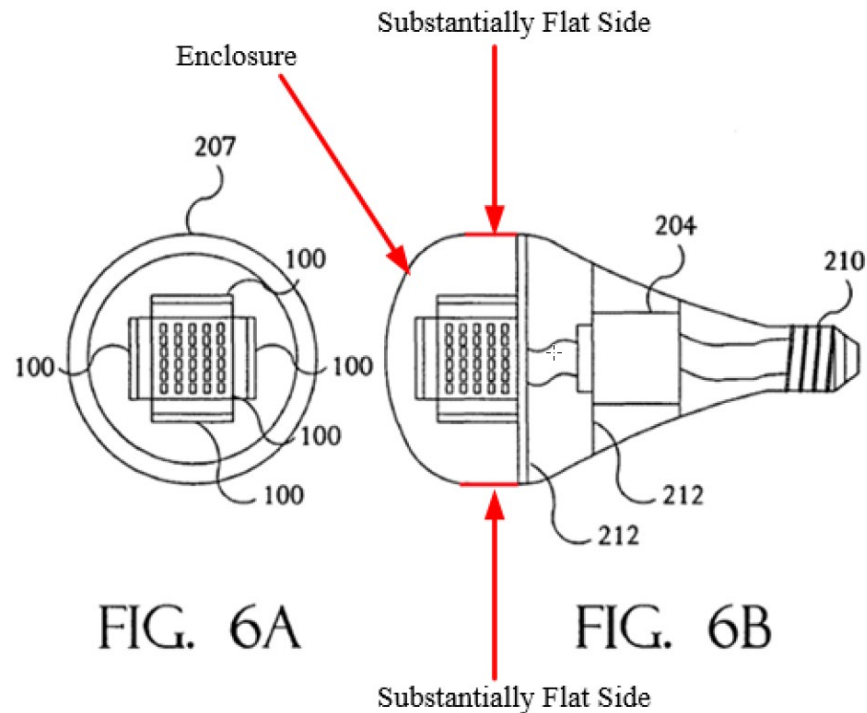
provides evidence that a “die” is a way of referring to an LED chip. *Id.* (citing Ex. 1006 ¶ 144).

Patent Owner argues that this passage does not teach applying the coating directly to the face of an LED chip because the coating could instead encapsulate the LED chip as taught by U.S. Patent No. 5,959,316. Resp. 40–41 (citing Ex. 2024, Fig. 3, 3:6–11).

The preponderance of the evidence supports Petitioner’s position. Allen suggests that it is its die that has a coating rather than suggesting that there is a spacer adjacent to the die that is coated. Reply 17 (citing Ex. 1011, 4:11–12). The die is the LED chip. Ex. 1006 ¶ 144. We are persuaded Petitioner has established by a preponderance of the evidence that the combination of Begemann, Krames, and Allen renders claim 36 obvious.

g. *Dependent Claim 41*

Dependent claim 41 recites, “[T]he semiconductor light source as recited in claim 40 wherein: said enclosure includes a substantially flat side.” Ex. 1001, EPRC 3:21–23. Petitioner annotates Figure 6B of Allen to argue that Allen’s enclosure has a substantially flat side. Below, we reproduce Figure 6A alongside Figure 6B as Petitioner annotates that figure.



Pet. 71–72 (reproducing Ex. 1011, Figs. 6A, 6B). Allen Figure 6A shows a top view of an exemplary embodiment of Allen “employed in an ‘A-type’ screw-in hemispherical lamp configuration,” and Figure 6B shows a side view of the same embodiment. Ex. 1011, 3:17–20. Petitioner annotates Figure 6B by pointing to the enclosure and top and bottom portions labeled as “[s]ubstantially flat side.” Pet. 72.

Patent Owner argues that Petitioner does not establish that Allen’s Figure 6B enclosure has a “substantially flat side” because “the two purportedly ‘flat sides’ are actually part of a cylindrical—not flat—portion of Allen’s enclosure.” Resp. 41–42. The preponderance of the evidence supports Patent Owner’s position.

The ’770 patent addresses use of a “flat” enclosure in the context of Figure 10. We reproduce Figure 10 below for reference.

