

Oral Hearing: Petitioner's Demonstrative Exhibits

IPR2024-00094

Patent No. 7,812,409

Inergy Technology, Inc. v. Force Mos Technology Co., Ltd.

February 21, 2025

Demonstrative Only - Not Evidence

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INSTITUTED GROUNDS

Ground	Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1	1, 3–5	102(b) ²	Kobayashi ^{3,4}
2	2, 6	103(a)	Kobayashi, Kikkawa ⁵
3	5	103(a)	Kobayashi

Ground	Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
4	1, 3–5	103(a)	Kobayashi, Hshieh ⁶
5	2, 6	103(a)	Kobayashi, Hshieh, Kikkawa
6	5	103(a)	Kobayashi, Hshieh

Paper 9, Institution Decision, at 7-8

CLAIM CONSTRUCTION

Paper 1, Petition, at 14-19

Paper 26, Reply, at 1-2

Demonstrative Only – Not Evidence



CLAIM CONSTRUCTION – “SUBSTANTIALLY SQUARE-SHAPED CELLS WITH ROUNDED CORNERS”

1. A trench semiconductor power device comprising a plurality of trenched gates surrounding a plurality of transistor cells formed in a semiconductor substrate, wherein:
said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with rounded corners;

Ex. 1001 at 5:10-12 (Claim 1)

CLAIM CONSTRUCTION – “SUBSTANTIALLY SQUARE-SHAPED CELLS WITH ROUNDED CORNERS”



Rather, at this stage of the proceeding and on this record, we see no reason to determine that “substantially square-shaped cells with rounded corners” deviates from its ordinary and customary meaning, and we determine that, apart from our discussion above, no other claim construction analysis is necessary for our decision to institute an *inter partes* review.

Paper 9, Institution Decision, at 11-12

CLAIM CONSTRUCTION – “SUBSTANTIALLY SQUARE-SHAPED CELLS WITH ROUNDED CORNERS”

Petitioner agrees with the Board’s preliminary conclusion that there is no need to interpret “rounded corners” or “truncated corners.” Petitioner’s patentability grounds stand under all of the proposed constructions, as well as the plain and ordinary meaning of these terms.

Paper 26, Reply, at 2

CLAIM CONSTRUCTION – “SUBSTANTIALLY SQUARE-SHAPED CELLS WITH TRUNCATED CORNERS”

6. A trench semiconductor power device comprising a plurality of trenched gates surrounding a plurality of transistor cells formed in a semiconductor substrate, wherein:
said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with truncated corners;

Ex. 1001 at 6:14-16 (Claim 6)

CLAIM CONSTRUCTION – “SUBSTANTIALLY SQUARE-SHAPED CELLS WITH TRUNCATED CORNERS”



For reasons similar to those discussed above, we decline to adopt either of the parties’ proposed claim constructions. Rather, at this stage and on this record, we see no reason to determine that the term deviates from its ordinary and customary meaning, which does not include any process limitations and does not necessarily require all four corners to be truncated.

Paper 9, Institution Decision, at 12

CLAIM CONSTRUCTION – “SUBSTANTIALLY SQUARE-SHAPED CELLS WITH TRUNCATED CORNERS”

Petitioner agrees with the Board’s preliminary conclusion that there is no need to interpret “rounded corners” or “truncated corners.” Petitioner’s patentability grounds stand under all of the proposed constructions, as well as the plain and ordinary meaning of these terms.

Paper 26, Reply, at 2

UNPATENTABILITY: GROUND 1

Kobayashi Anticipated Claims 1 and 3–5

Paper 1, Petition, at 22-36

Paper 26, Reply, at 2-15



Demonstrative Only – Not Evidence



GROUND 1 – ANTICIPATION

Kobayashi (Claims 1 and 3-5)

A. “said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with rounded corners” (Claim 1)

Paper 1, Petition at 25-27; Paper 26, Reply, at 3-14

B. “a diameter of a top surface of said circular trench contact is smaller than 1.0 micrometer” (Claim 5)

Paper 1, Petition at 35-36; Paper 26, Reply, at 15

C. Patent Owner only disputes that Kobayashi anticipates Claims 3-4 for the same reasons as Claim 1

Paper 26, Reply, at 15

GROUND 1 – ANTICIPATION

“Substantially Square-Shaped Cells With Rounded Corners” – Board’s Preliminary Construction



Based on the preliminary arguments and evidence, we disagree with Petitioner’s proposed construction requiring *the corners to be rounded via a particular process* because it improperly imports a process of manufacture from the Specification into apparatus claims.

Paper 9, Institution Decision, at 10



At this stage, we do not adopt Patent Owner’s proposed construction, which requires *“all” corners being rounded from a “top view perspective.”*

Paper 9, Institution Decision, at 11

GROUND 1 – ANTICIPATION

“Substantially Square-Shaped Cells With Rounded Corners” – Board’s Preliminary Construction

- Kobayashi discloses several cell layouts
 - *Square unit cells arranged in a matrix (Fig. 3A)*
 - *Hexagonal unit cells arranged in a matrix (Fig. 4A)*
- Each cell layout (Fig. 3A and Fig. 4A) has trenched gates surrounding transistor cells as closed cells constituting substantially square-shaped cells with rounded corners

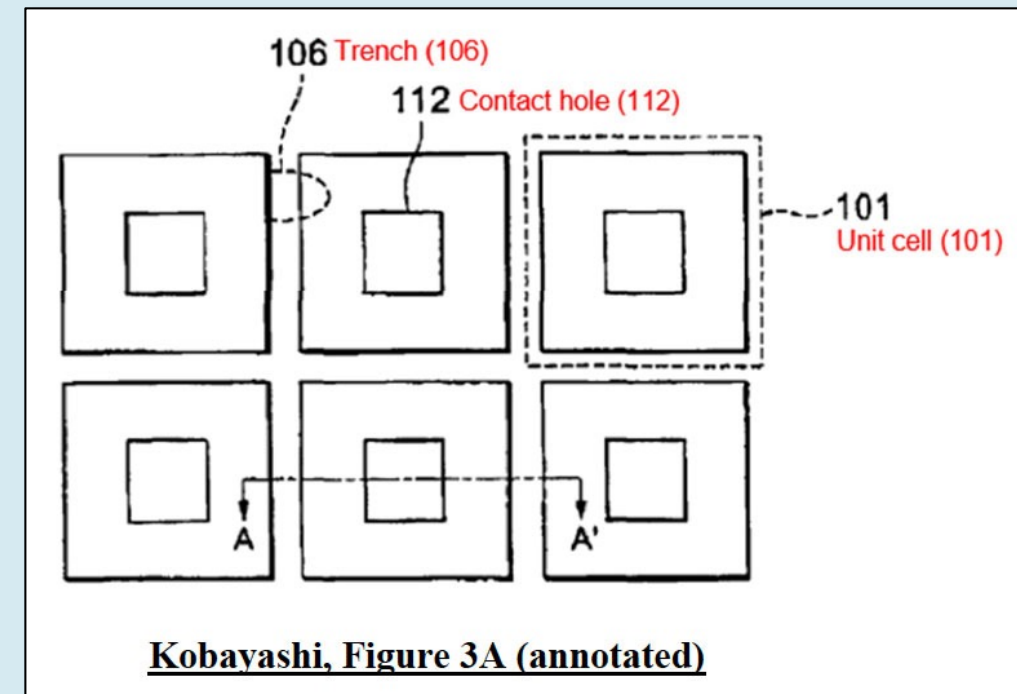
Paper 1, Petition at 25-27; Paper 26, Reply, at 3-14

GROUND 1 – ANTICIPATION

*“Substantially Square-Shaped Cells With Rounded Corners” –
Board’s Preliminary Construction [Square Unit Cells]*

Kobayashi discloses “a plurality of *square cells* [that] are arranged in a matrix” in Figure 3A. Ex. 1005, 6:26—27 (emphasis added).

