

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BMW OF NORTH AMERICA, LLC, and GENERAL MOTORS LLC,
Petitioner,

v.

ARIGNA TECHNOLOGY LTD.,
Patent Owner.

IPR2021-01321¹
Patent 8,247,867 B2

Before GARTH D. BAER, SHARON FENICK, and IFTIKHAR AHMED,
Administrative Patent Judges.

Opinion for the Board filed by *Administrative Patent Judge* BAER.

Opinion Dissenting-in-part filed by *Administrative Patent Judge* AHMED.

BAER, *Administrative Patent Judge.*

JUDGMENT

Final Written Decision

Determining Some Challenged Claims Unpatentable

35 U.S.C. § 318(a)

Denying as Moot Patent Owner's Motion to Exclude

37 C.F.R. § 42.64

¹ BMW of North America, LLC, who filed a petition in IPR2022-00631 and General Motors LLC, who filed a petition in IPR2022-00641 have been joined as petitioners in this proceeding.

I. INTRODUCTION

A. BACKGROUND

Volkswagen Group of America, Inc. (“VW”) filed a Petition (Paper 2, “Pet.”), requesting an *inter partes* review of claims 1–9 (the “challenged claims”) of U.S. Patent No. 8,247,867 B2 (Ex. 1001, “the ’867 patent”). Arigna Technology Ltd. (“Patent Owner”) filed a Preliminary Response to the Petition (Paper 9). Pursuant to 35 U.S.C. § 314, we instituted this *inter partes* review as to all of the challenged claims and all grounds raised in the Petition. Paper 10 (“Institution Dec.”).

Following institution, BMW of North America, LLC (“BMW”) filed a petition in IPR2022-00631 (challenging the same claims of the ’867 patent on the same grounds), and a motion for joinder (seeking to join this proceeding as a petitioner). *BMW of N. Am., LLC v. Arigna Tech. Ltd.*, IPR2022-00631 (PTAB Mar. 8, 2022), Papers 1, 2 (petition), 4 (motion for joinder). We granted institution in IPR2022-00631 and granted BMW’s motion for joinder. Paper 28 (PTAB Sept. 1, 2022). Similarly, General Motors LLC (“GM”) filed a petition in IPR2022-00641 (challenging the same claims of the ’867 patent on the same grounds), and a motion for joinder (seeking to join this proceeding as a petitioner). *General Motors, LLC v. Arigna Tech. Ltd.*, IPR2022-00641 (PTAB Mar. 8, 2022), Papers 2 (petition), 3 (motion for joinder). We granted institution in IPR2022-00641 and granted GM’s motion for joinder. Paper 29 (PTAB Sept. 1, 2022). VW and Patent Owner then reached a settlement and this proceeding was terminated only as to VW. Paper 30 (PTAB Sept. 9, 2022). Accordingly, we refer to BMW and GM, collectively, as “Petitioner.”

Also following institution, Patent Owner filed a Response. Paper 17 (“PO Resp.”). Subsequently, Petitioner filed a Reply to Patent Owner’s

Response (Paper 21, “Pet. Reply”), and Patent Owner filed a Sur-reply (Paper 31, “PO Sur-reply”). Patent Owner also filed a Motion to Exclude Evidence (Paper 35), which Petitioner opposes (Paper 36). On November 18, 2022, we held an oral hearing. A transcript of the hearing is included in the record. Paper 41.

We have jurisdiction under 35 U.S.C. § 6. This decision is a Final Written Decision issued pursuant to 35 U.S.C. § 318(a). For the reasons we discuss below, we determine that Petitioner has proven by a preponderance of the evidence that claims 4, 6, and 7 of the ’867 patent are unpatentable, but has not proven that claims 1–3, 5, 8, and 9 are unpatentable.

B. RELATED PROCEEDINGS

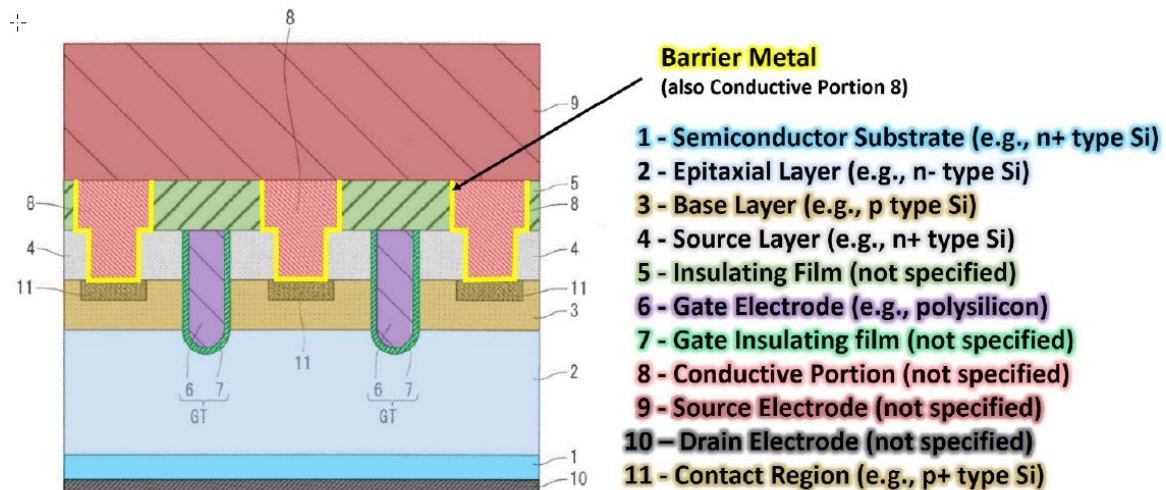
The ’867 patent is at issue in *Arigna Technology Limited v. Volkswagen AG et al.*, No. 2:21-cv-00054-JRG-RSP (E.D. Tex.); ITC Proceeding 337-TA-1267 (“ITC proceeding”); and IPR2021-01382. Pet. 110, Paper 5, 2.

C. REAL PARTY-IN-INTEREST

Petitioner identifies BMW of North America, LLC; Bayerische Motoren Werke AG; General Motors LLC; General Motors Company; and BrightDrop. LG Magna e-Powertrain Co., Ltd. as real parties-in-interest. *BMW*, IPR2022-00631, Paper 2, at 110; *GM*, IPR2022-00641, Paper 2, at 110. Patent Owner identifies Arigna Technology Limited as the real party-in-interest. Paper 5, 2.

D. THE ’867 PATENT

The ’867 patent is directed to a semiconductor device. Ex. 1001, code (54). The ’867 patent’s Figure 1, with Petitioner’s annotations, is reproduced below.



EX1001, Fig. 1 (annotated)

Pet. 31. Figure 1 illustrates a cross-section of a semiconductor device. *Id.* at 3:35–54. The device has an n+-type substrate 1 (*id.* at 4:4–5); n-type drift layer 2 (*id.* at 4:6–10); p-type base 3 (*id.* at 4:13–14); n+-type source 4 (*id.* at 4:14–16); insulating film 5 (*id.* at 4:31–32); gate electrode 6 (*id.* at 4:19–30); gate insulating film 7 (*id.* at 4:19–30); conductive portions 8 (*id.* at 4:32–33); source electrode 9 (*id.* at 4:59–67); drain electrode 10 (*id.* at 4:5–6); and p+ type contact region 11 in base 3 (*id.* at 4:39–46).

E. CHALLENGED CLAIMS

Petitioner challenges claims 1–9. Claims 1, 4, and 8 are independent.

Independent claim 1 is representative and is reproduced below:

1. A semiconductor device, comprising:
 - a base layer having a first conductivity type;
 - a source layer formed on said base layer and having a second conductivity type;
 - an insulating film formed on said source layer;
 - a plurality of gate structures penetrating said base layer;
 - a plurality of conductive portions penetrating said insulating film and said source layer and electrically connected to said source layer and said base layer; and

a source electrode formed on said insulating film and electrically connected to said conductive portions, wherein:

said gate structures are formed in a stripe shape in plan view;

parts in which said conductive portions are connected to said base layer are formed, in plan view, with a distance from said gate structures between said gate structures so as to be parallel to a direction of said stripe shape of said gate structures; and

a dimension of a part in which said source layer and said base layer are in contact with each other between said gate structures and said conductive portions are 0.36 μm or more and 0.43 μm or less.

