

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY, LTD.,
Petitioner,

v.

GODO KAISHA IP BRIDGE 1,
Patent Owner.

Case No. IPR2016-01376
Patent Number 6,197,696

Before JUSTIN T. ARBES, MICHAEL J. FITZPATRICK, and
JENNIFER MEYER CHAGNON, *Administrative Patent Judges*.

PATENT OWNER'S RESPONSE
UNDER 37 C.F.R. §42.120

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EXHIBITS

Exhibit	Description
EX2001	N. Sclater & J. Markus, McGraw-Hill Electronics Dictionary (6th ed. 1997) (excerpted)
EX2002	R. F. Graf, Modern Dictionary of Electronics (6th ed. 1984) (excerpted)
EX2003	R. F. Graf, Modern Dictionary of Electronics (7th ed. 1999) (excerpted)
EX2004	S. M. Kaplan, Wiley Electrical and Electronics Engineering Dictionary (2004) (excerpted)
EX2005	October 7, 2016 Preliminary Constructions, <i>Godo Kaisha IP Bridge 1 v. Broadcom Ltd., et al.</i> , Case. No. 2:16-cv-134
EX2006	Declaration of Seung Woo Hur
EX2007	RESERVED
EX2008	RESERVED
EX2009	Declaration of Alexander Glew, Ph.D.
EX2010	Transcript of Deposition of Bruce Smith on March 23, 2017
EX2011	Redline Comparing Grill (EX1005) with Grill's Provisional (EX1017) Application
EX2012	Translation of Japanese Application 10-079371 to Aoi as Submitted in European Patent Application No. 99 105 946.0
EX2013	Declaration of Takeo Ohashi, Ph.D.
EX2014	<i>Influence of reactor wall conditions on etch processes in inductively coupled fluorocarbon plasmas</i> by M. Schaepkens, et al., J. Vac. Sci. Tech. A 16(4), Jul/Aug 1998
EX2015	<i>Handbook of VLSI Microlithography, Second Edition, Principles, Technology, and Applications</i> , edited by John N. Helbert, Noyes Publications, William Andrew Publishing, LLC, 2001 (excerpted)
EX2016	<i>Silicon VLSI Technology Fundamentals, Practice and Modeling</i> , by James D. Plummer, et al., Prentice Hall, 2000 (excerpted)

EX2017	<i>Microlithography: Science and Technology</i> , by James R. Sheats and Bruce W. Smith, Marcel Dekker, Inc., 1998 (excerpted)
EX2018	<i>Microlithography: Science and Technology</i> , 2 nd ed., by Kazuaki Suzuki and Bruce W. Smith, CRC Press, 2007 (Chapter 12) (excerpted) (Smith Deposition Exhibit 3)
EX2019	<i>Microlithography: Science and Technology</i> , 2 nd ed., by Kazuaki Suzuki and Bruce W. Smith, CRC Press, 2007 (Chapter 11) (excerpted) (Smith Deposition Exhibit 9)
EX2020	Silicon Processing for the VLSI Era Vol. 1 by S. Wolf and R.N. Tauber (excerpted)
EX2021	Kenkyusha's New Japanese-English Dictionary, 4 th ed., 35 th Impression, published by Kenkyusha Ltd., 1997 (excerpted)
EX2022	Declaration of Jordan Rossen

Pursuant to §42.120,¹ Patent Owner Godo Kaisha IP Bridge 1 (“IP Bridge”) submits this Response to the above-captioned Petition for *Inter Partes* Review (“Pet.”, Pap.1) of U.S. Patent No. 6,197,696 (“’696”). As detailed below, because Petitioner’s evidence fails to make the required showing of obviousness on its sole instituted ground, IP Bridge respectfully submits that the Board should issue a final written decision confirming the patentability of all challenged claims of the ’696.

I. Introduction

The Board instituted *inter partes* review on only one of the grounds urged by Petitioner: whether claims 13 and 15 of the ’696 (the “Claims”) are rendered obvious by Grill in view of Aoyama. Pap.11 (Institution Decision (“ID”)) 43. The Petition was denied as to all other grounds, and trial and this response is accordingly limited to the ground set forth above. *Id.*; §42.120(a). Patent Owner addresses in detail below the numerous substantive errors, omissions and shortcomings that underlie Petitioner’s sole alleged ground of invalidity for which *inter partes* review was instituted.² Petitioner fails to demonstrate by a

¹ Section cites are to 35 U.S.C. or 37 C.F.R. as context indicates, and all emphasis/annotations/color added and internal quotations/citations omitted unless noted.

² Should Petitioner, or any other party, in this or any other proceeding, attempt to rely upon non-instituted grounds or alleged evidence submitted by Petitioner in

preponderance of the evidence that the combination argued by Petitioner renders obvious the specific method for forming an interconnection structure claimed in the '696. §316(e).

In particular, Grill is not prior art because at least '696 claim 13 is entitled to the priority of '696's foreign priority document filing date and Petitioner has not shown and cannot show that Grill is entitled to the benefit of its provisional application filing date.³ While the Board adopted Patent Owner's construction for "using the [first resist pattern/second resist pattern and the mask pattern/patterned third insulating film] as a mask," Patent Owner respectfully submits that the Board improperly added a negative limitation excluding "a layer, positioned between an overlying layer and the layer being etched and having an edge in line and flush with an edge of the overlying layer" from being "used as a mask" within the meaning of claim 13." ID 18. Construed properly, '696 claim 13 is entitled to the support of those non-instituted grounds, Patent Owner reserves the right to respond to such arguments, grounds and/or evidence at that time.

³ Petitioner knew of and had an opportunity to brief this issue in its Petition and should not be allowed to introduce new arguments on reply in the hope that Patent Owner will not have the ability to respond. *See, e.g., Intelligent Bio-System v. Illumina Cambridge*, 821 F.3d 1359, 1369-70 (Fed.Cir. 2016) (upholding Board's decision to refuse consideration of Petitioner's arguments first presented in reply).

benefit of '696's foreign priority date. In contrast, Grill's claims rely on material added to and/or not present in the provisional to which Grill claims priority.

Moreover, a person of ordinary skill in the art ("POSITA") would not have found it obvious to modify Grill by combining it with Aoyama to arrive at the Claims for several reasons. **First**, Petitioner's proposed modification of Grill would render Grill unsatisfactory for Grill's stated purpose of forming a "dual relief pattern" by eliminating the "dual relief pattern" from the resulting combination. See EX1005 Abstract, 1:12-15, 2:41-50, 7:16-29; EX2009 ¶¶138-147;⁴ *In re Gordon*, 733 F.2d 900, 902 (Fed.Cir. 1984); *Purdue Pharma v. Depomed*, 643 F.App'x 960, 963-64 (Fed.Cir. 2016). Indeed, Petitioner's Fig.5H' shows that the "dual relief cavity" solution described in Grill and depicted in Grill's Fig.5H is *eliminated* by Petitioner's proposed alteration (both annotated below). EX2009 ¶144.

⁴ This Response is supported by the Declaration of Dr. Alexander Glew, Ph.D.

E.g., EX2009 ¶¶1-43.

Dual relief cavity

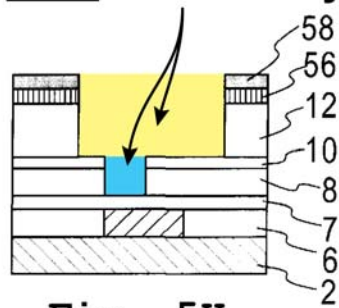


Fig. 5H

No dual relief cavity

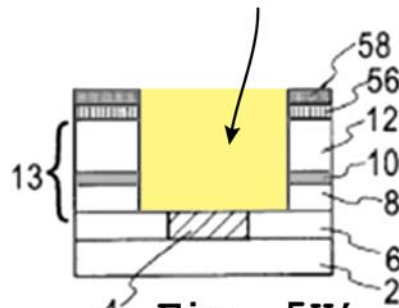


Fig. 5H'

EX1005 Fig.5H; Pet.68. Petitioner's proposed elimination of Grill's "dual relief pattern" impedes Grill's "critical dimension" control over via dimensions and frustrates Grill's ability to achieve higher integration density of wire lines. EX1005 Abstract, 1:12-15, 2:41-50, 7:16-29, 5:24-33; EX2010 13:15-14:20, 15:12-16:8, 20:8-20; EX1002 ¶¶47, 158; EX2009 ¶¶138, 141-44.

Second, Petitioner's proposed modification of Grill with Aoyama would also change Grill's principle of operation by impeding Grill's "critical dimension" control over wire dimensions. *See Gen. Plastic Indus., v. Canon*, IPR2015-01954, Pap.9, 26 ("If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious."); *Uniroyal v. Rudkin-Wiley*, 837 F.2d 1044, 1052 (Fed.Cir. 1988) ("antithetical principles of operation"); *Palo Alto Networks v. Finjan*, IPR2015-01979, Pap.62, 57. Petitioner's proposed modification would result in a wiring groove that is wider over the via hole—limiting the integration density of wire

lines. EX1005 Abstract, 1:12-15, 2:41-50, 5:22-33; EX2010 13:15-14:20, 15:12-16:8, 20:8-20; EX1002 ¶¶47, 158; EX2009 ¶¶148-67.

Third, Petitioner’s proposed modification of Grill would be inoperable without also incorporating Aoyama’s etch stopper because the wiring groove would be widened over the via hole without Aoyama’s etch stopper film. EX1018 Figs.5A-5C, 18A-18C, 16:12-16; EX2010 106:6-20; EX2009 ¶¶168-74. However, Petitioner’s proposed combination of Grill and Aoyama does not include Aoyama’s etch stopper. *E.g.*, Pet.56. And even if Petitioner improperly attempts to now also incorporate Aoyama’s carbon-based etch stopper to meet the “*using* the second resist pattern *and* the mask pattern *as a mask*” limitation, a POSITA would not have been motivated to modify Grill in this manner because Grill teaches away from the use of a carbon-based etch stopper. EX1005 2:26-32, 4:5-6, 35-40; *see DePuy Spine v. Medtronic Sofamor Danek*, 567 F.3d 1314, 1327 (Fed.Cir. 2009); EX2009 ¶¶168-79. Further, a POSITA would not have been motivated to incorporate Aoyama’s wider through-hole pattern because Grill discourages the thicker resist profile that would have been required by such an incorporation. *See* EX1005 Fig.2A; EX2009 ¶¶180-84.

Thus, even if Grill were prior art to the ’696, a POSITA still would not have been motivated to combine these references in the way suggested by Petitioner, nor would a POSITA have had a reasonable expectation of success. EX2009 ¶¶135-37.

II. '696 Overview

The '696, entitled "Method for Forming Interconnection Structure," was filed Mar. 23, 1999 and issued Mar. 6, 2001, and claims priority to Japanese Application 10-079371 ("371") filed Mar. 26, 1998 (EX1014). EX1001.

The '696 generally relates to "[a] method for forming an interconnection structure" through a series of steps. EX1001 Abstract. In prior methods, low dielectric constant films used during the course of fabricating a metal interconnection structure could be damaged in a process known as ashing. *Id.* 2:41-52, 3:47-62; EX2009 ¶42. Ashing is a process used to remove polymer-based photo-lithography resists. EX1001 2:41-43; EX2009 ¶42. The '696 applicants solved this problem by inventing a method of processing that used a hard mask and multiple resist layers to pattern a low dielectric constant film to avoid damage to the film caused by ashing. EX1001 3:55-62; EX2009 ¶¶38-43. The '696 discloses, for example, that the interconnection structure of the modified third embodiment can be formed by a method illustrated in Figures 15(a)-17(c). EX1001 18:59-20:49; EX2009 ¶43.

For example, as illustrated in Figures 16(c)-16(d), annotated below, the patterned organic film 354A is dry-etched using the mask pattern 358 and the

patterned second silicon dioxide film 355A as a mask (*e.g.*, using, as a mask, two layers having flush edges).⁵ EX1001 19:50-54; EX2009 ¶¶43.

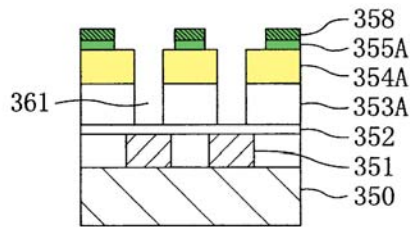


Fig. 16(c)

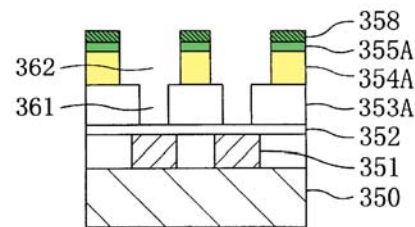


Fig. 16(d)

As illustrated in Figures 16(d)-17(a), annotated below, the silicon nitride film 352 is dry-etched using the patterned first silicon dioxide film 353A as a mask. EX1001 20:9-13; EX2009 ¶43.

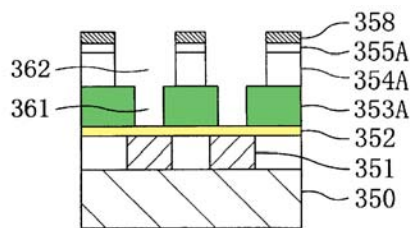


Fig. 16(d)

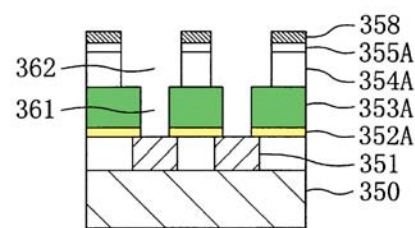


Fig. 17(a)

III. Claim Construction

For purposes of *inter partes* review, “[a] claim in an unexpired patent...shall be given its broadest reasonable construction in light of the specification of the

⁵ As illustrated herein layers being used as a mask for a certain step are indicated in green, layers to be or having been etched for a certain step are indicated in yellow, and other layers are sometimes indicated in blue. EX2009 ¶43n.2.

patent in which it appears.” §42.100(b). Under this standard and “absent any special definitions,” the Board shall give claim terms their ordinary and customary meaning, as would be understood by one of ordinary skill in the art at the time of the invention. *See Lupin v. Senju Pharm.*, IPR2015-01100, Pap.16, 8.

A. “Using the [first resist pattern/second resist pattern and the mask pattern/patterned third insulating film] as a mask” (Claim 13)

Claim 13 requires etching “using” various layers—for example, the second resist pattern and the mask pattern (step h)—“as a mask.” The BRI of this term is “*using the [first resist pattern/second resist pattern and the mask pattern/patterned third insulating film] to define areas for etching*” as the Board recognized at Institution.⁶ ID 15; EX2009 ¶44.⁷

Properly applying the BRI, Patent Owner’s construction confirms that

⁶ Patent Owner also agrees with the Board that a layer positioned between an overlying layer and an underlying layer being etched also acts as a mask, within the meaning of claim 13, in an instance where the overlying layer also is removed during etching, and thus, the intermediate layer acts to shield the layer being etched. *See* ID 18, n.7; EX2009 ¶44.

⁷ Petitioner had an opportunity to brief this issue in its Petition and chose not to do so, and should not be allowed to introduce new arguments on constructions on reply. *See, e.g., Intelligent Bio-System*, 821 F.3d at 1369-70; n.3, *supra*.

“using” something “as a mask” during etching means *using it to define areas for etching*, as confirmed by the use of the term throughout the ’696, which discloses numerous examples of structures being used as masks to define areas for etching. *See, e.g.*, EX1001 22:47-24:19, 24:54-26:34, 26:52-27:60, 27:62-29:20, 29:62-31:26, 31:49-32:9, Figs.21-37; EX2009 ¶¶45-46.⁸ Contemporaneous dictionary definitions further support Patent Owner’s construction. *See, e.g.*, EX2001 3; EX2002 3; EX2003 4; EX2004 3; EX2009 ¶47.

