

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CREE, INC.,
Petitioner,

v.

DOCUMENT SECURITY SYSTEMS, INC.,
Patent Owner.

IPR2020-00557
Patent 6,784,460 B2

Before SCOTT C. MOORE, AMBER L. HAGY, and JASON M. REPKO,
Administrative Patent Judges.

HAGY, *Administrative Patent Judge.*

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 314

I. INTRODUCTION

A. *Background and Summary*

Petitioner Cree, Inc. (“Petitioner”) filed a petition for *inter partes* review (Paper 1 (“Pet.”)) challenging claims 1–8 of U.S. Patent No. 6,784,460 B2 (Ex. 1001, the “’460 patent”). *See* 35 U.S.C. § 311 (2018). Document Security Systems, Inc. (“Patent Owner”) did not file a preliminary response. Pursuant to 35 U.S.C. § 314, we instituted an *inter partes* review of all challenged claims on all grounds presented in the Petition. Paper 6 (“Institution Decision” or “Inst. Dec.”). Patent Owner filed a Patent Owner Response (Paper 12, “PO Resp.”), Petitioner filed a Reply (Paper 15, “Reply”), and Patent Owner filed a Sur-reply (Paper 24, “Sur-reply”).

On May 27, 2021, we conducted an oral hearing. A copy of the transcript (Paper 36, “Tr.”) is included in the record.

We have jurisdiction under 35 U.S.C. § 6(b). For the reasons that follow, we determine that Petitioner has shown by a preponderance of the evidence that claims 1–8 of the ’460 patent are unpatentable. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a).

B. *Real Parties in Interest*

Petitioner identifies the real party-in-interest as Cree, Inc. Pet. iv.

Patent Owner identifies the real party-in-interest as Document Security Systems, Inc. Paper 4, 1.

C. *Related Matters*

Both parties identify the following matter as related: *Document Security Systems, Inc. v. Cree, Inc.*, No. 2-19-cv-08141 (C.D. Cal.). Pet. iv; Paper 4, 2.

D. The '460 Patent (Ex. 1001)

The '460 patent, titled “Chip Shaping for Flip-Chip Light Emitting Diode,” issued August 31, 2004, based on an application filed October 10, 2002. Ex. 1001, codes (22), (45), (54).

The '460 patent relates to a method of fabricating a semiconductor flip-chip light emitting diode (“LED”) to improve light extraction. Ex. 1001, 1:7–10, 1:39–41. The '460 patent does not explicitly define the term “flip-chip,” but Petitioner’s declarant, Robert Karlicek, Ph.D., testifies that “[f]lip-chip’ refers to a semiconductor packaging technique in which a device is fabricated by depositing layers on a substrate,” and “one of the resultant devices is then inverted, or flipped upside down for packaging, such that the substrate faces up, and the semiconductor layers are at the bottom.” Ex. 1012 ¶ 28. This testimony is consistent with the disclosure of the '460 patent. The '460 patent first describes prior art LEDs that were fabricated on, and emitted light through, substrates having a “cuboidal shape (e.g., a rectangular prism),” with semiconductor layers below the substrate, as depicted in Figure 1, reproduced below. Ex. 1001, 1:13–19.

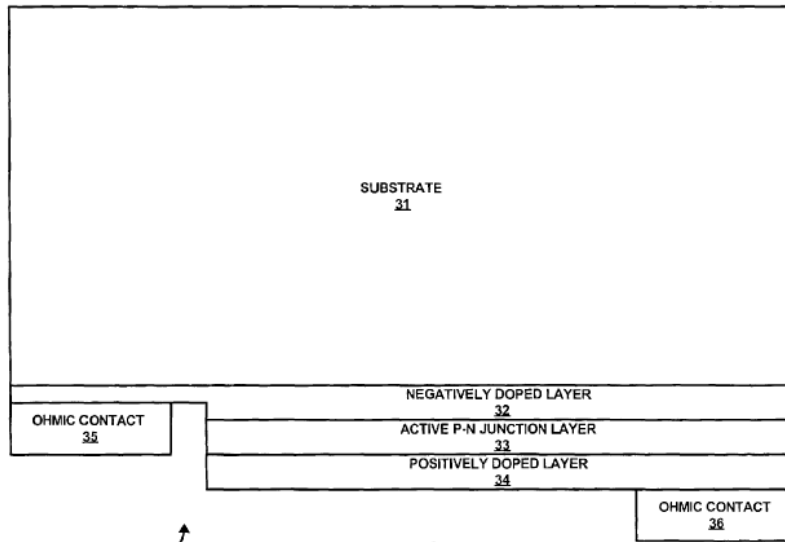


FIG. 1
(PRIOR ART)

Figure 1 of the '460 patent depicts “a side view of a known LED of flip-chip design.” Ex. 1001, 1:66–67.

Figure 2 of the '460 patent, reproduced below, purports to show a drawback of a cuboidal substrate in terms of light “trap cones”:

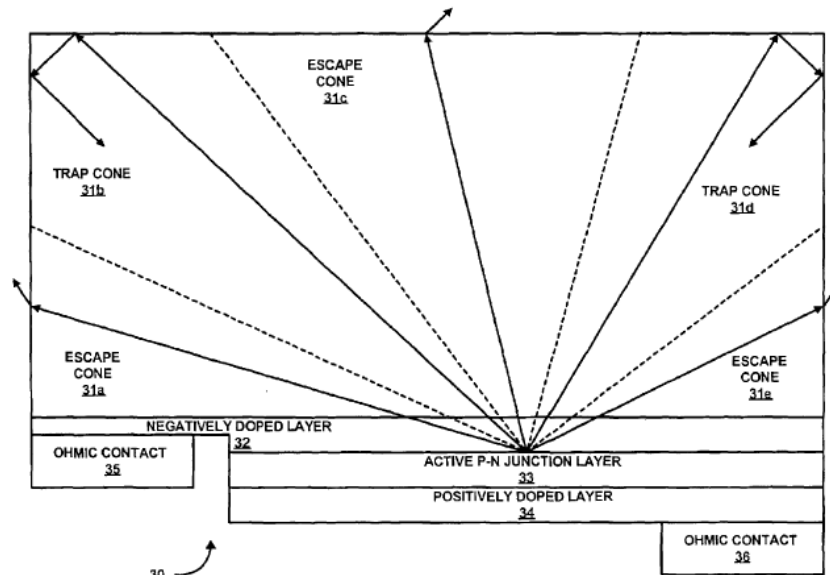
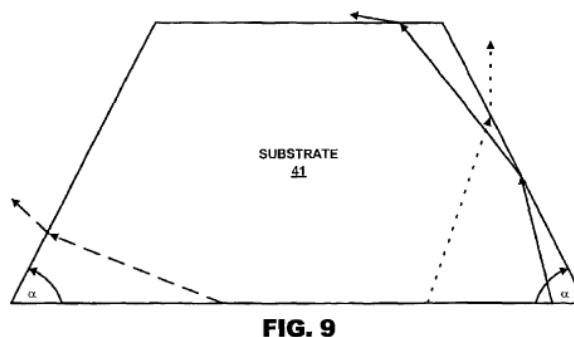
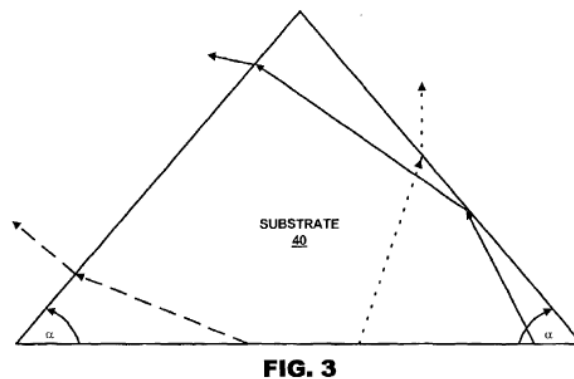


FIG. 2
(PRIOR ART)

Figure 2 of the '460 patent “illustrates a light extraction operation of the LED of FIG. 1.” Ex. 1001, 2:1–2.

The '460 patent explains that, as illustrated in Figure 2, because of the difference between the optical index of refraction of the substrate and the surrounding environment, light emitted from an active p-n junction layer at angles within “trap cones” is trapped within the substrate by total internal reflection (“TIR”). *See* Ex. 1001, 1:22–38. The '460 patent purports to address this problem by providing substrates having a pyramidal shape. *Id.* at 2:22–23, 3:1–2. According to the '460 patent, such shapes (as shown in Figures 3 and 9, reproduced below), enable light to escape the substrate that would otherwise be trapped by TIR, because more light intersects the walls of the substrate at angles that are less than the “critical angle,” i.e., the angle of TIR. *See id.* at 2:26–35, 3:5–15.



Figures 3 and 9 of the '460 patent illustrate “a side view of a LED substrate having an apexed pyramidal shape” and “side view of a LED substrate having a truncated pyramidal shape,” respectively. Ex. 1001, 2:3–4, 2:9–10.

E. Illustrative Claim

Of the challenged claims, claims 1, 6, and 8 are independent. Challenged claims 2–5 depend directly or indirectly from claim 1, and claim 7 depends from claim 6. Claim 1 illustrates the claimed subject matter and is reproduced below (formatting and lettering added)¹:

1[p] A semiconductor light-emitting diode of flip-chip design, comprising:

[a] a light-emitting region including a negatively doped layer, a positively doped layer, and an active p-n junction layer between said negatively doped layer and said positively doped layer;

[b] a transparent substrate overlying said light-light emitting region,

[c] said substrate having a pyramidal shape so that said substrate has a cross-sectional area that decreases with distance from said junction

[d] and wherein lateral extent of said substrate is bound by lateral extent of a doped layer nearest to the trans[p]arent substrate; and

[e] ohmic contacts for forward biasing said junction layer so that at least most of the light is emitted from the junction layer into the surrounding environment is emitted through said substrate.

Ex. 1001, 6:12–25.²

¹ We have added lettering to the elements in keeping with the lettering used by Petitioner. *See* Pet. 5–7.

² Claim 1 has an apparent typographical error in referring to a “transnarent” substrate instead of “transparent.” *Fitbit, Inc. v. Valencell, Inc.*, 964 F.3d 1112, 1119–20 (Fed. Cir. 2020) (holding the Board erred in not correcting a “conspicuous” and undisputed error related to antecedent basis).

F. Instituted Grounds of Unpatentability

We instituted *inter partes* review of all challenged claims based on all grounds of unpatentability asserted in the Petition (Dec. 2–3, 32; Pet. 1–2):

Claims Challenged	35 U.S.C. §	Reference(s)/Basis
1–7	103(a) ³	Slater ⁴
1–7	103(a)	Slater, Steigerwald ⁵
1–7	103(a)	Slater, Steigerwald, Haitz ⁶
1–8	103(a)	Applicant’s Admitted Prior Art (“AAPA”) ⁷ , Camras ⁸
1–7	103(a)	AAPA, Steigerwald, Haitz

³ The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (“AIA”), included revisions to 35 U.S.C. § 103 that became effective after the filing of the application that led to the challenged patent.

Therefore, we apply the pre-AIA version of 35 U.S.C. § 103.