Ex. 1001, 12:19–40.

F. ASSERTED GROUNDS OF UNPATENTABILITY

Petitioner asserts the following grounds of unpatentability. Pet. 54.

Claim(s) Challenged	Basis (35 U.S.C. §) ²	Reference(s)	Ground
4, 7	102	Torii ³	1a
5	103	Torii, Hebert ⁴	1b
6	103	Torii, Hebinuma ⁵	1c
8, 9	102	Kim03 ⁶	2a
1–3	103	Kim03, Sekiguchi ⁷	2b
8, 9	103	Sekiguchi, Hebert	3a

² Because the parties agree that the challenged claims of the '867 patent have an effective filing date before March 16, 2013, we apply the pre-AIA (“America Invents Act”) version of § 103. Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112-29, 125 Stat. 284, 285–88 (2011).

³ WO 2009/060670 A1, Pub. May 14, 2009 (Translation) (Ex. 1030, “Torii”).

⁴ US 2009/0218619 A1, Pub. Sep. 3, 2009 (Ex. 1025, “Hebert”).

⁵ JP 2006-59940, Pub. Mar. 2, 2006 (Translation) (Ex. 1027, “Hebinuma”).

⁶ J. Kim et al., High-Density Trench MOSFETs Employing Two Step Trench Technique and Trench Contact Structure, Proceedings of the 2003 IEEE 15th International Symposium on Power Semiconductor Devices and ICs, pp. 165–67 (2003) (Ex. 1034, “Kim03”).

⁷ US 2009/0179261 A1, Pub. Jul. 16, 2009 (Ex. 1044, “Sekiguchi”).

Claim(s) Challenged	Basis (35 U.S.C. §)²	Reference(s)	Ground
1, 3	103	Sekiguchi, Williams99 ⁸	3b
2	103	Sekiguchi, Williams99, Hebert	3c

Petitioner also relies on a declaration from Dr. Sanjay K. Banerjee (Ex. 1002).

II. PRELIMINARY MATTERS

A. LEVEL OF ORDINARY SKILL

Petitioner contends a person of ordinary skill in the art “would have possessed (1) the equivalent of a Master of Science degree in electrical engineering, materials science, physics, or equivalent; (2) working knowledge of power semiconductors and semiconductor processing; and (3) at least two years of experience in related semiconductor processing, analysis, design, or development.” Pet. 54–55. Further, “[a]dditional education could substitute for professional experience, and significant work experience could substitute for formal education.” *Id.* at 55.

Patent Owner contends a person of ordinary skill in the art would have had (1) a bachelor’s degree in electrical engineering or a similar field, and approximately two years of industry or academic experience designing or analyzing power semiconductor devices or (2) a master’s degree or Ph.D. in electrical engineering or an equivalent field, with coursework, thesis, or dissertation work, or research experience in power semiconductor devices.

PO Resp. 8.

These formulations are similar. We adopt Petitioner’s description as it is consistent with the prior art and patent specification before us and

⁸ US 6,413,822 B2, Jul. 2, 2002 (Ex. 1033, “Williams99”).

supported by credible expert testimony. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (prior art itself may reflect an appropriate level of skill). However, our decision would be the same under either formulation.

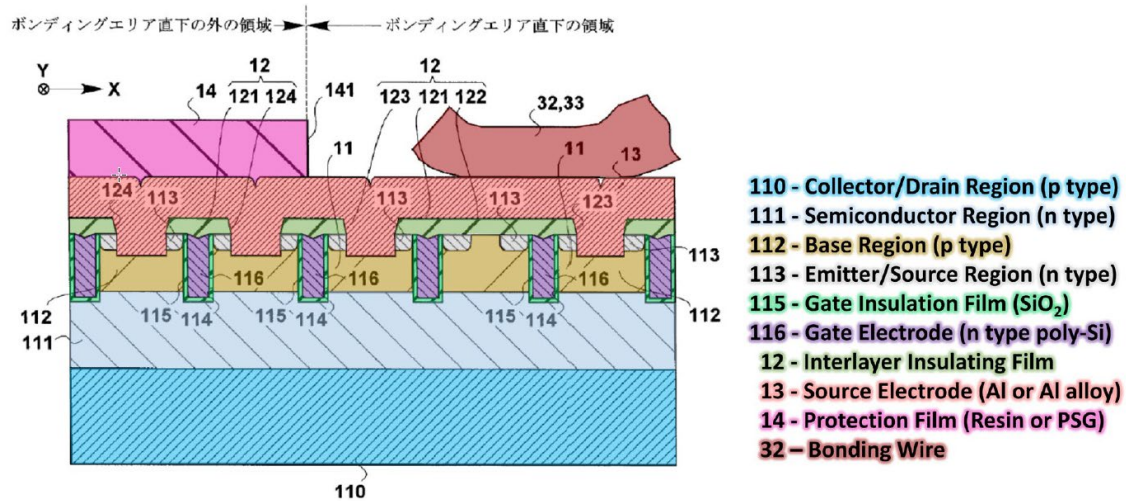
B. CLAIM CONSTRUCTION

Petitioner and Patent Owner offer different constructions for a single claim term—“penetrating.” *See* PO Resp. 19; Pet. Reply 1. However, the parties’ differing constructions do not impact our unpatentability analysis. Therefore, we decline to construe this term. We find no claim terms require express construction to determine unpatentability. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co. Matal*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (“[W]e need only construe terms ‘that are in controversy, and only to the extent necessary to resolve the controversy.’”) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

C. DESCRIPTION OF ASSERTED PRIOR ART REFERENCES

1. Torii (Ex. 1030)

Torii discloses a semiconductor device. Ex. 1030, code (54). Torii’s Figure 11, with Petitioner’s annotations, is reproduced below.



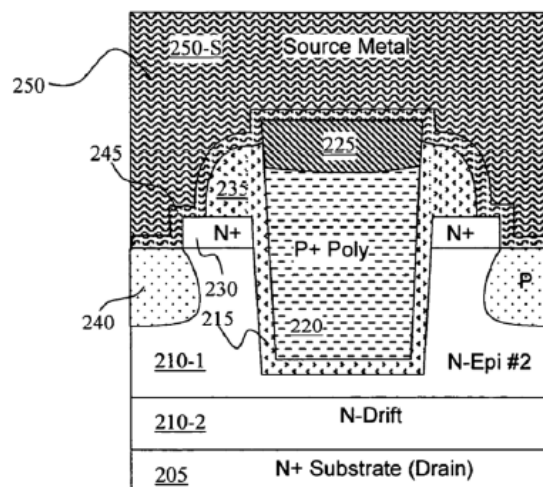
[upper-left] REGION OUTSIDE OF DIRECTLY BELOW BONDING AREA
[upper-right] REGION DIRECTLY BELOW BONDING AREA

EX1030, Fig. 11 (annotated)

Pet. 41. Figure 11 is a semiconductor device with the elements noted above.
Ex. 1030 ¶ 78; *see* Ex. 1002 ¶ 197 (citing Ex. 1030 ¶¶ 38–43, 55–56, 80, 90, 92, 93, Fig. 11).

2. *Hebert (Ex. 1025)*

Hebert discloses a semiconductor power device with trench gate structures and sidewall spacers. Ex. 1025 ¶ 12. Hebert's Figure 10k is reproduced below.



Ex. 1007, Figure 10k

Figure 10k is a cross sectional view of a semiconductor. *Id.* ¶ 19. Hebert discloses that spacers 235 may be etched back “200 Angstroms to 2000 Angstroms.” *Id.* ¶¶ 39–40.

3. Hebinuma (Ex. 1027)

Hebinuma teaches a trench gate semiconductor device. Ex. 1027 ¶ 1. Hebinuma’s Figure 9 is reproduced below.

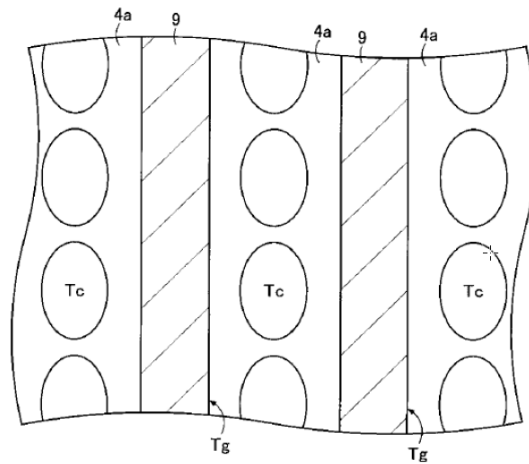


Figure 9 “is a main part planar schematic . . . of a trench gate semiconductor device having a cross-sectional elliptical contact trench.” *Id.* ¶ 50.