In construing the term “using the [designated layer] as a mask” at Institution, however, Patent Owner respectfully submits that the Board also incorrectly added an ***additional negative limitation*** that “a layer, positioned between an overlying layer and the layer being etched and having an edge in line and flush with an edge of the overlying layer” is **not** “‘used as a mask’ within the meaning of claim 13”

⁸ For example, in the context of Figures 25(c) and 27(b), ’696 teaches how both the second resist pattern and the mask pattern are used to define areas for etching: the underlying layer is patterned (etched) where the openings of the resist pattern and the openings of the mask pattern overlap. *See, e.g.*, EX1001 8:1-6, 7:62-8:7, 25:52-57, 26:63-27:3, 27:19-60, 31:60-67, Figs.25(c), 27(b), 34(b), 37(a)-(b); EX2009 ¶46.

(hereinafter, the “additional negative limitation”). ID 18.⁹ Patent Owner respectfully submits that this additional negative limitation is improper at least because it: (1) excludes three preferred embodiments of the ’696, (2) makes the term narrower than the *Phillips* construction, and (3) is inconsistent with the understanding of a person of ordinary skill in the art and Petitioner’s expert’s prior publication. EX2009 ¶49.

Accordingly, Patent Owner requests that the term “using the [designated layer] as a mask” be properly construed as “using the [designated layer] to define areas for etching,” without the negative limitation added at Institution. EX2009 ¶48.

1. The additional negative limitation impermissibly excludes preferred embodiments of the ’696

The Federal Circuit has made it clear that claims should be interpreted in such a way as to not exclude a preferred embodiment. *See, e.g., On-Line Techs. v. Bodenseewerk Perkin-Elmer GmbH*, 386 F.3d 1133, 1138 (Fed.Cir. 2004) (“exclud[ing] a preferred embodiment... ‘is rarely, if ever, correct’”); *Parrot S.A. v. Drone Technologies*, IPR2014-00730, Pap.27, 8. The additional negative limitation improperly excludes three preferred embodiments (*i.e.*, the third embodiment, a

⁹ Note that the Board has replaced the middle terms “[first resist pattern/second resist pattern and the mask pattern/patterned third insulating film]” with “[designated layer].” ID 15.

modified version of the third embodiment, and a modified version of a fifth embodiment) because they each require using an overlying layer and an intermediate layer together as a mask, where the intermediate layer has an edge that is *in line and flush with* an edge of the overlying layer. *See, e.g.,* EX1001 10:19-20, 16:39-48, 18:59-20:49, 24:52-27:60; Ex2009 ¶¶50-62.¹⁰

As illustrated in Figures 16(c) and 16(d), the *modified version of the third embodiment* discloses that “the patterned organic film 354A is dry-etched *using the mask pattern 358 and the patterned second silicon dioxide film 355A...as a mask....*” EX1001 19:50-54.¹¹ Notably, layer 355A has an edge that is *in line and*

¹⁰ These interpretations are further confirmed by the '371, to which '696 claims priority. *See* EX2013 ¶¶1-17; EX1013 ¶¶[0080], [0094], [0095]; EX2012 30:7-23, 34:20-35:11; EX2009 ¶¶59-60. Notably, Petitioner's translation misinterprets paragraphs [0094]-[0095] to mean “masks” instead of “a mask” in a manner inconsistent with the rest of the Petitioner's translation. *Compare* EX1014 ¶¶[0080], [0094], [0095] *with* EX2012 30:7-23, 34:20-35:11; EX2013 ¶¶8-17; *see also* EX2013 ¶¶18-22 (discussing Petitioner's mistranslation of the phrase “first resist pattern **and** the second resist pattern as the mask” to be “**or**” instead of “**and**” in EX1013 ¶[0025]); EX2021 1335; EX2012 4:18-5:4, 13:19-14:5.

¹¹ Petitioner's expert's only explanation for this clear language was an unsupported assertion that it was somehow “not consistent” with the rest of the '696. EX2010

flush with an edge of overlying layer 358. Ex2009 ¶52.

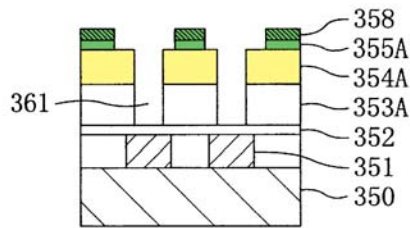


Fig. 16(c)

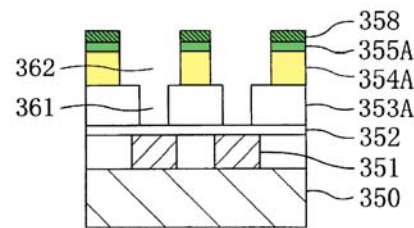


Fig. 16(d)

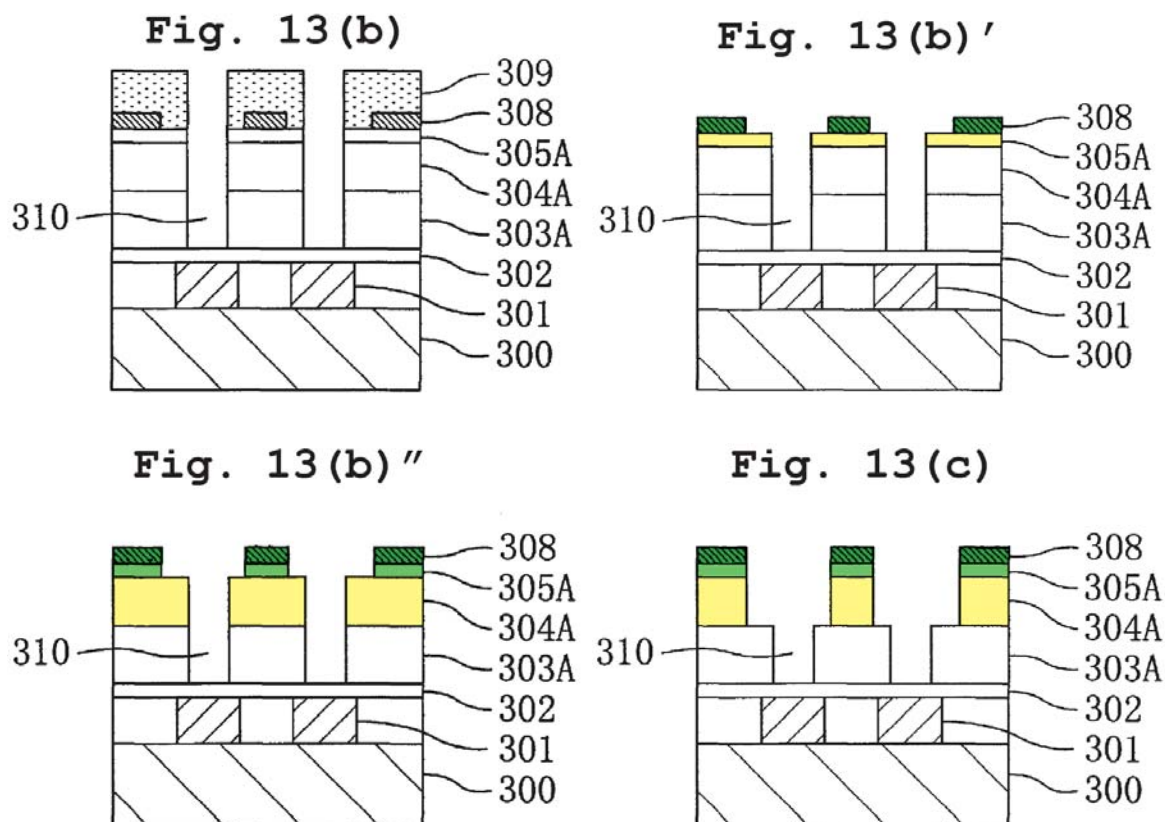
Similarly, as shown in the following illustrations based on Figures 13(b)-13(c), the *third embodiment* discloses that “the patterned low-dielectric-constant SOG film 304A is dry-etched *using the mask pattern 308 and the patterned second organic-containing silicon dioxide film 305A...as a mask....*” EX1001 17:34-40.¹² Notably, layer 305A also has an edge that is *in line and flush with* an

46:21-47:18. Contrary to Dr. Smith’s analysis, the specification must be considered “in the context of the *entire disclosure*”—it is improper to simply ignore passages as Petitioner has done. *See Apple v. Immersion*, IPR2016-01371, Pap.7, 5.

¹² Starting from Fig.13(b), ’696 discloses that resist pattern 309 is removed as shown in illustration Fig.13(b)’ (EX1001 17:30-31), 305A is dry-etched using 308 as a mask as shown in illustration Fig.13(b)’’ (*id.* 17:31-35), and then 304A is dry-etched using 305A and 308 “as a mask” as shown in Fig.13(c) (*id.* 17:35-40).

Ex2009 ¶¶55-57.

edge of overlying layer 308. Ex2009 ¶¶54-57.¹³



Similarly, as illustrated in Figures 28(b) and 29(a), the *modified version of the fifth embodiment* discloses that “the patterned second organic film 555A is dry-etched *using the mask pattern 559 and the patterned second silicon dioxide film 556B as a mask....*” EX1001 26:15-29. Notably, layer 556B also has an edge that is *in line and flush with* an edge of overlying layer 559. Ex2009 ¶¶58-61.¹⁴

¹³ Figures indicated with a ', ', or '' or –[] herein have been modified from their original appearance to reflect other disclosures as discussed herein. Ex2009 ¶55 n.5.

¹⁴ The modified fifth embodiment provides 3D-perspective views in Figures 28(b) and 29(a) that illustrate using an intermediate layer 556B and an overlying layer

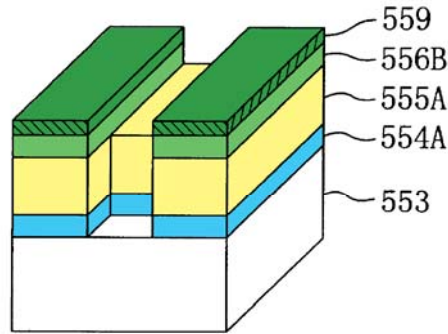


Fig. 28 (b)

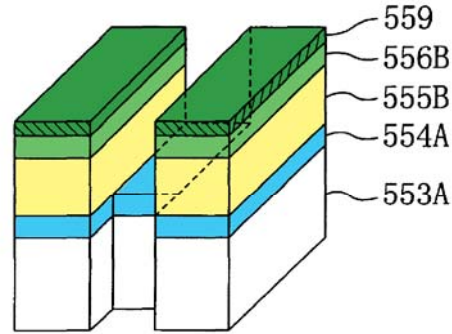


Fig. 29 (a)

As the Board acknowledged at Institution (ID 12), “even under the [BRI], the Board’s construction cannot be divorced from the specification and the record evidence, and must be consistent with the one that those skilled in the art would reach.” *Microsoft v. Proxyconn*, 789 F.3d 1292, 1298 (Fed.Cir. 2015). But the additional negative limitation imposed at Institution impermissibly excludes at least these three preferred embodiments of the ’696.¹⁵ EX2009 ¶62.

2. The additional negative limitation is impermissibly narrower than the *Phillips* Standard

The BRI “cannot be narrower” than the construction under *Phillips*. See *Facebook v. Pragmaus AV*, 582 Fed.App’x 864, 868-69 (Fed.Cir. 2014) (nonprecedential). The Eastern District of Texas has construed this term to mean

559 having flush edges together as a mask in both dimensions. EX1001 23:40-46; EX2009 ¶61.

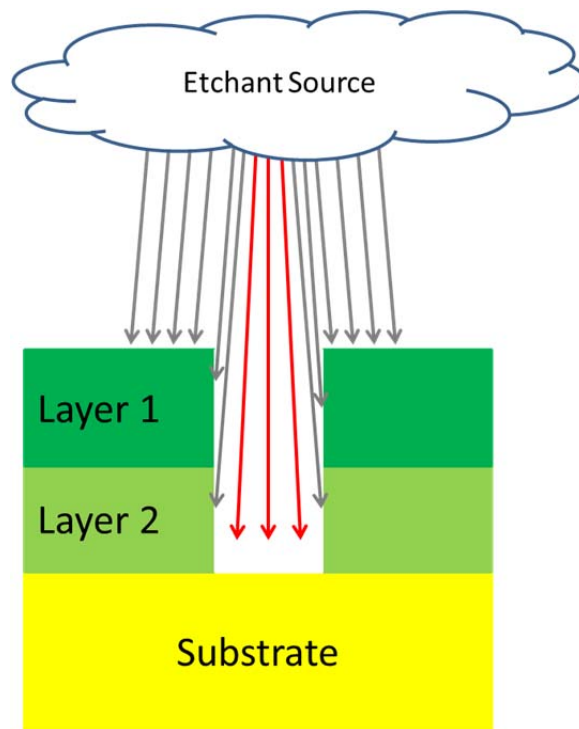
¹⁵ There also has been no disclaimer of these preferred embodiments in either the specification or file history. See generally EX1001; EX1012.

“using the [first resist pattern/second resist pattern and the mask pattern/patterned third insulating film] to define areas for etching” under the narrower *Phillips* standard. *See* EX3002 22. The additional negative limitation under the BRI improperly further limits the District Court’s construction. The additional negative limitation improperly incorporates into the claim language a “negative limitation [that] finds no anchor in the explicit claim language,” *Omega Eng’g v. Raytek*, 334 F.3d 1314, 1322-23 (Fed.Cir. 2003); EX2009 ¶¶48-49, and—while purporting to apply BRI—further narrows the District Court’s *Phillips* construction such that “to be ‘used as a mask,’ the between layer would need to define an additional portion of the layer being etched that is to be shielded from etching.” *Compare* ID 18 with EX3002 22.

3. The additional negative limitation is inconsistent with the plain and ordinary meaning, understanding of a person of ordinary skill in the art and Petitioner’s Expert’s prior publication

The Board had agreed with Patent Owner that “to meet the limitation ‘using the [designated layer] for etching,’ the designated layer ‘must actually be *used* to *define areas for etching*.” ID 15. However, in imposing the additional negative limitation, the Board has taken a narrow view that considers only top surfaces of a layer and excludes sidewalls of a layer from defining areas for etching that is inconsistent with the term’s plain and ordinary meaning. ID 15; EX2009 ¶¶63-65. As illustrated below for a multi-layer mask (composed of an intermediate layer

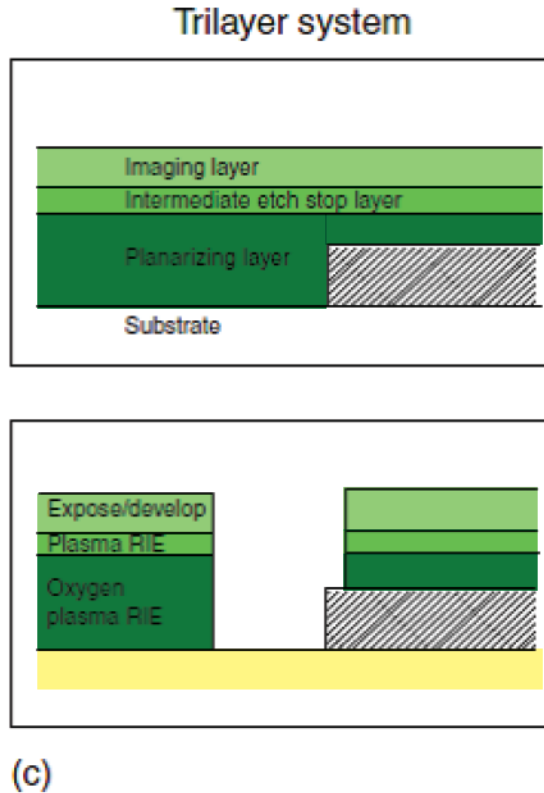
having edges in line and flush with edges of a top layer), although top surfaces of the top layer mask vertical flow of etchant, sidewalls of the top layer and the intermediate layer also mask horizontal flow of etchant, thereby collimating the flow of etchant to define areas of etching a substrate. EX2009 ¶¶66. Indeed, the resulting etch would also be different without the intervening layer (*e.g.*, Layer 2 below)—etching a wider hole than the opening in the first layer (*e.g.*, Layer 1 below). *Id.*



Moreover, it is undisputed that Layer 1's bottom portion bordering the hole is part of the mask, and there is no meaningful difference between the function of the material bordering the hole at the top of Layer 2 from the material bordering the hole at the very bottom of Layer 1. EX2009 ¶¶67-68. Layer 1 and Layer 2 act

together as a mask as shown above. *Id.* Consistent with the Board’s dictionary definition, Layer 1 and Layer 2 together act as “a pattern of opaque material used to shield selected areas of a surface (as of a semiconductor) in deposition or etching (as in producing an integrated circuit).” EX3001 1; EX2009 ¶¶67.