⁴ Slater, Jr., et al., U.S. Pat. No. 6,791,119 B2, issued September 14, 2004 (Ex. 1003, “Slater”).

⁵ Steigerwald, et al., U.S. Pat. No. 6,573,537 B1, issued June 3, 2003 (Ex. 1004, “Steigerwald”).

⁶ Haitz, U.S. Pat. No. 5,087,949, issued February 11, 1992 (Ex. 1008, “Haitz”).

⁷ Petitioner identifies disclosure in the ’460 patent at column 1, lines 13–38, and Figures 1 and 2 as AAPA. Pet. 15–16.

⁸ Camras, et al., U.S. Pat. No. 6,784,463 B2, issued August 31, 2004 (Ex. 1005, “Camras”).

II. ANALYSIS

A. *Principles of Law*

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.⁹ *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden of persuasion never shifts to Patent Owner. *See Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

⁹ The parties do not direct our attention to any objective evidence of nonobviousness.

B. Level of Ordinary Skill in the Art

The level of skill in the art is a factual determination that provides a primary guarantee of objectivity in an obviousness analysis. *Al-Site Corp. v. VSI Int'l Inc.*, 174 F.3d 1308, 1324 (Fed. Cir. 1999) (citing *Graham*, 383 U.S. at 17–18; *Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714, 718 (Fed. Cir. 1991)).

Relying on the declaration testimony of Dr. Karlicek (Ex. 1012 (“Karlicek Decl.”)), Petitioner asserts the person of ordinary skill in the art of the ’460 patent “would have had a B.S. in electrical engineering or a related field, and four years’ experience designing LED packages,” noting that “a higher level of education or skill might make up for less experience, and vice-versa.” Pet. 15 (citing Ex. 1012 ¶¶ 23–26). Patent Owner does not propose an alternative assessment. *See generally* PO Resp.

Having reviewed the arguments and evidence in the full record, we adopt Petitioner’s definition above, as we did initially in the Institution Decision, as it is consistent with the ’460 patent and the asserted prior art.

C. Claim Construction

In interpreting the claims of the ’460 patent, we “us[e] the same claim construction standard that would be used to construe the claim[s] in a civil action under 35 U.S.C. [§] 282(b).” *See* 37 C.F.R. § 42.100(b) (2019). The claim construction standard includes construing claims in accordance with the ordinary and customary meaning of such claims as would have been understood by one of ordinary skill in the art in light of the written

description and the prosecution history pertaining to the patent. *See id.*; *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–14 (Fed. Cir. 2005) (en banc).

1. “ohmic contacts for forward biasing said junction layer so that at least most of the light . . . emitted from the junction layer into the surrounding substrate is emitted through said substrate” (limitation 1[e])

In our Institution Decision, we addressed construction of the phrase “ohmic contacts for forward biasing said junction layer so that at least most of the light is emitted from the junction layer into the surrounding environment is emitted through said substrate,”¹⁰ which appears in independent claims 1, 6, and 8. Ex. 1001, 6:22–25, 6:51–55, 7:3–8:3. We determined, on the preliminary record, that the “so that” clause recites a limitation on the physical placement of the ohmic contacts. Inst. Dec. 13–14. We construed this phrase as “including ohmic contacts positioned to allow most of the light emitted from the junction layer into the surrounding environment to be emitted through the substrate.” *Id.* at 13–14. We further noted: “As illustrated in the ’460 patent, this may be accomplished by placing the ohmic contacts below the substrate, where they do not block light from passing through the substrate into the surrounding environment.” *Id.* at 14.

Patent Owner states that it “agrees with the Board’s construction based on the Board’s reasoning,” and “applies this construction” in its Response. PO Resp. 14. Petitioner does not challenge or otherwise further

¹⁰ We determine the claim language contains a typographic error. The first “is” appears to be in error, and should be preceded by “that” or omitted entirely. The parties do not address this point. Reading the language in context and in light of the Specification, we read the first “is emitted” as “that is emitted.” *See Fitbit, Inc.*, 964 F.3d at 1119–20.

address our construction. *See generally* Reply. We, therefore, maintain our original construction of this phrase.

2. “*having a pyramidal shape*”(limitation 1[c])

Claim 1 recites a substrate “having a pyramidal shape so that said substrate has a cross-sectional area that decreases with distance from said junction.” Ex. 1001, 6:17–18. Claims 6 and 8 have similar recitations. *Id.* at 6:46–47, 6:66–67.

During trial, the parties presented constructions of “pyramidal shape.” Patent Owner first contended that “[p]yramidal shape” should be construed as a “shape in which all sides of the substrate are angled inward from the outer edge.” PO Resp. 13. Petitioner responded that the term should be construed consistently with “the definition of ‘pyramidal’ Applicant provided during prosecution.” Reply 2. In particular, Petitioner stated: “During prosecution, Applicant explicitly defined the phrase ‘pyramid shape’ as ‘a polyhedron having a polygon base and triangular faces with a common vertex as illustrated in all of the Figures of the present invention. For truncated pyramid shape, the shape should be a pyramid shape but for the truncation.’” *Id.* (citing Ex. 1002 at 36, 51). Petitioner took issue with Patent Owner’s proposed construction as requiring “only that all sides incline inwardly, which would permit the sides to meet at a common edge, rather than a common vertex,” a construction Petitioner asserts was disclaimed by Applicant in distinguishing the prior art during prosecution. *Id.* at 2. Thus, Petitioner proposed that “pyramidal shape” be construed as “a polyhedron having a polygon base and triangular faces with a common vertex.” *Id.* at 4. Patent Owner responded that it “is willing to modify its construction to ‘shape with a polygonal base in which all sides of the

substrate are angled such that they meet at a common vertex or would meet at a common vertex save for a truncation.”” Sur-reply 2.

Ultimately, the parties’ proposed constructions of “pyramidal shape” are not materially different within the context of this proceeding. Rather, as is clear from the parties’ arguments regarding the prior art, the core of the parties’ dispute lies in whether the claim limitation “substrate having a pyramidal shape” is open-ended or closed-ended—that is, whether it excludes substrates in which a portion is cuboidally shaped. *See* Reply 5; Sur-reply 3.

For the reasons explained herein, we determine that we need not resolve this dispute to resolve Petitioner’s patentability challenge to claims 1–8 herein, as this dispute is not material to at least one of Petitioner’s unpatentability grounds—namely, the ground premised on Camras and AAPA, which we determine below is dispositive. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (per curiam) (claim terms need to be construed “only to the extent necessary to resolve the controversy” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))). We also determine that no explicit construction of any other terms is needed to resolve the issues presented by the arguments and evidence of record.

D. Ground 4: Asserted Obviousness over AAPA and Camras

Petitioner contends claims 1–8 are unpatentable under 35 U.S.C. § 103(a) over AAPA and Camras. Pet. 57–66. Because we find this ground is dispositive of all claims in this proceeding, we do not address the other grounds raised by Petitioner. *See infra* Section II.E.

1. Overview of Camras (Ex. 1005)

Camras is a United States Patent issued on August 31, 2004, based on an application filed on March 11, 2002. Ex. 1005, codes (22), (45).

Petitioner contends Camras is prior art under 35 U.S.C. § 102(e). Pet. 19. Patent Owner does not dispute the prior-art status of Camras. *See generally* PO Resp.

Camras discloses a semiconductor LED. Ex. 1005, 2:52–65. Figure 7A of Camras, reproduced below, shows substrate 117 overlying first doped layer 114. *Id.* at 12:8–31.

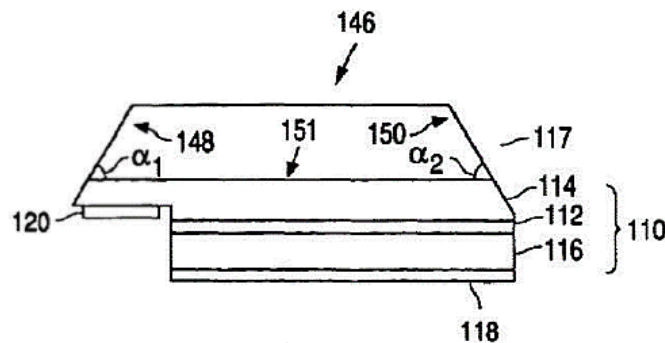


FIG. 7A

Figure 7A schematically illustrates a light-emitting device with a superstrate shaped to “increase light extraction efficiency.” Ex. 1005, 3:61–63.

Camras states that the substrate “may approximate the shape of, for example, a dome or a hemisphere.” *Id.* at 12:19–22. Camras explains that this shape ensures that “more of the light emitted by active region 112 is incident on interfaces between the superstrate and the external environment at angles close to normal incidence than is the case for a superstrate having a cubic or rectangular prism shape.” *Id.* at 12:22–27. Camras teaches that the substrate can be formed by a conventional wafer-dicing process. *Id.* at 12:13–15.

2. Overview of AAPA

The '460 patent depicts known flip-chip semiconductor LEDs in Figure 1 (reproduced below) and provides the following description:

FIG. 1 illustrates a known LED 30 of flip-chip design, where the LED 30 includes a transparent substrate 31 having a cuboidal shape (e.g., a rectangular prism), a negatively doped layer 32, an active p-n junction layer 33, and a positively doped layer 34. A pair of ohmic contacts 35 and 36 are employed to forward bias LED 30 whereby light is generated and emitted from the active p-n junction layer 33 into the substrate 31.

Ex. 1001, 1:13–38.¹¹

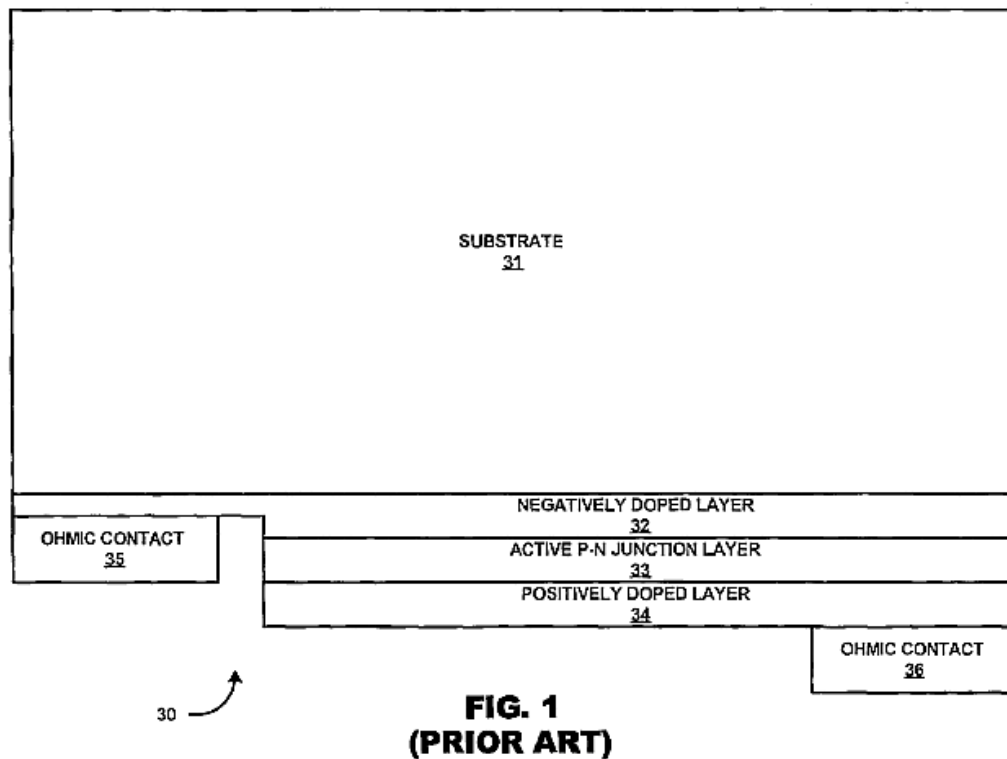


Figure 1 “illustrates a side view of a known LED of flip-chip design.” Ex. 1001, 1:66–67.

