UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

THE GILLETTE COMPANY, FUJITSU SEMICONDUCTOR LIMITED, FUJITSU SEMICONDUCTOR AMERICA, INC., ADVANCED MICRO DEVICES, INC., RENESAS ELECTRONICS CORPORATION, RENESAS ELECTRONICS AMERICA, INC., GLOBAL FOUNDRIES U.S., INC., GLOBALFOUNDRIES DRESDEN MODULE ONE LLC & CO. KG, GLOBALFOUNDRIES DRESDEN MODULE TWO LLC & CO. KG, TOSHIBA AMERICA ELECTRONIC COMPONENTS, INC., TOSHIBA AMERICA INC., TOSHIBA AMERICA INFORMATION SYSTEMS, INC., and TOSHIBA CORPORATION,

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Petitioners

v.

ZOND, LLC
Patent Owner

Case No. IPR2014-00803[1]

Patent 7,808,184 B2

PATENT OWNER'S NOTICE OF APPEAL
35 U.S.C. § 142 & 37 C.F.R. § 90.2

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[1] Cases IPR 2014-00858, IPR 2014-00996, and IPR 2014-01061 have been joined with the instant proceeding.

Pursuant to 37 C.F.R. § 90.2(a), Patent Owner, Zond, LLC, hereby provides notice of its appeal to the United States Court of Appeals for the Federal Circuit for review of the Final Written Decision of the United States Patent and Trademark Office ("USPTO") Patent Trial and Appeals Board ("PTAB") in *Inter Partes* Review 2014-00803, concerning U.S. Patent 7,808,184 ("the '184 patent"), entered on September 30, 2015, attached hereto as Appendix A.

ISSUES TO BE ADDRESSED ON APPEAL

A. Whether the PTAB erred when construing, according to its broadest reasonable interpretation in light of the specification of the '184 patent as understood by one of ordinary skill in the art at the time of the invention, the term "without forming an arc," as recited in the claims of the '184 patent, as "substantially eliminating the possibility of arcing?"

B. Whether the PTAB erred in finding claims 6, 7, 9, 10, 16, 17, 19, and 20 unpatentable as being obvious under 35 U.S.C. § 103 in view of U.S. Pat. 6,413,382 to Wang ("Wang") and A. A. Kudryavtsev and V.N. Skrebov, *Ionization Relaxation in a Plasma Produced by a Pulsed Inert-Gas Discharge*, 28(1) SOV. PHYS. TECH. PHYS. 30–35 (Jan. 1983) ("Kudryavtsev")?

C. Whether the PTAB erred in finding claims 68 and 18 unpatentable as being obvious under 35 U.S.C. § 103 in view of Wang, Kudryavtsev, and D.V. Mozgrin, et al., *High-Current Low-Pressure Quasi-Stationary Discharge in a Magnetic Field: Experimental Research*, 21 PLASMA PHYSICS REPORTS 400–409 (1995) ("Mozgrin")?

Simultaneous with submission of this Notice of Appeal to the Director of the United States Patent and Trademark Office, this Notice of Appeal is being filed with the Patent Trial and Appeal Board. In addition, this Notice of Appeal, along with the required docketing fees, is being filed with the United States Court of Appeals for the Federal Circuit.

Respectfully submitted,

Dated: November 23, 2015

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APPENDIX A

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

THE GILLETTE COMPANY, FUJITSU SEMICONDUCTOR LIMITED, FUJITSU SEMICONDUCTOR AMERICA, INC., ADVANCED MICRO DEVICES, INC., RENESAS ELECTRONICS CORPORATION, RENASAS ELECTRONICS AMERICA, INC., GLOBALFOUNDRIES U.S., INC., GLOBALFOUNDRIES DRESDEN MODULE ONE LLC & CO. KG, GLOBALFOUNDRIES DRESDEN MODULE TWO LLC & CO. KG, TOSHIBA AMERICA ELECTRONIC COMPONENTS, INC., TOSHIBA AMERICA INC., TOSHIBA AMERICA INFORMATION SYSTEMS, INC., and TOSHIBA CORPORATION,
Petitioners,

v.

ZOND, LLC,
Patent Owner.

Case IPR2014-00803[1]
Patent 7,808,184 B2

Before KEVIN F. TURNER, DEBRA K. STEPHENS, JONI Y. CHANG, SUSAN L. C. MITCHELL, and JENNIFER MEYER CHAGNON, *Administrative Patent Judges*.

MITCHELL, *Administrative Patent Judge.*

FINAL WRITTEN DECISION
Inter Partes Review
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

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[1] Cases IPR2014-00858, IPR2014-00996, and IPR2014-01061 have been joined with the instant *inter partes* review.

I. INTRODUCTION

We have jurisdiction under 35 U.S.C. § 6(c). This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons set forth below, we determine that Petitioners have shown, by a preponderance of the evidence, that claims 6–10 and 16–20 of U.S. Patent No. 7,808,184 B2 (Ex. 1101, "the '184 patent") are unpatentable under 35 U.S.C. § 103(a).

A. Procedural History

Taiwan Semiconductor Manufacturing Company, Ltd. and TSMC North America Corp. (collectively, "TSMC") filed a Petition (Paper 2, "Pet.") seeking *inter partes* review of claims 6–10 and 16–20 ("the challenged claims") of the '184 patent. TSMC included a Declaration of Mr. Richard DeVito (Ex. 1102) to support its positions. Patent Owner Zond, LLC ("Zond") filed a Preliminary Response (Paper 7, "Prelim. Resp."). Pursuant to 35 U.S.C. § 314(a), on October 1, 2014, we instituted an *inter partes* review of challenged claims 6, 7, 9, 10, 16, 17, 19, and 20 to determine if the claims are unpatentable under 35 U.S.C. § 103 as obvious over the combination of Wang and Kudryavtsev, and of challenged claims 8 and 18 to determine if the claims are unpatentable under 35 U.S.C. § 103 as obvious over the combination of Wang, Kudryavtsev, and Mozgrin. Paper 9 ("Dec.").

Subsequent to institution, we granted revised Motions for Joinder filed by other Petitioners (collectively, "Gillette") listed in the Caption above, joining Cases IPR2014-00858, IPR2014-00996, and IPR2014-01061 with the instant trial (Papers 16 and 17), and also granted a Joint Motion to Terminate with respect to TSMC (Paper 37). Zond filed a Patent Owner Response (Paper 32, "PO Resp."), along with a Declaration of Larry D. Hartsough, Ph.D. (Ex. 2015) to support its positions. Gillette filed a Reply (Paper 42, "Reply") to the Patent Owner Response, along with a supplemental Declaration of Dr. John Bravman (Ex. 1128). An oral hearing[2] was held on May 28, 2015. A transcript of the hearing is included in the record. Paper 53 ("Tr.").

B. Related Matters

Gillette indicates that the '184 patent was asserted against Petitioner, as well as other defendants, in seven district court lawsuits pending in the District of Massachusetts. Pet. 1.

C. The '184 Patent

The '184 patent relates to methods for generating strongly-ionized plasmas in a plasma generator. Ex. 1101, Abs. When creating a plasma in a chamber, a direct current ("DC") electrical discharge, which is generated between two electrodes with a feed gas, generates electrons in the feed gas, that ionize atoms to create the plasma. *Id.* at 1:16–20. For an application, such as magnetron plasma sputtering, a relatively high level of energy must be supplied, which may result in overheating the electrodes or the work piece. *Id.* at 1:21–26. Such overheating may be addressed by complex cooling mechanisms, but such cooling can cause temperature gradients in the

[2] The oral arguments for the instant review and IPR2014-00477, IPR2014-00479, and IPR2014-00799 were consolidated.

chamber causing a non-uniform plasma process. *Id.* at 1:26–30. These temperature gradients may be reduced by pulsing the DC power, but high-power pulses may result in arcing at plasma ignition and termination. *Id.* at 1:31–36. Arcing is problematic because it can cause the release of undesirable particles in the chamber thereby contaminating the work piece. *Id.* at 1:36–37, 4:8–11.

According to the ’184 patent, a pulsed power supply may include circuitry that minimizes or eliminates the probability of arcing in the chamber by limiting the plasma discharge current to a certain level and dropping the generated voltage for a certain period of time if the limit is exceeded. *Id.* at 4:6–15. Figure 2, reproduced below, shows measured data of discharge voltage as a function of discharge current for admitted prior-art, low-current plasma 152, and high-current plasma 154 created by the claimed methods using the pulsed power supply. *Id.* at 1:58–60.