Contrary to the additional negative limitation and Petitioner’s expert’s (Dr. Smith) arguments during his deposition, Petitioner’s expert has admitted in prior publications that a “multiple layer resist” having *flush* edges can be used to define a “substrate film material” to be etched—*i.e.*, can be used as a mask. EX2018 642-643, 657; EX2010 49:6-50:9; EX2009 ¶¶70-71; *see also* EX2017 574, 592. For example, the figure below from Dr. Smith’s publication illustrates using a trilayer resist system (*e.g.*, including an imaging layer, an intermediate etch stop layer, and a planarizing layer) having flush edges for “feature shaping”—*i.e.*, to etch an underlying substrate layer. EX2018 624-643 (“***Three resist layers*** may be ***used to allow specific feature shaping...***”). As Dr. Smith testified, the resist has “multiple layers,” which must each be etched through before etching the substrate, shown below as “the very bottom horizontal line.” EX2010 50:10-52:10, 58:8-59:1 (“...there are the three layers...”), 64:5-65:8 (“...that very bottom horizontal line...would be etched using this process...”); EX2009 ¶¶71-72.



Other references recognize that “[m]ulti-layer processing techniques” that collectively form a “total patterning layer” for etching were beneficial and “common in semiconductor and computer manufacturing R & D labs.” *See, e.g.*, EX2015 260-261; EX2009 ¶¶69, 73; EX2017 574, 592; CBM2012-00002, Pap.66, 64.

For at least these reasons, Patent Owner respectfully submits that the additional negative limitation in the ID is incorrect.

IV. Grill Is Not Prior Art

The '696 claims priority to '371, filed March 26, 1998. U.S. Patent 6,140,226 (“Grill”), entitled “Dual Damascene Processing for Semiconductor Chip

Interconnects,” was filed July 30, 1998, and claims priority to the Provisional Application 60/071,628 (“’628”) (EX1017), filed January 16, 1998. EX1005 1:6-8. As discussed below (§IV.A), ’696 claim 13 is fully supported by ’371 under the requirements of §112 and entitled to the foreign priority date of March 26, 1998. EX2009 ¶¶74-75. Thus, in order for Grill to be prior art to ’696 claim 13, Grill must be able to claim the benefit of its provisional application filing date. However, Petitioner failed to demonstrate that Grill is entitled to the earlier filing date in the Petition and Petitioner should not be permitted to make up for this failure in reply in the hope that Patent Owner will not have the ability to respond. *Intelligent Bio-System*, 821 F.3d at 1369-70; n.3, *supra*. Indeed, Grill is not entitled to the earlier provisional date because each of Grill’s independent claims recites subject matter that was not disclosed in the provisional as explained below in §IV.B. Grill’s non-provisional application contains numerous statements that were not present in or were substantively modified from the provisional, including, *e.g.*, EX1005 2:32-35, 4:5-11, 4:45-47, 4:60-61, 7:25-29, 7:51-55, 7:64-66, 9:39-43, and 9:60-62, as shown in the attached redline comparing the two applications (EX2011). EX2009 ¶¶105-08.

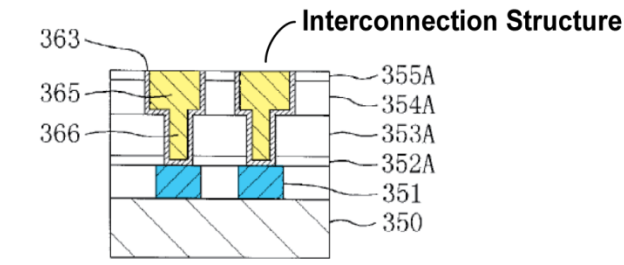
For example, Grill claims five variations of forming interconnect structures. EX1005 1:27-56. Each of Grill’s five independent claims requires the concurrent removal of a photoresist layer or residuals of a photoresist layer while transferring

a pattern into a second dielectric layer. *Id.* 10:59-65, 12:25-30, 13:54-58, 15:3-7, 16:14-17. However, the recited concurrent removal is not supported by Grill's provisional application. *See, e.g., id.* 10:58-62, 12:25-30, 13:47-50, 14:62-65, 16:14-18; EX2009 ¶104. Because '696 claim 13 is entitled to a foreign priority date of March 26, 1998, and Grill is only entitled to its non-provisional filing date of July 30, 1998, Grill is not prior art to '696 claim 13.

A. '696 Claim 13 is entitled to its claimed priority date of March 26, 1998

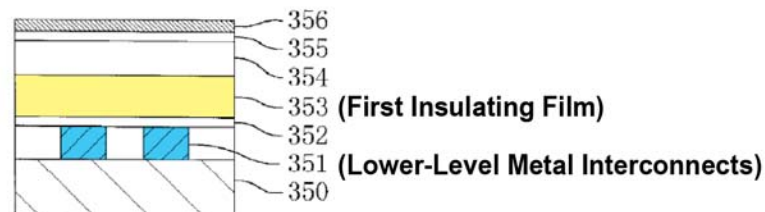
Despite acknowledging the '696's express claim of priority to '371, Petitioner argues that the Claims are not entitled to priority to '371 because the embodiments disclosed in that application allegedly do not disclose steps (g), (h), and (i) of '696 claim 13. Pet.20-27. However, as shown below, '696 claim 13 is fully supported under §112 ¶1 by at least the third embodiment variant disclosed in '371. *See* EX2009 ¶¶76-77; *Star Sci., Inc. v. R.J. Reynolds Tobacco Co.*, 655 F.3d 1364, 1371 (Fed.Cir. 2011). Indeed, '371 describes the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that applicant had possession of the claimed invention. EX2009 ¶77; *see Moba, B.V. v. Diamond Automation*, 325 F.3d 1306, 1319, (Fed.Cir. 2003). Furthermore, '371 satisfies the enablement requirement because a POSITA, after reading the specification, "could practice the claimed invention without undue experimentation. EX2009 ¶77; *AK Steel Corp. v. Sollac & Ugine*, 344 F.3d 1234, 1243-44 (Fed.Cir. 2003).

Preamble: '371 discloses a method for “forming an interconnection structure” over first metal wiring 351:



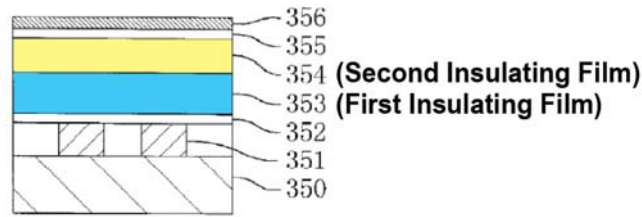
E.g., EX1014 ¶¶[0089]-[0090], Fig.17(c); EX2009 ¶78.

Step a: '371 discloses “forming a first insulating film [*e.g.*, first silicon dioxide film 353] over lower-level metal interconnects [*e.g.*, first metal wiring 351]”:



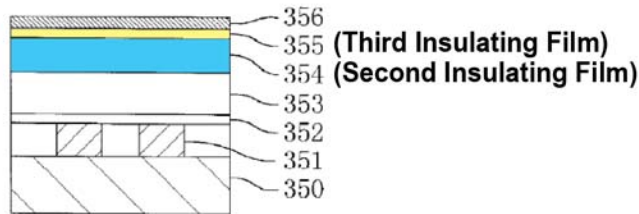
E.g., EX1014 ¶[0090], Fig.15(a); EX2009 ¶79.

Step b: '371 discloses “forming a second insulating film [*e.g.*, organic film 354], having a different composition than that of the first insulating film [*e.g.*, first silicon dioxide film 353], over the first insulating film [*e.g.*, first silicon dioxide film 353]”:



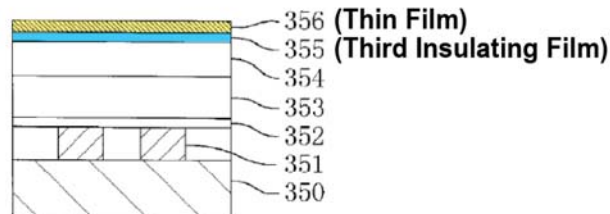
E.g., EX1014 ¶[0090], Fig.15(a); EX2009 ¶80.

Step c: '371 discloses “forming a third insulating film [*e.g.*, a second silicon dioxide film 355], having a different composition than that of the second insulating film [*e.g.*, organic film 354], over the second insulating film [*e.g.*, organic film 354]”:



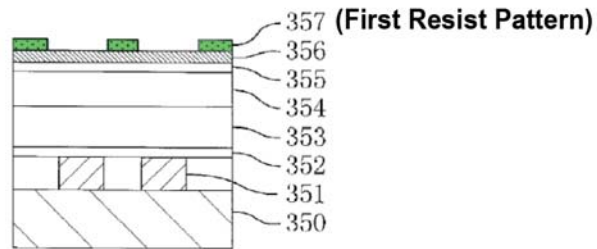
E.g., EX1014 ¶[0090], Fig.15(a); EX2009 ¶81.

Step d: '371 discloses “forming a thin film [*e.g.*, titanium nitride film 356] over the third insulating film [*e.g.*, a second silicon dioxide film 355]”:



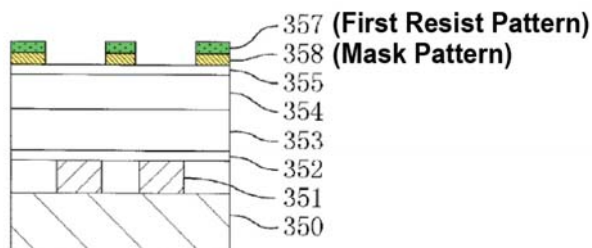
E.g., EX1014 ¶[0090], Fig.15(a); EX2009 ¶82.

Step e: '371 discloses “forming a first resist pattern [e.g., first resist pattern 357] on the thin film [e.g., titanium nitride film 356], the first resist pattern having opening for forming wiring grooves”:



E.g., EX1014 ¶[0092], Fig.15(b); EX2009 ¶83.

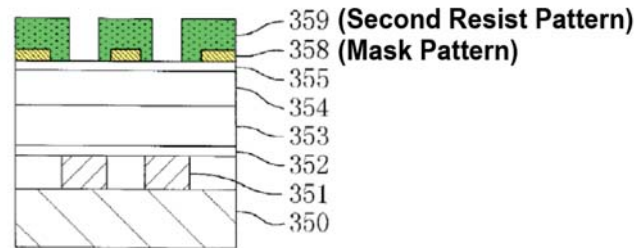
Step f: '371 discloses “etching the thin film [e.g., titanium nitride film 356] using the first resist pattern [e.g., first resist pattern 357] as a mask, thereby forming a mask pattern [e.g., mask pattern 358] out of the thin film [e.g., titanium nitride film 356] to have the openings for forming wiring grooves”:



E.g., EX1014 ¶[0092], Fig.15(c); EX2009 ¶84.

Step g: Contrary to Petitioner’s assertions directed to the first, second and fourth embodiments (Pet.20-22), the third embodiment variant in '371 discloses “removing the first resist pattern [e.g., first resist pattern 357] and then forming a second resist pattern [e.g., second resist pattern 359] on the third insulating film

[e.g., second silicon dioxide film 355] and the mask pattern [e.g., mask pattern 358], the second resist pattern having openings for forming contact holes”:



E.g., EX1014 ¶[0093], Fig.16(a); EX2009 ¶85.

Step h: Contrary to Petitioner’s contention (Pet.23-25), ’371’s third embodiment variant discloses “dry-etching the third insulating film [e.g., second silicon dioxide film 355] using the second resist pattern [e.g., resist pattern 359] and the mask pattern [e.g., mask pattern 358] as a mask, thereby patterning the third insulating film [e.g., second silicon dioxide film 355] to have the openings for forming contact holes.” E.g., EX1014 ¶¶[0093]-[0096], Figs.16(a)-(c); EX2009 ¶¶86-91.

For example, ’371 discloses that the second resist pattern may be misaligned during fabrication. EX1014 ¶[0096]. To address this misalignment, the underlying mask pattern is etched using the second resist pattern as a mask. *Id.* As an effect of such etching, edges of the second resist pattern become *in line and flush with* the edges of the mask pattern. EX2009 ¶87. Accordingly, when the underlying third insulating film is subsequently patterned, both the second resist

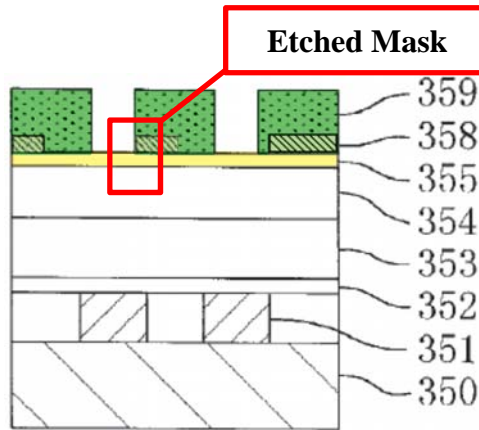
pattern and the mask pattern together define areas for the patterning—*i.e.*, they are both “used...as a mask,” as claimed. EX2009 ¶87.

The series of illustrations below show this patterning in case of misalignment, according to '371's disclosure. For example, “if the mask pattern 358 is exposed to the openings of the second resist pattern 359 for the formation of contact holes because of the misalignment,” Fig.16(a) would appear as:



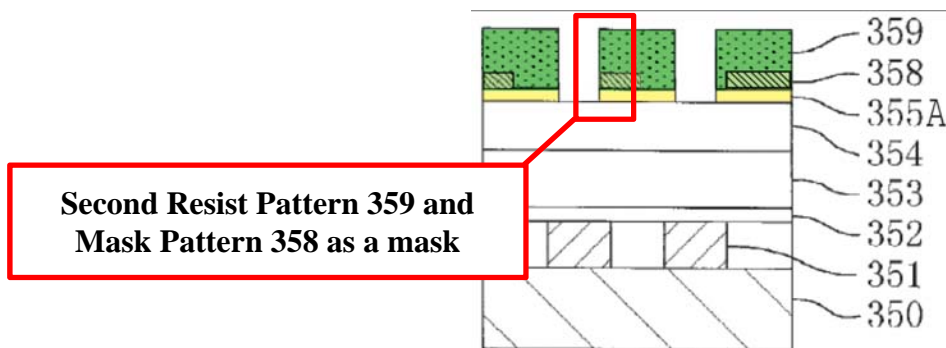
E.g., EX1014 ¶[0096]; EX2009 ¶88.

After “the mask pattern 358 is dry-etched using the second resist pattern 359 as a mask,” an edge of mask pattern 358 is *in line and flush with* an edge of second resist pattern 359 and Fig.16(a) would appear as:



E.g., EX1014 ¶[0096]; EX2009 ¶89.

Etching of the “third insulating film [355]” is then done “using the second resist pattern [359] and the mask pattern [358] as a mask,” using the edges that are in line and flush, and Fig.16(a) would appear as shown below (meeting the requirements of (step h)):

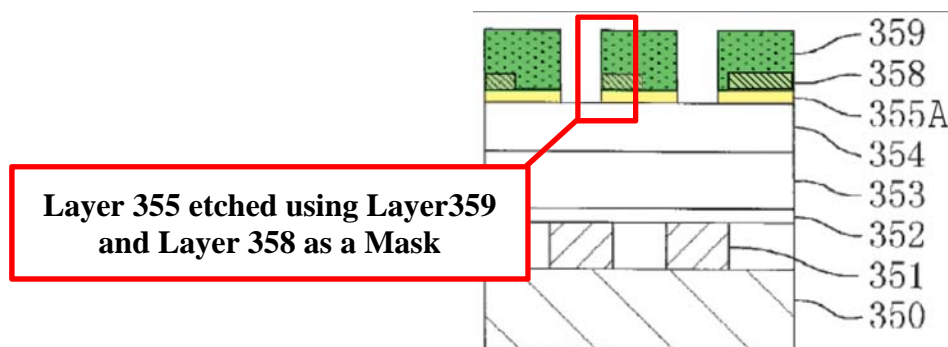


E.g., EX1014 ¶¶[0093], [0096]; EX2009 ¶90.