4. Williams99 (Ex. 1033)

Williams99 describes a “structure and manufacturing process . . . to define critical features and dimensions of a trench-gated vertical power DMOSFET [Depletion Trench Metal Oxide Semiconductor Field Effect Transistor].” Ex. 1033, code (57). Williams99’s Figure 13 is reproduced below.

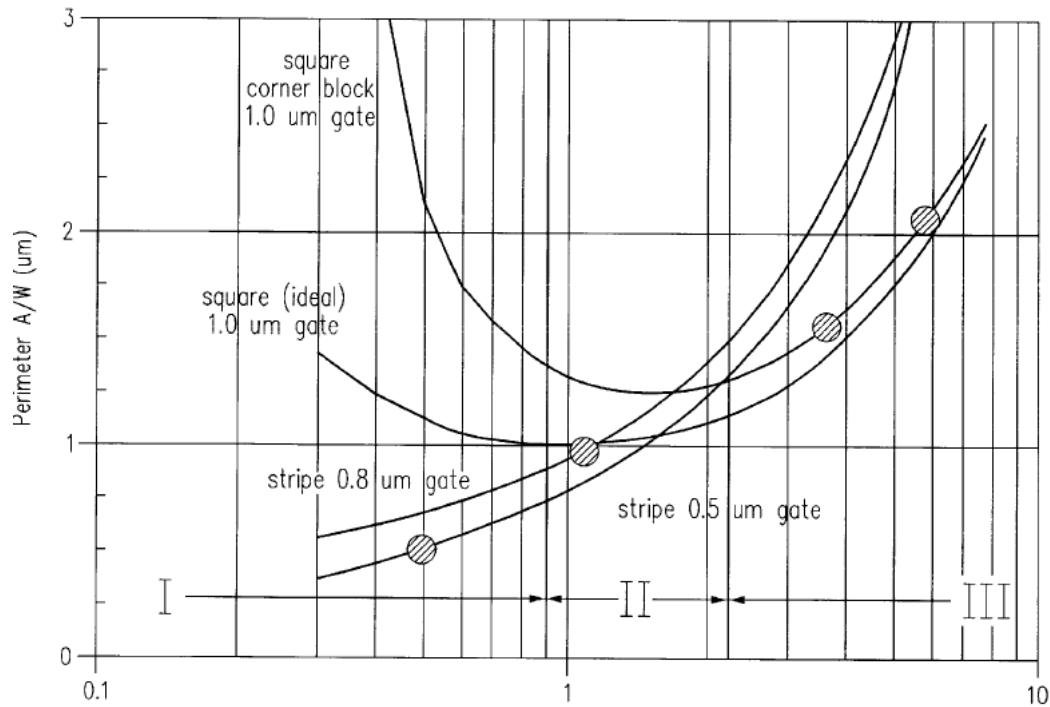
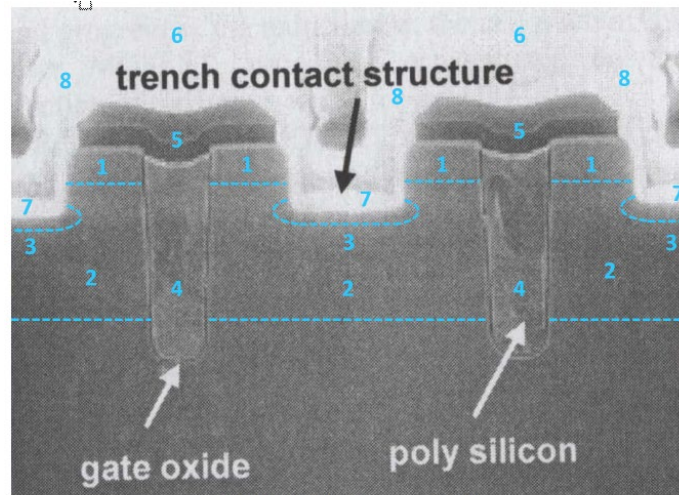


Figure 13 “is a graph of the vertical DMOS cell perimeter ratio A/W [device area A to gate width W] as a function of mesa width.” *Id.* at 9:56–57.

5. Kim03 (Ex. 1034)

Kim03 teaches DMOSFET. Ex. 1034, 4.⁹ Kim03’s Figure 5, with Petitioner’s annotations, is reproduced below.

⁹ We cite to Petitioner’s provided page numbering.



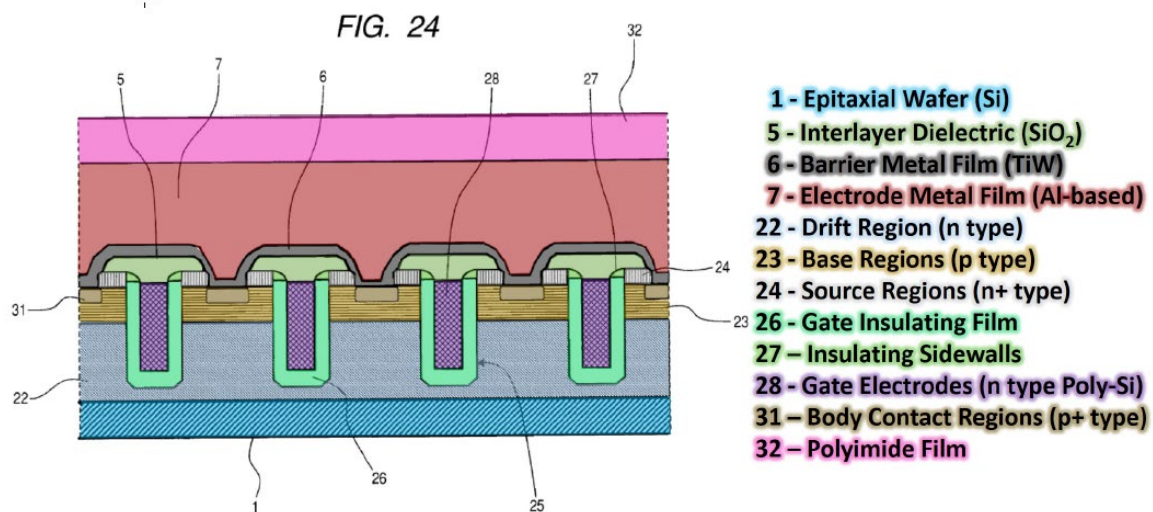
EX1034, Fig. 5 (annotated)

Pet. 44. Figure 5 is a trench DMOSFET device. Ex. 1034, 6. It includes (1) n⁺-type source regions; (2) p-type body regions with (3) a p⁺-type contact landing; (4) a trenched gate; (5) interlayer insulator; and (6) source/body metallization with (7) a barrier metal and (8) at least one additional metal layer. Ex. 1002 ¶¶ 111–125, 186.

6. *Sekiguchi (Ex. 1044)*

Sekiguchi teaches a semiconductor device. Ex. 1044, code (54).

Sekiguchi's Figure 24, with Petitioner's annotations, is reproduced below.



EX1044, Fig. 24 (annotated)

Pet. 48. Figure 24 is a semiconductor with the elements noted above.

Ex. 1044 ¶ 41; *see* Ex. 1002 ¶ 195 (citing Ex. 1044, 98–105).

