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Paper 85
Date: February __, 2025

PUBLIC VERSION

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SEMICONDUCTOR COMPONENTS INDUSTRIES, LLC and
TEXAS INSTRUMENTS INCORPORATED
Petitioner,

v.

GREENTHREAD LLC,
Patent Owner.

IPR2023-01242[1]
Patent 11,121,222 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)

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[1] Texas Instruments Incorporated, which filed a petition in IPR2024-00673, has been joined as a petitioner in this proceeding. Paper 69.

I. INTRODUCTION

A. Background and Summary

Semiconductor Components Industries, LLC ("Petitioner") filed a petition for an *inter partes* review (Paper 2 ("Pet.")) challenging claims 1–9, 13–28, and 32–42 of U.S. Patent No. 11,121,222 B2 (Ex. 1001, "the '222 patent"). In addition, Petitioner filed a paper explaining and ranking the parallel petitions challenging the '222 patent, i.e., the present Petition and the petition filed in IPR2023-01244. Paper 3. Greenthread, LLC ("Patent Owner") filed a Preliminary Response (Paper 18, "Prelim. Resp."). With our authorization, Petitioner filed a Preliminary Reply (Paper 22), and Patent Owner filed a Preliminary Sur-Reply (Paper 28).

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 35 ("Institution Decision" or "Inst. Dec."). Patent Owner filed a Response (Paper 47, "Patent Owner's Response" or "PO Resp."), Petitioner filed a Reply to Patent Owner's Response (Paper 62, "Petitioner's Reply" or "Pet. Reply"), and Patent Owner filed a Sur-Reply (Paper 65, "Patent Owner's Sur-Reply" or "PO Sur-Reply").[2] On November 13, 2024, we held an oral hearing. A transcript of the hearing is of record. Paper 83 ("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 '222 patent is unpatentable.

[2] Except where noted, we cite to redacted versions of Patent Owner's Preliminary Response (Paper 56), Patent Owner's Response (Paper 59), Patent Owner's Sur-Reply (Paper 66), and Petitioner's Reply (Paper 71).

B. Real Parties-in-Interest

Each party identifies itself as a real party-in-interest. Pet. 1; Paper 5, 2. In addition, Petitioner identifies ON Semiconductor Corporation as a real party-in-interest. Pet. 1. Texas Instruments Incorporated was joined as a petitioner in this proceeding and identifies itself as a real party-in-interest. Paper 69, 4.

C. Related Matters

The parties identify several proceedings involving the '222 patent as related matters, including *Greenthread, LLC v. ON Semiconductor Corp.*, No. 1:23-cv-00443 (D. Del.); *Greenthread, LLC v. Western Digital Corp.*, No. 1:23-cv-00326 (D. Del.); *Greenthread, LLC v. Cirrus Logic, Inc.*, 1:23-cv-00369 (W.D. Tex.); *Greenthread, LLC v. Texas Instruments Inc.*, No. 2:23-cv-00157 (E.D. Tex.); *Greenthread, LLC v. OSRAM GmbH*, No. 2:23-cv-00179 (E.D. Tex.); *Greenthread, LLC v. OmniVision Technologies, Inc.*, No. 2:23-cv-00212 (E.D. Tex.); *Greenthread, LLC v. Monolithic Power Systems, Inc.*, No. 1:23-cv-00579 (D. Del.); *Greenthread, LLC v. Intel Corp.*, No. 6:22-cv-105 (W.D. Tex.); *Greenthread, LLC v. Intel Corp.*, No. 6:22-cv-01293 (W.D. Tex.); *Greenthread, LLC v. Micron Technology, Inc.*, No. 1:23-cv-00333 (D. Del.); *Intel Corp. v. Greenthread, LLC*, IPR2023-00420 (PTAB); *Intel Corp. v. Greenthread, LLC*, IPR2023-00552 (PTAB); *Dell Technologies Inc. v. Greenthread, LLC*, IPR2023-00509 (PTAB); and *Sony Group Corp. v. Greenthread, LLC*, IPR2023-00324 (PTAB). Pet. 1–3; Paper 5, 2–5.

In addition, Petitioner challenges claim 44 of the '222 patent in IPR2023-01244, currently pending. Paper 3, 3. Further, Patent Owner identifies two additional matters involving the '222 patent: *Cirrus Logic,*

Inc. v. Greenthread, LLC, IPR2024-00020 (PTAB); and *Cirrus Logic, Inc. v. Greenthread, LLC*, IPR2024-00021 (PTAB). Paper 16, 2.

D. The '222 Patent

The '222 patent, titled "Semiconductor Devices with Graded Dopant Regions," issued on September 14, 2021. Ex. 1001, codes (45), (54). The '222 patent "relates to all semiconductor devices and systems." *Id.* at 1:23–24. According to the '222 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" versus the standard "uniformly doped base." *Id.* at 1:34–48. 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 1:48–53.

The invention of the '222 patent implements graded dopant concentration in these devices, which causes "[t]wo important performance enhancements." *Id.* at 3:4–31. 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 3:31–35.

E. Illustrative Claims

Of the challenged claims, claims 1, 21, 39, 41, and 42 are independent. Claims 1 and 21 are illustrative and reproduced below with Petitioner's claim identifiers added for reference.

1. [pre] A VLSI semiconductor device, comprising:

[1.1] a substrate of a first doping type at a first doping level having a surface;

[1.2] a first active region disposed adjacent the surface 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 and second active regions towards an area of the substrate where there are no active regions; 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 surface towards the area of the substrate where there are no active regions,

[1.7] wherein at least some of the transistors form digital logic of the VLSI semiconductor device.

Ex. 1001, 4:39–62; Pet. Appendix A.

21. [pre] A VLSI semiconductor device, comprising:

[21.1] a substrate of a first doping type at a first doping level having a surface;

[21.2] a first active region disposed adjacent the surface with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed;

[21.3] a second active region separate from the first active region disposed adjacent to the first active region and within which transistors can be formed;

[21.4] transistors formed in at least one of the first active region or second active region;

[21.5] 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 surface to an area of the substrate where there are no active regions; and

[21.6] 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 surface to the area of the substrate where there are no active regions, and

[21.7] wherein the graded dopant concentration is linear, quasilinear, error function, complementary error function, or any combination thereof.

Ex. 1001, 5:51–6:8.

F. Asserted Unpatentability Challenges

Petitioner asserts that claims 1–9, 13–28, and 32–42 are unpatentable based on the following challenges:

Ground	Claims Challenged	35 U.S.C. §	Reference(s)/Basis
I	1–9, 13, 14, 16–21, 23–28, 32–42	103(a)[3]	Kawagoe[4]
II	1, 2, 4–9, 13–23, 25–	103(a)	Wieczorek,[5] Wolf[6]

[3] The Leahy-Smith America Invents Act, Pub. L. No. 112–29, 125 Stat. 284 (2011) ("AIA"), included revisions to 35 U.S.C. § 103 that became effective after the effective filing date of the challenged claims. *See* Ex. 1001, codes (22), (60). Therefore, we apply the pre-AIA version of 35 U.S.C. § 103.
[4] U.S. Patent No. 6,043,114, filed September 22, 1997 and issued March 28, 2000, to Kawagoe et al. (Ex. 1007, "Kawagoe").
[5] U.S. Patent Application Pub. No. 2003/0183856 A1, filed October 29, 2002 and published October 2, 2003, to Wieczorek et al. (Ex. 1006, "Wieczorek").
[6] Petitioner cites four volumes for Wolf: Stanley Wolf & Richard Tauber, Silicon Processing For The VLSI Era, Volume 1 – Process Technology, 2nd ed., (Lattice Press 2000) (Ex. 1008A); Stanley Wolf & Richard Tauber,

Ground	Claims Challenged	35 U.S.C. §	Reference(s)/Basis
	28, 32–42		
III	1–9, 13, 14, 16–21, 23–28, 32–42	103(a)	Kawagoe, Gupta[7]
IV	1, 2, 4–9, 13–23, 25–28, 32–42	103(a)	Wieczorek, Wolf, Gupta
V	19, 37	103(a)	Kawagoe, Silverbrook[8]
VI	19, 37	103(a)	Wieczorek, Wolf, Silverbrook

Petitioner relies on the Declaration of Travis Blalock, Ph.D. Ex. 1003. Patent Owner relies on the Declaration of Alexander Glew, Ph.D. Ex. 2057.

II. 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).

Silicon Processing For The VLSI Era, Volume 2 – Process Integration, (Lattice Press 2000) (Ex. 1008B); Stanley Wolf & Richard Tauber, Silicon Processing For The VLSI Era, Volume 3 – The Submicron MOSFET, (Lattice Press 2000) (Ex. 1008C); and Stanley Wolf & Richard Tauber, Silicon Processing For The VLSI Era, Volume 4 – Deep-Submicron Process Technology, (Lattice Press 2000) (Ex. 1008D).

[7] U.S. Patent No. 6,163,877, filed November 5, 1996 and issued December 19, 2000, to Gupta (Ex. 1014, "Gupta").

[8] U.S. Patent No. 6,614,560 B1, filed July 10, 1998 and issued September 2, 2003, to Silverbrook (Ex. 1042, "Silverbrook").

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] fact finder 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).

Petitioner asserts that a person of ordinary skill in the art "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." Pet. 5–6 (citing Ex. 1003 ¶ 48). According to Petitioner, "[a]dditional education might compensate for less experience, and vice-versa." *Id.* at 6.

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. 12 (citing Ex. 2057 ¶¶ 17–18).

Petitioner's and Patent Owner's definitions for level of ordinary skill in the art are substantially similar. In light of the record before us, we adopt Petitioner's proposal regarding the level of ordinary skill in the art. Based on

our review of the '222 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 '222 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)).

Patent Owner does not argue, nor do we determine, that the outcome of our Decision depends on which party's definition is selected.

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. 6; PO Resp. 12–13 (citing Ex. 2057 ¶¶ 20–25, 46). However, Patent Owner implicitly construes "at least one graded dopant concentration to aid carrier movement" to require carrier movement, and Petitioner disagrees. We address the implicit constructions below.

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. Obviousness Based on Kawagoe

Petitioner contends claims 1–9, 13, 14, 16–21, 23–28, and 32–42 would have been obvious in view of Kawagoe. Pet. 5–45.

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,"[9] as well as "drastically reduc[ing] the defect density of the gate insulating film" of a semiconductor integrated device. *Id.* at 1:33–40.

