

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INERGY TECHNOLOGY, INC.,
Petitioner

v.

FORCE MOS TECHNOLOGY CO. LTD.,
Patent Owner

Inter Partes Review No. IPR2024-00094
U.S. Patent No. 7,812,409

PATENT OWNER’S SURREPLY TO PETITIONER’S REPLY

Table of Contents

Table of Authorities.....	iv
Patent Owner’s Exhibit List.....	v
I. INTRODUCTION	1
II. ARGUMENT.....	4
A. Grounds 1-3: Kobayashi Fails to Disclose “said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with rounded corners” (claim 1).....	4
1. Petitioner Has Abandoned Its Theory Regarding Kobayashi’s Hexagons Being Square-Shaped Cells with Rounded Corners.....	5
2. Petitioner’s Theory That Kobayashi’s Square Shaped Cells Satisfy Limitation 1(a) Based on Rounded Trench Openings and Bottoms Only Visible in the Side View Disregards the Clear Meaning of Limitation 1(a).....	5
3. The Petition Sets Forth No Theory Based on Fig. 3A of Kobayashi Independent of Side View-Visible Rounding of Trench Opening and Bottom Corners	9
4. Truncated Corners are Irrelevant for Claim 1	12
B. Ground 2: Kobayashi Fails to Disclose “said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with truncated corners” (claim 6) ..	12
C. Grounds 1, 3, 4, 6: Kobayashi Fails to Disclose: “a diameter of a top surface of said circular trench contact is smaller than 1.0 micrometer” (claim 5)	13
D. Grounds 2, 5: Kikkawa, in Combination with Kobayashi or Kobayashi-Hshieh, Fails to Render Obvious the Titanium Structures of Claims 2 and 6	16
1. Kikkawa is Not Analogous Art.....	16

2. A POSITA Would Not Be Motivated to Combine Kikkawa With Kobayashi (or Kobayashi-Hshieh) in the Manner Claimed 18

E. Grounds 4-6: The Combination of Kobayashi and Hshieh Fails to Render Obvious “said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with rounded corners” (claim 1)” 20

1. Petitioner’s vague, generalized argument that it was “known” to be advantageous to “round” square corners is without merit 20

2. Petitioner’s motivation to combine argument based on alleged express teachings in Hshieh is without merit 22

3. Petitioner Fails to Dispute that the Proposed Combination Cherry-Picks and Contradicts Hshieh’s Basic Objectives 24

F. Ground 5: The Combination of Kobayashi and Hshieh Fails to Render Obvious “said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with truncated corners” (claim 6)” 26

III. CONCLUSION.....26

Certificate of Service 37 C.F.R. § 42.6(e) 28

Certificate of Compliance Pursuant to 37 C.F.R. § 42.24 29

Table of Authorities

	Page(s)
Cases	
<i>Ex Parte Hsu et al.</i> , Appeal of Appl. No. 12/109,910 (P.T.A.B. Feb. 24, 2016)	14
<i>In re Wright</i> , 569 F.2d 1124 (C.C.P.A. 1977)	14
<i>Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.</i> , 821 F.3d 1359 (Fed. Cir. 2016)	11
<i>Nystrom v. TREX Co.</i> , 424 F.3d 1136 (Fed. Cir. 2005)	13, 14
<i>Wang Labs, Inc. v. Toshiba Corp.</i> , 993 F.2d 858 (Fed. Cir. 1993)	17
<i>WBIP, LLC v. Kohler Co.</i> , 829 F.3d 1317 (Fed. Cir. 2016)	25
<i>Zenith Electronics v. PDI Communication Systems</i> , 522 F. 3d 1348 (Fed. Cir. 2005)	10
Statutes	
35 U.S.C. § 312(a)(3)	16

Patent Owner's Exhibit List

Exhibit No.	Description
2001	Transcript of Feb. 13, 2024 Deposition of David Kuan-Yu Liu, PhD in <i>Force MOS Technology Co., Ltd. v. ASUSTeK Computer, Inc.</i> , Case No. 2:22-cv-00460-JRG (E.D. Tex.)
2002	Declaration of David Kuan-Yu Liu, Ph.D., served on Jan. 30, 2024 in <i>Force MOS Technology Co., Ltd. v. ASUSTeK Computer, Inc.</i> , Case No. 2:22-cv-00460-JRG (E.D. Tex.)
2003	Defendant ASUSTek Computer, Inc.'s Motion to Stay Pending Resolution of Inter Partes Reviews, filed on Nov. 30, 2023 as Dkt. No. 30 in <i>Force MOS Technology Co., Ltd. v. ASUSTeK Computer, Inc.</i> , Case No. 2:22-cv-00460-JRG (E.D. Tex.)
2004	Amended Docket Control Order, filed on Jan. 18, 2024 as Dkt. No. 35 in <i>Force MOS Technology Co., Ltd. v. ASUSTeK Computer, Inc.</i> , Case No. 2:22-cv-00460-JRG (E.D. Tex.)
2005	Cover pleading to Defendant ASUSTek Computer, Inc.'s Invalidity Contentions, served on Jul. 18, 2024 in <i>Force MOS Technology Co., Ltd. v. ASUSTeK Computer, Inc.</i> , Case No. 2:22-cv-00460-JRG (E.D. Tex.)
2006	U.S. Patent No. 6,700,158 to Cao et al. (issued Mar. 2, 2004)
2007	Excerpts from Webster's New World Dictionary, Third College Ed. (1991) for "square," "substantial," "round," "rounded," and "truncate"
2008	Memorandum Opinion and Order denying Defendant ASUSTek Computer, Inc.'s Motion to Stay Pending Resolution of Inter Partes Reviews, filed on April 11, 2024 as Dkt. No. 74 in <i>Force MOS Technology Co., Ltd. v. ASUSTeK Computer, Inc.</i> , Case No. 2:22-cv-00460-JRG (E.D. Tex.)
2009	--Intentionally Not Used--
2010	--Intentionally Not Used--