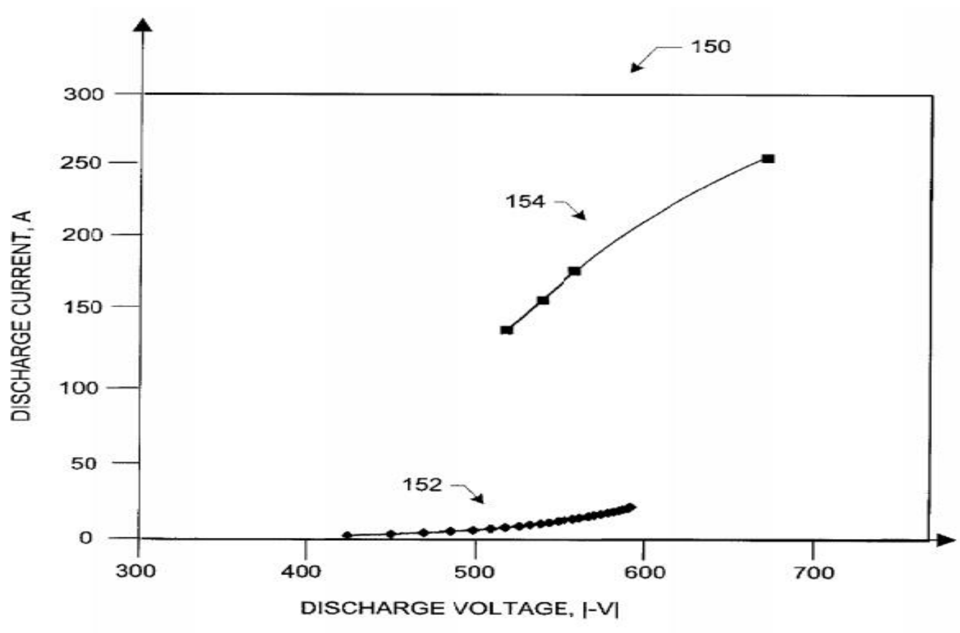

FIG. 2

Figure 2 shows current-voltage characteristic 154 that represents actual data for plasma generated by the pulsed power supply in the plasma sputtering system depicted in Figure 1 (not reproduced here). *Id.* at 5:28–30. The current-voltage characteristic 154 is in a high-current regime that generates a relatively high plasma density (greater than 10^{12}–10^{13} cm^{-3}). *Id.* at 5:40–43. The pulsed power supply generates waveforms that create and sustain the high-density plasma with current-voltage characteristics in the high-current regime. *Id.* at 5:55–59. The '184 patent explicitly defines the term "high-current regime" as "the range of plasma discharge currents that are greater than about 0.5 A/cm^2 for typical sputtering voltages of between about -300V to -1000V. *Id.* at 5:43–46. The power density is greater than about 250 W/cm^2 for plasmas in the high-current regime." *Id.* at 5:43–48.

The '184 patent also describes a multi-stage ionization process wherein a multi-stage voltage pulse that is generated by the pulsed power supply creates a strongly-ionized plasma. *See id.* at 2:1–3, 7:4–7 (describing Figure 4 (not reproduced here) as such an example); *id.* at 14:50–15:46 (describing Figure 5C (not reproduced here) as an illustrative multi-stage voltage pulse). Such a multi-stage voltage pulse initially generates a weakly-ionized plasma in a low-current regime (shown as 152 in Figure 2 above), and then eventually generates a strongly-ionized or high-density plasma in a high-current regime. *Id.* at 7:10–13. "Weakly-ionized plasmas are generally plasmas having plasma densities that are less than about 10^{12}–10^{13} cm^{-3} and strongly-ionized plasmas are generally plasmas having plasma densities that are greater than about 10^{12}–10^{13} cm^{-3}." *Id.* at 7:14–18.

D. Illustrative Claim

All of the challenged claims are dependent on either independent claim 1 or 11, which were addressed in IPR2014-00799. Challenged claims 6 through 10 depend from claim 1, and challenged claims 16 through 20 depend from claim 11. Claim 1, reproduced below, is illustrative:

> 1. A method of generating a strongly-ionized plasma, the method comprising:
>
> a) supplying feed gas proximate to an anode and a cathode assembly; and
>
> b) generating a voltage pulse between the anode and the cathode assembly, *the voltage pulse having at least one of a controlled amplitude and a controlled rise time that increases an ionization rate so that a rapid increase in electron density and a formation of a strongly-ionized plasma occurs without forming an arc between the anode and the cathode assembly*.

Ex. 1101, 22:24–54 (emphasis added). Gillette characterizes the challenged dependent claims as "directed to further operational details, such as moving a magnet, characteristics of the voltage pulse, processes that occur during the generation of the voltage pulse, and the type of power supply used." Pet. 8.

E. Prior Art Relied Upon

Gillette relies upon the following prior art references:

Wang	US 6,413,382 B1	July 2, 2002	(Ex. 1105)

D.V. Mozgrin, et al., *High-Current Low-Pressure Quasi-Stationary Discharge in a Magnetic Field: Experimental Research*, 21 PLASMA PHYSICS REPORTS 400–409 (1995) (Ex. 1103) ("Mozgrin").

A. A. Kudryavtsev and V.N. Skrebov, *Ionization Relaxation in a Plasma Produced by a Pulsed Inert-Gas Discharge*, 28(1) SOV. PHYS. TECH. PHYS. 30–35 (Jan. 1983) (Ex. 1104) ("Kudryavtsev").

D.V. Mozgrin, *High-Current Low-Pressure Quasi-Stationary Discharge in a Magnetic Field: Experimental Research*, Thesis at Moscow Engineering Physics Institute (1994) (Ex. 1107) ("Mozgrin Thesis").[3]

F. Grounds of Unpatentability

We instituted the instant trial based on the following grounds of unpatentability (Dec. 31–32):

Claims	**Basis**	**References**
6, 7, 9, 10, 16, 17, 19, and 20	§ 103(a)	Wang and Kudryavtsev
8 and 18	§ 103(a)	Wang, Kudryavtsev, and Mozgrin

II. ANALYSIS

A. Claim Construction

In an *inter partes* review, claim terms in an unexpired patent are given their broadest reasonable construction in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b); *see also In re Cuozzo Speed Techs., LLC*, 793 F.3d 1268, 1279 (Fed. Cir. 2015) ("Congress implicitly approved the broadest reasonable interpretation standard in

[3] The Mozgrin Thesis is a Russian-language reference. TSMC provided a certified English-language translation (Ex. 1106).

enacting the AIA,"[4] and "the standard was properly adopted by PTO regulation."). Significantly, claims are not interpreted in a vacuum but are part of, and read in light of, the specification. *United States v. Adams*, 383 U.S. 39, 49 (1966) ("[I]t is fundamental that claims are to be construed in the light of the specifications and both are to be read with a view to ascertaining the invention . . . ."). Claim terms are given their ordinary and customary meaning as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). An inventor may rebut that presumption by providing a definition of the term in the specification with reasonable clarity, deliberateness, and precision. *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994). In the absence of such a definition, limitations are not to be read from the specification into the claims. *In re Van Geuns*, 988 F.2d 1181, 1184 (Fed. Cir. 1993).

1. "weakly-ionized plasma" and "strongly-ionized plasma"

Both independent claims 1 and 11, from which all challenged claims depend, recite "formation of a strongly-ionized plasma." Ex. 1101, 22:52–53, 23:26–27. Prior to institution, Zond and Gillette submitted constructions of the terms "weakly-ionized plasma" and "strongly-ionized plasma." Prelim. Resp. 11–13; Pet. 14–15. In the Decision on Institution, we adopted Zond's proposed constructions, in light of the Specification, as the broadest reasonable interpretation. Dec. 9–11; Ex. 1101, 7:14–18. We construed the

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[4] The Leahy-Smith America Invents Act, Pub. L. No. 112–29, 125 Stat. 284 (2011) ("AIA").

claim term "weakly-ionized plasma" as "a plasma with a relatively low peak density of ions," and the claim term "strongly-ionized plasma" as "a plasma with a relatively high peak density of ions." Dec. 11.

Subsequent to institution, notwithstanding that neither Zond, nor its expert witness, expressly challenged our claim construction as to this term (PO Resp. 16–25; Ex. 2015 ¶ 21), Zond improperly attempts to import extraneous limitations into the claim by arguing that the measure of the peak density of ions is necessary to determine whether a strongly-ionized plasma is formed. *See* PO Resp. 3–4, 46–47. It is well settled that if a feature is not necessary to give meaning to a claim term, it is "extraneous" and should not be read into the claim. *Renishaw PLC v. Marposs Societa' per Azioni*, 158 F.3d 1243, 1249 (Fed. Cir. 1998); *E.I. du Pont de Nemours & Co. v. Phillips Petroleum Co.*, 849 F.2d 1430, 1433 (Fed. Cir. 1988).

We observe that the claim terms "*weakly*-ionized plasma" and "*strongly*-ionized plasma" are relative terms. The cross-examination testimony of Gillette's declarant, Mr. DeVito, in which he discusses our construction, confirms that Mr. DeVito agrees the terms are relative (Ex. 2014, 166:21–24) and that three to four orders of magnitude difference in the peak density of ions between the initial ionized state and a plasma density that may be considered strongly-ionized is sufficient (*id.* at 166:25–170:25). Gillette's second declarant, Dr. John C. Bravman, also confirms that weakly-ionized and strongly-ionized plasma are relative terms, as the '184 patent uses overlapping ranges of plasma density to describe them (*see* Ex. 1128 ¶¶ 31–32 (citing Ex. 1101, 7:14–18)), and that one of ordinary skill in the art would not understand strongly-ionized plasma to require any specific magnitude in the peak density of ions. *Id.* ¶ 30. Dr. Bravman also notes that strongly-ionized plasma is the same as high-density plasma. *Id.* ¶ 33 (citing Ex. 1101, 7:11–14).