III. UNPATENTABILITY ANALYSIS

A. GROUNDS FOR WHICH PETITIONER HAS SHOWN UNPATENTABILITY

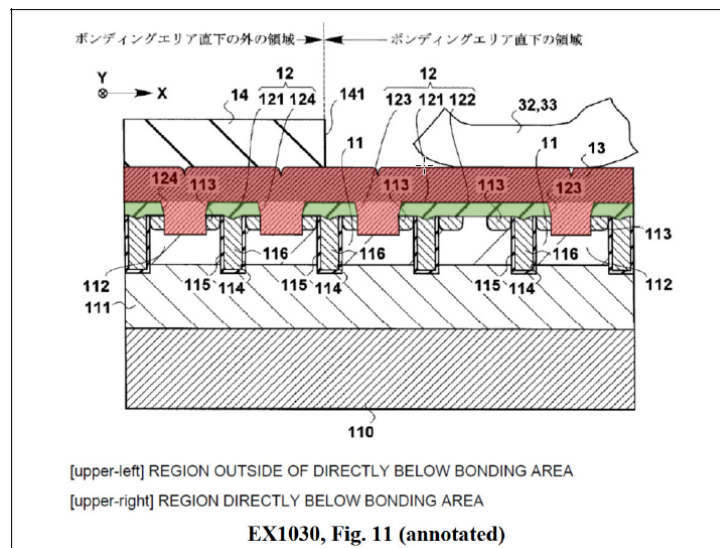
1. Anticipation of Claims 4 and 7 based on Torii (Ground 1a)

Petitioner contends Torii anticipates claims 4 and 7. Pet. 59–66.

Based on Petitioner’s analysis and for the reasons explained below, we find Petitioner has proven by a preponderance of the evidence that Torii anticipates claims 4 and 7.

a. Source Electrode and Conductive Portions in Torii

Claim 4 requires “a source electrode” and a “plurality of conductive portions.” Ex. 1001, 12:58–61. Claim 4 further requires that the source electrode and conductive portions are “electrically connected.” *Id.* at 12:61–62. Petitioner relies on the top portion of Torii’s electrode 13 (colored red by Petitioner) as the claimed source electrode, and the bottom portions (colored pink by Petitioner) as the claimed conductive portions. *See* Pet. 64–65 (annotating Torii’s Fig. 11) (reproduced below).



Further, Petitioner explains, “electrode 13 outside the trenches . . . contacts insulation film 12 . . . and electrically connects to portions of electrode 13 in the trenches.” *Id.* at 62–63.

Patent Owner argues that Petitioner’s challenge fails because “Petitioner relies on the same Torii element (electrode 13) as disclosing both the claimed source electrode and conductive portions,” whereas claim 4 requires two distinct elements. PO Resp. 64–69. Patent Owner asserts claim 4 requires two “distinct elements” because it lists the source electrode and conductive portions separately, and because it recites a relationship between the two elements—i.e. they must be electrically connected. *Id.* at 65–67. Patent Owner cites *Becton, Dickinson & Co. v. Tyco Healthcare Grp., LP*, 616 F.3d 1249 (Fed. Cir. 2010) as support for its separate-structures argument. PO Resp. 66. As Patent Owner notes, in *Becton*, the court held that “[w]here a claim lists elements separately, the clear implication of the claim language is that those elements are distinct component[s] of the patented invention.” *Id.* (quoting *Becton*, 616 F.3d at 1254 (internal quotation marks omitted)). Further, Patent Owner notes that the ’867 patent’s specification shows different hash lines for the two elements, whereas “Torii show[s] the same hash lines for what the Petition contends is the source electrode and conductive portions.” *Id.* at 67 (citing Ex. 1001, Fig. 1). Patent Owner additionally argues that, “Petitioner’s theory would nonsensically require a single element in Torii (electrode 13) to be electrically connected to itself.” *Id.*

We disagree with Patent Owner’s argument because it mischaracterizes Petitioner’s reliance on Torii. Petitioner does not rely on a single structure as disclosing both the claimed source electrode and conductive portions.

Rather, as explained above, Petitioner relies on the top portion of Torii's electrode 13 as the claimed source electrode, and the bottom portions as the claimed conductive portions. That is, even if Patent Owner is correct that the claimed source electrode and conductive portions must be distinct structures, that does not undermine Torii's disclosure because Petitioner relies on distinct portions of Torii's larger, single-hashed element labeled electrode 13.

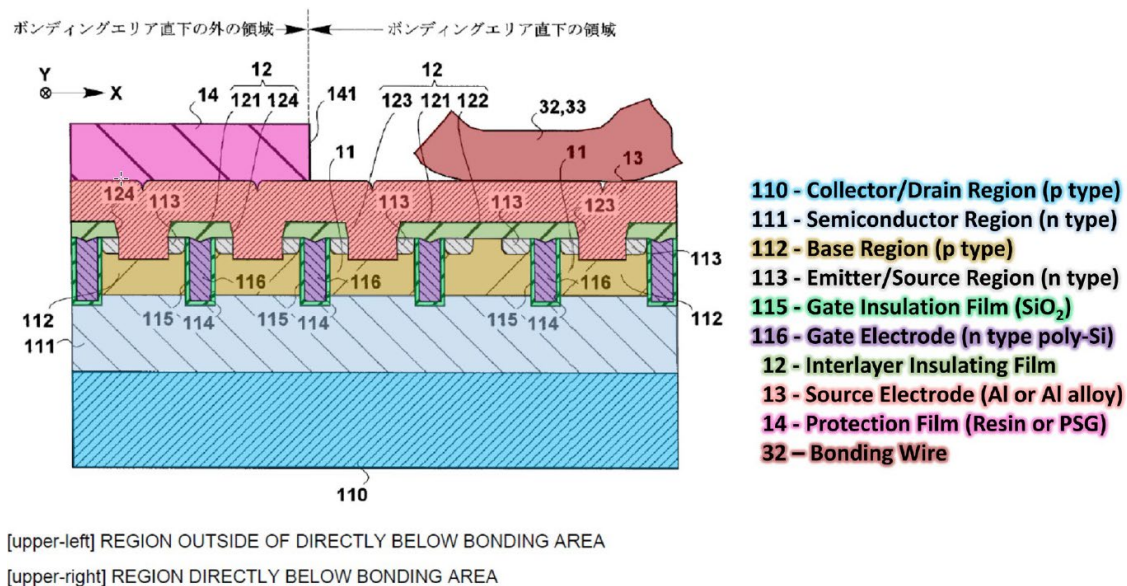
Because Petitioner does not rely on the same structure, i.e., the entire electrode 13 of Torii, for each of two distinct claim elements, our conclusion does not conflict with the Federal Circuit's holding in *Becton*. See *Becton*, 616 F.3d at 1254 (holding that a single hinge structure could not be both the claimed spring means and the claimed separate hinged arm); *id.* at 1255 (noting that “[i]f the hinged arm and the spring means are *one and the same*, then the hinged arm must be ‘connected to’ itself,” which is “a physical impossibility”) (emphasis added). Instead, we agree with Petitioner that this case is more analogous to *Powell v. Home Depot U.S.A., Inc.*, 663 F.3d 1221, 1231–32 (Fed. Cir. 2011), where the court held the front half of a cutting box satisfied a “cutting box” limitation, and its rear half satisfied a separate “dust collection structure” limitation. See *id.*; Pet. Reply 3. Like *Powell*, which “divided the cutting box” into two portions that each met a single claim limitation, Petitioner argues that one portion of Torii's electrode 13 (the top portion, colored red by Petitioner) discloses the source electrode, and the remaining portions of Torii's electrode 13 (the bottom portions, colored pink by Petitioner) discloses the conductive portions. See *Powell*, 663 F.3d at 1231. In *Powell*, the claim required “[the] cutting box interior [to be] in fluid communication with [the] dust collection structure,” and the court found that this requirement did not require that the two elements “be wholly separate

structures.” *Id.* at 1229, 1231–32. Similarly, we determine that the requirement that the source electrode and conductive portions are electrically connected does not require that these be wholly separate structures.

For these reasons, we agree with Petitioner that together, the top portion of Torii’s electrode 13 discloses the source electrode and the bottom portions of Torii’s electrode 13 disclose the conductive portions recited in claim 4.

b. Additional Undisputed Elements in Claim 4

According to Petitioner, Torii’s Figure 11 discloses claim 4’s base layer (112, yellow), source layer (113, white), insulating film (12, green), and gate structures (115, green and 116, purple), as shown in the figure below. Pet. 59–63; *see id.* at 41.



EX1030, Fig. 11 (annotated)

Petitioner further explains that Torri’s gate structures (i.e., gate insulation film 115 and gate electrode 116) are “formed in a stripe shape in plan view,” as claim 4 requires. *Id.* at 63 (citing Ex. 1030 ¶¶ 40–42, Figs. 9–11). In addition, Torri’s Figures 3 and 5 show “parts in which said conductive

portions are connected to said base layer are formed, in plan view, side by side in an island shape in a direction of said stripe shape of said gate structures with a distance from said gate structures between said gate structures,” as claim 4 requires. *Id.* at 64–65. That is so, as Petitioner notes, because in Torii, “[a]perture parts 123 correspond to the contact trench” and “repeat along the direction of the striped gates.” *Id.* at 64 (citing Ex. 1030 ¶¶ 46, 89, 116, Figs. 3, 5, 9–11).

