

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY
LIMITED,

Petitioner,

v.

ALIDDOUBLE, INC.

Patent Owner.

IPR2023-00373
U.S. Patent No. 9,431,455

PATENT OWNER'S PRELIMINARY RESPONSE

UNDER 37 C.F.R. § 42.107

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2001	Characteristics of SiOxNy films deposited by inductively coupled plasma enhanced chemical vapor deposition using HMDS/NH3/O2/Ar for water vapor diffusion barrier (September 2006)
2002	SiOxNy thin film deposited by plasma enhanced chemical vapor deposition at low temperature using HMDS–O2–NH3–Ar gas mixtures (September 2006)
2003	Formation of size-controlled silicon nanocrystals in plasma enhanced chemical vapor deposition grown SiOxNy/SiO2 superlattices (2011)
2004	On the nitrogen and oxygen incorporation in plasma-enhanced chemical vapor deposition (PECVD) SiOxNy films (October 2001)
2005	US Patent No. 3,849,204
2006	OXIDATION OF SILICON (OXY)NITRIDE AND NITRIDATION OF SILICON DIOXIDE: MANIFESTATIONS OF THE SAME CHEMICAL REACTION SYSTEM? (1990)
2007	Oxidation of silicon nitride films in an oxygen plasma (March 1999)
2008	Physical and electrical characterisation of oxynitride films produced by plasma oxidation of deposited silicon nitride layers (1995)
2009	Suppression of hydrogen-ion drift into underlying layers using plasma deposited silicon oxynitride film during high-density plasma chemical vapor deposition (November 2006)
2010	<i>Alidouble Inc., v. Taiwan Semiconductor Manufacturing Company Limited.</i> , Case No. 2:22-cv 00298-JRG (E.D. Tex), Docket Control Order.

Alidouble, Inc. (“Patent Owner” or “Alidouble”) submits this Preliminary Response to the Petition of Taiwan Semiconductor Manufacturing Company Limited (“Petitioner” or “TSMC”) seeking *inter partes* review (“IPR”) of claims 1–3, 5–12, and 15–19 (“the Challenged Claims”) of U.S. Patent No. 9,431,455 (“the ’455 patent”). For purposes of this Preliminary Statement, Alidouble addresses some but not all of Petitioner’s arguments. Alidouble does not concede any of Petitioner’s arguments that are not addressed in this Preliminary Response.

I. INTRODUCTION

The Board should deny institution under *Apple, Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (P.T.A.B. Mar. 20, 2020) (designated precedential May 5, 2020) and related guidance from the Director. The ongoing parallel district court litigation will likely be completed about three months before any Final Decision. Petitioner has not moved for a stay nor argued that it will move for a stay should institution be granted. Institution should be denied because an IPR “would not ... provide an effective and efficient alternative to the district court litigation.” *NHK Spring Co. v. Intri-Plex Techs., Inc.*, IPR2018-00752, 2018 WL 4373643, at *7 (P.T.A.B. Sep. 12, 2018) (precedential) (citations omitted). Also, Petitioner’s argument regarding its so-called “stipulation” falls far short of that considered by the Board in *Sotera*, which is not the type of “stipulation” that should preclude discretionary denial. *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (P.T.A.B. Dec. 1, 2020)

(designated precedential as of Dec. 17, 2020).

Further, the Petition should be denied on the merits. Petitioner argues that the independent claim 1 is anticipated by Oshima or Nagai. Petitioner's assertions are wrong because the material limitation regarding that there is no cap layer over the uppermost metallization layer in claim 1 is not disclosed by the cited references. As the independent claim 19 recites the same no cap layer limitation, claim 19 would not be disclosed by Oshima for the same reason. The last independent claim 17 would not be rendered obvious because there would be no motivation to combine Nagai and Omi.

Because the Petition does not meet its burden of demonstrating that there is a "reasonable likelihood" that Petitioner would prevail as to at least one of the claims challenged, institution must be denied.

II. BACKGROUND

A. The '455 patent

The '455 patent titled "Back-end Processing Using Low-Moisture content Oxide Cap Layer" was filed on November 9, 2014, and issued to Amos Fenigstein, Yakov Roizin, and Avi Strum on August 30, 2016. Ex. 1001. The '455 patent is directed to semiconductor fabrication processes, particularly to back-end-of-the-line (BEOL) processes. *Id.*, 1:7–9. The '455 patent is directed to fabricating image sensors with structures/processes that control the hydrogen level at a beneficial level,

instead of blocking hydrogen altogether. Hydrogen is generated in semiconductor devices through residual or environmental moisture. *See Id.*, 2:54–57 (“it is apparent that the generation of hydrogen takes place if aluminum is disposed over the dielectric, possibly through a reaction with residual moisture contained in the dielectric”); 4:42-44 (“particularly H⁺ ions [i.e. hydrogen] generated by back-end processing involving aluminum interactions with residual moisture disposed in ILD layers”); 5:61-64 (“TEOS-based oxides contain large amounts of moisture that produces hydrogen in charged and neutral states (i.e., atomic hydrogen and hydrogen positively charged ions) during each back-side aluminum etch process.”).

The abstract of ‘455 discloses “[a] method for fabricating *image sensors* and other semiconductor ICs that **controls the amount of hydrogen** generated during back-end processing.” *Id.*, Abstract. Instead of blocking the generation and migration of hydrogen altogether, the ‘455 patent describes that “[w]hat is needed is a modified back-end processing methodology and associated modified back-end metallization structure that facilitates **control** over the generation and migration of mobile hydrogen atoms/ions, thus improving a semiconductor device's operating performance (e.g., improving image quality of CMOS image sensors).” *Id.*, 4:45-50. The ‘455 patent discloses “[a]ccording to an exemplary embodiment set forth below, the present invention is described with reference to the fabrication of a semiconductor integrated circuit (IC) including an image sensor using a CMOS

process flow in which the back-end process is modified to **control** the amount of hydrogen generated during aluminum over-etch, whereby dark current in the image sensor is decreased and radiation hardness is improved by way of utilizing a cap layer consisting of low-moisture-content oxide in at least one of the metallization layers forming the back-end metallization structure.” *Id.*, 10:11-21.

