

PUBLIC VERSION

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CIRRUS LOGIC, INC., OMNIVISION TECHNOLOGIES, INC., and
TEXAS INSTRUMENTS, INC.

Petitioner,

v.

GREENTHREAD, LLC,
Patent Owner.

IPR2024-00001¹
Patent 10,734,481 B2

Before GRACE KARAFFA OBERMANN, JON B. TORNQUIST, and
MONICA S. ULLAGADDI, *Administrative Patent Judges*.

ULLAGADDI, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)
Denying Petitioner's Motion to Exclude
37 C.F.R. § 42.71

¹ Texas Instruments Inc., which filed a petition in IPR2024-00772, has been joined as a party to this proceeding.

I. INTRODUCTION

A. *Background and Summary*

Cirrus Logic, Inc., OmniVision Technologies, Inc., and ams Sensors USA, Inc. filed a Petition (Paper 1, “Pet.”) requesting *inter partes* review of claims 1–9, 12–27, and 30–36 (“the challenged claims”) of U.S. Patent No. 10,734,481 B2 (Ex. 1001, “the ’481 patent”), accompanied by the supporting Declaration of Dr. Sanjay Banerjee (Ex. 1003).² Greenthread, LLC (“Patent Owner”) filed a Preliminary Response. Paper 15 (“Prelim. Resp.”). With our authorization, Petitioner filed a Reply to Patent Owner’s Preliminary Response (Paper 19), and Patent Owner filed a Preliminary Sur-Reply to Petitioner’s Preliminary Reply (Paper 21).

Upon review of the preliminary record, we instituted *inter partes* review, pursuant to 35 U.S.C. § 314, as to the challenged claims based on the challenges set forth in the Petition. Paper 29 (“Institution Decision” or “Inst.Dec.”). Patent Owner filed a Response (Paper 45, “Patent Owner’s Response” or “PO Resp.”), Petitioner filed a Reply to Patent Owner’s Response (Paper 54, “Petitioner’s Reply” or “Pet. Reply”), and Patent Owner filed a Sur-Reply (Paper 63, “Patent Owner’s Sur-Reply” or “PO

² Petitioner filed Mandatory Notices stating that ams Sensors USA, Inc. merged into Heptagon Holding CA Inc., which in turn merged into ams-OSRAM USA, Inc. Paper 23, 1. ams-OSRAM USA Inc. was terminated from this proceeding. Paper 27. In addition, as noted above in footnote 1, Texas Instruments Inc. was later joined as a petitioner in this proceeding. Paper 52, 15–20, 22. Therefore, we collectively refer to Cirrus Logic, Inc., OmniVision Technologies, Inc., and Texas Instruments, Inc. as “Petitioner.”

Sur-Reply”).³ Petitioner filed a motion to exclude evidence. Paper 66 (“Mot.”). Patent Owner filed an opposition to the motion (Paper 69, “Opp.”) to which Petitioner filed a reply (Paper 70). On January 28, 2025, we held an oral hearing. A transcript of the hearing is of record. Paper 76 (“Tr.”).

For the reasons that follow, we conclude that Petitioner has established, by a preponderance of the evidence, that each of the challenged claims of the ’481 patent is unpatentable. We also deny Petitioner’s Motion to Exclude.

B. Real Parties-in-Interest

Each party identifies itself as a real party-in-interest. Pet. 1; Paper 6, 1. In addition, Petitioner identifies OSRAM GmbH, ams-OSRAM AG, and GlobalFoundries U.S., Inc. as real parties-in-interest. Pet. 1. In its Updated Mandatory Notices, Petitioner further identifies “ams-OSRAM USA Inc., Heptagon Holding CA Inc., ams Sensors USA, Inc.,” as “real parties-in-interest.” Paper 23, 1 (emphasis omitted). As noted above in footnote 2, the instant proceeding has been terminated with respect to ams-OSRAM USA Inc. Paper 27. As noted above in footnote 1, Texas Instruments Inc. was joined as a petitioner in this proceeding and identifies itself as a real party-in-interest. Paper 52, 2.

C. Related Matters

The parties indicate that the ’481 patent is involved in the following district court cases:

³ Except where noted, we cite to redacted versions of Patent Owner’s Preliminary Response (Paper 42), Petitioner’s Reply to Patent Owner’s Preliminary Response (Paper 39), Patent Owner’s Response (Paper 47), Patent Owner’s Sur-Reply (Paper 65), and Petitioner’s Reply (Paper 55).

Greenthread, LLC v. Cirrus Logic, Inc., No. 1:23-cv-00369 (W.D. Tex.); *Greenthread, LLC v. OmniVision Technologies, Inc.*, No. 2:23-cv-00212 (E.D. Tex.); *Greenthread, LLC v. OSRAM GmbH et al.*, No. 2:23-cv-00179 (E.D. Tex.); *Greenthread, LLC v. Texas Instruments Inc.*, No. 2:23-cv-00157 (E.D. Tex.); and *Greenthread, LLC v. Monolithic Power Systems, Inc.*, No. 1:23-cv-00579 (D. Del.). Pet. 1–2; Paper 6, 1–2.

The parties also indicate that the '481 patent was involved in the following district court cases:

Greenthread, LLC v. Intel Corporation, Dell Inc., and Dell Technologies Inc., Case No. 6:22-cv-00105 (W.D. Tex.), a portion of which was transferred to *Greenthread, LLC v. Intel Corporation*, 3-22-cv-02001 (D. Or.); *Greenthread, LLC v. Micron Technology, Inc. et al.*, Case No. 1:23-cv-00333 (D. Del.); and *Greenthread, LLC v. Western Digital Corporation et al*, Case No. 1:23-cv-00326 (D. Del.). Pet. 2–3; Paper 6, 2–3.

The parties indicate that the '481 patent was the subject of the following administrative proceedings:

Sony Group Corporation v. Greenthread, LLC, IPR2023-00375 (challenging U.S. Patent No. 10,734,481 B2); *Intel Corporation v. Greenthread, LLC*, IPR2023-00260 (challenging U.S. Patent No. 10,734,481 B2); and *Dell Technologies Inc. et al v. Greenthread, LLC*, IPR2023-00507 (challenging U.S. Patent No. 10,734,481 B2). Pet. 3; Paper 6, 3.

D. The '481 Patent

The '481 patent, titled “Semiconductor Devices with Graded Dopant Regions,” issued on August 4, 2020. Ex. 1001, codes (45), (54). The '481 patent “relates to all semiconductor devices and systems.” *Id.* at 1:36–37. According to the '481 patent, in bipolar junction transistors, “[e]fforts have

been made in graded base transistors to create an aiding drift field to enhance the diffusing minority carrier's speed from emitter to collector." *Id.* at 1:59–61. This improvement has not been implemented in "most semiconductor devices, including various power MOSFETs . . . [and] IGBT[s]," which "still use a uniformly doped 'drift epitaxial' region in the base." *Id.* at 1:61–66.

The invention of the '481 patent implements graded dopant concentration in these devices, which causes "[t]wo important performance enhancements." Ex. 1001, 3:42–43. These include sweeping electrons "from source to drain rapidly" and simultaneously causing holes to "be recombined closer to the n^+ buffer layer," which "can improve t_{on} and t_{off} in the same device." *Id.* at 3:43–47.

E. Illustrative Claim

Of challenged claims 1–9, 12–27, and 30–36, claims 1 and 20 are independent. Claim 1 is illustrative and reproduced below.

1. [1.pre] A semiconductor device, comprising:
 - [1.1] a substrate of a first doping type at a first doping level having first and second surfaces;
 - [1.2] a first active region disposed adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed;
 - [1.3] a second active region separate from the first active region disposed adjacent to the first active region and within which transistors can be formed;
 - [1.4] transistors formed in at least one of the first active region or second active region;
 - [1.5] at least a portion of at least one of the first and second active regions having at least one graded dopant

concentration to aid carrier movement from the first surface to the second surface of the substrate; and

[1.6] at least one well region adjacent to the first or second active region containing at least one graded dopant region, the graded dopant region to aid carrier movement from the first surface to the second surface of the substrate.

Ex. 1001, 4:50–5:3 (bracketed designations added by Petitioner (*see* Pet., App. A, 100)).

F. Asserted Unpatentability Challenges

Petitioner asserts that claims 1–9, 12–27, and 30–36 are unpatentable based on the following challenges:

Claim(s) Challenged	35 U.S.C. §⁴	Reference(s)/Basis
1–9, 12–14, 16–27, 30–36	103(a)	Kawagoe ⁵
1, 2, 4–9, 12–22, 24–27, 30–36	103(a)	Wieczorek, ⁶ Wolf ⁷
1–9, 12–14, 16–27, 30–36	103(a)	Kawagoe, Gupta ⁸
1, 2, 4–9, 12–22, 24–27, 30–36	103(a)	Wieczorek, Wolf, Gupta
19, 36	103(a)	Kawagoe, Silverbrook ⁹
19, 36	103(a)	Wieczorek, Wolf, Silverbrook

Pet. 7. Petitioner relies on the Declaration and Supplemental Declaration of Dr. Sanjay Banerjee. Exs. 1003, 1060. Patent Owner relies on the Declaration of Dr. Alexander Glew. Ex. 2057.

⁴ The Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112-29, 125 Stat. 284 (2011), amended 35 U.S.C. § 103, effective March 16, 2013. Because applications from which the ’481 patent claims priority were filed before this date, the pre-AIA version of § 103 applies.

⁵ U.S. Patent No. 6,043,114 to Kawagoe et al., issued Mar. 28, 2000 (Ex. 1007, “Kawagoe”).

⁶ U.S. Patent Pub. No. 2003/0183856 A1 to Wieczorek et al., published Oct. 2, 2003 (Ex. 1006, “Wieczorek”).

⁷ STANLEY WOLF & RICHARD N. TAUBER, SILICON PROCESSING FOR THE VLSI ERA, Vols. 1–4 (Lattice Press 2000) (Exs. 1008A–D, “Wolf”).

⁸ U.S. Patent No. 6,163,877 to Gupta, issued Dec. 19, 2000 (Ex. 1014, “Gupta”).

⁹ U.S. Patent No. 6,614,560 B1 to Silverbrook, issued Sept. 2, 2003 (Ex. 1042, “Silverbrook”).

II. TIMELINESS OF PETITION UNDER 35 U.S.C. § 315(B)¹⁰

Pursuant to 35 U.S.C. § 315(b), “[a]n *inter partes* review may not be instituted if the petition requesting the proceeding is filed more than 1 year after the date on which the petitioner, real party in interest, or privy of the petitioner is served with a complaint alleging infringement of the patent.” Patent Owner argues that the Petition should be dismissed because it is untimely. PO Resp. 34–61. In particular, Patent Owner argues Petitioner is in privity with [REDACTED] Intel Corp. (“Intel”), and [REDACTED] (collectively “Licensees”), who Patent Owner asserts are time-barred under 35 U.S.C. § 315(b) and licensed under the ’481 patent. *Id.* at 34–45. Prior to institution, Patent Owner’s arguments regarding privity were based on several theories, including that Petitioner and Licensees “are ‘preceding and succeeding owners of’ the licensed and/or infringing products,” that Petitioner is a beneficiary of the Licensee’s agreements related to accused products, that Petitioner’s licensed sales encumber otherwise infringing articles, that Petitioner(s) apparently indemnify the time-barred parties for custom-made products, and that Petitioner serves as an “agent” of Licensees by exercising their “have made” rights under the license. *See generally* Prelim. Resp.

The question of whether Petitioner is time-barred under § 315(b) is part of the determination of whether to institute an *inter partes* review. *See Thryve, Inc. v. Click-to-Call Techs., LP*, 590 U.S. 45, 54 (2020) (“§ 315(b) expressly governs institution and nothing more”). In our Institution Decision, we determined that Patent Owner had not provided a sufficient

¹⁰ In Section II, we refer to the sealed versions of the Patent Owner Response in Paper 45 and the Preliminary Response in Paper 15.

factual basis upon which to question Petitioner’s representation that it is not time barred (Inst. Dec. 22–23), or that Petitioner and [REDACTED] Intel, or [REDACTED] were privies, based on any of its theories regarding privity (*id.* at 15–22). We incorporate that analysis here, and reconsider Patent Owner’s contention only to the extent it is warranted by subsequent argument and evidence.¹¹ *Id.* at 11–23; *see Achates Reference Publ’g. Inc. v. Apple Inc.*, 803 F.3d 652, 658 (Fed. Cir. 2015) (“The Board’s reconsideration of the time-bar [in the final determination] is ‘still fair[ly] characterize[ed] as part of the decision to institute.’”) (citations omitted).

Since our Institution Decision, the only new arguments regarding § 315(b) Patent Owner asserts are: (1) control of prior litigation is not required to establish privity (PO Resp. 42–44); (2) even though Petitioner bears the burden to show that its petition was timely, i.e., that Petitioner is not in privity with [REDACTED] Intel, or [REDACTED] Petitioner has not attempted to carry its burden (*id.* at 44–49); (3) evidence of record shows that the petition is time-barred (*id.* at 50–58); and (4) a finding in Petitioner’s favor would violate Patent Owner’s constitutional right to due process (*id.* at 58–61). We address these arguments below.

With regard to arguments (1)–(3), we note that Patent Owner presented these arguments in its request for Director review of our Institution Decision (Paper 32), which was summarily denied (Paper 34). Further, these arguments are not based on any evidence that was entered subsequent to our Institution Decision. Indeed, although Patent Owner unsuccessfully sought additional discovery relating to § 315(b) prior to our

¹¹ Patent Owner’s exhibits 2001–2055 were entered prior to Institution and exhibits 2056–2079 were submitted during trial.

Institution Decision (Papers 9, 13), our Order denying that discovery noted that Patent Owner’s “discovery requests are not narrowly tailored to discover any indemnification obligation” (Paper 18, 16), and Patent Owner did not renew or tailor its request for additional discovery during trial. In view of the denial of Director review and absence of additional evidence, we are not persuaded to reconsider Patent Owner’s arguments (1)–(3).

Patent Owner’s argument (4) regarding violation of its constitutional right to due process is based on denial of its opportunity to show that Petitioner’s assertions as to its relationships with Licensees are untrue. PO Resp. 60–61 (citing *Goldberg v. Kelly*, 397 U.S. 254, 269 (1970); *Greene v. McElroy*, 360 U.S. 474, 496 (1959)). Patent Owner argues it had no notice of evidence to support a finding for Petitioner under § 315(b), asserting as example, “[t]he Board has apparently determined that Petitioners have merely ‘a standard supplier-customer relationship’ with Licensees.” *Id.* at 61 (citing Paper 18, 11).

Patent Owner’s argument is not persuasive. As noted above, Patent Owner did not request additional discovery following entry of Petitioner’s Preliminary Reply, or during trial. Because Patent Owner did not pursue discovery during trial through the regular course as our rules provide, we do not agree it has been denied due process. Further, we do not agree with Patent Owner’s assertion that our determination that it did not demonstrate privity was necessarily based on examining the terms of Petitioner’s customer relationships. *See* PO Resp. 60–61.

The record thus demonstrates Patent Owner’s argument that it was denied an opportunity to examine evidence underlying our Institution Decision lacks support.

III. ANALYSIS

A. *Legal Standards*

“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). The burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

A claim is unpatentable under 35 U.S.C. § 103(a) if “the differences between the subject matter sought to be patented 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.” 35 U.S.C. § 103(a). 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 present, objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

To show obviousness, it is not enough to merely show that the prior art includes separate references covering each separate limitation in a challenged claim. *Unigene Labs., Inc. v. Apotex, Inc.*, 655 F.3d 1352, 1360 (Fed. Cir. 2011). “Rather, obviousness requires the additional showing that a person of ordinary skill at the time of the invention would have selected and combined those prior art elements in the normal course of research and development to yield the claimed invention.” *Id.* (citing *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007)). “This is so because inventions in

most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known.” *KSR*, 550 U.S. at 418–19. On the other hand, an obviousness analysis “need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ.” *Id.* at 418; *accord In re Translogic Tech., Inc.*, 504 F.3d 1249, 1259 (Fed. Cir. 2007). Nevertheless, “[a] factfinder should be aware, of course, of the distortion caused by hindsight bias and must be cautious of arguments reliant upon *ex post* reasoning.” *KSR*, 550 U.S. at 421.

B. Level of Ordinary Skill in the Art

In determining 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).

According to Petitioner,

[a] person of ordinary skill in the art (“POSITA”) of the subject matter of the ’481 Patent would have had a Bachelor’s degree in electrical engineering, material science, applied physics, or a related field, and four years of experience in semiconductor design and manufacturing or equivalent work experience. Additional education might compensate for a deficiency in experience, and vice-versa.