¹¹ All bolding of reference numerals has been omitted herein.

3. Analysis

a. Claim 1

Although Petitioner purports to rely on AAPA as disclosing elements 1[p], 1[a], 1[b], 1[d], and 1[e]—that is, all of the claimed elements aside from the pyramidally shaped substrate recited in limitation 1[c]—Petitioner also presents evidence that Camras discloses those limitations as well. Pet. 52–62. Petitioner relies on Camras in particular as teaching the pyramidally shaped substrate (limitation 1[c]). *Id.* at 54–57.

As set forth in our analysis below, we determine Petitioner has demonstrated by a preponderance of the evidence that Camras, and alternatively, AAPA combined with Camras,¹² teaches or suggests the subject matter of claim 1.

(1) Limitation 1[p]: “A semiconductor light-emitting diode of flip-chip design”

Petitioner presents evidence that AAPA admits that a semiconductor flip-chip LED was known in the art. Pet. 52 (citing Ex. 1001, 1:13–15,

¹² On August 18, 2020, the Director of the Patent & Trademark Office issued a Memorandum addressing the use of “applicant admitted prior art” (“AAPA”) as the basis for an *inter partes* review challenge. See USPTO Memorandum, Treatment of Statements of the Applicant in the Challenged Patent in Inter Partes Reviews Under § 311 (August 18, 2020), available at https://www.uspto.gov/sites/default/files/documents/signed_aapa_guidance_memo.pdf. That Memorandum concludes that a permissible use of admitted prior art in an *inter partes* review is to “supply missing claim limitations that were generally known in the art prior to the invention.” *Id.* at 9. As discussed herein, Petitioner’s citation, as to certain limitations, to the description of known flip-chip LEDs in the ’460 patent falls within this category. We further note, as also addressed herein, that Petitioner additionally demonstrates that Camras teaches or suggests the limitations of the challenged claims, and thus Petitioner does not rely solely on AAPA.

Fig. 1 (“An LED is a semiconductor chip or die that emits light when a forward current flows through the LED. FIG. 1 illustrates a known LED 30 of flip-chip design.”) (bolding omitted).

Petitioner also presents evidence that Camras discloses “a flip-chip, semiconductor LED.” *Id.* at 54 (citing Ex. 1005, 2:52–53 (“light-emitting semiconductor device includes a stack of layers including an active region”), 2:63–65 (“the light-emitting semiconductor device may be advantageously mounted as a flip chip to a submount”)).

Petitioner’s arguments and evidence as to both AAPA and Camras are persuasive on this record. Patent Owner does not present evidence or argument addressing Petitioner’s showing as to the preamble.

We are persuaded Petitioner has demonstrated that both Camras and AAPA teach “[a] semiconductor light-emitting diode of flip-chip design,” as recited in claim 1.

(2) Limitation 1[a]: “a light-emitting region including a negatively doped layer, a positively doped layer, and an active p-n junction layer between said negatively doped layer and said positively doped layer”

Petitioner presents evidence that AAPA teaches this limitation by describing a prior-art LED, shown in Figure 1 of the ’460 patent, as having “a negatively doped layer 32, an active p-n junction layer 33, and a positively doped layer 34 . . . whereby light is generated and emitted from the active p-n junction layer.” Ex. 1001, 1:17–22; Pet. 52. Figure 1 of the ’460 patent, as annotated by Petitioner (Pet. 52), is reproduced below.

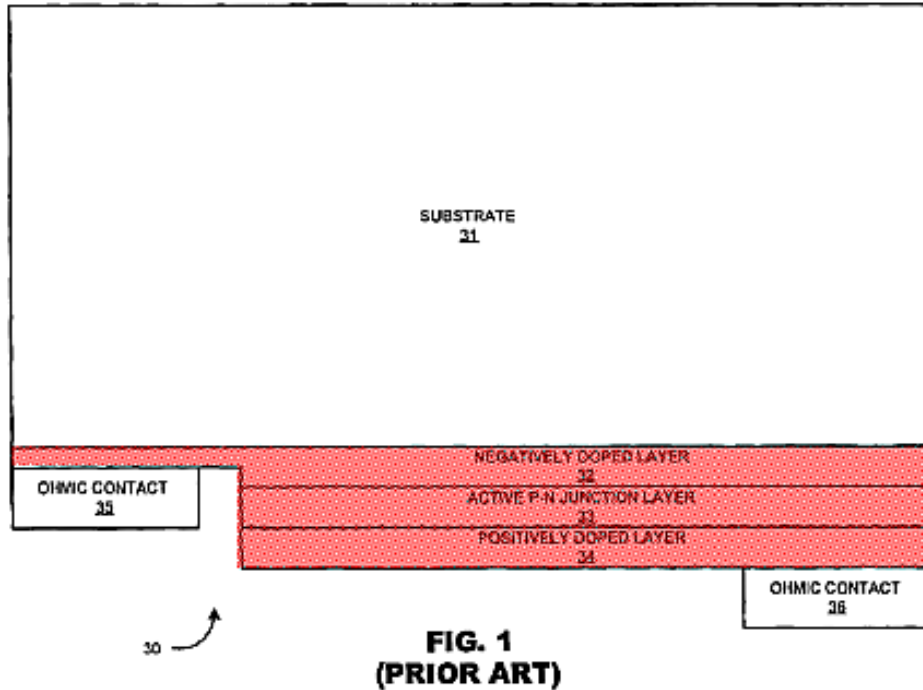


Figure 1 of the '460 patent, as annotated by Petitioner (Pet. 52), “illustrates a side view of a known LED of flip-chip design.” Ex. 1001, 1:66–67.

Petitioner also presents evidence that Camras discloses a flip-chip semiconductor LED “having the typical diode structure.” Pet. 54 (citing Ex. 1005, 4:13–54, Fig. 7A). Figure 7A of Camras is reproduced below.

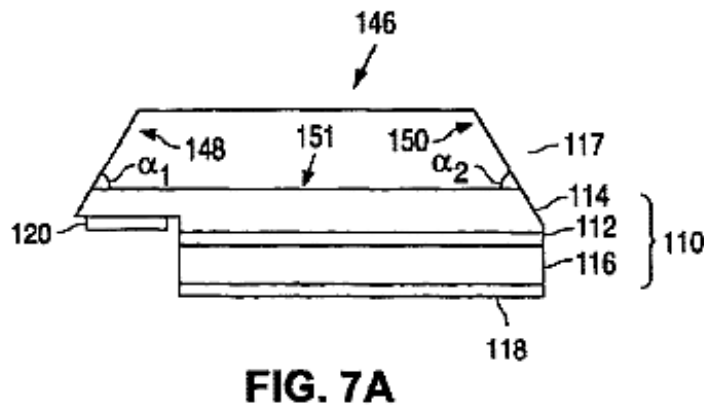


Figure 7A schematically illustrates a light-emitting device.
Ex. 1005, 3:62–64.

In Figure 7A, Camras discloses light-emitting device 146 having superstrate 117 and active region 112 between regions 114 and 116. Ex. 1005, 12:10–11, 12:15–16, 12:23. In describing the embodiments generally, Camras discloses that “[a]ctive region 112 is disposed between a first semiconductor region 114 having a first conductivity type and a second semiconductor region 116 having a second conductivity type,” and states that these layers may be “undoped or doped either n-type or p-type.” *Id.* 4:24–32. Camras also states that “a diode junction is formed in or adjacent to active region 112,” thus disclosing a p-n junction. *See id.* at 4:27–28.

Patent Owner does not present arguments or evidence addressing Petitioner’s showing as to this limitation. *See generally* PO Resp.

We are persuaded Petitioner has demonstrated that Camras, and alternatively AAPA, teaches “a light-emitting region including a negatively doped layer, a positively doped layer, and an active p-n junction layer between said negatively doped layer and said positively doped layer,” as recited in claim 1.

(3) Limitation 1[b]: “a transparent substrate overlying said light-light emitting region”

Petitioner presents evidence that AAPA discloses this limitation by describing the prior-art LED depicted in Figure 1 as including “transparent substrate 31.” Ex. 1001, 1:16.

Petitioner also presents evidence that Camras discloses this limitation, as illustrated in Petitioner’s annotated version of Camras Figure 7A reproduced below.

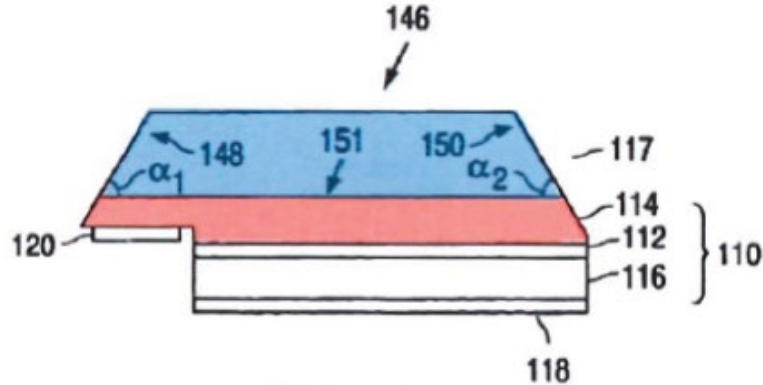


Figure 7A of Camras, as annotated by Petitioner (Pet. 54), schematically illustrates a light-emitting device. Ex. 1005, 3:62–64.

In particular, Petitioner presents evidence that Camras discloses transparent substrate 117 (shaded blue by Petitioner), which is depicted in Figure 7A as overlying doped regions 114 (shaded red by Petitioner) and 116 and active region 112. Pet. 54; Ex. 1005, 4:24–32. Relying in part on the testimony of Dr. Karlicek, Petitioner presents evidence that “[w]hile Camras calls substrate 117 a ‘superstrate’, the [ordinarily skilled artisan] would understand it as a substrate because the diode stack 110 may be grown on it.” Pet. 54 (citing Ex. 1005, 11:41–43; Ex. 1012 ¶¶ 71, 211–212) (emphasis omitted). Camras further discloses that substrate 117 is “substantially transparent to light emitted by active region 112.” Ex. 1005, 4:42–44.