Ex. 1003 at ¶ 67; Paper 1, Petition, at 25



Ex. 1003 at ¶ 67; Paper 1, Petition, at 26

GROUND 1 – ANTICIPATION

“Substantially Square-Shaped Cells With Rounded Corners” – Board’s Preliminary Construction [Square Unit Cells]

As Kobayashi explains, “unit cells 101, 201, and 301 in each figure can be defined as structural units separated by trenches 106, 206, and 306 where gate electrodes are to be formed.” Ex. 1005 at 6:32-35. This relationship between the trenches and cells is the same as in the '409 Patent, for which Patent Owner’s expert admitted that the trenches surrounding a unit cell define the shape of the cell. Ex. 1020 (Neikirk Tr.) at 18:16-19:2.

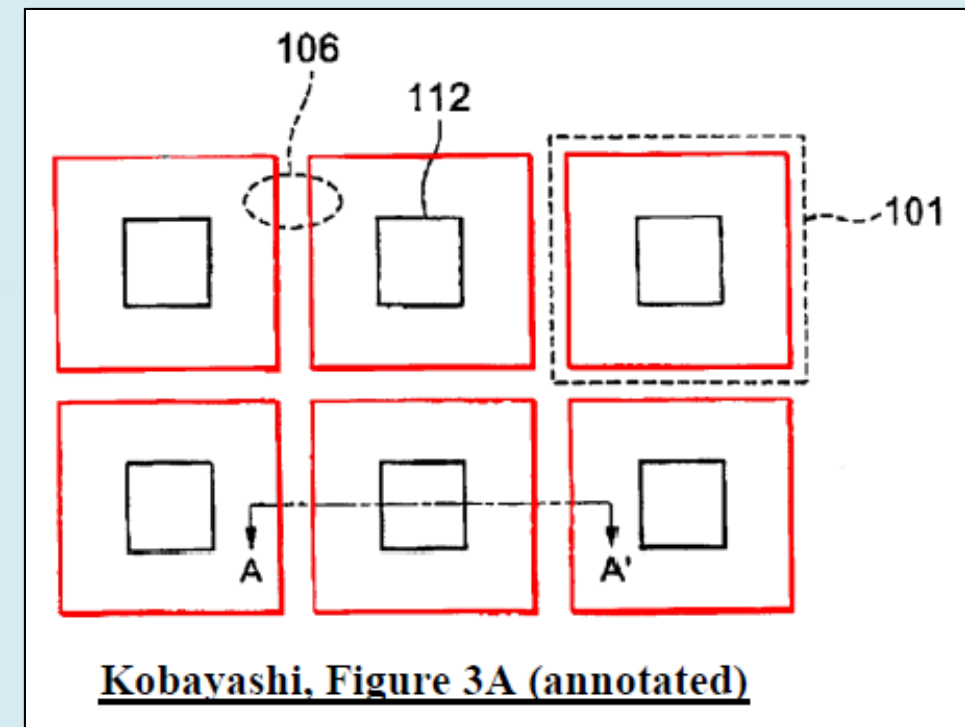
Paper 26, Reply, at 12

GROUND 1 – ANTICIPATION

*“Substantially Square-Shaped Cells With Rounded Corners” –
Board’s Preliminary Construction [Square Unit Cells]*

Accordingly, in both Kobayashi and the '409 Patent, the shape of the trench gates defines the shape of the unit cells, including their corners.

Paper 26, Reply, at 13



Paper 26, Reply, at 13

GROUND 1 – ANTICIPATION

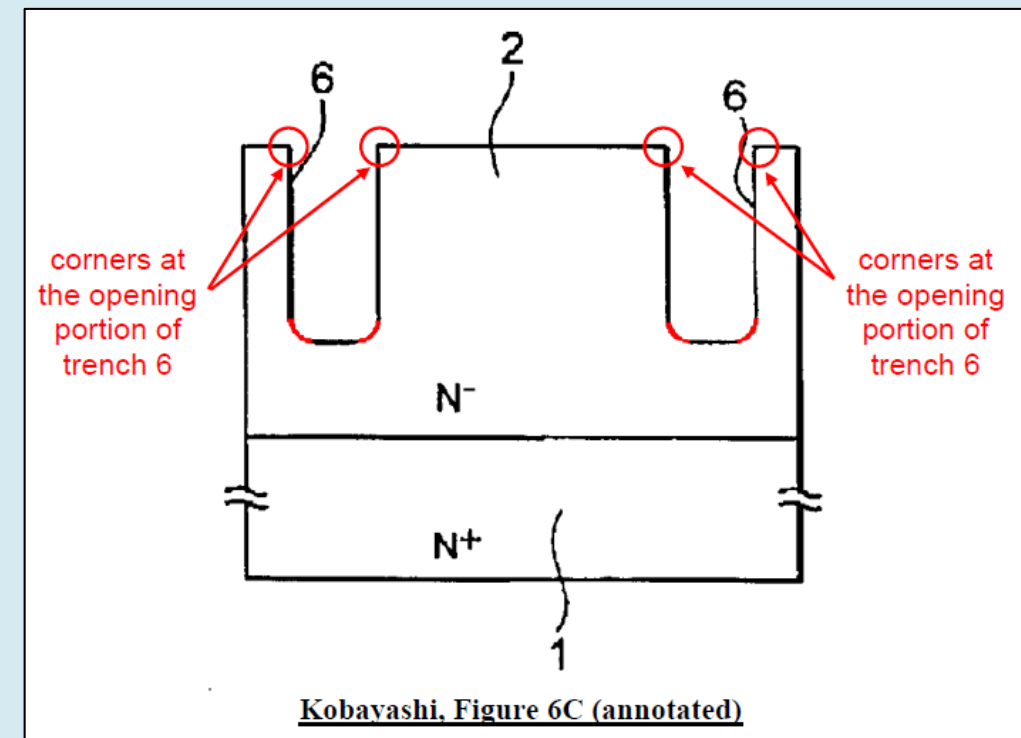
“Substantially Square-Shaped Cells With Rounded Corners” – Board’s Preliminary Construction [Square Unit Cells]

Kobayashi shows, in Figure 6C, that the “corners of each trench 6 at the bottom are rounded [and] corners of each trench 6 at an opening portion may also be rounded” Ex. 1005, 7:57—8:4.