The ‘455 patent discloses that “in cases where provides beneficial operating characteristics (e.g., in the case of image sensors, where limited hydrogen ion production is believed to be beneficial), hydrogen production is “**tuned**,” e.g., by alternating high-density low-moisture content oxide cap layers with TEOS cap layers (e.g., forming “even” numbered metallization layers with TEOS cap layers, and forming “odd” numbered metallization layers with silane oxide cap layers), whereby beneficial levels of hydrogen production are achieved and harmful levels of hydrogen are avoided.” *Id.*, 6:62-7:5. The ‘455 patent further discloses “[t]he inventors found that image sensor performance is connected with the amount of hydrogen in a certain area of the device (e.g., center or periphery of a CMOS image sensor array), and also to the form of hydrogen (atomic hydrogen, attached atomic hydrogen, H⁺ ions, etc.). By utilizing the methodologies associated with the present invention, the amount of hydrogen and its form can be precisely controlled (“tuned”) to achieve both low initial dark currents and high radiation immunity.” *Id.*, 7:5-13.

Thus, POSA would understand that the ‘455 patent intends to **generate**

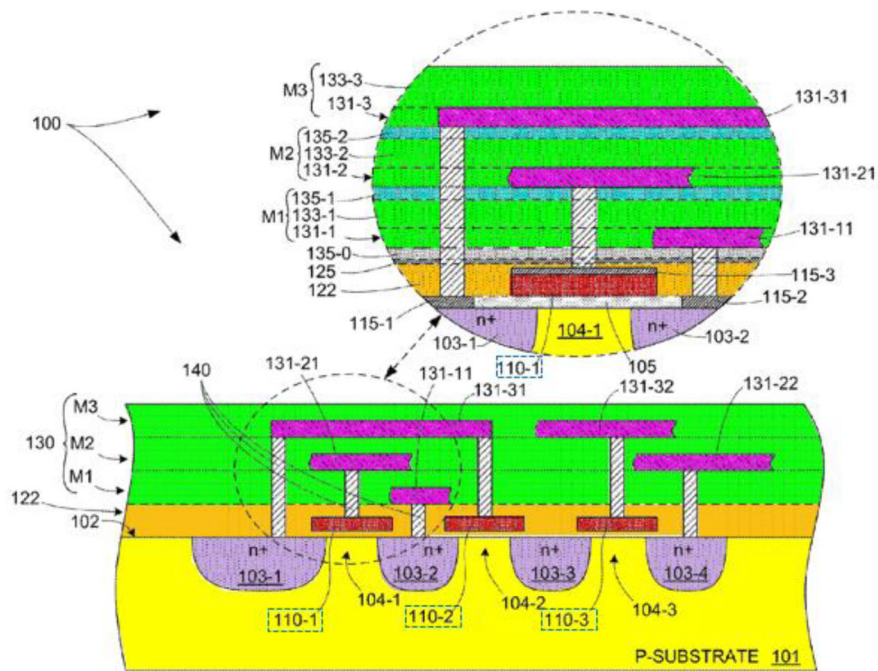
beneficial levels of hydrogen in a controlled manner instead of completely preventing the generation and diffusion/migration of the hydrogen to the front-end structures/circuit elements.¹ *E.g., id.*, Abstract; 1:7–9; 2:19–24; 5:33–36; 6:10–14; 6:30–33; 6:50–7:13. The cap layer (i.e., the layer 135-1, 135-2) serves as an etch-stop for the subsequently-formed metal layer of a next metallization layer by isolating the underlying Interlevel dielectric (ILD) material from the plasma environment during aluminum over-etch, which controls the production and diffusion of hydrogen into front-end structures. *Id.*

The structure of a semiconductor device of the '455 patent is illustrated in FIG. 2 as reproduced below. In the front-end-of-the-line (FEOL) processes, doped diffusion regions are formed in a semiconductor substrate 101, and then polycrystalline silicon structures are formed on respective gate oxide structures on an upper surface 102. *Id.*, 11:62–67. A pre-metal dielectric layer 122 is then deposited over the polycrystalline silicon structures.

In the BEOL processes, metallization layers M1, M2, and M3 (magenta) are sequentially formed in a stack arrangement over the pre-metal dielectric layer 122.

¹ In contrast to controlling the hydrogen level at a beneficial level as disclosed by the '455 patent, the primary references Oshima and Nagai cited by the Petitioner both seek to completely block off the hydrogen. This is one of the reasons why Oshima and Nagai must include a cap layer over the uppermost metallization layer, against the limitation [1e] “forming a cap layer ... *except an uppermost said metallization layer* [emphasis added]” of claim 1 of the '455 patent.

Id., 10:47–53. Each metallization layer further includes a patterned metal structure covered by an ILD layer. *Id.*, 10:53–62. Cap layers 135-1 and 135-2 are formed on ILD layers 133-1 and 133-2 **except the uppermost/last metallization layer M3.** *E.g., id.*, 5:4–12; 6:25-34; 10:56-62; 15:22-25. Petitioner also admits that the ‘455 patent does not have a cap layer in the uppermost metallization layer M3 as shown in the figure reproduced below from the Petition (no “blue” layer in M3).



Pet. at 8.

The PTO’s publicly accessible patent assignment records indicate that inventors Amos Fenigstein, Yakov Roizin, and Avi Strum assigned the entire right, title, and interest in the ‘455 patent to Tower Semiconductor Ltd. (reel 034131; frame 0905), which assigned its entire right, title and interest to Keystone Intellectual Property Management Limited (reel 057110; frame 0190), which subsequently

assigned the '455 patent to Alidouble (reel 058130; frame 0548). As a result, Alidouble owns the entire right, title, and interest in the '455 patent.

B. The '455 patent claims

The patent contains 19 claims, with claims 1, 17, and 19 being independent. Independent claim 1 is reproduced below. The limitations for claim 1 are identified below consistent with the Petition for ease of reference.

U.S. Patent No. 9,431,455	
Claim 1	
1pre	A method for fabricating a semiconductor integrated circuit, the method comprising:
1a	generating front-end structures including one or more doped diffusion regions disposed in a semiconductor substrate, one or more polycrystalline silicon structures disposed over a surface of the substrate, and a pre-metal dielectric layer over the one or more polycrystalline silicon structures;
1b	forming a plurality of metallization layers over the pre-metal dielectric layer, wherein forming at least one of said metallization layers includes:
1c	forming a patterned metal structure;
1d	forming an interlevel dielectric (ILD) layer comprising a TEOS-based oxide over the patterned metal structure; and
1e	forming a cap layer over the ILD layer over said ILD layer of all of said plurality of metallization layers except an uppermost said metallization layer,
1f	wherein forming the cap layer comprises forming a high-density, low-moisture content oxide material having a minimum thickness of 100 Å.