[9] Petitioner submits Wang et al., *Single Event Upset: An Embedded Tutorial*, 21st Int'l Conf on VLSI Design, 429–434, IEEE 2008) (Ex. 1009, "Wang"), 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. Blalock characterizes "latchup" as "a 'short-circuit' failure condition in poorly designed circuits." Ex. 1003 ¶ 77.

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 the 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 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

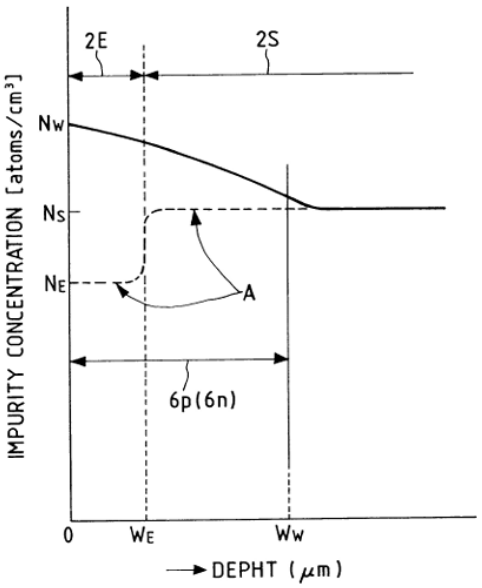

FIG. 23

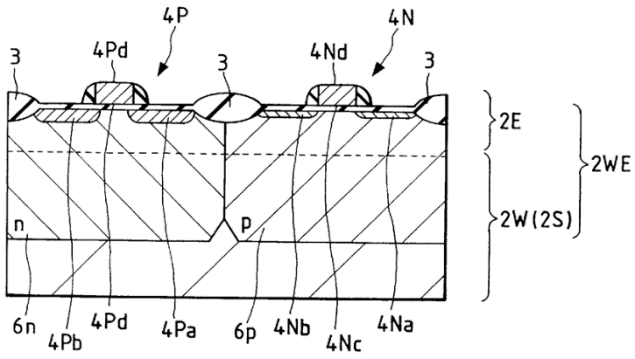

Figure 17 is a plot of impurity concentration as a function of depth in a semiconductor integrated circuit device, which shows "the p-well 6*p* and n-well 6*n* have their impurity concentrations gradually lowered in the depthwise direction from the principal surface (having an impurity

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 6*p* formed with nMOS 4N and n-well 6*n* formed with pMOS 4P. *Id.* at 5:1–4, 15:26–32, 18:3–35.

2. Petitioner's Contentions for Independent Claim 1

Petitioner argues that Kawagoe teaches or suggests the limitations of the challenged claims. Pet. 5–28.

[pre] "[a] VLSI semiconductor device."

Petitioner argues that Kawagoe teaches the preamble. Pet. 6–8. Kawagoe discloses "a semiconductor integrated circuit device." Ex. 1007, 1:15–16, 14:50–51. In particular, Kawagoe discloses "4 Megabit Dynamic RAM" devices. *Id.* at 19:15–18. Dr. Blalock testifies that such devices have "millions of transistors." Ex. 1003 ¶ 68. Petitioner also cites evidence that "a VLSI semiconductor device means a device consisting of at least one million active elements," where "an active element is a semiconductor transistor." Ex. 1016, 73.

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 a surface."

Relying on a combination of Kawagoe's Embodiment 1 and Embodiment 4, Petitioner argues that Kawagoe teaches this limitation. Pet. 8–13. Petitioner contends that "a substrate of a first doping type" is taught by Kawagoe's epitaxial substrate—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 8–9 (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. *Id.* at 10 (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. Pet. 10 (citing Ex. 1003 ¶ 74).

Relying on Dr. Blalock's testimony and prior art disclosures cited in Kawagoe, 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. *Id.* at 10–13 (citing Ex. 1003 ¶¶ 75–80; 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. Blalock's testimony, teach this limitation of claim 1.

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

Petitioner argues that Kawagoe teaches this limitation. Pet. 13–16. 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. 14. Kawagoe discloses that these semiconductor regions 4Na and 4Nb "are doped with an n-type impurity such as phosphor[us] (P) or arsenic (As)." Ex. 1007, 8:67–9:3. Petitioner contends 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. Pet. 13 (citing Ex. 1003 ¶ 81; 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."

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 cites 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."). Kawagoe depicts 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. Blalock'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."

Petitioner argues that Kawagoe teaches this limitation. Pet. 18.[10] Kawagoe discloses forming transistors 4N and 4P, each in an active region,

[10] Petitioner's entire argument with respect to this limitation is a cross-reference to another portion of the Petition. Pet. 18. Specifically, Petitioner cites "§§VIII.A.1.c-d." *Id.* We note that these sections of the Petition do not exist. It is clear from context, however, that Petitioner intended to cite to § VII.A.1.c–d of the Petition, where Petitioner discusses the formation of the

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. 14 ("[A] POSITA would have understood that Kawagoe teaches forming multiple nMOS transistors in this [first active] region to minimize chip area, as good layout practice dictates."), 17 ("[A] POSITA would have understood that Kawagoe teaches forming multiple pMOS transistors in this [second active] region."), 79 (citing Ex. 1003 ¶¶ 82, 87; 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. Blalock'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 and second active regions towards an area of the substrate where there are no active regions."

Petitioner argues that Kawagoe teaches this limitation. Pet. 18–23. Petitioner points to disclosure in Kawagoe that states that its wells "have their impurity concentrations gradually lowered in the depthwise direction

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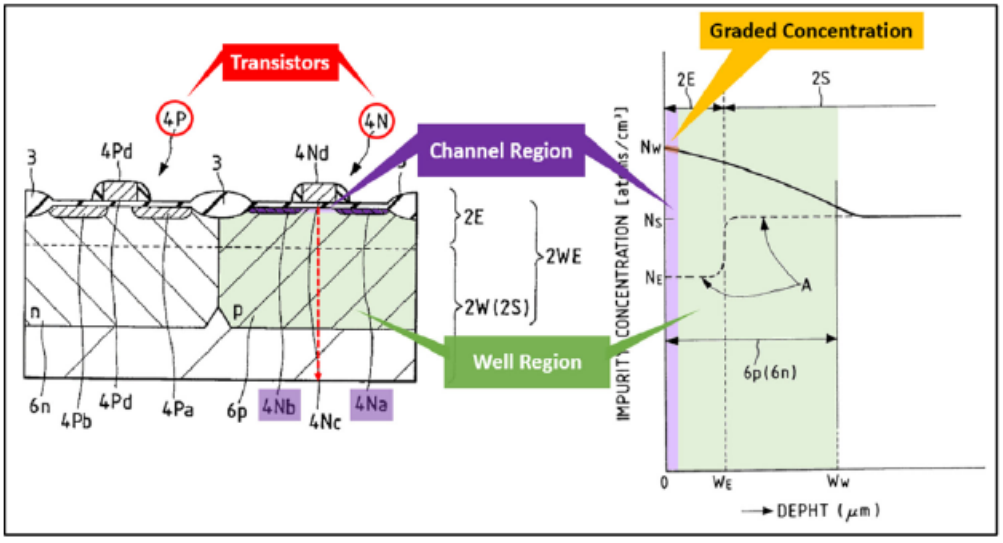
nMOS 4N and pMOS 4P transistors. Accordingly, we treat Petitioner's citation as directing us to the portion of the Petition to which Petitioner intended to cited. Similar errors occur throughout the Petition. *See, e.g.*, Pet. 29, 30, 37, 55, 64, 71, 72. For similar reasons, we treat these errors the same way.

from the principal surface (having an impurity concentration N_W) of the epitaxial layer 2E." Pet. 19–20 (quoting Ex. 1007, 15:66–16:2; emphasis omitted) (citing Ex. 1007, 5:41–45, Figs. 17, 23; Ex. 1003 ¶¶ 90, 91); *see id.* at 23 (citing Ex. 1016, 289–90; Ex. 1003 ¶ 98); *see id.* at 20 (citing Ex. 1007, 9:41–48, 14:46–55, 15:32, 15:37–40; Ex. 1008B, 298–301, Figs. 5-2/6-4; Ex. 1003 ¶ 92). Citing the testimony of Dr. Blalock, Petitioner contends that "[t]he dopant concentration is thus graded in the channel region of transistor 4N, which is a portion of the first active region formed at 'the principal surface' of epitaxial layer 2E." *Id.* at 19 (citing Ex. 1003 ¶ 91).

Petitioner presents annotated versions of Kawagoe's Figures 17 and 23, reproduced below, and argues that these depth-wise variations in impurity concentrations include the channel regions of each active region and that such variations in impurity concentrations aid or sweep carriers down into the substrate, away from any active regions. Pet. 22–23.



In the annotated versions of Kawagoe's Figures 17 and 23, above, Petitioner depicts the doping profile in the channel region in light purple and the

doping profile of the p-well in light green. Pet. 19 (citing Ex. 1007, 5:41–45).

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 surface towards the area of the substrate where there are no active regions."

Petitioner argues that Kawagoe teaches this limitation. Pet. 23–28. Petitioner contends that that Kawagoe discloses "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." Pet. 23 (quoting Ex. 1007, 15:66–16:2) (citing Ex. 1007, 14:46–55, 15:62–16:40, 16:11–15). Petitioner argues that "Kawagoe discloses a well region containing at least one graded dopant region (*e.g.*, the region highlighted in light green in both Figures 23 and 17) having a downward-sloping graded dopant concentration." *Id.* (citing Ex. 1003 ¶ 100). Petitioner contends that these depth-wise variations in impurity concentrations aid or sweep carriers down into the substrate, away from any active regions. Pet. 24–27 (citing-in-part Ex. 1007, 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.

[1.7] "wherein at least some of the transistors form digital logic of the VLSI semiconductor device."

Petitioner argues that Kawagoe teaches this limitation. Pet. 28. The cited portions of Kawagoe disclose a "semiconductor integrated circuit

device" that can be a "DRAM," "a flash memory," or "a logic circuit." Ex. 1007, 20:1–33, 22:10–29, 24:28–31; Ex. 1003 ¶ 108.

Patent Owner does not contest Petitioner's evidence pertaining to limitation [1.7]., we determine that Petitioner establishes by a preponderance of the evidence that the cited portions of Kawagoe, supported by Dr. Blalock's testimony, teach this limitation of claim 1.

3. Patent Owner's Arguments

Patent Owner disputes Petitioner's showing with respect to Kawagoe based on six sets of contentions, which we set forth below. *See generally* PO Resp.; PO Sur-Reply.

i.