Ex. 1003 at ¶ 69; Paper 1, Petition, at 27

The figures of Kobayashi do not illustrate this optional rounding of the corners at the openings of the trenches. However, the figures do show where these corners at the openings are located. For example, Figure 6C shows a side view of the corners at the openings of the trenches 6.

Paper 26, Reply, at 11



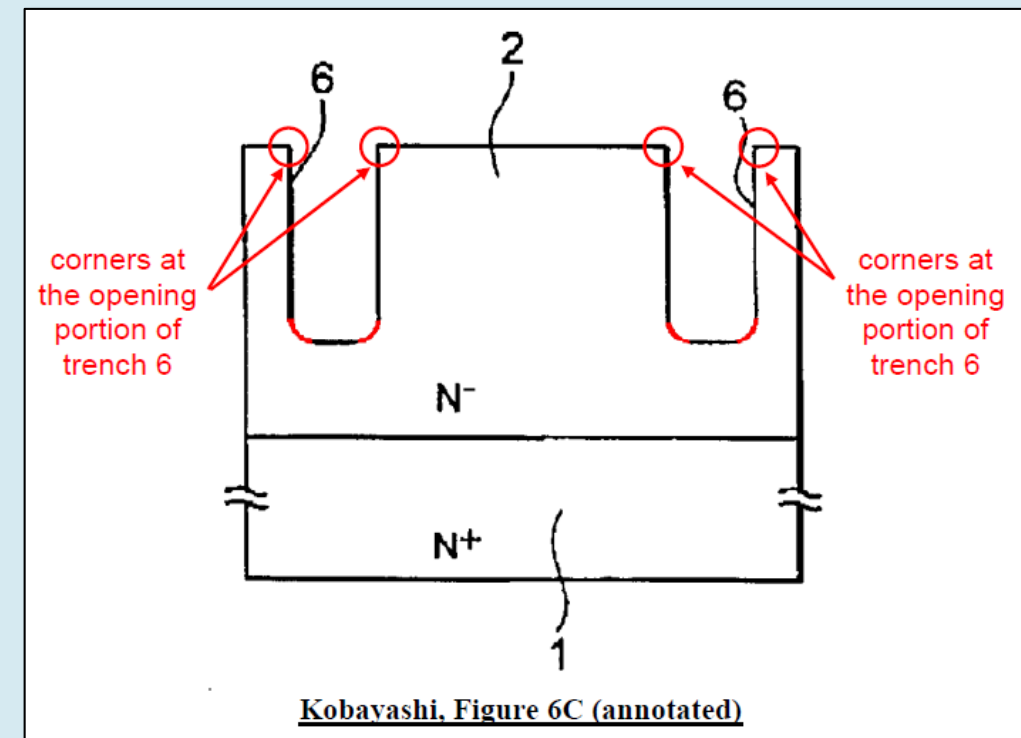
Paper 26, Reply, at 12

GROUND 1 – ANTICIPATION

“Substantially Square-Shaped Cells With Rounded Corners” – Board’s Preliminary Construction [Square Unit Cells]

Rounding the corners at the trench openings requires removing semiconductor material from the walls of the trenches 106 and 206 by etching or similar fabrication process, which results in rounding every corner of the cell defined by the surrounding trench, exactly as Kobayashi described. Ex. 1005 at 7:57-8:4; see also Paper 1 at 27.

Paper 26, Reply, at 13



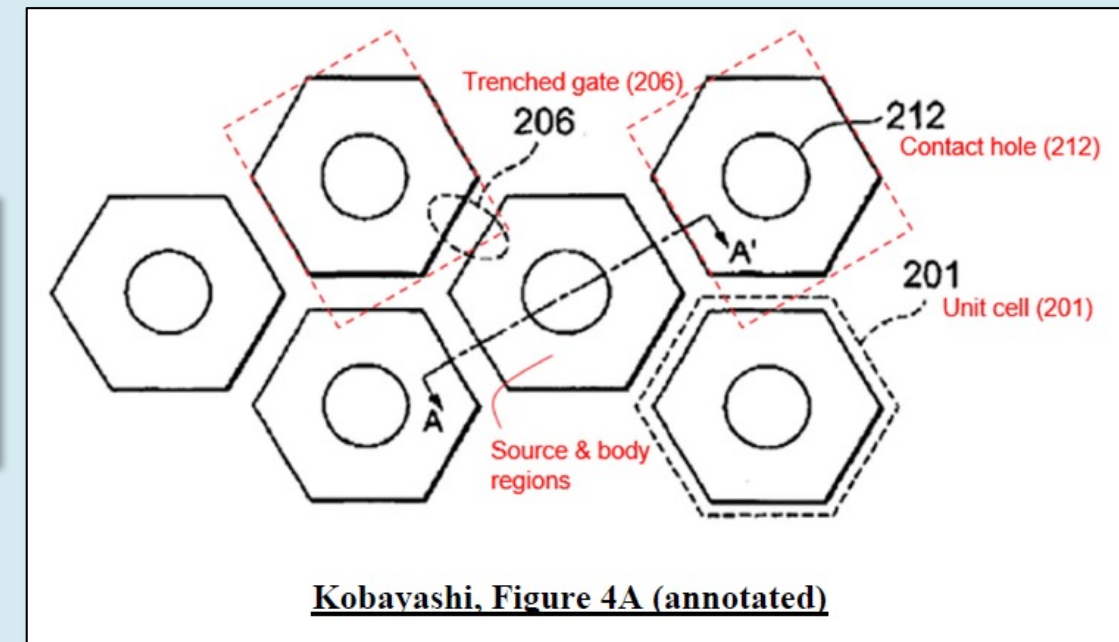
Paper 26, Reply, at 12

GROUND 1 – ANTICIPATION

“Substantially Square-Shaped Cells With Rounded Corners” – Board’s Preliminary Construction [Hexagonal Unit Cells]

Furthermore, as shown below in Kobayashi’s Figure 4A (annotated), Kobayashi discloses “a plurality of hexagonal cells”—i.e., substantially square cells with truncated corners. Ex. 1005, 6:30; Ex. 1003 ¶ 68.