For the foregoing reasons, we decline to adopt Zond's assertion that the measure of the peak density of ions is necessary to determine whether a strongly-ionized plasma is formed. Rather, upon review of the parties' explanations and supporting evidence before us, we discern no reason to modify our claim constructions set forth in the Decision on Institution with respect to this claim term, which adopted Zond's originally proposed construction. Dec. 9–11. Therefore, for purposes of this Final Written Decision, we construe, in light of the Specification, the claim term "weakly-ionized plasma" as "a plasma with a relatively low peak density of ions," and the claim term "a strongly-ionized plasma" as "a plasma with a relatively high peak density of ions."

2. "a voltage pulse having at least one of a controlled amplitude and a controlled rise time"

Independent claims 1 and 11, from which all challenged claims depend, recite the feature of "generating a voltage pulse . . . having at least one of a controlled amplitude and a controlled rise time" to achieve increasing an ionization rate so that a rapid increase in electron density and a formation of a strongly-ionized plasma occurs without forming an arc between the anode and the cathode assembly.[5] During the pretrial stage of this proceeding, Gillette did not proffer an explicit construction for this feature (*see* Pet. 13–14), but Zond offered a construction, focusing on the meaning of the term "control." Prelim. Resp. 14. In our Decision on Institution, we adopted Zond's proposed construction, in light of the '184 patent Specification, as the broadest reasonable interpretation, which is "generating a voltage pulse whose amplitude and/or rise time are directed or restrained" to achieve the increased ionization rate for a rapid increase in electron density and a formation of a strongly-ionized plasma without arcing. Dec. 11–12; *see, e.g.*, Ex. 1101, 6:8–9 (stating the pulsed power supply "can be programmed to generate voltage pulses having various shapes"); *id.* at 8:41–60 (referring to Fig. 4, describing specific, relatively fast rise time of the voltage shifts the electron energy distribution to higher energies for formation of the strongly-ionized plasma).

Subsequent to institution, Zond seeks a further clarification of our construction in light of our application of our construction to the prior art. PO Resp. 16–25.[6] Zond takes issue with our claim construction as not

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[5] Claim 11 adds that such amplitude or controlled rise time of the voltage pulse "shifts an electron energy distribution in the plasma to higher energies" to achieve the increased ionization rate. *See* Ex. 1101, 23:21–28.

[6] Zond contends that our use of Figure 3 of the '184 patent in the Decision on Institution to show control of a voltage pulse is misplaced because Figure 3 shows only weakly-ionized plasma. PO Resp. 16–19. We relied on the description of Figure 3 to illustrate the difference between a desired or idealized square pulse and an actual voltage pulse that shows oscillations. Dec. 22–23. As Gillette acknowledges, both Figure 3 and Figure 8 of the '184 patent, which Zond asserts describes "the compelling advantages of

encompassing the broadest reasonable interpretation. *Id.* at 19. Zond asserts that we "concluded that the claimed pulse control encompasses any change in voltage amplitude that is incidental to directing a pulse to a target *power* level (or set point) as in Wang, regardless of whether the voltage amplitude is the parameter under control." *Id.*

Zond asserts that Mr. DeVito agrees that this limitation requires a target *voltage* level or set point. *Id.* at 20 (citing Ex. 2014, 173:14–174:20). Zond also utilizes the Eronini[7] reference to explain how a desired value or "set point," also known as a "controlled variable," is achieved in a closed loop system using a feedback signal to control the manipulated variable, here the voltage pulse. PO Resp. 21–22. Zond concludes that:

> [T]he proper interpretation of the claim language—"voltage pulse having at least one of a *controlled* amplitude and a *controlled* rise time"—requires controlling these voltage parameters to target levels or set points as shown in the specification, and not to any uncontrolled variation or manipulation that may occur incidental to controlling a different parameter, such as power. In other words, any variations or

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combining *voltage amplitude* control with *voltage rise time* control," PO Resp. 14, show an idealized square pulse showing a target voltage level versus the actual output voltage amplitude and rise time showing numerous fluctuations. *See* Ex. 1101, Figs. 3, 8; Reply 5–7. The difference in the attainment of a strongly-ionized plasma in Figure 8 is explained not by how the voltage pulse was "controlled," but by use of the high-power voltage mode that "supplies a sufficient amount of uninterrupted power" to drive the plasma to a strongly-ionized state. Ex. 1101, 13:52–57, 18:64–66; Reply 6–7.

[7] Eronini Umez-Eronini, SYSTEM DYNAMICS AND CONTROL 10–13 (1999) (Ex. 2021).

> manipulations in voltage that may occur as a supply controls power to a target level do not equate with a control of voltage.

Id. at 22. Zond points to Figure 5C of the ’184 patent as exemplary of a power supply programmed to direct the voltage amplitude to successive target levels or set points 306, 370, 380. *Id.* at 23 (citing Ex. 1101, 11:55–61). Zond concludes that “[t]his example shows that the specification describes a power supply that achieves the claimed conditions (of a rapid increase in electron density without arc) by controlling the voltage amplitude and rise times to target levels.” *Id.* at 25. Therefore, according to Zond, “generating a voltage pulse . . . having at least one of a *controlled* amplitude and a *controlled* rise time that increases an ionization rate so that a rapid increase in electron density and a formation of a strongly ionized plasma occurs without forming an arc” should be construed as “generating a voltage pulse whose amplitude and/or rise time *are controlled variables* that are directed or restrained *to a target voltage level and/or a rise time level* to increase an ionization rate so that a rapid increase in electron density and a formation of a strongly ionized plasma occurs without forming an arc.” *Id.* at 23.

Gillette counters that Zond’s newly proposed construction is unsupported by the Specification of the ’184 patent. Reply 1. For instance, Gillette asserts that the ’184 patent teaches that “the *actual output* voltage amplitude and rise time . . . is not ‘directed or restrained’ to the *target* value because there are numerous fluctuations that exceed and/or undershoot the *target* voltage level, and a lag in rise time is observed as compared to the *target* value.” Reply 6. We agree with Gillette and decline to adopt Zond’s newly proposed construction.

Dr. Bravman testifies that Figure 5C of the ’184 patent, which is annotated by Dr. Bravman as shown below,

> shows a difference between a *desired* voltage pulse (annotated in red) and an *actual* voltage pulse (annotated in green). The ’184 patent states with respect to Fig. 5A–5C: “The desired pulse shapes requested from the pulsed power supply 102 are superimposed in dotted lines 304, 304’, and 304” onto each of the respective multi-stage voltage pulses 302, 302’, and 302”.”

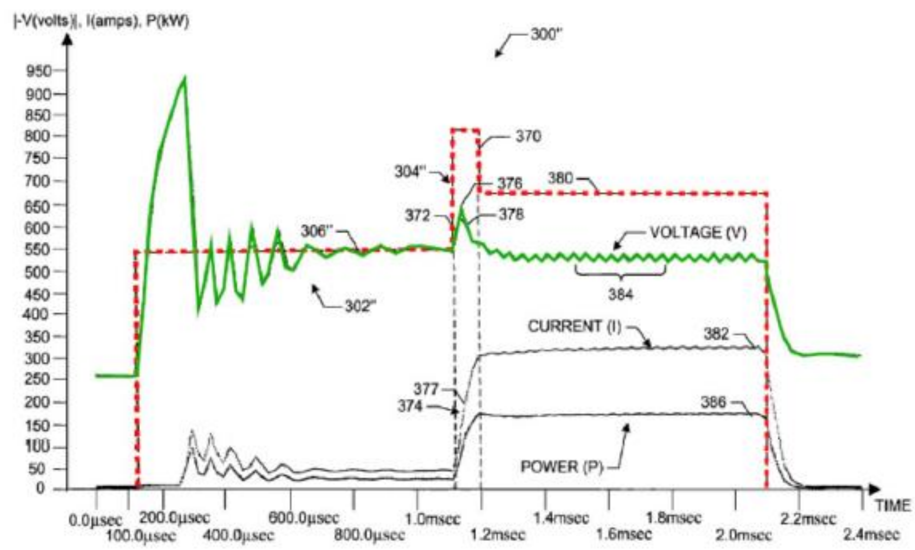


FIG. 5C

Annotated Figure 5C of the ‘184 patent (Ex. 1001): Target voltage pulse is shown in dotted red line and the actually generated voltage pulse is shown in green.

Ex. 1128 ¶ 38. We also agree that for every figure in the ’184 patent that shows the target and actual voltage pulses, such as Figure 8, which Zond asserts “demonstrates the compelling advantages of combining *voltage amplitude* control with *voltage rise time* control” (PO Resp. 15), the actually generated voltage pulse deviates significantly from the desired target voltage pulse. *See* Ex. 1128 ¶¶ 37–39. Therefore, based on the Specification of the ’184 patent, we agree with Dr. Bravman that “control as construed using the broadest reasonable interpretation includes direction and restraint of a voltage pulse’s amplitude and rise time that do or do not exactly follow the target voltage amplitude and/or rise time.” *Id.* ¶ 40.