Patent Owner argues limitations 1[b], 1[c], and 1[d] collectively, asserting that Petitioner does not consistently apply the “substrate” limitations according to their antecedent basis. PO Resp. 57–59. In particular, Patent Owner argues the Petition reads the “substrate” of limitation 1[b] on substrate 31 as depicted in Figure 1 of the ’460 patent

(which shows a “prior art” LED, and is part of Petitioner’s asserted AAPA). *Id.* at 58. Patent Owner asserts this is inconsistent with Petitioner’s reliance, for limitation 1[c], on substrate 17 of Figure 7A of Camras, and is also inconsistent with Petitioner’s contention, for limitation 1[d], that the “substrate” is met by either or both Figure 1 from the ’460 patent and Figure 7A of Camras. *Id.* at 59. In short, according to Patent Owner, what Petitioner contends meets the “substrate” limitation in 1[c] “has a different shape” than what Petitioner contends meets the “substrate” limitation of 1[b], and comes from a different reference. *Id.*

Patent Owner’s argument is unavailing. First, as noted above, Petitioner presents evidence that *both* Camras and AAPA disclose a “transparent substrate” as recited in limitation 1[b]. As noted below, Petitioner also presents evidence that Camras discloses the pyramidally shaped substrate as recited in limitation 1[c] and the substrate being bound by the lateral extent of the nearest doped layer as recited in limitation 1[d]. *See infra* Sections II.D.3.a.(4), (5). Thus, in presenting evidence that Camras teaches or suggests all of the substrate limitations, Petitioner has not presented an inconsistent analysis.

Second, even regarding Petitioner’s showing based on AAPA combined with Camras, Petitioner’s arguments are not inconsistent. Petitioner presents evidence that AAPA discloses a transparent substrate, although cuboidally shaped, and also presents evidence that the ordinarily skilled artisan would have modified AAPA’s cuboidal substrate to have a truncated pyramidal shape as disclosed in Camras. *See infra* Section II.D.3.a(4). In particular, Petitioner argues: “Thus, replacement of the AAPA’s cuboidal substrate with Camras’ truncated pyramidal substrate

would have been the application of a known modification (beveling the substrate), to a known device (the cuboidal substrate of the AAPA), which was ready for improvement, to yield predictable results (decreased light trapping).” Pet. 57 (emphasis omitted) (citing Ex. 1012 ¶ 218). In so doing, Petitioner is not inconsistently applying the substrate limitations, but is presenting a typical obviousness analysis based on a combination of prior art references. *See, e.g., KSR*, 550 U.S. at 416 (noting that the “combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results”).

We are persuaded Petitioner has demonstrated that Camras, and alternatively AAPA, teaches “a transparent substrate overlying said light-light emitting region,” as recited in claim 1.

(4) Limitation 1[c]: “said substrate having a pyramidal shape so that said substrate has a cross-sectional area that decreases with distance from said junction”

Petitioner presents evidence that Camras discloses, in Figure 7A:

light-emitting device 146 includes superstrate 117 having surfaces 148 and 150 which form acute angles . . . with a top surface 151 of stack 110. . . . The shapes of the superstrates in light-emitting devices 146 and 152 may approximate the shape of, for example, a dome or a hemisphere.

Pet. 54 (citing Ex. 1005, 12:10–13, 12:19–22). Figure 7A, as annotated by Petitioner, is reproduced below.

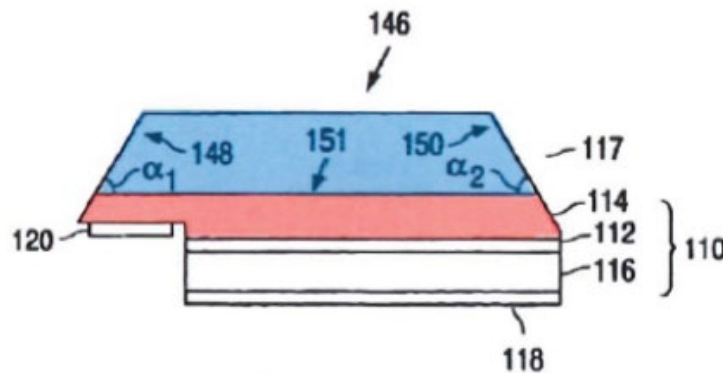
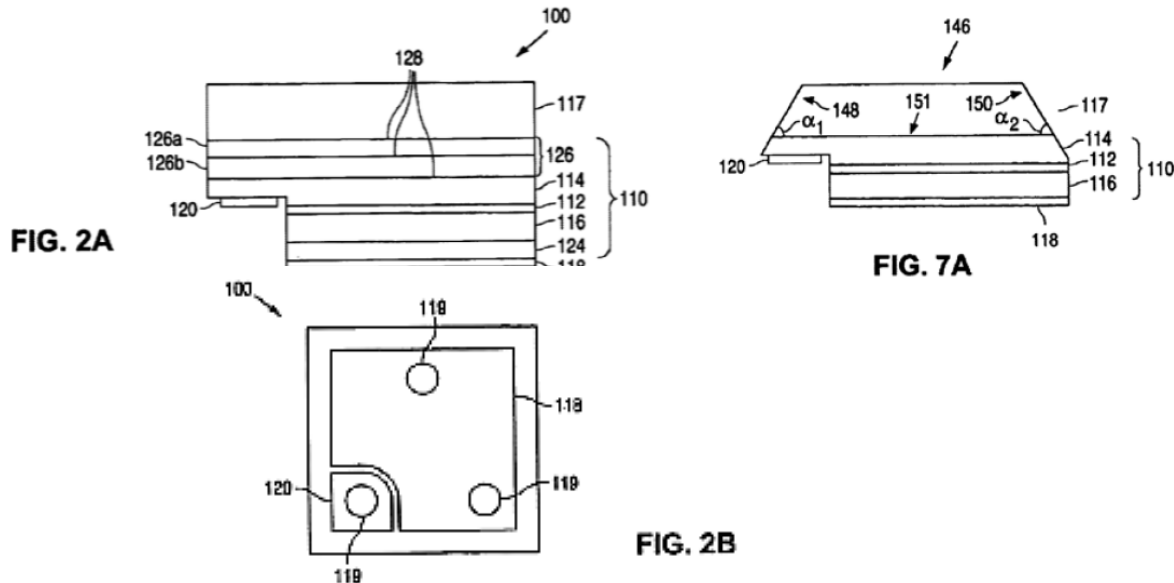


Figure 7A of Camras, as annotated by Petitioner (Pet. 54), schematically illustrates a light-emitting device. Ex. 1005, 3:62–64.

Petitioner further presents testimony of Dr. Karlicek attesting that because substrate 117 (shaded blue by Petitioner) is chosen to “approximate a dome,” the ordinarily skilled artisan would have understood that its angled surfaces are formed on all sides, and the angles of the sidewalls would be equal and inclined toward a central point (as pictured in annotated Figure 7A, above), since this configuration would approximate a dome or hemisphere. Pet. 54 (citing Ex. 1012 ¶¶ 212–215). Petitioner further notes, also with reference to Figure 7A: “As seen, the cross sectional area of substrate 117 decreases with distance from nearest doped layer 114.” *Id.* at 55.

As further support for its contention that Camras discloses a pyramidal shape in Figure 7A, Petitioner presents evidence, in the form of testimony by Dr. Karlicek, that the ordinarily skilled artisan would have understood “substrate 117 to have a square base, or at least for this feature to be obvious,” because the artisan would have understood that the device depicted in Figure 7A of Camras is essentially the “square FIG. 2 device but

with a beveled, instead of a cuboidal, substrate.” *Id.* (citing Ex. 1012 ¶¶ 214, 75). Figures 2A, 2B, and 7A of Camras are reproduced below.



Figures 2A, 2B, and Figure 7A of Camras schematically illustrate light-emitting devices. Ex. 1005, 3:48–49, 3:62–64.

By reference to these figures, Petitioner further notes that “[t]he two devices have very similar cross sections, and Camras describes the FIG. 7A device immediately after discussing the light trapping disadvantage of the FIG. 2 device,” and also “a square device with a square substrate would be consistent with Camras’ teaching that the substrate 117 is intended to approximate a dome or hemisphere.” *Id.* (emphasis omitted) (citing Ex. 1012 ¶¶ 75, 214; Ex. 1005, 11:66–12:31).

Petitioner also presents evidence regarding the combination of AAPA and Camras, asserting (based on supporting testimony by Dr. Karlicek) that “[i]t would have been obvious to replace the cuboidal substrate 31 of the AAPA with Camras’ centered, truncated, pyramidal substrate 117, in order to improve light extraction.” Pet. 56 (emphasis omitted) (citing Ex. 1012 ¶¶ 216–219). With regard to the motivation for the combination, Petitioner

presents evidence that “Camras recognizes that light may be trapped by TIR in cuboidal substrates,” and the ordinarily skilled artisan “would have understood that the cuboidal substrate 31 of the AAPA, like FIG. 2 of Camras, was ready for improvement” by using Camras’ “dome-like substrate,” which Camras describes as improving light extraction over a cuboidal substrate. *Id.* (emphasis omitted) (citing Ex. 1005, 12:1–5, 12:8–10, 12:22–31). Relying in part on the testimony of Dr. Karlicek, Petitioner contends, therefore, “replacement of the AAPA’s cuboidal substrate with Camras’ truncated pyramidal substrate would have been the application of a known modification (beveling the substrate), to a known device (the cuboidal substrate of the AAPA), which was ready for improvement, to yield predictable results (decreased light trapping).” *Id.* at 57 (emphasis omitted) (citing Ex. 1012 ¶ 218).

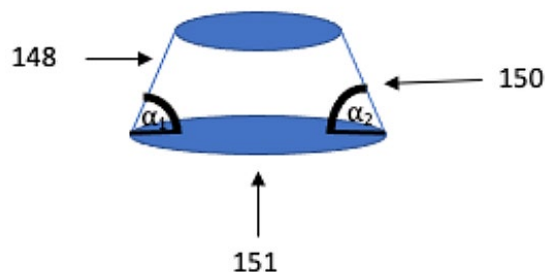
Petitioner additionally presents evidence that the ordinarily skilled artisan would have been motivated “to keep Camras’ centered, truncated pyramid in the combination.” *Id.* In particular, Petitioner presents evidence, including the testimony of Dr. Karlicek, that “Camras teaches that the substrate’s bevel angles can be varied to optimize extraction efficiency,” and the ordinarily skilled artisan “would have been motivated to choose one optimal angle to use around the entire perimeter, in order to optimize overall efficiency without the need for additional manufacturing steps.” *Id.* (emphasis omitted) (citing Ex. 1005, 12:51–56; Ex. 1012 ¶ 219). Also relying on the testimony of Dr. Karlicek, Petitioner presents evidence that “a centered, truncated pyramid would advantageously create an axial symmetric emission pattern, which would be compatible with rotationally symmetric optics like domes or hemispheres.” *Id.* (citing Ex. 1012 ¶ 220).