Ex. 1003 at ¶ 68; Paper 1, Petition, at 26



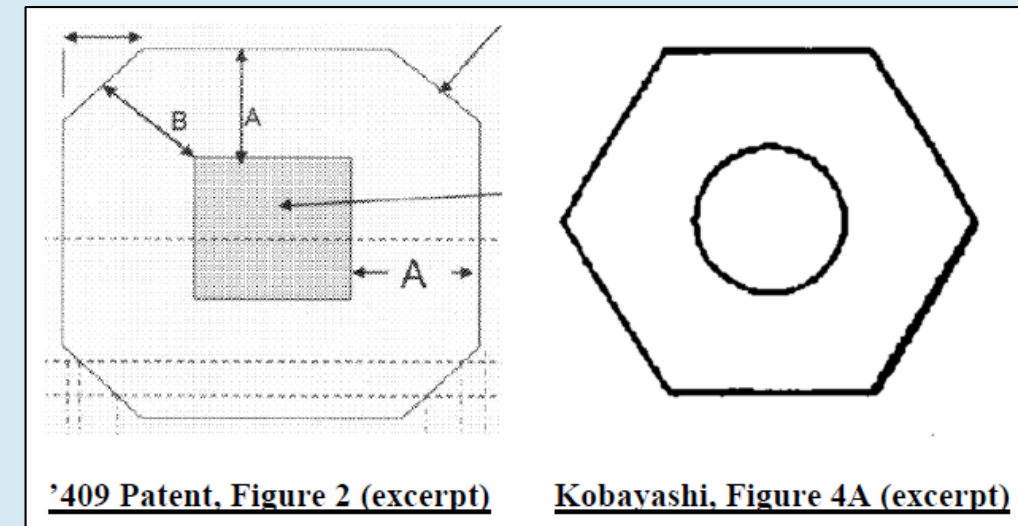
Ex. 1003 at ¶ 68; Paper 1, Petition, at 26

GROUND 1 – ANTICIPATION

“Substantially Square-Shaped Cells With Rounded Corners” – Board’s Preliminary Construction [Hexagonal Unit Cells]

Figure 2 of the '409 Patent and Figure 4A of Kobayashi both show substantially square-shaped transistor cells with truncated corners. In Figure 2 of the '409 Patent, the corners are truncated to form an octagon. In Kobayashi Figure 4A, the corners are truncated more to form a hexagon. Patent Owner cites nothing in the '409 Patent that limits *how* or *how much* the corners should be truncated.

Paper 26, Reply, at 8



Paper 26, Reply, at 8

GROUND 1 – ANTICIPATION

“Substantially Square-Shaped Cells With Rounded Corners” – Board’s Preliminary Construction [Hexagonal Unit Cells]

As Kobayashi explains, “unit cells 101, 201, and 301 in each figure can be defined as structural units separated by trenches 106, 206, and 306 where gate electrodes are to be formed.” Ex. 1005 at 6:32-35. This relationship between the trenches and cells is the same as in the '409 Patent, for which Patent Owner’s expert admitted that the trenches surrounding a unit cell define the shape of the cell. Ex. 1020 (Neikirk Tr.) at 18:16-19:2.

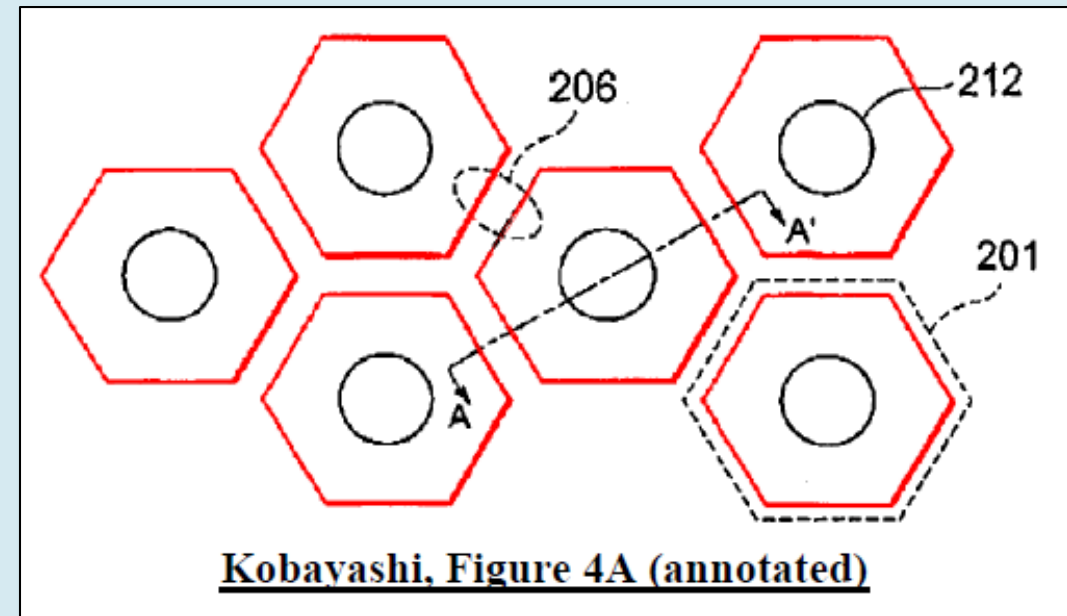
Paper 26, Reply, at 12

GROUND 1 – ANTICIPATION

*“Substantially Square-Shaped Cells With Rounded Corners” –
Board’s Preliminary Construction [Hexagonal Unit Cells]*

Accordingly, in both Kobayashi and the '409 Patent, the shape of the trench gates defines the shape of the unit cells, including their corners.

Paper 26, Reply, at 13



Paper 26, Reply, at 13

GROUND 1 – ANTICIPATION

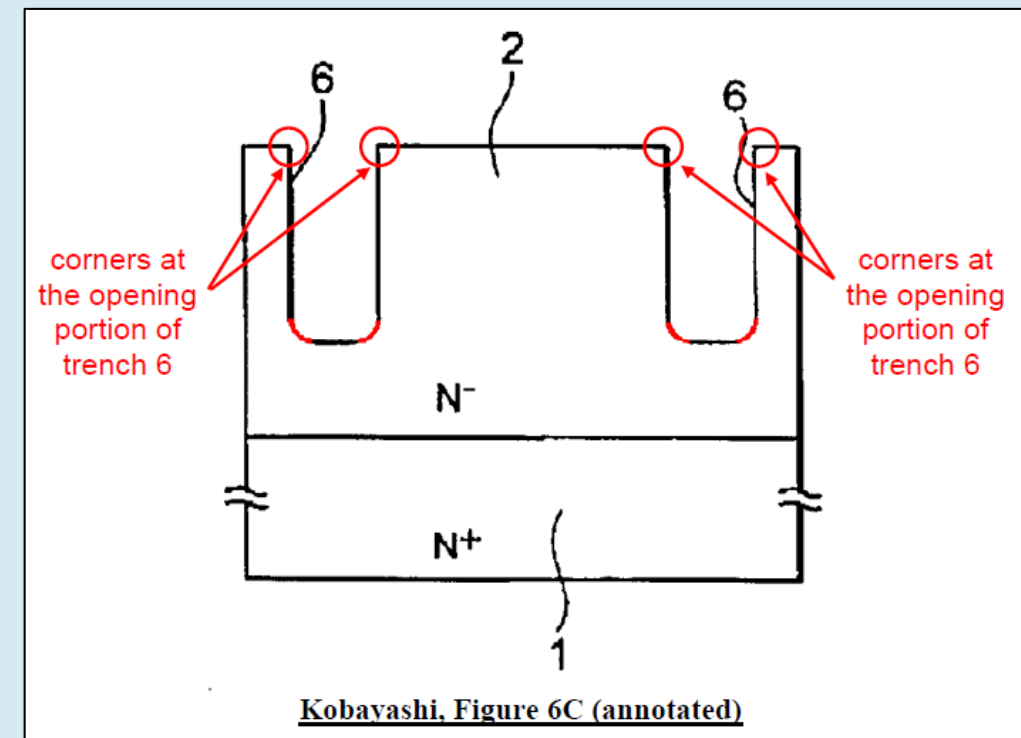
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Kobayashi shows, in Figure 6C, that the “corners of each trench 6 at the bottom are rounded [and] corners of each trench 6 at an opening portion may also be rounded” Ex. 1005, 7:57—8:4.