Additionally, '371 provides support for using two layers as a mask in a similar manner as discussed above in §III.A.1. *See, e.g.*, EX1014 Figs.13(b)-(c), 16(c)-(d), ¶¶[0080]-[0095]; EX2009 ¶91.

Step i: '371 discloses “dry-etching the second insulating film [*e.g.*, organic film 354] using the patterned third insulating film [*e.g.*, patterned second silicon dioxide film 355A] as a mask, thereby patterning the second insulating film to have the openings for forming contact holes.” *E.g.*, EX1014 ¶[0093], Fig.16(b); EX2009 ¶¶92-95. Petitioner’s assertions to the contrary (Pet.25-27) improperly focus on '371’s figures and ignore its text.

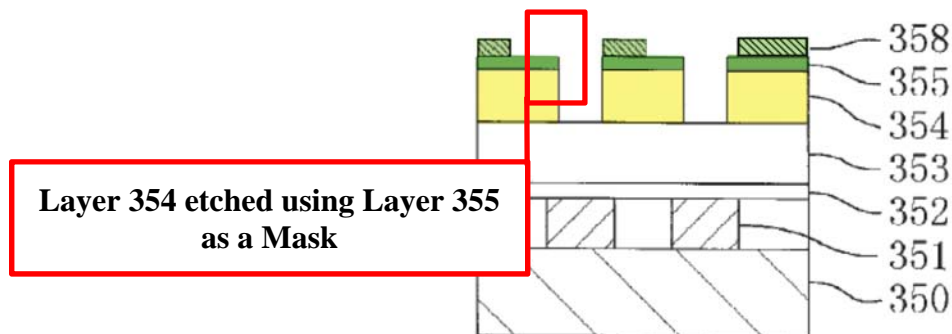
'371 discloses that layers 355 and 354 are “*sequentially*” *etched* using the pattern 359 as a mask. EX1014 ¶[0093]. Continuing with the illustrations from above, when layer 355 is etched using pattern 359 as a mask as disclosed in '371, edges of layer 355 become *in line and flush with* edges of 359 and Fig.16(a) would appear as:



EX1014 ¶¶[0093], [0096]; EX2009 ¶¶93-94.

Layer 354 is then etched “using” *at least* layer 355A (“patterned third insulating film”) “as a mask” for two reasons: (1) pattern 359 and layer 355 together define areas for etching layer 354, and (2) “the second resist pattern 359 is removed during the step of etching the organic film 354”—leaving layer 355 to act

“as a mask.” EX1014 ¶¶[0093],[0096]; EX2009 ¶94. Fig.16(b) would then appear as:

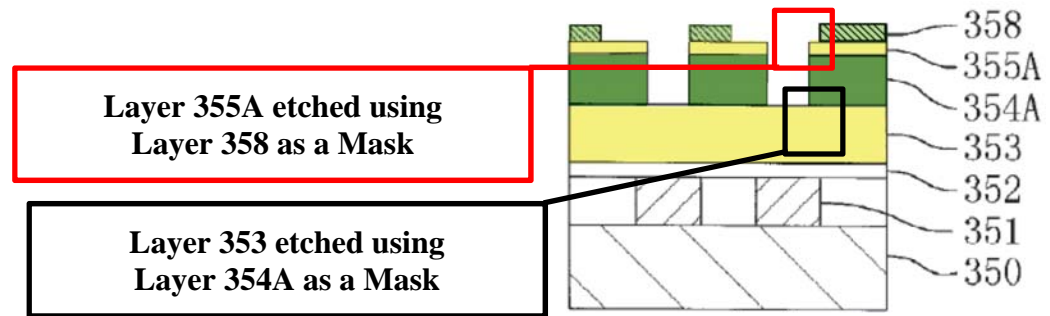


E.g., EX2009 ¶¶94-95.

Step j: '371 discloses “dry-etching the patterned third insulating film [*e.g.*, patterned second silicon dioxide film 355A] and the first insulating film [*e.g.*, first silicon dioxide film 353] using the mask pattern [*e.g.*, mask pattern 358] and the patterned second insulating film [*e.g.*, patterned organic film 354A] as respective masks, thereby forming wiring grooves and contact holes in the patterned third insulating film [*e.g.*, patterned second silicon dioxide film 355A] and the first insulating film [*e.g.*, patterned first silicon dioxide film 353A], respectively.” *E.g.*, EX1014 ¶[0094], Figs.16(b)-(c); EX2009 ¶96.

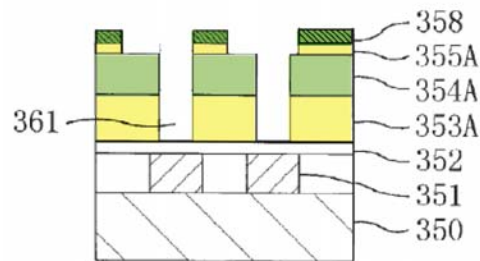
Continuing with the illustrations from above, Fig16(b) as modified above and shown below depicts the mask pattern (*e.g.*, mask pattern 358), which acts as a mask to etch the patterned third insulating film (*e.g.*, patterned insulating film 355A), and the patterned second insulating film (*e.g.*, patterned insulating film 354A), which acts as a mask to etch the first insulating film (*e.g.*, insulating film

353):¹⁶



E.g., EX1014 ¶[0094], Fig.16(b); EX2009 ¶96

After dry-etching the patterned third insulating film (*e.g.*, patterned insulating film 355A) and dry-etching the first insulating film (*e.g.*, insulating film 353) as disclosed in '371, Fig.16(c) would appear as:

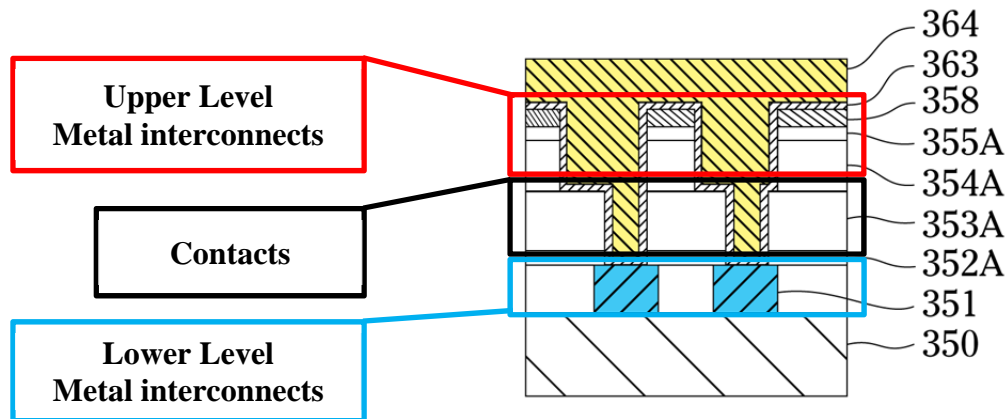


E.g., EX1014 ¶[0094], Fig.16(c); EX2009 ¶97.

Step k: '371 discloses “filling in the wiring grooves and the contact holes with a metal film [*e.g.* when the pattern of 358 is misaligned to the pattern of 359],

¹⁶ Although the '696 provides exemplary labels for several films at, *e.g.*, 19:4-9 (referring to, *e.g.*, “second insulating film”), these labels are neither definitional nor limiting. *See Thorner v. Sony Computer Entm't Am.*, 669 F.3d 1362, 1365 (Fed.Cir. 2012).

thereby forming upper-level metal interconnects and contacts connecting the lower- and upper-level metal interconnects together.” *E.g.*, EX1014 ¶[0098], Figs.17(b)-(c); EX2009 ¶98. Continuing with the illustrations from above, Fig.17(b) would appear as:



E.g., EX1014 ¶[0098], Fig.17(b); EX2009 ¶98-100.

The above final illustration shows a case where a wiring groove resist pattern was misaligned from a contact hole resist pattern, and a portion of the misaligned wiring groove mask pattern was etched (*e.g.*, as discussed above in step (h)). EX2009 ¶100. Although the etching of the misaligned portion of the wiring groove mask pattern may result in a slightly wider wiring groove and slightly narrower spacing between wires, it does not affect density or number of wires that can be formed. EX2009 ¶100.

’371 describes the subject matter claimed in each limitation of the claimed subject matter of claim 13 and enables one skilled in the art to practice the claimed invention without undue experimentation. EX2009 ¶101. Therefore, each of the

limitations of claim 13 is supported by '371, and accordingly claim 13 of the '696 is entitled to the priority date of '371, March 26, 1998.

B. Petitioner has not shown, and cannot show, that Grill is entitled to the priority date of '628

Although Grill claims the benefit of Provisional Application 60/071,628 ("'628") (EX1017), filed January 16, 1998 (EX1005 1:6-7), Grill is not entitled to the earlier provisional date because each of Grill's independent claims recites subject matter that was not disclosed in the provisional. EX2009 ¶¶102-04. Grill's non-provisional application contains numerous statements that were not present in or were substantively modified from the provisional, including, *e.g.*, EX1005 2:32-35, 4:5-11, 4:45-47, 4:60-61, 7:25-29, 7:51-55, 7:64-66, 9:39-43, and 9:60-62, as shown in the attached redline comparing the two applications (EX2011). EX2009 ¶¶105-08. For example, Grill claims five variations of forming interconnect structures. *Id.* 1:27-56, cls.1, 15, 28, 35, 42. Each of Grill's five independent claims requires the concurrent removal of a photoresist layer or residuals of a photoresist layer while transferring a pattern into a second dielectric layer. *Id.* 10:59-65, 12:25-30, 13:54-58, 15:3-7, 16:14-17. However, the recited concurrent removal is not supported by Grill's provisional application. EX2009 ¶¶104-108.

1. Legal Standard

In order for Grill to be considered prior art as of the filing date of its provisional application under §102(e), Grill's provisional must provide written

description support “*for the claims* in the reference patent in compliance with §112, ¶1.” *Dynamic Drinkware v. National Graphics*, 800 F.3d 1375, 1381 (Fed.Cir. 2015). As detailed below, Petitioner cannot prevail in making the required showing.

2. Petitioner has failed to demonstrate that ’628 provides §112¶1 support for the claimed invention of Grill

Although Petitioner clearly knew it would need to show Grill’s entitlement to the filing date of its provisional, the Petition contains no evidence or argument attempting to provide this showing required by §42.22(a)(2) and should not be allowed to fix this failure in reply. *See, e.g.*, Pet.28-29, n.3; *Intelligent Bio-System*, 821 F.3d at 1369-70; n.3, *supra*.

Petitioner tries to excuse this failure by arguing that *Drinkware* suggests Petitioner “need not do anything more at this stage to meet its initial burden of production to demonstrate *Grill* is prior art under §102(e).” *Id.* But in *Drinkware*, the claim to an earlier reduction to practice was not apparent from the patent and the petitioner had no way of knowing the patent owner would attempt to swear behind the prior art reference. *Dynamic Drinkware*, 800 F.3d at 1379-80. Here, in contrast, Petitioner clearly recognized the issue of the ’696’s priority date—*e.g.*, because the priority claim is on the face of the patent itself, Petitioner argues about it (Pet.20-27), and Petitioner knew Grill could need its provisional priority date to qualify as prior art at all (Pet.28-29, n.3). Petitioner should not be allowed to

withhold its arguments on this issue until reply in an attempt to deprive Patent Owner of the opportunity to respond. *Intelligent Bio-System*, 821 F.3d at 1369-70; n.3, *supra*; *see also* §42.22(a)(2).¹⁷

Petitioner should not be allowed to now raise new arguments that it omitted from its petition—depriving Patent Owner of the opportunity to respond to any new arguments and evidence. But even if Petitioner were allowed to improperly incorporate its declarant’s appendix into the Petition, its efforts to show Grill is entitled to the earlier provisional date still fail. **First**, Petitioner’s declarant opines about only *one* of Grill’s numerous claims (claim 28), when Federal Circuit precedent provides that an application must provide support, more broadly, for “*the claims* in the reference patent.” *See Dynamic Drinkware*, 800 F.3d at 1381.¹⁸

¹⁷ Petitioner’s efforts to evade the word limit in §42.24(a)(1) by including some of its arguments in the form of an expert declaration similarly should not be considered. *See* EX1002, App.B; *ZTE (USA) v. Elecs. & Telecomms. Research Inst.*, IPR2015-00029, Pap.12, 6 (“we do not consider arguments not made in the Petition itself”).

¹⁸ While Board panels (in decisions not binding here) have permitted a Petitioner to show support for fewer than all claims, *see, e.g., Cisco*, IPR2014-01276, Pap.40, 22-23, referencing the notion that there may be multiple inventions in a patent, *see id.*, Patent Owner respectfully submits this is in conflict with the Federal Circuit’s

Second, as detailed below, even Petitioner’s improperly-referenced chart for claim 28 fails to satisfy either of the requirements for priority—it fails to show that claim 28 is actually supported by ’628. Thus, even if considered, Petitioner’s improperly incorporated arguments and evidence fail to show a reasonable likelihood of proving that Grill qualifies as prior art, and its Petition should be denied institution on all grounds.

3. Dr. Smith has failed to show that ’628 provides §112¶1 support for the claims of Grill

Even if Petitioner were entitled to rely on arguments made only by its declarant, Dr. Smith, the declaration fails to show that ’628 contains written description support for any claim of Grill. Appendix B of Dr. Smith’s declaration (EX1002) purportedly charts ’628 against Grill claim 28, but as explained below, it cannot supply the elements missing in ’628. *See* EX1002, App.B.

Prior art discloses a feature if it either expressly or inherently discloses a feature. In order for a prior art reference to inherently disclose a feature, the

holding in *Dynamic Drinkware*, 800 F.3d at 1381 (requiring showing of “support for *the claims*”), and also inconsistent with, *inter alia*, long-held positions of the Patent Office. *See, e.g.*, MPEP §802 (providing for restriction to one invention when “two or more independent and distinct inventions are claimed in one application”).

evidence “must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill.” *See In re Robertson*, 169 F.3d 743, 745 (Fed.Cir. 1999) (“may result from a given set of circumstances is not sufficient”). However, as discussed below, claim 28’s limitations are not expressly disclosed and are not “necessarily present” because there exist other possible alternative implementations. *Id.*

For example, Dr. Smith fails to show that ’628 discloses “transferring the via pattern in the patterned first hard mask layer into the second dielectric layer, *while concurrently removing said via patterned second layer of resist*,” as required by Grill’s claim 28.¹⁹ EX2009 ¶¶109-132.

¹⁹ Each of Grill’s independent claims contains a similar limitation: claims 1, 15, and 28 recite “transferring said [wiring/via] pattern into said second dielectric layer to form [wiring/via] cavities corresponding to said [wiring/via] pattern, *while concurrently removing said [wiring/via]-patterned layer of resist*”; and claims 35 and 42 recite “transferring said via pattern in said patterned first hard mask layer into said second dielectric layer *while concurrently removing any residuals of said patterned second layer of resist[.]*” EX1005. Thus, ’628 fails to support any of Grill’s claims for the same reasons. EX2009 ¶112 n.7.

'628 is devoid of any support for this element, which requires concurrently removing the second layer of resist when transferring the via pattern of the first hard mask into the second dielectric layer. EX2009 ¶¶109-13. In fact, '628 does not contain any support for concurrently removing *any* layer of resist while etching any dielectric layer, let alone concurrently removing the specific resist layer during the patterning of the specific dielectric layer recited in the claim. EX2009 ¶113.