Pet. 10 (citing Ex. 1003 ¶¶ 44–47; Ex. 1039 ¶ 13).

Patent Owner argues that

[a] person of ordinary skill in the art (POSITA) in the technology field of the Challenged Patent would be a person with at least a Bachelor’s of Science degree in electrical or computer

engineering, materials science, chemical engineering, applied physics, or a related field, with emphasis on semiconductor manufacturing, or an equivalent degree, and at least four years of experience in semiconductor design and manufacturing. Additional education in a relevant field or industry experience may compensate for a deficit in one of the other aspects of the requirements stated above.

PO Resp. 5 (citing Ex. 2057 ¶¶ 17–18).

In light of the record before us, we adopt Petitioner’s proposal regarding the level of ordinary skill in the art. Neither party explains if and how the proposed definitions materially differ. *Id.* Based on our review of the ’481 patent and the prior art of record, we determine that the definition offered by Petitioner comports with the qualifications a person would have needed to understand and implement the teachings of the ’481 patent and the prior art. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (explaining that specific findings regarding ordinary skill level are not required “where the prior art itself reflects an appropriate level and a need for testimony is not shown”) (quoting *Litton Indus. Prods., Inc. v. Solid State Sys. Corp.*, 755 F.2d 158, 163 (Fed. Cir. 1985)). Neither party argues, nor do we determine, that the outcome of our Decision depends on which party’s definition is selected. For these reasons, in light of the record before us, we adopt Petitioner’s proposal regarding the level of ordinary skill in the art.

C. Claim Construction

In an *inter partes* review, we construe claim terms according to the standard set forth in *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–17 (Fed. Cir. 2005) (en banc). 37 C.F.R. § 42.100(b) (2023). Under *Phillips*, claim terms are afforded “their ordinary and customary meaning.” *Phillips*, 415

F.3d at 1312. “[T]he ordinary and customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention.” *Id.* at 1313. “Importantly, the person of ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification.” *Id.*

Neither party proposes any claim terms for *express* construction. Pet. 11; PO Resp. 5–6 (citing Ex. 2057 ¶¶ 20–25, 45). However, Patent Owner implicitly construes “graded dopant concentration to aid carrier movement” to require carrier movement, and Petitioner disagrees. PO Resp. 6–13; Pet. Reply 1–17. We address the implicit constructions below in Sections III.E and III.F.

After considering the arguments and information presented during trial, we agree that we do not need to expressly construe any terms in order to resolve the dispute between the parties. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.”)).

*D. Objective Indicia of Non-Obviousness*¹²

Objective indicia of non-obviousness, or secondary considerations of non-obviousness, serve “an important role as a guard against the statutorily proscribed hindsight reasoning in the obviousness analysis,” and must be considered in every case in which they are presented. *WBIP, LLC v. Kohler*

¹² In Section II.D, we refer to the sealed version of the Patent Owner Response in Paper 45.

Co., 829 F.3d 1317, 1328 (Fed. Cir. 2016). Objective indicia of non-obviousness may include evidence of a long-felt need in the art, praise within the industry, skepticism in the industry about whether or how a problem could be solved, copying, and commercial success. *Id.* at 1132–37.

To be probative of non-obviousness, Patent Owner must prove there is a nexus between the presented evidence and the merits of the claimed invention. *See Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1392 (Fed. Cir. 1988). A rebuttable presumption of nexus applies when the “patentee shows that the asserted evidence is tied to a specific product and that the product ‘is the invention disclosed and claimed.’” *Fox Factory, Inc. v. SRAM, LLC*, 944 F.3d 1366, 1373 (Fed. Cir. 2019) (quoting *Demaco*, 851 F.2d at 1392). When the evidence relied upon is that of a license, however, we “require affirmative evidence of nexus,” “because it is often ‘cheaper to take licenses than to defend infringement suits.’” *Iron Grip Barbell Co., Inc. v. USA Sports, Inc.*, 392 F.3d 1317, 1324 (Fed. Cir. 2004) (quoting *EWP Corp. v. Reliance Universal Inc.*, 755 F.2d 898, 908 (Fed. Cir. 1985)).

Patent Owner contends that “[d]uring its prior litigation against [REDACTED] RPX Corp. (‘RPX’) approached Greenthread about negotiating a license for [REDACTED], . . . [REDACTED] and [REDACTED]” PO Resp. 26–27 (citing Ex. 2072 (Rao Declaration)). Patent Owner contends that it “never threatened litigation against either [REDACTED] in any way.” *Id.* at 27. Patent Owner further contends that as part of litigation settlements at least five large, sophisticated parties have taken licenses, with eight major semiconductor companies now having paid more than \$50 million for licenses to just one patent family. *Id.* at 29–30.

Patent Owner does not specifically address the nexus requirement, but asserts that licenses taken without threat of litigation are especially probative of non-obviousness, and contends even litigation inspired licenses have some probative value. PO Resp. 27, 29 (citing *Transocean Offshore Deepwater Drilling, Inc. v. Maersk Drilling USA, Inc.*, 699 F.3d 1340, 1353 (Fed. Cir. 2012); *Fox Factory Inc. v. SRAM LLC*, IPR2017-00472, Paper 64 at 44) (PTAB April 18, 2018)). Patent Owner contends [REDACTED] and [REDACTED] are sophisticated companies who frequently file IPR petitions, yet both paid for licenses covering just the single patent family at issue here. *Id.* at 27–28.

Petitioner argues in its Reply that licenses that result from settlement require affirmative evidence of nexus because it is often cheaper to take a license than to defend infringement suits, and [REDACTED] and [REDACTED] licenses were made through RPX, which structures its arrangements to avoid litigation costs. Pet. Reply 27–28. Petitioner further argues that a recent license for the relevant patent family was made for a greatly reduced amount. *Id.* at 28 (citing Ex. 2072, 103–117; Ex. 1066, 29:16–30:19).

Patent Owner argues in its Sur-reply that “[p]aying money for a patent license, when no litigation is threatened only makes sense if the licensee thinks the patent is valid and valuable.” PO Sur-reply 24. Patent Owner further argues that the sales volume for the recent licensee was lower than Patent Owner’s other licensees, which “confirms the value” of Patent Owner’s patents. *Id.* In view of the above, Patent Owner provides persuasive evidence that the patent family at issue has generated significant licensing revenue both from settlements during litigation and during direct negotiations with parties who had not been threatened with litigation. Patent

Owner's evidence of nexus with respect to the '481 patent, however, is lacking.

“Where a product embodies claims from two patents, a presumption of nexus can be appropriate only if the claims of both patents generally cover the same invention.” *Fox Factory*, 944 F.3d at 1377. And where objective evidence of non-obviousness is in the form of a license, we require specific evidence of a nexus between the licensing revenue and the merits of the claimed invention. *See Iron Grip Barbell*, 392 F.3d at 1324; *Demaco*, 851 F.2d at 1392.

The '481 patent is part of a family of patents concerning graded dopant concentrations in transistors. Ex. 1001, code (60). The '481 patent is not terminally disclaimed to one or more of these patents and we are presented with no persuasive evidence that the patents cover essentially the same invention. *See Fox Factory*, 944 F.3d at 1377–78 (noting that the fact patent owner separately sought patent protection for different combinations of features “is alone probative of whether [the] combination of features adds up to more than an insignificant additional feature”). Nor are we presented with persuasive evidence to determine how much of the licensing activity or revenue was due to the specific subject matter recited in the challenged claims of the '481 patent. As such, Patent Owner fails to sufficiently demonstrate a nexus between its substantial licensing revenue and the subject matter of the '481 patent.

Even if Patent Owner established a nexus between its licensing revenue and the merits of the '481 patent, such evidence would not outweigh the strong evidence of obviousness presented by Petitioner. Patent Owner asserts that the innovative and “novel technique” of the patent family is

creating “a drift field to sweep . . . carriers from the active circuitry at the surface into the substrate.” PO Resp. 28 (citing Ex. 1001, 3:64–4:1). For the reasons discussed above, Petitioner persuasively demonstrates that Kawagoe and Wieczorek disclose such a drift field. Thus, the allegedly novel advancement of the ’481 patent is found in the prior art. *See Yita LLC v. MacNeil IP LLC*, 69 F.4th 1356, 1364 (Fed. Cir. 2023) (“But our case law makes clear that objective evidence of nonobviousness lacks a nexus if it exclusively relates to a feature that was known in the prior art—not necessarily well-known.” (internal quotations and citations omitted)).

For the foregoing reasons, we determine that Patent Owner’s objective indicia of non-obviousness, including Patent Owner’s sizable licensing revenue for the relevant patent family, is entitled to little weight due to a lack of nexus. And, even if we were to assign this evidence more weight, it would be insufficient to outweigh the strong case of obviousness set forth in the Petition.

E. Obviousness Based on Kawagoe

Petitioner contends that claims 1–9, 12–14, 16–27, and 30–36 would have been obvious in view of Kawagoe. Pet. 7, 15–52.

1. Kawagoe

Kawagoe discloses a process for manufacturing a semiconductor integrated circuit device using an epitaxial wafer, i.e., a semiconductor wafer having a semiconductor single crystal epitaxial layer grown over a polished semiconductor substrate. Ex. 1007, 1:13–27, 2:31–35. According to Kawagoe, “[t]he epitaxial wafer is advantageous in that it is excellent in

suppressing the soft errors and resisting to the latchup,”¹³ as well as “drastically reduc[ing] the defect density of the gate insulating film” of a semiconductor integrated device. *Id.* at 1:33–40.

Kawagoe discloses various “representative” processes, including processes in which the single crystal (epitaxial) layer contains an impurity of the same type and in the same concentration as the substrate body. Ex. 1007, 2:55–3:9. According to Kawagoe, the impurity concentration of the substrate body can be made higher than that of epitaxial layer “so that the resistance of the semiconductor substrate body can be relatively lowered to improve the resistance to the latchup.” *Id.* at 4:1–8. Kawagoe discloses a process for manufacturing a semiconductor integrated circuit device including a step of forming a semiconductor region (well) extending below the epitaxial layer and having an impurity concentration that decreases with increasing depth below the epitaxial layer. *Id.* at 3:10–25. According to Kawagoe, the well can be used for forming a complementary Metal-Oxide-Semiconductor Field-Effect Transistor (“MOS.FET”) circuit. *Id.* at 3:32–38.

Kawagoe describes seven embodiments, including Embodiment 1 (Ex. 1007, 6:41–12:40, Figs. 1–8) and Embodiment 4 (*id.* at 14:46–19:64, Figs. 16–25). According to Embodiment 1, a semiconductor integrated

¹³ Petitioner submits Exhibit 1009 (Wang and Agrawal, *Single Event Upset: An Embedded Tutorial*, 21st Int’l Conf on VLSI Design, 429–434, IEEE 2008), which explains that “soft errors” are “random and not related to permanent hardware faults” and “[t]heir causes may be internal (e.g., interconnect coupling) or external (e.g., cosmic radiation),” including “alpha particles [that] are emitted when the nucleus of an unstable isotope decays to a lower energy state.” Ex. 1009, Abstract, 430. Dr. Banerjee characterizes “latchup” as “a ‘short-circuit’ failure condition in poorly designed circuits.” Ex. 1003 ¶ 75.

circuit device includes semiconductor substrate body 2S, epitaxial layer 2E, and gettering layer 2G. *Id.* at 6:51–56, Fig. 1. Substrate body 2S and epitaxial layer 2E are doped with p-type impurity in equal concentrations. *Id.* at 6:60–7:3, 10:51–55, 11:12–16. Embodiment 1 includes n-channel MOS.FET (“nMOS”) 4N and p-channel MOS.FET (“pMOS”) 4P, the latter being formed in n-well 6, which is doped with n-type impurity and extends below the epitaxial layer. *Id.* at 8:46–52, 9:32–40, 11:18–24, 11:43–50, Figs. 1, 5, 7.

According to Embodiment 4, substrate body 2S and epitaxial layer 2E are doped with p-type impurity, and the impurity concentration of substrate body 2S is higher than that of epitaxial layer 2E “to improve the resistance to the latchup.” Ex. 1007, 14:64–15:6, 15:13–17, 16:16–21, 19:59–63, Fig. 17. Embodiment 4 includes p-well 6_p formed with nMOS 4N and n-well 6_n formed with pMOS 4P. *Id.* at 15:26–40, 17:40–18:35, Figs. 16, 21–23. In Embodiment 4, the impurity concentration in p-well 6_p and n-well 6_n decreases with increasing depth below the epitaxial layer. *Id.* at 15:62–16:15, 17:55–61, Fig. 17. Kawagoe discloses that the concentration gradient reduces soft errors by attracting carriers (electrons) to the substrate and preventing them from entering the p-well. *Id.* at 16:2–11.

Petitioner relies on Kawagoe Figures 17 and 23, which are reproduced below and illustrate Embodiment 4 and its properties.

FIG. 17

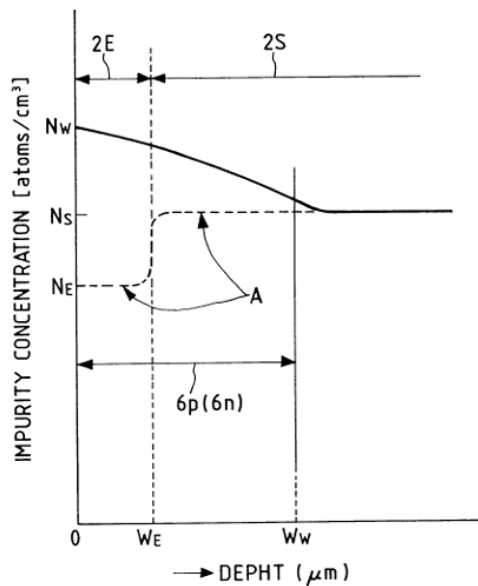


FIG. 23

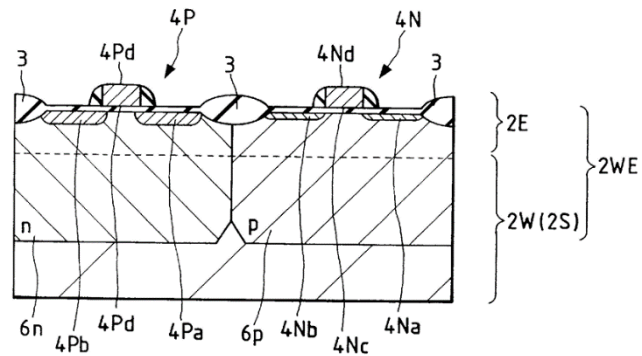


Figure 17 is a plot of impurity concentration as a function of depth in a semiconductor integrated circuit device, which shows “the p-well 6p and n-well 6n have their impurity concentrations gradually lowered in the depthwise direction from the principal surface (having an impurity concentration N_w) of the epitaxial layer 2E.” Ex. 1007, 5:41–45, 15:62–16:40. Figure 23 shows a step in a process for manufacturing a semiconductor integrated circuit device, including p-well 6p formed with nMOS 4N and n-well 6n formed with pMOS 4P. *Id.* at 6:1–4, 15:26–32, 18:3–35.

2. *Petitioner's Contentions for Independent Claim 1*

Petitioner argues that Kawagoe teaches or suggests the limitations of independent claim 1. Pet. 16–39.

[1.pre] “[a] semiconductor device.”

The preamble of claim 1 recites “[a] semiconductor device.”
Ex. 1001, 4:50. Petitioner argues that Kawagoe teaches the preamble.

Pet. 16–17. Kawagoe discloses “a semiconductor integrated circuit device.” Ex. 1007, 1:15–16, 14:50–51.

Patent Owner does not contest Petitioner’s evidence pertaining to the preamble of claim 1. Based on the complete record developed during trial, we determine that Petitioner demonstrates by a preponderance of evidence that Kawagoe teaches the subject matter of the preamble of claim 1. As such, we need not and do not determine whether the preamble of claim 1 is limiting.

[1.1] “a substrate of a first doping type at a first doping level having first and second surfaces.”

Claim 1 recites “a substrate of a first doping type at a first doping level having first and second surfaces.” Ex. 1001, 4:51–52. Relying on a combination of Kawagoe’s Embodiment 1 and Embodiment 4, Petitioner argues that Kawagoe teaches this limitation. Pet. 17–24. Petitioner contends that “a substrate of a first doping type” is taught by Kawagoe’s epitaxial substrate, including epitaxial layer 2E and substrate body 2S doped with p-type impurity, and that the recited “surface” corresponds to the top surface of the epitaxial substrate. *Id.* at 17–19 (citing Ex. 1007, 6:50–7:3, 14:61–15:12, 17:10–18:38, Figs. 20, 23).