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Paper 26, Reply, at 11



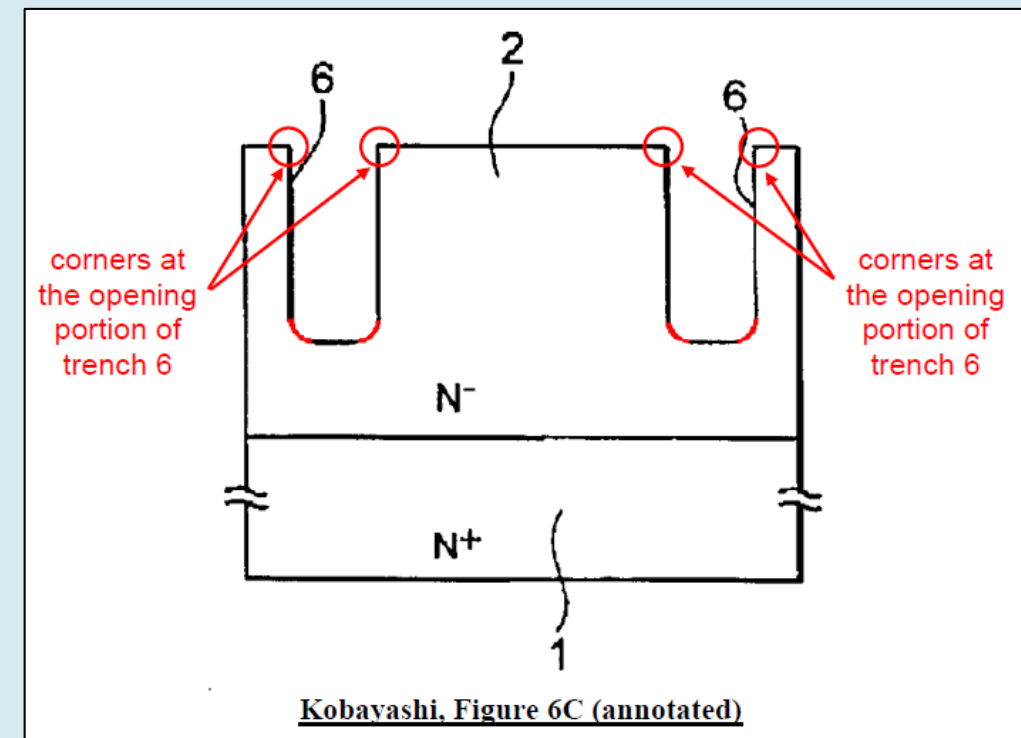
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GROUND 1 – ANTICIPATION

“Substantially Square-Shaped Cells With Rounded Corners” – Board’s Preliminary Construction [Hexagonal Unit Cells]

Rounding the corners at the trench openings requires removing semiconductor material from the walls of the trenches 106 and 206 by etching or similar fabrication process, which results in rounding every corner of the cell defined by the surrounding trench, exactly as Kobayashi described. Ex. 1005 at 7:57-8:4; see also Paper 1 at 27.

Paper 26, Reply, at 13



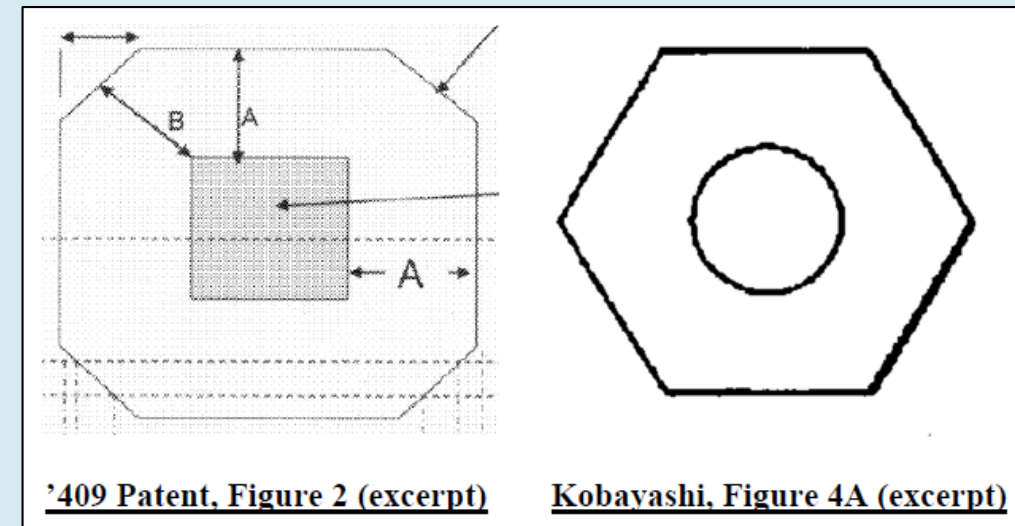
Paper 26, Reply, at 12

GROUND 1 – ANTICIPATION

“Substantially Square-Shaped Cells With Rounded Corners” – Board’s Preliminary Construction [Hexagonal Unit Cells]

Patent Owner further argues that “truncated corners are not rounded corners.” Paper 24 at 23. This is true, but **nothing in claim 1 *excludes* truncating the corners.** Indeed, the exemplary embodiment of the '409 Patent describes truncating the corners (Figure 2) as the first step toward rounding them (Figure 3A). Ex. 1001 at 4:53-62; *see also* Paper 1 at 5-6.

Paper 26, Reply, at 8



Paper 26, Reply, at 8

GROUND 1 – ANTICIPATION

“Substantially Square-Shaped Cells With Rounded Corners” – Rejected Constructions

In accordance with **Petitioner’s proposed construction**, Kobayashi taught truncating the corners of the cells in the design phase (Figure 4A) and then rounding them in the fabrication phase. Ex. 1005 at 7:59-60; *see also* Paper 1 at 26-27.

Paper 26, Reply, at 14

Finally, even if the Board changes course and adopts **Patent Owner’s proposal** that *all* corners must be rounded, Kobayashi taught that too. Kobayashi taught “corners *of each trench 6* at an opening portion may also be rounded, and nothing in Kobayashi suggests that this meant less than all corners. Ex. 1005 at 7:59-60.