First, Patent Owner contends that the combination of Kawagoe and Gupta does not teach or suggest limitation [1.2] of claim 1. 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. 32 (citing Pet. 8, 14). Patent Owner argues that "the Petition also states that the *channel* of transistor 4N is [*also*] part of the first active region." *Id.* (citing Ex. 1007, 8:66–9:3; Pet. 13 ("Source-drain regions 4Na/4Nb (purple) form part of the claimed first active region, which also includes the channel region . . . .")) (alteration added). 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 32 (citing-in-part Pet. 14 (pointing to Kawagoe's Figure 23, which shows channel of transistor 4N at the top of p-well 6p), 13 ("the channel region (light purple) between source-drain regions 4Na/4Nb"), 18–20).

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 33 (citing Ex. 2057 ¶ 62) (emphasis added).

ii.

Second, Patent Owner contends that "Dr. Blalock admitted that, to determine whether a dopant concentration gradient would 'aid carrier movement,' he looked *only* at the direction of the slope" and "did not look at the magnitude of the slope or other possible forces acting on a carrier." PO Resp. 19–20. Citing the testimony of Dr. Glew, Patent Owner takes the position that "the magnitude of the concentration gradient plays a big role, because a small gradient may not be sufficient to overcome the resistance of the material in which the gradient exists." *Id.* at 20 (citing Ex. 2057 ¶ 52). According to Patent Owner, "[t]he record confirms that simply grading dopants does not *guarantee* carrier movement." PO Sur-reply 1 (emphasis added); *see id.* at 2–3. Patent Owner further contends that "[i]n the absence of an express teaching that a specific gradient disclosed in the prior art is 'sufficiently graded' to 'aid carrier movement,' Petitioner must show that the prior art '*necessarily* include[s] the unstated limitation.'" *Id.* at 6–7 (citing *Transclean Corp. v. Bridgewood Servs., Inc.*, 290 F.3d 1364, 1373 (Fed. Cir. 2002)). According to Patent Owner, "[a] gradient alone does not '*necessarily*' or inherently 'aid carrier movement,' because there is no

dispute that other forces affect carrier movement and can overwhelm the force of the gradient." *Id.* at 7.

Patent Owner also takes the position that Petitioner's arguments reflect a change in claim construction position. *Id.* at 1.

iii.

Third, Patent Owner also 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. 23.

> Specifically, 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. (quoting Ex. 1007, 16:7–11 (emphasis by Patent Owner, highlighting omitted)); *see id.* (citing Ex. 2057 ¶ 53). Instead, Patent Owner argues that

> Dr. Blalock admitted that, according to Kawagoe, SEUs[11] 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 24 (citing Ex. 2057 ¶¶ 53–54; Ex. 1003 ¶ 94, n.6) (footnote omitted). According to Patent Owner, "[a] force also cannot push in one direction and 'aid movement' in the opposite direction." PO Sur-reply 2. Patent Owner further argues that "Petitioner does not dispute Dr. Glew's . . . testimony that

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

'if two forces are acting on an object in opposite directions, both forces cannot aid its movement.'" PO Resp. 23 (citing Ex. 2057, 29). Patent Owner further contends,

> Dr. Glew confirms (citing Nishizawa[12]) that Kawagoe is discussing carriers outside the surface layer. Nishizawa explicitly states that that probability of carriers from an alpha ray at the top of a device is "extremely low" and any such carriers can be "disregarded."

Id. at 24–25 n.10. In addition, Patent Owner argues,

> Kawagoe does not address carriers in the "active region," and does not "aid carrier movement*from the [first and second active regions | first or second active region | surface]*" because Kawagoe's carriers are nowhere near what Petitioner identifies as the "surface" or first/second "active regions" and are in fact "*prevented from entering the p-well 6p*" which stands between them and the "active regions."

PO Resp. 24–25 (citing Ex. 2057 ¶ 54) (alterations in original).

iv.

Fourth, 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 Dr. Blalock and" Wang "to fill the gap" with respect to Kawagoe. PO Resp. 25 (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 date of the Challenged Patent." *Id.* at 25–26 (emphasis omitted) (citing Ex. 1003 ¶ 95; Pet. ix; Ex. 1009, 429 (listing Wang's copyright date as 2008)) (emphasis omitted).

[12] U.S. Patent No. 5,384,476 issued January 24, 1995 to Nishizawa et al. (Ex. 2060, "Nishizawa").

v.

Fifth, Patent Owner further 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 <u>*not*</u> describing electrons near the surface. Dr. Glew cites Nishizawa—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. 26–27 (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, 57; Ex. 1007, 16:7–11). Patent Owner further contends that "Dr. Blalock testified that the location of an alpha-ray strike cannot be predicted," but even still "Dr. Blalock misses that even if the location of an alpha-ray strike cannot be predicted, a POSITA would have known that the probability of the alpha-ray strike <u>*creating electrons*</u> (like disclosed in Kawagoe, Ex. 1007, 16:7-11) is <u>*extremely low*</u> near the surface (as demonstrated by Nishizawa)." *Id.* at 27–28 (citing Ex. 1007, 16:7–11; Ex. 2057 ¶ 58; Ex. 2058, 147–148). Based on this assertion, Patent Owner further contends that "the better reading of Kawagoe is that Kawagoe is describing electrons '***produced in the large substrate body below the***

wells,' as Dr. Blalock conceded" and "[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 28.

vi.

Sixth, Patent Owner also argues that "[a]ll of Kawagoe's (purported) teachings about a gradient that 'aids carrier movement' refer to gradients and carriers *outside* the active region." PO Sur-reply 9 (emphasis added). According to Patent Owner, "[t]he Petition itself confirms that Kawagoe's teaching 'refers to electrons produced in the large substrate body below the wells.' The carriers Kawagoe discusses are 'prevented from entering the p-well,' and are thus below it." *Id.* (citing Pet. 21, n.7; PO Resp. 23). Patent Owner further contends that "Dr. Glew testified that Kawagoe only describes that this dopant gradient is able to keep SEU electrons out of the well,' and says nothing about drawing carriers '*from* the . . . active regions.'" *Id.* at 10 (citing Ex. 1052, 121:11–17, 122:6–9). Patent Owner also argues that "Petitioner offers no analysis of Kawagoe's electric field to show that it has the same effect in the active region as further down." *Id.*

Patent Owner also disputes Petitioner's mapping of limitation [1.2] by arguing, for example, that "[t]he doping type of the 'active region' cannot be the doping type of the source and drain as Petitioner proposes, because an 'active region' can exist without a source and drain." PO Sur-reply 12–13; *contra* PO Resp. 32 ("Kawagoe discloses that regions 4Na and 4Nb are doped n-type (Ex. 1007, 8:66-9:3), but the Petition also states that the channel of transistor 4N is part of the first active region." (emphasis omitted) (citing Ex. 1007, 8:66–9:3; Pet. 13)); *see* PO Sur-reply 11–14.

4. Petitioner's Reply Arguments

Petitioner responds to Patent Owner's arguments with respect to Kawagoe. *See generally* Pet. Reply.

i.

In response to Patent Owner's *first* set of arguments that Kawagoe does not teach or suggest limitation [1.2] of claim 1, Petitioner contends that Patent Owner "does not (and cannot) cite to any support for its interpretation of the 'first active region' as only having the 'doping type' of the transistor channel." Pet. Reply 16 (citing PO Resp. 32–33). According to Petitioner, Figures 5B and 5C of the specification of the '222 patent "show NMOS devices having n-type source and drain regions (labeled 'nt' or 'N+'), and a p-type substrate." *Id.* at 16–17 (citing Ex. 1001, Figs. 5B, 5C; Ex. 1052, 23:21–24:25; PO Resp. 3–4; Ex. 2057 ¶ 34). Petitioner takes the position that "[t]his indicates that the source and drain regions of the active region (n-type in Figures 5B and 5C) should be compared to the conductivity of the substrate (p-type in Figures 5B and 5C)." *Id.* at 17. Thus, Petitioner contends, "[f]ollowing the format of Figures 5B and 5C—*and the general convention* for identifying NMOS/PMOS transistors—Petitioner submits that the 'doping type' of the 'first active region' is the doping type of the associated source and drain regions." *Id.* at 17–18 (citing Ex. 1001, Figs. 5B, 5C; Ex. 1008B, 298–99) (italicized emphasis added).

Petitioner further asserts that "the Board need not resolve this dispute because even under the PO's incorrect interpretation, Kawagoe still teaches this limitation" because "Kawagoe describes a CMOS device that has both the NMOS device ***and*** an adjacent PMOS transistor 4P having source and drain regions 4Pa, 4Pb formed with an n-type channel in n-type well 6n." *Id.*

at 18 (citing Ex. 1007, 9:40–54, 17:50–54, 18:15–23, 21:55–61, Fig. 23); *see id.* at 19 (citing Ex. 1052, 22:7–28:24, 71:12–75:23, 132:24–137:14).

ii.

In response to Patent Owner's *second* set of arguments, Petitioner contends that

> Dr. Blalock correctly analyzed Kawagoe and Wieczorek, and explained how the specific devices in those references generate electric fields that "aid carrier movement" in the claimed directions. These electric fields, in turn, apply a force on carriers going from one surface of a device to another. Because the direction of these electric fields aligns with the direction of carrier movement recited in the claims, the teachings of Kawagoe and Wieczorek meet the "aid carrier movement" limitations.

Pet. Reply 2 (citing Pet. 18–28, 55–62). Petitioner contends that Patent Owner's "own expert, Dr. Glew, agrees with the underlying physics" when he "testified that 'a field will provide a force in a direction aiding [] movement in the direction of the force. **That's just basic physics**.'" *Id.* (citing Ex. 1052, 108:15–109:14) (alteration by Petitioner).

Petitioner also contends that it "is not arguing that 'graded' means 'aided,'" and that Patent Owner "wrongly suggests that the 'aid carrier movement' limitation requires calculating the slope of a dopant concentration, which is not disclosed in the patent, not discussed in the prosecution history, and would be inconsistent with [its] statements in district court litigation." Pet. Reply 2–3. Petitioner further contends that Patent Owner's "own expert confirmed that graded dopant concentrations always create electric fields that always interact with carriers—which is exactly what Petitioner argues." *Id.* at 3 (citing Ex. 1052, 83:13–84:23); *see id.* (citing PO Resp. 14) (quoting Ex. 1020, 29). Petitioner further contends

that, "[a]s PO's expert acknowledged, the challenged claims do not require any set number of carriers to move—much less 'all minority carriers.'" *Id.* at 5 (citing Ex. 1052, 82:19–83:7).