C. Parallel District Court Proceedings

The '455 patent is presently at issue in the following district court litigation brought by Patent Owner against Petitioner for infringement of several patents, including the '455 patent: *Alidouble Inc., v. Taiwan Semiconductor Manufacturing Company Limited.*, United States District Court for the Eastern District of Texas, Case No. 2:22-cv 00298-JRG. Patent Owner filed the lawsuit against Petitioner in August 2022 for infringement of several patents, including the '455 patent, for its use of and sale of products incorporating accused image sensors made by Petitioner. The Court has entered docket control and discovery orders (Dkt. 39). Ex. 2010. Invalidity and infringement contentions have been exchanged, written discovery has been served and responded to, and the parties are now fully engaged in remaining fact discovery and claim construction. Jury selection is set for May 6, 2024. *Id.* at 1.

D. Petitioner's Arguments

Petitioner asserts that the Challenged Claims of the '455 Patent are obvious in light of seven references on eight different grounds:

- Certified English Translation of JPH11-284067 ("Oshima") [Ex. 1005]
- U.S. Patent No. 7,598,557 ("Nagai") [Ex. 1006]
- U.S. Patent Publication No. 2009/0072282 ("Lee") [Ex. 1007]
- U.S. Patent No. 9,165,762 ("Crook") [Ex. 1008]

- European Patent Publication No. 1,065,714 (“Miyazaki”) [Ex. 1009]
- U.S. Patent No. 7,803,647 (“Wang”) [Ex. 1010]
- U.S. Patent No. 7,816,749 (“Omi”) [Ex. 1011]

Petitioner asserts the following Grounds:

Ground	Claims	Statutory Basis	References
1	1, 5, 6, 9, and 19	§102	Oshima
2	2, 3, 7	§103	Oshima and Lee
3	10	§103	Oshima and Crook
4	1, 8, and 11	§102	Nagai
5	12	§103	Nagai and Miyazaki
6	15	§103	Nagai and Lee
7	16	§103	Nagai and Wang
8	17, 18	§103	Nagai and Omi

III. PERSON OF ORDINARY SKILL IN THE ART (“POSA”)

Petitioner asserts that a POSA “would have been a person having a Master’s degree in Electrical Engineering, Chemical Engineering, Materials Science, or Physics and three to five years of industry experience in integrated circuit design, layout, packaging or fabrication; or a Ph.D. specializing in the field.,” and further asserts that “a greater level of experience may compensate for less education, and vice versa.” Pet. at 10. Patent Owner reserves the right to dispute Petitioner’s definition of a POSA if an IPR is instituted. For present purposes, this Response establishes that Petitioner’s arguments fail even under its proffered definition of a POSA.

IV. CLAIM CONSTRUCTION

Except the claim 19 preamble, “silane oxide,” and “TEOS-based oxide,” Petitioner states that “Petitioner has applied the ordinary and customary meaning as it would have been understood by a person of ordinary skill in the art at the time of the alleged invention, in the context of the ’455 patent and its prosecution history.” Pet. at 10-11. The Petition should be denied regardless of Petitioner’s claim construction, and patent Owner reserves the right to advance its own construction for any claim term should an IPR be instituted.

V. THE BOARD SHOULD EXERCISE ITS DISCRETION TO DENY INSTITUTION

Whether to institute an IPR is “a matter committed to the Patent Office’s discretion.” *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2140 (2016). The Board should exercise its discretion and deny this petition under 35 U.S.C. § 314(a) because it would be a waste of the Board’s resources and fundamentally unfair to Patent Owner to institute trial when a final written decision would issue after the conclusion of the same validity challenge in overlapping district court litigation. In *Apple, Inc.*, the Board stated that the following factors are relevant to a determination of whether the Board should exercise discretion not to institute a petition in view of parallel district court proceedings on the same patent:

1. whether the court granted a stay or evidence exists that one may be granted if a proceeding is instituted;

2. proximity of the court's trial date to the Board's projected statutory deadline for a final written decision;
3. investment in the parallel proceeding by the court and the parties;
4. overlap between issues raised in the petition and in the parallel proceeding;
5. whether the petitioner and the defendant in the parallel proceeding are the same party; and
6. other circumstances that impact the Board's exercise of discretion, including the merits.

On June 1, 2022, the Director issued a guidance, which stated that the PTAB will not rely on the *Fintiv* factors where a petition presents compelling evidence of unpatentability. See Memorandum from USPTO on Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation (June 21, 2022), at 2. For the reasons set forth below, the Petition in this case does not present compelling evidence.

In this case, Patent Owner first sued Petitioner for infringement of the patent-at-issue on December 14, 2021. That suit was voluntarily dismissed on May 14, 2022. Petitioner did not file a Petition against the patent-at-issue while the first lawsuit was pending. Patent Owner again sued Petitioner for infringement on August 4, 2022. Petitioner waited until December 16, 2022 to file the Petition in this case, just narrowly beating the deadline for filing a Petition.

According to the Second Amended Docket Control Order, the jury selection would be on May 6, 2024. Ex. 2010 at 1. The Final Decision by the Board would

be due on or about July 20, 2024, about three months after the jury is scheduled to be impaneled in the district court case. In this case, Petitioner’s long delay in filing a Petition, coupled with the likelihood that the jury will render its verdict substantially before the Board issues its final written decision, compels the conclusion that the Board should exercise its discretion to deny institution.

Although Petitioner contends that it has provided a “*Sotera*-type stipulation,” it has not done so. In *Sotera*, the Petitioner filed a stipulation in the district court, stating that Petitioner “will not pursue in [the District Court] the specific grounds [asserted in the inter partes review], or on any other ground . . . that was raised or could have been reasonably raised in an IPR (i.e., any ground that could be raised under §§ 102 or 103 on the basis of prior art patent or printed publications).” *Id.* at 13-14. Here, in contrast, the Petitioner has not filed a stipulation in district court. Further, the alleged “stipulation” offered in the Petition falls short of the stipulation that was filed in the district court in *Sotera*. Here, the Petitioner states only that it “will not pursue in the district court litigation any ground raised or that could have been reasonably raised in the instituted IPR with respect to the patent claim subject to the instituted IPR.” This is significantly narrower than the petition filed in the district court that was considered by the Board in *Sotera*. There the stipulation precluded Petitioner from litigating in the district court “*any other ground . . . that was raised or could have been reasonably raised in an IPR*” which the Petitioner

there characterized as “any ground that could be raised under §§ 102 or 103 on the basis of prior art or printed publications.” *Sotera* at 13-14. Thus, Petitioner’s argument regarding its so-called “stipulation” falls far short of that considered by the Board in *Sotera*. This is not the type of “stipulation” that should preclude discretionary denial.