Patent Owner argues that Petitioner incorrectly views Camras' substrate, as depicted in Figure 7A, as a truncated pyramid:

Contrary to the contentions of Petitioner and Dr. Karlicek, nothing in this disclosure teaches or renders obvious to one of skill in the art, the number of sides that an LED with the cross section of Figure 7A would have or that it would necessarily be pyramidal if rendered in three-dimensions. . . . Indeed, Dr. Karlicek confirmed at deposition that "Camras doesn't . . . actually include a description specifically of the number of sides it would have."

PO Resp. 61–62 (citing Ex. 2001 ¶ 146; Ex. 2002, 76:16–77:2).

Referencing Camras' teaching that the shape of the substrate is "designed to approximate the shape of, for example, a dome or a hemisphere," Patent Owner contends that the ordinarily skilled artisan would have understood that the substrate depicted in Figure 7A is *conical in shape*. *Id.* at 62 (citing Ex. 2001 ¶ 147). Patent Owner reproduces the following illustration from the Baker Declaration to graphically illustrate its contention:



The figure reproduced above is an illustration of the substrate depicted in Figure 7A of Camras as having a conical shape.

PO Resp. 62 (citing Ex. 2001 ¶ 147).

Patent Owner asserts "[s]uch a conical shape could . . . easily be created by the dicing, etching and milling techniques referenced by Camras as quoted above." PO Resp. 62 (citing Ex. 2001 ¶ 148). As further support for its reading of Camras, Patent Owner points to Camras' Figure 7B,

reproduced below, which depicts superstrate 117 as “having curved surfaces 154 and 156.” *Id.* at 61; Ex. 1005, 12:14–17.

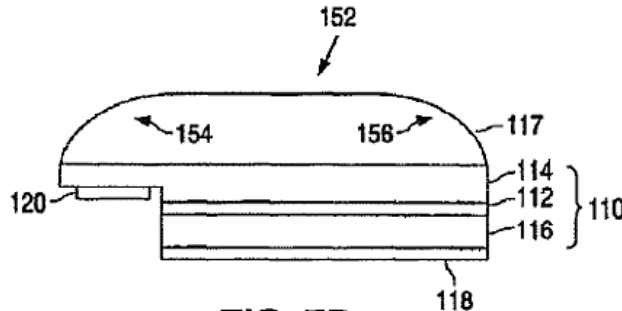


Figure 7B of Camras schematically illustrates a light-emitting device. Ex. 1005, 3:62–63.

Patent Owner further asserts that the embodiment disclosed in Figure 7B has a “conical shape” with a “curved surface” that is specifically claimed in Camras in claims 14 and 50, but “a substrate with a pyramidal shape is not claimed” in Camras. PO Resp. 63. Patent Owner acknowledges deposition testimony by Dr. Karlicek that a conical substrate “would not be ‘cost-effective’ from a manufacturing perspective” (*id.* (citing Ex. 2002, 79:10–80:25)), but asserts this does not undermine Patent Owner’s interpretation of Camras’ disclosure because “Camras is not teaching or disclosing substrates that are cost-effective to manufacture,” but is instead “teaching the design of LEDs with ‘improved light generating capability.’” *Id.* (citing Ex. 2001 ¶ 149; Ex. 1005, 1:15–20).

Petitioner responds by reiterating that the ordinarily skilled artisan would have understood Camras’ Figure 7A substrate is a centered truncated pyramid, and thus not a truncated cone. Petitioner first points to Camras’ description of Figure 7A itself, in which Camras “describes its substrate 146 as having side surfaces₂ (plural), 148, 150.” Reply 7–8 (citing Ex. 1005,

12:12–14). According to Petitioner, “[i]f substrate 146 had a circular perimeter, Camras would describe a single continuous side surface.” *Id.* at 8 (emphasis omitted) (citing Ex. 1014 ¶ 17). Petitioner further notes that Patent Owner’s expert admitted that if Camras’ substrate “was a truncated cone, it would have only a single side surface.” *Id.* at 7–8 (citing Ex. 1013, 122:1–9).

Patent Owner dismisses Petitioner’s side-surfaces argument as merely a “matter of labeling.” Sur-reply 7 (quoting Reply 7–8). Patent Owner points to Figure 7B, which Patent Owner asserts “undisputedly only has one curved side,” and notes that Camras also gives both side surfaces a separate label (154 and 156). *Id.* Patent Owner contends that “[s]uch labeling is merely a function of depicting a three-dimensional object in two-dimensions.” *Id.* at 8.

Patent Owner’s argument is unavailing. For one thing, it is not undisputed, as Patent Owner contends (*id.* at 7), that Figure 7B depicts only one curved side. Petitioner presents evidence, in the form of testimony by Dr. Karlicek, which we credit, that “FIG. 7B shows a device having a square perimeter, but with rounded or chamfered upper edges on the substrate.” Ex. 1014 ¶ 26; Reply 8–9 (citing expert testimony “explaining that the FIG. 7B device is a square device with rounded upper edges”). Dr. Karlicek bases his opinion on disclosure in Camras, which states that the devices are fabricated by saw cutting, which Dr. Karlicek states “can only be used to fabricate square or rectangular devices,” which is consistent with the fact that “all of the devices shown in Camras are square.” Ex. 1014 ¶ 26 (emphasis omitted). Dr. Karlicek further testifies that, therefore, the ordinarily skilled artisan would have understood the Figure 7 devices “to be

versions of the square FIG. 2 device having different substrate modifications.” *Id.*

Petitioner next argues that the ordinarily skilled artisan would have understood that Camras’ Figure 7A device, like all other devices disclosed in Camras, has a square perimeter. *Id.* at 8 (citing Camras Figs. 2A, 2B, 7A, 11:66–12:31; Ex. 1012 ¶¶ 75, 214). In that regard, notes Petitioner, Patent Owner’s expert admitted that Camras does not explicitly disclose any circular device. *Id.* (citing Ex. 1013, 110:18–20).

Patent Owner counters Petitioner’s view of the devices in Figures 7A and 7B as “modifications of the square perimeter device” of Figures 2A and 2B by pointing to Dr. Karlicek’s concession that “Camras doesn’t . . . actually include a description specifically of the number of sides it would have.” Sur-reply 8 (quoting Ex. 2002, 76:16–77:2). This contention is unavailing, as it fails to consider the entirety of that testimony. Dr. Karlicek qualified that concession by stating immediately thereafter that “Camras does describe, as does Haitz and Slater and others, dicing, implying that one would have a symmetric device where multiple sidewalls would have the sidewall facets shown in Figure 7.” Ex. 2002, 76:23–77:2.

Patent Owner also argues that Petitioner wrongly assumes that the shape of the base of the substrate must be the same as the perimeter of the device. Sur-reply 8 (citing Reply 8–9). Patent Owner contends “Camras has many embodiments where the base of the substrate is not limited to the shape of the device, especially in Figs. 7B, 7C, and 7D.” *Id.* Thus, Patent Owner posits, “nothing in Camras precludes a conical substrate from being on top of a square perimeter device.” *Id.* Patent Owner’s argument is unavailing. Not only does it consist only of attorney argument, but it is

contrary to Petitioner's more reasonable reading of Camras in light of manufacturing practices disclosed therein, as discussed below, which is persuasive and supported by testimony of Dr. Karlicek.

Petitioner presents evidence that circular shapes were unlikely to be produced by the technique disclosed in Camras and would not be practical from a manufacturing standpoint. Reply 8–9. In particular, Petitioner points to Camras' disclosure that the embodiment of Figure 7A is formed “by dicing a wafer into separate devices with a beveled or angled saw blade.” *Id.* at 9 (citing Ex. 1005, 12:13–15). Petitioner then asserts that Patent Owner's expert admitted, and Dr. Karlicek agreed, “that a conical shape could not practically be produced with a dicing saw, which is capable of only making straight, linear cuts.” *Id.* (citing Ex. 1013, 124:3–16; Ex. 1014 ¶¶ 18–22). Petitioner also presents testimony by Dr. Karlicek, which we credit, that the ordinarily skilled artisan would not have understood Camras as disclosing circular shapes because such shapes waste wafer area. *Id.* (citing Ex. 1014 ¶¶ 20–25).

Patent Owner counters by pointing to Camras' disclosure of creating the curved surfaces of the embodiment shown in Figure 7B by “dicing with an appropriately shaped saw blade.” Sur-reply 9 (quoting Ex. 1005, 12:18–22). Patent Owner posits that “if Camras teaches that the curved surfaces of Fig. 7B can be achieved through dicing and a saw blade, a conical shape could likewise be achieved using the same process.” *Id.* Patent Owner does not, however, support this argument with any evidence. We further note that Patent Owner's contention glosses over differences in the description provided by Camras as to cutting the embodiments in Figures 7A and 7B. With regard to Figure 7A, Camras describes dicing using a “beveled or

angled saw blade.” Ex. 1005, 12:12–14. Petitioner presents persuasive evidence, in the form of testimony by Dr. Karlicek (as noted above), which we credit, that the ordinarily skilled artisan would have understood that dicing with an “angled saw blade” would result in *all four sides* being angled. Ex. 1012 ¶ 74. In contrast, in describing forming the surfaces of the embodiment in Figure 7B, Camras describes using different techniques—namely, “an *appropriately shaped* saw blade, or by etching or milling.” Ex. 1005, 12:17–19 (emphasis added).

Relatedly, Patent Owner also challenges Petitioner’s assertion that a truncated pyramidal shape “approximate[s] the shape . . . of a dome or hemisphere,” as Camras describes the embodiments depicted in Figures 7A and 7B. Sur-reply 6. In support of that contention, Petitioner points to the following disclosure in Haitz as indicating that a pyramidal shape may approximate a hemisphere:

Taken to its ultimate or optimal configuration for light extraction, a LED would have a surface of a hemisphere so that light from the center of the p-n junction is normal to the surface regardless of the ray direction and light from other areas of the p-n junction either exits on the first pass or after a limited number of reflections. This is not a feasible geometry for semiconductor manufacturing techniques. The *square LED with beveled edges hereinabove described is a better approximation of a hemisphere than the rectangular parallelepiped of a conventional LED.*

Ex. 1008, 5:43–54 (emphasis added); Reply 7.

Patent Owner first argues that Petitioner’s cite to Haitz amounts to a “new ground of obviousness” that should not be considered “as it was not included in the Petition.” Sur-reply 6. We disagree. Petitioner’s cite to Haitz in its Reply does not amount to a new combination. Rather, in

responding to Patent Owner’s argument, Petitioner cites to Haitz as evidence of the understanding of the ordinarily skilled artisan that a shape approximating a dome or hemisphere need not have a curved surface, but includes pyramidal shapes with square bases. As such, Petitioner relies on Haitz as evidence of how the ordinarily skilled artisan would have interpreted *Camras’ disclosure* of a substrate that approximates the shape of a dome or hemisphere. *See, e.g., Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1372–73 (Fed. Cir. 2019) (affirming an obviousness determination in an *inter partes* review in which a first prior art reference disclosed all of the claim limitations and a second prior art reference was used to “demonstrate that a person of ordinary skill in the art would have understood” that a teaching in the first reference satisfied a claim limitation).