Petitioner also argues that Patent Owner "wrongly tries to ignore the applicant's representation that a downward-sloping graded dopant concentration was known to create an 'inherent "built-in" unidirectional electric field' that sweeps carriers down into the substrate." *Id.* at 4 (citing PO Resp. 15; Ex. 1016, 289–290). Petitioner further takes the position that Patent Owner's statements during prosecution "do[] not imply that any specific magnitude or absolute value of slope is required." *Id.* at 5. Petitioner supports its contention by pointing to "the specification's statement that '[t]he ***relative*** slope of the donor concentration throughout the base creates a suitable aiding drift electric field' does not suggest any specific magnitude is required." *Id.* at 5–6 (quoting Ex. 1001, 2:60–64 (emphasis by Petitioner)). "Instead," Petitioner contends that "'relative' refers to the directionality of the slope (i.e., increasing or decreasing in concentration), which is consistent with the general presentation of gradient fields in Figures 5B and 5C" of the specification. *Id.* at 6.

iii.

In response to Petitioner's *third* set of arguments, Petitioner responds that Patent Owner's

> argument that Kawagoe only teaches "using a graded slope to *impede* carrier movement" is incomprehensible. As PO's expert Dr. Glew admitted, whether an electric field from a graded dopant concentration aids movement or impedes movement ***depends on the direction of the movement***. It, thus, makes no sense to say an electric field would impede all movement (nor aid all movement): any given electric field will aid electron

> movement in one direction and impede electron movement in the opposite direction.

Pet. Reply 7 (citing PO Resp. 16; Ex. 1052, 83:13–89:13, 92:2–97:8, 102:2–109:14, 109:25–116:3, 121:19–123:15).

Citing Kawagoe's teaching that "electrons produced by the α-ray are attracted to the substrate body 2S by that concentration gradient and prevented from entering the p-well," Petitioner contends that this "means an electric field aids carrier movement 'to the substrate body 2S' and impedes carrier movement in the opposite direction from 'entering the p-well.'" *Id.* (citing Ex. 1007, 16:2–11, Figs. 17, 23; Pet. 27–28); *see id.* at 10 (citing Ex. 1052, 102:2–109:14; Ex. 1007, 16:2–11).

iv.

With regard to Patent Owner's *fourth* set of arguments regarding Wang's priority date, Petitioner contends that it "supported [its challenge] with citations to Wang," the subject matter of which was "known before the priority date" because the Nishizawa reference, which issued in 1995, "confirms that alpha-ray strikes generate electrons in the active region, and PO's expert confirmed that alpha ray strikes from cosmic rays were well known before" the earliest possible priority date of the '222 patent. Pet. Reply 15 (citing Ex. 1052, 82:6–83:7, 116:4–123:15; Ex. 2057, 30, n.4; PO Resp. 25–26).

v.

With regard to Patent Owner's *fifth* set of arguments, Petitioner further contends that

> [w]ithout expert support, PO also wrongly states in footnote 10 that Kawagoe's concentration gradient would prevent carriers ***above*** well region 6p from entering the well. This is wrong and

> contrary to the testimony of PO's own expert. As shown in Figures 17 and 23 . . . (and confirmed by Dr. Glew), the graded concentration in Kawagoe consistently decreases from the surface to the substrate, which means the resulting electric field points in the same downward direction above and below well 6p.

Pet. Reply 11 (citing PO Resp. 24; Ex. 1007, Figs. 17, 23; Ex. 1052, 110:18–116:3).

Petitioner further contends that "[b]ecause there are electrons in the active region of Kawagoe—regardless of any alpha ray strikes—PO's discussion of alpha rays is largely irrelevant." *Id.* at 13 (citing PO Resp. 24–29). Petitioner argues that "Petitioner referenced Kawagoe's discussion of alpha rays because it *illustrates features of the electric field generated by the graded dopant concentration* in Kawagoe, but that *electric field exists regardless* of whether an alpha ray strike ever occurs." *Id.* (emphasis added). Pointing to Nishizawa, Petitioner further contends

> Nishizawa says after an alpha ray strike "several ten thousand electrons will flow into the n+ type region 13," which is part of the active region. Because the challenged claims do not require a specific number or portion of electrons, it does not matter whether more electrons are also created in the substrate—an alpha ray strike still creates thousands of electrons in the relevant region.[] Additionally, Nishizawa discloses various examples—which PO ignores—where an alpha ray strike actually generates the majority of electron-hole pairs at a depth closer to a device's "top-most surface," contradicting PO's assertion that the probability of generating electron-hole pairs in this area would be "extremely low."

Id. at 13–14 (citing Ex. 2060, 19:41–42, 19:54–20:11; Figs. 34–36; Ex. 1052, 82:6–83:7, 116:4–123:15, 123:17–128:11, Fig. 36; PO Resp., 27–28) (footnote omitted); *see id.* at 14 (citing Ex. 1052, 82:6–83:7, 116:4–123:15; Ex. 2060, 19:54–20:11, Fig. 36; PO Resp. 27–28).

5. Analysis of the Parties' Arguments

We have considered the cited evidence, including expert testimony, 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.

i.

With regard to the parties' arguments concerning limitation [1.2] (and by association, limitation [1.5]) of claim 1, we agree with Petitioner that there is insufficient support for interpreting the "'first active region' as *only* having the 'doping type' of the transistor channel." Pet. Reply 16 (citing PO Resp. 32–33) (emphasis added). 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. 13 (citing Ex. 1003 ¶ 81; Ex. 1008B, 299–300); PO Resp. 32 ("Kawagoe discloses that regions 4Na and 4Nb are doped n-type (Ex. 1007, 8:66-9:3), 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 and third alterations added); *but see* PO Sur-reply 13 (impermissibly shifting positions to assert that the *well region* is the active region—"as Dr. Glew explained, Petitioner is ignoring Figure 5A. 'Looking back at 5A, one can see a p-well and an n-well. … [S]ources and drains are of the opposite type of well or active area they're formed in. So if I have an n-type source and drain, it will be formed in a p-type [active] region'" (alterations by Patent Owner) (quoting Ex. 1052, 24:1–9)).

The parties' dispute is whether the active region should be characterized by the dopant type of the source-drain regions, or by the

dopant type of the channel region connecting the source and drain. Upon review of the evidence of record, including the language of the claims, the written description of the '222 patent, and the prior art of record, we find Petitioner's argument persuasive that the doping type of the active region in claim 1 may be the doping type of the source and drain regions.

First, 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 as to require *a channel region* with a doping type opposite in conductivity to the first doping type, or to preclude reliance on the doping type of the source and drain within the active region. And, 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 be characterized by the doping type of the source and drain regions of the MOS.

Second, Dr. Glew testifies that "[t]he claimed invention is clearly disclosed in Figs. 5B-5C of the Challenged Patent, and the corresponding parts of the specification." Ex. 2057 ¶ 34; *but see* PO Sur-reply 13 (asserting Petitioner ignored Fig. 5A of '222 patent). Figure 5B of the '222 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, 3:53–56. The '222 patent further discloses that "the subterranean n-layer has a graded donor concentration to sweep the minority carriers deep into the substrate" and that "[t]his n-layer 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 3:56–64 (emphasis added). Thus, the written description of the '222 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, Petitioner persuasively demonstrates that "the general convention for identifying NMOS/PMOS transistors" is "the 'doping type' of the 'first active region,'" that is, "the doping type of the associated source and drain regions." Pet. Reply 17–18 (citing-in-part Ex. 1008B, 298–99). 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. Petitioner also 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. 13–16. Thus, Petitioner persuasively demonstrates that Kawagoe discloses limitation [1.2].

Moreover, separate and independent from the reasons above, Petitioner persuasively argues that "Kawagoe describes a CMOS device that has both the NMOS device ***and*** an adjacent PMOS transistor 4P having source and drain regions 4Pa, 4Pb *formed with an n-type channel in n-type well 6n*." Pet. Reply 18 (citing Ex. 1007, 9:40–54, 17:50–54, 18:15–23,

21:55–61, Fig. 23) (second emphasis added); *see id.* at 19 (citing Ex. 1052, 22:7–28:24, 71:12–75:23, 132:24–137:14). Kawagoe's Figure 23, cited with respect to limitation [1.2], supports Petitioner's argument. *See* Pet. 14 (Ex. 1007, Fig. 23).

ii.

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"

> 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."[13] *Id.* at 289.

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

[13] 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.

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 '222 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.'" Tr. 24:19–24; Ex. 3011, 9.

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 '222 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 '222 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 Sur-reply 20–21. Patent Owner argues that the '222 patent discloses that

> the donor dopant concentration may be 10 to 100x" at one end of the gradient *compared to the other*. The next sentence recites that "[t]he 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…." In the context of a bipolar junction transistor ("BJT"), the specification recites that "the relative doping concentrations of emitter and collector regions varies from 10^{18} to $10^{20}/cm^3$, whereas the base region is 10^{14} to $10^{16}/cm^3$.

Id. (first emphasis added) (quoting Ex. 1001, 2:54–56, 2:58–63 (emphasis added)). All of the disclosed terms are relative: "The relative doping concentrations of emitter and collector regions varies from 10^{18} to $10^{20}/cm^3$, whereas the base region is 10^{14} to $10^{16}/cm^3$." Ex. 1001, 2:54–56, 2:58–63. Further still, these concentrations are set forth with respect to a bipolar junction transistor (BJT) embodiment that is not encompassed by independent claim 1. *See* Tr. 26:1–8. In the BJT embodiment of the '222 patent, the graded dopant concentration moves carriers from emitter to collector, that is, *within* the active region. *Id.* at 25:9–16, 25:19–23. In contrast, independent claim 1 requires moving carriers *away* from the active region to the substrate. *Id.* at 25:17–18, 25:23–25; *cf. id.* at 65:14–66:2.

We find persuasive, Petitioner's quotation from the testimony of Patent Owner's expert, Dr. Glew—"a field will provide a force in a direction aiding [] movement in the direction of the force. **That's just basic physics**."