Exhibit No.	Description
2011	Claim Construction Order, Dkt. No. 132 from <i>Force MOS Technology Co., Ltd. v. ASUSTeK Computer, Inc.</i> , Case No. 2:22-cv-00460-JRG (E.D. Tex.)
2012	U.S. Patent No. 5,304,831 to Yilmaz et al., “Low on-resistance power MOS technology”
2013	U.S. Patent No. 6,867,083 to Imam et al., “Method of forming a body contact of a transistor and structure there”
2014	Excerpts of Lutz, Josef, et al. "Semiconductor power devices." 2018, ISBN 978-3-319-70917-8 (“Lutz”);
2015	Li, S., & Boyd, J. P. (2015). Approximation on non-tensor domains including squircles, Part III: Polynomial hyperinterpolation and radial basis function interpolation on Chebyshev-like grids and truncated uniform grids. <i>Journal of Computational Physics</i> , 281, 653–668. doi:10.1016/j.jcp.2014.10.035
2016	Maneuski, Dima, V. Gostilo, and A. Owens. "TCAD simulation studies of novel geometries for CZT ring-drift detectors." <i>Journal of Physics D: Applied Physics</i> 53.1 (2019): 015114
2017	Cohen, S. Simon. "Contact resistance and methods for its determination." <i>MRS Online Proceedings Library (OPL)</i> 18 (1982): 361.
2018	Excerpts from Semiconductor Glossary
2019	Ng, Hong Seng. "Review on Methods for Trench MOSFET Gate Oxide Reliability and Switching Speed Improvement." <i>ECS Transactions</i> 27.1 (2010): 21
2020	--Intentionally Not Used--
2021	Declaration of Dean Neikirk, Ph.D. in Support of Patent Owner’s Response
2022	Curriculum Vitae of Dean Neikirk, Ph.D.

Exhibit No.	Description
2023	Transcript of August 6, 2024 Deposition of Sylvia D. Hall-Ellis, Ph.D.
2024	Transcript of August 23, 2024 Deposition of Dr. David Kuan-Yu Liu

I. INTRODUCTION

In contrast to the conclusory expert analysis accompanying the Petition, the Patent Owner Response (Paper No. 24, hereinafter “POR”) was accompanied by a detailed, evidence-based expert analysis and explanation as to why each of Petitioner’s grounds failed. In its Reply (Paper No. 26), Petitioner offers no new expert testimony, and instead, relies on attorney argument alone to respond to the deficiencies identified by the POR. None of Petitioner’s arguments have merit.

As to Grounds 1-3 (where Kobayashi is the primary reference), the POR demonstrated that Kobayashi failed to disclose or suggest “trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with rounded corners” or “truncated corners” because: (1) truncated corners are different from rounded corners, and Kobayashi’s hexagons are not substantially square shaped; and (2) Kobayashi’s side-view rounding of trench corners and openings is not rounding of the corners of square shaped cells, as required by the claim. In its Reply, Petitioner now admits that “truncated corners” and “rounded corners” are different, and relies entirely on its argument about side-view trench opening and bottom rounding for the “rounded corners” limitation. In particular, based on mere attorney argument, Petitioner asserts that Kobayashi’s rounding of trench bottoms and openings satisfies the “rounded corner” limitation

because such rounding would purportedly be visible from above Kobayashi's conventional square cells.

But Petitioner still misses the point. Claim 1 does not recite “substantially square shaped cells” “*and rounded corners*”—it recites “substantially *square-shaped cells with rounded corners*,” i.e. essentially square shaped but replacing the square's normally right-angled corners with rounded corners. As Patent Owner showed, this is consistent with how cell shape is consistently described in the field—from the top view perspective. Moreover, any ambiguity about this term's meaning is clearly resolved by the specification of the '409 Patent—whose Fig. 3 depicts exactly what Patent Owner submits the claim requires. Petitioner's Reply wholly ignores Patent Owner's argument about the structure of this limitation and the disclosures of the '409 Patent's specification. Indeed, the Reply presents no substantive claim construction analysis whatsoever. Because Petitioner's arguments distort the text of the claim and contradict the specification's clear disclosures, they should be rejected.

As to Grounds 4-6 (where Kobayashi is combined with Hshieh), the POR dispelled any argument that there was a general motivation to “round” any and all gate corners. Indeed, the POR showed that Petitioner had conflated Hshieh's top view rounding of cell corners with the entirely unrelated side view rounding of trench bottoms and openings in Kobayashi. In response, Petitioner repeats the erroneous argument that Kobayashi's side-view rounding of corner openings and

bottoms is really the type of rounding claimed. Not only is that false (as discussed in connection with Grounds 1-3), but Petitioner cannot dispute that the rounding in Kobayashi is a materially different kind of rounding than that in Hshieh. Thus, there is no evidence of a motivation in the field to generally round all gate corners visible in all perspectives.

Furthermore, the POR also provided detailed, evidence-based expert analysis that the structure of Kobayashi would not benefit from Hshieh's only expressed motivation for rounding, i.e. that the three-dimensional diffusion phenomenon did not arise in Kobayashi's structure. Rather than providing responsive expert testimony, Petitioner relies on pure attorney argument to assert that Kobayashi and Hshieh both address "punch-through." But, that argument is without merit. As Patent Owner's expert has already explained, Kobayashi's side view rounding solution addresses gate leakage due to gate oxide thinning, whereas Hshieh's "punch-through" problem and top view rounding solution is related to the three-dimensional diffusion phenomenon. Moreover, Patent Owner's expert provided un rebutted testimony that Kobayashi's structure does not suffer from the punch-through problem identified in Hshieh (i.e. punch-through caused by the three-dimensional diffusion phenomenon). In short, Petitioner is improperly conflating two different solutions to two different problems. In any event, Kobayashi does not disclose or suggest top-view visible rounding of cell corners (e.g. the type shown in

Fig. 3 of the '409 Patent), and Petitioner has never submitted *any* evidence or argument that Kobayashi's design would benefit from Hshieh's top view rounding. Thus, Petitioner's obviousness theory lacks any factual basis for any motivation to combine Kobayashi and Hshieh to have "closed cells constituting substantially square-shaped cells with rounded corners."

For all of these reasons, the Board should hold that all challenged claims are patentable.