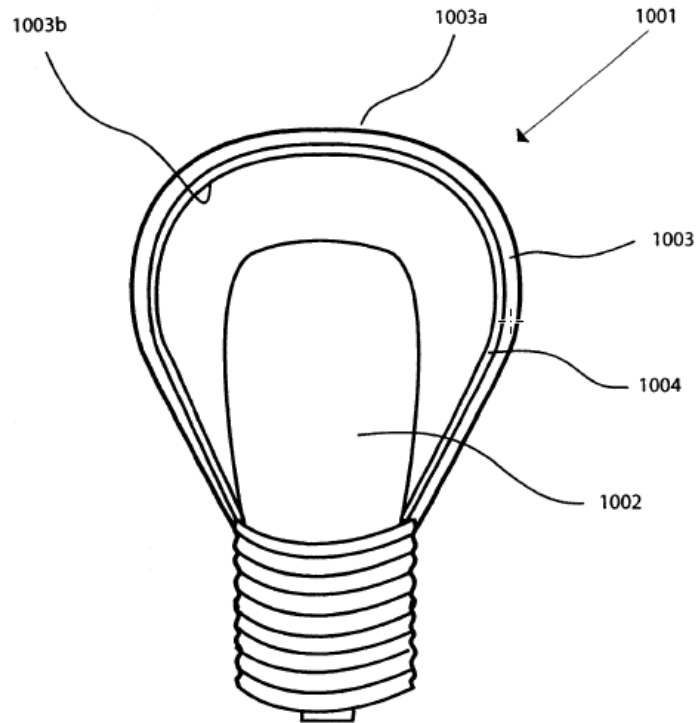


**Fig. 10**

Ex. 1001, Fig. 10. Figure 10 “depicts an LED or laser light source located in a light enclosure having a phosphor coating.” *Id.* at 2:42–43. The ’770 patent distinguishes Figure 10 from a flat shape by stating that “[t]he depicted shape is that of a bulb, but flat, arcuate, rounded or other shapes may be used depending on the application.” *Id.* at 8:41–43.

Petitioner argues that Figure 6B depicts a disclosure with a “substantially flat side” because, even though the disclosure is cylindrical, it still “comprises a flat side which encircles the lamp.” Reply 18–19. We disagree. The surface of the Figure 6B bulb is cylindrical. Given the context of the ’847 patent, “flat” describes a three-dimensional object being flat—in other words being flat in three dimensions. The ’770 patent does not indicate

that “flat” or “substantially flat” can be understood so broadly that it includes a curved three-dimensional surface that only *appears* flat based on viewing the surface from a particular direction.

We further emphasize that Petitioner’s position is based upon combining Allen’s teachings with Begemann (as opposed to, for example, modifying the art’s teachings based on what is generally known in the art). Pet. 72 (“[a] POSITA would have found it obvious to use Allen’s enclosure with two substantially flat sides as the enclosure of Begemann”); Reply 19 (“a POSITA would have found it obvious to use Allen’s enclosure with two substantially flat sides as the enclosure of Begemann”). Because Allen does not teach a substantially flat surface, combining the teachings will also not result in a substantially flat surface.

Thus, for the reasons explained above, Petitioner has not adequately established by a preponderance of the evidence that claim 41 would have been obvious in view of the cited art.

- h. *Dependent Claims 22, 25, 26, 28, 30, 33, 35, 40, 42–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91*

Petitioner accounts for the limitations recited in claims 22, 25, 26, 28, 30, 33, 35, 40, 42–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91. Pet. 54–98. Petitioner provides detailed explanations as to how the combined teachings of Begemann, Krames, and Allen disclose, teach, or suggest the limitations of these claims and why it would have been obvious to combine those teachings with a reasonable expectation of success, citing Dr. Lebby’s testimony for support. *Id.* (citing Ex. 1006).

We are persuaded that Petitioner has demonstrated that all of the limitations recited in claims 22, 25, 26, 28, 30, 33, 35, 40, 42–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91 would have been obvious over Begemann, Krames, and Allen. Patent Owner provides no arguments regarding these claims outside of the arguments discussed above. *See generally* Resp. Having reviewed Petitioner’s arguments and supporting evidence, we are persuaded that Petitioner has established by a preponderance of the evidence that claims 22, 25, 26, 28, 30, 33, 35, 40, 42–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91 are unpatentable under § 103(a) over Begemann, Krames, and Allen.

5. Ground Two: Unpatentability over Begemann, Sugiura, Allen, and Krames

Petitioner asserts that claims 18, 22, 25, 26, 28–30, 32–36, 40–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91 are unpatentable under 35 U.S.C. § 103(a) as obvious over Begemann, Sugiura, Allen, and Krames, citing the Declaration of Dr. Michael S. Lebby for support. Pet. 98–112 (citing Ex. 1006). To the extent Petitioner’s assertions and Patent Owner’s counter arguments do not relate to SugiuraSugiura, we address those issues above when addressing Ground One and, for brevity, we do not repeat that analysis here. Below, we first address Petitioner’s argued reasons to combine the references’ teachings. We then address independent claim 18. Next, we address disputed recitations of dependent claims. Finally, we address the remaining dependent claims collectively.