Paper 26, Reply, at 14

GROUND 1 – ANTICIPATION

Kobayashi (Claims 1 and 3-5)

A. “said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with rounded corners” (Claim 1)

Paper 1, Petition at 25-27; Paper 26, Reply, at 3-14

B. “a diameter of a top surface of said circular trench contact is smaller than 1.0 micrometer” (Claim 5)

Paper 1, Petition at 35-36; Paper 26, Reply, at 15

C. Patent Owner only disputes that Kobayashi anticipates Claims 3-4 for the same reasons as Claim 1

Paper 26, Reply, at 15

“A Diameter Of A Top Surface Of Said Circular Trench Contact Is Smaller Than 1.0 Micrometer”

disclosed specific sizes for several features shown in Figure 5A, and each of those sizes is consistent with one another, establishing that the figure has a consistent relative scale. Paper 1 at 35-36. Thus, Figure 5A and Kobayashi's supporting disclosure demonstrate that the diameter of the top surface of the circular trench contact is less than 1.0 micrometer, as claim 5 requires. *Id.*

[illegible]

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GROUND 1 – ANTICIPATION

Kobayashi (Claims 1 and 3-5)

A. “said trenched gates surrounding said transistor cells as closed cells constituting substantially square-shaped cells with rounded corners” (Claim 1)

Paper 1, Petition at 25-27; Paper 26, Reply, at 3-14

B. “a diameter of a top surface of said circular trench contact is smaller than 1.0 micrometer” (Claim 5)

Paper 1, Petition at 35-36; Paper 26, Reply, at 15

C. Patent Owner only disputes that Kobayashi anticipates Claims 3-4 for the same reasons as Claim 1

Paper 26, Reply, at 15

UNPATENTABILITY: GROUND 2 [and 5]

Kobayashi in View of [Hshieh and] Kikkawa Renders Obvious Claims 2 and 6

Paper 1, Petition, at 36-49 and 63-67

Paper 26, Reply, at 16-21 and 25



Demonstrative Only – Not Evidence



GROUND 2 [and 5] – OBVIOUSNESS

*Kobayashi in View of [Hshieh and] Kikkawa Renders Obvious
(Claims 2 and 6)*

A. Combination of Kobayashi and Kikkawa discloses all elements of Claims 2 and 6

Ex. 1003 at ¶¶ 83-85, 87-94; Paper 1, Petition, at 37-41

B. Combination of Kobayashi, Hshieh and Kikkawa discloses all elements of Claims 2 and 6

Ex. 1003 at ¶¶ 144-155; Paper 1, Petition, at 63-67

C. Obvious to Combine Kobayashi, Hshieh and Kikkawa

Ex. 1003 at ¶¶ 86, 95-109, 146, 155; Paper 1, Petition, at 38, 41-49, 64, 67

GROUND 2 [and 5] – OBVIOUSNESS

Obvious to Combine Kobayashi [and Hshieh] and Kikkawa

Kikkawa shows that it was well known in the art, at least by the time of the filing of the '409 Patent, that an AlCu / AlSiCu metal layer could have a bottom layer made of titanium (e.g., Ti or TiN) designed as both an electro- and stress-migration resistant interconnection structure. Ex. 1007 p. 4. This would also reduce the contact resistance when the device undergoes electro-migration stress, which also would have been appreciated by a POSITA at the time of the filing of the '409 Patent (Dec. 4, 2006).

Ex. 1003 at ¶ 85; Paper 1, Petition, at 38

GROUND 2 [and 5] – OBVIOUSNESS

Obvious to Combine Kobayashi [and Hshieh] and Kikkawa

With respect to claim 6, Patent Owner challenges the combined teachings of Kobayashi and Kikkawa on two bases. First, Patent Owner challenges the teaching of square-shaped cells with truncated corners.” Paper 24 at 35-38. As explained above in connection with Ground 1, claim 1, Kobayashi taught hexagonal cells, which are “substantially square-shaped with truncated corners,” just like the octagonal cells described in the ’409 Patent.

Paper 26, Reply, at 20

GROUND 2 [and 5] – OBVIOUSNESS

Motivation to Combine Kobayashi [and Hshieh] and Kikkawa

The '409 Patent, Kobayashi, and Kikkawa are all directed to solutions to similar problems with semiconductor devices (including high power devices). These would include, for example, designing for electro- and stress migration resistant interconnection structures, which also serves to reduce the contact resistance when a device is undergoing electro-migration stress.

Ex. 1003 at ¶ 99; Paper 1, Petition, at 42

GROUND 2 [and 5] – OBVIOUSNESS

Motivation to Combine Kobayashi [and Hshieh] and Kikkawa

For example, it was well known to a POSITA that adding a titanium (Ti) or titanium nitride (TiN) layer to the bottom of Kobayashi's source metal layer would improve the reliability of the metal layer through the reduction of stress-induced electro-migration, which would also result in reduced contact resistance between metal layers and also reinforce the mechanical strength of the source metal layer. Ex. 1007 at 4. A POSITA would know that the resultant composite interconnect structure of adding a titanium (Ti) or titanium nitride (TiN) with AlSi/AlSiCu will have higher electrical and mechanical endurance in comparison to AlCu/AlSiCu single layer. This would yield a contact resistance that is more stable and lower over time.

Ex. 1003 at ¶ 101; Paper 1, Petition, at 43

GROUND 2 [and 5] – OBVIOUSNESS

Motivation to Combine Kobayashi [and Hshieh] and Kikkawa

Kikkawa expressly teaches that Ti and TiN barrier layers combined with an AlSiCu metal layer in a semiconductor structure reduces contact resistance and addresses problems with electro-migration. Ex. 1007 at 4. As explained in Kikkawa, the addition of the TiN / Ti layers as a bottom layer to the source metal of Kobayashi would further achieve the aim set out by Kikkawa.

Ex. 1003 at ¶ 103; Paper 1, Petition, at 43-44

GROUND 2 [and 5] – OBVIOUSNESS

Motivation to Combine Kobayashi [and Hshieh] and Kikkawa

A POSITA at the time of the filing of the '409 Patent (Dec. 4, 2006), would have understood how to combine Kobayashi and Kikkawa using known techniques for improving similar devices in the same way.

Ex. 1003 at ¶ 104; Paper 1, Petition, at 44-45

A POSITA at the time of the filing of the '409 Patent (Dec. 4, 2006), would have understood combining the teachings of Kobayashi and Kikkawa as a known technique being applied to a known device that was ready for improvement and that the combination would yield predictable results.

Ex. 1003 at ¶ 105; Paper 1, Petition, at 45-46

To a POSITA, combining Kobayashi and Kikkawa would involve combining familiar elements using known methods for predictable results.

Ex. 1003 at ¶ 106; Paper 1, Petition, at 46

GROUND 2 [and 5] – OBVIOUSNESS

Motivation to Combine Kobayashi [and Hshieh] and Kikkawa

A POSITA would have known how to modify Kobayashi in view of Kikkawa's teachings in the same field. And a POSITA would have been motivated to do so based on design incentives or other market forces. Further, this modification would have been predictable to a POSITA.