Petitioner contends that the recitation, “at a first doping level,” is taught by Kawagoe’s Embodiment 1, which has a uniformly-doped epitaxial substrate, with epitaxial layer 2E and substrate body 2S having the same impurity concentration. Pet. 19–20 (citing Ex. 1007, code (57), 2:57–3:9, 6:60–7:3). Petitioner contends that a POSITA would have understood that Kawagoe teaches forming a twin-well CMOS device on either a uniformly doped epitaxial substrate, as described in Embodiment 1, or a non-uniformly

doped latchup-resistant epitaxial substrate, as described in Embodiment 4. *Id.* at 20 (citing Ex. 1003 ¶ 70).

Relying on Dr. Banerjee’s testimony and various prior art disclosures, Petitioner contends that a POSITA would have been motivated to use a uniformly-doped epitaxial substrate to form a twin-well CMOS device and would have had a reasonable expectation of success. Pet. 20–24 (citing Ex. 1003 ¶¶ 71–76; Ex. 1007, 1:33–40, 2:57–65, 8:40–52, 12:8–40, 14:58–60, 15:7–40, 19:49–63, Fig. 23; Ex. 1008, 381, 387–89, 406, 419, 523, 530; Ex. 1026, 1).

Patent Owner does not contest Petitioner’s evidence pertaining to limitation [1.1]. Based on the complete record developed during trial, we determine that Petitioner establishes by a preponderance of the evidence that the cited portions of Kawagoe, supported by Dr. Banerjee’s testimony, teach this limitation of claim 1.

[1.2] “a first active region disposed adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed.”

Claim 1 recites “a first active region disposed adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed.” Ex. 1001, 4:53–56. Petitioner argues that Kawagoe teaches this limitation. Pet. 24–26. Kawagoe discloses “semiconductor regions 4Na and 4Nb . . . for forming the source-drain regions of the nMOS 4N.” Ex. 1007, 8:66–67, Fig. 23. Petitioner contends that Kawagoe’s semiconductor regions 4Na and 4Nb (corresponding to the “first active region”) have a doping type (n-type) opposite to the doping type (p-type) of the substrate. Pet. 25. Kawagoe discloses that these regions “are doped with an n-type impurity such as

phosphor[us](P) or arsenic (As).” Ex. 1007, 8:67–9:3. Petitioner directs us to evidence tending to show that source-drain regions 4Na and 4Nb, as well as the channel region between those regions and below insulating film 4Nc, all would have been considered part of an active region. Ex. 1008B, 299–300 (“The active regions are those in which transistor action occurs; i.e., the channel and the heavily doped source and drain regions.”).

Patent Owner disputes Petitioner’s evidence pertaining to limitation [1.2]. We resolve the dispute about this limitation in our analysis below.

[1.3] *“a second active region separate from the first active region disposed adjacent to the first active region and within which transistors can be formed.”*

Claim 1 recites “a second active region separate from the first active region disposed adjacent to the first active region and within which transistors can be formed.” Ex. 1001, 4:57–59. Petitioner argues that Kawagoe teaches this limitation. Pet. 16–18. Kawagoe discloses “semiconductor regions 4Pa and 4Pb . . . for forming the source-drain regions of the pMOS 4P.” Ex. 1007, 9:47–48, Fig. 23. These regions “are doped with a[] p-type impurity such as boron.” *Id.* at 9:48–50. Petitioner directs us to evidence that source-drain regions 4Pa and 4Pb, as well as the channel region between those regions and below insulating film 4Pc all would have been considered part of an active region. Ex. 1008B, 299–300 (“The active regions are those in which transistor action occurs; i.e., the channel and the heavily doped source and drain regions.”). This active region is separate from and disposed adjacent to the first active region. Ex. 1007, Fig. 23.

Patent Owner does not contest Petitioner’s evidence pertaining to limitation [1.3]. Based on the complete record developed during trial, we

determine that Petitioner establishes by a preponderance of the evidence that the cited portions of Kawagoe, supported by Dr. Banerjee's testimony, teach this limitation of claim 1.

[1.4] "transistors formed in at least one of the first active region or second active region."

Claim 1 recites "transistors formed in at least one of the first active region or second active region." Ex. 1001, 4:60–61. Petitioner argues that Kawagoe teaches this limitation. Kawagoe discloses forming transistors 4N and 4P, each in an active region, as discussed above. Ex. 1007, 8:66–9:3, 9:47–50, Fig. 23. Petitioner notes that the disclosure of Kawagoe satisfies claim 1's recitation of "transistors" either under Patent Owner's district court construction of "transistors" as requiring one or more transistors, or under an alternative construction requiring multiple transistors in each active region. Pet. 25 ("forming multiple nMOS transistors would have been obvious as a mere duplication of parts lacking unexpected results"), 27–28 ("a POSITA would have understood that forming multiple pMOS transistors in this [second active] region would have been obvious"), 84–85 (citing Ex. 1003 ¶¶ 78, 82; Ex. 1014, 1:52–54, 2:17–21, Fig. 23; Ex. 1020, 31).

Patent Owner does not contest Petitioner's evidence pertaining to limitation [1.4]. Based on the complete record developed during trial, we determine that Petitioner establishes by a preponderance of the evidence that the cited portions of Kawagoe, supported by Dr. Banerjee's testimony, teach this limitation of claim 1.

[1.5] “at least a portion of at least one of the first and second active regions having at least one graded dopant concentration to aid carrier movement from the first surface to the second surface of the substrate.”

Claim 1 recites “at least a portion of at least one of the first and second active regions having at least one graded dopant concentration to aid carrier movement from the first surface to the second surface of the substrate.” Ex. 1001, 4:62–65. Petitioner argues that Kawagoe teaches this limitation. Pet. 28–34. Kawagoe discloses its wells “hav[ing] their impurity concentrations gradually lowered in the depthwise direction from the principal surface . . . of the epitaxial layer 2E.” Ex. 1007, 15:62–16:2, Figs. 17, 23. Petitioner directs us to evidence that tends to show that these depthwise variations in impurity concentrations include the channel regions of each active region and that such variations in impurity concentrations help to move carriers down into the substrate, away from the top surface and toward the bottom surface. Ex. 1003 ¶ 86; Ex. 1007, 5:41–45, 15:32–36, 16:2–11, Figs. 17, 23; Ex. 1016, 289–90.

Patent Owner disputes Petitioner’s evidence pertaining to limitation [1.5]. We resolve the dispute about this limitation in our analysis below.

[1.6] “at least one well region adjacent to the first or second active region containing at least one graded dopant region, the graded dopant region to aid carrier movement from the first surface to the second surface of the substrate.”

Claim 1 recites “at least one well region adjacent to the first or second active region containing at least one graded dopant region, the graded dopant region to aid carrier movement from the first surface to the second surface of the substrate.” Ex. 1001, 4:66–5:3. Petitioner argues that Kawagoe teaches this limitation. Pet. 34–39. Kawagoe discloses its wells “hav[ing] their impurity concentrations gradually lowered in the depthwise direction from

the principal surface . . . of the epitaxial layer 2E.” Ex. 1007, 15:62–16:2, Figs. 17, 23. Petitioner directs us to evidence that tends to show that these depthwise variations in impurity concentrations sweep carriers down into the substrate, away from the top surface and toward the bottom surface. *Id.* at 5:41–45, 15:32–36, 16:2–11, Figs. 17, 23; Ex. 1016, 289–90.

Patent Owner disputes Petitioner’s evidence pertaining to limitation [1.6]. We resolve the dispute about this limitation in our analysis below.

3. *Patent Owner’s Arguments*

Patent Owner disputes Petitioner’s showing with respect to Kawagoe based on five sets of contentions, which we set forth below. *See generally* PO Resp.; PO Sur-Reply. Patent Owner’s first set of contentions relates to limitation [1.2] and the second through fifth sets of contentions relate to limitations [1.5] and [1.6].

a) *Patent Owner’s Contentions that Petitioner’s Challenge does not Teach or Suggest “a first active region . . . with a second doping type opposite in conductivity to the first doping type”*

Patent Owner contends that the combination of Kawagoe does not teach or suggest limitation [1.2]. According to Patent Owner, “the Petition mapped ‘a first doping type’ to p-type doping” and asserts that “Kawagoe’s [source-drain] regions 4Na and 4Nb ‘have a second doping type (n-type) opposite in conductivity to the first doping type (p-type) of the substrate.’” PO Resp. 23 (citing Pet. 17, 25, 49). Patent Owner argues that “the Petition also states that the *channel* of transistor 4N is [*also*] part of the first active region.” *Id.* (alteration added) (citing Ex. 1007, 8:66–9:3; Pet. 24 (“Source-drain regions 4Na/4Nb (purple) form part of the claimed first active region, which also includes the channel region . . . ”)). Patent Owner thus contends that, with respect to limitation [1.5],

which recites “at least a portion of at least one of the first and second active regions having at least one graded dopant concentration . . . ,” the Petition pointed to the concentration profile under the *channel*. But the channel of transistor 4N is doped p-type, because it is the top portion of a p-well (as shown in Figure 23 of Kawagoe).

Id. at 24–25 (citing-in-part Pet. 25 (pointing to Kawagoe’s Figure 23, which shows channel of transistor 4N at the top of p-well 6p), 24 (“the channel region (light purple) between source-drain regions 4Na/4Nb”), 29–31).

Patent Owner points to Dr. Glew’s testimony and contends that it “explain[s] that the channel in a CMOS transistor has the same doping type as the well in which the source and drain are formed” and that “the channel of NMOS 4N made from *the p-well, the p-well, and the p type substrate are all doped p-type.*” *Id.* at 24 (citing Ex. 2057 ¶ 59) (emphasis added).

b) *Patent Owner’s Contentions that Petitioner’s Challenge does not Calculate Magnitude of Slope of Graded Dopant Concentration*

Patent Owner contends that Petitioner’s challenge is based on inherency and that, as such, “[t]he ‘probability or possibility’ that a dopant gradient aids carrier movement ‘is insufficient.’” PO Resp. 2 (citing *In re Robertson*, 169 F.3d 743, 745 (Fed. Cir. 1999)). According to Patent Owner, “[t]he prior art ‘must *necessarily* include the unstated limitation.’” *Id.* (citing *Transclean Corp. v. Bridgewood Servs., Inc.*, 290 F.3d 1364, 1373 (Fed. Cir. 2002)); *see id.* at 10 (citing *Phillips*, 415 F.3d at 1314). Patent Owner contends that “Petitioners’ references do not teach the ‘aid carrier movement’ claim limitation” and that, “[t]herefore, to locate ‘aid carrier movement’ in the prior art, Petitioners assert that any ‘graded dopant concentration’ will ‘aid carrier movement.’” *Id.* at 6.

Patent Owner contends that “the specification, like Greenthread’s statements during prosecution, describes the slope of the dopant concentration as a relevant parameter for determining whether a concentration gradient will aid carrier movement.” PO Resp. 8; *see id.* at 8–9 (quoting Ex. 1001, 3:1–5 (“The gradient can be linear, quasi linear, exponential or complimentary error function.”)).

With regard to related litigations, Patent Owner contends that “not one but two District Courts have previously agreed with Greenthread that not all doping gradients must aid carrier movement.” PO Resp. 9. According to Patent Owner, “[t]he Western District of Texas^[14] unequivocally stated, ‘a graded concentration...that is [not “sufficiently graded”] will not aid in the movement of minority carriers[.]’” *Id.* (citing Ex. 2074, 39–40) (alterations by Patent Owner). “And the Eastern District of Texas^[15] understood that direction alone does not determine whether a gradient aids carrier movement—the magnitude of the gradient must also be considered.” *Id.* (citing Ex. 2075, 15 (Patent Owner arguing that a cited reference “explain[s] that ‘the slope [of the gradient] has both a direction and a magnitude and [d]efendant [incorrectly] suggests that the direction of the drift electric field depends solely on the direction of the slope of the graded concentration’”) (first alteration added)).

Patent Owner also contends

[r]egarding the WDTX order, Petitioners say that “sufficiently graded” “*may*” not refer to the magnitude of the slope. But the very next sentence from the Court’s order contradicts that reading. The Court said it was referring to a “minimum graded

¹⁴ Exhibit 2074, “WDTX Order”

¹⁵ Exhibit 2075, “EDTX Order”

concentration of dopants, i.e., a graded concentration of dopants that is below this minimum will not aid in the movement of minority carriers and thus is not a graded concentration.”

PO Sur-reply 9 (quoting Ex. 2074, 39–40; Ex. 2075, 15) (citing Pet. Reply 15).

c) *Patent Owner’s Contentions that Petitioner’s Challenge does not Account for Additional Forces Acting on a Carrier*

Patent Owner contends that “Petitioners’ assumption that the gradients in their prior art references would aid carrier movement fails, because they assume that any gradient would suffice to overcome the other forces that are present, such as the inherent resistance of silicon.” PO Resp. 7–8. Patent Owner argues that “if the forces acting on a carrier—i.e. the force exerted by a gradient and *any other forces*—cancel each other out, the carriers do not move at all.” *Id.* at 8 (emphasis added). Patent Owner also argues that,

during prosecution, the examiner said that in “a complex electronic device, movement of minority carriers is affected by multiple forces and fields” and that a “drift field may attempt to apply a force on all minority carriers in a specific direction” but that “without knowing other parameters of the device” one cannot say whether the field would aid carrier movement. This is exactly what Cirrus Logic’s 30(b)(6) [expert] and Greenthread’s expert testified.

Id. at 9 (citing Ex. 2016, 270; Ex. 2057 ¶ 50) (alteration added); *see id.* at 14 (citing Ex. 2056, 95:2–96:13; Ex. 2057 ¶¶ 50–57) (“Since the Petition fails to analyze the magnitude of the dopant gradient or the magnitude of other forces, it cannot show that the prior art dopant gradients aided carrier movement.”).

Patent Owner contends that it

showed Cirrus’s corporate representative a doping profile from one of the Cirrus accused products and asked him if the

downward sloping gradient met the “aid carrier movement” claim limitation. He said “*I cannot tell you that.*” Greenthread then asked “*is that because there’s other things that might affect carrier movement besides the gradient?*” to which Mr. Warrick replied “*Yes.*”

PO Resp. 7 (citing Ex. 2056, 95:2–5; 96:1–13); *see id.* at 2–3 (citing Ex. 2056, 72:6–8, 95:2–5, 96:1–13).

Patent Owner argues that

Petitioners now argue that Greenthread has “mischaracterized” the claim and that “aiding carrier movement” does not refer to the flow of carriers in a semiconductor device, but rather the constant, random, thermal—a.k.a. “Brownian”—vibration of individual electrons. . . . The specification and claim language speak of moving electrons “from” one location “to” another to influence the operation of the device, not individual electrons vibrating. Furthermore, Dr. Banerjee said that the net effect of “Brownian” motion is precisely zero, because “statistically you have as many electrons moving to the right as to the left.”

PO Sur-reply 1–2 (citing Ex. 2078, 104:11–14); *see id.* at 5–6 (citing Pet. Reply 8, 12, n.8; Ex. 1060 ¶¶ 19, 95) (“According to Petitioners, ‘carriers do not need to overcome any opposing forces before they move’ because carriers ‘are constantly moving (i.e., in “Brownian” motion) due to thermal effects.’”).

d) *Patent Owner’s Contentions that Kawagoe Teaches Inhibiting, not Aiding, Carrier Movement*

Patent Owner takes issue with Petitioner’s truncating of a quotation from Kawagoe and, based on the complete quote from Kawagoe, contends that Kawagoe “teach[es] that the graded concentration actually *inhibits* carrier movement.” PO Resp. 16. Specifically, Patent Owner contends that

the electrons produced by the α -ray are attracted to the substrate body 2S by that concentration gradient and *prevented from entering the p-well 6p* [] so that the soft errors can be reduced in case the MIS memory of the DRAM or the like is formed in the p-well 6p.

Id. at 15 (quoting Ex. 1007, 16:2–11) (citing Pet. 31–32). Instead, Patent Owner argues that

Petitioners state in a footnote that, according to Kawagoe, SEUs^[16] generate “electrons produced in the large substrate body below the wells”—far below the active regions. Kawagoe’s electrons are *below* p-well 6p, and prevented from moving *upward* into p-well 6p. Kawagoe’s 6p extends to the very top of the device. Therefore, carriers travelling vertically could only enter 6p from below.