We thus continue to construe the claim phrase “generating a voltage pulse having at least one of a controlled amplitude and a controlled rise time” as “generating a voltage pulse whose amplitude and/or rise time are directed or restrained” to achieve the increased ionization rate for a rapid increase in electron density and a formation of a strongly-ionized plasma without arcing.

3. “without forming an arc”

Neither party offers an explicit construction of the claim phrase “without forming an arc,” but we discern that Zond’s arguments are based on an incorrect interpretation of this claim phrase. Therefore, we construe the claim phrase “without forming an arc.”

Specifically, Zond asserts that a key claim limitation missing from the teachings of the prior art, is the *absence* of arcing in the transition from a weakly-ionized plasma to a highly-ionized plasma. PO Resp. 4. Zond describes Figure 4 as set forth in the ’184 patent as showing no arcing, as evidenced by the relatively steep continuous rise in current to achieve “controlled rapid growth to a strongly-ionized plasma without arcing.” *Id.* at 8, 10–11 (“By carefully controlling the target pulse voltage amplitude and voltage rise times at selected moments and by selected amounts, the system increases the electron density to quickly transition a plasma to a strongly-ionized condition, while still restraining the plasma from arcing."); *id.* at 11–13 (stating Figs. 5A–5C show rapidly achieving a strongly-ionized plasma without arcing).

Finally, Zond identifies Figure 8 of the '184 patent as evidencing a single-stage voltage pulse that ignites and grows a plasma to high density without arcing. Zond concludes that:

> Thus, this example demonstrates that compelling advantages of combining *voltage amplitude* control with *voltage rise time* control: Dr. Chistyakov was able to find a controlled voltage level coupled with a controlled rise time for his programmable supply that could both ignite a plasma and stably grow it into a plasma that was dense enough for sputtering, but without arcing.

PO Resp. 15.

The Specification of the '184 patent contains only a few references to arcing. For instance, the Specification of the '184 patent, in describing Figure 1, which illustrates a cross-sectional view of a plasma sputtering apparatus having a pulsed direct current (DC) power supply according to one embodiment of the invention, discloses the following:

> The pulsed power supply 102 can include circuitry that minimizes or eliminates the *probability* of arcing in the chamber 104. Arcing is generally undesirable because it can damage the anode 124 and cathode assembly 116 and can contaminate the wafer or work piece being processed. In one embodiment, the circuitry of the pulse supply 102 limits the plasma discharge current up to a certain level, and if this limit is

> exceeded, the voltage generated by the power supply 102 drops for a certain period of time.

Ex. 1101, 4:6–15 (emphasis added). In describing Figure 2, the Specification of the ’184 patent states that “[s]puttering with discharge voltages greater than –800V can be undesirable because such high voltages can increase the probability of arcing and can tend to create sputtered films having relatively poor film quality.” *Id.* at 5:23–27.

The Specification of the ’184 patent also describes other ways to reduce arcing. For instance, ’184 patent discusses Figure 9, which depicts a plasma sputtering apparatus according to the invention and describes the gap between the anode and the cathode assembly. *See* Ex. 1101, 19:4–7. The Specification of the ’184 patent states that “[t]he gap 514 can reduce the probability that an electrical breakdown condition (i.e., arcing) will develop in the chamber 104.” *Id.* at 19:34–36, 20:40–41 (“The geometry of the gap 514 can be chosen to minimize the probability of arcing . . . .”).

Zond does not explain adequately why *one with ordinary skill in the plasma art* would have interpreted the claim term “without forming an arc,” *in light of the Specification*, to require the ionization of excited atoms be performed *completely* free of arcing. *See* Tr. 22–29; *In re NTP, Inc.*, 654 F.3d 1279, 1288 (Fed. Cir. 2011) (stating that the Board’s claim construction “cannot be divorced from the specification and the record evidence”); *see also In re Cortright*, 165 F.3d 1353, 1358 (Fed. Cir. 1999) (stating that the Board’s claim construction “must be consistent with the one that those skilled in the art would reach”). Nor does Zond direct our attention to credible evidence that would support its attorney's arguments regarding the disputed claim term at issue. *See* PO Resp. 2–5, 7–15.

Here, nothing in the Specification indicates that *no* arcing occurs in the formation of the strongly-ionized plasma. Rather, the Specification explicitly states that such a *probability* may be minimized or eliminated. Ex. 1101, 4:6–8. Given the disclosure in the Specification, we decline to adopt Zond's implicit construction—absolutely no arcing—because it would be unreasonable to exclude the disclosed embodiments. *See Phillips v. AWH Corp.*, 415 F.3d 1303, 1315 (Fed. Cir. 2005) (en banc) (stating that the Specification is "the single best guide to the meaning of a disputed term"). Instead, we construe the claim term "without forming an arc" as "substantially eliminating the possibility of arcing," consistent with an interpretation that one of ordinary skill in the art would reach when reading the claim term in the context of the Specification.

Finally, although Zond acknowledges that "Wang's teachings of a 'reduction' in arcing upon ignition are inapposite to the '184 patent's requirement of avoiding arcing during the rapid increase in electron density and a formation of the strongly-ionized plasma" (PO Resp. at 3), Zond faults Wang's alleged teaching that arcing was unavoidable upon plasma ignition (*id*. at 15). Zond is attempting to import improperly a limitation not in the claims. Independent claims 1 and 11 require formation of a strongly-ionized plasma without an arc, but do not require that the ignition or the formation of a weakly-ionized plasma occur without an arc. *See* Ex. 1101, 22:52–54, 23:6–8; *Renishaw*, 158 F.3d at 1249; *E.I. du Pont de Nemours*, 849 F.2d at 1433.

B. Principles of Law

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

In that regard, an obviousness analysis "need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ." *KSR*, 550 U.S. at 418; *see Translogic*, 504 F.3d at 1259. The level of ordinary skill in the art may be reflected by the prior art of record. *See Okajima v. Bourdeau,* 261 F.3d 1350, 1355 (Fed. Cir. 2001); *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995); *In re Oelrich*, 579 F.2d 86, 91 (CCPA 1978).

We analyze the asserted grounds of unpatentability in accordance with the above-stated principles.

C. Claims 6, 7, 9, 10, 16, 17, 19, and 20 — Obviousness over Wang and Kudryavtsev

Gillette asserts that claims 6, 7, 9, 10, 16, 17, 19, and 20 are unpatentable under 35 U.S.C. § 103(a) as obvious over the combination of

Wang and Kudryavtsev. Pet. 44–57. As support, Gillette provides detailed explanations as to how each claim limitation is met by the references and rationales for combining the references (*id.*), as well as a Declaration of Mr. Richard DeVito (Ex. 1102) in support of its Petition, and a Declaration of Dr. John C. Bravman (Ex. 1128) in support of its Reply.

Zond responds that the combination of Wang and Kudryavtsev does not disclose every claim element. PO Resp. 26–51. Zond also argues that there is insufficient reason to combine the technical disclosures of Wang and Kudryavtsev. *Id*. at 51–54. To support its contentions, Zond proffers a Declaration of Dr. Larry D. Hartsough (Ex. 2015). Zond also asserts that secondary considerations mitigate against a determination of obviousness, but does not provide support for this contention from its declarant. PO Resp. 54–55.

We have reviewed the entire record before us, including the parties' explanations and supporting evidence presented during this trial. We begin our discussion with a brief summary of Wang and Kudryavtsev, and then we address the parties' contentions in turn.

<u>Wang</u>

Wang discloses a power pulsed magnetron sputtering apparatus for generating a very high plasma density. Ex. 1105, Abs. Wang also discloses a sputtering method for depositing metal layers onto advanced semiconductor integrated circuit structures. *Id*. at 1:4–15.

Figure 1 of Wang, reproduced below, illustrates a cross-sectional view of a power pulsed magnetron sputtering reactor:

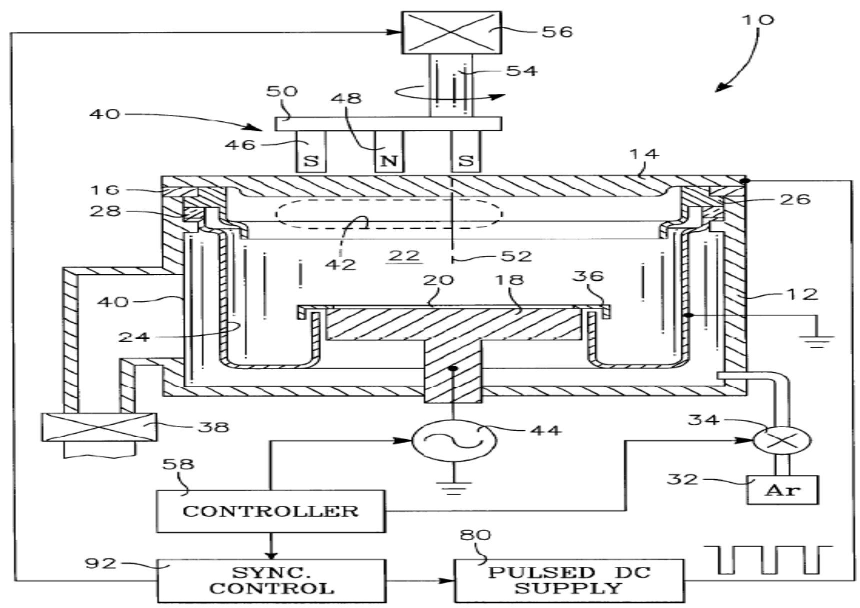


FIG. 1

As shown in Figure 1 of Wang, magnetron sputtering apparatus 10 has pedestal 18 for supporting semiconductor substrate 20, anode 24, cathode 14, magnet assembly 40, and pulsed DC power supply 80. *Id*. at 3:57–4:55, 4:35–36. According to Wang, the apparatus is capable of creating high density plasma in region 42, which ionizes a substantial fraction of the sputtered particles into positively charged metal ions and also increases the sputtering rate. *Id*. at 4:13–34. Wang further recognizes that, if a large portion of the sputtered particles are ionized, the films are deposited more uniformly and effectively—the sputtered ions can be accelerated towards a negatively charged substrate, coating the bottom and sides of holes that are narrow and deep. *Id*. at 1:24–29.