Patent Owner also argues that Haitz “teaches away from using the type of hemispheres taught and preferred by Camras,” because Haitz teaches that an actual hemisphere is not feasible, whereas “Camras discloses an embodiment with rounded edges in Fig. 7B.” Sur-reply 7. Patent Owner’s argument is unavailing because it addresses only the embodiment shown in Figure 7B, whereas Petitioner’s arguments are premised on the embodiment shown in Figure 7A. In that regard, we also note that when Camras explicitly describes an embodiment with “curved surfaces” (Ex. 1005, 12:14–17), it graphically illustrates that curved surface (Figure 7B). But in describing Figure 7A, Camras describes the side surfaces as “angled surfaces” 148 and 150, without any mention of curves. Ex. 1005, 12:10–13. This is significant, in that, as disclosed in Haitz, one of ordinary skill in the art would have understood that curved surfaces such as hemispheres were “not a feasible geometry for semiconductor manufacturing techniques.”

Ex. 1008, 5:44–49. It follows that the ordinarily skilled artisan would not assume a curved surface was disclosed in Camras without an explicit reference or depiction, as is the case with Figure 7B and the corresponding description. Petitioner’s declarant, Dr. Karlicek, provides testimony in this regard, which we credit. *See* Ex. 1014 ¶¶ 21 (discussing production efficiencies render the typical semiconductor die square-shaped), 23–24 (noting that dies having circular cross-sections would under-utilize packing density), 25 (noting that the ordinarily skilled artisan would have understood that Camras’ device shapes are square because of manufacturing techniques used).

In its Sur-reply, Patent Owner also changes course. Although Patent Owner reiterates that the substrate in Figure 7A of Camras is “conical in shape,” Patent Owner alternatively contends that “even if Camras did not teach a conical shape . . . at best Camras teaches a *rectangular substrate with angled sides*.” Sur-reply 5 (emphasis added). Patent Owner illustrates this interpretation with what it posits would be a “plan view” of Figure 7A, reproduced below side-by-side:

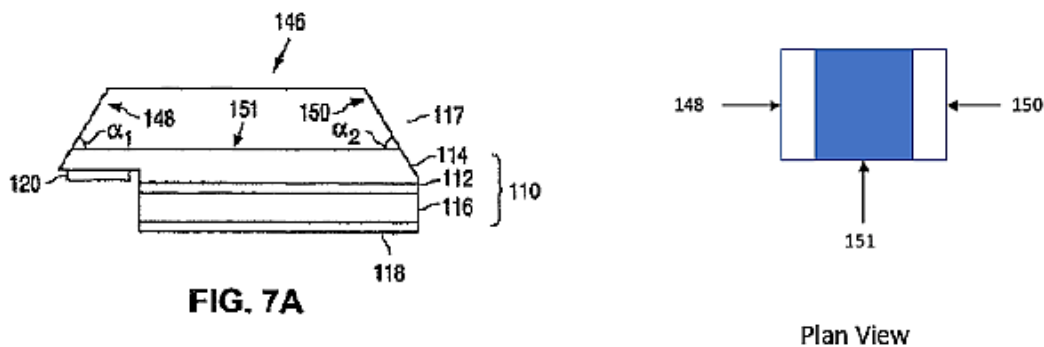


Figure 7A of Camras schematically illustrates a light-emitting device (Ex. 1005, 3:62–63); also reproduced above is a “plan view” illustration provided by Patent Owner with the top of Figure 7A shaded in blue (Sur-reply 5).

Patent Owner contends that because “[t]here is no teaching that the unlabeled front and back faces of the substrate are slanted” that means “they remain vertical.” Sur-reply 5. Therefore, according to Patent Owner, the ordinarily skilled artisan would have understood that the substrate of Camras’ Figure 7A would not have a pyramidal shape. *Id.*

Patent Owner’s new theory is unavailing. Notably, Patent Owner bases this new theory entirely on attorney argument without any supporting evidence, such as expert testimony, that the ordinarily skilled artisan would have viewed Camras’ Figure 7A as having only two angled side surfaces. *See id.* Moreover, Patent Owner’s theory is not supported by Camras. The description of Figure 7A in Camras emphasizes that angling the side surfaces will “reduce trapping of light by total internal reflection” because “more of the light emitted by active region 112 is incident on interfaces between the superstrate and the external environment at angles close to normal incidence than is the case for a superstrate having a cubic or rectangular prism shape.” Ex. 1005, 12:9–10, 12:23–26. Camras further states that with angled side surfaces, the superstrate in Figure 7A “may approximate the shape of, for example, a dome or a hemisphere.” *Id.* at 12:19–22. This description of the benefits of the embodiment of Figure 7A suggests *angling all four sides* so as to maximize the benefit of angling a side; moreover, angling all four sides better approximates a dome or hemisphere, as Camras describes the device depicted in Figure 7A. This view is supported by the testimony of Dr. Karlicek, which we credit, in which Dr. Karlicek testifies that Camras’ disclosure of the process of angling the sides, as shown in Figure 7A, by “dicing a wafer into separate devices with a beveled or angled saw blade,” would have indicated to the

ordinarily skilled artisan that all four sides are cut around the perimeter at the same angle, creating a pyramidal shape. Ex. 1012 ¶¶ 73–76.

For the foregoing reasons, we are persuaded Petitioner has demonstrated that Camras teaches “said substrate having a pyramidal shape so that said substrate has a cross-sectional area that decreases with distance from said junction,” as recited in claim 1.

(5) Limitation 1[d]: “wherein lateral extent of said substrate is bound by lateral extent of a doped layer nearest to the trans[p]arent substrate”

Petitioner asserts that Figure 7A of Camras, reproduced below as annotated by Petitioner, shows “substrate 117 being bound by the lateral extent of nearest doped layer, or first doped layer, 114”:

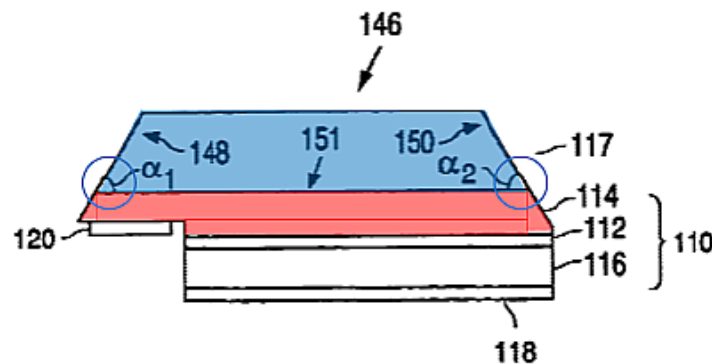


FIG. 7A

Figure 7A of Camras, as annotated by Petitioner (Pet. 58), schematically illustrates a light-emitting device.
Ex. 1005, 3:62–64.

In the annotated figure above, Petitioner circles the edges of substrate 117 (blue circles) to show that it is bound by the lateral extent of the nearest doped layer (layer 114, shaded in red). Pet. 58. Petitioner asserts that Figure 7A of Camras provides disclosure of the bound element commensurate with the disclosure in the '460 patent, which Petitioner

asserts discloses the bound limitation only “in cross-sectional Figures,” including AAPA depicted in Figure 1. Pet. 58.

Petitioner contends that additional teachings from Camras teach or suggest the bound element. In particular, Camras “states that the angled surfaces of the FIG. 7A embodiment ‘may be formed, for example, by dicing a wafer into separate devices with a beveled or angled saw blade.’” *Id.* (citing Ex. 1005, 12:13–15). Relying on the testimony of Dr. Karlicek, Petitioner contends that the ordinarily skilled artisan “would have been motivated to adopt this method of shaping the substrate during the dicing process, because it would have been an efficient method by which to shape the substrate while singulating the wafer, thereby reducing process steps.” *Id.* (citing Ex. 1012 ¶¶ 225–227). Petitioner further invokes Dr. Karlicek’s testimony in asserting

[t]his process would result in the substrate being bound by nearest doped layer 114, around its perimeter, because, during the dicing process described above, the same angled blade that formed angled surfaces 148, 150 at the perimeter of substrate 117 would also form individual LED devices by either sawing and cleaving or sawing through the active layer stack 110.

Id. at 58–59 (citing Ex. 1012 ¶ 227).

We find Petitioner’s contentions are supported by the cited disclosures, including the testimony of Dr. Karlicek (which we credit), and are persuasive.

As noted above (Section II.D.3.a(3)), Patent Owner argues limitation 1[d] collectively with the other “substrate” limitations (1[b] and 1[c]), asserting that Petitioner does not properly apply those limitations “in accordance with their antecedent basis.” This argument is unavailing, for

the reasons we have expressed above. *Id.* Patent Owner does not otherwise challenge Petitioner’s arguments or evidence for limitation 1[d].

We are persuaded Petitioner has demonstrated that Camras teaches “wherein lateral extent of said substrate is bound by lateral extent of a doped layer nearest to the trans[p]arent substrate,” as recited in claim 1.

(6) *Limitation 1[e]: “ohmic contacts for forward biasing said junction layer so that at least most of the light is emitted from the junction layer into the surrounding environment is emitted through said substrate”*

As noted above, we construe this limitation as “including ohmic contacts positioned to allow most of the light emitted from the junction layer into the surrounding environment to be emitted through the substrate.”

Supra Section II.C.1.

Petitioner presents evidence that AAPA discloses this limitation by disclosing ohmic contacts 35, 36 on the bottom of the device, just as the ohmic contacts are placed in the other, “purportedly inventive” embodiments of the ’460 patent. Pet. 59 (citing Ex. 1001, Fig. 1).

Petitioner also presents evidence that Camras teaches the claimed ohmic contacts, by explicitly disclosing ohmic contacts 118, 120 placed on the bottom of stack 110 so that most of the light is emitted into the substrate where it can be extracted:

Since contacts 118 and 120 (FIGS. 2A-2B, 3A-3C) are both disposed on the bottom of stack 110, in embodiments in which contacts 118 and 120 are opaque (e.g., reflective), ***a larger fraction of light emitted by active region 112 exits the stack through its top side into superstrate 117 than through its bottom side.***

Id. at 59–60 (quoting Ex. 1005, 9:25–30 (emphasis added by Petitioner); citing 9:66–10:3 (stating that bottom side contacts “do not block light

emitted by active region 112 from exiting device 100 through superstrate 117”)); *see also* Ex. 1005, 6:8–14 (describing contacts 18 and 20 as “electrical contacts” that are “configured to apply a voltage across active region 112” and are disposed on “a bottom side of stack 110 opposite to” the side on which “superstrate 117 is disposed”), 6:49–56 (describing contact 118 as including ohmic contacts). Petitioner also presents testimony of Dr. Karlicek in support of finding the ordinarily skilled artisan would have understood these teachings to apply to bottom side contacts 118, 120 depicted in Figure 7A of Camras. Pet. 60 (citing Ex. 1012 ¶¶ 229–230).

Petitioner also presents evidence that Camras teaches other features, not present in the ’460 patent, that enhance light extraction through the substrate. *Id.* In particular, Petitioner presents evidence that Camras discloses reflective bottom side contacts, which reflect downwardly emitted light back into the substrate for extraction: “In some embodiments, contact 118 is highly reflective to light emitted by active region 112 and consequently reflects such light incident on it from active region 112 back toward substantially transparent superstrate 117.” *Id.* (quoting Ex. 1005, 6:35–38).