II. ARGUMENT

A. Grounds 1-3: Kobayashi Fails to Disclose "said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with rounded corners" (claim 1)

In the Petition's argument for limitation 1[a], Petitioner conclusorily stated that "Element 1[a] is disclosed by Kobayashi." Pet., 25. It then cited to three disclosures in Kobayashi: Fig. 3A of Kobayashi (which depicts conventional square cells with 90-degree corners), Fig. 4A of Kobayashi (which depicts cells in the shape of regular hexagons), and Kobayashi's disclosure of trench bottom corner and opening rounding (illustrated using an annotated version of Kobayashi's Fig. 6C). Pet., 27-29. The Petition itself contains almost no explanation for those theories, or how they interrelate, and Petitioner's expert was similarly brief and conclusory. *Id.*; Ex. 1003, ¶¶67-70. Trying its best to understand such vague allegation, Patent

Owner understood Ground 1 of the Petition as setting forth two theories. Neither of those have merit.

1. Petitioner Has Abandoned Its Theory Regarding Kobayashi's Hexagons Being Square-Shaped Cells with Rounded Corners

First, based on Petitioner's proposed claim construction of "rounded corners"—which conflated them with "truncated corners" (Pet., 18)—and Petitioner's annotated version of Fig. 4A (Pet., 26), Patent Owner understood Petitioner to argue that a hexagon is a square with rounded corners because one could conceive of a hexagon as being formed via truncation of a square. Thus, the POR explains in detail why Kobayashi's hexagonal cell embodiment cannot satisfy limitation 1(a) (i.e. that hexagons are not squares and truncation is not rounding). POR, 22-23. In its Reply, Petitioner's express admissions demonstrate that it has abandoned its hexagon cell theory. In particular, Petitioner now discards its prior proposed claim construction (Reply, 1-2) and admits that it "is true" that "truncated corners are not rounded corners" (Reply, 8). Thus, the hexagon theory can be readily rejected based on those admissions.

2. Petitioner's Theory That Kobayashi's Square Shaped Cells Satisfy Limitation 1(a) Based on Rounded Trench Openings and Bottoms Only Visible in the Side View Disregards the Clear Meaning of Limitation 1(a)

Second, Patent Owner understood the Petition as having set forth a theory that Kobayashi's "square cell" embodiment of Fig. 3A has rounded corners visible in the

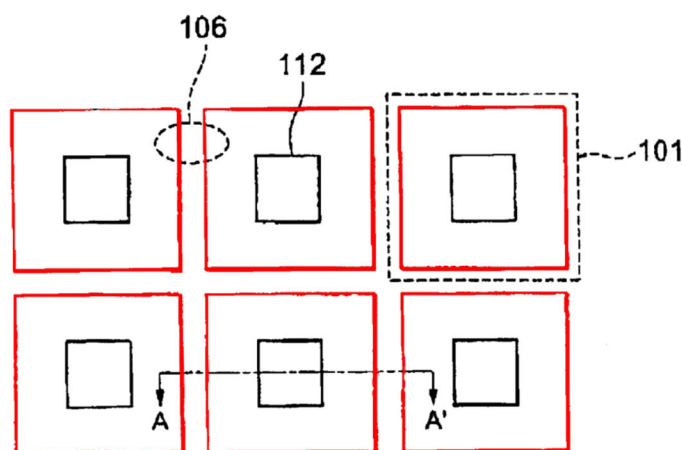
side view (i.e. rounding the gate trench's bottom and opening corners), based on the disclosure of Kobayashi, 7:57-8:4. *See* Pet., 26-27. Patent Owner explained in detail that this does not satisfy the claim language because the claim requires that the essentially *square shape* have rounded corners, i.e. that it has the shape essentially shown in Fig. 3 of the '409 Patent. Thus, the relevant "rounded corners" are those of the cell—which are visible in the top view—not the corners of the trench gate visible in the side view. POR, 14-18. Patent Owner supported its argument by a detailed claim construction analysis of the text and structure of claim 1, the '409 Patent's specification and file history, as well as detailed expert testimony. *Id.*; Ex. 2021, ¶¶76-96.

In its Reply, Petitioner presents no substantive rebuttal whatsoever to Patent Owner's claim construction arguments. Reply, 1-2. Instead, Petitioner largely continues to improperly treat "substantially square-shaped cells" and "rounded corners" as two distinct limitations. Reply, 5, 9 (addressing as two separate limitations). As discussed in the POR, and above, this is incorrect, as the only relevant corners are those of the square-shaped *cell*, which is defined in the top-view perspective. POR, 14-18.

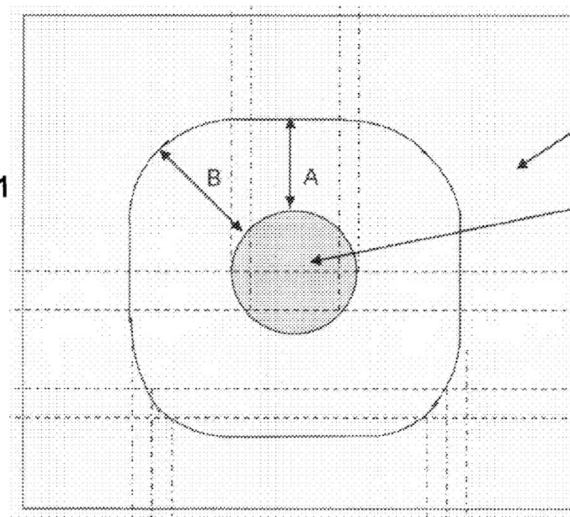
Finally, Petitioner argues—for the first time—that the rounding of trench corner openings and bottoms in Kobayashi is actually top view-visible rounding, even though it admits that Kobayashi's figures "do not illustrate" this. Reply, 11-

12. But Petitioner submits no reply expert declaration supporting this argument. And, Petitioner's expert's declaration filed with the Petition was entirely silent on this issue (and conclusory on this limitation in general). Ex. 1003, ¶¶67-70. Thus, there is simply no factual basis to conclude that Kobayashi's rounding of corners and openings would be visible from a top view.