Figure 6 of Wang, reproduced below, illustrates how the apparatus applies a pulsed power to the plasma:

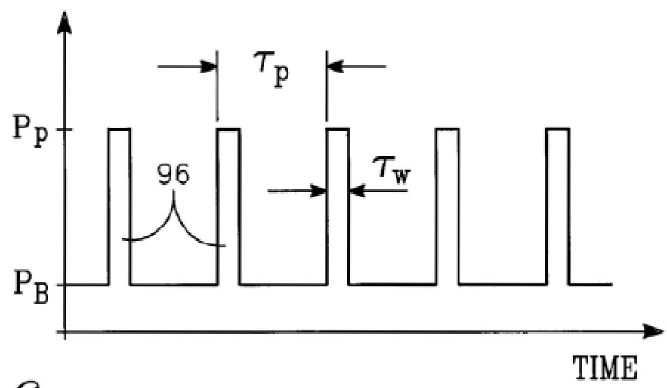


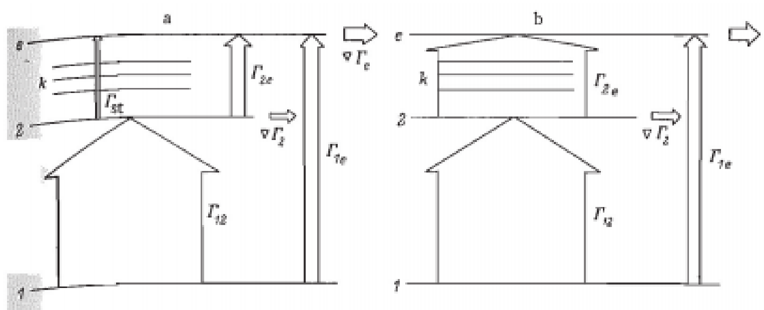
FIG. 6

As shown in Figure 6 of Wang, the target is maintained at background power level P_B between high power pulses 96 with peak power level P_P. *Id.* at 7:13–39. Background power level P_B exceeds the minimum power necessary to support a plasma in the chamber at the operational pressure (e.g., 1kW). *Id.* Peak power P_P is at least 10 times (preferably 100 or 1000 times) background power level P_B. *Id.* The application of high peak power P_P causes the existing plasma to spread quickly and increases the density of the plasma. *Id.* According to Mr. DeVito, Wang's apparatus generates a low-density (weakly-ionized) plasma during the application of background power P_B, and a high-density plasma during the application of peak power P_P. Ex. 1102 ¶¶ 110, 114; *see* Pet. 42–43, 46.

<u>Kudryavtsev</u>

Kudryavtsev discloses a multi-step ionization plasma process, comprising the steps of exciting the ground state atoms to generate excited atoms and then ionizing the excited atoms. Ex. 1104, Abs., Figs. 1, 6.

Figure 1 of Kudryavtsev illustrates the atomic energy levels during the slow and fast stages of ionization. Figure 1 of Kudryavtsev is reproduced below:



As shown in Figure 1 of Kudryavtsev, ionization occurs with a "slow stage" (Fig. 1a) followed by a "fast stage" (Fig. 1b). During the initial slow stage, direct ionization provides a significant contribution to the generation of plasma ions (arrow Γ_{1e} showing ionization (top line labeled "e") from the ground state (bottom line labeled "1")). Mr. DeVito explains that Kudryavtsev pre-ionized a gas and then applied a voltage pulse. Ex. 1102 ¶ 119; Pet. 48. Under these conditions, Kudryavtsev discloses:

> *an explosive increase in n_e* [plasma density]. *The subsequent increase in n_e* then reaches its maximum value, equal to the rate of excitation . . . which is several orders of magnitude greater than the ionization rate during the initial stage.

Ex. 1102 ¶ 119 (quoting Ex. 1104, 31). Kudryavtsev also recognizes that "in a pulsed inert-gas discharge plasma at moderate pressures . . . [i]t is shown that the electron density increases explosively in time due to accumulation of atoms in the lowest excited states." Ex. 1104, 30, Abs., Fig. 6.

Voltage Pulse Having a Controlled Amplitude or Rise Time

Gillette relies upon Wang to disclose the limitations recited in claims 6, 7, 9, 10, 16, 17, 19, and 20 (Pet. 44–57; Ex. 1102 ¶¶ 109–139), and further relies on Kudryavtsev to provide additional support for teaching "the pulsed power supply generating at the output a voltage pulse having at least one of a controlled amplitude and a controlled rise time that increases an ionization rate of sputtered material atoms so that a rapid increase in electron density and a formation of a strongly-ionized plasma occurs." Pet. 48–51. Gillette asserts:

> Like Wang, Kudryavtsev pre-ionizes a gas and applies a voltage pulse. . . . Under these conditions, Kudryavtsev observed a fast stage, corresponding to "an *explosive increase in* n_e [plasma density]. *The subsequent increase in* n_e then reaches its maximum value, equal to the rate of excitation . . . which *is several orders of magnitude greater than the ionization rate during the initial stage*."

Id. at 48 (citations omitted). Citing to Mr. DeVito's testimony, Gillette asserts that if such an "explosive increase" in density in Wang is not experienced, it would have been obvious to adjust the operating parameters like pulse length or pressure to trigger Kudryavtsev's fast stage of ionization. *Id.* at 49 (citing Ex. 1102 ¶ 120). Gillette concludes that:

> One of ordinary skill would have been motivated to use Kudryavtsev's fast stage of ionization in Wang so as to increase plasma density and thereby increase the sputtering rate. Also, Kudryavtsev's fast stage would reduce the time required to reach a given plasma density in Wang. Further, use of Kudryavtsev's fast stage in Wang would have been a combination of old elements that yielded the predictable results of rapidly increasing the ionization rate and electron density.

> Finally, because Wang's pulse, or the pulse used in the combination of Wang and Kudryavtsev, produced Kudryavtsev's fast stage of ionization, the rise time and amplitude of the pulse result in increasing the ionization rate so that a rapid increase in electron density and formation of a strongly-ionized plasma occurs.

Id. at 49–51 (citing Ex. 1102 ¶ 120).

Zond argues that neither Wang nor Kudryavtsev teaches the claimed voltage control or the avoidance of arcing during the rapid increase in electron density and formation of a strongly-ionized plasma. PO Resp. 26–55. For instance, citing Dr. Hartsough's testimony in support, Zond asserts that:

> Wang is not *controlling voltage* rise time so as to achieve the claimed objectives, and he never suggests *controlling* rise time of either voltage or of power: He is controlling *power level* only to obtain as fast a rise time in power as he can, and the actual rise time of power that results is an *uncontrolled* variation that occurs incidental to his attempt to control power to a constant target level.

PO Resp. 43; Ex. 2015 ¶¶ 103–104, 114–116.

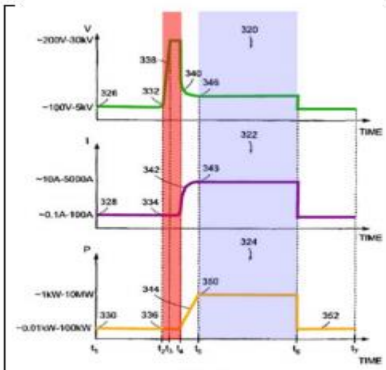
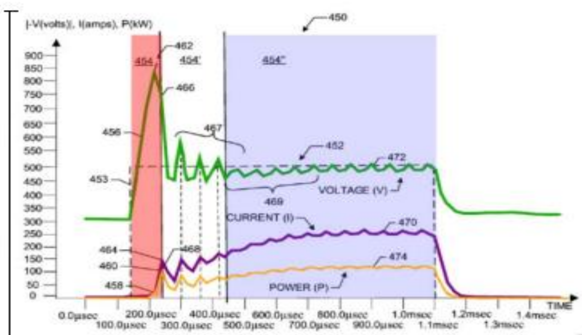
In its Reply, Gillette asserts that Zond concedes that all the limitations in claim 1 are met by the prior art except for control of voltage amplitude or rise time to avoid arcing when rapidly forming a strongly-ionized plasma. Reply 2 (citing PO Resp. 26). Gillette points to Dr. Hartsough's testimony admitting that Figure 10 in the '184 patent shows a prior art power supply that can generate voltage pulses according to the invention described in the '184 patent. *Id.* at 3 ("Again, Dr. Chistyakov says that these pulses are *according to the present invention*, and – so I will use my understanding of what he said there, since *a controlled rise time is part of his present* *invention, that these power supplies could do that*.") (quoting Ex. 1126, 84:25–86:23).