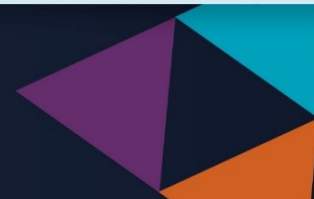
Ex. 1003 at ¶ 107; Paper 1, Petition, at 46-47

UNPATENTABILITY: GROUND 3 [and 6]

Kobayashi in View of [Hshieh and] the Knowledge of a POSITA Renders Obvious Claim 5

Paper 1, Petition, at 49-51 and 67

Paper 26, Reply, at 21-22 and 25



Demonstrative Only – Not Evidence



GROUND 3 [and 6] – OBVIOUSNESS

Obvious to Combine Kobayashi [and Hshieh] and the Knowledge of a POSITA

When considering the relative proportions of the MOSFET of Figure 5A (annotated below), a POSITA would have understood that the diameter of the circular trench contact is approximately the same as the width as the trench 6 (which Kobayashi teaches can be a width less than 1.0 μm). Ex. 1005, 7:34-55; Ex. 1003 ¶ 110. In addition, a POSITA would understand several design considerations that would result in a diameter of less than 1 μm . For example, a POSITA would consider the need to minimize the overall width of the cell and minimize the width of the source contact trench for purposes of an easier subsequent filling of the source contact trench without having voids or unwanted variations in the topography. Ex. 1003 ¶ 111.

Paper 1, Petition, at 50; Ex. 1003 at ¶¶ 111-115

UNPATENTABILITY: GROUND 4

Kobayashi in View of Hshieh Renders Obvious Claims 1 and 3-5

Paper 1, Petition, at 51-63

Paper 26, Reply, at 22-24



Demonstrative Only – Not Evidence



GROUND 4 – OBVIOUSNESS

Kobayashi in View of Hshieh (Claims 1 and 3-5)

A. Combination of Kobayashi and Hshieh discloses “substantially square shaped cells with rounded corners” (Claim 1)

Paper 1, Petition at 56-63; Paper 26, Reply, at 22-24

B. Kobayashi discloses the elements of Claims 3-5

Paper 1, Petition at 55-56; Paper 26, Reply, at 24

GROUND 4 – OBVIOUSNESS

“Substantially Square-Shaped Cells With Rounded Corners”

- Kobayashi discloses cell layouts having trenched gates surrounding transistor cells as closed cells constituting substantially square-shaped cells
 - *Square unit cells arranged in a matrix (Fig. 3A)*
 - *Hexagonal unit cells arranged in a matrix (Fig. 4A)*
- Hshieh discloses rounding the corners of transistor cells
- Obvious to combine Kobayashi with Hshieh to achieve “substantially square shaped cells with rounded corners”

Paper 1, Petition at 25-27, 51-54, 56-63; Paper 26, Reply, at 22-24

GROUND 4 – OBVIOUSNESS

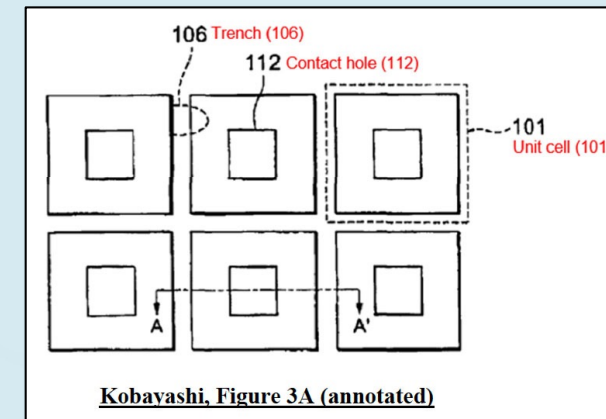
“Substantially Square-Shaped Cells With Rounded Corners”

Kobayashi discloses “a plurality of *square cells* [that] are arranged in a matrix” in Figure 3A. Ex. 1005, 6:26—27 (emphasis added).

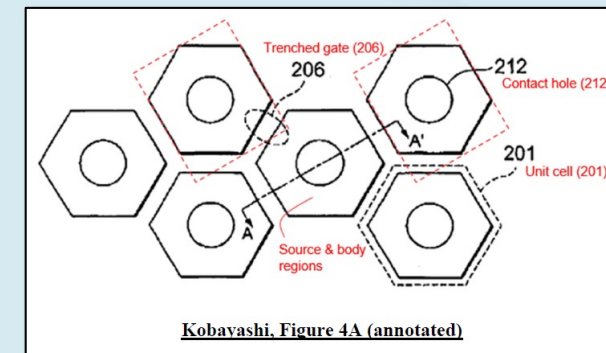
Ex. 1003 at ¶ 67; Paper 1, Petition, at 25

Furthermore, as shown below in Kobayashi’s Figure 4A (annotated), Kobayashi discloses “a plurality of hexagonal cells”—i.e., substantially square cells with truncated corners. Ex. 1005, 6:30; Ex. 1003 ¶ 68.

Ex. 1003 at ¶ 68; Paper 1, Petition, at 26



Ex. 1003 at ¶ 67; Paper 1, Petition, at 26



Ex. 1003 at ¶ 68; Paper 1, Petition, at 26

GROUND 4 – OBVIOUSNESS

“Substantially Square-Shaped Cells With Rounded Corners”

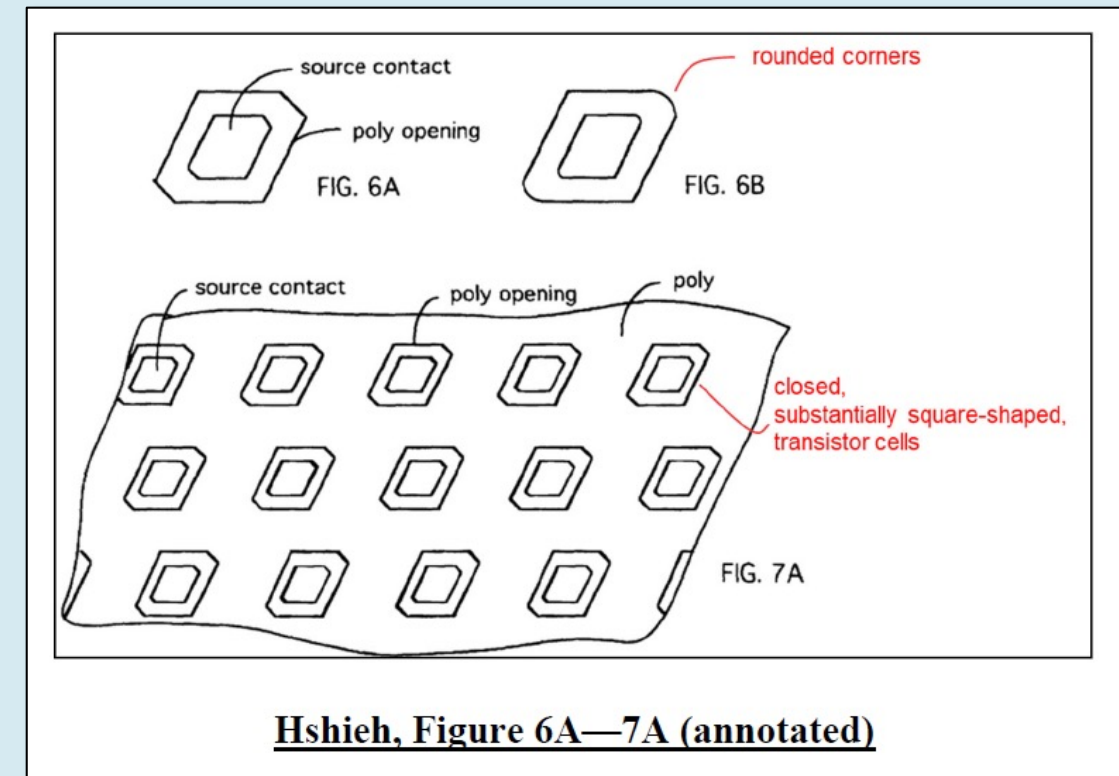
Hshieh also discloses rounding the corners of transistor cells. Ex. 1006, 5:3-28. Hshieh Figure 6A—7A (annotated below) shows transistor cells that are closed cells constituting cells with multiple truncated and rounded corners.