Claim 4 additionally requires “a dimension of a part in which said source layer and said base layer are in contact with each other between said gate structures in a region in which said conductive portions are not connected to said base layer is 0.36 μm or more.” As Petitioner notes, Torii teaches this feature because it discloses the claimed dimension “can be 1.5 μm .” *Id.* at 65 (citing Ex. 1030 ¶¶ 46, 89, Figs. 9, 10).

c. Claim 7

Claim 7 depends from claim 4 and further requires “said source layer and said base layer include silicon or silicon carbide.” Petitioner explains that Torii discloses this because Torii uses a silicon substrate. *Id.* at 66 (citing Ex. 1030 ¶¶ 38, 81).

d. Summary

Other than the distinct-structures argument explained above, Patent Owner does not additionally challenge that Torii anticipates claims 4 and 7. We have reviewed Petitioner’s arguments and evidence and, based on Petitioner’s analysis as outlined above, we find that Petitioner has shown by a preponderance of the evidence that Torii anticipates claims 4 and 7.

2. Obviousness of Claim 6 based on Torii and Hebinuma (Ground 1c)

Petitioner contends claim 6 would have been obvious over Torii and Hebinuma. Pet. 71–74. Based on Petitioner’s analysis and for the reasons

explained below, we find Petitioner has proven by a preponderance of the evidence that claim 6 would have been obvious over Torii and Hebinuma.

Claim 6 depends from claim 4 and further requires “the part in which said conductive portion is connected to said base layer has a circular shape or an oval shape in plan view.” Petitioner relies on Hebinuma for teaching this feature. Pet. 71 (citing Ex. 1027 ¶¶ 47–49, Figs. 6, 9, 11). According to Petitioner, Hebinuma teaches oval-shaped contact trenches and one skilled in the art would have been motivated to substitute these oval trenches for Torii’s rectangular ones “because a rounded shape, such as an ellipse, eliminates sharp corners where electric fields can concentrate and cause problems.” *Id.* at 72 (citing Ex. 1002 ¶ 365; Ex. 1033, 3:30–38, 13:48–63; Ex. 1030 ¶ 116). In addition, Petitioner explains, its proposed Torii-Hebinuma combination is “an example of (1) substituting one known element (Hebinuma’s elliptical trenches) for another (Torii’s trenches) to obtain predictable results.” *Id.* at 72–73.

We agree with Petitioner that Hebinuma teaches the oval trenches recited in claim 6. *See* Ex. 1027, Fig. 9. In addition, we agree that Petitioner’s proposed combination would have been obvious because it amounts to no more than a simple substitution of one known element for another, i.e., Hebinuma’s elliptical trenches for Torii’s rectangular ones. *See KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007). Thus, with the analysis outlined above, Petitioner has articulated sufficient reasoning with rational underpinning to support the legal conclusion that its proffered combination would have been obvious to one skilled in the art. *See id.* at 418.

Patent Owner raises several arguments in contesting Petitioner's obviousness challenge, none of which we find persuasive. For example, we disagree with Patent Owner that Torii and Hebinuma are not analogous art because a skilled artisan "would not have looked to Hebinuma to improve on Torii." PO Resp. 72–76. The '867 patent, Torii, and Hebinuma are all in the same field of "power semiconductor device[s] having a trench gate structure." Ex. 1001, 1:5–8; Ex. 1027 ¶¶ 1–3; Ex. 1030 ¶¶ 1–4. Thus, Torii and Hebinuma are analogous to the '867 patent. *See In re Bigio*, 381 F.3d 1320, 1325 (Fed. Cir. 2004). We also disagree with Patent Owner's argument that one skilled in the art would not have had a reasonable expectation of success because Hebinuma's oval-shaped trenches were "substantially *more* challenging" than Torii's "well-known and well-studied" rectangular-trench solution. PO Resp. 77 (citing Ex. 2013 ¶¶ 128–130). Instead, we agree with Petitioner that one skilled in the art could reasonably expect success because the change "requires only minor changes to the photolithography mask" (Pet. 72; *see* Ex. 1002 ¶ 364), and because both Torii and Hebinuma expressly teach different trench shapes (*see* Ex. 1030 ¶ 116 (teaching that "the corner portion of the aperture . . . may be rounded"); Ex. 1027 ¶ 49 (teaching that "the contact trench Tc can be formed under similar conditions . . . with the exception of changing the patterning shape"))).

We also disagree with Patent Owner's argument that the proposed modification would not improve Torii's device because "existing patterning technology allows for elimination of sharp corners without requiring the use of a circular or oval shape." PO Resp. 78 (citing Ex. 2013 ¶ 133). Even if true, that argument does not undermine obviousness because Petitioner's proposed motivation need not be the only option for achieving a desired

result. Rather, it must only “be a suitable option from which the prior art did not teach away.” *Par Pharm., Inc. v. TWi Pharms., Inc.*, 773 F. 3d 1186, 1197–98 (Fed. Cir 2014). Last, we disagree with Patent Owner’s arguments challenging whether the proposed modification would increase the contact surface area, decrease ON resistance, and/or suppress increases in channel impurity concentration. *See* PO Resp. 77–78. Even if correct, Patent Owner’s arguments do not undermine that Petitioner’s proposed modification is no more than a simple substitution of one known element for another, yielding only predictable results, and therefore obvious.

Other than the arguments outlined above, Patent Owner does not additionally challenge Petitioner’s showing for this ground. We have reviewed Petitioner’s arguments and evidence and find that Petitioner has shown by a preponderance of the evidence that claim 6 would have been obvious over Torii and Hebinuma.

B. GROUNDS FOR WHICH PETITIONER HAS NOT SHOWN UNPATENTABILITY

1. Obviousness of Claim 5 based on Torii and Hebert (Ground 1b)

Petitioner contends claim 5 would have been obvious over Torii and Hebert. Pet. 66–70. Based on Petitioner’s analysis and for the reasons explained below, we find Petitioner has not proven by a preponderance of the evidence that claim 5 would have been obvious over Torii and Hebert.

a. 10–40 nm Stair-Step in Hebert

Claim 5 requires “a dimension of a part in which the upper surface of said source layer and said conductive portions are in contact with each other is 10 nm or more and 40 nm or less.” Ex. 1001, 13:13–15. Petitioner asserts this limitation would have been obvious because Hebert teaches stair-step dimensions between 20 and 200 nm, which overlaps the claimed range. *See* Pet. 70; Pet. Reply 21. Petitioner does not dispute that Hebert teaches only a

20–200 nm range of stair-steps, rather than discrete values within the claimed 10–40 nm range. *See* Pet. Reply 21–22. However, according to Petitioner, Hebert’s 20–200 nm range overlaps the claimed range, and thus creates a presumption of obviousness. *Id.* (citing *Genentech, Inc. v. Hospira, Inc.*, 946 F.3d 1333, 1341 (Fed. Cir. 2020)).

As the court in *E.I. DuPont* recognized, an overlapping range in the prior art is sufficient for obviousness “in the absence of evidence indicating that there is something special or critical about the claimed range.” *E.I. DuPont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1008 (Fed. Cir. 2018). Petitioner asserts “[t]he claimed range lacks ‘criticality.’” Pet. Reply 22. We disagree. Instead, we agree with Patent Owner that the claimed 10–40 nm range is critical (and thus not obvious) because it “allows for small cell size while still maintaining the desired low short circuit defect rate.” PO. Resp. 41. This criticality is reflected in the ’867 patent’s Figure 8, which shows that dimensions below 10 nm result in significant increases in short-circuit defect rate, while dimensions above 40 nm undesirably increase size without further reducing short-circuit defect rate. Ex. 1001, 11:20–32, Fig. 8.