- a. *Combining the teachings of Begemann, Sugiura, Krames, and Allen*

Petitioner argues that it would have been obvious to combine Sugiura's chip with Begemann's bulb structure while increasing the area and operating current of Sugiura's LED chips, as taught by Krames. Pet. 28–29. Begemann teaches that “[c]ustomary incandescent lamps can only be replaced by LED lamps which are provided with LEDs having ... a high luminous flux.” Ex. 1007, 2:3–5. Begemann discloses LEDs mounted to surfaces within the interior of its bulb and as part of an LED package. *Id.* at Figs. 2, 3A. Begemann does not, however, disclose what specific LED chip should be used with its device. Pet. 28. A person having ordinary skill in the art would have naturally searched LED chip references to determine what existing chips could be combined with Begemann's disclosure.

Sugiura teaches LED chip structures meant to achieve improved luminous output. Ex. 1006 ¶ 87; *see also, e.g.*, Ex. 1010, 14:58–67 (explaining that the Sugiura LED provides various advantages). Petitioner provides evidence that a person having ordinary skill in the art would have had reason to increase the area and operating current of the Sugiura chips to achieve the goal of Begemann. Pet. 29; Ex. 1006 ¶ 87.

Patent Owner argues that Petitioner fails to consider how increasing size or drive current could impact output or efficiency of the Sugiura chips. Resp. 43. This argument does not persuasively undermine Petitioner's position. The details of how to increase size or drive current are not relevant to claim recitations, and Patent Owner lacks persuasive evidence that a person having ordinary skill in the art would have had difficulty or lack of reason to modify Sugiura to an appropriate size and drive current. Reply 12–13. Also, Krames teaches increasing chip size to, in line with Begemann's

goals, “compete more favorably with conventional lighting technologies in many applications.” Ex. 1008, 1 (abstract), 6.

Patent Owner also argues that driving the Sugiura chip at 1.5 amps and 40 milliwatts would create too much heat. Resp. 45. This argument does not persuasively undermine Petitioner’s rationale and evidence regarding reason to combine because, as we explain in ground one, the claims only require a chip capable of a 40 milliwatt output.

To summarize, the preponderance of the evidence establishes that a person of ordinary skill in the art would have had good reason to combine implement the Sugiura chip (as modified as Krames suggests) in the Begemann device while also making use of a phosphor coating as Allen teaches, and that a person of ordinary skill in the art would have had a reasonable expectation of success in combining the references’ teachings in this manner.

b. *Independent Claim 18*

For brevity, we address only claim recitations that relate to Sugiura. For other recitations, we refer to our assessment of Ground One.

Claim 18 depends from cancelled claims 1 and 9. Claim 1 recites “said chip including a substrate on which epitaxial layers are grown.” Petitioner asserts that Sugiura discloses this limitation by showing an n-type silicon substrate 60 on which epitaxial layers have been grown. Pet. 100. The preponderance of the evidence supports that Begemann teaches or suggests this recitation. Ex. 1010, Fig. 10, 17:12; Ex. 1006 ¶¶ 222.

Claim 1 recites “a buffer layer located on said substrate.” Petitioner asserts that Sugiura discloses this limitation. Pet. 101–102. The preponderance of the evidence supports that Sugiura teaches or suggests this

recitation. Sugiura Figure 10 shows the buffer layer as n-type contact layer 63. Ex. 1010, Fig. 10, 17:28, 17:30–33; Ex. 1006 ¶¶ 223–225; *See also* Ex. 1005, 1/24/2014 Action, 22 (reexamination examiner recognizing this layer).

Claim 1 recites “said buffer layer serving to mitigate differences in material properties between said substrate and other epitaxial layers.” Petitioner argues that Sugiura’s buffer layers would serve this function. Pet. 102. The preponderance of the evidence supports that Sugiura teaches or suggests this recitation. Ex. 1010, Fig. 10, 17:28, 17:30–33; Ex. 1006 ¶¶ 223–225.

Claim 1 recites “a first cladding layer serving to confine electron movement within the chip.” Petitioner asserts that Sugiura discloses a cladding layer that serves to perform the recited function. Pet. 103. The preponderance of the evidence supports that Sugiura teaches or suggests this recitation. Ex. 1010, Fig. 3, 17:34; Ex. 1006 ¶¶ 227–229; *see also* Ex. 1005, 1/24/2014 Action, 23.