Id. at 16 (citing Ex. 2057 ¶ 52; Pet. 32, n.10). According to Patent Owner, “Kawagoe’s 6p extends to the very top of the device” and “[t]herefore, carriers travelling vertically could only enter 6p from below.” *Id.* at 16–17 (footnote omitted).

e) Patent Owner’s Contentions About the Cited Underlying Evidence and Whether There are Carriers in Kawagoe’s Active Region

Patent Owner contends that “[t]he Petition relies on a post-priority date reference to make up for Kawagoe’s deficiency,” and more particularly, “relies on testimony from their expert witness Dr. Banerjee and” Wang “to fill the gap” with respect to Kawagoe. PO Resp. 17 (emphasis omitted). Patent Owner contends that Petitioner has not established public availability of Wang, “which purports to be from 2008, i.e., four years after the critical

¹⁶ “SEU” refers to a “single event upset.” PO Resp. 16 (citing Ex. 1007, 16:7–11).

date of the Challenged Patent.” *Id.* at 18 (citing Ex. 1003 ¶ 89; Pet. ix; Ex. 1009, 429 (listing Wang’s copyright date as 2008)) (emphasis omitted).

Patent Owner also contends that

[a]s explained by Dr. Glew—who has experience working with alpha rays/alpha particles—a POSITA would have understood when Kawagoe mentions “electrons produced by the α -ray”, Kawagoe is not describing electrons near the surface. Dr. Glew cites Nishizawa^[17]—a reference from *before* the Challenged Patent’s priority date—to demonstrate what a POSITA would have known:

Accordingly, it will be understood that the alpha-particle immediately after irradiation to the surface of a semiconductor body has an energy of several MeV, for example about 5 MeV, and that, accordingly, ***the probability of creation of electron-hole pairs is extremely low near the surface.*** The alpha-particle will begin to create electron-hole pairs after it has entered into the semiconductor substrate to a certain distance.

PO Resp. 19 (quoting Ex. 2060, 19:21–34) (citing Ex. 2060, 20:19–22 (“[T]he amount of electrons created which adversely affect the memory action is no greater than only 10% of the stored electric charge, and thus it can be disregarded.”); Ex. 2057 ¶¶ 10, 54; Ex. 1007, 16:7–11).

Patent Owner further contends that “[t]hus, a POSITA would have understood that Kawagoe’s electrons that are prevented from entering the p-well are not created near the surface.” *Id.* at 20. Patent Owner takes the position that “Kawagoe does not address carriers in the ‘active region’ and does not ‘aid carrier movement *from the [first surface | surface]*’ because Kawagoe’s carriers are nowhere near what Petitioners identify as the

¹⁷ U.S. Patent No. 5,384,476 issued January 24, 1995 to Nishizawa et al. (Ex. 2060, “Nishizawa”).

‘surface.’” *Id.* at 17; *see id.* at 1–2 (“Kawagoe does not teach *anything* about carriers in the active region at the *top* of the device.”).

4. *Petitioner’s Reply Arguments*

Petitioner responds to Patent Owner’s arguments. *See generally* Pet. Reply.

a) *Petitioner’s Reply to Patent Owner’s Contentions that Petitioner’s Challenge does not Teach or Suggest “a first active region . . . with a second doping type opposite in conductivity to the first doping type”*

In response to Patent Owner’s *first* set of arguments, Petitioner contends that “Greenthread’s argument incorrectly presumes that the claims require the ‘second doping type’ to be distributed *throughout the entirety* of the identified ‘first active region.’” Pet. Reply 24. According to Petitioner, “[i]t is sufficient that *some portions* of the ‘first active region’—here, the source and drain of Kawagoe’s NMOS (4N) formed in p-well 6p—include a ‘second doping type’ (e.g., n-type dopants).” *Id.* Petitioner contends that “Greenthread concedes this.” *Id.* (citing PO Resp. 23 (Patent Owner acknowledging Kawagoe’s “regions 4Na and 4Nb are doped n-type.”)). “Similarly,” Petitioner contends, “Figures 5B and 5C—which Greenthread says ‘clearly disclose[]’ the ‘claimed invention’—show NMOS devices having n-type source and drain regions and a p-type substrate.” *Id.* (citing PO Resp. 4; Ex. 2057 ¶ 34; Ex. 1001, Figs. 5B–5C; Ex. 1060 ¶¶ 99, 100).

b) *Petitioner’s Reply to Patent Owner’s Contentions that Petitioner’s Challenge does not Calculate Magnitude of Slope of Graded Dopant Concentration*

With respect to Patent Owner’s *second* set of contentions, Petitioner contends that “[t]he challenged claims are drawn to *devices*, not *methods*” and “[a]s such, they ‘cover what a device *is*, not what a device *does*.’” Pet.

Reply 16 (citing *ParkerVision, Inc. v. Qualcomm Inc.*, 903 F.3d 1354, 1361 (Fed. Cir. 2018)). According to Petitioner, “[t]his is an example of a limitation that, according the Federal Circuit, ‘recites “*capability*, as opposed to actual operation,’” such that the limitation is met by ‘an apparatus that is “*reasonably capable*” of performing the claimed function[.]’” *Id.* (quoting *ParkerVision*, 903 F.3d at 1362 (citation omitted)). Thus, Petitioner contends “[a]s to the claimed devices here, a device having a ‘graded dopant concentration’ sloped in a particular direction *has* the required capability (*i.e.*, ‘to aid carrier movement’), for all of the reasons discussed.” *Id.* (citing Pet. Reply § II.A; *ParkerVision*, 903 F.3d at 1361).

Petitioner contends that Patent Owner did not dispute the Examiner’s finding, “[d]uring prosecution, as to pending claims that were identical in relevant respects, . . . that ‘any magnitude of the drift electric field, however small, reads on the claim.’” Pet. Reply 3 (quoting Ex. 1016, 139–40) (emphasis omitted).

Petitioner contends that “Greenthread reiterated—without qualification—that ‘[w]hen the dopant concentration is graded in a particular direction, other charge carriers will move in the gradient direction (or opposite direction) depending on the charge carrier’s polarity.’” Pet. Reply 6–7 (quoting Ex. 1020, 2) (citing Ex. 2057 ¶ 33) (emphasis omitted). Petitioner further contends that “Greenthread further explained, ‘[w]hile the claims require that the graded dopants create an electric field that aids movement of the carriers, they do not require a specific range of doping, a particular doping field, or a particular result,’ which are beyond ‘the scope of Dr. Rao’s invention.’” *Id.* at 7 (citing Ex. 1020, 28) (emphasis omitted).

Petitioner further argues that “Greenthread clearly argued to the USPTO that ‘particular slope’ is not a reference to the slope’s magnitude, but only its direction (‘down’ or ‘up’), but now attempts to evade these statements.” *Id.* at 4 (citing PO Resp. 12–13; Ex. 1016, 289). Petitioner asserts that

Greenthread now cites the specification’s discussion of *relative slope* . . . but that merely refers to *slope direction* (increasing or decreasing), not magnitude. Indeed, Greenthread recently represented to the USPTO that the specification’s reference to “relative slope” means “*nothing more than the fact that one-side is relatively lower than the other side.*” The specification also provides exemplary gradient slopes . . . but that does not suggest that carrier movement hinges on the magnitude of those slopes. The intrinsic record thus completely undermines Greenthread’s present argument that the slope magnitude must be “measure[d]” and “compare[d]” with alleged other forces.

Id. at 5–6 (citing PO Resp. 8–9; Ex. 1001, 2:66–3:5; Ex. 1070, 9; Ex. 1064, 5) (footnote omitted).

With respect to the WDTX Order,

the Court was evaluating whether the term “graded” was indefinite and did not evaluate whether a minimum slope magnitude is needed to aid movement (a different issue that was not briefed). Greenthread cites the Court’s assessment that “graded concentration has to be sufficiently graded,” but that does not imply that the *magnitude* of the slope matters. “*Sufficiently graded*” may refer to whether the graded concentration is sloped appropriately across the entire span specified by the claims—i.e., “*from...to...*”; for example, if the gradient’s slope is in the right direction for only some segment(s) of that claimed span, but in the wrong direction for other segment(s), that may be *insufficiently* graded to satisfy the claims. Greenthread’s suggestion that “sufficiently graded” refers to some threshold *magnitude* . . . is belied by the Examiner’s assessment (which Greenthread did not dispute) that

“any magnitude of the drift electric field, however small, reads on the claim.”

Pet. Reply 15 (citing PO Resp. 9; Ex. 1060 23; Ex. 1016, 139–40).

With respect to the EDTX Order,

the Court was addressing whether a unidirectionally-sloped graded concentration is *necessary* to create a unidirectional electric drift field. That is a different inquiry from whether a graded concentration is *sufficient* to create a drift field, and in turn, *sufficient* to move carriers. Indeed, in the same page of the Order, the Court acknowledged that “the patentee cited Grove to support that a graded dopant concentration ***will provide a unidirectional electric drift field to move the minority carriers*** in a single direction.” Nothing in this Order suggests a threshold slope magnitude is needed to aid carrier movement.

Id. at 15–16 (citing Ex. 2075, 15).

c) *Petitioner’s Reply to Patent Owner’s Contentions that Petitioner’s Challenge does not Account for Additional Forces*

Petitioner contends that a “static field superimposes a force onto minority carriers, thereby causing those carriers to *move* in a particular direction (depending on charge type), based on a phenomenon called ‘**carrier drift**’—that is, to *aid carrier movement* in that direction.” Pet. Reply 8 (citing Ex. 1060 ¶¶ 21–27) (bold emphasis added). Critically, Petitioner contends that “carriers do not need to overcome any opposing forces before they move,” because “in a doped semiconductor region, at room temperatures, carriers in the conduction band of a silicon atom are not bound, but are *free to move*,” and “are *constantly moving* (i.e., in ‘Brownian’ motion) due to thermal effects.” *Id.* (citing Ex. 1060 ¶¶ 12–20; Ex. 1003 ¶ 95). For this reason, Petitioner argues that Patent Owner’s position that a threshold voltage is required to “liberate an extra electron from a crystal structure” is unsupported because “the extra electrons in a doped

semiconductor are not bonded to silicon atoms, but are free to move, and already in Brownian motion.” *Id.* at 9–10 (citing Ex. 1063, 105:6–9, 107:8–10; Pet. Reply § IIA.3).

Petitioner further contends that “[i]ntrinsic resistance’ (or resistivity) is an inherent property of a material and its effect on carriers is analogous to a dampening force that may affect the degree of carrier mobility (i.e., the speed of carrier movement), but does not prevent carrier movement altogether.” Pet. Reply 11 (citing Ex. 1060 ¶¶ 36–41, 58–59). Petitioner also contends that its 30(b)(6) witness Mr. “Warrick[,] never suggested they could overwhelm the drift field and preclude it from aiding carrier movement altogether. Warrick’s statements are thus entirely consistent with Dr. Banerjee’s analysis.” *Id.* at 14 (citing Ex. 1060 ¶¶ 58–59).

Petitioner also contends that “[t]he devices in their ON state (i.e., when an external voltage is applied) presents an entirely different scenario that was not raised by Greenthread when describing its invention during prosecution (i.e., that the ‘built in’ electric field alone **move carriers via drift**).” Pet. Reply 12 (citing Ex. 1060 ¶¶ 49–51, 91–95) (emphasis added). According to Petitioner, “Dr. Glew’s failure to analyze OFF-state carrier movement, even when given the opportunity during deposition, warrants disregarding his analysis on this term altogether.” *Id.* at 13 (citing Ex. 1063, 50:10–62:22).

d) Petitioner’s Reply to Patent Owner’s Contentions that Kawagoe Teaches Inhibiting, not Aiding, Carrier Movement

Petitioner contends that “Greenthread fixates on Kawagoe’s statement that electrons are ‘prevented from entering the p-well,’ but that statement

supports Petitioner’s analysis.” Pet. Reply 19 (citing PO Resp. 15–16).

Petitioner takes the position that

Kawagoe explains that its concentration gradient prevents electrons found *below* the well from moving upwards, which is the result of the same electric field that aids downward movement of the electrons in the well. As to the *claimed* direction—“from the first surface to the second surface of the substrate”—Kawagoe teaches that electrons are “attracted to the substrate body 2S by that concentration gradient,” lending further support to Petitioner’s analysis. In other words, aiding downwards is consistent with inhibiting movement in the opposite direction . . . Since Kawagoe’s gradient is consistently decreasing “from the first surface to the second surface of the substrate,” the resulting electric field induces minority carrier drift above and below well region 6p.

Id. at 19–20 (citing Pet. 31–32).

e) Petitioner’s Reply to Patent Owner’s Contentions About the Cited Underlying Evidence and Whether There are Carriers in Kawagoe’s Active Region

Petitioner contends that “Greenthread dismisses Wang as not indicative of a POSITA’s understanding as of the 2004 priority date, but fails to appreciate that Wang cites an earlier 2004 article, Baumann, containing the same figure relied upon by Petitioners, showing carriers in the active region.” Pet. Reply 21 (citing PO Resp. 18; Ex. 1065). According to Petitioner, “Greenthread’s arguments about whether Wang ‘give[s] a POSITA a reason to use Kawagoe in the active region,’ . . . are pointless; Petitioner is *not* proposing to modify Kawagoe in view of Wang.” *Id.* (citing PO Resp. 18). Petitioner also points out that “Nishizawa expressly states that, following an alpha-ray strike, ‘several ten thousand electrons will flow into the n+ type region 13,’ which is part of the active region.” *Id.* at 21–22 (citing Ex. 2060, 19:41–42, Figs. 34–36).

Petitioner further argues that “Greenthread’s argument that ‘Kawagoe’s carriers are not in the active region,’ is also baseless.” Pet. Reply 20 (citing PO Resp. 16–17). Petitioner takes this position because “[e]lsewhere, Greenthread itself admits that “Kawagoe’s transistors presumably have carriers in the active region” and because “Dr. Glew likewise agreed that electrons would be present throughout Kawagoe’s devices.” *Id.* (citing PO Resp. 1–2; Ex. 1069, 116:4–123:15, 120:16). Accordingly, Petitioner contends that “Greenthread’s ‘carriers in the wrong place’ argument fails for this reason alone.” *Id.* “Further,” Petitioner contends, “contrary to Greenthread’s arguments, the evidence makes clear that alpha-ray strikes create carriers in the active region. The 2008 Wang reference shows and describes this.” *Id.* at 20–21 (citing Ex. 1009, 431).

5. *Analysis of the Parties’ Contentions*

We have considered the cited evidence, including expert testimony, as cited in the parties’ briefs, and the parties’ arguments pertaining to the limitations of claim 1 that are in dispute. Below, we set forth our findings and conclusions as to those disputed issues.

a) *Analysis Concerning “a first active region . . . with a second doping type opposite in conductivity to the first doping type”*

With regard to the parties’ arguments concerning limitation [1.2] (and by association, limitation [1.5]), we agree with Petitioner that “[i]t is sufficient that *some portions* of the ‘first active region’—here, the source and drain of Kawagoe’s NMOS (4N) formed in p-well 6p—include a ‘second doping type’ (e.g., n-type dopants).” Pet. Reply 24. The claims are not so narrow as to “require the ‘second doping type’ to be distributed *throughout the entirety* of the identified ‘first active region,’” as Petitioner

argues. *Id.* Petitioner asserts, and Patent Owner does not persuasively dispute, that the source-drain regions and the channel regions would be considered part of the active regions where transistor activity occurs. Pet. 24 (citing-in-part Ex. 1003 ¶ 77; Ex. 1008B, 299–300); PO Resp. 23 (“Kawagoe discloses that regions 4Na and 4Nb are doped n-type . . . but the Petition *also* states that the *channel* of transistor 4N is *part of the first active region*.” (citing Ex. 1007, 8:66–9:3; Pet. 13) (first, second, and fourth alterations added)).

The parties’ dispute concerns the active region, and in particular, if *only* the “second doping type opposite in conductivity to the first doping type” must be present in the active region. After review of the evidence of record, including the language of the claims, the written description of the ’481 patent, and the prior art of record, we find Petitioner persuasively shows that the active region has the “second doping type” in the source and drain regions.

Claim 1 requires “a first *active region* . . . with a second doping type opposite in conductivity to the first doping type,” and is not so specific so as to require *only* the “second doping type,” nor to require the “second doping type” throughout the *entirety* of the “first active region.” Claim 1 does not require that the channel region of the active region has the “second doping type opposite in conductivity to the first doping type.” It is enough that the source and drain regions within the active region have the “second doping type.” And, because the claim does not preclude the first doping type from *also* being in the source and drain regions, it is sufficient to meet the claims if the source and drain regions have the “first doping type” in the source and drain regions, *along with* the “second doping type.”

As discussed below, Petitioner persuasively demonstrates that the “active region” of a MOS device would have been understood by one of ordinary skill in the art to have dopants of the “second doping type,” in this case, n-type dopants, in the source and drain regions of the active region.