Ex. 1003 at ¶ 121; Paper 1, Petition, at 54



Of note, Petitioner also cites to Figures 8A and 8B, which illustrate similar cells having **all four corners rounded**.
Pet. 59; Ex. 1003 ¶ 137.

Paper 9, Institution Decision, at 12



Ex. 1003 at ¶ 121; Paper 1, Petition, at 54

GROUND 4 – OBVIOUSNESS

“Substantially Square-Shaped Cells With Rounded Corners” – Motivation To Combine

The '409 Patent, Kobayashi, and Hshieh are all directed to semiconductor structures. Therefore, these references are analogous art in the same field of endeavor. More specifically, the '409 Patent relates to “the cell structure, device configuration and fabrication process of power semiconductor devices.” Ex. 1001, 1:7-9. Kobayashi also relates to “a vertical MOSFET (Metal Oxide Semiconductor Field Effect Transistor) reduced in cell size . . . and a method of producing the same.” Ex. 1005, 1:7-12–6. Hshieh also relates to a “power transistor cell[s] supported on a semiconductor substrate.” Ex. 1006, Abstract.

Ex. 1003 at ¶ 132; Paper 1, Petition, at 56-57

GROUND 4 – OBVIOUSNESS

“Substantially Square-Shaped Cells With Rounded Corners” – Motivation To Combine

The '409 Patent, Kobayashi, and Hsieh are all directed to solutions to similar problems with semiconductor devices (including high power devices). This includes solutions for vulnerabilities at the corners of square cells in semiconductor devices. The corners of such square cells tend to induce higher peak electric fields, leading to a low avalanche breakdown voltage, which is undesirable.

Ex. 1003 at ¶ 133; Paper 1, Petition, at 57-58

GROUND 4 – OBVIOUSNESS

“Substantially Square-Shaped Cells With Rounded Corners” – Motivation To Combine

The '409

Patent acknowledges that square cell configurations with sharp corners in the prior art cause **low avalanche current** and reduced device ruggedness due to the parasitic N+PN latches near the corners. Ex. 1001 1:15-62.

Ex. 1003 at ¶ 133; Paper 1, Petition, at 57-58

In support of

rounding the corners of the trenches in the square cells, Kobayashi cites to Sang-Gi Kim et al's paper (Ex. 1012). In the cited paper, Kim et al discuss the benefits of trench corner rounding leading to **higher breakdown voltage and lower leakage current**—the same benefits discussed in the '409 Patent. Ex. 1005, 7:57-8:4; Ex. 1012.

Ex. 1003 at ¶ 133; Paper 1, Petition, at 57-58

Hshieh also discloses **vulnerable punch-through weak points** in the corners of square cell. Again this is due to an **undesirable higher peak electric field** being reached due to the same corner effect. Ex. 1006, 2:19-39.

Ex. 1003 at ¶ 133; Paper 1, Petition, at 57-58

GROUND 4 – OBVIOUSNESS

“Substantially Square-Shaped Cells With Rounded Corners” – Motivation To Combine

Hshieh expressly teaches the benefits of rounding the corners of square cells. Ex. 1006, 5:3-17, Figs. 6A-8B. A POSITA would have appreciated that combining (1) rounding the corners (as disclosed by Hshieh) with (2) the truncated corners Kobayashi, would further achieve the benefits taught in Hshieh.

Ex. 1003 at ¶ 137; Paper 1, Petition, at 59

A POSITA at the time of the filing of the '409 Patent (Dec. 4, 2006), would have understood how to combine Kobayashi and Hshieh using known techniques for improving similar devices in the same way.

Ex. 1003 at ¶ 138; Paper 1, Petition, at 59-60

GROUND 4 – OBVIOUSNESS

“Substantially Square-Shaped Cells With Rounded Corners” – Motivation To Combine

Patent Owner contends that Petitioner ignores differences between Hshieh and the claimed invention. Paper 24 at 52-54. **None of the purported differences Patent Owner highlights are relevant here.** Petitioner relies on Hshieh solely for its teaching that rounding sharp corners helps prevent corner vulnerability due to punch through. To the extent Kobayashi did not already teach the Kobayashi’s transistor cells would have been obvious to a POSITA for the reasons expressly discussed in Hshieh. For the same reason, Petitioner is not engaging in improper hindsight because the motivation to combine was express.

Paper 26, Reply, at 22

GROUND 4 – OBVIOUSNESS

“Substantially Square-Shaped Cells With Rounded Corners” – Motivation To Combine

Patent Owner contends that Hshieh’s teachings regarding the “three dimensional diffusion” phenomenon are inapplicable to Kobayashi. Paper 24 at 54-60. Patent Owner’s argument, which the Board preliminarily rejected, again fails for the simple reason that both Kobayashi and Hshieh faced the problem of “punch-through” at sharp cell corners.

Paper 26, Reply, at 22

⁴ One claim of Hsieh does recite a trench gate with rounded corners. Ex. 1006, cl. 37. However, neither Hsieh itself, nor Petitioner, nor Dr. Liu, provide any explanation how rounded corners would be beneficial for a trench gate MOSFET.

Ex. 2021 at 74 n.4

GROUND 4 – OBVIOUSNESS

“Substantially Square-Shaped Cells With Rounded Corners” – Motivation To Combine

Patent Owner also seems to suggest that there can be no motivation to modify Kobayashi with Hsieh’s rounded corners because Kobayashi allegedly does not disclose this feature in the first place. That clearly is not the test for obviousness.

Paper 26, Reply, at 22

GROUND 4 – OBVIOUSNESS

“Substantially Square-Shaped Cells With Rounded Corners” – Motivation To Combine

Nor is there any merit to Patent Owner’s argument that the combination of Kobayashi and Hshieh would render Hshieh inoperable. Petitioner has not argued that Hshieh’s non-orthogonal parallelogram cells should be modified. Instead, as discussed above, Petitioner relies on the teachings of Hshieh regarding the benefits of rounding sharp cell corners to modify Kobayashi’s square cells. Paper 1 at 54.

Paper 26, Reply, at 23