

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

THE GILLETTE COMPANY,
Petitioner,

v.

ZOND, LLC,
Patent Owner.

Case IPR2014-00479
Patent 8,125,155 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

I. INTRODUCTION

The Gillette Company (“Gillette”) filed a Petition requesting *inter partes* review of claims 17–19 of U.S. Patent No. 8,125,155 B2 (“the ’155 patent”). Paper 2 (“Pet.”). Zond, LLC (“Zond”) filed a Preliminary Response. Paper 10 (“Prelim. Resp.”). We instituted the instant trial on September 8, 2014, pursuant to 35 U.S.C. § 314. Paper 11 (“Dec.”). Subsequent to institution, Zond filed a Response (Paper 34, “PO Resp.”), and Gillette filed a Reply (Paper 39, “Reply”). Oral hearing¹ was held on May 28, 2015, and a transcript of the hearing was entered into the record. Paper 48 (“Tr.”)

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 Gillette has shown, by a preponderance of the evidence, that claims 17–19 of the ’155 patent are unpatentable under 35 U.S.C. § 103(a).

A. Related Matters

Gillette indicates that *Zond, LLC v. The Gillette Co.*, No.1:13-cv-11567-DJC (D. Mass. 2013) would affect or be affected by a decision in this proceeding. Pet. 1. Gillette also identifies other Petitions for *inter partes* review that are related to this proceeding. *Id.*

¹ The hearings for this review and the following *inter partes* reviews were consolidated: IPR2014-00477, involving the ’155 patent; and IPR2014-00799 and IPR2014-00803, involving U.S. Patent No. 7,808,184, the parent of the ’155 patent.

B. The '155 Patent

The '155 patent relates to methods and apparatus 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, generated between two electrodes in the presence of a feed gas, creates electrons in the feed gas that ionize atoms to create the plasma. *Id.* at 1:20–24. 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 in the chamber. *Id.* at 1:25–29. This overheating may be addressed by complex cooling mechanisms, but such cooling can cause temperature gradients in the chamber causing non-uniform plasma process. *Id.* at 1:30–34. 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 1:35–40. Arcing is problematic because it can cause the release of undesirable particles in the chamber contaminating the work piece. *Id.* at 1:40–42, 4:10–14.

According to the '155 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 4:8–17. 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 1:65–67.

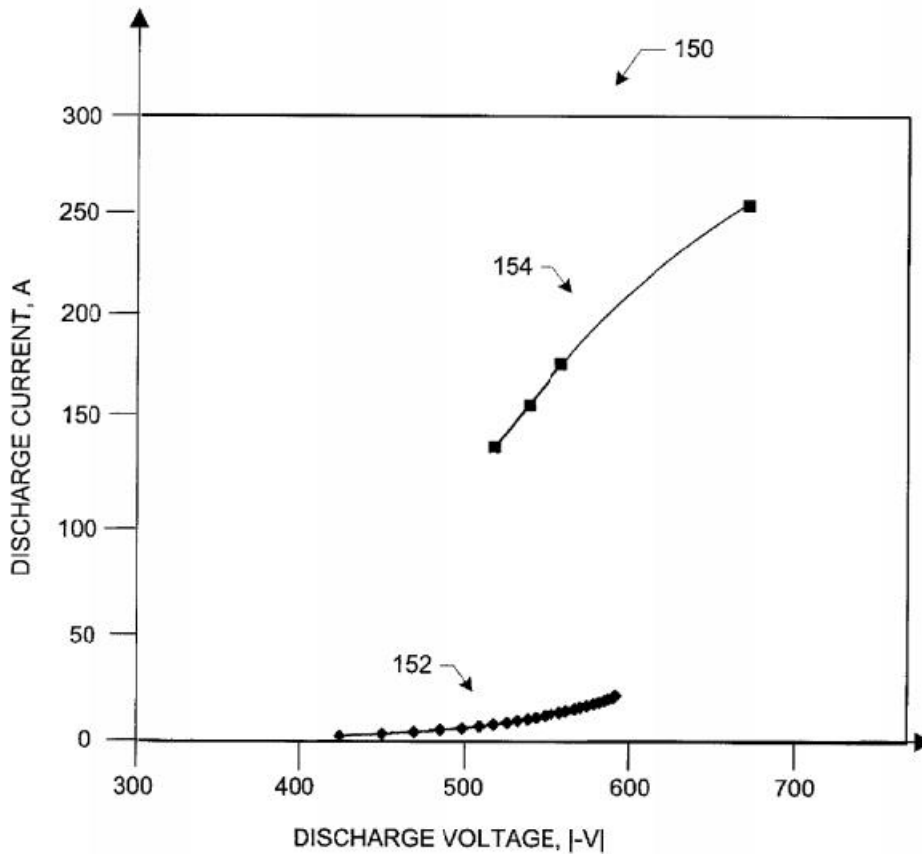


FIG. 2

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 5:31–33. 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 5:43–46. 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 5:58–62. The '155 patent explicitly defines the term “high-current regime” as “the range of plasma discharge currents that are greater than about 0.5 A/cm² for typical sputtering voltages of between

about -300V to -1000V. The power density is greater than about 250 W/cm^2 for plasmas in the high-current regime.” *Id.* at 5:46–51.