VI. THE BOARD SHOULD DENY INSTITUTION

Petitioner must establish a reasonable likelihood of prevailing on unpatentability to support institution of an IPR. *See* 35 U.S.C. § 314(a) (prohibiting the institution of IPR absent “a reasonable likelihood that Petitioner would prevail”); 37 C.F.R. § 42.108(c). Petitioner has not shown a reasonable likelihood of success that Challenged Claims are anticipate or rendered obvious.

A. Applicable Legal Standard

1. Anticipation

To anticipate a claim, a prior art reference must disclose every limitation of the claimed invention, either expressly or inherently. *E.g., Rapoport v. Dement*, 254 F.3d 1053, 1057 (Fed. Cir. 2001). The Federal Circuit has emphasized that “disclosure of each element is not quite enough—this court has long held that anticipation requires the presence in a single prior art disclosure of all elements of a claimed invention arranged as in the claim.” *Finisar Corp. v. DirecTV Group, Inc.*, 523 F.3d 1323, 1334 (Fed. Cir. 2008) (emphasis in original, internal quotations and citation omitted). The question of anticipation is not whether a prior art reference

suggests the claimed subject matter, but whether one skilled in the art would reasonably understand or infer from a prior art reference that every claim element is disclosed in that reference. *AstraZeneca LP v. Apotex, Inc.*, 633 F.3d 1042, 1055 (Fed. Cir. 2010).

2. **Obviousness**

“[A] patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007). “This is so because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known.” *Id.* at 418-19. For this reason, “it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does.” *Id.* at 418. “One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art.” *In re Fine*, 837 F.2d 1071, 1075 (Fed. Cir. 1988).

A proper petition must both “clearly point out the differences between the claimed invention and [the prior art]” and “explain why a person of ordinary skill in the art would have found the claimed subject matter obvious in spite of those differences.” *Synopsys, Inc. v. Mentor Graphics Corp.*, IPR2012-00041, 2013 WL

3355865 at *8 (P.T.A.B. Feb. 22, 2013). A Petitioner must specifically recite where the challenged limitation is found in the secondary reference(s), and explain why a POSA would have modified the primary reference with the recited limitation from the secondary reference(s). *See Microsoft Corp. v. Secure Web Conf. Corp.*, IPR2014-00745, 2014 WL 4925718, at *6-7 (P.T.A.B. Sept. 29, 2014). “[M]ere conclusory statements” are not sufficient. *Wowza Media Sys., LLC v. Adobe Sys. Inc.*, IPR2013-00054, 2013 WL 5653113, at *8 (P.T.A.B. April 8, 2013).

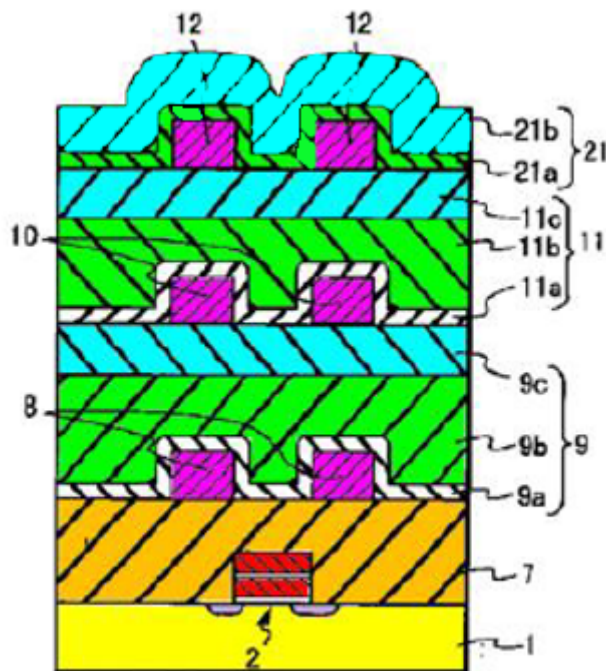
B. The References Relied Upon by Petitioner

1. Oshima

Oshima is a Japanese patent publication, with the original publication provided as Exhibit 1003. A certified translation is provided as Exhibit 1005. Oshima is directed to a semiconductor device having a multilayer wiring structure and a method of manufacturing the same. Ex. 1005 at [0001]. Different from the ’455 patent, Oshima has a cap layer 21b over the uppermost metallization layer as shown below.

One of the reasons that Oshima provides a cap layer (the blue layer as shown below) over every metallization layer, including the uppermost metallization layer (i.e., 21b), is that Oshima seeks to completely prevent the generation and diffusion of hydrogen. *Id.* at [0005] (“[i]t has become evident that, when used in an actual non-volatile memory cell, performance is impaired by trace amounts of hydrogen and

moisture.”); [0007] (“[t]his invention...seeks to improve reliability by...ameliorating the interlayer insulation film structure of a multilayered trace so as to prevent the diffusion of moisture...”). Because Oshima is directed to non-volatile memory cells, inclusion of any moisture/hydrogen is harmful. *Id.* at Abstract; [0005]-[0007]. In contrast, the ‘455 patent is directed to CMOS based imaging sensors, of which a certain amount of moisture/hydrogen is beneficial. Oshima recognizes this key difference by stating in paragraph [0005]: “[i]t has become evident that, when used in an actual non-volatile memory cell, performance is impaired by trace amounts of hydrogen and moisture, which might otherwise not be an issue in a standard MOS transistor.” As discussed above, the ’455 patent intends to generate hydrogen in a controlled manner instead of completely preventing the diffusion of the hydrogen as discussed above. *Supra.* §II.A.; Ex. 1005 at Abstract, [0005], etc.