We start our analysis with where the parties appear to agree on what the prior art teaches. For instance, referring to Figure 1 of Wang set forth above, Wang teaches supplying a feed gas proximate to processing region 22, which is defined by the anode and cathode assembly, and pulsed DC power supply 80 that generates a train of voltage pulses between the anode and cathode assembly. Pet. 44–47; Ex. 1102 ¶¶ 110–116 (citing Ex. 1105, Figs. 1, 6, and 7, 3:66–4:1, 4:5–8, 4:20–21, 7:61–62).

We find Zond's contention that Wang is directed to *power* pulses throughout its disclosure, rather than a *voltage* pulse, is misplaced and contrary to the pertinent evidence of record. *See* PO Resp. 2, 26–33, 41–44. As Gillette indicates in its Petition, Wang discloses a pulsed DC power supply connected to the target that produces "*a train of negative voltage pulses*." Pet. 46 (citing Ex. 1105, 7:61–62 (emphasis added), Fig. 7). Mr. DeVito explains that "[t]hose voltage pulses create Wang's peak power pulses, P_P, which are applied to Wang's weakly-ionized plasma, i.e., the plasma generated by the background power P_B. . . . Because Wang's anode is grounded, when one of Wang's voltage pulses is applied to the cathode/target 14, a voltage pulse is generated between the anode and the cathode assembly." Ex. 1102 ¶¶ 114–115; *see* Pet. 46–47.

Also, Dr. Bravman explains that "[g]enerally, a pulsed power supply outputs a voltage pulse. The current responds to the applied voltage pulse, depending on the impedance of the load, leading to an increase in the current and concomitant lowering of the voltage." Ex. 1128 ¶ 53. Therefore, to generate a power pulse, a power supply first provides a voltage pulse with a specific amplitude and rise time. *Id.* ¶ 54. Dr. Bravman demonstrates how Wang shows such behavior by noting Wang's teaching that a typical "pulsed power supply will output relative high voltage and almost no current in the ignition phase and a lower voltage and substantial current in the maintenance phase." *Id.* ¶ 55 (quoting Ex. 1105, 5:32–35).

Dr. Bravman points to Dr. Hartsough's testimony that Figure 5 of U.S. Patent No. 6,896,775 ("the '775 patent"), assigned to Zond, illustrates a typical power supply also as described in Wang. *Id.* ¶ 56 (citing Ex. 1125, 149:22–150:20). Dr. Bravman testifies that, in his opinion, Figure 5 of the '775 patent behaves in a nearly identical manner as Figure 8 of the '184 patent, reproduced below with annotations by Dr. Bravman. *Id.* ¶ 57.

 FIG. 5	 FIG. 8
Annotated Figure 5 of the '775 patent (Ex. 1032): Voltage is shown in green, current is shown in purple, and power is shown orange. This figure also illustrates how the typical power supply described by Wang operates.	**Annotated Figure 8 of the '184 patent (Ex. 1001):** Voltage is shown in green, current is shown in purple, and power is shown orange.

Id. ¶ 58.[8] Dr. Bravman explains that "[i]n both cases, when the voltage pulse is initially applied (red region), voltage (green) is initially higher with low current (purple). Then, when the strongly-[ionized] plasma is generated (blue region), the voltage (green) becomes lower with the corresponding rise in current (purple)." *Id.* We credit Dr. Bravman's testimony, which is consistent with the Specification of the '184 patent and the prior art as set forth above, in addition to Dr. Hartsough's statements concerning the similarity of Figure 5 of the '775 patent to the teachings in Wang.

Based on the evidence before us, we are persuaded that Gillette has demonstrated, by a preponderance of evidence, that the combination of Wang and Kudryavtsev discloses a voltage pulse having at least one of a controlled amplitude and a controlled rise time that increases an ionization rate so that a rapid increase in electron density and a formation of a strongly-ionized plasma occurs.

Without Forming an Arc Between the Anode and Cathode Assembly

Zond also asserts Wang fails to teach a critical claim limitation of a lack of arcing during the formation of a strongly-ionized plasma through control of pulse voltage. *See* PO Resp. 31–33. Zond argues that, because Wang admits arcing occurs upon plasma ignition with the discussed power control technique and that Figure 6 of Wang demonstrates use of a background power so arcing would be significantly *reduced*, but not

[8] The references to exhibits in the figure refer to exhibits in the related case, IPR2014-00799. In this case, the '775 patent is Exhibit 1129, and the '184 patent is Exhibit 1101.

eliminated, Wang does not teach the "lack of arcing" limitation. *Id.* at 31–32. This particular argument of Zond is not persuasive because, as we have stated in our claim construction, given the disclosure in the Specification, we decline to construe the claims to require the transformation of the weakly-ionized plasma to a strongly-ionized plasma occur with a *guarantee* of eliminating *all possibility* of an electrical breakdown condition or arcing, because it would be unreasonable to exclude the disclosed embodiments, all of which stop short of such a guarantee. *See Phillips*, 415 F.3d at 1315 (stating that the Specification is "the single best guide to the meaning of a disputed term").

Zond also argues that Kudryavtsev's teaching of an "explosive" build–up of electron density would transition into an arc as evidenced by the resultant measured voltage and current waveforms shown in Figure 2 of Kudryavtsev. PO Resp. 34–41 (citing Ex. 2015 ¶¶ 121–131, 134). Therefore, according to Zond, Kudryavtsev does not teach "that the applied voltage amplitude or voltage rise time were controlled in the manner claimed to achieve a rapid increase in electron density without arcing." *Id.* at 48.

Gillette counters that Wang teaches the avoidance of arcing because the impedance changes relatively little between the two power levels P_B and P_P, indicating no arcing, which Gillette asserts Dr. Hartsough admits. Reply 2–4 (citing Ex. 1105, 7:49–51; Ex. 1125, 89:8–24). Gillette also disagrees that Kudryavtsev causes an arc condition. *See* Ex. 1128 ¶¶ 65–66.

A preponderance of the evidence before us supports Gillette's position that the combination of Wang and Kudryavtsev discloses the claim feature. *See* Pet. 51–52 (citing Ex. 1102 ¶¶ 124–125). As Gillette notes, Wang explains that arcing may occur during plasma ignition before the first pulse shown in Figure 6. *Id*. at 51 (citing Ex. 1105, 7:3–6). Indeed, Wang recognizes that plasma ignition in a sputtering reactor has a tendency to generate arcing, dislodging large particles from the target or chamber. Ex. 1105, 7:3–8. This is because plasma ignition is an electronically noisy process, and each power pulse would need to ignite the plasma (as illustrated in Figure 4 of Wang) if background power level P_B is not maintained between the high power pulses. *Id*. at 7:8–12.

Figure 6 of Wang (reproduced previously in our initial discussion of Wang) is reproduced again below:

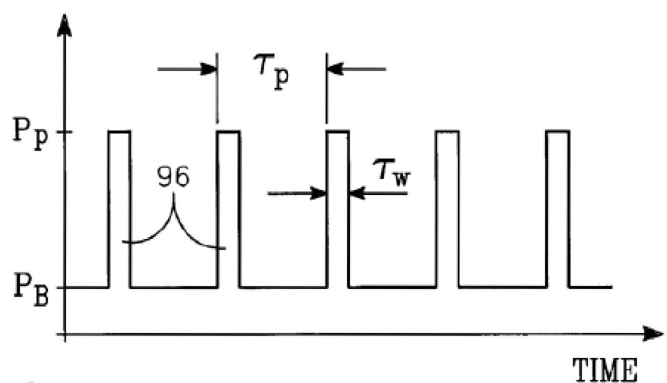


FIG. 6

As shown in Figure 6 of Wang, the target is maintained at background power level P_B between power pulses 96, rising to peak level P_P. Ex. 1105, 7:13–25. Background level P_B is chosen to exceed the minimum power necessary to support a plasma with little, if any, actual sputter deposition. *Id*. The initial plasma ignition needs to be performed only once, and at a very low power level, so that particulates produced by arcing are much reduced. *Id*. at 7:26–55. According to Mr. DeVito, because "the plasma need not be reignited thereafter, arcing will not occur during subsequent applications of the background and peak power levels, P_B and P_P." Ex. 1102 ¶ 125.

We agree with Gillette that Wang teaches the avoidance of arcing (as Dr. Hartsough admits), and, in contrast to Zond's assertions, we further agree with Gillette that Kudryavtsev does not teach that arcing must occur. *See* Ex. 1104, 34 (discussing uniformity of ionization across cross section of discharge tube). Based on the evidence before us, we are persuaded Gillette has demonstrated, by a preponderance of evidence, that the combination of Wang and Kudryavtsev discloses a voltage pulse having at least one of a controlled amplitude and a controlled rise time that increases an ionization rate of sputtered material atoms so a rapid increase in electron density and a formation of a strongly-ionized plasma occurs *without forming an arc* between the anode and the cathode assembly.