Patent Owner does not present arguments or evidence particularly directed to Petitioner’s showing as to limitation 1[e] with regard to AAPA or Camras. *See generally* PO Resp.

We find Petitioner’s contentions are supported by the cited evidence, including the testimony of Dr. Karlicek (which we credit), and are persuasive on this record. We are, therefore, persuaded Petitioner has demonstrated that Camras, and AAPA combined with Camras, teaches “ohmic contacts for forward biasing said junction layer so that at least most

of the light is emitted from the junction layer into the surrounding environment is emitted through said substrate,” as recited in claim 1.

(7) Claim 1: Conclusion

After having analyzed the entirety of the trial record and assigning appropriate weight to the cited supporting evidence, we determine Petitioner has shown by a preponderance of the evidence that claim 1 is unpatentable over the teachings of Camras alone, and also over the teachings of AAPA combined with Camras. We also find that Petitioner has persuasively shown that one of ordinary skill in the art would have had reason to combine the teachings of AAPA and Camras in the manner set forth in the Petition, and would have reasonably expected such a combination to be successful.

See Pet. 57–58, 60–64, 66 (citing Ex. 1012 ¶¶ 219–220, 225–227, 231–234, 238–239, 244–246).

b. Claims 2–8

Petitioner also challenges claims 2–8 on the same ground. Pet. 52.

As Petitioner correctly notes, independent claims 6 and 8 are very similar to claim 1, with slight wording differences, such as using the more generic terms “first doped layer” and “second doped layer” in claims 6 and 8 instead of “negatively doped layer” and “positively doped layer,” as recited in claim 1. Pet. 5–7 (comparison chart). Petitioner presents a joint analysis of claims 1, 6, and 8 (separately arguing limitation 8[f], discussed below).

Id. at 52–63. Patent Owner also presents a joint analysis of these claims.

PO Resp. 57–63. For the reasons stated above regarding claim 1, we determine Petitioner has demonstrated that claim 6 is unpatentable as obvious over Camras alone, and over AAPA combined with Camras.

Claim 8 additionally recites “wherein an upper portion of said first doped layer has a pyramidal shape.” Ex. 1001, 8:1–3. Petitioner presents evidence that Camras discloses an upper portion of first doped layer, 114 (Ex. 1005, 4:29-32), which has a pyramidal shape. Pet. 62. Petitioner additionally presents evidence, including the testimony of Dr. Karlicek, which we credit, that the ordinarily skilled artisan “would understand that layer 114 would be beveled . . . by the same perimeter saw cuts that shaped substrate 117 into a pyramidal shape during the dicing process.” *Id.*; Ex. 1012 ¶ 238. Figure 7A of Camras, as annotated by Petitioner, is reproduced below.

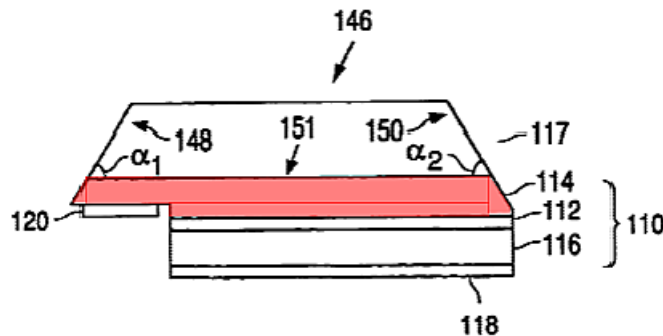


FIG. 7A

Figure 7A of Camras, reproduced above as annotated by Petitioner (Pet. 62) is a schematic illustration of a light-emitting device. Ex. 1005, 3:61–63.

In the annotated figure reproduced above, Petitioner has shaded in red first doped layer 114, which is illustrated as having the same angled sides as superstrate 117. Pet. 62. Petitioner contends, relying on the testimony of Dr. Karlicek (which we credit) that the ordinarily skilled artisan “would have been motivated to include the pyramidal upper layer in the combination to increase the amount of light extracted from the layer by reducing total internal reflection at its edges.” *Id.* at 62–63 (citing Ex. 1012 ¶ 239). Petitioner additionally contends the ordinarily skilled artisan would have

recognized “that the first doped layer could efficiently be given a pyramidal shape by the same perimeter sawing process used to form Camras’ substrate 117 into a pyramidal shape, simply by adjusting the depth of the saw cut, singulating the LED chip with the angled saw in one pass.” *Id.* at 63 (citing Ex. 1012 ¶ 238) (emphasis omitted).

Patent Owner does not present arguments particularly directed to Petitioner’s arguments and evidence as to limitation 8[f]. *See generally* PO Resp.

For the foregoing reasons, in addition to reasons stated above regarding claim 1, we determine Petitioner has demonstrated that claim 8 is unpatentable as obvious over Camras alone, and over AAPA combined with Camras.

Dependent claims 2–5 and 7 recite additional details as to the structure of the claimed LED. For example, claims 2 and 7 (which depend from claims 1 and 6, respectively), recite that the substrate has a “side surface” and a “bottom surface,” and that the side surface has a slope relative to the bottom surface “within a range of 10–80 degrees.” Ex. 1001, 6:27–31.

Petitioner presents evidence, with reference to annotated Figure 7A, reproduced below, that “substrate 117 has a bottom surface 151 (blue), which makes an angle with side surfaces 148, 150 of 60° degrees.” Pet. 63 (citing Ex. 1012 ¶ 240).

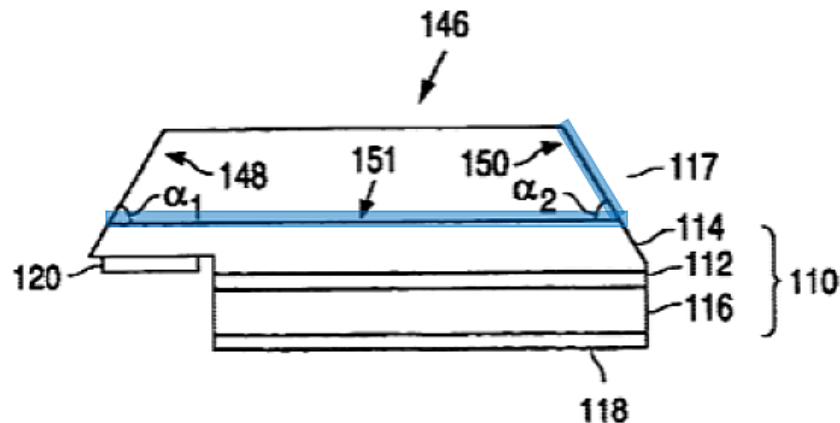


FIG. 7A

Figure 7A of Camras, reproduced above as annotated by Petitioner (Pet. 63), is a schematic illustration of a light-emitting device. Ex. 1005, 3:61–63.

Petitioner further presents evidence that Camras teaches that the bevel angle may vary to optimize light extraction efficiency. Pet. 63 (citing Ex. 1005, 12:51–56 (“The extraction efficiency of the light-emitting devices shown in FIGS. 7A-7D may be optimized, for example, by varying the thickness of superstrate 117 and by varying the bevel angles (e.g., α_1 , α_2 , β_1 , β_2 , γ_1 , and γ_2) of the surfaces of superstrate 117”). Relying on testimony by Dr. Karlicek, Petitioner contends that it would have been obvious to try angles falling within the range of 10° to 80° to appreciably reduce the angle of incidence of light striking surfaces 148 and 150. *Id.* (citing Ex. 1012 ¶ 241); *see also* Pet. 36 (noting that the ordinarily skilled artisan would have understood that for very small bevel angles (e.g., less than 10°), the sidewall would remain substantially vertical (approximating a cuboidal substrate), and for very large angles (e.g., above 80°), the sidewall would be essentially horizontal (also approximating a cuboidal substrate, but a very thin one; thus, it would have been obvious for the ordinarily skilled artisan to choose among the finite range of angles near the middle of the

range, which would have a reasonable probability of increasing extraction (citing Ex. 1012 ¶ 59)).

Patent Owner contends Petitioner's contention as to Camras' disclosure of an angle within the range of 10° to 80° "is belied by the fact that Camras specifically notes that 'the dimensions in the figures are not necessarily drawn to scale.'" PO Resp. 64 (citing Ex. 1005, 4:3–6). According to Patent Owner, the ordinarily skilled artisan would therefore "not understand the angles drawn in the figures to be representative of the angles that should be used." *Id.* (citing Ex. 2001 ¶ 150). Patent Owner further contends that "nothing in the teaching of Camras cited by the Petition or Dr. Karlicek discloses use of any particular angle, just that an angle[d] surface will have better light emitting properties." *Id.* (citing Pet. 63; Ex. 1012 ¶¶ 240–241; Ex. 1005, 12:22–27). Patent Owner asserts that Petitioner's showing is deficient because the ordinarily skilled artisan "would not necessarily understand that an angle within the range of 1–80 degrees must be used, and could instead use an angle outside of this range that would not meet the claim limitations." *Id.* at 64–65 (citing Ex. 2001 ¶ 151).

Patent Owner's argument is unavailing. By arguing that the ordinarily skilled artisan "*could* instead use" an angle outside of the claimed range, Patent Owner tacitly acknowledges that Camras teaches angles in a range overlapping the claimed ranges of 10° to 80° (for claim 2) or the broader range of 1° to 80° (for claim 7). And Petitioner's arguments and evidence persuasively demonstrate that to be the case. Even if Camras' Figure 7A is not drawn to scale, we are persuaded by, and credit, the testimony of Dr. Karlicek that the ordinarily skilled artisan would have been motivated to

choose an angle among the finite range of angles near the middle of the range between 0° and 90°, and that Figure 7A at least suggests an angle roughly in the midpoint of that range of 60°. Ex. 1012 ¶ 241. We consequently conclude that the claimed angle ranges overlap with the teachings of Camras, and hence Petitioner demonstrates a *prima facie* case of obviousness. *See In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003) (holding that “[i]n cases involving overlapping ranges, we and our predecessor court have consistently held that even a slight overlap in range establishes a *prima facie* case of obviousness”); *see also DuPont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1006, 1008 (Fed. Cir. 2018) (applying the *prima facie* case and burden-shifting framework for overlapping ranges in the context of an *inter partes* review).

Moreover, as Petitioner contends and Dr. Karlicek avers, Camras discloses that the bevel angle may be varied to optimize light extraction efficiency. *See* Ex. 1005, 12:51–56; Pet. 63; Ex. 1012 ¶ 241. We, therefore, additionally determine that the bevel angle is a result-effective variable, and that it would have been within the skill of an artisan to optimize to the claimed range. *See In re Boesch*, 617 F.2d 272, 276 (C.C.P.A. 1980) (holding that “discovery of an optimum value of a result effective variable . . . is ordinarily within the skill of the art”).

We determine Petitioner has demonstrated that Camras discloses a “slope angle . . . within a range of 10–80 degrees,” as recited in claim 2, and also “a slope angle . . . within a range of 1–80 degrees,” as recited in claim 7.