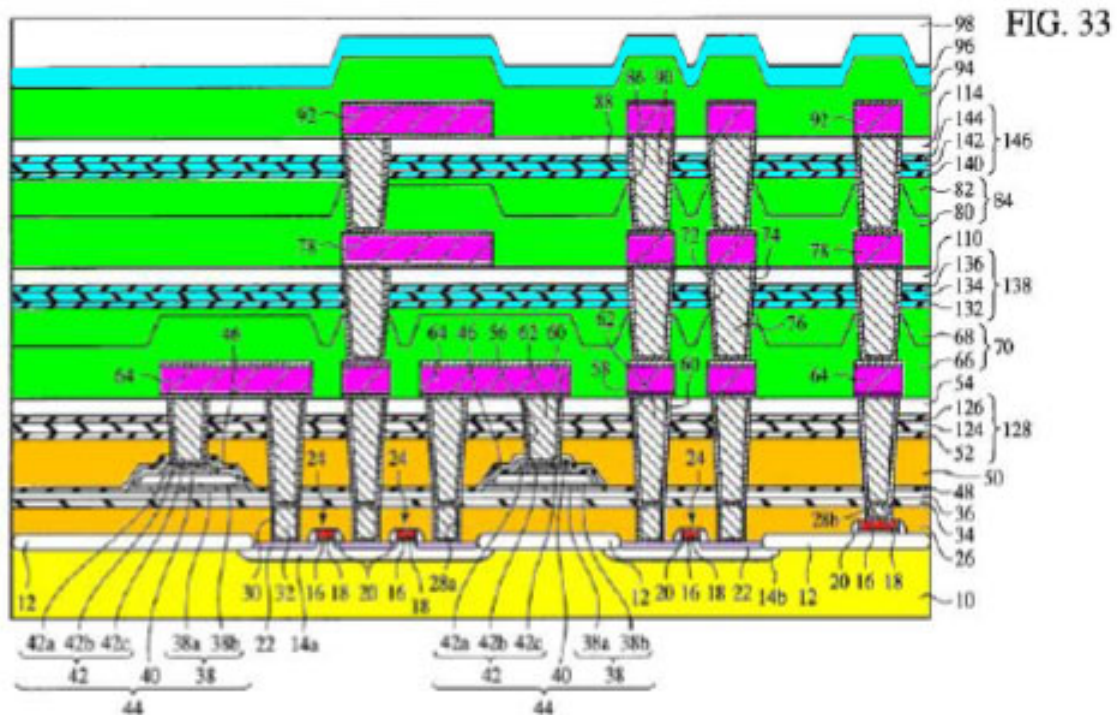
Pet. at 15 (colors added).

2. Nagai

Nagai is a U.S patent directed to general semiconductor devices (e.g., capacitors, memory cells, etc.). comprising stacked metallization layers, ILD layers, and hydrogen diffusion prevention films. Ex. 1006. Like Oshima but different from the '455 patent, Nagai also has a cap layer 96 over the uppermost metallization layer as shown below.

Similar to Oshima, Nagai is directed to stacked memory cells. *Id.*, 6:50-53; 35:52-53; 43:34-36. One of the reasons that Nagai provides a cap layer (the blue layer as shown below) over every metallization layer, including the uppermost metallization layer, is that Nagai seeks to completely prevent the generation and diffusion of hydrogen. *Id.*, 1:43-46, 4:22-35. For example, Nagai states in the

“Background of the Invention” section: “the proposed techniques can prohibit the hydrogen and water from arriving at the dielectric film, whereby the deterioration of the dielectric film with the hydrogen and the water can be prevented.” Further, Nagai states in the same section: “[a]ccording to the present invention, the barrier film is formed of a plurality of the first films for preventing the diffusion of the hydrogen and the water which are laid one on another with the second film of a dielectric substance formed there between, whereby the diffusion of the hydrogen and the water can be surely prevented.” Instead, the ’455 patent is about generating beneficial levels of hydrogen in a controlled manner. *Supra.* §II.A.



Pet. at 15 (colors added).

3. Omi

Omi is directed to image sensor devices (i.e., image sensing pixels) and

method for fabrication. Ex. 1011. Omi discloses that a plurality of rectangular line image sensor integrated circuits 110 are formed on a semiconductor substrate 101 with gaps in between the image sensors. *Id.*, 9:28–54; Fig. 5F. However, there would be no motivation to combine Nagai and Omi as proposed in the Petition as discussed below.

C. Institution Should Be Denied As To Ground 1 Because Claims 1, 5, 6, 9, and 19 Are Not Anticipated By Oshima

1. Claim 1 is not anticipated by Oshima

As shown above, claim 1 of the '455 patent recites in limitation [1e]: “forming a cap layer over the ILD layer over said ILD layer of all of said plurality of metallization layers except an uppermost said metallization layer.” Thus, the '455 patent claim language requires that the cap layer does *not* form on the uppermost metallization layer. As shown in the FIG. 2 of the '455 patent (reproduced above), an exemplary embodiment consistent with claim 1, the uppermost metallization layer M3 only has two layers: 131-3 (the patterned metal structure layer) and 133-3 (the ILD layer), without a cap layer. *Supra.* §II.A. In contrast, the other two metallization layers M1 and M2 both have an additional cap layer 135-1 and 135-2. *Id.*; Ex. 1001, 10:56-11:26.

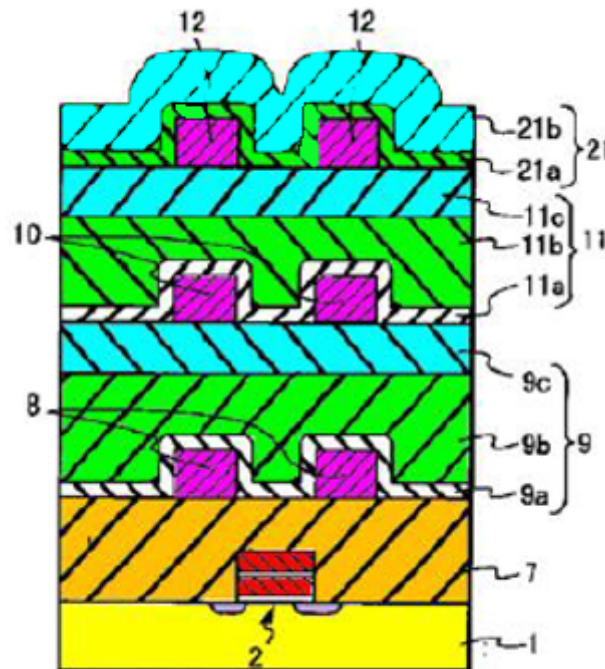
For Oshima, Petitioner argues that there is no cap layer over the uppermost metallization layer as claimed in limitation [1e], with the annotated/colored figure reproduced supporting its argument. Pet. at 32-36. Particularly, Petitioner argues