Moreover, even if some degree of trench opening or bottom rounding were theoretically visible from the top view, Petitioner's argument still applies an incorrect claim construction. As explained in the POR, "closed cells constituting substantially square-shaped cells with rounded corners" means the cell's structure is essentially like that depicted in Fig. 3 of the '409 Patent. *See, e.g.*, POR, 15-17, 24-25. That is, "substantially square-shaped cells with rounded corners" have an essentially square shape, but instead of the conventional 90 degree corners, the corners have been rounded, resulting in greater uniformity between the gate corners and the contact. *Id.* As Petitioner's own diagrams show, Kobayashi's rounding of trench bottoms and openings would not result in that shape:



Reply, 13 (annotating Ex. 1005, Fig. 3A)



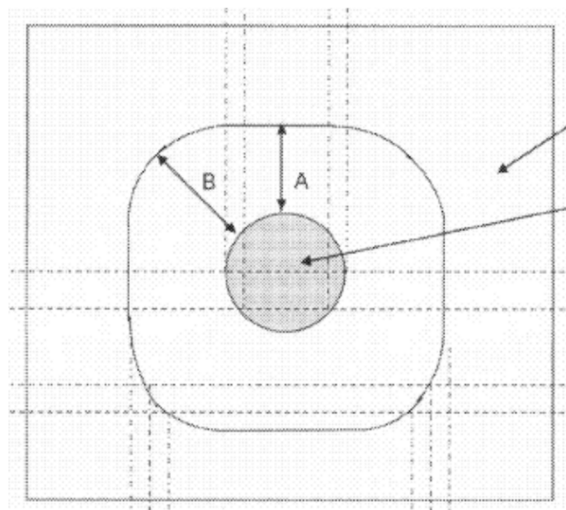
'409 Patent, Fig. 3 (cropped)

Petitioner argues that “because the trench gates define the cells, rounding the trench gate corners also rounds the cell corners.” Pet., 12. But, as discussed, the claim separately recites both the trench gates *and* the square-shaped closed cell. POR, 14; Ex. 1001, cl. 1. Thus, Petitioner’s argument would only make sense if the claim 1 recited that the “trenched gates” had “rounded corners.” However, the claim instead recites “substantially square-shaped cells with rounded corners.” And, under the last antecedent rule, that recitation supports that the relevant “rounded corners” are those of the *cell’s square shaped layout*, i.e. the corners defined in the top view perspective. POR, 14, 17-18. Thus, even if the rounding of trench corners and bottoms were visible from the top view of Kobayashi’s Fig. 3A, they would still not be the corners that the claim requires to be rounded: the corners of the otherwise essentially square shape of the cell.

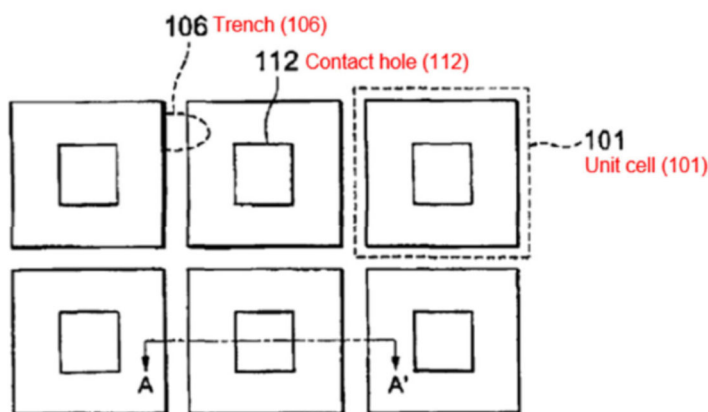
3. The Petition Sets Forth No Theory Based on Fig. 3A of Kobayashi Independent of Side View-Visible Rounding of Trench Opening and Bottom Corners

Despite the Petition setting forth, at best, two theories for this limitation, Petitioner states that “Patent Owner ignores the square-shaped cells that Kobayashi taught in Figure 3A.” Reply, 6. This is false—the Petition sets forth no theory that “square shaped cells” have rounded corners other than potentially the side view-visible rounding of trench bottoms and openings. Pet., 25-27; Ex. 1003, ¶¶67-70. Nor could the Petition be plausibly understood as setting forth such a theory. Indeed, Fig. 3A of Kobayashi—as shown in the Petition itself—plainly depicts a conventional square shape with 90 degree corners, and Petitioner’s annotation of Fig. 3A in the petition does not attempt to identify any rounded corners in that figure. *Compare* Pet., 26 (annotating Ex. 1005, Fig. 3A without identifying rounded corners) *with* Pet., 27 (identifying “rounded corners” in side view of Kobayashi’s Fig. 6C); *see also* POR, 36 (“the squares of Kobayashi’s Figure 3A ... have the full, normal ninety-degree angled corners of a conventional square”). Thus, the Patent Owner Response addressed the only theory relating to Fig. 3A of Kobayashi which was even arguably disclosed in Ground 1 of the Petition—the theory that Kobayashi’s “square cell” embodiment of Fig. 3A has rounded corners visible in the side view (i.e. rounding of the gate trench’s bottom and opening). As discussed above and in the POR, that theory fails.

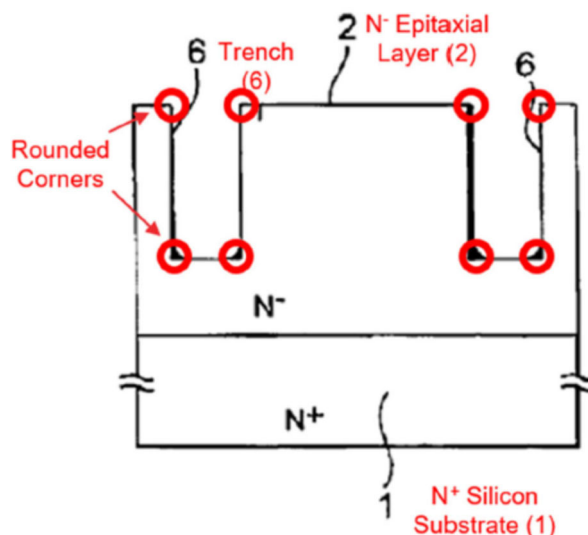
Petitioner's Reply also includes a lengthy section contending that "Kobayashi mirrored the disclosure of the '409 Patent." Reply, 3-5. As an initial issue, a comparison of the specification of the '409 Patent to Kobayashi's disclosures is legally irrelevant—the relevant inquiry is a comparison of the properly construed claims of the '409 Patent to Kobayashi's disclosures. *See Zenith Electronics v. PDI Communication Systems*, 522 F. 3d 1348, 1363 (Fed. Cir. 2005). Moreover, Petitioner's argument is plainly incorrect—nothing in Kobayashi looks anything like Fig. 3 of the '409 Patent, which is the embodiment reflected by claim 1 and its "substantially square shaped cell."