Dr. Glew testifies that “[t]he claimed invention is clearly disclosed in, e.g., Figs. 5B-5C of the Challenged Patent, and the corresponding parts of the specification.” Ex. 2057 ¶ 34. Figure 5B of the ’481 patent depicts *n-type source and drain regions formed within a P^- substrate*, and a graded dopant region which is disclosed as “creat[ing] a drift field to sweep [] unwanted minority carriers from the active circuitry at the surface into the substrate in a monolithic die as quickly as possible.” Ex. 1001, 3:64–4:1. The ’481 patent further discloses “a graded donor concentration to sweep the minority carriers deep into the substrate” that “can be a deeply-implanted layer,” an *epitaxial layer*, an n-well, or a *p-well*, like Kawagoe, and when implemented in a well region, can be “graded or retrograded in dopants to sweep those carriers away from the surface as well.” *Id.* at 4:1–10. Thus, the written description of the ’481 patent supports Petitioner’s identification of the doping type of the active region being represented by the doping type of the source and drain.

Third, the cited, underlying evidence, Wolf, supports Petitioner’s position; it describes how a POSITA would have understood an *nMOS* as including a source and drain that are doped with an n-type dopant and “[a] channel region in the semiconductor under the gate electrode[,] separat[ing] the source and drain” that “is lightly doped with a dopant type opposite to that of the source and drain.” Ex. 1008B, Fig. 5-1(a), 298 (emphasis added).

In view of the foregoing, Petitioner persuasively demonstrates that the doping type of the active region of limitation [1.2] may be identified as the doping type of the source and drain regions. *See e.g.*, Pet. Reply 24–25. Petitioner persuasively demonstrates that Kawagoe discloses a first active region (including the source and drain) having a second doping type (n-type) that is opposite in conductivity to the first doping type (p-type). Pet. 24–26. Thus, Petitioner persuasively demonstrates that Kawagoe discloses limitation [1.2].

b) Analysis Concerning Calculating Magnitude of Scope

With regard to the parties’ arguments concerning the “at least one graded dopant concentration to aid carrier movement” limitation, we briefly summarize the prosecution of U.S. Patent Application No. 11/622,496, the application leading to parent U.S. Patent No. 8,421,195 (“the ’195 patent”). During prosecution, the Examiner rejected claims under the pre-AIA version of 35 U.S.C. § 112, first paragraph and found that “movement of minority carriers is affected by multiple forces and fields” and that “it does not appear that simply the presence of ‘a unidirectional drift field’ in itself can achieve ‘drawing all minority carriers from said surface layer to said substrate.’” Ex. 1016, 270, *see id.* at 289. The Applicant responded with following argument:

[A] unidirectional drift (electric) field necessarily affects all the present minority carriers in the same way - moving all minority carriers in the same direction because of the unidirectional drift due to the existence of the electric field. *See* “Physics and Technology of Semiconductor Devices,” A.S. Grove, pp. 224–225, John Wiley and Sons, Inc., New York, 1st Edition 1967 (“This same electric field will then be of such direction as to aid the motion of injected holes. Thus the injected minority carriers will now move not only by diffusion but also by drift due to the existence of this electric field.”). Depending on the particular

slope of the graded concentration of dopant, all minority carriers are either swept “down” (from the surface layer to the substrate) or “up” (from the substrate to the surface layer). *See* Applicant’s Figs. 5(b) and 5(c).

Id. Patent Owner further argued that the Examiner’s argument that the simple presence of a “graded dopant concentration” “does not appear to ensure (without knowing [the] other parameters of the device) that it will draw ‘all’ minority carriers” and

appears to not consider that the graded dopant concentration itself creates a “built-in” electrical field that forces the movement of carriers into a particular direction, whereby the “direction” of the electrical field and the resulting direction of the carrier movement depends *solely* on the slope of the graded concentration of dopant. With regard to the existence of a “built-in” electric field created by a graded dopant density, . . . *this inherent “built-in” unidirectional electric field is the additional parameter for ensuring that all minority carriers are being moved in one direction* and which parameter the Office Action deemed to be missing from the disclosure.

Id. at 289–90 (emphases added). Also, “without conceding [its] position on this issue,” Patent Owner amended the claims to no longer require “drawing all minority carriers,” and instead, requiring that the claimed “unidirectional drift field” created by the “graded concentration of dopants” “aid the movement of minority carriers.”¹⁸ *Id.* at 289.

¹⁸ The examined claims of the ’195 patent application generally recited “a unidirectional drift field drawing all minority carriers from said surface layer to said substrate.” Ex. 1016, 250. Patent Owner amended the claims of the ’195 patent application to recite “maintain[ing] a single static unidirectional electric drift field to aid the movement of minority carriers from said surface layer to said substrate.” *Id.* at 286.

We determine that the statements made by Patent Owner during prosecution of the '195 parent patent were clear, unambiguous, and indicate that one of ordinary skill in the art need not know whether there are other “forces and fields” in an electronic device, as the mere presence of a graded dopant concentration creating a “unidirectional drift field,” facing in the appropriate direction, will “aid the movement of minority carriers from” the surface layer to the substrate. Ex. 1016, 270, 289–290. The public was entitled to rely on these clear and unambiguous statements when considering the scope of the challenged claims. *Hockerson-Halberstadt v. Avia Group Int'l*, 222 F.3d 951, 957 (Fed. Cir. 2000) (“The prosecution history constitutes a public record of the patentee’s representations concerning the scope and meaning of the claims, and competitors are entitled to rely on those representation when ascertaining the degree of lawful conduct, such as designing around the claim invention.”).

We agree with Petitioner that, contrary to Patent Owner’s arguments in this proceeding, neither the specification nor the prosecution history requires a calculation of magnitude of a slope to meet the requirements of claim 1—all that is required is a determination of relative slope as described by direction. Pet. Reply 2–3. Petitioner’s arguments about the prosecution of descendent U.S. Patent Application No. 17/728,588 (“the ’588 application”), an application that claims priority to both the ’481 patent and the ’195 patent, are similarly persuasive. During prosecution of the ’588 application, Patent Owner asserted that “relative slope ‘means nothing more than the fact that one side is relatively lower than the other.’” Ex. 1070, 9; *see* Pet. Reply 5 (citing Ex. 1070, 9; Ex. 1064, 5).

Based on the complete record developed during trial, Patent Owner's statements during prosecution of the '195 patent and '588 application, along with the specification of the '481 patent, support a determination that a graded dopant concentration is enough to teach aiding carrier movement in a particular direction. We observe, in that regard, that the inventor "did not provide the type of detail in" the '481 patent's specification that Patent Owner "now argues is necessary in [the] prior art references." *In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994).

We also find Patent Owner's arguments pointing to a portion of the specification that discloses what it regards as a specific dopant concentration unavailing. PO Resp. 8–9 (quoting Ex. 1001, 3:1–5). The '481 patent discloses that

[t]he *relative* doping concentrations of emitter and collector regions varies from 10^{18} to $10^{20}/\text{cm}^3$, whereas the base region is 10^{14} to $10^{16}/\text{cm}^3$ depending on the desired characteristics of the BJT. In graded base p-n-p transistors, the donor dopant concentration may be 10 to 100× at the emitter-base junction, *relative* to the base-collector junction (1×). The gradient can be linear, quasi linear, exponential or complimentary error function. The *relative* slope of the donor concentration throughout the base creates a suitable aiding drift electric field, to help the holes (p-n-p transistor) transverse from emitter to collector.

Ex. 1001, 2:66–3:9 (emphases added). All of the disclosures of doping concentrations are relative. *Id.* Further still, these concentrations are set forth with respect to a bipolar junction transistor (BJT) embodiment that is not encompassed by independent claim 1. In the BJT embodiment of the '481 patent, the graded dopant concentration moves carriers from emitter to collector, that is, *within* the active region. In contrast, independent claim 1 requires moving carriers *away* from the active region to the substrate.

Claim 1 does not require that movement of any particular number of carriers, let alone a need to move all the carriers. We further agree that independent claim 1 is not a method claim—as Petitioner’s counsel explained during the hearing. Tr. 16:1–3; 54:22–53:1.

In *ParkerVision*, the Court held that “[a]pparatus claims cover what a device *is*, not what a device *does*.” *Hewlett-Packard Co. v. Bausch and Lomb Inc.*, 909 F.2d 1464, 1468 (Fed. Cir. 1990)). That is, to effectively challenge claim 1, Petitioner must show that “the reference discloses an apparatus that is reasonably capable of operating so as to meet the claim limitations, *even if it does not meet the claim limitations in all modes of operation*.” *Id.* (emphasis added).

Petitioner must show “a graded dopant concentration” that is *capable* of “aid[ing] carrier movement from the first surface to the second surface of the substrate.” We are persuaded Petitioner has done so by showing that Kawagoe discloses a graded dopant concentration with a slope, in a particular direction, in Figures 17 and 23 of Kawagoe that is not only reasonably capable, but actually does, move carriers in the claimed direction.

Petitioner contends Patent Owner “blatantly mischaracterizes the deposition” of Mr. Warrick, as the question Mr. Warrick was actually asked was whether “there’s anything that affects the *ease of* carrier movement.” Pet. Reply 13 (quoting Ex. 2056, 71:22–72:8). According to Petitioner, because other factors may affect the speed or acceleration of carrier movement, Mr. Warrick’s statements did not suggest that these forces could overwhelm the drift field and preclude it from aiding carrier movement. *Id.* Petitioner also contends Patent Owner never established the “where” it was referring to, or whether the direction of the gradient was suited to aid

movement “downward,” let alone that Mr. Warrick understood such to be the case. *Id.* at 14.

With respect to Petitioner’s 30(b)(6) testimony, we note that Mr. Warrick was testifying as a corporate representative of Cirrus Logic in the district court proceeding. Patent Owner does not contend that Mr. Warrick is one of ordinary skill in the art or that he considered the Applicant’s assertions regarding the meaning and scope of the “aid carrier movement” limitation during prosecution. Nor does Patent Owner contend that Mr. Warrick considered Patent Owner’s representations to the district court that “a [person of ordinary skill in the art] would have readily recognized that when a ‘static unidirectional electric drift field’ is present that it aids the movement of minority carriers.” Ex. 1016, 289–90; Ex. 1020, 25–26. And, although Mr. Warrick provided a statement that is generally consistent with both Patent Owner’s arguments in this proceeding and the Examiner’s initial assertion during prosecution, the Applicant expressly stated during prosecution that this reasoning was incorrect in view of the scope of the claims. Ex. 1016, 289–290. As such, we find that Mr. Warrick’s testimony does not evidence that a sloping dopant gradient in the appropriate direction and location will not necessarily aid the movement of carriers.

Patent Owner contends that “two District Courts have previously agreed with [Patent Owner] that not *all* doping gradients *must* aid carrier movement.” PO Resp. 9. In particular, Patent Owner contends the Western District of Texas “unequivocally stated, ‘a graded concentration . . . that is [not ‘sufficiently graded’] will not aid in the movement of minority carriers,’” and the Eastern District of Texas understood that direction alone does not determine whether a gradient aids carrier movement, as the

magnitude of the gradient must also be considered. *Id.* (citing Ex. 2074, 39–40; Ex. 2075, 15).

Before the Western District of Texas, Petitioner (Cirrus Logic) asserted that the term “graded dopant concentration” was indefinite, as it was unclear where the boundary between “graded” and “uniform” doping concentrations would be. Ex. 2074, 32. Patent Owner argued in response that the patent provides sufficient guidance as to the meaning of the claim term, with “graded” meaning varying or not “uniform.” *Id.* at 37–38 (“Greenthread contends that Figure 1 in the ’195 Patent depicts the difference between uniform and graded concentrations, namely, that the concentration in the former is the same across a region while in the latter, the concentration has a slope.”). The District Court determined that the term was not indefinite for multiple reasons and that “graded” “describes a sloped doping concentration.” *Id.* at 39–41. According to the Court, a graded dopant concentration must be sufficiently graded to result in a “static unidirectional electric drift field to aid the movement of minority carriers,” as recited in claim 1 of U.S. Patent No. 8,421,195. *Id.* at 39–40.

We discern no finding in the Court’s order that one must quantify the magnitude of the field in order to know if the electric field will “aid the movement of minority carriers.” First, the Court was not addressing the same argument raised by Patent Owner in this proceeding. Rather, it was addressing whether the term “graded dopant concentration” is indefinite. Second, the Court’s Order can reasonably be interpreted to require only that the graded dopant concentration be sufficiently graded to create a “static unidirectional electric drift field,” as recited in the claims, which, as the Applicant argued during prosecution and in its claim construction brief

before the Western District of Texas, would “aid in the movement of minority carriers.” Ex. 1074, 39–40; Ex. 1020, 26 (“a [person of ordinary skill in the art] would have readily recognized that when a ‘static unidirectional electric drift field’ is present that it aids the movement of minority carriers. If it isn’t present, then it doesn’t.”), 28 (“the intrinsic record consistently confirms that the electric fields aid the movement of the carriers.”).

Before the Eastern District of Texas, the parties disputed the proper construction of the term “single drift layer . . . having a graded concentration of dopants generating a first static unidirectional drift field.” Ex. 2075, 10. The plaintiff asserted that no construction was necessary, whereas the defendant argued that the term should be construed as a “single layer whose concentration of dopants either increases across the layer or decreases across the layer.” *Id.* The Court explained that the dispute distilled into two issues: (1) whether the graded concentration of dopants could only increase or decrease; and (2) whether the “single drift layer” is necessarily a single layer. *Id.* at 13–14. In addressing the question of whether the graded concentration of dopants could both increase and decrease in the drift layer, the Court rejected the defendant’s suggestion that the prosecution statement that the direction of the electrical field and the carrier movement “depends solely on the slope of the graded concentration of dopant” demonstrates that “the slope must be only increasing or only decreasing to maintain a unidirectional drift field.” *Id.* at 15. In rejecting this argument, the Court found that the patentee affirmatively argued during prosecution “that a graded dopant concentration will provide a unidirectional electric drift field to move the minority carriers in a single direction and *Grove*,” relied upon

by the Applicant during prosecution, “discloses a dopant concentration that both increases and decreases in the drift layer.” *Id.* at 15–16. Contrary to Patent Owner’s arguments, the Court’s conclusion regarding the scope of the claims appears consistent with both the Applicant’s assertion during prosecution and Petitioner’s arguments in this proceeding, i.e., that “a graded dopant concentration will provide a unidirectional electric drift field to move the minority carriers in a single direction.” *Id.*

c) Analysis Concerning Accounting for Additional Forces

Initially, we determine that the mechanism of carrier movement encompassed by the claims does not require devices to be in their “ON” state—that is, the relevant carrier motion at issue does *not* require an application of external voltage. *See e.g.*, Ex. 1001, 3:64–4:1; Ex. 1016, 289–90, 128 (“the ***claimed invention*** relates to . . . devices which include graded dopant concentrations in regions capable of providing a localized drift electric field ***without the application of an external potential***”).

We agree with Petitioner that the mechanism of carrier movement disclosed in the ’481 patent, and encompassed by the claims, is a “static field [that] superimposes a force onto minority carriers, thereby causing those carriers to *move* in a particular direction (depending on charge type), based on a phenomenon called ‘**carrier drift**.’” Pet. Reply 8 (citing Ex. 1060 ¶¶ 21–27) (bold emphasis added); *id.* at 12 (citing Ex. 1060 ¶¶ 49–51, 91–95).

Dr. Banerjee explains that “[t]he static electric field $\mathcal{E}$ is self-generated due to the decrease in the acceptor impurity concentration from the surface into the substrate” and “spans the entire length for which the slope is monotonically decreasing and is not externally applied” and “will aid the movement of minority carrier electrons from the surface to the substrate”

and ‘conversely will aid the movement of majority carrier holes from the substrate to the surface.’ Ex. 1060 ¶ 25. In the device described in Dr. Banerjee’s testimony, “carrier drift will necessarily occur by virtue of the graded (i.e., non-zero sloping) dopant concentration, and the resulting electric field $\mathcal{E}$.” *Id.* (citing Ex. 1061, 48, 57. *See generally* Ex. 1062, 98–103, 134–138).^{19, 20}

We disagree with Patent Owner that Petitioner is relying on “the constant, random, thermal—a.k.a. ‘Brownian’—vibration of individual electrons” to teach or suggest the carrier movement recited in the claims. PO Sur-Reply 1–2, 5–6. Petitioner only discusses Brownian Motion to support its position that no additional threshold voltage is required to “liberate an extra electron from a crystal structure” because “the extra electrons in a doped semiconductor are not bonded to silicon atoms, but are free to move, and already in Brownian motion.” Pet. Reply 9–10 (citing Ex. 1063, 105:6–9, 107:8–10; Pet. Reply § IIA.3).²¹ Petitioner persuasively contends that “carriers do not need to overcome any opposing forces before they move,”

¹⁹ Sze, *Semiconductor Devices: Physics and Technology*, 2nd Ed. 1985, excerpted (Ex. 1061, “Sze”).