that the plasma nitride layer 21b formed over the TEOS oxide film 21a as shown below cannot be a cap layer. *Id.* The assertion is wrong. As discussed above, Oshima provides a cap layer (the blue layer as shown below) over every metallization layer, including the uppermost metallization layer, so as to completely prevent the generation and diffusion of hydrogen. *Supra.* §VI.B.1. A POSA would have understood that the term “plasma nitride” is a general term in the semiconductor manufacturing process referring to a variety of nitride compounds that can include silicon nitride and other oxide material, e.g., oxynitride, silicon oxynitride. *See, e.g.,* Ex. 2001 (“SiO_xN_y [i.e., silicon oxynitride] thin films were deposited by inductively coupled plasma enhanced chemical vapor deposition (ICP-PECVD) using hexamethyldisilazane (HMDS, 99.9%)/NH₃/O₂/Ar at a low temperature, and examined for use as a water vapor diffusion barrier.”); Ex. 2002 (“[i]n this study, SiO_xN_y [Silicon Oxynitride] thin film was deposited by plasma enhanced chemical vapor deposition at the temperature lower than 40 °C using hexamethyldisilazane (HMDS)/Ar while varying the ratio of O₂/NH₃.”); Ex. 2003 (“[s]ize controlled silicon nanocrystals (SiNC) in silicon oxynitride matrix were prepared using plasma enhanced chemical vapor deposition.”); Ex. 2004 (“[s]ilicon oxynitride films were deposited by plasma-enhanced chemical vapor deposition at low temperatures using nitrous oxide (N₂O) and silane (SiH₄) as gas precursors . . . Two distinct types of material were obtained, silicon dioxide-like oxynitrides SiO_{2-x}N_x and silicon-rich

oxynitrides SiO_xN_y ($x+y<2$).”). A POSA would have understood that Oshima’s plasma nitride layer 21b is a cap layer because plasma nitride films, which includes silicon nitride, silicon oxynitride, and other oxynitride films, are well-known to be excellent diffusion barriers. *See* Ex. 2009 (“[h]ydrogen ions drifting into underlying layers during HDP-CVD were successfully suppressed by the insertion of plasma deposited silicon oxynitride ($\text{p-SiO}_x\text{N}_y\text{H}_z$) film, and the hydrogen-trapping mechanism was clarified.”). Thus, a POSA would have understood that Oshima’s plasma nitride layer 21b is a high-density, low-moisture content oxide material (i.e., a cap layer) as claimed in limitation [1f]. *See e.g.*, Ex. 2001-2004, 2009.

Petitioner’s argument that Oshima’s plasma nitride film 21b is a source, rather than a blocker, of hydrogen is also wrong. Pet. at 36. To support its assertion, Petitioner only relies on a short phrase in the “Prior Art” section of Oshima regarding “prevent the diffusion of hydrogen from the nitride film” instead of disclosures explicitly stating that the plasma nitride film 21b is a source for generating hydrogen. Ex. 1005 at [0002], [0005], [0015]. “Prevent[ing] the diffusion of hydrogen from the nitride film” can mean preventing the diffusion of hydrogen based on (or using) nitride film, which contradicts Petitioner’s assertion. Thus, A POSA would have understood that Oshima’s plasma nitride layer 21b is a blocker of hydrogen, rather than a source of hydrogen. *See* Ex. 2009 (“[h]ydrogen ions drifting into underlying layers during HDP-CVD were successfully suppressed by the insertion of plasma

deposited silicon oxynitride ($\text{p-SiO}_x\text{N}_y\text{H}_z$) film, and the hydrogen-trapping mechanism was clarified.”).



Pet. at 15 (colors added).

Thus, Oshima does not teach that the cap layer does not form on the uppermost metallization layer as required by claim 1 of the '455 patent. Accordingly, claim 1 would not be anticipated by Oshima.

2. Dependent Claims 5, 6, and 9 are not anticipated by Oshima

As is demonstrated above, Oshima fails to anticipate independent claim 1. Because claim 1 is patentable, dependent claims 5, 6, and 9 are also patentable. *Cf.*, *Rembrandt Wireless Techs., LP v. Samsung Elecs. Co.*, 853 F.3d 1370, 1380 (Fed. Cir. 2017), citing, *In re Fine*, 837 F.2d at 1076 (“Dependent claims are nonobvious under section 103 if the independent claims from which they depend are

nonobvious.”). The same doctrine is even more applicable to allegations of anticipation.

3. Claim 19 is not anticipated by Oshima

Claim 19 is an independent apparatus claim that recites the same “except an uppermost metallization layer” limitation as claim 1. *Compare*, Ex. 1001, 18:6 (claim 1) with Ex. 1001, 20:57-58 (claim 19). Thus, claim 19 would not be anticipated by Oshima for the same reasons as stated above for claim 1.

D. Institution Should Be Denied As To Ground 2 Because Claims 2, 3, and 7 Are Not Rendered Obvious By Oshima In View Of Lee

As is demonstrated above, Oshima fails to anticipate claim 1. Petitioner does not assert that claim 1 is obvious in view of Oshima and Lee. Because claim 1 is patentable, dependent claims 2, 3 and 7 are also patentable. *See Rembrandt Wireless*, 853 F.3d at 1380.

E. Institution Should Be Denied As To Ground 3 Because Claim 10 Is Not Rendered Obvious By Oshima In View Of Crook

As is demonstrated above, Oshima fails to anticipate claim 1. Petitioner does not assert that claim 1 is obvious in view of Oshima and Crook. Because claim 1 is patentable, dependent claim 10 is also patentable. *See Rembrandt Wireless*, 853 F.3d at 1380.