Claim 1 recites “said first cladding layer being adjacent said buffer layer.” Petitioner asserts that Sugiura Figure 10 discloses this recitation. Pet. 105. The preponderance of the evidence supports that Sugiura teaches or suggests this recitation. Ex. 1010, Fig. 10; Ex. 1006 ¶ 230.

Claim 1 recites “an active layer.” Petitioner asserts that Sugiura teaches this layer as active layer 65. Pet. 105–106. The preponderance of the evidence supports that Krames teaches or suggests this recitation. Ex. 1010, Fig. 10, 17:34; Ex. 1006 ¶ 231

Claim 1 recites “said active layer emitting light when electrons jump to a valance state.” Petitioner asserts that Sugiura’s active layer will meet this function. Pet. 106. The preponderance of the evidence supports that Sugiura teaches or suggests this recitation. Ex. 1006 ¶ 232.

Claim 1 recites “a second cladding layer.” Petitioner asserts that Sugiura discloses this limitation as current injection layer 66. Pet. 106–107. The preponderance of the evidence supports that Sugiura teaches or suggests this recitation. Ex. 1010, Fig. 10, 17:36–37; Ex. 1006 ¶¶ 233–235; *see also* Ex. 1005, 1/24/2014 Action, 18–19, 23.

Claim 1 recites “said second cladding layer positioned so that said active layer lies between cladding layers.” Petitioner asserts that Sugiura Figure 10 discloses this recitation. Pet. 109. The preponderance of the evidence supports that Sugiura teaches or suggests this recitation. Ex. 1010, Fig. 10; Ex. 1006 ¶ 236.

Claim 1 recites “a contact layer on which an electron [sic, electrode] may be mounted for powering said chip.” Petitioner asserts that Sugiura teaches contact layer 67. The preponderance of the evidence supports that Sugiura teaches or suggests this recitation. Ex. 1010, Fig. 10, 17:37–38, 44; Ex. 1006 ¶ 237.

We next address elements of claim 9 which depends from claim 1. Claim 9 recites “[a] device as recited in claim 1 wherein said substrate is electrically conductive.” Petitioner asserts that Sugiura teaches N-type silicon substrate 60 and that silicon is electrically conductive. Pet. 111. The preponderance of the evidence supports that Sugiura teaches or suggests this recitation. Ex. 1010, 17:12; Ex. 1006 ¶ 239.

We next address elements of claim 18. Claim 18 depends from claim 9. Claim 18 recites “[t]he semiconductor light source as recited in claim 9 wherein: said semiconductor chip is a light emitting diode (LED) chip configured to output light at greater than about 40 milliwatts.” This claim language requires a semiconductor chip *capable* of the recited output.

Petitioner argues that the combination of Sugaira and Krames discloses this claim recitation.

Patent Owner argues that Petitioner never establishes that the modified Sugaira chip “would output light at greater than 40 milliwatts.” Resp. 44. Patent Owner’s argument misses the mark because claim 18 is not a method claim and does not require a particular light output. A preponderance of the evidence, as Petitioner cites, supports that a person of ordinary skill in the art would have been motivated to modify Sugaira to increase area and operating current. Pet. 28–29; Ex. 1007, 2:3–5; Ex. 1006 ¶ 87. The preponderance of the evidence supports that the modified Sugaira chip would, like Krames, be capable of outputting light at greater than 40 milliwatts. Ex. 1008, Abstract, Fig. 12, 5 (Table I, Fig. 12), 10; Ex. 1006 ¶¶ 87, 119.

Claim 18 recites “said LED chip is configured to emit monochromatic visible light.” Petitioner asserts that Sugaira in combination with Krames discloses the limitation. Pet. 111. The preponderance of the evidence supports that Petitioner’s assertion for the reasons we explain when addressing this element with regard to ground 1 and when addressing reasons to combine the references’ teachings.

To summarize, Petitioner has shown by a preponderance of the evidence that the combined teachings of Begemann, Sugaira, Krames, and Allen teach or reasonably suggest all of the elements of claim 18 in the manner claim 18 (and the claims that claim 18 depends from) recites. Thus, we are persuaded that Petitioner has established by a preponderance of the evidence that the combination of Begemann, Sugaira, Krames, and Allen renders claim 18 obvious.