Pet. Reply 2 (quoting Ex. 1052, 108:20–23) (emphasis by Petitioner); *see id.* at 4 (citing Ex. 1052, 83:13–84:23, 108:15–109:14). We agree with Petitioner that claim 1 does not require that movement of any particular number of carriers, let alone a need to move all the carriers. *See* Pet. Reply 8. We further agree that independent claim 1 is not a method claim—as Petitioner's counsel explained during the hearing:

> [Petitioner's Counsel]: We're not dealing with a method claim that has an affirmative step of aiding carrier movement. When the claims say, "one graded dopant concentration to aid carrier movement," the aid carrier movement limitation is modifying a characteristic of the graded dopant concentration.

Tr. 7:14–18.

In *ParkerVision, Inc. v. Qualcomm Inc.*, 903 F.3d 1354, 1361 (Fed. Cir. 2018), the Court held that "[a]pparatus claims cover what a device *is*, not what a device *does*." *ParkerVision*, 903 F.3d at 1361 (quoting *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 "a prior art reference may anticipate or render obvious an apparatus claim—depending on the claim language—if 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.*

Petitioner must show "a graded dopant concentration" that is *capable* of "aid[ing] carrier movement from the first and second active regions towards an area of the substrate where there are no active regions," and "aid[ing] carrier movement from the surface towards the area of the substrate where there are no active regions" as claimed. 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.

We next address Patent Owner's arguments that, during prosecution, Patent Owner "disagreed with the Examiner's conclusion that the claim at issue there (which never issued) should be rejected, but was not disagreeing with the relevant part of the Examiner's statement" that "[a] gradient is not the only force acting on a carrier." PO Sur-reply 18. As to the hypothetical opposing forces that Patent Owner asserts are missing from Petitioner's analysis, neither the specification nor the prosecution history nor any of the prior art mention such forces or a need to compensate for them. We agree with Petitioner that "[t]he challenged claims also do not require the graded dopant concentration be strong enough . . . to overcome a hypothetical resistance." Pet. Reply 16. Citing Kawagoe's disclosure in column 6, lines 2 through 11, Petitioner's counsel persuasively explained during the hearing that "what it's telling us is that they've intentionally picked the gradient in *Kawagoe* so that it will handle whatever other fields and forces may be going on here to the extent you needed something else to make sure these electrons are attracted to the substrate." Tr. 22:15–23.

We disagree with Patent Owner that "Petitioner must show that" these hypothetical opposing forces "would *never* overwhelm the gradient." PO Sur-reply 8. Patent Owner also argues that "[t]he fact that a reference does not explicitly discuss a force does not mean that the force is absent or that a POSITA would disregard it." *Id.* Even if "it is undisputed that [some] resistance is '*always*' present" as Patent Owner argues (*id.* (citing Ex. 1052, 146:16–18 (emphasis by Patent Owner)), we disagree with Patent Owner

that "[t]o carry its burden, Petitioner must affirmatively show that the other forces are absent or that the gradient is stronger" (*id.*). Here again, where the inventor "did not provide the type of detail in his specification that" Patent Owner "now argues is necessary in" Kawagoe, we find "that one skilled in the art would have known how to implement the features of the reference[]." *In re Epstein*, 32 F.3d at 1568.

Transclean is distinguishable from the facts at issue in the present proceeding because it concerned "anticipation by inherent disclosure" which "is appropriate only when the reference discloses prior art that must necessarily include the unstated limitation." *Transclean Corp.*, 290 F.3d 1364, 1373 (citing *Cont'l Can Co. v. Monsanto Co.*, 948 F.2d 1264, 1268–69 (Fed. Cir. 1991)). The challenges in the present proceeding, including that based on Kawagoe, are based on obviousness, and are not based on an assertion of inherent disclosure. To the contrary, as explained above, Petitioner relies on the "capability" of a prior art device to perform a claimed function and the *express* disclosure in Kawagoe of a graded dopant concentration that extends from the surface to the substrate. *See ParkerVision*, 903 F.3d at 1361–62.

Patent Owner does not explain, nor are we able to ascertain, any shift in Petitioner's claim construction position. PO Sur-reply 1; Mot. Strike 6–7. Instead, Petitioner's Reply arguments are directly responsive to Patent Owner's arguments in its Patent Owner Response.

iii.

As to the parties' arguments concerning whether Kawagoe discloses aiding or inhibiting the movement of carriers, Petitioner persuasively argues that it is inaccurate to assert that "an electric field would impede all

movement" *or* would "aid all movement." Pet. Reply 7. We agree with Petitioner that an "electric field will aid electron movement in one direction and impede electron movement in the opposite direction." *Id.* (citing PO Resp. 16; Ex. 1052, 83:13–89:13, 92:2–97:8, 102:2–109:14, 109:25–116:3, 121:19–123:15). We determine that Patent Owner's expert, Dr. Glew, also agrees. Ex. 1052, 103:25–104:4, 104:14–16, 105:22–106:6. Thus, we agree with Petitioner that in Kawagoe, "an electric field aids carrier movement 'to the substrate body 2S' and impedes carrier movement in the opposite direction [from] 'entering the p-well.'" Pet. Reply 7 (citing Ex. 1007, 16:2–11, Figs. 17, 23; Pet. 27–28) (alteration added); *see id.* at 10 (citing Ex. 1052, 102:2–109:14; Ex. 1007, 16:2–11).

With respect to Patent Owner's argument that "Petitioner does not dispute Dr. Glew's . . . testimony that 'if two forces are acting on an object in opposite directions, both forces cannot aid its movement,'" we determine that this is not the relevant inquiry. PO Sur-reply 2 (citing Ex. 2057, 29) ("[A] force also cannot push in one direction and 'aid movement' in the opposite direction."). 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 during related litigation.

iv.

With regard to the parties' arguments concerning Wang's priority date, Petitioner contends that it "supported [its challenge] with citations to Wang" that were "known before the priority date" because the Nishizawa reference, which issued in 1995, "confirms that alpha-ray strikes generate electrons in the active region, and PO's expert confirmed that alpha ray strikes from cosmic rays were well known before" the earliest possible priority date of the '222 patent. Pet. Reply 14 (citing Ex. 1052, 82:6–83:7, 116:4–123:15; Ex. 2057, 30, n.4 4; PO Resp. 25–26). Even though Wang was published four years after the earliest possible priority date of the '222 patent, Petitioner supports its contention that other evidence in the record supports the assertions for which Petitioner relied on Wang and accordingly, the subject matter relied upon in Wang would have been understood by a POSITA as of the earliest possible priority date of the '222 patent.

v.

With regard to the parties' arguments concerning alpha ray strikes, we are persuaded by Petitioner's arguments that Kawagoe's disclosure that "electrons [are] produced by the α-ray" is illustrative to show how Kawagoe's graded dopant concentration performs. 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. 26–27 (citing Ex. 2057 ¶¶ 10, 57; Ex. 1007, 16:7–11; Ex. 2060, 19:21–34, 20:19–22) (emphasis omitted)), we agree with Petitioner that alpha ray strikes are not even required for the Kawagoe's graded dopant concentration to create an electric field that will have an effect on a carrier depending on its charge polarity. Pet Reply 13–14 (citing Ex. 2060, 19:41–42, 19:54–20:11).

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 30º, this alpha-particle will enter into silicon up to a depth of 25 μm. However, the depth measured

> from the topmost surface of the device is 12.5 μm. 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 absent an alpha ray strike, Petitioner persuasively points out that even if an alpha ray strike were required, Nishizawa indicates that the alpha ray strike could produce electrons near the surface of the CMOS device. *See* Pet. Reply 13–14 (citing Ex. 2060, 19:41–42, 19:54–20:11); Ex. 2060, 19:34–42, 19:56–57.

vi.

Patent Owner's arguments concerning the location of the graded dopant concentration are first presented in Patent Owner's Sur-Reply. *See, e.g.*, PO Sur-reply 9 ("All of Kawagoe's (purported) teachings about a gradient that 'aids carrier movement' refer to gradients and carriers *outside the active region*." (emphasis added)), 11 ("Petitioner points to no evidence that Kawagoe's field is the same throughout and is not 'negated or reversed' *in the active region*. Kawagoe only discusses 'electrons produced in the large substrate body below the wells.'" (citing Pet. 21 n.7) (emphasis added)). We decline to consider these belated arguments, which properly should have been raised in Patent Owner's Response to allow Petitioner to fairly address them in its Reply.

Patent Owner also belatedly shifts position and argues that the active region is the well region. PO Sur-reply 13 ("As Dr. Glew explained, Petitioner is ignoring Figure 5A. 'Looking back at 5A, one can see a p-well and an n-well . . . [S]ources and drains are of the opposite type of well or active area they're formed in. So if I have an n-type source and drain, it will be formed in a p-type [active] region.'" (alterations by Patent Owner)).

For patent owners, arguments not raised in a patent owner response may be deemed forfeited if raised later, and the sur-reply "may only respond to arguments raised in the corresponding [petitioner] reply." 37 C.F.R. § 42.23(b). If the Board determines that a party is making untimely arguments, it may decline to consider them on the merits. That is the case here. As Patent Owner has not shown where its arguments were present in Patent Owner's Response, nor are we able to ascertain such, we discern on the complete record that, due to the untimeliness of Patent Owner's arguments, Petitioner was denied a full and fair opportunity to respond to this sixth set of arguments.

Nevertheless, even if we were to consider these belated arguments, we would not be persuaded because we agree with Petitioner's position that "the 'doping type' of the 'first active region' is the doping type of the associated source and drain regions," which is supported by the underlying evidence in Wolf. Pet. Reply 18 (citing Ex. 1001, Figs. 5B, 5C; Ex. 1008B, 298–299); *see* PO Sur-reply 12 (quoting Pet. Reply 18); *see* Ex. 1008B Fig. 5-1(a), 298–99; *accord* Ex. 2057 ¶ 34; PO Resp. 32; Ex. 1001, 3:53–64).

We also note that Exhibits 2077 through 2081, which were submitted by Patent Owner with its Sur-reply without prior Board authorization, were

stricken. Paper 80 (Order Granting Motion to Strike). We do not consider arguments based on these documents.