'409 Patent, Fig. 3 (cropped)



Kobayashi, Fig. 3A (as annotated on Pet., 26)



Kobayashi, Fig. 6C (as annotated on Pet., 27)

And, as discussed in the POR—without rebuttal by Petitioner—the appropriate construction of limitation 1(a) requires cells that have, from the top view perspective, largely or essentially the shape of a square with all corners rounded, i.e. essentially what is depicted in Fig. 3 of the '409 Patent. POR, 14, 17-18, 24-25. To the extent that Petitioner is trying to assert that the top-view visible corners of Fig. 3A of Kobayashi inherently become rounded in the top view during fabrication, the Petition sets forth no such theory (Pet., 25-27, Ex. 1003, ¶¶67-70), and it would be improper to assert that new invalidity theory for the first time in the Reply. *See Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1369 (Fed. Cir. 2016); PTAB Consolidated Trial Practice Guide (Nov. 2019) at 74.

4. Truncated Corners are Irrelevant for Claim 1

Petitioner's Reply also spends a significant portion discussing "truncated corners" in its discussion of Ground 1, claim 1. Reply, 7-9. However, given that Petitioner has abandoned its prior construction of "rounded corners" (which conflated them with "truncated corners" (Reply, 2, 8)) and admits that hexagons are not substantially square shaped (Reply, 7), those arguments are irrelevant for claim 1. Patent Owner will instead address "truncated corners" below in connection with claim 6. *Infra.*, II.B.

B. Ground 2: Kobayashi Fails to Disclose "said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with truncated corners" (claim 6)

As to claim 6, Petitioner argues that Kobayashi's hexagonal cells are "substantially square-shaped with truncated corners." Reply, 20-21. But, hexagons are not substantially square shaped. Indeed, as discussed in the POR—without rebuttal in the Reply—hexagon-shaped cells and square-shaped cells are distinct categories of cell topologies in MOSFETs, and Kobayashi itself treats squares and hexagons as alternative options for its cell structure. POR, 37 (citing Ex. 2021, ¶128).

Petitioner notes that the shape depicted in Fig. 2 of the '409 Patent has eight sides, and thus argues six sides must also be permissible for a square shape with truncated corners. Reply, 20-21. However, as discussed in the POR—without

rebuttal in the Reply—the amount of truncation of the corners still has to leave something that is “substantially square-shaped,” i.e. having four main sides which are longer than the truncated corners’ sides. POR, 37; Ex. 1001, Fig. 2; Ex. 2021, ¶¶111, 128. But Petitioner’s hexagon theory would require truncating far more than the four corners of a hexagonal square—it would truncate two whole sides to a point, and result in a shape with six equal sides. *Id.* Moreover, Petitioner presents no non-conclusory expert analysis that one of skill in the art would understand a regular hexagon as being substantially square-shaped with truncated corners. Accordingly, Petitioner’s arguments for claim 6 in Ground 2 fail.

C. Grounds 1, 3, 4, 6: Kobayashi Fails to Disclose: “a diameter of a top surface of said circular trench contact is smaller than 1.0 micrometer” (claim 5)

In the Patent Owner response, Patent Owner demonstrated that each of Petitioner’s grounds relating to claim 5 relied on legal error: measuring a figure not to scale. POR, 28-29. In its Reply, as to each ground, Petitioner primarily argues that this is acceptable because of an “exception to [that] rule.” Reply, 15, 21, 24, 25. In particular, Petitioner cites to the language in *Nystrom v. TREX Co.*, 424 F.3d 1136, 1149 (Fed. Cir. 2005) that “patent drawings do not define the precise proportions of the elements and may not be relied on to show particular sizes if the specification is completely silent on the issue.” Then, Petitioner argues that its usage falls into such

“exception” because Kobayashi’s “specification is not silent” because it “disclose[s] specific sizes for several features shown in Figure 5A.” Reply, 15.

But *Nystrom* does not set forth some exception permitting calculations using out-of-scale patent figures as long as the written description says *something* about *some* dimension in the figure—that exception would swallow the rule. When *Nystrom* refers to “the issue,” it is referring to the specific issue for which a party is attempting to use the figure—in this case, whether the dimension of the diameter of the circular trench contract in Kobayashi is smaller than 1.0 micrometer. Petitioner points to no disclosure in the written description of Kobayashi of that dimension—thus Kobayashi *is* completely silent on the issue. Indeed, Petitioner’s argument—that one can satisfy a specific linear dimension by measuring part of a figure and comparing it with known measurements—is the exact type of analysis that *Nystrom* and related cases prohibit. *See Ex Parte Hsu et al.*, Appeal of Appl. No. 12/109,910 at 5 (P.T.A.B. Feb. 24, 2016) (analyzing case law on the issue and concluding that “precedent indicates that drawings, without any indication of scale, cannot convey linear dimensions”); *In re Wright*, 569 F.2d 1124, 1127 (C.C.P.A. 1977) (prohibiting examiner from relying on apparent “relative dimensions” of a figure to determine prior art disclosed a “roughly ½ to 1 inch” dimension).

Petitioner also argues that, in Petitioner’s grounds purportedly asserting “knowledge of a POSTIA” as part of the combination (grounds 3 and 6), Petitioner’s

expert “provided additional reasons why” the added limitations of claim 5 would be obvious. Reply, 21 (citing Ex. 1003, ¶¶110-111), 25. However, the POR expressly rebutted those arguments in detail, supported by detailed expert testimony. POR, 42-44 (citing Ex. 2021 ¶131). In particular, Dr. Neikirk noted that Kobayashi already specifically solves the problem that Dr. Kim identifies as motivating using smaller trench contacts—increased threshold voltage from the P+ base layer. Ex. 2021 ¶131 (citing Ex. 1003, ¶113, Ex. 1005, 5:44-49). Dr. Neikirk also explained that Dr. Kim’s generic arguments regarding reducing feature size and process time were inadequate to motivate modifying Kobayashi, given that such reductions would result in reduced current carrying ability of the trench contacts and difficulty in filling in Kobayashi’s plugs. Ex. 2021 ¶131. Petitioner’s Reply does not respond to those arguments.