Rationale to Combine Wang and Kudryavtsev

Finally, Zond points to the physical differences between Kudryavtsev's and Wang's systems, concluding "[c]ombining the teachings of Kudryavtsev's flash tube with no magnet with Wang's pulsed magnetron sputter reactor would not have lead one of ordinary skill in the art to an expected result." PO Resp. 52. For instance, Zond asserts that Kudryavtsev's system does not use magnets or magnetic fields, in contrast to Wang's magnetron; Wang's and Kudryavtsev's reactors have very different dimensions; and the location of the application of the voltage pulse in Kudryavtsev's system is substantially different from Wang's. *Id.* at 53.[9]

Gillette supports its conclusion that one of ordinary skill in the art would have been motivated to use Kudryavtsev's explosive ionization in Wang to increase plasma density, concomitantly increasing the sputtering rate, with testimony from each of Mr. DeVito and Dr. Bravman. Reply 9 (citing Ex. 1102 ¶¶ 120–123; Ex. 1128 ¶¶ 67–68; Pet. 49–51). Gillette concludes that "[a]s Dr. Bravman explains, a person of ordinary skill in the art would have combined the teachings of Wang with Kudryavtsev, despite the physical differences that may exist, just as Mozgrin had done in applying Kudryavtsev in designing his magnetron sputtering system." Reply 12 (citing Ex. 1128 ¶ 69).

Upon consideration of the evidence before us, we are persuaded by Gillette's contentions. Gillette merely relies upon Kudryavtsev's teaching that an "explosive increase" in plasma density is achieved by applying a voltage pulse to a weakly-ionized plasma. Pet. 48–51. Zond's arguments

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[9] Zond attempts to argue secondary considerations. PO Resp. 54–55. Zond's arguments, however, are unsupported attorney argument to which we give little weight. *See Meitzner v. Mindick*, 549 F.2d 775, 782 (CCPA 1977) (finding argument of counsel cannot take the place of evidence lacking in the record); *see also* PO Resp. 55 n.109 (cited excerpts of Mr. DeVito's deposition concerning experimentation to combine the teachings of Kudryavtsev with Wang do not support a conclusion that the experimentation is undue; Mr. DeVito simply testifies to the time that it would take to build the appropriate chamber to perform the testing); Reply 12–13 (citing Ex. 2014, 306:2–6, 307:1–13; Ex. 1128 ¶ 72) (supporting conclusion that experimentation to combine teachings of Wang and Kudryavtsev is unnecessary, and if done, is not undue).

concerning the differences between Wang's and Kudryavtsev's systems are not persuasive. "It is well-established that a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of elements." *In re Mouttet*, 686 F.3d 1322, 1332 (Fed. Cir. 2012) (citation omitted); *In re Etter*, 756 F.2d 852, 859 (Fed. Cir. 1985) (en banc) (noting that the criterion for obviousness is not whether the references can be combined physically, but whether the claimed invention is rendered obvious by the teachings of the prior art as a whole)). In that regard, one with ordinary skill in the art is not compelled to follow blindly the teaching of one prior art reference over the other without the exercise of independent judgment. *Lear Siegler, Inc. v. Aeroquip Corp.*, 733 F.2d 881, 889 (Fed. Cir. 1984); *see also KSR*, 550 U.S. at 420–21 (stating that a person with ordinary skill in the art is "a person of ordinary creativity, not an automaton," and "in many cases . . . will be able to fit the teachings of multiple patents together like pieces of a puzzle").

More importantly, Wang discloses that application of the high peak power P_P to the background power P_B "*quickly* causes the already existing plasma to spread and increases the density of the plasma" to form a strongly-ionized plasma. Ex. 1105, 7:29–30 (emphasis added); Ex. 1102 ¶ 117. Mr. DeVito testifies that "[l]ike Kudryavtsev's voltage pulse, application of Wang's voltage pulse (which produces the peak power P_P) to the weakly-ionized plasma rapidly increases the plasma density and the density of the free electrons." Ex. 1102 ¶ 119; *see also id*. ¶ 121 ("Because Wang applies voltage pulses that 'suddenly generate an electric field,' one of ordinary skill reading Wang would have been motivated to consider Kudryavtsev and to use Kudryavtsev's fast stage in Wang.").

On this record, we credit Mr. DeVito's testimony, as it is consistent with the prior art disclosures. Moreover, we are persuaded by Mr. DeVito's testimony that if one of ordinary skill did not experience Kudryavtsev's "explosive increase" in plasma density in Wang, triggering a fast stage of ionization (as disclosed by Kudryavtsev) in Wang's apparatus would have been a combination of known techniques yielding the predictable results of rapidly increasing the ionization rate and electron density. *See id.* ¶ 120.

We further are not persuaded by Zond's argument that applying Kudryavtsev's model on plasma behavior to Wang's sputtering apparatus would have been beyond the level of ordinary skill, or that one with ordinary skill in the art would not have had a reasonable expectation of success in combining the teachings. PO Resp. 51–54. Obviousness does not require absolute predictability, only a reasonable expectation that the beneficial result will be achieved. *In re Merck & Co.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986). As Dr. Bravman testifies, Kudryavtsev's theoretical framework on plasma behavior is not intended to be limited to a particular type of plasma apparatus. Ex. 1128 ¶ 67. Indeed, Kudryavtsev discloses a study of the ionization relaxation in plasma when the external electric field suddenly increases. Ex. 1104, 30. Specifically, Kudryavtsev discloses that "the *electron density increases explosively* in time due to accumulation of atoms in the lowest excited states." *Id*. at Abs. (emphasis added). Kudryavtsev also describes the experimental results that confirm the model. *Id*. at 32–34. Moreover, Kudryavtsev expressly explains that "the effects studied in this work are characteristic of ionization *whenever a field is suddenly applied to a weakly ionized gas*." *Id*. at 34 (emphasis added); *see* Ex. 1128 ¶ 65.

Dr. Bravman also testifies that a person having ordinary skill in the art "would have looked to Kudryavtsev to understand how plasma would react to a quickly applied voltage pulse, and how to achieve an explosive increase in electron density," when generating a strongly-ionized plasma in view of Wang's application for the benefit of improved sputtering and manufacturing processing capabilities. Ex. 1128 ¶ 68. Dr. Bravman further explains that such an artisan would know how to apply the teachings of Kudryavtsev to Wang's system for performing sputtering, by making any necessary changes to accommodate the differences of pressures, dimensions, sizes, magnets, or other features through routine experimentation. *Id.* ¶ 69. On this record, we credit Dr. Bravman's testimony because his explanations are consistent with the prior art of record. Accordingly, we are persuaded Gillette has articulated a reason with rational underpinning why one with ordinary skill in the art would have combined the technical teachings of Wang and Kudryavtsev.

<u>Remaining Limitations of Challenged Claims</u>

Zond does not address specifically whether the references teach or suggest a "method of generating a strongly-ionized plasma" comprising: (a) "supplying feed gas proximate to an anode and a cathode assembly," and (b) "generating a voltage pulse between the anode and the cathode assembly" as required by both independent claims 1 and 11. *See* PO Resp. 26–55; Reply 2; Ex. 1101, 22:44–49. We are persuaded on this record that

Gillette has shown sufficiently that Wang teaches these features. *See* Pet. 44–47; Ex. 1102 ¶¶ 107–116.

In addition to the limitations discussed above found in independent claims 1 and 11, and those discussed below with respect to other dependent claims, dependent claims 6, 9, 10, 16, 19, and 20 add limitations that Gillette asserts are taught by the combination of Wang and Kudryavtsev. Zond does not address these limitations. *See* Reply 2. We are persuaded on the record before us that Gillette has demonstrated by a preponderance of the evidence that the combination of Wang and Kudryavtsev would have suggested the additional limitations of the dependent claims to one with ordinary skill in the art at the time of the invention. *See* Pet. 54–57; Ex. 1102 ¶¶ 131–137.

Dependent Claims 7 and 17

Dependent claims 7 and 17 recite the method of claims 1 and 11, respectively, wherein "a lifetime of the strongly-ionized plasma is greater than 200 μsec." Zond asserts that although Wang states that his power supply was capable of wider pulse widths up to less than a millisecond, he suggests that the pulses should be shorter than 200 microseconds. PO Resp. 56–57. This, coupled with Mr. DeVito's alleged admission that the lifetime of a highly ionized plasma is less than the duration of Wang's pulse, Zond argues, shows that Wang

> teaches against the claimed method of sustaining an arc free strongly-ionized plasma for over 200 microseconds by control of pulse voltage. Accordingly, when Wang merely mentions that his power pulses could be extended for over 200 microseconds, he does not teach or suggest the claimed method

> of controlling pulse voltage to rapidly form a strongly-ionized plasma and maintain it arc free for over 200 micro-seconds.

Id. at 57–58.