Indeed, the only support for this element contained in Grill was added (indicated in bold and underlined) in the non-provisional application of Grill:

The via level pattern is then transferred into dielectric 12 by an etching process such as reactive ion etching, to produce the structure of FIG.5F. **Patterned second resist layer 62 is absent from FIG.5F because it is typically removed by the etching process used to pattern dielectric 12.**

Compare EX1005 7:62-66 with EX1017 15; EX2011 15; EX2009 ¶114.²⁰ Absent any clear disclosure, a POSITA would have understood that the '628 does not

²⁰ Further demonstrating that this disclosure was not in '628, several similar sentences were added to the non-provisional. *E.g., compare* EX1005 4:41-48 with EX1017 13; EX1005 4:44-48, 4:58-60 with EX1017 13; EX1005 9:55-65 with EX1017 17. *See* EX2009 ¶114 n.8. In addition, Figures 3A-3C shown in Grill's non-provisional application further shows the photoresist pattern 34 being removed *after* transferring the wiring pattern into the second dielectric layer 12, *not concurrently* with the transfer. *Compare* EX1005 Fig.3A, Fig.3B (showing that the

disclose concurrent removal of photoresist, and indeed fails to provide a disclosure of any timing for when the removal of the photoresist happens (*e.g.*, it might occur before or after the transfer of the pattern). EX2009 ¶115. Because alternatives exist to the concurrent removal of the photoresist layer or residuals of a photoresist layer, Grill's provisional does not inherently disclose any of these claimed features. EX2009 ¶115.

Dr. Smith admits that the bolded and underlined statement was missing from Grill's '628 provisional and added to Grill's non-provisional application, but he asserts that a POSITA would already have understood this missing text "to be part of the '628 application's disclosures." EX1002, App.B B-9-10. Dr. Smith's contention fails because it is based on two assumptions that are unsupported by and inconsistent with the actual disclosures of the '628 and Grill. EX2009 ¶116.

(a) Dr. Smith's reliance on a disclosure relating to etch characteristics in the Background of '628 is misplaced

In attempting to argue that '628 discloses concurrently removing the second layer of resist when transferring the via pattern of the first hard mask into the second dielectric layer, Dr. Smith relies on a portion of '628's Background of the

photoresist layer 34 is present *after* hard mask layer 14, dielectric 12 and etch stop 10 have been etched), Fig.3C (showing the photoresist layer 34 has been removed); EX2009 ¶114 n.8.

Invention section, which states that “difficulties in reworking the second lithography step may occur if the interconnect dielectric and the photoresist stencil used to pattern the hard mask have similar etch characteristics.” EX1002 App.B B-9-10 (citing EX1017 10-11). Based on this disclosure, Dr. Smith concludes a POSITA “would have understood that etching layer 12 under such circumstances concurrently etches layer 58 because the two layers have similar etch properties.” *Id.* Petitioner attempted to revise Dr. Smith’s declaration in November 2016 to change the statement from “concurrently etches **layer 58**” to “concurrently etches **layer 62**,” but the Board did not authorize the revision. EX1002, App.B. B-10; Pap.7, 4. Petitioner again improperly attempted to correct this error during Dr. Smith’s deposition. EX2010 28:16-32:6. Petitioner should not be able to revise Dr. Smith’s declaration now for the same reasons set forth in the Board’s order, including prejudice to Patent Owner and because the arguments were improperly incorporated into the Petition to begin with. Pap.7, 4.

Based on Dr. Smith’s originally-filed Declaration, his conclusion that “etching layer 12 under such circumstances concurrently etches layer 58 because the two layers have similar etch properties” is entirely unsupported. EX2009 ¶¶117-18. Dr. Smith fails to explain why this portion of ’628 that discusses a *problem in the prior art* criticized by Grill (EX1002 App.B B-9-10) actually applies to the particular embodiment containing layers 12 and 58 in Grill’s asserted

invention *responding to these problems*. EX2009 ¶119. He does not point to any evidence that indicates that “such circumstances”—*i.e.*, the etch properties present in a problematic situation described in the Background section—are present in the particular embodiment and the particular layers disclosed in ’628. To the contrary, ’628 expressly discloses that the very layers Dr. Smith points to as having “similar etch properties”—layers 12 and 58—preferably have *different* etch properties: “Hard mask layers 56 and 58 are preferably formed from different materials which have different etch properties from each other and from the dielectric underlayers 12 and 8.” EX1017 15; EX2009 ¶119. And Dr. Smith himself explains in the same chart that when two layers have different etch properties, one layer is not removed concurrently when etching the other. EX1002, App.B B-7; EX2009 ¶119.

Even if Dr. Smith were improperly allowed to change his testimony as he tried to do at deposition, Dr. Smith fails to explain how the disclosure regarding “etching” in the Background section can be applied to this embodiment to provide support for this limitation, which requires “removing” an entire layer. Indeed, the very claim of Grill being discussed by Dr. Smith uses the terms “etching” and “removing” to describe different acts. *See, e.g.*, EX1005, cl.28 (“selective *etching* of said second hard mask layer with respect to said first hard mask layer”); cl.28 (“concurrently *removing*...layer”); EX2009 ¶120. Even if it could be shown that

“etching” equates to partial removal—and Petitioner has made no such showing—the claims require “concurrently removing...layer” and not just partial removal. EX2009 ¶120.

(b) Dr. Smith’s opinion that concurrent etching of the photoresist layer and the dielectric layer is the only possibility is unsupported by and contradictory to ’628

Dr. Smith additionally opines that a POSITA would have “further understood that the photoresist layer 62 is not removed prior to etching [dielectric] layer 12” and concludes a POSITA “would have thus understood that the transition between Figures 5E and 5F above is *only possible by concurrently etching* photoresist layer 62 and dielectric layer 12.” EX1002, App.B B-10. However, Dr. Smith’s opinion is unsupported by and inconsistent with ’628. EX2009 ¶121.

First, the ’628 does not disclose concurrent removal of photoresist, and indeed fails to provide a disclosure of any timing for when the removal of the photoresist happens (*e.g.*, it might occur before or after the transfer of the pattern). EX2009 ¶122.

Second, even if it is assumed, *arguendo*, that a POSITA would not have removed the photoresist layer prior to etching the dielectric layer, as Dr. Smith opines, he fails to explain why the photoresist layer must *necessarily* be removed **concurrently** with the etching of the dielectric layer, as opposed to **after** the etching of the dielectric layer. EX2009 ¶123.

Dr. Smith also opines that stripping the photoresist before etching the dielectric would “make it difficult to control the via dimension.” EX1002, App.B B-10. However, even if that were true, Dr. Smith’s unsupported conclusion that the transition between Figures 5E and 5F is “*only possible* by concurrently etching photoresist layer 62 and dielectric layer 12” simply does not follow. *Id.*; EX2009 ¶124. In other words, even if Dr. Smith is correct that etching the resist concurrently with the etching of the dielectric makes it *easier* to obtain a certain desirable characteristic, it does not follow that such a way is the “only possible” way.²¹ EX2009 ¶124. Dr. Smith’s attempt to argue inherent disclosure of this limitation clearly fails. *E.g., Enfora v. M2M Solutions*, IPR2015-01672, Pap.14, 5-7 (denying institution where petitioner’s “conclusory assertion of inherency” not supported; “extrinsic evidence must make clear that the missing descriptive matter is *necessarily present*....Inherency...*may not be established by probabilities or*

²¹ Indeed, the language added in Grill’s non-provisional application further confirms that concurrent removal of the photoresist when etching the dielectric layer is *not* the only possibility. EX2009 ¶124 n.9. As discussed above, the non-provisional application added the following: “Patterned second resist layer 62 is absent from FIG.5F because it is *typically* removed by the etching process used to pattern dielectric 12.” EX1005 7:61-67. Contrary to Dr. Smith’s declaration, this added language shows that concurrent removal is not the *only* possibility.

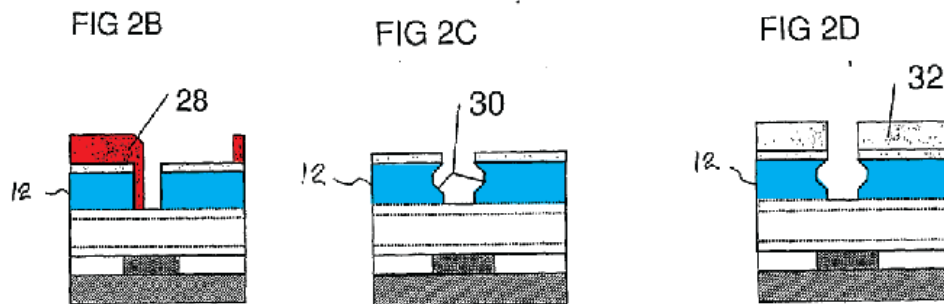
possibilities” (quoting *In re Robertson*, 169 F.3d 743, 745 (Fed.Cir. 1999)); *Unified Patents v. William Grecia*, IPR2016-00602, Pap.11, 13-14; *Motorola Mobility v. Int’l Trade Comm’n*, 737 F.3d 1345, 1350 (Fed.Cir. 2013) (finding “[i]nherency requires more than probabilities or possibilities” and the art did not “necessarily” require the limitation). And obvious possibilities—even desirable ones—cannot provide Grill the supporting disclosure it lacks under §112(¶1). *E.g.*, *Ariad Pharms. v. Eli Lilly*, 598 F.3d 1336, 1352 (Fed.Cir. 2010) (*en banc*) (“a description that merely renders the invention obvious does not satisfy the [written description] requirement”).

(c) Dr. Smith’s opinions are not credible because they are based on problems inapplicable to the relevant embodiments

Furthermore, Dr. Smith’s assertion that “the transition between Figs. 5E and 5F is *only possible* by concurrently etching photoresist layer 62 and dielectric layer 12” (EX1002, App.B B-10) is based on mischaracterizations of ’628’s disclosure. EX2009 ¶125. To support his opinion, Dr. Smith asserts “[a] person of ordinary skill in the art would have further understood that...if the photoresist is stripped with a wet chemical treatment before etching layer 12, the problems described with regard to Figures 2C result.... This would damage the exposed interlayer dielectric layer 12 and make it difficult to control the via dimension.” *See* EX1002, App.B

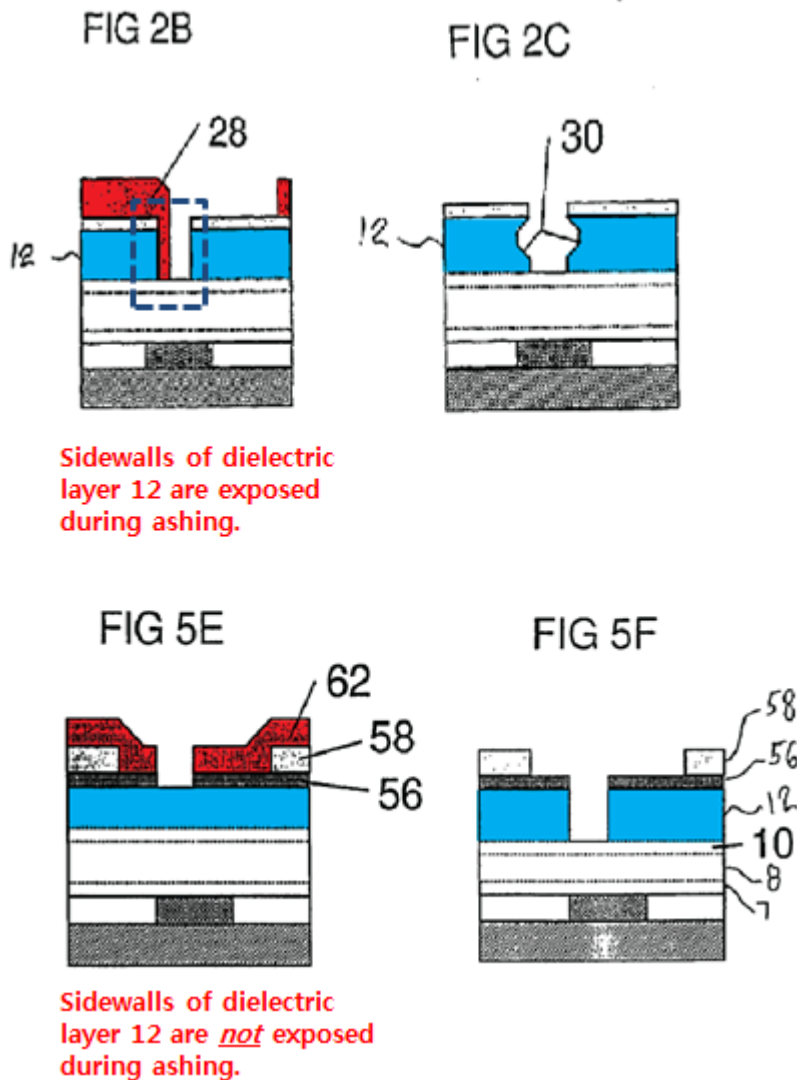
B-10. However, contrary to Dr. Smith’s opinion, the problems described in Figure 2C are inapplicable to the embodiment of Figures 5E and 5F. EX2009 ¶125.

The “problem” addressed in Figs. 2C-2D is that the “[s]idewalls 30 of dielectric 12 [shown in blue] are clearly undercut” when “an ashing process [is used] to remove misaligned patterned resist layer 28 [shown in red].” *See* EX1017 13, Figs. 2B-2D (disclosing the formation of concave undercuts (*e.g.*, 30) of dielectric layer 12). EX2009 ¶126.



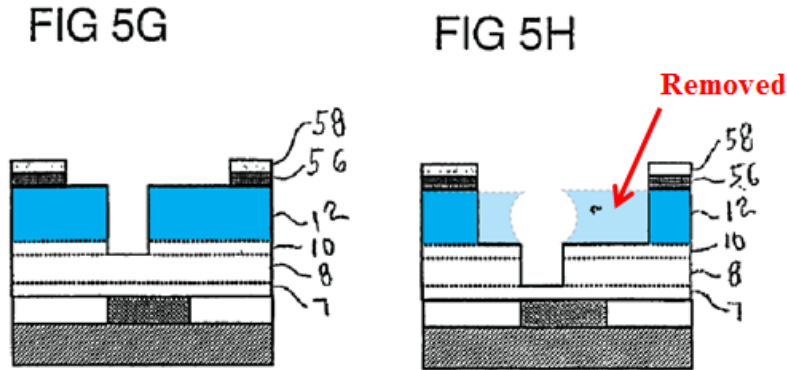
Dr. Smith’s opinion that the “undercut” problem of Figs. 2C-2D applies to the process of Figs. 5E-5F is incorrect for three reasons. **First**, ’628 only discloses removing the resist by ashing—the disclosure of removing resist by wet chemical treatment was only added later to the specification by Grill’s non-provisional application. *Compare* EX1017 with EX1005, *e.g.*, 4:37-40, 5:62-67, 6:6-20, 6:49-53; *see* EX2009 ¶127. Thus, Dr. Smith’s opinion that a POSITA would have recognized problems *with wet etching* based on ’628 is unsupported and unsupportable. EX2009 ¶127.

Second, the “undercut” problem of Figs.2C-2D occurs when the sidewalls are exposed *during ashing*. See EX1017 13, Figs.2B-2D; EX2009 ¶128. Figure 5E, on the other hand, clearly shows that sidewalls in the etching layer 12 are not yet formed. See EX1017, Figs.5E-5F (annotated to show that dielectric layer 12 (blue) sidewalls are not exposed until Fig.5F—after photoresist 62 (red) is removed); EX2009 ¶128:



Therefore, because the sidewalls are not exposed, the dielectric would not be subject to the “undercut” problem of Figs. 2C-2D even if the photoresist were removed before etching layer 12 in Fig.5E. EX2009 ¶129.

Third, the same paragraph relied on by Dr. Smith explicitly teaches that “[undercutting] may not be a problem when the dimensions of said second pattern substantially exceed the dimensions of the first pattern, since the undercut regions would be etched away.” EX1017 13. This is precisely the circumstance illustrated in Figs.5E-5H. EX2009 ¶130. Dr. Smith fails to address the fact that any damage or undercutting to the exposed portion of layer 12 that may result from removing the resist prior to etching (Figs.5E-5F) would be immaterial for the finished structure because any damaged portion would be ultimately removed during the subsequent etch. EX2009 ¶130. Specifically, the embodiment of Figs. 5E-5G has an opening in the second hard mask layer 58 with greater dimensions (width) than that of the first hard mask (56). *See* EX1017 Figs.5G-5H (annotated to disclose portion of layer 12 ultimately removed, even assuming undercutting occurred); EX2009 ¶130.