Finally, the POR noted that the Petition failed to contain *any* reasoning for the motivation to combine in Ground 6, which sets forth a distinct combination not elsewhere combined in the Petition. POR, 66. Petitioner does not provide any citation disputing that. Instead, Petitioner inscrutably states that “Patent Owner, however, only argues that Petitioner allegedly failed to demonstrate that the combination of Kobayashi and Hshieh renders obvious claim 1 and that Kobayashi in view of the knowledge of a POSITA renders obvious claim 5.” Reply, 25. It is true that Patent Owner’s substantive arguments for Ground 6 in the POR

incorporated Patent Owner’s substantive arguments for the other grounds relating to claim 5. POR, 66. However, that does not relieve Petitioner of the obligation to set forth a motivation to combine for each ground in the Petition. 35 U.S.C. § 312(a)(3).

Thus, Petitioner’s arguments relating to the additional limitations of claim 5, as addressed in Petitioner’s Grounds, 1 3, 4, and 6, should be rejected.

D. Grounds 2, 5: Kikkawa, in Combination with Kobayashi or Kobayashi-Hsieh, Fails to Render Obvious the Titanium Structures of Claims 2 and 6

In the POR, Patent Owner demonstrated that Petitioner’s combinations based on Kikkawa failed to render obvious the specific titanium limitations of claims 2 and 5. POR, 29-34, 38-39. Petitioner’s arguments in Reply fail to substantively address those arguments, and thus Petitioner’s Grounds 2 and 5 should be rejected.

1. Kikkawa is Not Analogous Art

In the POR, Patent Owner demonstrated, supported by expert testimony, that Kikkawa is not analogous art. In particular, Patent Owner noted that, unlike the ’409 Patent and Kobayashi—which are directed to trenched power MOSFETs or similar power semiconductor devices—Kikkawa is directed to DRAM, and is thus in a different field of endeavor. POR, 29-30 (citing Ex. 2021, ¶119). In its Reply, Petitioner presents no further field of endeavor arguments other than noting that the ’409 Patent and the cited art are all “directed to problems with semiconductor devices.” Reply, 19. But, as Patent Owner and its expert explained, a POSITA

would not consider “semiconductor devices” as a whole, to be a single field of endeavor—that would simply be too broad. POR, 30 (*citing Wang Labs, Inc. v. Toshiba Corp.*, 993 F.2d 858, 864 (Fed. Cir. 1993)). Petitioner’s reply advances no evidence or argument that a POSITA would consider “semiconductor devices” (or the “problems with semiconductor devices”) to be a single field of endeavor.

The POR also demonstrated that Kikkawa is not pertinent to the problem being solved because Kikkawa is directed to reducing electromigration, *not* contact resistance. POR, 31-32. In particular, it offered detailed evidence-based arguments explaining that electromigration and contact resistance are distinct and unrelated concepts. *Id.* (citing Ex. 2021, ¶¶121). But in its Reply, Petitioner ignores these arguments and simply repeats the same error it made in the Petition—conflating the ’409 Patent’s “contact resistance” problem and with Kikkawa’s “electro-migration” problem. Reply, 19. This argument fails for the reasons already discussed in the POR—contact resistance and electromigration are not the same thing. POR, 31-32.

Petitioner also curiously states—without explanation—that Kikkawa discloses addressing “problems with ... contact resistance.” POR, 19 (citing Ex. 1007, 4). But nothing on the cited page of Kikkawa mentions “contact resistance.” That page does mention “electro- and stress-migration-resistant,” which as discussed, is distinct from “contact resistance.” That page also mentions “Ti which increased the resistance after heat treatment,” but that is in a discussion of the relative

benefits between a “TiN thin film” design as compared to a “pure transition metal ... Ti” design with respect to resistance “after a heat cycle.” Ex. 1007, 4. Neither the Petition nor Petitioner’s expert’s declaration contained any analysis or reliance on that sentence (Pet., 29-34, 38-39; Ex. 1003, ¶¶83-86, 96-109, 144-146), and thus any reliance by Petitioner on that disclosure is late and improper.

Moreover, as Dr. Neikirk explained, “reduc[ed] contact resistance” (as used in the ’409 Patent) does not refer to what occurs as a result of the device being used over a period of time (e.g. after electromigration or stress migration is allowed to occur). Ex. 2021, ¶121. Rather, it is a property that can be measured based on the contribution to resistance, regardless of whether the device is on or off. *Id.* Petitioner’s reply fails to rebut or dispute this point. Thus, Kikkawa’s reference to “resistance after heat treatment” does not demonstrate that its disclosures are pertinent to the problem of “reduc[ed] contact resistance.” Accordingly, Kikkawa is not analogous art.

2. A POSITA Would Not Be Motivated to Combine Kikkawa With Kobayashi (or Kobayashi-Hsieh) in the Manner Claimed

In the POR, Patent Owner demonstrated, supported by detailed expert testimony, that a POSITA would not be motivated to combine Kikkawa with Kobayashi in the manner claimed. In particular, it noted that Petitioner provide no reason to believe that Kobayashi’s power MOSFET—an entirely different type of

device than Kikkawa's DRAM—would suffer from electromigration or stress-migration. POR, 32-33 (citing Ex. 2021, ¶122). And, it noted that Kobayashi already has a Ti/TiN layer between its aluminum source layer and silicon layers, simply not one that is in the position claimed. *Id.* It also noted that rather than disclosing the benefits of a titanium layer in the claimed position of a MOSFET (as Petitioner's obviousness theory used Kikkawa), Kikkawa itself only touted the benefits of a specific *multi-layer* structure for use in a DRAM cell. *Id.*

The Reply wholly fails to respond to these arguments. Indeed, other than its analogous arts argument, the only statement that the Reply makes regarding motivation to combine is the single sentence that “it would have been obvious to a POSITA that Kobayashi would benefit from a bottom titanium layer in addition to its existing aluminum layer for exactly the reasons Kikkawa taught.” Reply, 19-20. But, as noted, Kikkawa teaches a specific structure for DRAM cells. Petitioner does not articulate that the proposed combination would have the same structure as Kikkawa's DRAM interconnect, and does not articulate a reason why a POSITA would believe that Kobayashi's MOSFET would benefit from such a structure. Thus, Petitioner's obviousness argument fails.