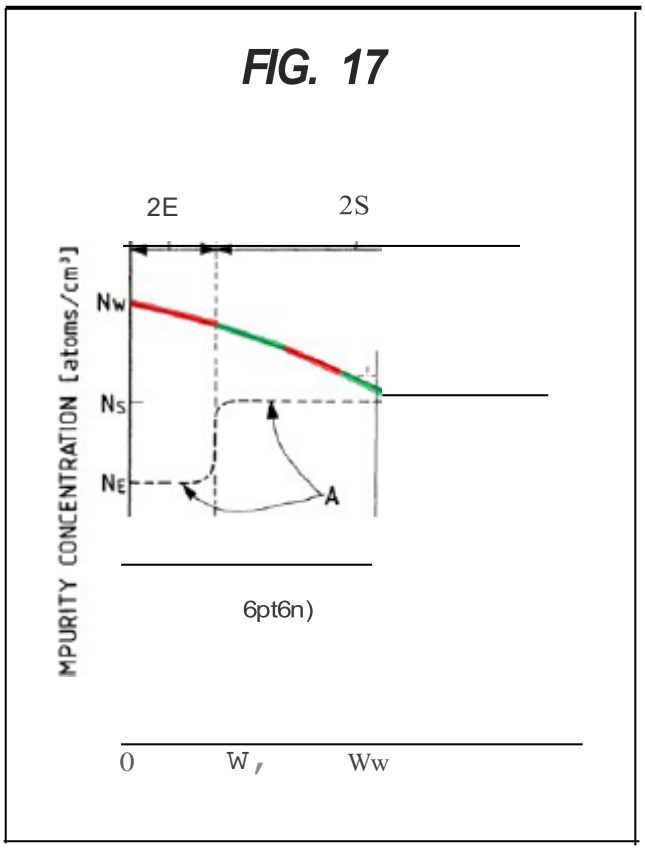
Conclusion

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

6. Remaining Independent Claims 21, 39, 41, and 42

Petitioner relies on substantially the same cited teachings in Kawagoe for teaching the limitations of independent claims 21, 39, 41, and 42. Pet. 6–29.

Independent claim 21 includes most of the same limitations in independent claim 1 and one limitation not included in claim 1. Limitation [21.7] of independent claim 21 additionally recites "wherein the graded dopant concentration is linear, quasilinear, error function, complementary error function, or any combination thereof." Pointing to its annotated version of Kawagoe's Figure 17 reproduced below, Petitioner contends "the graded dopant concentration is linear or nearly linear (quasilinear)." Pet. 29 (citing Ex. 1003 ¶ 109).



Petitioner's annotated version of Kawagoe's Figure 17 illustrating the curvature of graded dopant concentration. *Id.* (citing Ex. 1007, Fig. 17). Petitioner contends that "[i]t is also a combination of linear/quasilinear segments, illustrated in green/red—as the segments get smaller, they become even more linear/quasilinear." *Id.* (citing Ex. 1003 ¶ 109). Based on the complete record developed during trial, we agree that Petitioner's cited evidence supports its contentions by a preponderance of the evidence.

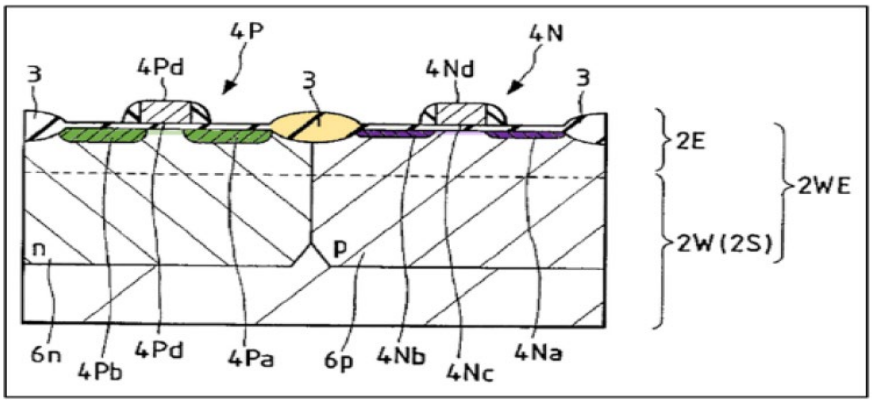
Independent claim 41 includes most of the same limitations in independent claim 1 and one limitation not included in claim 1. Limitation [41.5] of independent claim 41 additionally recites "graded dopant acceptor concentration." Petitioner contends that "[t]he graded channel region of Kawagoe's first active region is 'doped with a p-type impurity such as boron.'" Pet. 20 (citing Ex. 1007, 15:28–29, Pet. § VIII.A.9). According to

Petitioner, "[b]oron is an acceptor dopant." *Id.* (citing Ex. 1037, 30; Ex. 1003 ¶ 93); *see id.* at 20–22. Limitation [42.5] recites a "graded donor dopant concentration." Petitioner contends that "[t]he graded channel region of Kawagoe's second active region 'is doped with an n-type impurity such as phosphor.'" *Id.* at 20 (citing Ex. 1007, 15:30–32; Pet. § VIII.A.9). According to Petitioner, "[p]hosphor is a donor dopant." *Id.* (citing Ex. 1037, 27; Ex. 1003 ¶ 93); *see id.* at 20–22.

Patent Owner does not present specific arguments for any of independent claims 21, 39, 41, and 42 beyond what is presented for independent claim 1. In view of the above and notwithstanding Patent Owner's alleged objective indicia of nonobviousness discussed below, we determine that Petitioner establishes, by a preponderance of the evidence, that independent claims 21, 39, 41, and 42 are unpatentable as obvious over Kawagoe.

7. Dependent Claims 6 and 27

Claims 6 and 27 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. 34–36. 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. 32.

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***." Kawagoe provides similar disclosure regarding regions 4Pa and 4Pb. Thus, 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 27.

PO Resp. 35 (citing Ex. 1007, 8:66–67, 9:3–6, 9:47–53; Ex. 2057 ¶ 66). Accordingly, Patent Owner contends that "[t]he 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." *Id.* at 35–36 (citing Ex. 2057 ¶ 66; Ex. 1007, 8:40–42).

Petitioner replies that Patent Owner's "argument rests on an unsupported assumption that claims 6 and 27 require the isolation region to separate the first and second active regions at *all points along their respective depth*." Pet. Reply 20 (citing PO Resp. 35–36) (emphasis added).

According to Petitioner, "the claims do not specify where and to what extent the isolation region must separate the first and second active regions." *Id.*

Petitioner also points out Patent Owner's "two misunderstandings of the geometry in Kawagoe." *Id.* First, Petitioner argues that the epitaxial layer 2E can range from 0.3 μm to 5 μm, the top end of the range being significantly larger than the maximum 0.5 μm depth of semiconductor active region 4Na, 4Nb, 4Pa, and 4Pb. *Id.* at 20–21. Second, Petitioner argues that "Kawagoe teaches that insulating film 3 is formed via LOCOS [Local Oxidation of Silicon] which (according to PO's own expert) 'consumes a portion of the silicon and works its way downward.'" *Id.* at 21 (citing Ex. 1052, 139:2–142:2). Petitioner thus contends that Dr. Glew's conclusory testimony simply reiterates the assertion in the Patent Owner Response "that the active regions extend beyond insulating film—without supporting evidence or technical reasoning" and thus, "should be given little weight." *Id.* (citing *Xerox Corp.*, IPR2022-00624, Paper 9, 15-17 (PTAB Aug. 24, 2022) (precedential)).

Finally, Petitioner contends that, even if the "claims require[ed] separation on the full depth of the active regions ***and*** if PO were right about the active regions protruding deeper into the device than insulating film 3, Kawagoe would ***still*** teach an 'isolation region' that separates the first and second active regions," and points to Kawagoe's teaching of "a channel stopper region is formed below the field insulating film 3" which is not depicted in Kawagoe's figures. Pet. Reply 21–22 (citing Ex. 1007, 8:43–45).

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. In view of the above and notwithstanding Patent Owner's alleged objective indicia of nonobviousness discussed below, we determine that Petitioner establishes obviousness of claims 6 and 27 over Kawagoe by a preponderance of the evidence.

8. Remaining Dependent Claims

We have reviewed Petitioner's arguments and evidence for remaining claims 2–5, 7–9, 13, 14, 16–20, 23–26, 28, 32–38, and 40, and we are persuaded that the cited portions of Kawagoe teach what Petitioner asserts they teach and that Dr. Blalock's testimony sufficiently supports Petitioner's arguments. Pet. 29–45. Patent Owner does not present arguments for these claims beyond that 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 below, we determine that Petitioner establishes obviousness of claims 2–5, 7–9, 13, 14, 16–20, 23–26, 28, 32–38, and 40 over Kawagoe by a preponderance of the evidence.

E. Obviousness Based on the Combination of Wieczorek and Wolf

Petitioner contends claims 1, 2, 4–9, 13–23, 25–28, and 32–42 would have been obvious in view of the combination of Wieczorek and Wolf. Pet. 45–78.

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. *See, e.g.*, Pet. 45.

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.

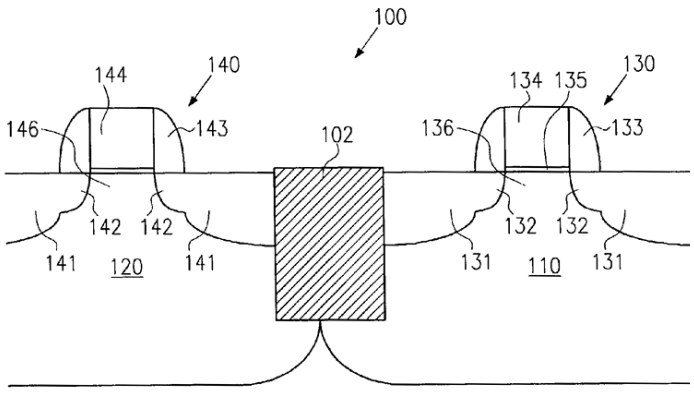


FIG.1b
(Prior Art)

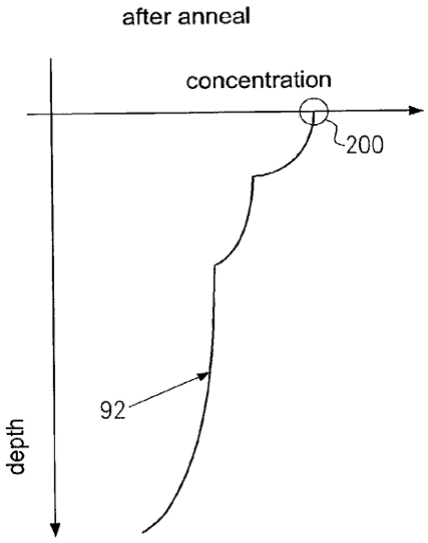


FIG.2b
(Prior Art)

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. Wieczorek 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." Ex. 1008. A portion of the textbook focuses on CMOS technology. Ex. 1008A, 807–40.