²⁰ Streetman et. al., *Solid State Electronic Devices*, 6th Ed. 2006, excerpted (Ex. 1062, “Streetman”).

²¹ We note that we need not even address this argument because Patent Owner does not assert in its briefing that the electrons in a semiconductor are not free to move without an externally applied voltage, and Petitioner confirmed during oral argument that it was not relying on Brownian motion to demonstrate any claim limitations. Tr. 22:11–23:16 (Petitioner’s counsel agreeing that the Petition does not rely on Brownian motion to show a disclosure of the claim limitations), 55:6–7 (Patent Owner’s counsel stating that “[i]n light of Petitioner’s representations, I don’t think I need to go into Brownian Motion in detail”).

because “in a doped semiconductor region, at room temperatures, carriers in the conduction band of a silicon atom are not bound, but are *free to move*,” and “are *constantly moving* (i.e., in ‘Brownian’ motion) due to thermal effects.” *Id.* (citing Ex. 1060 ¶¶ 12–20; Ex. 1003 ¶ 95). Patent Owner even points to Dr. Banerjee’s testimony that the net effect of “Brownian” motion is precisely zero, because “statistically you have as many electrons moving to the right as to the left.” PO Sur-reply 1–2 (citing Ex. 2078, 104:11–14); *see id.* at 5–6 (citing Pet. Reply 8, 12, n.8; Ex. 1060 ¶¶ 19, 95). Thus, Dr. Banerjee cogently explains why Brownian Motion is not the relevant mechanism attributable to carrier movement addressed by the ’481 patent and its claims. *See* Ex. 1001, 3:64–4:1; Ex. 1016, 289–90, 128 (“the ***claimed invention*** relates to . . . devices which include graded dopant concentrations in regions capable of providing a localized drift electric field ***without the application of an external potential***”).

Against that backdrop, we agree with Petitioner that “[i]ntrinsic resistance’ (or resistivity) is an inherent property of a material and its effect on carriers is analogous to a dampening force that may affect the degree of carrier mobility (i.e., the speed of carrier movement), but does not prevent carrier movement altogether.” Pet. Reply 11 (citing Ex. 1060 ¶¶ 36–41, 58–59). Dr. Banerjee explains that “neither resistivity nor resistance serves as a barrier that a carrier must overcome in order to drift under the influence of a static electric field.” Ex. 1060 ¶ 59 (citing Ex. 1060 § IV.C.1–2). Rather, “[t]he resistance of the silicon would affect the speed of carrier movement, or the ease of carrier movement in response to an electric field.” *Id.* Dr. Banerjee testifies that “[i]t would not impose a barrier to the drift of minority carriers caused by the graded dopant concentration.” *Id.* To the extent Dr.

Glew provides conflicting testimony on these points, Patent Owner does not adequately explain or clarify that testimony in its briefing. *See e.g.*, Ex. 2057 ¶¶ 49, 50 (discussing “e.g., opposing forces, e.g., due to the intrinsic resistance of silicon”), 51–57.

In its Sur-reply, Patent Owner identifies a series of potential forces that Dr. Banerjee testified could influence carrier movement, including three broad categories of forces (1) “periodic crystalline potential,” (2) “externally applied forces or a built-in electric field,” and (3) “random forces, . . . such as lattice vibrations or static random forces due to structural defects in the crystal.” PO Sur-reply 4 (citing Ex. 2078, 80:18–81:5, 82:9–12, 83:19–84:1, 84:16–21). Dr. Banerjee testified on re-direct, however, that these forces are either not mentioned in the ’481 patent or would not be sufficient to overcome or negate the downward-facing electric field of Kawagoe. Ex. 2078, 319:10–22, 320:1–14.²² Patent Owner and Dr. Glew present no evidence to suggest that these forces are present in Kawagoe, or if they are

²² Prior to re-direct, Dr. Banerjee met with counsel for approximately 20 minutes. Ex. 2078, 339:9–20; Sur-reply 13–14. When asked if he discussed his testimony during this time, counsel instructed the witness not to answer. Ex. 2078, 339:21–340:4. As asserted by Patent Owner, this gives the appearance of improper witness coaching. *See* Sur-reply 13–14. Counsel is warned that such behavior may lead to the Board giving redirect testimony little to no weight. In this case, however, Patent Owner does not move to strike or exclude Dr. Banerjee’s re-direct testimony. Moreover, Dr. Banerjee was able to clearly articulate why the three categories of forces mentioned during cross-examination would either not affect whether the electric field of Kawagoe would “aid carrier movement” or are not mentioned or contemplated in the ’481 patent, without counsel’s guidance. As such, we do not disregard this testimony.

that they are sufficiently large to negate the field expressly disclosed in Kawagoe and relied upon by Dr. Banerjee. PO Sur-reply 4–5.

d) Analysis Concerning Kawagoe’s Teachings

As to the parties’ arguments concerning whether Kawagoe discloses aiding or inhibiting the movement of carriers, Petitioner persuasively argues “aiding downwards is consistent with inhibiting movement in the opposite direction.” Pet. Reply 20. Petitioner also persuasively argues that “Kawagoe explains that its concentration gradient prevents electrons found below the well from moving upwards, which is the result of the same electric field that aids downward movement of the electrons in the well.” *Id.* at 19.

We determine that Patent Owner’s expert, Dr. Glew, also agrees. Ex. 1069, 103:25–104:4, 104:14–16, 105:22–106:6.

According to Petitioner, because “Kawagoe’s gradient is consistently decreasing ‘from the first surface to the second surface of the substrate,’ the resulting electric field induces minority carrier drift above and below well region 6p.” Pet. Reply 20. Thus, we agree that “[t]his undermines Greenthread’s speculation that ‘[o]ther forces . . . may . . . push [carriers] in the opposite direction from the force exerted by the gradient,’ and that Kawagoe’s concentration gradient would prevent carriers ‘located above’ from entering well region 6p below.” *Id.* at 20 (citing PO Resp. 7, 17, n.4).

Patent Owner’s litigation position is more on point: “Electric drift fields are a well-known phenomenon that cause carriers to move, and a POSITA would have readily recognized that when a ‘static unidirectional electric drift field’ is present that it aids the movement of the minority carriers. If it isn’t present, then it doesn’t.” Ex. 1020, 26 (Patent Owner’s Responsive Claim Construction Brief in a related litigation, *supra* § I.C).

Patent Owner’s litigation position is also that “[t]he drift field points to one direction and charge carriers, when free to move, respond to the drift field by moving in *one direction or the other depending on their charge polarity*.” *Id.* at 27 (emphasis added). More particularly, Patent Owner contends in the related litigation that

Defendants argue that the claims do not recite a range of doping, a particular doping profile, or a particular result. But this is not the test for indefiniteness. While the claims require that the graded dopants create an electric field that aids movement of the carriers, *they do not require a specific range of doping, a particular doping field, or a particular result, and this information is not necessary to understand the scope of Dr. Rao’s invention.*

Id. at 28 (emphasis added). Thus, Patent Owner’s arguments in this proceeding are unavailing and are inconsistent with positions taken in related litigation.

e) Analysis Concerning the Cited Underlying Evidence and Whether There are Carriers in Kawagoe’s Active Region

With regard to the parties’ arguments concerning Wang’s priority date, we agree that “Petitioner is **not** proposing to modify Kawagoe in view of Wang,” but rather citing evidence that shows the knowledge of skill in the art with regard to physical effects in transistors. Pet. Reply 21 (citing PO Resp. 18). Further, there is no real dispute that SEUs will occur in Kawagoe’s transistor, as discussed below in Nishizawa and Patent Owner’s Declarant asserts. Ex. 1057 ¶¶ 54–55.

Petitioner contends, and we agree, that “Nishizawa expressly states that, following an alpha-ray strike, ‘*several ten thousand electrons will flow into the n+ type region 13,*’ which is part of the active region.” Pet. Reply 21–22 (citing Ex. 2060, 19:41–42, Figs. 34–36). We are persuaded by

Petitioner's arguments that Nishizawa's disclosure that electrons are produced by the α -ray is illustrative to show how Kawagoe's graded dopant concentration behaves. *See* Pet. Reply 20–22. Thus, even though Wang was published four years after the earliest possible priority date of the '481 patent, Petitioner supports its contention that the subject matter relied upon in Wang would have been understood by a POSITA as of the earliest possible priority date of the '481 patent, based on the teachings of Nishizawa.

Even assuming, *arguendo*, that Patent Owner is correct that “the alpha-particle immediately after irradiation to the surface of a semiconductor body has an energy of several MeV” and “the probability of creation of electron-hole pairs is extremely low near the surface” (PO Resp. 19 (quoting Ex. 2060, 19:21–34) (citing Ex. 2057 ¶¶ 10, 54; Ex. 1007, 16:7–11; Ex. 2060, 20:19–22) (emphasis omitted)) as taught by Nishizawa, we find unavailing Patent Owner's argument that Kawagoe's carriers are not in the active region. *See* Pet. Reply 20–22. This is because “Greenthread itself admits that ‘Kawagoe's transistors presumably have carriers in the active region’” and because “Dr. Glew likewise agreed that electrons would be present throughout Kawagoe's devices.” Pet. Reply 20 (citing PO Resp. 1–2, 16–17; Ex. 1069, 116:4–123:15, 120:16).

Further still, Patent Owner's own evidence, namely, Nishizawa, does not support its position. Nishizawa discloses that

[t]he number of electron-hole pairs which are created in that portion of semiconductor region up to a depth of about 0.8 μm from the surface of the semiconductor body is about 1/50 or less of the total number (which is of the order of 10^6) of those electron-hole pairs which are created in the semiconductor body by a single alpha-particle, where [the] alpha-particle is irradiated

in a vertical direction. *In other words, several ten thousand electrons will flow into the n^+ type region 13.*

Ex. 2060, 19:34–42 (emphasis added). Nishizawa further discloses that

in case [an] alpha-particle is irradiated with an inclination thereonto, the situation will become different. For example, in case an alpha-particle having an initial energy of 5 MeV impinges onto the surface of a silicon semiconductor body at an angle of incidence of 30° , this alpha-particle will enter into silicon up to a depth of $25\text{ }\mu\text{m}$. However, the depth measured from the topmost surface of the device is $12.5\text{ }\mu\text{m}$. Also, *as the initial energy of alpha-particle attenuates, the site at which electron-hole pairs are created in a large number will shift toward and closer to the surface of the device.*

Id. at 19:56–67 (emphasis added).

ParkerVision guides us that the relevant inquiry is whether the graded dopant concentration is *capable* of performing the claimed limitation, *not* how likely the claimed limitation is to be performed or occur. Not only is Kawagoe’s graded dopant concentration capable of creating an electric drift field, and do so absent an alpha ray strike as discussed above in Section III.E.5.c, Patent Owner admits there are electrons in the active region, and further still, actual carrier movement is not required. In any event, Nishizawa indicates that the alpha ray strike could produce electron-hole pairs near the surface of the CMOS device, and again, carriers would be aided to move to the substrate by the graded dopant concentration. Pet. Reply 21–22 (citing Ex. 2060, 19:41–42, Figs. 34–36); Ex. 2060, 19:34–42, 19:56–57.

6. Conclusion Regarding Independent Claim 1

In view of the foregoing and notwithstanding Patent Owner’s alleged objective indicia of nonobviousness discussed above, we are persuaded that

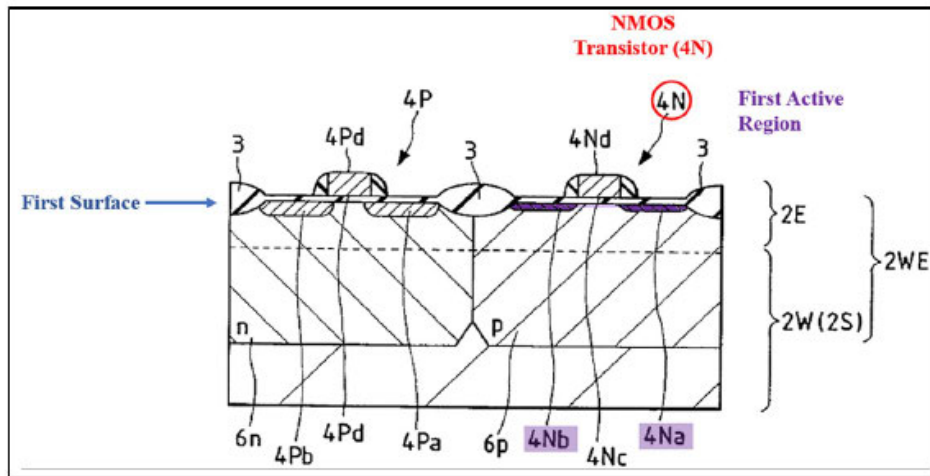
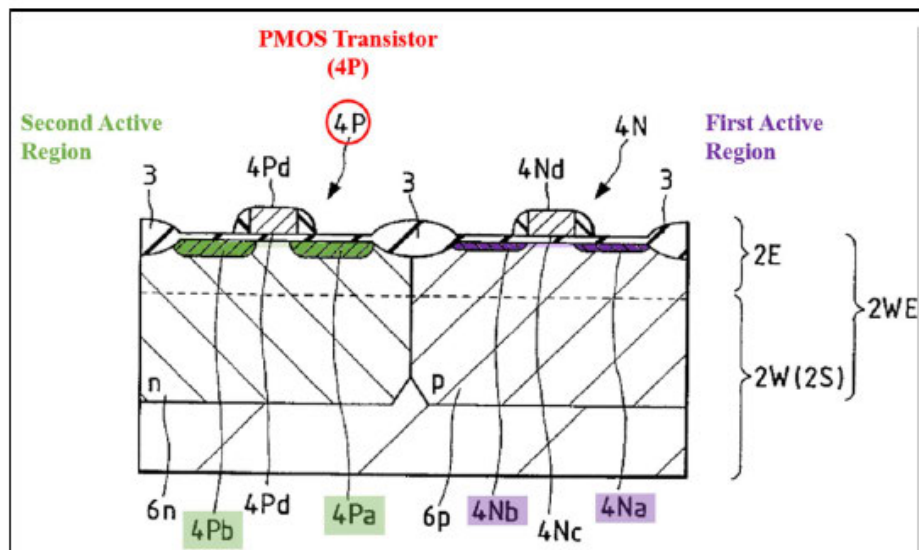
Petitioner establishes, by a preponderance of the evidence, that claim 1 is unpatentable as obvious over Kawagoe. As discussed above in Section III.D, Patent Owner's objective indicia of non-obviousness lack nexus and are entitled to little weight, but even if we gave them more weight, they would not overcome Petitioner's strong case of obviousness.

7. *Independent Claim 20*

Petitioner relies on substantially the same cited teachings in Kawagoe for teaching the limitations of independent claim 20. Pet. 48–50.

Independent claim 20 includes most of the same limitations in independent claim 1 and three limitations not included in claim 1. Limitation [20.2] of independent claim 20 recites “a first active region disposed adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed *in the surface thereof*.” Ex. 1001, 5:57–60 (emphasis added). Limitation [20.3] of independent claim 20 recites “a second active region separate from the first active region disposed adjacent to the first active region and within which transistors can be formed *in the surface thereof*.” *Id.* at 6:1–3 (emphasis added). Limitation [20.5] of independent claim 20 recites “at least a portion of at least one of the first and second active regions having at least one graded dopant concentration to aid carrier movement *from the surface to the substrate*.” *Id.* at 6:6–9 (emphasis added).

Pointing to its annotated versions of Kawagoe's Figure 23 reproduced below, Petitioner contends “Kawagoe discloses nMOS transistor 4N formed in the surface of the first active region” and “pMOS transistor 4P formed in the surface of the second active region.” Pet. 49–50 (citing Ex. 1003 ¶¶ 123–124).

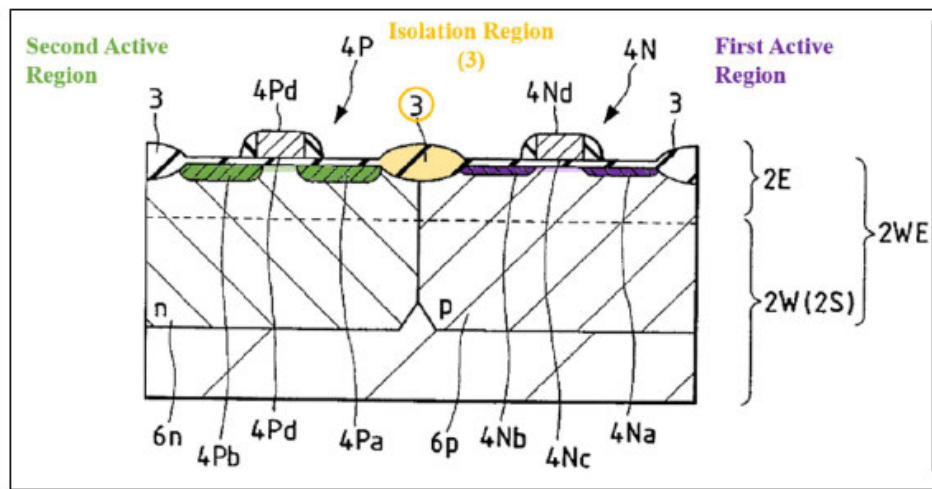


Petitioner's annotated versions of Kawagoe's Figure 23 depicting field insulating film. Pet. 49–50.