Claim 3 depends from claim 1, and recites that the substrate “is composed of [electrically] non-conductive material.” Ex. 1001, 6:33–34.

Petitioner presents evidence, including the testimony of Dr. Karlicek (which we credit), that “AAPA suggests that its substrate 31 can be non-conductive because of its contact placement.” Pet. 64 (citing Ex. 1012 ¶ 242).

Petitioner additionally presents evidence that, in describing the flip-chip embodiment of Figure 2, Camras provides that “[S]ubstrate 117 has no electrical function” and therefore “[S]uperstrate 117 may be formed from a substantially non-conducting or highly resistive material.” *Id.* (quoting Ex. 1005, 4:55–61, 4:30–32) (alteration in original). Relying on the testimony of Dr. Karlicek, Petitioner presents evidence that this teaching in Camras also applies to Figure 7A, which is also a flip-chip configuration, and the ordinarily skilled artisan would have similarly understood that Figure 7A’s “substrate 117 has no electrode, need not carry current, and may therefore be non-conductive.” *Id.* (citing Ex. 1012 ¶ 242). Petitioner further presents evidence that Camras discloses that its substrate may be non-conductive sapphire (Ex. 1005, 5:9–10), and that the ordinarily skilled artisan “would have been motivated to select sapphire in cases where cost was a concern because it was cheap and the most common substrate for GaN devices (Pet. 64 (citing Ex. 1012 ¶ 243)). Patent Owner does not present argument or evidence particularly challenging Petitioner’s showing as to claim 3. *See generally* PO Resp.

We determine Petitioner has demonstrated that both Camras, and AAPA combined with Camras, teach a substrate “composed of [electrically] non-conductive material,” as recited in claim 3.

Claim 4 depends from claim 1 and recites that the substrate “has a truncated pyramidal shape so as to define a flat top surface through which at least some of said light is emitted into said surrounding environment.”

Ex. 1001, 6:34–37. Petitioner presents evidence that Camras’ Figure 7A substrate 117 “is a truncated, pyramidal shape” because it “has a flat top surface” (shown in blue, in Petitioner’s annotated Figure 7A, reproduced below), “through which at least some light would be emitted.” Pet. 64–65 (citing Ex. 1012 ¶ 244).

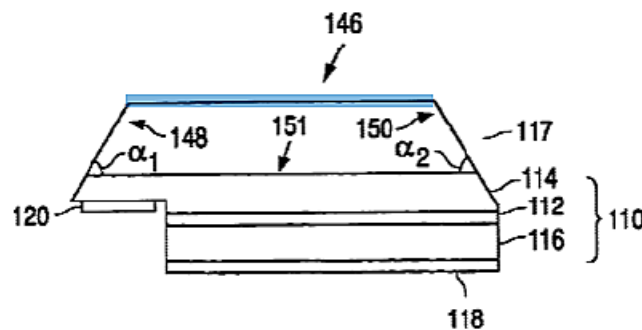


FIG. 7A

Figure 7A of Camras, reproduced above as annotated by Petitioner (Pet. 65), is a schematic illustration of a light-emitting device. Ex. 1005, 3:61–63.

Patent Owner contends “[t]he Petition and Dr. Karlicek ha[ve] failed to show that the combination of AAPA and Camras discloses a ‘truncated pyramidal shape’ for the same reason that they fail to show that this combination discloses a ‘pyramidal shape’ discussed above.” PO Resp. 65 (citing Ex. 2001 ¶ 152). We find Patent Owner’s contention unavailing for the reasons discussed above. *See* Section II.D.3.a.(4).

We determine Petitioner has shown that Camras discloses a “truncated pyramidal shape” as recited in claim 4.

Claim 5 depends from claim 4, and states that the “top surface has a center coinciding with a center longitudinal axis of said substrate.” Ex. 1001, 6:40–41. Petitioner presents evidence that Camras’ “substrate 117 has a top surface 146 that has a center coinciding with a longitudinal axis of the substrate,” which Petitioner shows with an annotated version of Figure

7A, reproduced below. Pet. 66.

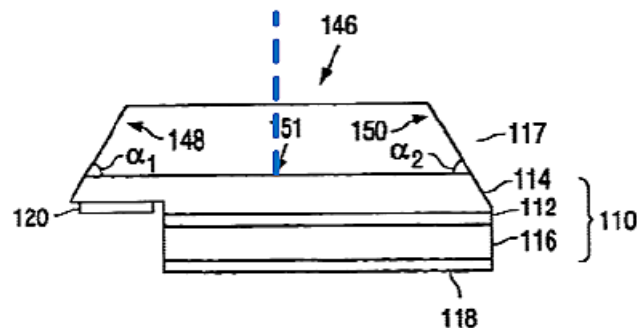


FIG. 7A

Figure 7A of Camras, as annotated by Petitioner (Pet. 66), schematically illustrates a light-emitting device. Ex. 1005, 3:61–63.

Petitioner presents evidence, including the testimony of Dr. Karlicek, that the ordinarily skilled artisan would have understood that Camras teaches a centered top surface because Camras “teaches that a substrate approximating a dome or hemisphere is advantageous, and such a shape would have a centered, flat top surface.” *Id.* (citing Ex. 1005, 12:19–27; Ex. 1012 ¶ 246). Petitioner additionally presents evidence that “this feature results from selecting the same bevel angle around the perimeter of the device, which the [ordinarily skilled artisan] would do to increase light extraction while reducing the need for additional manufacturing steps.” *Id.* (citing Ex. 1005, 12:18–19; Ex. 1012 ¶ 246). Petitioner additionally presents evidence that “a centered, truncated pyramidal substrate would generate a symmetrical light emission pattern, which the POSA would recognize as advantageous.” *Id.* (citing Ex. 1012 ¶ 246).

Patent Owner challenges Petitioner’s showing as to claim 5 by asserting that “none of the teaching from Camras on which [Petitioner relies] states that the ‘top surface has a center coinciding with a center longitudinal axis of said substrate’ as required by the claim.” PO Resp. 65–66. Patent

Owner further contends that Dr. Karlicek admitted at his deposition that “nothing in Camras requires that angles of the side surfaces Alpha 1 and Alpha 2 ‘necessarily [be] the same.’” *Id.* at 66 (quoting Ex. 2002, 78:2–16). Patent Owner posits that, “[i]n the situation where the angles are different, and assuming the top surface is flat, the center of the top surface would not coincide with the center longitudinal axis of the substrate.” *Id.* (citing Ex. 2001 ¶ 153).

Patent Owner’s arguments do not undermine Petitioner’s persuasive showing on this record. Patent Owner does not acknowledge that, immediately following the statement quoted above, Dr. Karlicek clarified that equal angles for Alpha 1 and Alpha 2 would be “the logical approach” for a symmetrical device produced by dicing:

But as I mentioned in my prior comment about dicing and being symmetric on four sides, it would have been clear to a person of ordinary skill in the art that if you’ve optimized the device-design angle for the pyramidal shape on two of the four sides of a device, it would be logical to have them on all four sides of the device; and, therefore, having Alpha 1 and Alpha 2 being equal would be a subset of what’s described in that figure and the logical approach that a POSA would take in fabricating the Camras device.

Ex. 2002, 78:6–16. Thus, although Camras does not necessarily require that the angles be the same, Petitioner has presented persuasive evidence in the form of expert testimony, which we credit, that the ordinarily skilled artisan would likely have chosen the angles to be equal, given the manufacturing practices disclosed in Camras.

For the foregoing reasons, as to claims 2–8, we find Petitioner’s arguments and evidence, including the testimony of Dr. Karlicek (which we credit) to be persuasive on this record. We have fully considered Patent

Owner's contrary arguments, but do not find that they undermine Petitioner's persuasive showing on this record.

4. Conclusion: Ground 4

After having analyzed the entirety of the trial record and assigning appropriate weight to the cited supporting evidence, we determine Petitioner has shown by a preponderance of the evidence that claims 1–8 are unpatentable over the teachings of Camras alone, and over AAPA combined with Camras.

E. Other Grounds

Petitioner also contends that claims 1–7 are unpatentable as obvious over: (1) Slater; (2) Slater combined with Steigerwald; (3) Slater combined with Steigerwald and Haitz; and (4) AAPA combined with Steigerwald and Haitz. Pet. 1–2; Dec. 7–8.

We have determined herein that Petitioner has shown, by a preponderance of the evidence, that claims 1–8 are unpatentable as obvious. *Supra* Section II.D. In reaching that conclusion, we have rendered a final written decision on claims 1–8.

In final written decisions both before and after *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348 (2018), the Board has declined to reach grounds challenging claims that were already held unpatentable. *See, e.g., Sure-Fire Elec. Corp. v. Yongjiang Yin*, IPR2014-01448, Paper 56 at 25 (PTAB Feb. 22, 2016), *aff'd*, 702 F. App'x 981 (Fed. Cir. 2017); *SK Hynix Inc. v. Netlist, Inc.*, IPR2017-00692, Paper 25 at 40 (PTAB July 5, 2018). The Federal Circuit has acknowledged the Board's discretion in this regard. *See Boston Sci. Scimed, Inc. v. Cook Grp. Inc.*, Nos. 2019-1594, -1604, -1605, 2020 WL 2071962, at *4 (Fed. Cir. Apr. 30, 2020) (non-precedential) (recognizing

that the “Board need not address issues that are not necessary to the resolution of the proceeding” and, thus, agreeing that the Board has “discretion to decline to decide additional instituted grounds once the petitioner has prevailed on all its challenged claims”).

For the foregoing reasons, we determine that it is unnecessary for us to decide whether Petitioner has also shown by a preponderance of the evidence that claims 1–7 would have been obvious based on the other grounds presented in the Petition and on which we instituted review.

III. CONCLUSION¹³

For the foregoing reasons, we determine Petitioner has demonstrated by a preponderance of the evidence that claims 1–8 of the '460 patent are unpatentable.

IV. ORDER

Accordingly, it is

ORDERED that claims 1–8 of U.S. Patent 6,784,460 B2 are held unpatentable under 35 U.S.C. § 103 as obvious; and

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

¹³ 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).

In summary:

Claims	35 U.S.C. §	References	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–7	103	Slater ¹⁴		
1–7	103	Slater, Steigerwald ¹⁵		
1–7	103	Slater, Steigerwald, Haitz ¹⁶		
1–8	103	Camras, AAPA	1–8	
1–7	103	AAPA, Steigerwald, Haitz ¹⁷		
Overall Outcome			1–8	

¹⁴ As explained above (Section III.E), we do not reach this ground in light of our determining claims 1–8 are unpatentable on another ground. *See, e.g., Trading Techs. Int’l, Inc. v. IBG LLC*, 921 F.3d 1378, 1386 (Fed. Cir. 2019) (affirming unpatentability on one asserted ground and declining to address unpatentability on an additional ground).

¹⁵ We do not reach this ground in light of our determining claims 1–8 are unpatentable on another ground. *Id.*

¹⁶ We do not reach this ground in light of our determining claims 1–8 are unpatentable on another ground. *Id.*

¹⁷ We do not reach this ground in light of our determining claims 1–8 are unpatentable on another ground. *Id.*

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