F. Institution Should Be Denied As To Ground 4 Because Claims 1, 8, and 11 Are Not Anticipated By Nagai

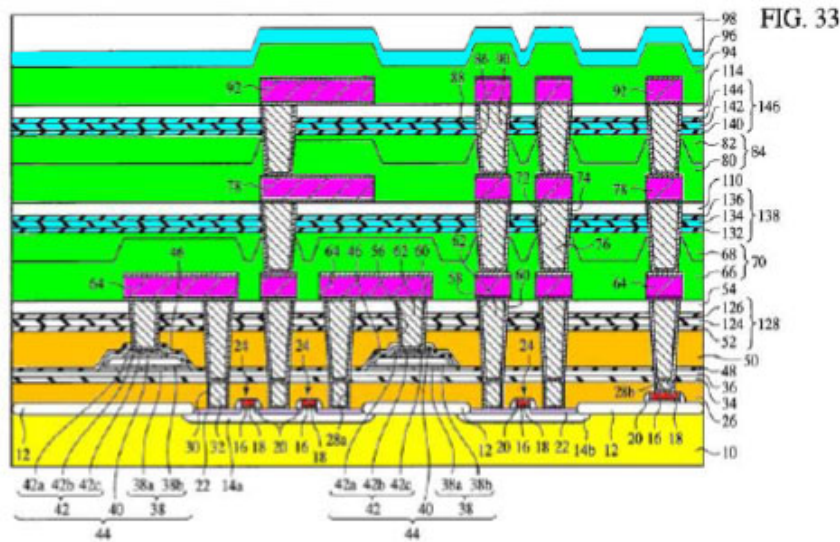
1. Claim 1 is not anticipated by Nagai

Similar to Oshima, Nagai fails to disclose limitation [1e], because Nagai has a cap layer 96 over the uppermost metallization layer. Petitioner argues that the silicon nitride film 96 as shown below is not a cap layer. Pet. at 61. The assertion is wrong. As discussed above, Nagai provides a cap layer (the blue layer as shown below) over every metallization layer, including the uppermost metallization layer, because Nagai seeks to completely prevent the generation and diffusion of the hydrogen instead of generating beneficial levels of hydrogen in a controlled manner as disclosed by the '455 patent. *Supra.* §VI.B.2. A POSA would have understood that Nagai's silicon nitride film 96 is a cap layer because silicon nitride is well-known to be excellent diffusion barriers. *See* Ex. 2005, Abstract ("a special problem arises in the presence of insulating layers such as silicon nitride and aluminum oxide layers which are impervious to the diffusion of gases such as hydrogen at lower temperatures which are usually encountered in the final fabrication steps of an integrated circuit device.") Further, a POSA would have understood that a silicon nitride film 96 may include oxide material such as silicon oxynitride because oxide materials are involved in the film deposition chemical reactions of silicon nitride. The possible synthesis reactions are: $\text{SiO}_2(\text{s}) + \text{C}(\text{s}) \rightarrow \text{SiO}(\text{g}) + \text{CO}(\text{g})$ and $3 \text{SiO}(\text{g}) + 2 \text{N}_2(\text{g}) + 3 \text{CO}(\text{g}) \rightarrow \text{Si}_3\text{N}_4(\text{s}) + 3 \text{CO}_2(\text{g})$ or $3 \text{SiO}(\text{g}) + 2 \text{N}_2(\text{g}) + 3 \text{C}(\text{s})$

→ $\text{Si}_3\text{N}_4(\text{s}) + 3 \text{CO}(\text{g})$. The inclusion of oxide compounds in silicon nitride is unavoidable. *See e.g.*, Ex. 2006 (“[t]he study of the oxidation mechanism of low pressure and plasma-enhanced chemically vapour-deposited silicon nitride and oxynitride thin films in H_2O O_2 mixtures and the nitridation of SiO_2 thin films in NH_3 is motivated by the growing interest in these processes for use in microelectronics technology.”); Ex. 2007 (“[t]his work focuses on the use of plasma anodization of low-pressure chemical vapor deposition (LPCVD) silicon nitride films to produce silicon oxynitride films, which are characterized structurally and electrically.”); Ex. 2008 (“LPCVD silicon nitride films have been oxidised in an oxygen plasma using low thermal budget plasma anodisation to produce oxynitride films. The electrical integrity of these films was generally shown to improve following oxidation and a model of the conduction processes in the oxynitride has been suggested.”). Thus, a POSA would have understood that Nagai’s silicon nitride film 96 is a high-density, low-moisture content oxide material (i.e., a cap layer) as claimed in limitation [1f]. *Id.*

Petitioner asserts that because Oshima’s plasma nitride film 21b is a source, rather than a blocker, of hydrogen, same assertion should be applicable to Nagai’s silicon nitride film 96. Pet. at 61. As an initial matter, because Nagai’s silicon nitride film 96 and Oshima’s plasma nitride film 21b compose different chemical composites, the argument for Oshima (even assuming it were true) does not apply to

Nagai. Further, as discussed above, Petitioner only relies on a short phrase in the “Prior Art” section of Oshima regarding “prevent the diffusion of hydrogen from the nitride film” to support its assertion, instead of disclosures explicitly stating that the plasma nitride film 21b is a source for generating hydrogen. Ex. 1005 at [0002], [0005], [0015]. “Prevent[ing] the diffusion of hydrogen from the nitride film” can mean that preventing the diffusion of hydrogen based on (or using) nitride film, which contradicts Petitioner’s assertion. Thus, a POSA would have understood that Nagai’s silicon nitride film 96 is a blocker of hydrogen, rather than a source of hydrogen. *See* Ex. 2005, Abstract (“a special problem arises in the presence of insulating layers such as silicon nitride and aluminum oxide layers which are impervious to the diffusion of gases such as hydrogen at lower temperatures which are usually encountered in the final fabrication steps of an integrated circuit device.”)



Pet. at 15 (colors added).

Thus, Nagai does not teach that the cap layer does not form on the uppermost metallization layer as required by claim 1 of the '455 patent. Accordingly, claim 1 would not be anticipated by Nagai.

2. Claims 8 and 11 are not anticipated by Nagai

As is demonstrated above, Nagai fails to anticipate claim 1. Because claim 1 is patentable, dependent claims 8 and 11 are also patentable. *Cf., Rembrandt Wireless*, 853 F.3d at 1380.

G. Institution Should Be Denied As To Ground 5 Because Claim 12 Is Not Rendered Obvious By Nagai In View Of Miyazaki

As is demonstrated above, Nagai fails to anticipate claim 1. Petitioner does not assert that claim 1 is obvious in view of Nagai and Miyazaki. Because claim 1 is patentable, dependent claim 12 is also patentable. *See Rembrandt Wireless*, 853 F.3d at 1380.

H. Institution Should Be Denied As To Ground 6 Because Claim 15 Is Not Rendered Obvious By Nagai In View Of Lee

As is demonstrated above, Nagai fails to anticipate claim 1. Petitioner does not assert that claim 1 is obvious in view of Nagai and Lee. Because claim 1 is patentable, dependent claim 15 is also patentable. *See Rembrandt Wireless*, 853 F.3d at 1380.