E. Grounds 4-6: The Combination of Kobayashi and Hshieh Fails to Render Obvious “said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with rounded corners” (claim 1)”

In the Petition, Petitioner made two arguments for motivation to combine Hshieh with Kobayashi: (1) that it was well known to a POSITA that rounding the corners of square cells in semiconductor structures had several advantages (i.e. higher peak electric fields) (Pet., 57-58; Ex. 1003, ¶¶135, 138-140); and (2) that Hshieh expressly teaches the benefits of rounding the corners of cells (Pet., 59; Ex. 1003, ¶137). *See* POR, 47.¹ As discussed in the POR and below, neither of Petitioner’s motivation to combine theories have merit, and thus Petitioner’s Ground 4-6 fail.

1. Petitioner’s vague, generalized argument that it was “known” to be advantageous to “round” square corners is without merit

Patent Owner demonstrated, using detailed expert testimony, that Petitioner’s first motivation to combine argument had improperly conflated Hshieh’s top view

¹ Patent Owner also noted that the Petitioner’s expert had inexplicably mentioned “improve electro-migration and contact resistance” in his declaration as part of the motivation to combine Kobayashi and Hshieh, even though that was identified as a disclosure of Kikkawa, not Hshieh. POR, 47 (discussing Ex. 1003, ¶¶139-140). Petitioner has not sought to formally correct those statements, nor has it attempted to justify those statements in its reply.

rounding of cell corners with the entirely unrelated side view rounding of trench bottoms and openings in Kobayashi. POR, 45-48. The side view rounding of gate trench bottoms and openings (as discussed in Kobayashi and Kim) relates to gate “leakage,” and in particular, the problem of current conduction between gate and drain that can occur via tunneling due to thinning of the gate oxide at such corners. POR, 46 (citing Ex. 2021, ¶¶113-115, 136-137). By contrast, Hsieh uses rounding in a different way and at a different place (top view rounding), and for an unrelated problem: addressing the three-dimensional diffusion phenomenon. POR, 46-47. Thus, the POR demonstrated that there was no factual basis behind Petitioner’s expert’s assertion that it was generally “known” to be advantageous to “round corners.”

In its Reply, Petitioner largely ignores these showings. Instead, Petitioner repeats its argument from Ground 1 that “Kobayashi taught rounding the corners at the opening of the gate trenches, which also define the corners of the cell that the gate trenches surround.” Reply, 22. However, as discussed above, Kobayashi’s rounding of trench openings and bottoms is not the type of rounding claimed (i.e. rounding of the corners of the otherwise essentially square-shaped cell). *Supra*, II.A.2. Moreover, in any event, Petitioner does not dispute that Kobayashi’s rounding (as well as the same rounding in Kim) is a different type of rounding, in a different place, for a different purpose, than the rounding in Hsieh. Thus,

Petitioner's argument that there was a generalized "known" motivation to round corners in semiconductors to achieve "advantages" is without factual basis and cannot motivate top-view rounding of cell corners.

2. Petitioner's motivation to combine argument based on alleged express teachings in Hshieh is without merit

The Petition's second motivation to combine expressly cites to Hshieh's column 5, lines 3-17 as "expressly teach[ing] the benefits of rounding the corners of square cells." Pet., 59; Ex. 1003, ¶137 (citing Ex. 1006, 5:3-17). But, that portion of Hshieh only mentions rounding cell corners to "prevent" "weak points [that] may be formed at the sharp corners due to a three dimension diffusion effect." Ex. 1006, 5:3-8. Thus, the POR provided detailed, evidence-based expert analysis that the structure of Kobayashi would not benefit from Hshieh's motivation for rounding, i.e. that the three-dimensional diffusion phenomenon did not arise in Kobayashi's structure. POR, 54-60 (citing Ex. 2021, ¶¶146-150).

Petitioner's Reply contains no substantive response disputing that analysis.² Instead, relying purely on attorney argument, Petitioner asserts that "both Kobayashi and Hshieh faced the problem of 'punch-through' at sharp cell corners." Reply, 24.

² Petitioner also incorrectly states that the Board "preliminarily rejected" this argument. Reply, 24. To the contrary, Patent Owner's Preliminary Response never attempted to show that Hshieh's problem of the three-dimensional diffusion effect was inapplicable to Kobayashi's structure. Paper No. 6, 23-27.

This contention is supported by no evidence whatsoever—indeed Petitioner does not even attempt to cite any evidence. Kobayashi itself never mentions “punch-through”—only avalanche breakdown, which is a distinct concept. Ex. 1005, 7:14-18; *see also* Ex. 2021, ¶¶69-70, 147-148, Ex. 2012, 4:5-8, Ex. 2014, 10. And Petitioner’s expert only opined that *Hshieh* addressed punch-through. Ex. 1003, ¶133. He asserted that Kobayashi’s side-view trench corner breakdown related to a problem he characterized as “similar”—low breakdown voltage.³ *Id.*

Thus, Petitioner’s argument is contradicted by the only non-conclusory evidence of record: Dr. Neikirk’s analysis. Dr. Neikirk opined in detail—and without rebuttal by Petitioner or its expert—that Kobayashi’s structure does not suffer from the punch-through problem identified in *Hshieh* as addressed by *Hshieh*’s top view rounding (i.e. punch-through caused by the three-dimensional diffusion phenomenon). POR, 58-60; Ex. 2021, ¶¶149-150. Thus, Petitioner’s assertion that “*Hshieh*’s solution of rounding the corners to avoid ‘punch-through’

³ Moreover, contrary to Petitioner’s statement (Reply, 24), Patent Owner has never admitted that Kobayashi addresses punch-through. Instead Patent Owner explained in detail how Kobayashi’s side view trench corner rounding addressed a different problem than *Hshieh*’s top view rounding. POR, 46-47. Indeed, Petitioner cites to a page where Patent Owner expressly argues that “the three-dimensional diffusion problem identified by *Hshieh* [as causing punch-through] is inapplicable to the structure of Kobayashi’s MOSFET.” POR, 55.

was equally applicable in Kobayashi” (Reply, 24) is baseless and contrary to the evidence of record. Moreover, Petitioner’s argument—that both Kobayashi and Hshieh address punch-through—is self-defeating. If that were true, then Kobayashi would *already* have a solution to punch-through (i.e. side view rounding) and thus would have no need for the punch-through mitigation provided by Hshieh’s top view rounding.