Therefore, Dr. Smith's testimony is unsupported and cannot be credited, as it relies on the problem of Figure 2, which is inapplicable to the process of Figure 5. EX2009 ¶131.

Thus, the Petition not only fails to show that the '696 is not entitled to its claimed foreign priority date (§IV.A), but it also fails to show (and can not show) that Grill is entitled to its provisional date. Even if Petitioner's evidence and arguments improperly incorporated by reference are considered (they should not be), and even if consideration is limited to Petitioner's selected claim 28 of Grill (which is contrary to the law, *see* n.18, *supra*), '628 fails to support, *inter alia*, the "concurrently removing" limitations in Grill's claim 28 (and in all other Grill claims), as discussed above. Because '628 fails to support the claims of the Grill non-provisional application, including claim 28, Grill does not antedate the '696's foreign priority date, and Petitioner cannot show by a preponderance of the evidence that Grill is prior art to the claim 13. EX2009 ¶132. *Dynamic Drinkware*, 800 F.3d at 1381-82; *see also Alarm.com*, IPR2016-00129, Pap.13, 16; EX2009

¶¶75, 132. Accordingly, all of Petitioner’s grounds—which are all based on Grill—should be dismissed at least with respect to claim 13.

V. Claims 13 and 15 Are Not Rendered Obvious By Grill in View of Aoyama

Petitioner bears the burden of showing “some reason why a person of ordinary skill in the art would have thought to combine particular available elements of knowledge, as evidenced by the prior art, to reach the claimed invention.” *Heart Failure Techs. v. Cardiokinetix*, IPR2013-00183, Pap.12, 9. At Institution, without the benefit of expert testimony from Dr. Glew (§42.107(a); 81 Fed.Reg. 18750, 18755 (“no negative inference”)), the Board provisionally accepted Petitioner’s arguments that a POSITA would have found it obvious to combine Grill’s two hard masks with Aoyama’s widened via pattern because Grill and Aoyama allegedly provided complementary solutions to address problems of misalignment in a dual damascene process. *See* ID 40. The Board relied upon Petitioner’s arguments that Aoyama addressed a misalignment problem by “using a resist pattern having a via opening that is wider than the wiring groove,” and upon testimony of Petitioner’s Expert that a POSITA would have found that “combining Grill’s two hard masks with Aoyama’s widened via pattern would not require modification of the Grill process.” *See* ID 40 (citing EX1002 ¶163). However, these arguments are based on Petitioner’s fundamental mischaracterizations of Aoyama and Grill, as described further below. Ex2009 ¶¶133-135.

In particular, Petitioner incorrectly asserts that applying, in Grill, an extracted teaching from Aoyama would not detract from Grill's contemplated solutions to the misalignment problem: "[n]othing about the width of the via pattern in *Aoyama* affects the dual-hard mask structure of *Grill*, and nothing about the dual-hard mask structure of *Grill* affects the width of the via pattern in *Aoyama*." See Pet.56 (citing its expert's unsupported testimony at EX1002 ¶163). Contrary to Petitioner's assertions, a skilled person would not have been motivated to combine Grill and Aoyama because Petitioner's proposed combinations change the stated purpose and principle of operation of Grill, and ignore teachings from Grill that would lead the skilled person away from a combination with Aoyama. Ex2009 ¶¶135-37.

First, Petitioner's proposed modifications would render Grill unsatisfactory for its intended purpose by eliminating Grill's use of a dual-relief pattern to form a dual-relief cavity and would change Grill's principle of operation by eliminating Grill's ability to control a critical dimension of vias within the dual-relief cavity. *Plas-Pak Indus. v. Sulzer Mixpac*, 600 F.App'x 755, 757-59 (Fed.Cir. 2015); Ex2009 ¶¶138-47.

Second, Petitioner's proposed modifications of Grill neglect effects that would change Grill's principle of operation by eliminating Grill's ability to control the width of its wiring groove. *Plas-Pak*, 600 F.App'x at 757-60; Ex2009 ¶¶148-67.

Third, Petitioner's proposed modifications ignore affirmative statements from Grill that would teach away from a combination with Aoyama. *See DePuy*, 567 F.3d at 1327. Aoyama's solution of controlling its wiring and through-hole dimensions using a wider through-hole pattern would not work without and Petitioner makes no reference to Aoyama's carbon etch stopper film. Ex2009 ¶¶168-84. Grill's avoidance of exposing carbon based layers (*e.g.*, Aoyama's etch stop layer) to stripping processes would teach away from a combination with Aoyama's embodiment, which exposes a carbon based layer to stripping processes. *Id.* Furthermore, Grill's express criticism of resists that are thicker over via areas would teach away from combining it as suggested by Petitioner with Aoyama's embodiment of Figure 18, which presents that very problem. *Id.*; *see, e.g., Intelligent Bio-System*, 821 F.3d at 1367-70; n.3, *supra*.

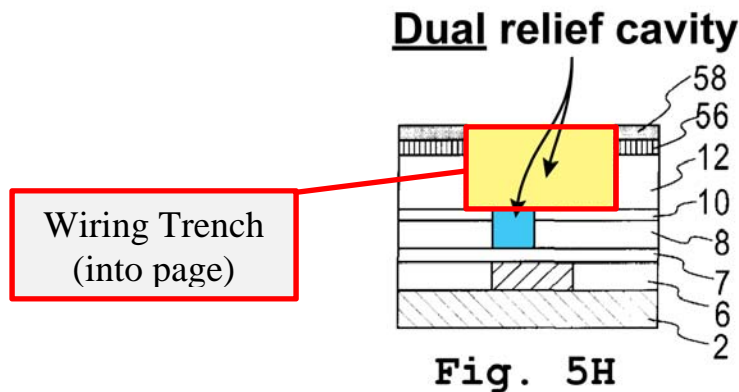
Petitioner has not addressed the numerous reasons why a POSITA would not have combined the references, nor has Petitioner shown that a person of ordinary skill in the art would have had a reasonable expectation of success in combining the references. *Intelligent Bio-System*, 821 F.3d at 1367-69. Any attempt by Petitioner to now supplement these failings in its Petition, in an attempt to deny Patent Owner any opportunity to respond, should not be permitted, and ultimately will fail because Petitioner's proposed combination obliterates Grill's principle of operation and intended purposes and renders Grill inoperable, and Grill teaches

away from such a combination. *See, e.g., id.* at 1369-70; *McGinley v. Franklin Sports*, 262 F.3d 1339, 1354 (Fed.Cir. 2001) (“If references taken in combination would produce a ‘seemingly inoperative device,’ we have held that such references teach away from the combination and thus cannot serve as predicates for a *prima facie* case of obviousness.”); *Gordon*, 733 F.2d at 902 (Fed.Cir. 1984); EX2009 ¶¶135-84.

A. Modifying Grill by Aoyama would render Grill unsatisfactory for its intended purpose of forming a dual relief pattern

Grill repeatedly emphasizes throughout its specification that its “present invention” is directed to forming a dual relief pattern and using said dual relief pattern to form a dual relief cavity in a substrate. EX1005 Abstract, 1:12-15, 2:41-50, 7:16-19; Ex2009 ¶138. Grill’s expressly-stated intended purpose of forming dual relief patterns and dual relief cavities facilitates its principle of operation: controlling critical dimensions of features such as vias (*see* §§V.A-B). EX1005 Abstract, 1:12-15, 2:41-50, 5:24-33; EX2009 ¶138. As Petitioner’s expert has acknowledged in his declaration and confirmed during his deposition, the dimensions of vias “need to be tightly controlled.” EX2010 16:16-17:12; EX1002 ¶47; *see also* EX1005 5:24-33, 7:16-29 (discussing “critical dimension” control). Controlling dimensions of vias is essential to increasing density of wires in underlying layers. EX2009 ¶138.

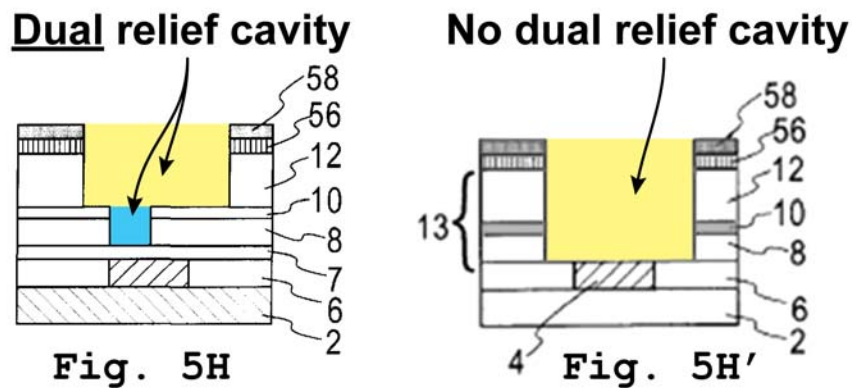
Grill describes lithographic methods for forming a dual relief pattern in a substrate in order to fabricate multilevel interconnect structures. EX1005 1:10-15; EX2009 ¶139. The dual-relief patterns of Grill include a larger wiring pattern over a smaller via pattern that are used to form a dual relief cavity that includes a wiring trench and via hole, respectively. EX1005 1:48-49, 7:25-29. As Petitioner's expert admits, Grill only discloses dual-relief patterns that are in a cross-section direction across a wiring trench, as shown, *e.g.*, in Figure 5H. *See, e.g.*, EX1005 Figs.5F-5H, 7:21-30; EX2009 ¶¶139-40; EX2010 81:5-18.



The dual-relief pattern of Grill enables “critical dimension” control of a via pattern dimension independently from an overlying wiring pattern dimension, and thereby facilitates precise placement of a via pattern over an underlying wider wiring pattern. EX1005 5:24-33, 7:16-29; EX2009 ¶¶141-43. Grill confirms that in “the general category of dual relief patterns,” “all features of a smaller area (via) pattern substantially overlap with the features of a larger area (wiring) pattern.” EX1005 7:26-30. The use of a smaller via pattern, combined with Grill’s dual-

hard mask system, which permits rework of photoresist patterns, facilitates precise placement of the via over an underlying wire. EX2009 ¶143.

Petitioner's proposed modification of Grill would eliminate the dual-relief patterns and dual-relief cavities of Grill. For example, as confirmed by Petitioner's expert, Fig.5H of Grill, reproduced below, illustrates a dual-relief cavity. EX2010 82:17-20. However, Fig.5H', also reproduced below and which illustrates Petitioner's proposed *modification* of Grill by Aoyama, does not include a dual-relief cavity. EX1005 5:18-22, 4:34-35, 4:51-52; EX2009 ¶¶144-45.



As is readily apparent from the above figures, Petitioner's proposed modification of Grill (Fig.5H') eliminates the dual-relief pattern and dual-relief cavity that are central to Grill's disclosure. EX2009 ¶144. This elimination of the dual-relief pattern eliminates Grill's ability to control placement of the via over the underlying wire. EX2009 ¶144. Thus, Petitioner's proposed modification of Grill would render Grill unsatisfactory for its intended purpose of using dual-relief cavities. EX2009 ¶¶146-47. Indeed, the Federal Circuit has found that proposed

modifications that change a primary reference's "intended purpose" are impermissible. *Plas-Pak*, 600 F.App'x at 757-59.

To the extent that Petitioner now tries to argue that Grill teaches dual-relief patterns in a direction along a wiring trench, as Petitioner's expert appeared to toy with suggesting during deposition, Grill does not show or expressly disclose such a structure, as Petitioner's expert was forced to admit. EX2010 80:15-81:18; EX2009 ¶145. Petitioner cannot now try to rewrite Grill and its arguments concerning the proposed combination to avoid eliminating Grill's intended purpose.²² See *InTouch Techs. v. VGO Commc'ns*, 751 F.3d 1327, 1351 (Fed.Cir.

²² To the extent Petitioner or its expert attempt to argue a POSITA would have understood Grill's structures to involve an analysis of cross-sections along a direction into the page of Grill's illustrations (which is not disclosed by Grill), this would be an improper new argument never before presented by Petitioner or its expert, and Patent Owner would be entitled to appropriate relief. See, e.g., *Intelligent Bio-System*, 821 F.3d at 1369-70; n.3, *supra*. Moreover, contrary to such an argument, Grill's dual-relief patterns are intended to enable precise placement of vias within a wire trench's width—not length. EX1005 2:64-3:1, 4:34-35, 4:51-52, 5:18-22, 5:24-33, 7:16-29; EX2010 13:7-14:20, 18:8-20, 19:14-20:7; EX2009 ¶¶140-145. Grill's dual-hard mask system facilitates rework (e.g., to complete "lithographic misalignment" between via and wiring patterns) in a

2014) (cannot rely on the patent as a “roadmap”).

B. Petitioner’s Modification of Grill using Aoyama would cause premature and undesirable degradation of Grill’s hard mask 58 that changes Grill’s principle of operation by eliminating Grill’s control over wire dimension

The Petition ignores the fact that the proposed modifications to Grill using Aoyama would have eliminated Grill’s principle of operation.²³ EX2009 ¶¶148-49. Petitioner relies on Aoyama’s example 7 for forming a wider through-hole to modify Grill. Pet.56, 73 (citing EX1018 3:6-38, 6:7-13, 15:48-16:30).

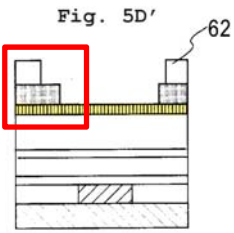
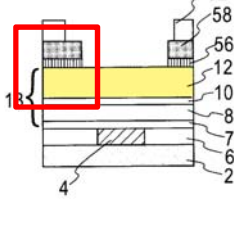
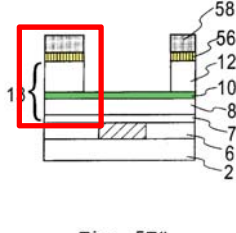
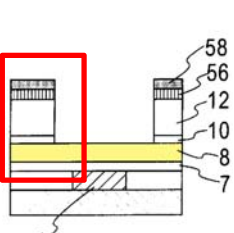
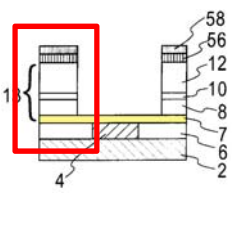
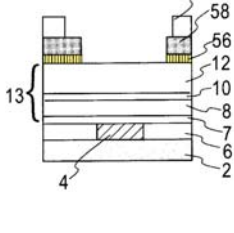
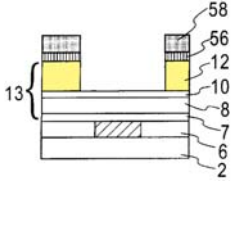
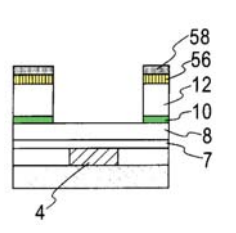
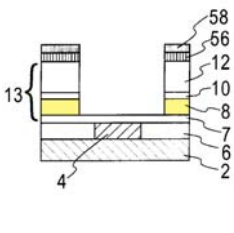
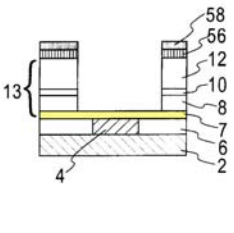
At Institution, the Board relied upon testimony of Petitioner’s expert that a POSITA “would have found it obvious that combining Grill’s two hard masks with Aoyama’s widened via pattern would not require modification of the Grill process.” EX1002 ¶163; ID 40. Petitioner’s expert also asserted that “[n]othing about the width of the via pattern in *Aoyama* affects the dual-hard mask structure of *Grill*.” See Pet.56 (citing EX1002 ¶163). However, these mischaracterizations by Petitioner and Petitioner’s expert ignore detrimental effects of Aoyama’s wider via

cross-sectional direction across the width of a wiring trench—not in a direction along a length of the wiring trench. *Id.*

²³ Petitioner should not be permitted to alter its proposed combinations to attempt to address these deficiencies. See, e.g., *Intelligent Bio-System*, 821 F.3d at 1369-70; n.3, *supra*.

hole pattern on Grill's dual-mask system that would undermine Grill's principle of operation of critical dimension control. EX2009 ¶149. As confirmed by Petitioner's expert, Grill's principle of operation is the control of critical dimensions (*e.g.*, a wire trench dimension) through its use of dual-hard masks,. EX2010 13:15-14:20, 18:8-20; EX1005 5:18-22, 4:34-35, 4:51-52; EX2009 ¶150.