Patent Owner does not present specific arguments for independent claim 20 beyond what is presented for independent claim 1. *See generally* PO Resp. In view of the above and notwithstanding Patent Owner's alleged objective indicia of nonobviousness discussed above, we determine that Petitioner establishes, by a preponderance of the evidence, that independent claim 20 is unpatentable as obvious over Kawagoe. *See* Pet. 49–50.

8. *Dependent Claims 6 and 26*

Claims 6 and 26 recite “wherein the first active region and second active region are each separated by at least one isolation region.” Patent Owner presents arguments for these claims. PO Resp. 25–26. In particular, Petitioner maps Kawagoe’s field insulating film 3, annotated in yellow in Kawagoe’s Figure 23, as reproduced below, to the claimed “isolation region.”



Petitioner’s annotated version of Kawagoe’s Figure 23 depicting field insulating film. Pet. 41.

Patent Owner argues that the “Petition fails to appreciate that regions 4Na and 4Nb, which ‘are regions for forming the source-drain regions of the nMOS 4N’ . . . ‘are made as deep as about 0.5 μm and *formed in the range of the thickness of the epitaxial layer 2E.*” PO Resp. 26 (citing Ex. 1007, 8:66–67, 9:3–6). According to Patent Owner, “Kawagoe provides similar disclosure regarding regions 4Pa and 4Pb.” *Id.* (citing Ex. 1007, 9:47–53). “Thus,” Patent Owner contends that

a POSITA would have understood that the first and second active regions extend to about the depth of the epitaxial layer 2E and abut each other laterally, and therefore they are not separated by

Kawagoe’s field insulating film 3, as required by claims 6 and 26. The field insulating film 3 is formed “[o]ver the principal surface of the epitaxial layer 2E” . . . and a POSITA would have understood that it does not extend deep enough to separate the two active regions.

PO Resp. 26 (citing Ex. 2057 ¶ 63; Ex. 1007, 8:40–42).

We find Petitioner has the better position, for the simple reason that the claims do not require the “isolation region” to completely separate the active regions, that is, that the isolation region extends to a depth that is the same as or deeper than the depth of the active regions. The claimed “isolation region” is not defined or set forth in the specification, only in the claims. To the extent the isolation region must be in between the first and second active regions at all points and field insulating film 3 is not so positioned, Petitioner also demonstrates that a “channel stopper region” is formed below the field insulating film and is used to ensure that errant carriers do not migrate from one transistor to another. *Id.* (citing Pet. 41; Ex. 1007, 8:43–45, 20:53–56, Fig. 26A; Ex. 1069, 142:4–143:11; Ex. 1060 ¶¶ 52, 104). Petitioner persuasively demonstrates that these two structures, in combination, also act as an isolation region. *Id.*

In view of the above and notwithstanding Patent Owner’s alleged objective indicia of nonobviousness discussed above, we determine that Petitioner establishes obviousness of claims 6 and 26 over Kawagoe by a preponderance of the evidence.

9. *Remaining Dependent Claims*

We have reviewed Petitioner’s arguments and evidence for remaining claims 2–5, 7–9, 12–14, 16–19, 21–25, 27, and 30–36, and we are persuaded that the cited portions of Kawagoe teach what Petitioner asserts they teach

and that Dr. Banerjee’s testimony sufficiently supports Petitioner’s arguments. Pet. 39–40, 41–48, 50–52. Patent Owner does not present arguments for these claims beyond that presented for independent claims 1 and 20. *See generally* PO Resp. In view of the above and notwithstanding Patent Owner’s alleged objective indicia of nonobviousness discussed above, we determine that Petitioner establishes obviousness of claims 2–5, 7–9, 12–14, 16–19, 21–25, 27, and 30–36 over Kawagoe by a preponderance of the evidence.

F. Obviousness Based on the Combination of Wieczorek and Wolf

Petitioner contends claims 1, 2, 4–9, 12–22, 24–27, and 30–36 would have been obvious in view of the combination of Wieczorek and Wolf. Pet. 7, 52–83.

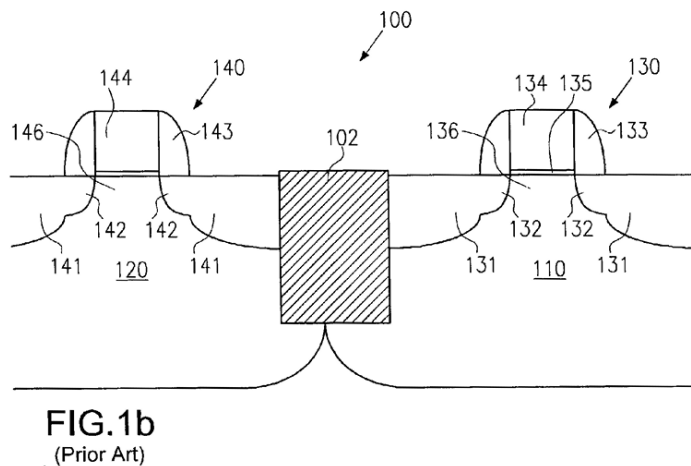
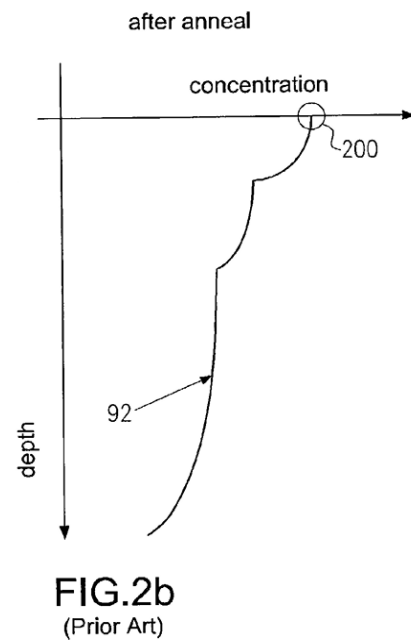
1. Wieczorek

Wieczorek relates “to a semiconductor device, such as a field-effect transistor, having an improved retrograde dopant profile in a channel region of the transistor element.” Ex. 1006 ¶ 2. The Petition relies on Wieczorek’s description of the prior art, not its disclosed improvement. Pet. 11, 40.

Wieczorek explains that a retrograde channel dopant profile is one where “the concentration of dopants increases from the gate insulation layer to the areas located deeper down the channel region.” Ex. 1006 ¶ 6. According to Wieczorek, a retrograde channel dopant profile is desirable, but “very difficult to obtain.” *Id.* Wieczorek states that “the dopant concentration immediately after the implantation process exhibits a desired retrograde dopant profile” (*id.* ¶ 9), but during heat treatment, “the initially retrograde profile in the vicinity of the surface of the semiconductor device

... may have become substantially uniformly distributed” due to diffusion of the dopant atoms (*id.* ¶ 11).

Petitioner relies on Figures 1b and 2b (reproduced below), which Wieczorek uses to illustrate the prior art.



Wieczorek Figure 1b shows a conventional semiconductor device at an intermediate manufacturing stage, including shallow trench isolation 102 separating N-well structure 120 from P-well structure 110. Ex. 1006 ¶¶ 7, 20. The device includes P-channel transistor 140 with source and drain regions 141 in N-well structure 120 and N-channel transistor 130 with source and drain regions 131 in P-well structure 110. *Id.* ¶ 12. Wiecezorek Figure 2b is a graph of dopant concentration versus depth of N-well structure 120 and P-well structure 110 and shows “a typical dopant profile with respect to the depth of the respective well structure” after ion implantation and heat treatment. *Id.* ¶¶ 9–11, 13, 21.

2. *Wolf*

Wolf is a four-volume textbook titled “Silicon Processing for the VLSI Era.” Exs. 1008A–1008D. A portion of the textbook focuses on CMOS technology. Ex. 1008A, 807–40.

3. *Petitioner’s Contentions for Independent Claim 1*

Petitioner argues that the combination of Wieczorek and Wolf teaches or suggests the limitations of independent claim 1 and that a person of ordinary skill in the art would have had reason to combine the teachings of Wieczorek and Wolf. Pet. 7, 52–68.

Reason to Combine Wieczorek and Wolf

Petitioner argues that a person of ordinary skill in the art would have had a reason to combine the teachings of Wieczorek with those of Wolf. Pet. 52–53. Petitioner argues specifically that Wieczorek discloses “a conventional prior-art CMOS device” and that “Wolf is a well-known textbook that teaches known fundamental features and concepts related to semiconductor manufacturing, with particular emphasis on CMOS devices.” Pet. 52–53. Wieczorek discloses “[a] typical process flow for forming the semiconductor device 100” which is “a complementary MOS transistor pair.” Ex. 1006 ¶ 12, Fig. 1b. Petitioner directs us to evidence that a person of ordinary skill in the art would have looked to Wolf for details on how to manufacture the conventional CMOS devices of Wieczorek. Ex. 1003 ¶ 142; Ex. 1008A, 807–40.

Patent Owner does not dispute Petitioner’s rationale for combining Wieczorek and Wolf. *See generally* PO Resp. Based on Petitioner’s persuasive contentions and evidence, we determine that Petitioner establishes that a person of ordinary skill in the art would have had a reason

to combine the teachings of Wieczorek with those of Wolf with a reasonable expectation of success.

[1.pre] “[a] semiconductor device.”

The preamble of claim 1 recites “[a] semiconductor device.” Ex. 1001, 4:50. Petitioner argues that the combination of Wieczorek and Wolf teaches the preamble. Pet. 54. Wieczorek discloses a “semiconductor device.” Ex. 1006 ¶ 12, Fig. 1b.

Patent Owner does not contest Petitioner’s evidence pertaining to the preamble. We determine that Petitioner establishes by a preponderance of the evidence that the combination of Wieczorek and Wolf teaches the subject matter of the preamble of claim 1. As such, we need not and do not determine whether the preamble is limiting.

[1.1] “a substrate of a first doping type at a first doping level having first and second surfaces.”

Claim 1 recites “a substrate of a first doping type at a first doping level having first and second surfaces.” Ex. 1001, 4:51–52. Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. Pet. 54–58. Wolf discloses that its twin-well CMOS devices “are formed . . . on a lightly doped substrate . . . of *n* or *p* material. Ex. 1008C, 530, Fig. 8-1(e). The substrates of Wieczorek and Wolf both have surfaces. Ex. 1006, Fig. 1b; Ex. 1008C, 525, Fig. 8-1(e). Relying on Dr. Banerjee’s testimony, Petitioner contends that “a POSITA would have found it obvious to use a uniformly doped *n*- or *p*-type substrate (‘a substrate of a first doping type at a first doping level’) as a suitable substrate for Wieczorek’s CMOS device in Figure 1b.” Pet. 56 (citing Ex. 1003 ¶ 147).

Patent Owner does not contest Petitioner’s evidence pertaining to limitation [1.1]. We determine that Petitioner establishes by a preponderance of the evidence that the combination of Wieczorek and Wolf teaches this limitation of claim 1.

[1.2] “a first active region disposed adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed.”

Claim 1 recites “a first active region disposed adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed.” Ex. 1001, 4:53–56. Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. Pet. 58–61. Petitioner contends that, “[b]ecause the source-drain regions of the first active region are N-doped, Wieczorek-Wolf’s first active region has a second doping type (N-type) opposite in conductivity to the first doping type (P-type) of the substrate.” *Id.* at 60 (citing Ex. 1003 ¶ 151; Ex. 1006 ¶ 12). Wieczorek discloses “N-channel transistor 130” that includes “heavily N-doped source and drain regions 131” and “channel region 136.” Ex. 1006 ¶ 12; *see id.* ¶ 4 (describing “field effect transistor[s]” generally as having the same parts). Wolf discloses that the source-drain and the channel region between those regions would have been considered part of an active region. Ex. 1008B, 299–300 (“The active regions are those in which transistor action occurs; i.e., the channel and the heavily doped source and drain regions.”).

Patent Owner does not contest Petitioner’s evidence pertaining to limitation [1.2]. We determine that Petitioner establishes by a preponderance of the evidence that the combination of Wieczorek and Wolf teaches this limitation of claim 1.

[1.3] “a second active region separate from the first active region disposed adjacent to the first active region and within which transistors can be formed.”

Claim 1 recites “a second active region separate from the first active region disposed adjacent to the first active region and within which transistors can be formed.” Ex. 1001, 4:57–59. Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. Pet. 61–62. Wieczorek discloses “P-channel transistor 140” that includes “heavily P-doped source and drain regions 141” and “channel region 146.” Ex. 1006 ¶¶ 4, 12. Wolf discloses that the source-drain and the channel region between those regions would have been considered part of an active region. Ex. 1008B, 299–300 (“The active regions are those in which transistor action occurs; i.e., the channel and the heavily doped source and drain regions.”). This active region is separate from and disposed adjacent to the first active region. Ex. 1006, Fig. 1b.

Patent Owner does not contest Petitioner’s evidence pertaining to limitation [1.3]. We determine that Petitioner establishes by a preponderance of the evidence that the combination of Wieczorek and Wolf teaches this limitation of claim 1.

[1.4] “transistors formed in at least one of the first active region or second active region.”

Claim 1 recites “transistors formed in at least one of the first active region or second active region.” Ex. 1001, 4:60–61. Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. Pet. 63. Wieczorek discloses forming transistors N-channel and P-channel transistors, each in an active region, as discussed above. Ex. 1006 ¶¶ 12–13, Fig. 1b. Petitioner notes that the disclosure of Wieczorek and Wolf satisfies

claim 1's recitation of "transistors" either under Patent Owner's district court construction of "transistors" as requiring one or more transistors or under an alternative construction requiring multiple transistors in each active region. Pet. 60 ("a POSITA would have understood that Wieczorek teaches forming multiple nMOS transistors in the first active region to minimize chip area, as good layout practice dictates"), 62 ("a POSITA would have understood that Wieczorek teaches forming multiple pMOS transistors in the second active region"), 84 (citing Ex. 1003 ¶¶ 148, 153; Ex. 1006 ¶ 4; Ex. 1014, 1:52–54, 2:17–21; Ex. 1020, 31).

Patent Owner does not contest Petitioner's evidence pertaining to limitation [1.4]. We determine that Petitioner establishes by a preponderance of the evidence that the combination of Wieczorek and Wolf either teaches or suggests this limitation of claim 1, as well as that a person of ordinary skill in the art would have had reason to combine the teachings of Wieczorek and Wolf.

[1.5] "at least a portion of at least one of the first and second active regions having at least one graded dopant concentration to aid carrier movement from the first surface to the second surface of the substrate."

Claim 1 recites "at least a portion of at least one of the first and second active regions having at least one graded dopant concentration to aid carrier movement from the first surface to the second surface of the substrate." Ex. 1001, 4:62–65. Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. Pet. 63–67. The channel region of Wieczorek's transistors exhibits graded dopant concentration, with the concentration decreasing with increasing depth away from the surface. Ex. 1006 ¶¶ 11, 13, Figs. 1b, 2b. Petitioner directs us to evidence that tends to show that these depthwise variations in impurity concentrations help to

move carriers down into the substrate, away from the top surface and toward the bottom surface. Ex. 1003 ¶¶ 161–162; Ex. 1010, 2:27–32, 5:14–22, Figs. 1a, 1b.

Patent Owner disputes Petitioner’s evidence pertaining to limitation [1.5]. We resolve the dispute about this limitation in our analysis below.

[1.6] *“at least one well region adjacent to the first or second active region containing at least one graded dopant region, the graded dopant region to aid carrier movement from the first surface to the second surface of the substrate.”*

Claim 1 recites “at least one well region adjacent to the first or second active region containing at least one graded dopant region, the graded dopant region to aid carrier movement from the first surface to the second surface of the substrate.” Ex. 1001, 4:66–5:3. Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. Pet. 67–68. Wieczorek’s P-well exhibits gradually decreasing dopant concentration with increasing depth away from the surface. Ex. 1006 ¶¶ 9, 11, 13, Figs. 1b, 2b. Petitioner directs us to evidence that tends to show that these depthwise variations in impurity concentrations help to move carriers down into the substrate, away from the top surface and toward the bottom surface. Ex. 1003 ¶¶ 95, 165; Ex. 1010, 2:27–32, 5:14–22, Figs. 1a, 1b; Ex. 1016, 289–90.