Petitioner raises several arguments in contesting that the claimed range is critical, none of which we find persuasive. *See* Pet. Reply 22–25. For example, Petitioner argues the claimed range lacks criticality because other features beyond the claimed range may also affect defect rate. *Id.* at 23. As evidence, Petitioner notes “*Torii*’s Working Example 4 lacks a staircase ($d_1=0$), yet it has **zero** wire-bonding defects.” *Id.* In addition, Petitioner asserts the 40 nm maximum stair-step would not affect miniaturization in devices that have to accommodate larger source regions, regardless of

stair-step width. *Id.* at 23–24 (explaining that “[t]he staircase dimension only matters if the staircase approaches the width of the source region—a much larger dimension”). We disagree with Petitioner’s arguments because they incorrectly assume that to be critical, the claimed range must be both necessary and sufficient for achieving the desired outcome of allowing for small cell size while still maintaining a low short circuit defect rate. That is, as Patent Owner explains, even if some devices may through other means achieve low defect rates without a 10 nm stair-step minimum, and even if a 40 nm stair-step maximum would not facilitate miniaturization in devices with relatively larger source widths, that does not undermine that as a whole, the claimed range facilitates those beneficial characteristics in some devices. *See* PO Sur-reply 21–23.

For these reasons, we agree with Patent Owner that the claimed 10–40 nm stair-step would not have been obvious in light of Hebert. Thus, we find Petitioner has not proven by a preponderance of the evidence that claim 5 would have been obvious over Torii and Hebert.

2. *Anticipation of Claims 8 and 9 over Kim 03 (Ground 2a)*

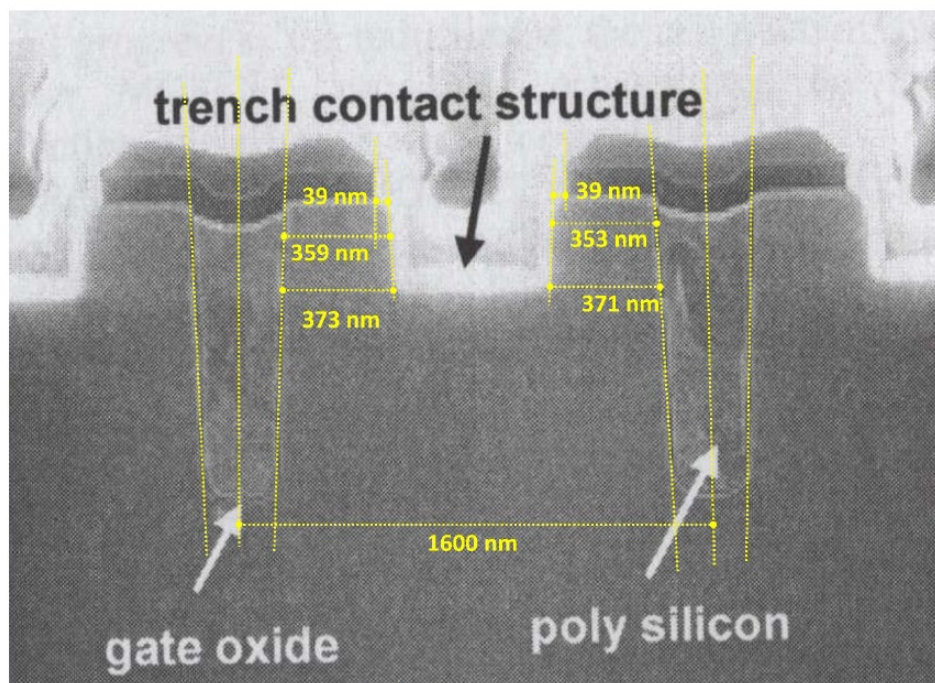
Petitioner contends Kim03 anticipates claims 8 and 9. Pet. 74–81. Based on Petitioner’s analysis and for the reasons explained below, we find Petitioner has not proven by a preponderance of the evidence that Kim03 anticipates claims 8 and 9.

a. *10–40 nm Stair-Step in Kim03*

Claim 8 (and, by dependence, claim 9) requires “a dimension of a part in which the upper surface of said source layer and said conductive portion are in contact with each other is 10 nm or more and 40 nm or less.”

Ex. 1001, 14:12–15. Petitioner asserts Kim03’s Figure 5 depicts this claimed dimension because Kim03 teaches Figure 5 has “unit cells with a cell pitch of

1.6 μm ,” which “provides scale for Figure 5.” Pet. 80. Using that scale, Petitioner’s expert, Dr. Banerjee, asserts that Figure 5 (reproduced below, Petitioner’s annotations)) depicts a 39 nm stairstep, which is within the claimed range. *Id.* (citing Ex. 1002 ¶¶146–148, 186–187); *see id.* at 81.



EX1034, Fig. 5 (annotated)

Patent Owner contests Dr. Banerjee’s Figure 5 stair-step calculation. *See* PO Resp. 23–25. We agree with Patent Owner that Dr. Banerjee’s 39 nm calculation, which is just narrowly inside the claimed 10–40 nm range, is too unreliable to support Petitioner’s burden. At his deposition, Dr. Banerjee admitted that he “did the measurements multiple times” and got measurements that ranged from 35 nm to 50 nm. Ex. 2018, 112:19–21. Dr. Banerjee’s measurements yield a midpoint of 42.5 nm, which is outside of the claimed range. *See id.* at 115:10–25. Given the uncertainty in his measurement process, Dr. Banerjee admitted that he could not “say conclusively” that Kim 03’s stair step is below 40 nm. *Id.* at 116:19–20. Moreover, as Patent Owner notes, when the measurement process was

repeated, both at Dr. Banerjee's deposition and later by Patent Owner's expert, the results were significantly larger than the claimed 40 nm cutoff. *See id.* at 95:14–96:16 (measuring 49 nm stair step), Ex. 2034 ¶ 70 (measuring 50 nm stair step).

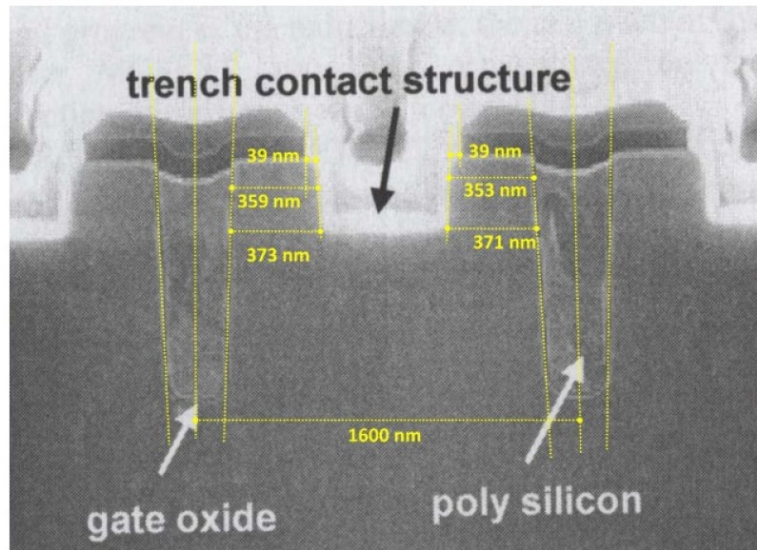
Given the uncertainty in Dr. Banerjee's 39 nm calculation, we agree with Patent Owner that Petitioner has not sufficiently established that Kim03 teaches the 10–40 nm stair step required in claims 8 and 9. Thus, we find Petitioner has not proven by a preponderance of the evidence that Kim03 anticipates claims 8 and 9.

3. Obviousness of Claims 1–3 based on Kim03 and Sekiguchi (Ground 2b)

Petitioner contends claims 1–3 would have been obvious over Kim03 and Sekiguchi. Pet. 81–91. Based on Petitioner's analysis and for the reasons explained below, we find Petitioner has not proven by a preponderance of the evidence that claims 1–3 would have been obvious over Kim03 and Sekiguchi.

a. .36–.43 μ m Source Width in Kim03

Claim 1 (and, by dependence, claims 2 and 3) requires “a dimension of a part in which said source layer and said base layer are in contact with each other between said gate structures and said conductive portions are 0.36 μ m or more and 0.43 μ m or less.” Ex. 1001, 12:37–40. Petitioner asserts Kim03's Figure 5 depicts this claimed dimension because it teaches that Figure 5 has “unit cells with a cell pitch of 1.6 μ m,” which provides a scale for Figure 5. *See* Pet. 80. Using that scale, Petitioner asserts Figure 5 (reproduced below, Petitioner's annotations) depicts the relevant surface as in a region that is between 35.9–37.3 μ m, which largely overlaps the claimed region. *Id.* at 87–88.