The ’155 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 2:4–6; 7:4–8 (describing Figure 4 (not reproduced here) as such an example); *id.* at 14:49–15:44 (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 7:11–15. “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 7:15–18.

C. Challenged Claims

Of the challenged claims, claims 18 and 19 directly depend from independent claim 17. The challenged claims are reproduced below.

17. An apparatus for generating a strongly-ionized plasma, the apparatus comprising:
- a) means for supplying feed gas proximate to an anode and a cathode assembly;
 - b) means for generating a voltage pulse that forms a plasma between the anode and the cathode; and
 - c) means for controlling an amplitude and a rise time of the voltage pulse to increase an ionization rate of sputtered material atoms 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, 24:5–16.

18. The apparatus of claim 17 further comprising shifting an electron energy distribution in the plasma to higher energies that increase the ionization rate of sputtered material atoms.

Id. at 24:17–20.

19. The apparatus of claim 17 further comprising a means for sustaining the strongly-ionized plasma for greater than 200 μ sec.

Id. at 22:21–23.

D. Prior Art Relied Upon

Gillette relies upon the following prior art references:

Wang US 6,413,382 July 2, 2002 (Ex. 1102)

Kouznetsov US Pat. Pub. 2005/0092596 May 5, 2005 (Ex. 1103)

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. 1104) (“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. 1108) (“Kudryavtsev”).

E. Ground of Unpatentability

We instituted the instant trial based on the following ground of unpatentability (Dec. 34):

Claims	Basis	References
17–19	§ 103(a)	Wang, Kudryavtsev, and Admitted Prior Art

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 enacting the AIA,”² 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”) (citations omitted). 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

² The Leahy-Smith America Invents Act, Pub. L. No. 112–29, 125 Stat. 284 (2011) (“AIA”).

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).

In the instant proceeding, Gillette proposed constructions for the following claim elements from the three challenged claims that Gillette construed as means-plus-function elements, invoking 35 U.S.C. 112, ¶ 6:³ (1) “means for supplying a feed gas proximate to the anode and cathode assembly”; (2) “means for generating a voltage pulse that forms a plasma between the anode and the cathode”; (3) “means for controlling an amplitude and a rise time of the voltage pulse to increase an ionization rate of sputtered material atoms 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”; and (4) “means for sustaining the strongly-ionized plasma for greater than 200 µsec.” Pet. 5–7. Zond offered constructions for these terms, as well as the term “strongly-ionized plasma,” (Prelim. Resp. 10–19), and we generally adopted Zond’s constructions as the broadest reasonable construction of the claim terms.

In its Patent Owner Response, Zond revisits its proposed constructions for “means for generating a voltage pulse that forms a plasma between the

³ Section 4(c) of the Leahy-Smith America Invents Act (AIA) re-designated 35 U.S.C. § 112, ¶ 6, as 35 U.S.C. § 112(f). Pub. L. No. 112-29, 125 Stat. 284, 296 (2011). Because the ’155 patent has a filing date before September 16, 2012 (effective date), we will refer to the pre-AIA version of § 112.

anode and cathode,” and “means for controlling an amplitude and rise time of the voltage pulse to increase an ionization rate of sputtered material atoms 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.” PO Resp. 18–32.

Means-Plus-Function Claim Elements

We agree that the four claim elements identified by Gillette are written in means-plus-function form and fall under 35 U.S.C. § 112, ¶ 6, because: (1) each claim element uses the term “means for”; (2) the term “means for” in each claim element is modified by functional language; and (3) the term “means for” is not modified by any structure recited in the claim to perform the claimed function. *Personalized Media Commc’ns LLC v. Int’l Trade Comm’n*, 161 F.3d 696, 703–04 (Fed. Cir. 1998) (A claim element using the term “means for” creates a rebuttable presumption that the drafter intended to invoke § 112, ¶ 6.); *Sage Prods. v. Devon Indus., Inc.*, 126 F.3d 1420, 1427–28 (Fed. Cir. 1997) (The presumption is not rebutted if the term “means for” is modified by functional language and is not modified by any structure recited in the claim to perform the claimed function.); see also *Williamson v. Citrix Online, LLC*, 792 F.3d 1339, 1349 (Fed. Cir. 2015) (confirming that “use of the word ‘means’ creates a presumption that § 112, ¶ 6 applies”) (citing *Personalized Media*, 161 F.3d at 703).