In any event, as discussed, Kobayashi itself does not disclose or suggest top-view visible rounding of cell corners (e.g. the type shown in Fig. 3 of the ’409 Patent). And, Petitioner has never submitted *any* non-conclusory evidence or argument that Kobayashi’s design would benefit from Hshieh’s top view rounding. Thus, there is no factual basis for any motivation to combine Kobayashi and Hshieh to have “closed cells constituting substantially square-shaped cells with rounded corners.”

3. Petitioner Fails to Dispute that the Proposed Combination Cherry-Picks and Contradicts Hshieh’s Basic Objectives

In its POR, Patent Owner demonstrated that Patent Owner’s combination is the result of cherry-picking elements from two references without factual basis, and that the result is a combination that directly contradicts Hshieh’s basic objective. POR, 48-52. As to cherry-picking, Petitioner’s reply does not dispute that its selection was selective and arbitrary (indicating use of hindsight), only justifying it as being expressly motivated by Hshieh. Reply, 23-24. But as discussed, Petitioner

has set forth no reason why a POSITA would believe Kobayashi's structure would be amenable to the top-view rounding disclosed in Hshieh. *Supra*, II.E.2. As to violating Hshieh's basic objective, Petitioner asserts that is acceptable as long as the combination would not be "inoperable." Reply, 23. But that is not the relevant inquiry. Rather, as the numerous cases cited in the POR demonstrated, the relevant inquiry requires examination of all of the teachings of all of the references, including those that would weigh against the combination. *See* POR, 51-52 (collecting cases). Here, Hshieh's specific purpose is improving the prior art by using non-orthogonal parallelograms. Petitioner's combination violates that purpose by combining Hshieh's rounded corners with Kobayashi's square cells to result in substantially square-shaped cells with rounded corners.

In both instances, Petitioner ignores a fundamental issue. It is *Petitioner's burden* to articulate why a POSITA would be motivated to select Hshieh for combination with Kobayashi, as well as why a POSITA would be motivated to select the relevant teachings of each for combination in the manner claimed. *WBIP, LLC v. Kohler Co.*, 829 F.3d 1317, 1337 (Fed. Cir. 2016) ("Whether a skilled artisan would be motivated to make a combination includes whether he would select particular references in order to combine their elements."). Petitioner fails to adequately articulate a reason to do so, because (among other things): (1) it sets forth no reason why Hshieh's express disclosures regarding the benefits of cell corner

rounding would be applicable to Kobayashi's structure; and (2) the combination would violate Hshieh's basic purpose of maximizing packing density by using non-orthogonal parallelograms. Accordingly, Petitioner's obviousness argument should be rejected.

F. Ground 5: The Combination of Kobayashi and Hshieh Fails to Render Obvious "said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with truncated corners" (claim 6)"

For the same reasons discussed above in Ground 4-6, claim 1, Petitioner fails to provide a motivation to combine Hshieh's blunted corners with Kobayashi in the manner recited by claim 6. Indeed, Petitioner's Reply makes no arguments for Ground 5, claim 6 distinct from its arguments regarding Ground 4, claim 1. Reply, 25. Thus, Petitioner's arguments fail for the same reasons discussed above regarding claim 1. *Supra*, II.E.

III. CONCLUSION

For the above reasons, Patent Owner requests that Board hold that all challenged claims are patentable.

Date: December 16, 2024

Respectfully submitted,

/Michael D. Saunders/

Michael D. Saunders, Reg. No. 77,739

DICKINSON WRIGHT PLLC

607 W. 3rd Street, Suite 2500

Austin, Texas 78701

Telephone: (512) 770-4200

Facsimile: (844) 670-6009

Email: msaunders@dickinsonwright.com

Attorney for Patent Owner

Certificate of Service 37 C.F.R. § 42.6(e)

The undersigned certifies that on December 16, 2024, I will cause true and correct copies of the foregoing Patent Owner's Surreply to Petitioner's Reply, and all associated exhibits or appendices referred to therein, to be served electronically upon the following attorneys who have consented to service via email. Paper No. 16.

Charles M. McMahon
Registration No. 44,926
BENESCH FRIEDLANDER
COPLAN & ARANOFF LLP
71 South Wacker Dr., Suite 1600
Chicago, IL 60606
Tel: (312) 212-4949
cmcMahon@beneschlaw.com

Mircea Tipescu
Registration No. 53,690
BENESCH FRIEDLANDER
COPLAN & ARANOFF LLP
71 South Wacker Dr., Suite 1600
Chicago, IL 60606
Tel: (312) 212-4949
mtipescu@beneschlaw.com

Ziyong "Sean" Li
Registration No. 76,089
BENESCH FRIEDLANDER
COPLAN & ARANOFF LLP
100 Pine Street, Suite 3100
San Francisco, CA 78701
Tel: (628) 600-2250
sli@beneschlaw.com

Respectfully submitted,

/Michael D. Saunders/
Michael D. Saunders, Reg. No. 77,739
DICKINSON WRIGHT PLLC
607 W. 3rd Street, Suite 2500
Austin, Texas 78701
Telephone: (512) 770-4200
Facsimile: (844) 670-6009
Email: msaunders@dickinsonwright.com
Attorney for Patent Owner

Certificate of Compliance Pursuant to 37 C.F.R. § 42.24

This paper complies with the type-volume limitation of 37 C.F.R. § 42.24.

This paper contains 5,586 words, excluding the parts of the paper exempted by 37 C.F.R. § 42.24(a).

This paper also complies with the typeface requirements of 37 C.F.R. § 42.6(a)(ii) and the type style requirements of 37 C.F.R. § 42.6(a)(iii)&(iv).

Dated: December 16, 2024

Respectfully submitted,

/Michael D. Saunders/

Michael D. Saunders, Reg. No. 77,739

DICKINSON WRIGHT PLLC

607 W. 3rd Street, Suite 2500

Austin, Texas 78701

Telephone: (512) 770-4200

Facsimile: (844) 670-6009

Email: msaunders@dickinsonwright.com

Attorney for Patent Owner