- c. *Dependent Claims 22, 25, 26, 28–30, 32–36, 40–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91*

Petitioner adequately accounts for the limitations recited in claims 22, 25, 26, 28–30, 32–36, 40, 42–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91. Pet. 54–98, 111. Petitioner’s position with respect to these claims is essentially the same as for Ground One except that claim elements relating to LED chip emission characteristics rely on the combination of Sugira and Krames. Patent Owner does not separately dispute these dependent claims except to the extent Patent Owner’s arguments with respect to Ground One still apply. Resp. 46. For the reasons we explain when addressing ground one, Patent Owner’s arguments do not persuasively undermine Petitioner’s showing of unpatentability except with regard to claim 41. As to claim 41, Petitioner does not adequately establish unpatentability for the reason we explain when addressing ground one.

We are persuaded that Petitioner has demonstrated that all of the limitations recited in claims 22, 25, 26, 28–30, 32–36, 40, 42–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91 would have been obvious over Begemann, Sugira, Krames, and Allen. Having reviewed Petitioner’s arguments and supporting evidence, we are persuaded that Petitioner has established by a preponderance of the evidence that claims 22, 25, 26, 28–30, 32–36, 40, 42–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 70–73, 77, 78, 81, 82, 85, 86, and 88–91 are unpatentable under § 103(a) over Begemann, Sugira, Krames, and Allen. Petitioner has not established by a preponderance of the evidence that claim 41 is unpatentable under § 103(a) over Begemann, Sugira, Krames, and Allen.

#### IV. CONCLUSION

Based on the evidence presented with the Petition, the evidence introduced during the trial, and the parties' respective arguments, Petitioner has shown by a preponderance of the evidence that claims 21, 22, 25, 26, 28–30, 32–36, 40, 42–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 71–73, 77, 78, 81, 82, 85, 86, and 88–91 of U.S. Patent No. 6,634,770 C3 are unpatentable.<sup>14</sup> Petitioner has not shown by a preponderance of the evidence that claim 41 of U.S. Patent No. 6,634,770 C3 is unpatentable.

In summary:

| <b>Claims</b>                                                                                                  | <b>35<br/>U.S.C.<br/>§</b> | <b>References/Basis</b>          | <b>Claims<br/>Shown<br/>Unpatentable</b>                                                                           | <b>Claims Not<br/>Shown<br/>Unpatentable</b> |
|----------------------------------------------------------------------------------------------------------------|----------------------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| 21, 22, 25, 26, 28–30, 32–36, 40–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 71–73, 77, 78, 81, 82, 85, 86, 88–91 | 103(a)                     | Begemann, Krames, Allen          | 21, 22, 25, 26, 28–30, 32–36, 40, 42–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 71–73, 77, 78, 81, 82, 85, 86, 88–91 | 41                                           |
| 21, 22, 25, 26, 28–30, 32–36, 40–                                                                              | 103(a)                     | Begemann, Sugiura, Allen, Krames | 21, 22, 25, 26, 28–30, 32–36, 40, 42–44,                                                                           | 41                                           |

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<sup>14</sup> 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).

| Claims                                                                                            | 35<br>U.S.C.<br>§ | References/Basis | Claims<br>Shown<br>Unpatentable                                                       | Claims Not<br>Shown<br>Unpatentable |
|---------------------------------------------------------------------------------------------------|-------------------|------------------|---------------------------------------------------------------------------------------|-------------------------------------|
| 44, 47–49,<br>52, 53, 56–<br>59, 62, 63,<br>65–68, 71–<br>73, 77, 78,<br>81, 82, 85,<br>86, 88–91 |                   |                  | 47–49, 52, 53,<br>56–59, 62, 63,<br>65–68, 71–73,<br>77, 78, 81, 82,<br>85, 86, 88–91 |                                     |

## V. ORDER

For the foregoing reasons, it is

ORDERED that Petitioner establishes by a preponderance of the evidence that claims 21, 22, 25, 26, 28–30, 32–36, 40, 42–44, 47–49, 52, 53, 56–59, 62, 63, 65–68, 71–73, 77, 78, 81, 82, 85, 86, and 88–91 of U.S. Patent No. 6,634,770 C3 are unpatentable;

FURTHER ORDERED that Petitioner does not establish by a preponderance of the evidence that claim 41 of U.S. Patent No. 6,634,770 C3 is unpatentable;

FURTHER ORDERED that Patent Owner’s Motion to Exclude Exhibit 1028 is *denied*;

FURTHER ORDERED that Petitioner’s Motion to Exclude Exhibits 2017 and 2030 is *dismissed as moot*; and

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

IPR2022-00848  
Patent 6,634,770 C3

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