I. Institution Should Be Denied As To Ground 7 Because Claim 16 Is Not Rendered Obvious By Nagai In View Of Wang

As is demonstrated above, Nagai fails to anticipate claim 1. Petitioner does

not assert that claim 1 is obvious in view of Nagai and Wang. Because claim 1 is patentable, dependent claim 16 is also patentable. *See Rembrandt Wireless*, 853 F.3d at 1380.

J. Institution Should Be Denied As To Ground 8 Because Claims 17 and 18 Are Not Rendered Obvious By Nagai In View Of Omi

Petitioner asserts that “[i]t would have been obvious to modify Nagai’s semiconductor integrated circuit in view of Omi such that it includes ‘an array of image sensing pixels disposed inside a rectangular imaging region of said semiconductor substrate.’” Pet. at 75. However, Petitioner’s analysis lacks any credible basis that would have led a POSA, in the absence of the ’455 patent disclosure, to the combination of Nagai and Omi as proposed in the Petition.

First, Nagai is directed to stacked memory cells, not image sensing pixels. Ex. 1006, 6:50-53; 35:52-53; 43:34-36. Petitioner admits that Nagai’s disclosures are not specific to image sensing pixels. Pet. at 15. Nagai provides nothing whatsoever indicating the stacked memory cells it disclosed are even relevant to image sensing pixels. Petitioner also provides no evidence indicating that a POSA would have understood that the multi-layered memory cell structures taught by Nagai could be used for image sensing pixels.

Second, as discussed above, Nagai intends to completely prevent diffusion of the hydrogen because the deterioration of the semiconductor devices such as capacitors and memory cells with the hydrogen would severely lower the fabrication

yield. *Supra.* §VI.B.2; Ex. 1006, 1:66-2:3. By contrast, a certain level of hydrogen is beneficial to image sensing pixels processing. *See e.g.*, Ex. 1001, 2:18-24 (“[t]he importance of hydrogen for the performance of CMOS devices is well known in semiconductor industry. A certain amount of the hydrogen at the Silicon-Gate Oxide interface is needed to passivate the Surface States (by forming Si-H complexes with dangling bonds).”); Ex. 2005, 1:27-33 (indicating that hydrogen is needed for greater drain current flows in CMOS devices). Thus, Petitioner’s proposed modification of Nagai’s semiconductor integrated circuits, which prevents any generation and diffusion of hydrogen, in view of Omi’s image sensing pixels, which requires certain amount of hydrogen to properly function, contradicts the disclosed manufacturing method and purpose of Nagai’s semiconductor integrated circuits. Petitioner’s suggestion that a POSA would consider such a modification to Nagai is unsupported as it runs contrary to Nagai’s design goal of completely preventing the generation and diffusion of hydrogen. *See Chemours Co. FC, LLC v. Daikin Indus. Ltd.*, 4 F.4th 1370, 1376 (Fed. Cir. July 22, 2021) (“[N]o motivation to modify the prior art where doing so ‘would destroy the basic objective’ of the prior art”) (internal citation omitted).

Third, Petitioner relies only on the conclusory opinions of its expert, Mr. Giapis, to support these alleged motivations. *See Pet.* at 75-77 (citing Ex.1020, ¶¶ 164-7). Mr. Giapis’s testimony simply repeats, nearly *ipsis verbis*, the Petition’s

hindsight-driven argument. *Compare, e.g.,* Pet. at 75-77 with Ex. 1020 ¶¶ 164-167 (parroting same argument with the use of same annotated Figures). It should be given no weight. *See, e.g., Xerox Corp. et al. v. Bytemark, Inc.*, IPR2022-00624, Paper 12 at 4-5 (P.T.A.B. Feb. 10, 2023) (expert declaration that offered conclusory assertions without underlying factual support and repeated, *verbatim*, Petitioner’s conclusory arguments given little weight); *Unirac, Inc. v. Ecofasten Solar, LLC*, IPR2021-00532, 2021 WL 3116853, at *7 (P.T.A.B. July 22, 2021) (denying institution where “Petitioner’s witness merely parrots the conclusory statements of Petitioner”); *Unified Patents Inc. v. GE Video Compression, LLC*, IPR2019-00726, 2019 WL 3714386, at *11 (P.T.A.B. Aug. 6, 2019) (giving little weight to expert testimony that “simply parrots the Petition without providing any basis for his opinion” and denying institution); *TQ Delta, LLC v. Cisco Sys., Inc.*, 942 F.3d 1352, 1359 (Fed. Cir. 2019) (“conclusory expert testimony is inadequate to support an obviousness determination”); *Elbit Sys. of Am., LLC v. Thales Visionix, Inc.*, 881 F.3d 1354, 1359 (Fed. Cir. 2018) (“Attorney argument is not evidence.”) (quoting *Icon Health & Fitness, Inc.*, 849 F.3d at 1043); *Free-Flow Packaging Int’l, Inc. v. Automated Packaging Sys., Inc.*, IPR2016-00447, Paper 7, at 10 (P.T.A.B. June 22, 2016) (denying institution where the petitioner’s expert did “nothing more than parrot the language of the Petition word for word”).

Thus, claims 17 and 18 would not be rendered obvious by Nagai in view of Omi because Petitioner has not shown a motivation to combine Nagai and Omi.

VII. CONCLUSION

For the reasons set forth above, Patent Owner respectfully requests that the Board deny the Petition for *inter partes* review in its entirety.

Dated: April 19, 2023

Respectfully submitted,

By: /s/Eric Cohen

Eric Cohen

Registration No. 27,429

*Counsel for Patent Owner
Alidouble Inc.*

CERTIFICATION OF WORD COUNT UNDER 37 CFR § 42.24(d)

Pursuant to 37 C.F.R. §§ 42.24(d) and 42.24(a)(1), I hereby certify that the number of words in this Response is no more than 6,474 excluding the parts of the petition exempted by 37 C.F.R. § 42.24(a), as determined using the word count provided by Microsoft Word, which was used to prepare this Petition.

DATE: April 19, 2023

Respectfully Submitted,

/s/Eric Cohen
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Registration No. 27,429

*Counsel for Patent Owner
Alidouble Inc.*

CERTIFICATE OF SERVICE

Pursuant to 37 CFR § 42.6(e), the undersigned hereby certifies that a copy of the Patent Owner's Preliminary Response Under 37 C.F.R. §42.107 by P-TACS electronic notification and electronic mail to each of the following individuals on the date indicated below:

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