3. Petitioner's Contentions

Petitioner argues that the combination of Wieczorek and Wolf teaches or suggests the limitations of the challenged claims and that a person of ordinary skill in the art would have had reason to combine the teachings of Wieczorek and Wolf. Pet. 5, 45–83.

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. 45. 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. 45. 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 cites 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 ¶ 138; 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.

[pre] The preamble of claim 1 recites "[a] VLSI semiconductor device." Ex. 1001, 4:39. Petitioner argues that the combination of Wieczorek and Wolf teaches the preamble. Pet. 45–47. Wieczorek discloses a "semiconductor device." Ex. 1006 ¶ 12, Fig. 1b. Wolf discloses that such devices include microprocessors, DRAM, and flash memory, each with at least one million transistors. Ex. 1008A, Fig. 1; Ex. 1008B, 596–97, 633–35. Petitioner also cites evidence that "a VLSI semiconductor device means a device consisting of at least one million active elements," where "an active element is a semiconductor transistor." Ex. 1016, 73.

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 a surface."

Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. Pet. 47–50. 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. Blalock'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. 48–49 (citing Ex. 1003 ¶ 143).

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 surface with a second doping type opposite in conductivity to the first doping type and within which transistors can be formed."

Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. Pet. 50–53. 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." Pet. 52 (citing Ex. 1003 ¶ 147; Ex. 1006 ¶ 12). Wieczorek discloses "N-channel transistor 130," which 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."

Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. Pet. 53–55. Wieczorek discloses "P-channel transistor 140," which includes "heavily P-doped source and drain regions 141" and "channel region 146." Ex. 1006 ¶¶ 4, 12, 13. 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."

Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. 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. 52 ("[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 . . . ."), 55 ("[A] POSITA would have understood that Wieczorek teaches forming multiple pMOS transistors in the second active region."), 79 (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 Weiczorek and Wolf (*supra* § III.E.3).

[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 and second active regions towards an area of the substrate where there are no active regions."

Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. 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 cites evidence to show that these depthwise variations in impurity concentrations sweep carriers down into the substrate, away from any active regions. Ex. 1003 ¶ 159; Ex. 1010, 2:27–32, 5:14–22; 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 surface towards the area of the substrate where there are no active regions."

Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. Pet. 60–62. 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 cites evidence shows that these depthwise variations in impurity concentrations sweep carriers down into the substrate, away from any active regions. Ex. 1003 ¶ 165; Ex. 1010, 2:27–32, 5:14–22; 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.

[1.7] "wherein at least some of the transistors form digital logic of the VLSI semiconductor device."

Petitioner argues that the combination of Wieczorek and Wolf teaches this limitation. Pet. 62–63. Petitioner cites evidence that Wieczorek's structure "was understood by a [person of ordinary skill in the art] to form digital logic gates." Ex. 1003 ¶ 168; Ex. 1006 ¶¶ 7, 26; Ex. 1008A, 810–11.

Patent Owner does not contest Petitioner's evidence pertaining to limitation [1.7]. We determine that Petitioner establishes by a preponderance of the evidence that the combination of Wieczorek and Wolf teaches this limitation of claim 1.

4. Patent Owner's Arguments

Patent Owner argues that "[t]he Petition points to Figure 2B of Wieczorek for the claimed 'graded dopant concentration' of limitation [1.5]" but "relies entirely on [Patent Owner's] supposed admissions" to teach "the

claimed 'aid carrier movement' feature of limitation [1.5]." PO Resp. 29 (citing Pet. 56–58); *see id.* at 31 (also addressing limitation [1.6]).

Patent Owner also argues that "Dr. Blalock admitted that he did not calculate the slope of the graded concentration curve in Wieczorek." *Id.* at 30 (citing Ex. 2058, 195). Patent Owner asserts that "it would have been impossible for Dr. Blalock to make such a calculation, because the dopant gradient Petitioner points to in Figure 2B (and Wieczorek generally) does not have any values from which one could calculate a slope." *Id.* (citing Ex. 2057 ¶ 60).

5. Petitioner's Reply Arguments

Petitioner contends that

> [t]he Petition does not "rel[y] entirely on Greenthread's supposed admissions" to show that the Wieczorek-Wolf combination satisfies the "aid carrier movement" limitation. POR, 29. Wieczorek describes a downward-sloping graded dopant concentration, and there is no dispute that the graded dopant concentration will create an electric field that points in the direction required by the claims.

Pet. Reply 15 (citing Ex. 1052, 32:15–33:25, 56:20–62:15, 69:3–71:9, 75:15–23, 83:17–89:13, 92:2–94:1, 102:2–109:14, 109:25–116:3, 120:11–123:15, 147:4–151:15). Petitioner further contends

> [w]hile PO insists that ***hypothetical*** forces opposing this field may exist, no such forces are identified by PO or PO's expert. [Ex. 1052,] 147:4-151:15. The challenged claims also do not require the graded dopant concentration be strong enough to move all carriers, or to accelerate any carrier to a specific speed, or to overcome a hypothetical resistance. The only requirement is "aid[ing] carrier movement" in the recited direction, and there is no reason to doubt that the gradient dopant concentration in Wieczorek would result in an electric field that "aids carrier movement" as claimed.

Id. at 16 (citing Pet. 55–62) (third alteration by Petitioner).

6. Analysis

For the same reasons set forth above in Section II.D.5, 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

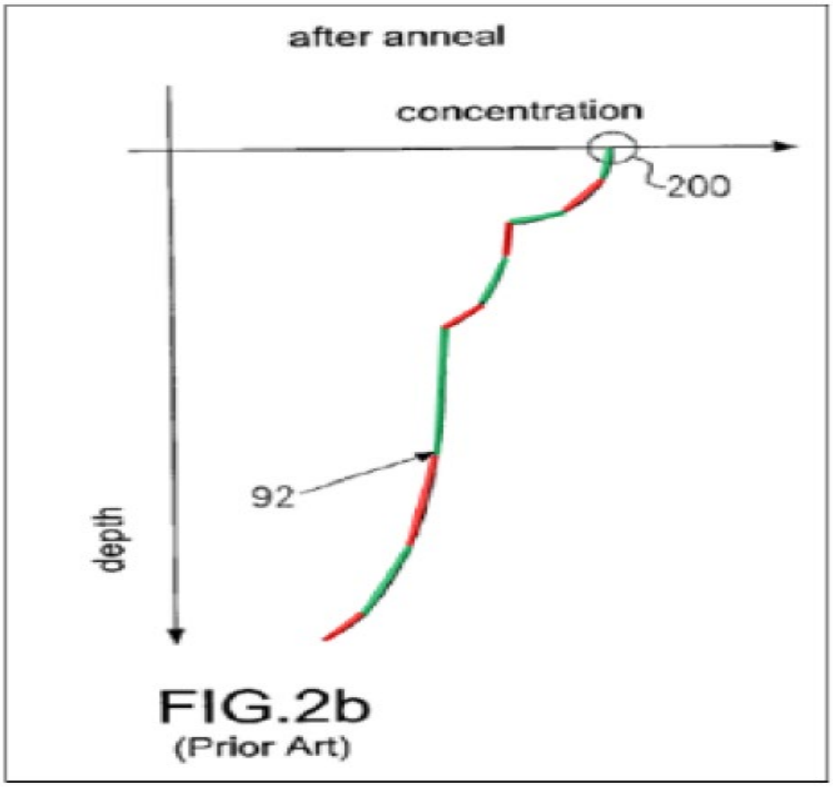
In view of the foregoing and notwithstanding Patent Owner's alleged objective indicia of nonobviousness discussed below, we are persuaded that Petitioner establishes, by a preponderance of the evidence, that claim 1 is unpatentable as obvious over the combination of Wieczorek and Wolf.

7. Remaining Independent Claims 21, 39, 41, and 42

Petitioner relies on the same cited teachings in the combination of Wieczorek and Wolf for teaching the limitations of independent claims 21, 39, 41, and 42. Pet. 45–63.

Independent claim 21 includes most of the same limitations in independent claim 1 and one limitation not included in claim 1. Limitation [21.7] of independent claim 21 additionally recites "wherein the graded dopant concentration is linear, quasilinear, error function, complementary error function, or any combination thereof." Pointing to its annotated version of Wieczorek's Figure 2B, reproduced below, Petitioner contends that "the graded dopant concentration is a combination of linear or nearly linear

(quasilinear) segments, illustrated in green/red." *Id.* at 63 (citing Ex. 1003 ¶ 169).



Petitioner's annotated version of Wieczorek's Figure 2B depicting curvature of graded dopant concentration. Pet. 63. Petitioner contends that, "[a]s the segments get smaller, they become even more linear/quasilinear." *Id.* (citing Ex. 1003 ¶ 169).

Independent claim 41 includes most of the same limitations in independent claim 1 and one limitation not included in claim 1. Limitation [41.5] of independent claim 41 additionally recites "graded dopant acceptor concentration." Pet. 58. Petitioner contends that "[t]he graded channel region of Wieczorek's first active region is doped with a p-type impurity such as boron, an acceptor dopant." *Id.* (citing Ex. 1006 ¶ 8; Pet. § VIII.B.8; Ex. 1037, 30; Ex. 1003 ¶ 158); *see id.* at 58–59. Independent claim 42 includes

most of the same limitations in independent claim 1 and one limitation not included in claim 1. Limitation 42.5 claims a "graded donor dopant concentration." *Id*. Petitioner contends that "[t]he graded channel region of Wieczorek's second active region is doped with an n-type impurity such as phosphorous, a donor dopant." *Id.* at 58 (citing Ex. 1006 ¶ 8; Pet. § VIII.B.8; Ex. 1037, 27; Ex. 1003 ¶ 158); *see id.* at 58–59.

Patent Owner does not present specific arguments for any of independent claims 21, 39, 41, and 42 beyond what is presented for independent claim 1. We have reviewed the cited portions of Weiczorek and Wolf and Dr. Blalock'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 below, we determine that Petitioner establishes, by a preponderance of the evidence, that independent claims 21, 39, 41, and 42 are unpatentable as obvious over the combination of Wieczorek and Wolf.

8. Remaining Dependent Claims

We have reviewed Petitioner's arguments and evidence for remaining claims 2, 4–9, 13–20, 22, 23, 25–28, 32–40 and we are persuaded that the cited portions of Weiczorek and Wolf teach what Petitioner asserts they teach and that Dr. Blalock's testimony sufficiently supports Petitioner's arguments. Pet. 64–78. Patent Owner does not present arguments for these claims beyond that presented for independent claim 1. *See generally* PO Resp. In view of our above analysis and notwithstanding Patent Owner's alleged objective indicia of nonobviousness discussed below, we determine that Petitioner establishes by a preponderance of the evidence that the

subject matter of claims 2, 4–9, 13–20, 22, 23, 25–28, and 32–40 would have been obvious over Wolf and Weiczorek.