Patent Owner disputes Petitioner’s evidence pertaining to limitation [1.6]. We resolve the dispute about this limitation in our analysis below.

4. Patent Owner’s Arguments

Patent Owner contends that the “Wieczorek grounds fail for similar reasons as the Kawagoe grounds: Wiecezorek does not say that the dopant gradient it discloses has any effect on carriers at all.” PO Resp. 21 (citing Ex. 2057 ¶¶ 56, 57). Patent Owner contends that although “[t]he Petition

points to Figure 2B of Wieczorek for the claimed ‘graded dopant concentration’ of limitations [1.5], [1.6], [20.5], and [20.6],” “[b]ut for the claimed ‘aid carrier movement’ feature of those limitations, the Petition relies entirely on Greenthread’s supposed admissions.” *Id.* (citing Pet. 63–65). Patent Owner contends this because the Petition states that “Wieczorek’s downward-sloping graded dopant concentrations aids movement of carriers . . . from the first surface to the second surface of the substrate *to the same extent* to which Applicant relied on the prior art and admitted to the Patent Office that such carrier movement would occur under the same scenario.” *Id.* (quoting Pet. 65–66).

Patent Owner further contends that the “existence of a downward-sloping graded-dopant concentration alone is not sufficient to establish the ‘aid carrier movement’ claim limitation.” *Id.* at 21–22 (citing PO Resp. § VI.A.2). Patent Owner argues that

Dr. Banerjee’s declaration does not indicate that he calculated the slope of the graded concentration curve in Wieczorek. Indeed, it would have been impossible for him to make such a calculation, because the dopant gradient Petitioners point to in Figure 2B (and Wieczorek generally) does not have any values from which one could calculate a slope. The magnitude of the slope is essential to determine the magnitude of the force the dopant gradient places on the carrier and thus the net force.

Id. at 22 (citing Ex. 1003; PO Resp. § VI.A.1; Ex. 2057 ¶ 57).

5. *Petitioner’s Reply Arguments*

Petitioner contends that “NMOS 130 formed in P-well 110 has a graded concentration of *p*-type dopants, and the resulting **built-in** electric field moves minority carrier electrons ‘from the first surface to the second surface.’” Pet. Reply 23 (citing Ex. 1006, Figs. 1b, 2b). “Similarly,”

Petitioner contends that “PMOS 140 formed in N-well 120 has a graded concentration of *n*-type dopants, and the resulting **built-in** electric field moves minority carrier holes ‘from the first surface to the second surface.’” *Id.* (citing Ex. 1006, Figs. 1b, 2b). Petitioner also relies on its contentions for the Kawagoe challenge to support its showing that Wieczorek teaches the claimed “graded dopant concentration to aid carrier movement.”

6. *Analysis of the Parties’ Arguments*

For the same reasons set forth above in Section III.E, Patent Owner’s arguments are unavailing. That is, no particular magnitude or specific numerical value of slope must be shown in order to satisfy the claims. Petitioner sufficiently shows that the combination of Wieczorek and Wolf teaches the relative slope encompassed by the scope of independent claim 1. Our reasoning above, presented in the context of the ground based on Kawagoe, applies with equal force here.

Conclusion

In view of the foregoing and notwithstanding Patent Owner’s alleged objective indicia of nonobviousness discussed above, we are persuaded that Petitioner establishes, by a preponderance of the evidence, that claim 1 is unpatentable as obvious over the combination of Wieczorek and Wolf.

7. *Independent Claim 20*

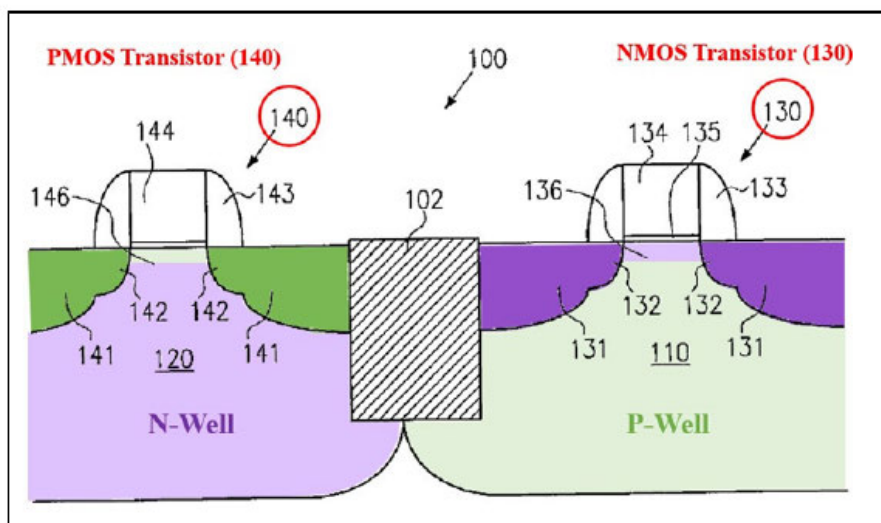
Petitioner relies on the same cited teachings in the combination of Wieczorek and Wolf for teaching the limitations of independent claim 20. Pet. 79–81.

Independent claim 20 includes most of the same limitations in independent claim 1 and three limitations not included in claim 1. Limitation [20.2] of independent claim 20 recites “a first active region disposed

adjacent the first surface of the substrate with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed *in the surface thereof*.” Ex. 1001, 5:57–60 (emphasis added).

Limitation [20.3] of independent claim 20 recites “a second active region separate from the first active region disposed adjacent to the first active region and within which transistors can be formed *in the surface thereof*.” *Id.* at 6:1–3 (emphasis added). Limitation [20.5] of independent claim 20 recites “at least a portion of at least one of the first and second active regions having at least one graded dopant concentration to aid carrier movement *from the surface to the substrate*.” *Id.* at 6:6–9 (emphasis added).

Pointing to its annotated version of Wieczorek’s Figure 1b reproduced below, Petitioner contends “Wieczorek discloses N-channel transistor 130 formed in the surface of the first active region” and “P-channel transistor 140 formed in the surface of the second active region.” Pet. 79–81 (citing Ex. 1003 ¶¶ 193–194).



Patent Owner does not present specific arguments for independent claim 20 beyond what is presented for independent claim 1. We have

reviewed the cited portions of Weiczorek and Wolf and Dr. Banerjee's testimony and determine that they support Petitioner's challenge and its positions. In view of the foregoing and notwithstanding Patent Owner's alleged objective indicia of nonobviousness discussed above, we determine that Petitioner establishes, by a preponderance of the evidence, that independent claim 20 is unpatentable as obvious over the combination of Weiczorek and Wolf.

8. *Remaining Dependent Claims*

We have reviewed Petitioner's arguments and evidence for remaining dependent claims 2, 4–9, 12–19, 21, 22, 24–27, and 30–36 and we are persuaded that the cited portions of Weiczorek and Wolf teach what Petitioner asserts they teach and that Dr. Banerjee's testimony sufficiently supports Petitioner's arguments. Pet. 69–79, 81–83. Patent Owner does not present arguments for these claims beyond that presented for independent claims 1 and 20. *See generally* PO Resp. In view of our above analysis and notwithstanding Patent Owner's alleged objective indicia of nonobviousness discussed above, we determine that Petitioner establishes by a preponderance of the evidence that the subject matter of claims 2, 4–9, 12–19, 21, 22, 24–27, and 30–36 would have been obvious over Wolf and Weiczorek.

G. *Remaining Challenges III through VI*

Given our determination that Petitioner establishes the unpatentability of claims 1–9, 12–14, 16–27, and 30–36 as obvious over Kawagoe (*supra* §§ II.D.5–8) and unpatentability of claims 1, 2, 4–9, 12–22, 24–27, and 30–36 as obvious over the combination of Weiczorek and Wolf (*supra* §§ II.E.6–8)—that is, having reached a disposition for each of challenged

claims 1–9, 12–27, and 30–36—we need not and, therefore, do not address the remaining challenges set forth in the Petition addressing these same claims. *See Boston Sci. Scimed, Inc. v. Cook Grp. Inc.*, 809 F. App’x 984, 990 (Fed. Cir. 2020) (nonprecedential) (“We agree that the Board need not address issues that are not necessary to the resolution of the proceeding.”); *SAS Institute, Inc. v. Iancu*, 138 S. Ct. 1348, 1359 (2018) (holding that a petitioner “is entitled to a final written decision addressing all of the claims it has challenged”); *see also Beloit Corp. v. Valmet Oy*, 742 F.2d 1421, 1423 (Fed. Cir. 1984) (holding that once a dispositive issue is decided, there is no need to decide other issues).

H. Reliability of Expert Testimony

Patent Owner argues that the declaration testimony of Petitioner’s expert Dr. Banerjee “is unreliable and should be disregarded for numerous reasons.” PO Resp. 30. In particular, Patent Owner contends that Dr. Banerjee’s declaration is unreliable because (1) he did not write and/or validate each statement or assertion made in his declaration; and (2) Dr. Banerjee has a monetary conflict of interest due to his pre-existing relationship with Texas Instruments (“TI”), which has joined IPRs addressing all asserted patents. PO Resp. 29–33; Sur-reply 12–14.

I. Manner of Drafting the Declaration

Patent Owner contends Dr. Banerjee admitted that he did not write his entire declaration and included material that was provided to him by Petitioner’s attorneys, which he did not necessarily verify. PO Resp. 29. Patent Owner further asserts that Dr. Banerjee’s declaration relies on the same grounds as those presented by Dr. Travis Blalock in another proceeding related to the ’481 patent and his analysis “matches

Dr. Blalock’s declaration nearly verbatim.” *Id.* at 30 (citing Ex. 1003; Ex. 2076). According to Patent Owner, “it is apparent that Petitioners just asked Dr. Banerjee to sign on to Dr. Blalock’s existing analysis, and Dr. Banerjee complied.” *Id.* at 31. Patent Owner also contends that Dr. Banerjee included a paragraph in his declaration stating that “[a]n internet search for [the Wolf textbook title]” “limited to the ‘.edu’ domain yields over 800 results,” but he did not do that search himself or confirm that it is accurate. *Id.* at 32.

Declarants have broad latitude in how they research, structure, and draft their declarations. They may rely upon information that they personally identified or information provided by the parties’ attorneys. They may also adopt nearly verbatim a previous declarant’s testimony. Indeed, this procedure is often required when a previous declarant is no longer able to testify in a proceeding. *See Jeisys Medical Inc v. Serendia, LLC*, IPR2024-00384, Paper 8 (PTAB March 1, 2024). This does not make the declaration inherently unreliable or necessarily entitled to less weight.

Through effective cross-examination, counsel may identify portions of a declaration that the declarant cannot explain or justify. In that case, the declarant’s testimony on those matters may be entitled to less or even no weight, and if it happens repeatedly may lead to a conclusion that the entire declaration should be given little to no weight. Patent Owner identifies no testimony related to the key, disputed issues in this case, however, that Dr. Banerjee could not explain or provide the basis for his testimony. As such, we find that the manner in which Dr. Banerjee’s declaration was drafted does not require that we disregard or give less weight to his testimony.

2. *Conflict of Interest*

Patent Owner contends that Dr. Banerjee depends on research funding from private industry for his career advancement and has only two active private grants, one of which is from TI and provides \$90,000 for his lab. PO Sur-reply 12 (citing Ex. 2078, 29:4–7, 29:14–30:4, 46:22–47:7).

Dr. Banerjee also indicated that he plans to pursue additional funding from TI in the future. *Id.* at 13 (citing Ex. 2078, 49:15–50:1). Declarants are often well paid for their efforts. *See* Ex. 1003 ¶ 2 (Dr. Banerjee explaining that he is being compensated \$675 per hour in this proceeding). This does not make their testimony inherently unreliable. Dr. Banerjee’s financial interest with TI does have the potential to bias his testimony, but it does not make it inherently unreliable or inadmissible.

I. *Constitutionality of AIA*

Patent Owner argues that we “should dismiss this IPR, because the AIA violates the Supreme Court’s non-delegation doctrine and the Constitution.” PO Resp. 61. According to Patent Owner, once a threshold finding under § 314(a) is made, “the Director can institute or not institute for any reason, no reason, or a completely arbitrary reason, like the flip of a coin.” *Id.* at 63. And, absent an “intelligible principle for the Director to apply,” Patent Owner contends “the statute governing these proceedings is unconstitutional and the Petition must be dismissed.” *Id.* We decline to address Patent Owner’s constitutional questions.

IV. PETITIONER’S MOTION TO EXCLUDE EVIDENCE

Petitioner moves to exclude Exhibit 2072, Dr. Rao’s Declaration. Mot. 1. Dr. Rao’s Declaration contains six paragraphs, which are provided to support Patent Owner’s contentions concerning objective indicia of non-

obviousness. Ex. 2072. According to Petitioner, Exhibit 2072 should be excluded because Dr. Rao “lacks personal knowledge of the underlying facts that are the subject of his declaration” and because “it is based on inadmissible hearsay.” Mot. 1.

In his Declaration, Dr. Rao identifies specific licenses and how much licensing revenue Patent Owner has received from each party. Ex. 2072 ¶ 2. Dr. Rao also testifies that Patent Owner never threatened litigation against [REDACTED] or any of their affiliates, and received \$30,000,000 from RPX for the license to [REDACTED] [REDACTED]. *Id.* ¶¶ 4, 6.

Petitioner contends Dr. Rao did not personally negotiate the licenses and learned of the facts from others and “was unaware of the amount each licensee contributed to the total payment under the first RPX license.” Mot. 3 (citing Ex. 2072, 38:4–7). As Dr. Rao lacked personal knowledge of the facts alleged in the Declaration, Petitioner contends the Declaration should be excluded under Federal Rules of Evidence 402, 403, and 602. *Id.*

We are not persuaded by this argument. Dr. Rao provides the identified licenses in the Appendix to his Declaration and appears to have personal knowledge of much of his Declaration testimony. For example, although he did not personally negotiate the licenses, he appears to have personal knowledge that they were entered into and how much licensing revenue was received. As such, we decline to exclude his Declaration. We note, however, that Dr. Rao testifies that the RPX license provided rights to future patents Patent Owner may acquire, and he asserts that this “is a standard term in RPX licenses and many other licenses to ensure permanent peace between the parties.” Ex. 2072 ¶ 3. As Dr. Rao does not adequately

explain his basis for the testimony regarding the standard terms of RPX's licenses, we give this testimony little weight. Mot. 5.

In view of the foregoing, Petitioner's Motion to Exclude Exhibit 2072 is *denied*.

V. CONCLUSION

In summary:

Claim(s)	35 U.S.C. §	Reference(s)/ Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
1–9, 12–14, 16–27, 30–36	103(a)	Kawagoe	1–9, 12–14, 16–27, 30–36	
1, 2, 4–9, 12–22, 24–27, 30–36	103(a)	Wieczorek, Wolf	1, 2, 4–9, 12–22, 24–27, 30–36	
1–9, 12–14, 16–27, 30–36	103(a)	Kawagoe, Gupta ²³		
1, 2, 4–9, 12–22, 24–27, 30–36	103(a)	Wieczorek, Wolf, Gupta ²⁴		
19, 36	103(a)	Kawagoe, Silverbrook ²⁵		
19, 36	103(a)	Wieczorek, Wolf, Silverbrook ²⁶		
Overall Outcome			1–9, 12–27, 30–36	

VI. ORDER

For the reasons given, it is:

²³ As explained above, because we determine that challenged claims 1–9, 12–14, 16–27, and 30–36 are unpatentable over Kawagoe, we decline to address this ground.

²⁴ As explained above, because we determine that challenged claims 1, 2, 4–9, 12–22, 24–27, and 30–36 are unpatentable over the combination of Wieczorek and Wolf, we decline to address this ground.

²⁵ As explained above, because we determine that challenged claims 19 and 36 are unpatentable over Kawagoe, we decline to address this ground.

²⁶ As explained above, because we determine that challenged claims 19 and 36 are unpatentable over Wieczorek and Wolf, we decline to address this ground.

ORDERED that Petitioner has established, by a preponderance of evidence, that each of the challenged claims 1–9, 12–27, and 30–36 of the '481 patent is unpatentable as obvious under 35 U.S.C. § 103(a);

FURTHER ORDERED that Petitioner's Motion to Exclude is denied;

FURTHER ORDERED that, in view of the motions to seal, this Decision is filed "Board and Parties Only";

FURTHER ORDERED that, after conferring, the parties shall, *within one week of this Decision*, jointly submit to the Board via email to Trials@uspto.gov, a version of this Decision to be filed in the public record, with any redactions proposed by either party; and

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

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