Kim 2003 at Fig. 5 (annotated)

Petitioner's source-width analysis depends critically on the assumption that the cell pitch in Figure 5 is 1.6 μm . Ex. 2018, 80:10–81:16. Patent Owner argues that assumption is unreliable. PO Resp. 26–30. For the reasons that follow, we agree.

Although Kim03 states “[w]e observed unit cells with a cell pitch of 1.6 μm ,” Ex. 1034, 6, nothing in Kim03 necessarily ties the 1.6 μm measurement to the space shown in Figure 5. Instead, as Patent Owner explains, Kim's cells are rectangular and thus have two different pitches, only one of which is shown in Figure 5. See PO Resp. 28; see also Pet. Reply 16 (agreeing that Kim05 discloses rectangular cells). As Patent Owner notes, it is unlikely that Figure 5 has a 1.6 μm cell pitch because it is plainly inconsistent with other known features also depicted in Figure 5, including the gate trench's depth and the gate oxide's thickness. See *id.* at 27–29. As Patent Owner notes, those known yard sticks suggest a cell pitch of about 3 μm . See PO Resp. 29–30 (citing Ex. 2013 ¶¶ 177–182).

Given these issues, we agree with Patent Owner that Petitioner has not sufficiently established that Figure 5's cell pitch is 1.6 μm . This critically undermines Petitioner's contention that Kim03 teaches a .36–.43 μm source width. Thus, we find Petitioner has not proven by a preponderance of the evidence that claims 1–3 would have been obvious over Kim03 and Sekiguchi.¹⁰

4. Obviousness of Claims 8 and 9 based on Sekiguchi and Hebert (Ground 3a)

Petitioner contends that claims 8 and 9 would have been obvious over Sekiguchi and Hebert. Pet. 91–100. For this ground, Petitioner again relies on Hebert for teaching the 10–40 nm stairstep required in claims 8 and 9. See Pet. 92. As explained above in section III.B.1.a (p. 19) we find the claimed 10–40 nm stair step would not have been obvious in light of Hebert. Thus, we find Petitioner has not proven by a preponderance of the evidence that claims 8 and 9 would have been obvious over Sekiguchi and Hebert.

5. Obviousness of Claims 1 and 3 based on Sekiguchi and Williams99 (Ground 3b), and of Claim 2 based on Sekiguchi, Williams99, and Hebert (Ground 3c)

Petitioner contends claims 1 and 3 would have been obvious over Sekiguchi and Williams99. Pet. 100–07. Petitioner further contends claim 2 would have been obvious over Sekiguchi, Williams99, and Hebert. *Id.* at 108–09. Based on Petitioner's analysis and for the reasons explained below, we find Petitioner has not proven by a preponderance of the evidence

¹⁰ For claim 2, petitioner's Ground 2b fails for an additional reason. Claim 2 recites the same 10–40 nm stair-step limitation as claim 8. For this ground, Petitioner relies on Kim03 for teaching the 10–40 nm stair-step feature. See Pet. 90. But Kim03 fails to teach a 10–40 nm stair step for the reasons stated in section III.B.2.a (p.19) above.

that claims 1 and 3 would have been obvious over Sekiguchi and Williams99, or that claim 2 would have been obvious over Sekiguchi, Williams99, and Hebert.

a. .36–.43 μm Source Width in Williams99

Claim 1 (and, by dependence, claims 2 and 3) requires “a dimension of a part in which said source layer and said base layer are in contact with each other between said gate structures and said conductive portions are 0.36 μm or more and 0.43 μm or less.” Ex. 1001, 12:37–40. Petitioner asserts that the claimed source width range would have been obvious in view of Williams99. Pet. 106–07. Specifically, Petitioner asserts, Williams99 teaches “mesa[s] about 1.0μm to 1.9μm wide” and assumes “a reasonable mesa trench width to be about 0.3μm to 1.0μm given the available technology.” *Id.* With that assumption, and using a subset of Williams99’s disclosed mesa widths, Petitioner argues that Williams99 suggests a range of source widths within the claimed 0.36–0.43 μm range. *Id.*

As noted above, an overlapping range in the prior art is sufficient for obviousness only “in the absence of evidence indicating that there is something special or critical about the claimed range.” *DuPont*, 904 F.3d at 1008. Petitioner asserts “[t]he claimed range lacks ‘criticality.’” Pet. Reply 31. We disagree. Instead, we agree with Patent Owner that the claimed 0.36–0.43 μm source-width range is critical (and thus not obvious) because it optimizes on-resistance considerations, while still allowing for small cell size. *See* PO Resp. 61–62; PO Sur-reply 28; Ex. 1001, 6:3–12. This criticality is reflected in the ’867 patent’s Figure 3, which shows that dimensions above 0.36 μm result in significant increases in on resistance,

while dimensions above 0.43 μm undesirably increase size without further reducing on resistance. Ex. 1001, 6:3–12, Fig. 3.

Petitioner raises several arguments in contesting that the claimed range is critical, none of which we find persuasive. *See* Pet. Reply 31–32. For example, Petitioner argues other features beyond the claimed range may also impact on resistance, and that the alleged on-resistance benefit would not have been universal for all devices. *Id.* at 31–32. We disagree with Petitioner’s arguments because they again incorrectly assume that to be critical, the claimed range must be both necessary for, and sufficient to, achieve the desired outcome of optimizing on resistance while allowing for small cell size.

For these reasons, we agree with Patent Owner that the claimed 0.36–0.43 μm source-width range would not have been obvious in light of Williams99. Thus, we find Petitioner has not proven by a preponderance of the evidence that claims 1 and 3 would have been obvious over Sekiguchi and Williams99, or that claim 2 would have been obvious over Sekiguchi, Williams99, and Hebert.¹¹

IV. PATENT OWNER’S MOTION TO EXCLUDE EVIDENCE

Patent Owner filed a Motion (Paper 35) seeking to exclude Dr. Banerjee’s rebuttal declaration (Ex. 1072). Because this decision does

¹¹ Petitioner’s ground 3c fails for an additional reason. Claim 2 recites the same 10–40 nm stair-step limitation as claim 8. For this ground, Petitioner relies on Hebert for teaching the 10–40 nm stair-step range. *See* Pet. 109. Hebert fails to teach a 10–40 nm stair step for the reasons explained in section III.B.1.a (p. 18) above.

not rely on the rebuttal declaration in question, we deny Patent Owner's motion as moot.

V. CONCLUSION¹²

For the foregoing reasons, we determine Petitioner has demonstrated by a preponderance of the evidence that claims 4, 6, and 7 of the '867 patent are unpatentable. Petitioner has not, however, demonstrated by a preponderance of the evidence that claims 1, 2, 3, 5, 8 and 9 of the '867 patent are unpatentable. Our conclusions are summarized in the table below.

Claim(s)	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not shown Unpatentable
4, 7	102	Torii	4, 7	
5	103	Torii, Hebert		5
6	103	Torii, Hebinuma	6	
8, 9	102	Kim03		8, 9
1–3	103	Kim03, Sekiguchi		1–3
8, 9	103	Sekiguchi, Hebert		8, 9
1, 3	103	Sekiguchi, Williams99		1, 3
2	103	Sekiguchi, Williams99, Hebert		2
Overall Outcome			4, 6, 7	1–3, 5, 8, 9

¹² Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

VI. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 4, 6, and 7 of the '867 patent are unpatentable;
and

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

FURTHER ORDERED that Patent Owner's Motion to Exclude
Evidence (Paper 35) is DENIED as moot.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BMW OF NORTH AMERICA, LLC, and GENERAL MOTORS, LLC,
Petitioner,

v.

ARIGNA TECHNOLOGY LTD.,
Patent Owner.

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AHMED, *Administrative Patent Judge*, dissenting-in-part.

I join the opinion's well-reasoned determinations that Petitioner has failed to show by a preponderance of the evidence that claims 1, 2, 3, 5, 8 and 9 of the '867 patent are unpatentable on Grounds 1b, 2a, 2b, 3a, 3b, and 3c. I disagree, however, with the majority's determination that Petitioner has shown by a preponderance of the evidence that Torii anticipates independent claim 4, and consequently, with the majority's determinations as to dependent claims 6 and 7, on Grounds 1a and 1c. Because I believe that under a proper claim construction, Torii simply does not disclose the claimed source electrode and conductive portions recited in claim 4, I respectfully dissent.