As acknowledged by Petitioner, Grill describes using two hard masks to complete lithographic alignment on the hard masks before transferring the pattern into thin films. *See* Pet.53; EX1002 ¶158. In Petitioner's proposed modification of Grill, illustrated by Petitioner's Figures 5D'-5G' and 5F''-5G'', and illustrative figures 5H''-5H''', all of which are annotated below, Grill's upper hard mask 58 must persist through at least five etch steps shown below: (1) etching through layer 56, (2) etching through layer 12, (3) etching through layer 10 and layer 56, (4) etching through layer 8, and (5) etching through layer 7. EX2009 ¶151.

(1) Layer 56 etch (EX1005 7:57-61; Pet.59-61)	(2) Layer 12 etch (EX1005 7:62-64; Pet.61-63)	(3) Layers 10/56 etch (EX1005 7:67-8:2; Pet.63-65)	(4) Layer 8 etch (EX1005 8:2-5; Pet.65-67)	(5) Layer 7 etch (EX1005 8:5-8)
				
				

But exposing Grill's upper hard mask 58 to these etch steps prematurely degrades Grill's upper hard mask 58, causing loss of control over the dimension of the wire trench over the via hole. EX2009 ¶152. This loss of control over the dimension of the wire trench is not only undesirable, but also undermines the

principle of operation of Grill's entire process, and requires redesigning Grill's system in a manner not contemplated by Petitioner—demonstrating that Petitioner has failed to submit evidence meeting its burden to show by a preponderance of the evidence that a POSITA would have been motivated to combine the references or had a reasonable expectation of success. EX2009 ¶153.

Although Grill states that the lower hard mask 56 and upper hard mask layer 58 are preferably formed from “different materials which have different etch properties from each other,” a POSITA would have understood from Grill's specification and drawings that an etch of lower hard mask 56 would degrade any exposed portions of upper hard mask 58. EX1005 7:33-35; EX2009 ¶¶154-55. For example, Grill states that lower hard mask 56 may be made of silicon nitride and upper hard mask 58 may be formed from silicon oxide. EX1005 7:34-39; EX2009 ¶155.²⁴ A POSITA would have understood that silicon oxide etches at a much

²⁴ Grill provides a list of other materials, but does not provide any suggestion on how to use those materials between the lower hard mask 56 and upper hard mask 58, and the Petition and accompanying Smith declaration made no suggestion that other materials should be used. EX1005 7:35-42; EX2009 ¶155 n.10. Grill also describes using an optional dielectric passivation/adhesion layer 7 and an optional dielectric etch stop layer 10. EX1005 4:1-5; EX2009 ¶155 n.10. Grill is silent as to the composition of layer 7 and discloses that the optional dielectric etch stop

faster rate than silicon nitride, when both films are exposed to a silicon nitride etch process. EX2009 ¶155; EX2020 555-556; EX2014 Fig.2. Thus, a POSITA would have recognized that Petitioner's proposed modification that exposes upper hard mask 58 to a dry etch process of lower hard mask 56, as shown in Petitioner's Figure 5D', would degrade the exposed portions of upper hard mask 58. EX2009 ¶156. This is confirmed by Figures 5F-5G of Grill, which illustrate that when etch conditions are set to remove exposed portions of lower hard mask layer 56 and optional etch stop 10 to form the structure of Fig.5G, the upper hard mask layer 58, despite having a different etch selectivity from lower hard mask layer 56, is substantially thinned. EX1005 Figs.5F-5G, 7:64-8:2; EX2009 ¶156.²⁵ The

layer 10 may be a silicon containing compound, such as SiO₂, Si₃N₄, SiO_xN_y, SiCOH compounds, silicon-containing DLC (SiDLC). EX1005 4:5-11; EX2009 ¶155 n.10.

²⁵ Patent Owner understands that Petitioner's expert has opined that the figures of Grill are not to scale. EX2010 88:8-12. However, the particular measurements of the Figures of Grill are not the basis for a POSITA's understanding that Grill's upper hard mask 58 would be prematurely degraded in Petitioner's proposed modification—instead, Grill's figures (which clearly illustrate the positioning of individual layers, *see Seoul Semiconductor*, IPR2014-00879, Pap.33, 13 (“drawings must be evaluated for what they reasonably disclose and suggest to one

degradation of Grill's upper hard mask 58 during the etch of lower hard mask 56 is why Grill described *protecting* upper hard mask 58 with resist layer 62 while etching lower hard mask 56 in Figures 5D-5E. EX1005 Figs.5D-5E, 7:51-61; EX2009 ¶156.

Thus, modifying Grill's second resist layer 62 to use Aoyama's wider via hole pattern in the manner proposed by Petitioner, which exposes Grill's upper hard mask 58, would also degrade the exposed portions of the upper hard mask 58. EX2009 ¶157. This degradation is illustrated below, and is contrasted with Petitioner's inaccurate illustrations. *Id.*

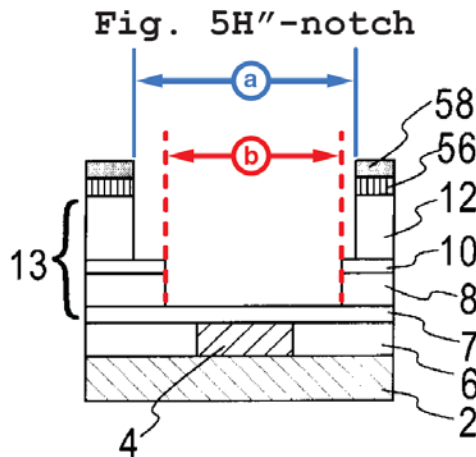
of ordinary skill in the art")) provide confirmation of this understanding. EX2009 ¶156 n.11.

	Before Etch of layer 56	After Etch of layer 56
Petitioner's Inaccurate Illustrations	<p>Fig. 5D'</p>	<p>Fig. 5E'</p>
Damage to Exposed portions of Grill's Hard Mask layer 58	<p>Fig. 5D'</p>	<p>Fig. 5E'-notch</p>

The premature thinning of Grill's upper hard mask 58 in the process of initially etching layer 56 illustrated above in illustrations Fig.5D' and Fig.5E'-notch would render it inoperable for the subsequent etching of layers 10 and 56 illustrated below in illustrations Fig.5F'-notch and Fig.5G'-notch. EX2009 ¶158. The premature thinning of hard mask 58 would result in the complete etching of lower hard mask 56 during the etching of layer 10. *Id.* This would leave underlying layer 12 exposed during a subsequent etch of layer 8 as illustrated below in Fig.5'-notch. *Id.*

	Before Etch of layer 10	After Etch of layer 10
Petitioner's Inaccurate Illustrations	<p>Fig. 5F'</p>	<p>Fig. 5G'</p>
Damage to Exposed portions of Grill's Hard Mask layer 58.	<p>Fig. 5F' -notch</p>	<p>Fig. 5G' -notch</p>

The result is a width of a wiring groove (annotated as “a” below) that is wider than a designed width (annotated as “b” below) over a via hole, which eliminates Grill's ability to control for wire dimension, thereby altering (and thwarting) Grill's principle of operation. EX2009 ¶159.

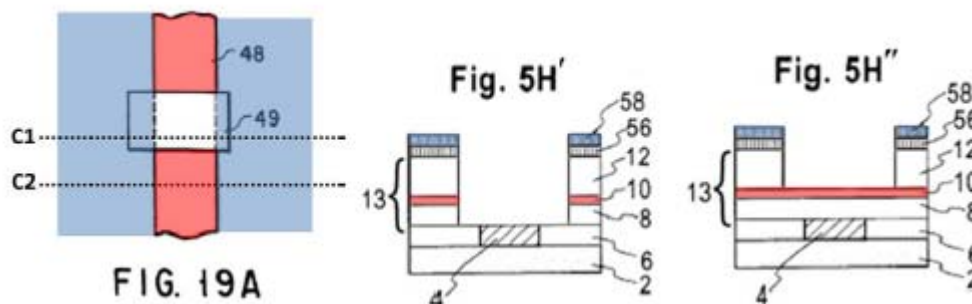


To the extent that Petitioner attempts to argue on reply that (1) a POSITA would have understood this issue and further considered using a thicker upper hard mask layer 58 to compensate for the premature degradation of upper hard mask layer 58, or that (2) layer 10 is considered optional by Grill and a POSITA would have considered excluding layer 10, both arguments would fail as they would require additional work not contemplated by Petitioner (and to which Patent Owners will not have a further opportunity to respond) and are inconsistent with Grill itself as discussed below. *Intelligent Bio-System*, 821 F.3d at 1369-70; n.3, *supra*; EX2009 ¶160.

For example, using a thicker upper hard mask film would introduce additional issues such as thicker resist over etched portions of the upper hard mask, which would require higher dose exposures that Grill disparages as causing loss in critical dimension control. EX1005 Fig.2A, 5:28-33; EX2009 ¶161; EX2010 106:6-8, 107:11-109:3. A POSITA, including Petitioner's expert, would have

understood that widely varied exposure requirements between thicker resists over via holes, and shallower patterns would have created problems for dimensional control. EX2019 605-606; EX2017 537-538; EX2016 229; EX2009 ¶161 Because Grill teaches away from using thicker resists, a POSITA would not have found it obvious to arbitrarily increase the thickness of the upper hard mask. EX2009 ¶165.

Excluding optional dielectric etch stop 10 would require a complete redesign of the process. EX2009 ¶162. A POSITA would have understood that optional dielectric etch stop 10 is necessary in the context of Figures 5A-5F. EX2009 ¶162. Otherwise, there would be no way to definitively determine when to terminate the etching of the wiring groove pattern into dielectric layer 12. EX2009 ¶162. For example, Petitioner's own illustrative Figures 5H' and 5H'', reproduced below, emphasize the important of dielectric etch stop layer 10 in the formation of wiring grooves. Pet.65-68. Without the dielectric etch stop layer 10, the end point of etching a wiring groove into layer 12, as illustrated in Petitioner's illustrative 5H'', would need to be approximated or guessed without any certainty or uniformity. EX2009 ¶¶163-64.



Furthermore, because Petitioner has failed to consider how their proposed modification would affect Grill's principle of operation, Petitioner has failed to show that a POSITA would have been motivated to combine the references or that the POSITA would have had a reasonable expectation of success. EX2009 ¶¶165-67.

C. Grill teaches away from a combination with Aoyama because it would interfere with Grill's goal of controlling critical dimension

A reference teaches away from a particular combination when it "criticize[s], discredit[s], or otherwise discourage[s]" investigation into the invention claimed. *DePuy*, 567 F.3d at 1327. Moreover, if references taken in combination would produce a "seemingly inoperative device," or would render the primary reference unsatisfactory for its intended purpose, such references also teach away from the combination. *McGinley*, 262 F.3d at 1354; *Plas-Pak*, 600 F.App'x at 757-59. Grill teaches away from using systems that (1) expose underlying organic layers to photoresist stripping processes, and (2) that use photoresist patterns that are "thicker over via areas." EX1005 2:26-32, 5:28-33; *Harris v. Fed. Express*, 502 F.App'x 957, 968 (Fed.Cir. 2013) ("A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant."). A POSITA would not have been

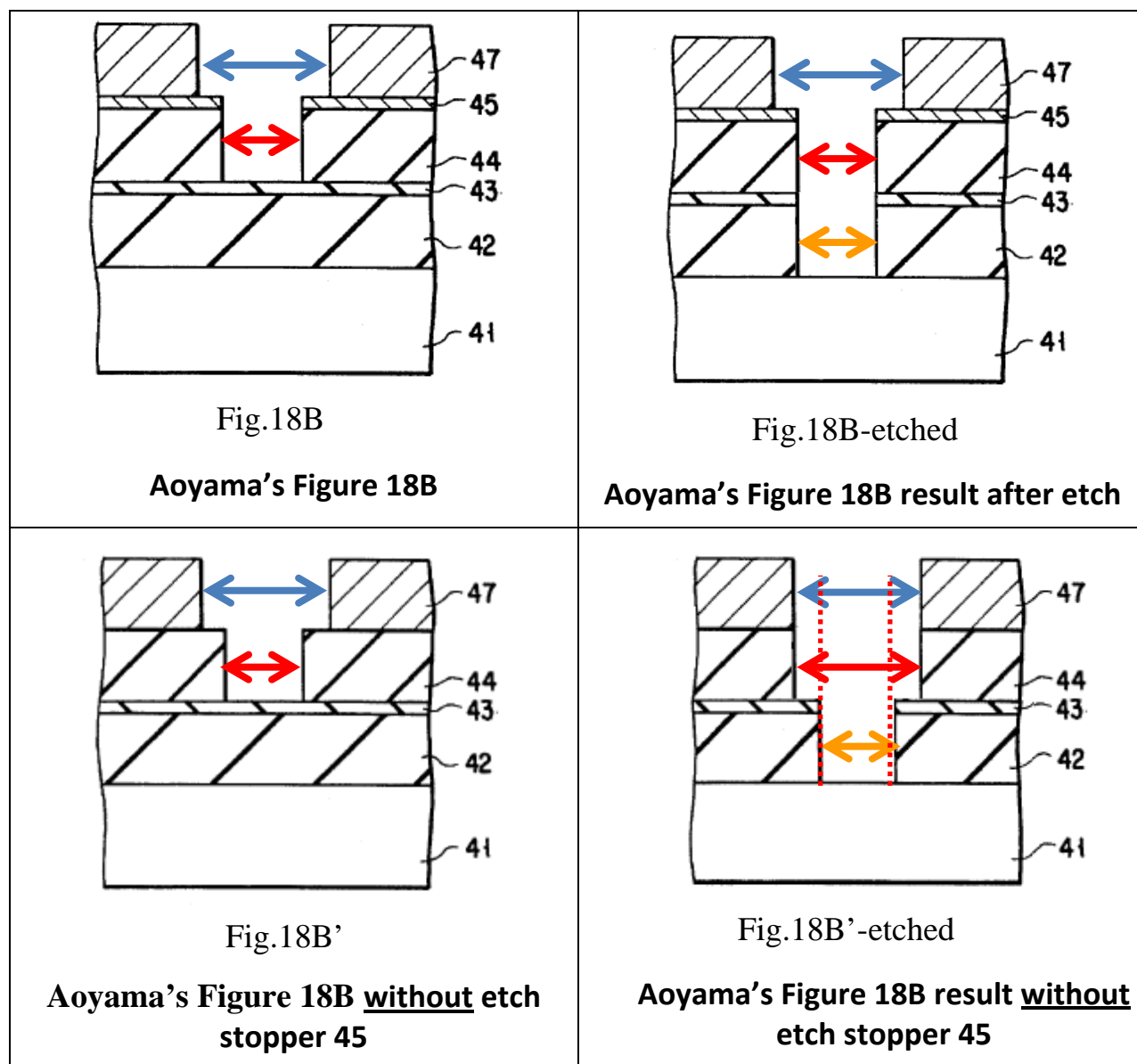
motivated to apply Aoyama's teachings to Grill at least because Petitioner's proposed combination requires (1) exposing underlying organic layers to photoresist stripping processes, and (2) using photoresist patterns that are "thicker over via areas." EX2009 ¶¶168-170.

1. Grill teaches away from the combination with Aoyama because its rework problem would result in damage to Aoyama's carbon-based etch stop layer

At Institution, the Board relied upon Petitioner's erroneous suggestion that Aoyama addresses the problem of misalignment (described in reference to Figures 5A-5D) *only* by "using a resist pattern having an opening that is wider than the wiring groove." See ID 40; Pet.54-55. Petitioner improperly ignores that part of Aoyama's misalignment solution is its use of carbon etch stopper film 45.²⁶ EX2009 ¶171. Indeed, without that film, Aoyama would end up with a result that is even worse than the problem it was trying to solve. EX2009 ¶172. Instead of a wider wiring groove at the through-hole only during instances of misalignment, Aoyama would always end up with a wider wiring groove at the through-hole, regardless of misalignment. EX2009 ¶172. This is illustrated by the annotated

²⁶ Aoyama discloses the use of a "second stopper film 45" and refers only to carbon as the material for such a film. EX1018 15:60-63; EX2009 ¶171 n.12. Petitioner's expert confirmed at deposition that the stopper film 45 is carbon. EX2010 106:12-20.

figures below, which show modified versions of Aoyama's Figs. 18B-18C with and *without* carbon etch stopper film 45. EX2009 ¶172.