Gillette responds that, as Zond admits, Wang's teaching of a pulse width of up to a millisecond is five times longer than 200 μsec. Reply 14; *see also* Pet. 55 (citing Ex. 1102 ¶ 134) (stating 1ms is five times longer than the claimed 200 μsec.). Mr. DeVito testifies that

> Because Wang's peak power P_P generates the strongly-ionized plasma, and because Wang's plasma will be at or near the peak density during the majority of the pulse (i.e., all of the peak power pulse except the very beginning of the pulse), Wang teaches "wherein a lifetime of the strongly-ionized plasma is greater than 200 μsec" as required by claims 7 and 17.

Ex. 1102 ¶ 134; Pet. 55.

Gillette also utilizes Dr. Hartsough's admission that Wang's typical power supply can be schematically represented by Fig. 5 of the '775 patent, reproduced above. *See supra* at 27 Gillette concludes that "[a]s shown, Wang's typical power supply generates and sustains the strongly-ionized plasma in the region shaded in blue, shown by the high plateau of the power pulse (orange), which can be up to a millisecond." Reply 14 (citing Ex. 1128 ¶¶ 96–98). Gillette also relies on Wang's teaching that "the chamber impedance changes relatively little between the two power levels P_B, P_P since a plasma always exist[s] in the chamber," teaching the avoidance of arcing that Zond disputes. Reply 14–15 (citing Ex. 1128 ¶¶ 99–100).

We credit the testimony of Mr. DeVito and Dr. Bravman, which is consistent with the Specification of the '184 patent and the prior art as set forth above, in addition to Dr. Hartsough's statements concerning the similarity of Figure 5 of the '775 patent to the teachings in Wang.

Based on the evidence before us, we are persuaded that Gillette has demonstrated that the combination of Wang and Kudryavtsev discloses a lifetime of the strongly-ionized plasma is greater than 200 μsec.

D. Claims 8 and 18 – Obviousness over Wang, Kudryavtsev, and Mozgrin

Gillette asserts that claims 8 and 18 are unpatentable under 35 U.S.C. § 103(a) as obvious over the combination of Wang, Kudryavtsev, and Mozgrin. Pet. 56–58. As support, Gillette provides detailed explanations as to how each claim limitation is met by the references and rationales for combining the references, as well as a declaration of Mr. DeVito (Ex. 1102). *Id*. Zond did not address specifically this ground in its Patent Owner Response.

Dependent claims 8 and 18 add the following limitation to claims 1 and 11, respectively, "further comprising discharging energy from an energy storage device into the plasma to enhance the rapid increase in electron density and the formation of the strongly-ionized plasma." Ex. 1101, 23:6–9, 24:17–20. Gillette notes that Wang's pulsed DC power supply 80 produces a train of negative voltage pulses applied to its cathode/target 14, with respect to its anode 24, and produces the peak power pulses P_P creating Wang's strongly-ionized plasma. Pet. 57 (citing Ex. 1105, 7:61–62; Ex. 1102 ¶ 142). Although Wang does not disclose the details of its pulsed power supply, Mr. DeVito explains that "it would have been obvious for one of ordinary skill to use 'energy storage devices,' such as capacitors, when implementing Wang's pulsed power supply 80." Ex. 1102 ¶ 142.

Gillette also notes that Mozgrin provides a schematic of his power supply in Figure 2, which includes capacitors. Pet. 57.

Figure 2 of Mozgrin is reproduced below.

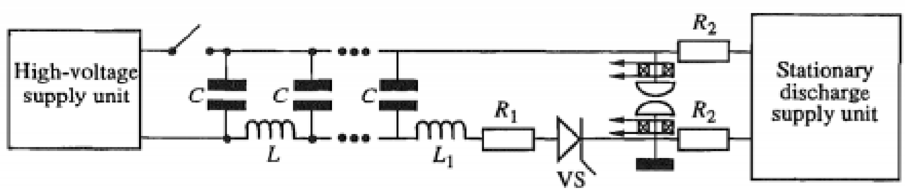

Fig. 2. Discharge supply unit.

Mozgrin describes Figure 2 as "a simplified scheme of the discharge supply system," which shows capacitors C, and wherein "[t]he supply unit involved a pulsed discharge supply unit and a system for pre-ionization." Ex. 1103, 401, left col., ¶ 5; Pet. 57. Mr. DeVito states that "[a]s one skilled in the art would readily recognize, those capacitors (labeled "C") store energy that is used to create Mozgrin's voltage pulse." Ex. 1102 ¶ 87. Because both Wang and Mozgrin describe using pulses to increase the density of a plasma for sputtering, Gillette asserts that one of ordinary skill would have looked to Mozgrin for the details of a power supply to be applied to Wang. Pet. 57 (citing Ex. 1102 ¶ 143).

In Figure 7, Mozgrin describes the current-voltage characteristic ("CVC") of a plasma discharge from the discharge supply unit that has energy storing capacitors as shown in Figure 2 above. *See* Ex. 1103, 401, left col., ¶ 5 (describing "quasi-stationary discharge-supply unit" of

Figure 2); *id.* at 406, left col., Fig. 7 (describing "generalized ampere-voltaic characteristic CVC of quasi-stationary discharge").

Figure 7 of Mozgrin is reproduced below.

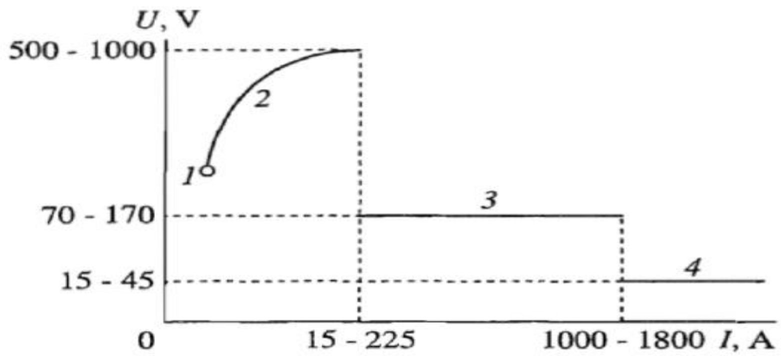

Fig. 7. Generalized ampere-voltaic characteristic CVC of quasi-stationary discharge.

Of the four regions shown in Figure 7 above, Mozgrin refers to region 1 as the pre-ionization stage (Ex. 1103, 402, right col., ¶ 2; Ex. 1102 ¶ 37), and region 2 as the high current magnetron discharge stage, which is useful for sputtering (Ex. 1103, 409, left col, ¶ 4, 403, right col, ¶ 4; Ex. 1102 ¶ 38). The plasma densities in these two regions are as follows; region 1 is in the 10^9–10^{11} cm^{-3} range and region 2 exceeds $2x10^{13}$ cm^{-3}. *See* Ex. 1103, 401, right col., ¶ 2, 409, left col., ¶ 4. Mozgrin generates a strongly-ionized plasma in region 2, as the density in region 2 matches the exemplary density given for a strongly-ionized plasma in the '184 patent. *See* Ex. 1102 ¶ 53 (quoting Ex. 1101, 7:14–17 ("[S]trongly-ionized plasmas are generally plasmas having plasma densities that are greater than above 10^{12}–10^{13} cm^{-3}.")). Therefore, Mr. DeVito concludes that "Mozgrin's density increase from 10^{11} in region 1 to 10^{13} in region 2 in response to Mozgrin's pulse shows that Mozgrin generated a strongly-ionized plasma by 'increasing ionization rate' and 'rapid increase in electron density' . . . ." Ex. 1102 ¶ 62.

Because both Wang and Mozgrin describe using pulses to increase the density of a plasma for sputtering, we are persuaded that one of ordinary skill in the art reading Wang would have looked to Mozgrin for details of the power supply. *See* Ex. 1102 ¶ 143. We are also persuaded that using Mozgrin's power supply in Wang would have been a combination of old elements wherein each element behaved as expected. *Id.* Therefore, on this record, we determine that Gillette has shown that the combination of Wang, Kudryavtsev, and Mozgrin would have suggested discharging energy from an energy storage device into the plasma to enhance the rapid increase in electron density and the formation of the strongly-ionized plasma to one with ordinary skill in the art at the time of the invention.

Upon consideration of the parties' contentions and evidence, we determine that Gillette has shown, by a preponderance of the evidence, that claims 8 and 18 are unpatentable under 35 U.S.C. § 103(a) over Wang, Kudryavtsev, and Mozgrin.

III. CONCLUSION

For the foregoing reasons, we conclude that Gillette has demonstrated, by a preponderance of the evidence, that claims 6–10 and 16–20 are unpatentable based on the following grounds of unpatentability.

Claims	**Basis**	**References**
6, 7, 9, 10, 16, 17, 19, and 20	§ 103(a)	Wang and Kudryavtsev
8 and 18	§ 103(a)	Wang, Kudryavtsev, and Mozgrin

IV. ORDER

For the foregoing reasons, it is

ORDERED that claims 6–10 and 16–20 of the ’184 patent are held *unpatentable*;

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

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing

PATENT OWNER'S NOTICE OF APPEAL

was served on November 23, 2015, by filing this document though the Patent Review Processing System as well as delivering a copy via electronic mail directed to the attorneys of record for the Petitioner at the following address:

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As required under 37 C.F.R. § 90.2(a).

Respectfully submitted,

Date: November 23, 2015

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