I agree with Patent Owner that the claimed source electrode and conductive portions must be distinct structures. PO Resp. 66–68; PO Sur-reply 1–3. The claim language requires that those be separate structures and the specification supports such a requirement. Claim 4 first recites “a plurality of conductive portions penetrating said insulating film and said source layer and electrically connected to said source layer and said base layer.” Ex. 1001, 12:58–60. The claim then separately recites “a source electrode formed on said insulating film and electrically connected to said conductive portions.” *Id.* at 12:61–62. As a matter of claim construction, when a claim separately lists two components, we begin with “a presumption that those components are distinct.” *Kyocera Senco Indus. Tools Inc. v. Intl. Trade Commn.*, 22 F.4th 1369, 1382 (Fed. Cir. 2022) (citing *Becton, Dickinson & Co. v. Tyco Healthcare Grp., LP*, 616 F.3d 1249, 1254 (Fed. Cir. 2010)). We then look to see if there is “any language in the [claim or the] written description that overcomes that presumption.” *Id.* I see nothing in the claim language to suggest that the source electrode and the conductive portions can be the same structure. The conductive portions *penetrate* the insulating film to connect to the source and base layers whereas the source electrode is formed *on* the insulating film. Ex. 1001, 12:58–62. If anything, the fact the claim recites the source electrode being “electrically connected” to the conductive portions underscores that these are separate components.¹ *See Becton*, 616 F.3d at 1255 (explaining that a claim construction requiring a component to connect to itself cannot be correct); *see also Comcast Cable*

¹ Notably, the claim also recites the conductive portions being “electrically connected” to the source layer as well as the base layer, which are also distinct structures, claimed separately from the conductive portion.

Commc 'ns, LLC v. Promptu Sys. Corp., 838 F. App'x 551, 553 (Fed. Cir. 2021) (“By listing the elements separately and by using the word ‘coupled,’ claim 14 strongly indicates the ‘speech recognition system’ is distinct from the ‘wireline node.’”); *cf. Engel Indus., Inc. v. Lockformer Co.*, 96 F.3d 1398, 1405 (Fed. Cir. 1996) (“Since a return portion is ‘also provided,’ they logically cannot be one and the same.”).

Turning to the specification, the figures and written description support the presumption that the source electrode and the conductive portions must be distinct components. Figure 1 numbers these two components separately and uses different hash lines to identify each of them separately. *See* Ex. 1001, Fig. 1, 3:65–4:3. That in itself should be sufficient to suggest that the source electrode and the conductive portions are distinct structures. But here, there is also plenty of expert testimony to support that an ordinarily skilled artisan would have understood them as such. For example, Petitioner’s own expert, Dr. Sanjay Banerjee, testifies that with regard to figures depicting a semiconductor device, different hash marks connote different structures, e.g., different layers, regions, etc. *See* Ex. 2018, 69:23–71:5. Agreeing with Dr. Banerjee, Patent Owner’s expert, Dr. Keln Kuhn, testifies that such use of different hash marks suggests that the conductive portion and source electrode are different materials, created by different fabrication processes, or both.² *See* Ex. 2013 ¶ 77.

² Dr. Kuhn further notes that Dr. Jack Lee, a different petitioner’s expert, testified in the parallel *inter partes* review proceeding challenging the ’867 patent that different hash marks indicate that the two elements are made of different materials or were deposited at different times. *See* Ex. 2013 ¶ 77 (citing Ex. 2029 ¶ 164).

The written description further supports the distinction between the source electrode and the conductive portions. The specification goes into some detail in laying out how the conductive portion is formed:

The conductive portion 8 (trench contact structure) is 50 formed by the following steps. First, a plurality of trenches that penetrate the insulating film 5 and the source layer 4 are formed by photolithography and etching. Then, a laminate structure of conductors is filled into the trench. As a result, as shown in FIG. 1, the conductive part 8 is formed so as to fill 55 the trench (that is, trench contact structure is formed).

Ex. 1001, 4:49–55; *see also id.* at 4:55–58 (listing examples of the conductors constituting the laminate structure). Dr. Banerjee testifies that “a laminate structure indicates that the structure is composed of multiple layers of either different materials or the same material deposited in successive deposition steps under different conditions.” Ex. 2036, 102:11–18. On the other hand, the source electrode is not disclosed as being formed in the same way or as being a laminate structure. *See* Ex. 1001, 4:59–67. The specification therefore supports the presumption that these claimed elements need to be distinct structures.

Petitioner relies primarily on the Federal Circuit’s decision in *Powell v. Home Depot U.S.A., Inc.*, 663 F.3d 1221, 1231–32 (Fed. Cir. 2011), as permitting a construction that allows a single structure to satisfy both the claim limitations here. Pet. Reply 3–4. In *Powell*, the court construed claims related to a radial arm saw assembly with a cutting box enclosure for containing and collecting the sawdust generated when the saw was in use. The court rejected Home Depot’s argument that the claimed “cutting box” and “dust collection structure” must be separate components because it found the disclosure in specification overcame the presumption that the claim terms

require separate structures. *Powell*, 663 F.3d at 1231–32. The court explained:

The specification discloses that the “[c]utting box . . . *defines* an internal chamber wherein the rotating saw blade meets the work piece during the cutting process and *functions* to contain the sawdust and wood chips generated as the blade cuts through the wood.” Thus, the specification teaches that the cutting box *may also function* as a “dust collection structure” to collect sawdust and wood chips generated during the wood cutting process. It does not suggest that the claim terms require separate structures.

Id. (citations omitted, emphasis added). Thus, although the claims there separately recited a “dust collection structure,” the specification made clear that the cutting box *itself* was the dust collection structure. Petitioner’s argument that the source electrode and conductive portions here are analogous to the cutting box in *Powell* is misplaced. The claim language and the specification here make it sufficiently clear that the source electrode and the conductive portions are different structures possibly formed in different ways and with different functions. *See* Tr. 26:7–8 (arguing that these structures are serving different functions). Neither of those are analogous to a cutting box that *also* collects dust and wood chips. Claim 4 is thus properly construed as requiring two separate structures for the claimed source electrode and the conductive portions. *See Becton*, 616 F.3d at 1255; *see also Powell*, 663 F.3d at 1231 (explaining that, in *Becton*, the claim language required and the specification confirmed the separate structure requirement).

As in *Becton*, a claim construction requiring distinct structures ends the inquiry here. *See Becton*, 616 F.3d at 1255 (“There can be no literal infringement where a claim requires two separate structures and one such structure is missing from an accused device.”). It is undisputed that Torii does not disclose separate structures for the claimed conductive portions and

source electrode—Petitioner does not argue otherwise. *See* Pet. 61–63; Pet. Reply 3–4 (“One structure can satisfy both limitations.”); Tr. 22:18–23:2 (explaining that Petitioner has mapped a single structure to both limitations). And Petitioner’s annotations of Torii’s figures, done for the purposes of litigation, cannot alter Torii’s disclosure of a single structure or change the fact that a person of ordinary skill in the art at the time of the invention would have clearly understood Torii’s *single-hashed* electrode 13 as one single structure or element. If Petitioner’s view were correct, with sufficient creativity, a prior art reference could be annotated to disclose any missing limitation. Instead, anticipation requires “that the reference describe not only the elements of the claimed invention, but also that it describe those elements arranged as in the claim.” *Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1371 (Fed. Cir. 2008) (internal quotations omitted); *see also TF3 Ltd. v. Tre Milano, LLC*, 894 F.3d 1366, 1374 (Fed. Cir. 2018) (“Claims cannot be anticipated by devices that are not the same. Invalidity for anticipation requires that the identical invention must be shown in as complete detail as contained in the patent claim.” (internal quotations omitted)); *Enfish, LLC v. Microsoft Corp.*, 822 F.3d 1327, 1343 (Fed. Cir. 2016). I therefore cannot agree with the majority’s conclusion that Petitioner has proven by a preponderance of the evidence that Torii anticipates claims 4 and 7, and that claim 6 would have been obvious over Torii and Hebinuma.

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