F. Remaining Challenges III through VI

Given our determination that Petitioner establishes the unpatentability of claims 1–9, 13, 14, 16–21, 23–28, and 32–42 as obvious over Kawagoe (*supra* §§ II.D.5–8) and unpatentability of claims 1, 2, 4–9, 13–23, 25–28, and 32–42 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, 13–28, and 32–42—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).

G. Objective Indicia of Non-Obviousness[14]

Patent Owner alleges that a license agreement with RPX Corp. ("RPX") ("the RPX license") that covers the patent family including the '222 patent is evidence supporting the objective indicia of nonobviousness. PO Resp. 2, 36–39. Patent Owner further argues that because the licensees, [redacted] approached Patent Owner through RPX

[14] In Section II.G, we refer to the sealed version of the Patent Owner Response in Paper 47.

without threat of litigation against them, the RPX license agreement is especially probative of non-obviousness. *Id.* at 36 (citing Ex. 2072). Patent Owner further argues that its invention is "part and parcel" of the RPX license because all of the claims of the licensed patents relate to using graded dopants to move carriers from active circuitry at the surface further down into the device. *Id.* at 38.

Patent Owner bears the burden of establishing that a nexus exists between the objective evidence and the claimed invention. *Fox Factory, Inc. v. SRAM, LLC*, 944 F.3d 1366, 1373 (Fed. Cir. 2019). Nexus is a legally and factually sufficient connection between the objective evidence and the claimed invention, such that the objective evidence should be considered in determining non-obviousness. *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1392 (Fed. Cir. 1988). "A nexus may not exist where, for example, the merits of the claimed invention were 'readily available in the prior art.'" *ClassCo, Inc. v. Apple, Inc.*, 838 F.3d 1214, 1220 (Fed. Cir. 2016) (quoting *Richdel, Inc. v. Sunspool Corp.*, 714 F.2d 1573, 1580 (Fed. Cir. 1983)). Further, "there is no nexus unless the evidence presented is 'reasonably commensurate with the scope of the claims.'" *Id.* (quoting *Rambus Inc. v. Rea*, 731 F.3d 1248, 1257 (Fed. Cir. 2013)).

Federal Circuit precedent "specifically require[s] affirmative evidence of nexus where the evidence of commercial success presented is a license" and requires that "only little weight can be attributed to [license] evidence if the patentee does not demonstrate a nexus between the merits of the invention and the licenses of record." *Iron Grip Barbell Co., v. USA Sports, Inc.*, 392 F.3d 1317, 1324 (Fed. Cir. 2004) (quoting *In re GPAC Inc.*, 57 F.3d 1573 (Fed. Cir. 1995)).

Here, Patent Owner does not expressly address the nexus requirement but it relies on the RPX license and asserts that its technique of "creating 'a drift field to sweep these unwanted minority carriers from the active circuitry at the surface into the substrate'" (PO Resp. 37, quoting Ex. 1001, 3:52–56) is "part and parcel" with the RPX license (*id.* at 38).

As to Patent Owner's argument that the licenses evidence non-obviousness because "moving carriers 'from the active circuitry at the surface' is missing from the prior art" (PO Resp. 38), we disagree that the relevant claim limitation ("aid carrier movement from the first and second active regions") is missing from the prior art for the reasons discussed above in Sections II.D.5. *See Tokai Corp. v. Easton Enters., Inc.*, 632 F.3d 1358, 1369 (Fed. Cir. 2011) ("If commercial success is due to an element in the prior art, no nexus exists."); *Ormco Corp. v. Align Technology, Inc.*, 463 F.3d 1299, 1312 (Fed. Cir. 2006) ("[I]f the feature that creates the commercial success was known in the prior art, the success is not pertinent.").

We have considered the RPX license and Patent Owner's argument and find that they do not demonstrate a sufficient nexus with the challenged claims. In particular, the RPX license on its face does not specifically refer to the claimed feature of using a graded dopant that PO asserts as "part and parcel" of the '222 patent, nor does it refer to any technical merits of the challenged claims. Further, Patent Owner offers no evidence that any licensee mentioned the challenged patents or the claimed feature of using a graded dopant during negotiation of the RPX license and no information relating to [redacted] consideration of the potential exposure of their products. Without this information, we cannot assess whether [redacted]

[redacted] through the RPX license, acquiesced to the purported strength of the '222 patent. We find that the mere existence of the RPX license is not sufficient to show a nexus.

Even if Patent Owner were found to have shown a nexus, we decline to give significant weight to the RPX license because there is insufficient evidence to evaluate its context. Further, we do not agree with Patent Owner that the RPX license is especially probative because [redacted] were under no apparent threat of litigation. *See* PO Resp. 2, 36. In any event, even if we assign some weight to the RPX license, it does not outweigh Petitioner's strong showing that the prior art teaches the claimed features, as discussed above. *See Tokai*, 632 F.3d at 1371 (Fed. Cir. 2011) ("A strong case of *prima facie* obviousness . . . cannot be overcome by a far weaker showing of objective indicia of nonobviousness.").

Although Patent Owner argues that the RPX license was not motivated by a threat of litigation and that the expense for [redacted] to litigate the challenged patents "would have been trivial" (*see* PO Resp. 37), the weight of evidence does not support those arguments. RPX markets itself as a cost-saving service that spreads litigation cost across a large network of companies and "remove[s] patents from circulation before they become costly issues." Ex. 1051, 1. RPX further markets itself as working on behalf of its clients to prevent potential litigation and associated legal defense costs and settlements. *Id.* at 3. In view of this evidence, Patent Owner's argument that [redacted] entered a license under no apparent threat of litigation is not persuasive.

Having determined that Patent Owner does not meet its burden to show a nexus between its alleged objective indicia and the challenged

claims, we look to the evidence and argument regarding the remaining *Graham* factors, discussed above, in evaluating Petitioner's obviousness contentions as to each of the challenged claims. Even if we were to give Patent Owner's evidence some weight, it would not overcome the strong case of obviousness set forth by Petitioner.

H. Timeliness of Petition Under 35 U.S.C. § 315(b)[15]

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. 39. In particular, Patent Owner argues Petitioner is in privity with 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 '222 patent. *Id.* at 41–47. 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 Petitioners 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.

[15] In Section II.H, we refer to the sealed versions of the Patent Owner Response in Paper 47 and the Preliminary Response in Paper 18.

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 factual basis upon which to question Petitioner's representation that it is not time barred (Inst. Dec. 22), or that Petitioner and Intel or [redacted] were privies, based on any of its theories regarding privity (*id.* at 14–22). We incorporate that analysis here, and reconsider Patent Owner's contention only to the extent it is warranted by subsequent argument and evidence.[16] *Id.* at 11–22; *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. 44–46); (2) Patent Owner had no opportunity to raise a *res judicata* defense in district court (*id.* at 48); (3) our finding that Petitioner's relationship with Intel did not create privity misallocated the § 315(b) burden of proof by requiring Patent Owner to produce evidence of Petitioner's and Intel's relationship (*id.* at 48–50); and (4) a finding in Petitioner's favor would violate Patent Owner's

[16] With certain exceptions for redacted documents, Patent Owner's exhibits 2001–2056 were entered prior to Institution and exhibits 2057–2100 were submitted during trial.

constitutional right to due process (*id.* at 59–62). 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 37), which was summarily denied (Paper 44). 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 Institution Decision (Papers 8, 31), our Order denying that discovery noted that Patent Owner's "discovery requests are not narrowly tailored to discover any indemnification agreement" (Paper 31, 10), 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, and specifically, denial of its opportunity to cross-examine a witness about Petitioner's assertion it did not indemnify Intel. PO Resp. 61–62 (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 an example, "[t]he Board could only institute IPR if it found that Petitioner's customer-supplier relationships do not create privity by examining the terms of those relationships." *Id.* at 62.

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. 61–62. As explained in our Institution Decision, a manufacturer-customer relationship does not necessarily suggest a privity relationship and, because Petitioner's sales to Intel are licensed (as Patent Owner acknowledges), they do not support privity. Inst. Dec. 15–16. Thus, we need not, and did not, rely on any representation from Petitioner's counsel regarding indemnification. Inst. Dec. 17–19 (noting that Patent Owner directed us to no evidence tending to support the existence of an indemnification obligation creating a privity relationship). The record thus demonstrates Patent Owner's argument that it was denied an opportunity to examine evidence underlying our Institution Decision lacks support.

III. CONCLUSION

In summary:

Claim(s)	35 U.S.C. §	Reference(s)/ Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
1–9, 13, 14, 16–21, 23–28, 32–42	103(a)	Kawagoe	1–9, 13, 14, 16–21, 23–28, 32–42	
1, 2, 4–9, 13–23, 25–28, 32–42[17]	103(a)	Wieczorek, Wolf	1, 2, 4–9, 13–23, 25–28, 32–42	
1–9, 13, 14, 16–21, 23–28, 32–42	103(a)	Kawagoe, Gupta[18]		
1, 2, 4–9, 13–23, 25–28, 32–42	103(a)	Wieczorek, Wolf, Gupta[19]		
19, 37	103(a)	Kawagoe, Silverbrook[20]		
19, 37	103(a)	Wieczorek, Wolf, Silverbrook[21]		
Overall Outcome			1–9, 13–28, 32–42	

[18] As explained above, because we determine that challenged claims 1–9, 13, 14, 16–21, 23–28, and 32–42 are unpatentable over Kawagoe, we decline to address this ground.

[19] As explained above, because we determine that challenged claims 1, 2, 4–9, 13–23, 25–28, and 32–42 are unpatentable over the combination of Weiczorek and Wolf, we decline to address this ground.

[20] As explained above, because we determine that challenged claims 19 and 37 are unpatentable over Kawagoe, we decline to address this ground.

[21] As explained above, because we determine that challenged claims 19 and 37 are unpatentable over Wieczorek and Wolf, we decline to address this ground.

IV. ORDER

For the reasons given, it is:

ORDERED that Petitioner has established, by a preponderance of evidence, that each of the challenged claims 1–9, 13–28, and 32–42 of the '222 patent is unpatentable as obvious under 35 U.S.C. § 103(a);

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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