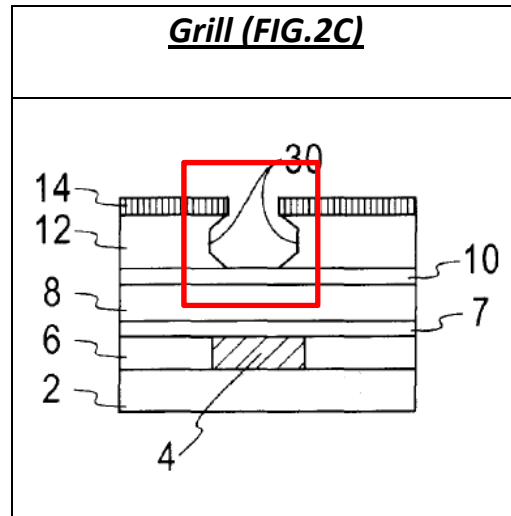


In Aoyama, “the second interlayer insulating film 44 below the stopper film 45 is **not etched by virtue of the second stopper film 45**. Accordingly, as shown in Fig.19B, a through-hole 50 having the same width as the wiring groove 48 can be formed.” EX1018 16:3-5, 16:9-16. However, when Aoyama's carbon etch

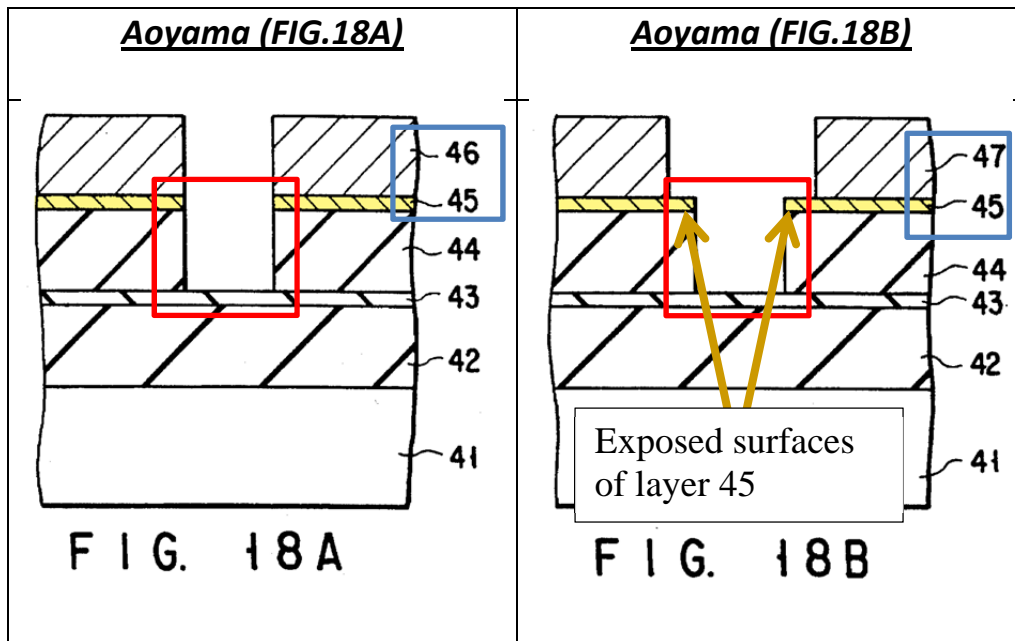
stopper film 45 is removed, it no longer protects layer 44 from etching as illustrated above. EX2009 ¶173.

Thus, Petitioner's misattribution of Aoyama's solution solely to the wider via opening pattern mischaracterizes Aoyama and what a POSITA would have understood and considered when evaluating whether to combine Grill and Aoyama. EX2009 ¶174. Instead, a POSITA would have understood that it would not be possible to modify Grill by combining it with Aoyama's wider via hole pattern (and certainly would not have had a reasonable expectation of success) without also including Aoyama's carbon etch stopper film 45. EX2009 ¶174. But a POSITA would have recognized that doing so—applying Aoyama's wider via hole patterns and carbon etch stopper film 45 to Grill—would interfere with Grill's dual-hard mask solution of controlling critical dimensions, rendering Grill unsatisfactory for its intended purpose (*see* §V.A). EX2009 ¶174.

Grill expressly identified a known rework problem where carbon-based dielectrics are damaged by exposure to photoresist removal processes such as ashing and wet chemical etching. *See* EX1005 2:26-32, 5:9-28; EX2009 ¶175. An example of damage caused to exposed surfaces 30 of the carbon-based dielectric 12 by the photoresist removal process is illustrated in Fig.2C, reproduced below. *See* EX1005 4:5-8, 14-21, Fig.2C. EX2009 ¶175.



As discussed above, Aoyama's example 7 relied on by Petitioner (Pet.34-36, 52-56) shows that using a wider through-hole in resist pattern 47 requires a carbon etch stopper layer 45 to protect insulating layer 44, when etching layers 43 and 42. *See* EX1018 15:60-63, 16:3-14; EX2009 ¶176. In Aoyama's example 7, the carbon etch stopper layer 45 is directly in contact with resist pattern 46 as illustrated in Fig.18A and resist pattern 47 as illustrated in Fig.18B, shown below. *See* EX1018 15:64-16:9; EX2009 ¶176.



The exposed surfaces of carbon-based layer 45 (annotated above) function as an “etching stopper” and are critical in Aoyama to protect portions of layer 44 that are not covered by resist pattern 47 during a subsequent etch of layers 43 and 42. EX1018 15:60-63, 16:9-17; EX2009 ¶177.

But Grill teaches that carbon-based layers should not be used because each photoresist removal step by ashing or wet etching *degrades* the carbon-based layers. EX1005 5:13-17; EX1018 16:12-14; EX2009 ¶178. When combined with Grill, a carbon based layer 45 as required for the teachings in Aoyama would be subjected to at least one photoresist removal step to remove resist pattern 46 and at least one photoresist removal step each time that rework of 47 has to be completed—causing layer 45 to degrade and preventing it from protecting underlying layers (as needed for Aoyama’s teachings to be operative). EX2009

¶178.

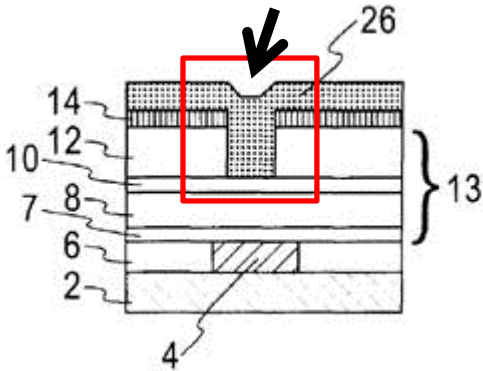
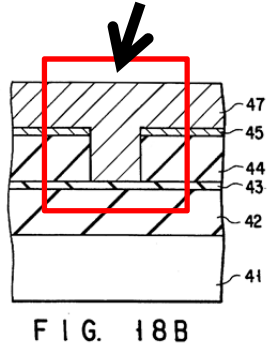
The Petition is thus inadequate at least because: (1) Petitioner fails to include in its proposed combination Aoyama's teachings of carbon-based layer 45 (which is necessary to achieve the result taught by Aoyama and argued by Petitioner), and thus the application of Aoyama's other teachings would not meet claim 13's limitations dry-etching the [fourth/third] insulating film using the second resist pattern and the mask pattern as a mask, thereby patterning the fourth insulating film to have the openings for forming contact holes; and (2) even if Petitioner now belatedly and improperly tries to argue that carbon-based etch stop layer 45's teachings should also be applied, the result of this new argument would itself be inoperable because Grill teaches that carbon-based should not be used. EX2009 ¶171-178. Moreover, Petitioner has not addressed why a POSITA considering Grill would ignore this problem of Aoyama's process and combine the two references' teachings, nor how a POSITA could overcome this problem. *See* Pet.56; EX2009 ¶179. Rather than complementary solutions to a common problem, as Petitioner argues as the sole rationale for combining them, this aspect of Aoyama is—according to Grill's own teachings—detrimental to Grill's approach. EX2009 ¶179. Therefore, a POSITA would have understood that Grill teaches away from the combination with Aoyama suggested by Petitioner and would not have had a reasonable expectation of success in combining the references as proposed by

Petitioner. *See* EX2009 ¶179.

2. Grill warns against layers of resist that are thicker over certain areas, which would be required by Aoyama's approach

Grill expressly criticizes techniques resulting in a resist layer that is thicker over via areas as problematic because such thicker resist requires “higher dose exposures, with consequent loss in CD [critical dimension] control.” *See* EX1005 5:29-35; EX2009 ¶180; *DePuy*, 567 F.3d at 1327. Grill illustrates this problem in Fig.2A, annotated below. But tellingly, this problem of thicker resist over via areas identified in Grill, which aggravates misalignment problems by frustrating control of critical dimensions, is actually *made worse by the teachings of Aoyama that Petitioner proposes to borrow*—including in Aoyama's example 7. EX2009 ¶180. For example, as shown below in an illustration based on Fig.18B of Aoyama and as admitted by Petitioner's expert (the profile of photoresist layer 47 in Aoyama's Fig.18B would be “thicker over the...[via] hole,” and with “some degree of conformity” (EX2010 108:18-109:2)), the thickness of the deposited resist layer 47, prior to exposure and developing, would be thicker over the intended via than over second insulating film 44. EX2009 ¶180. A POSITA, including Petitioner's expert, would have understood that widely varied exposure requirements between thicker resists over via holes, and shallower patterns would have created problems for dimensional control. EX2019 605-606; EX2017 537-

538; EX2016 229; EX2009 ¶181.

<u>Grill (FIG.2A)</u>	<u>Aoyama (FIG.18B-modified)</u>
	

While Petitioner asserts Aoyama does not detract from Grill’s teachings, Petitioner does not even attempt to address this warning in Grill against the very result that Petitioner’s proposed borrowing from Aoyama would cause, defeating its approach to misalignment. EX2009 ¶¶182-84. Petitioner cannot cherry-pick these teachings of a wider through-hole, disembodied from the rest of Aoyama’s example 7 that makes it possible, because borrowing these teachings alone would have the opposite effect as discussed in §V.C.1. *W.L. Gore v. Garlock*, 721 F.2d 1540, 1550 (Fed.Cir. 1983) (“the district court erred...in considering the references in less than their entirety, *i.e.*, in disregarding disclosures in the references that diverge from and teach away from the invention at hand”). In ignoring these affirmative teachings of Aoyama, Petitioner certainly fails to provide the “articulated reasoning with some rational underpinning to support the legal

conclusion of obviousness” required by *KSR*. See *KSR Int’l v. Teleflex*, 550 U.S. 398, 418 (2007).

VI. Conclusion

For at least the forgoing reasons, it is clear that Petitioner has failed to show that Grill in view of Aoyama renders obvious claims 13 and 15 of the ’696. Because Petitioner has not met its statutory burden of demonstrating the obviousness of claims 13 and 15 by a preponderance of the evidence (*see* §316(e)), Petitioner’s arguments should be rejected, and the patentability of these claims should be confirmed. EX2009 ¶185.

Respectfully submitted by:

Dated: April 14, 2017

/James L. Davis, Jr./

Andrew N. Thomases (lead
counsel) - Reg. No. 40,841
ROPES & GRAY, LLP
1900 University Ave., 6th Floor
East Palo Alto, CA 94303
(650) 617-4000
andrew.thomases@ropesgray.com

Jordan M. Rossen
Reg. No. 74,064
ROPES & GRAY LLP
2099 Pennsylvania Ave., NW
Washington D.C. 20006-6807
P: 202-508-4759/F: 202-508-4650
jordan.rossen@ropesgray.com

J. Steven Baughman
Reg. No. 47,414
Paul, Weiss, Rifkind, Wharton &
Garrison LLP
2001 K Street, NW
Washington, DC 20006-1047
P: 202-223-7340/F: 202-403-3740
sbaughman@paulweiss.com

James L. Davis, Jr.
Reg. No. 57,325
ROPES & GRAY LLP
1900 University Avenue, 6th
Floor
East Palo Alto, CA 94303-2284
P: 650-617-4794/F: 650-566-4147
james.l.davis@ropesgray.com

Attorneys For Patent Owner

CERTIFICATE OF WORD COUNT

The undersigned certifies that the foregoing PATENT OWNER'S RESPONSE UNDER 37 C.F.R. §42.120 complies with the type-volume limitation in 37 C.F.R. §42.24(b)(2). According to the word-processing system's word count, the brief contains 13,542 words, excluding the parts of the brief exempted by 37 C.F.R. §42.24(c).

Dated: April 14, 2017

Respectfully submitted,

By: /Jordan M. Rossen/
Name: Jordan M. Rossen

ROPES & GRAY LLP

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the following document has been served in its entirety by filing aforementioned document through the Patent Trial and Appeal Board PTAB E2E, as well as by causing the aforementioned document to be electronically mailed, pursuant to the Petitioner and Patent Owner's agreement, to the following attorneys of record for the Petitioner listed below:

Patent Owner's Response Under 37 C.F.R. §42.120 and accompanying exhibits:

EX2009	Declaration of Alexander Glew, Ph.D.
EX2010	Transcript of Deposition of Bruce Smith on March 23, 2017
EX2011	Redline Comparing Grill (EX1005) with Grill's Provisional (EX1017) Application
EX2012	Japanese Patent Application 10-079371 to Aoi as Submitted in European Patent Application No. 99 105 946.0 with accompanying translation
EX2013	Declaration of Takeo Ohashi, Ph.D.
EX2014	<i>Influence of reactor wall conditions on etch processes in inductively coupled fluorocarbon plasmas</i> by M. Schaepekens, et al., J. Vac. Sci. Tech. A 16(4), Jul/Aug 1998
EX2015	<i>Handbook of VLSI Microlithography, Second Edition, Principles, Technology, and Applications</i> , edited by John N. Helbert, Noyes Publications, William Andrew Publishing, LLC, 2001 (excerpted)
EX2016	<i>Silicon VLSI Technology Fundamentals, Practice and Modeling</i> , by James D. Plummer, et al., Prentice Hall, 2000 (excerpted)
EX2017	<i>Microlithography: Science and Technology</i> , by James R. Sheats and Bruce W. Smith, Marcel Dekker, Inc., 1998 (excerpted)
EX2018	<i>Microlithography: Science and Technology</i> , 2 nd ed., by Kazuaki Suzuki and Bruce W. Smith, CRC Press, 2007 (Chapter 12) (excerpted) (Smith Deposition Exhibit 3)

EX2019	<i>Microlithography: Science and Technology</i> , 2 nd ed., by Kazuaki Suzuki and Bruce W. Smith, CRC Press, 2007 (Chapter 11) (excerpted) (Smith Deposition Exhibit 9)
EX2020	<i>Silicon Processing for The VLSI Era Vol. 1 Process Integration</i> by Stanley Wolf and R.N. Tauber, Lattice Press, 1986 (excerpted)
EX2021	Kenkyusha's New Japanese-English Dictionary, 4 th ed., 35 th Impression, published by Kenkyusha Ltd., 1997 (excerpted)
EX2022	Declaration of Jordan M. Rossen

Petitioner's Counsel of Record:

Darren M. Jiron, Darren.jiron@finnegan.com
E. Robert Yoches, bob.yoches@finnegan.com
J. Preston Long, j.preston.long@finnegan.com
FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER, LLP
ATTN: Patent Administration, Two Freedom Square, 11955 Freedom Drive,
Reston, VA 20190-5675

Dated: April 14, 2017

Respectfully submitted,

By: /Bridget McAuliffe/
Name: Bridget McAuliffe

ROPES & GRAY LLP