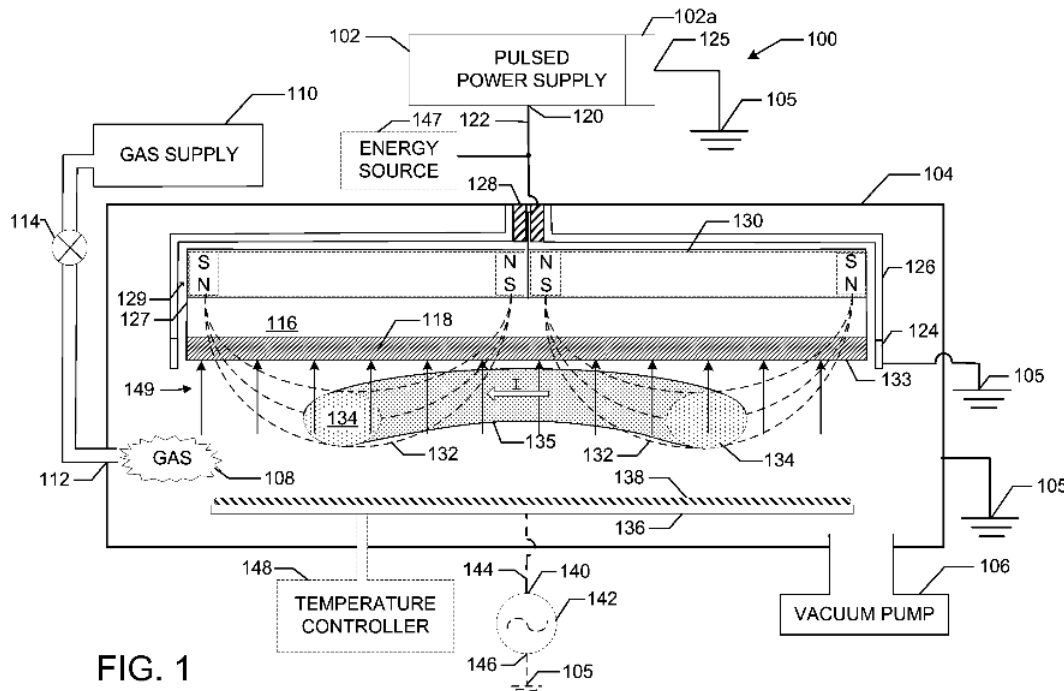
The first step in construing a means-plus-function claim element is to identify the recited function in the claim element. *Med. Instrumentation & Diagnostics Corp. v. Elekta AB*, 334 F.3d 1205, 1210 (Fed. Cir. 2003). The second step is to look to the specification and identify the corresponding

structure for that recited function. *Id.* A structure disclosed in the specification qualifies as “corresponding” structure only if the specification or prosecution history clearly links or associates that structure with the function recited in the claim. *B. Braun Med. v. Abbott Labs.*, 124 F.3d 1419, 1424 (Fed. Cir.1997). “While corresponding structure need not include all things necessary to enable the claimed invention to work, it must include all structure that actually performs the recited function.” *Default Proof Credit Card Sys. Inc. v. Home Depot U.S.A., Inc.*, 412 F.3d 1291, 1298 (Fed. Cir. 2005).

1. “*means for supplying a feed gas proximate to the anode and cathode assembly*”

We observe that the recited function for the claim element is “supplying a feed gas proximate to the anode and cathode assembly.” Gillette refers to the specific structure in Figure 9 of the ’155 patent as corresponding to this function, namely, feed gas injectors 516, coupled to one or more feed gas sources 518, and an inlet for providing the gas into the gap between the closely spaced parallel anode and cathode. Pet. 5. Zond asserted that Gillette narrowly focused on only one embodiment that provides structure for the recited function, Figure 9, overlooking Figure 1, which also provides such structure. Prelim. Resp. 11. Figure 1, Zond submitted, shows gas source 110, valve 114, and a conduit leading to inlet 112 to supply a feed gas to a location that is proximate to the anode and cathode assembly. *Id.* Therefore, Zond proposed that the corresponding structure is a gas source and conduits for delivering gas to a location that is proximate to the anode and cathode assembly. *Id.*

In the Decision on Institution, we agreed with Zond that both Figures 1 and 9 of the '155 patent show structure that performs the function of supplying a feed gas proximate to the anode and cathode assembly. Dec. 10–12. Figure 1, showing a cross-sectional view of a plasma sputtering apparatus having a pulsed direct current (DC) power supply, is reproduced below. Ex. 1101, 1:62–64.



As shown in Figure 1, process or feed gas 108 is introduced into vacuum chamber 104, which contains the plasma, through gas inlet 112 from feed gas source 110, which may be an argon gas source. Ex. 1101, 2:43–44, 50–53. In operation, feed gas source 110 of the plasma sputtering apparatus injects feed gas 108 into chamber 104 through gas inlet 112. *Id.* at 3:49–51. Ring-shaped anode 124 is positioned “proximate to” cathode assembly 116. *Id.* at 2:63–64.

By the same token, Figure 9 of the '155 patent, reproduced below, also shows a cross-sectional view of a plasma sputtering apparatus having a pulsed direct DC power supply. *Id.* at 2:22–24.

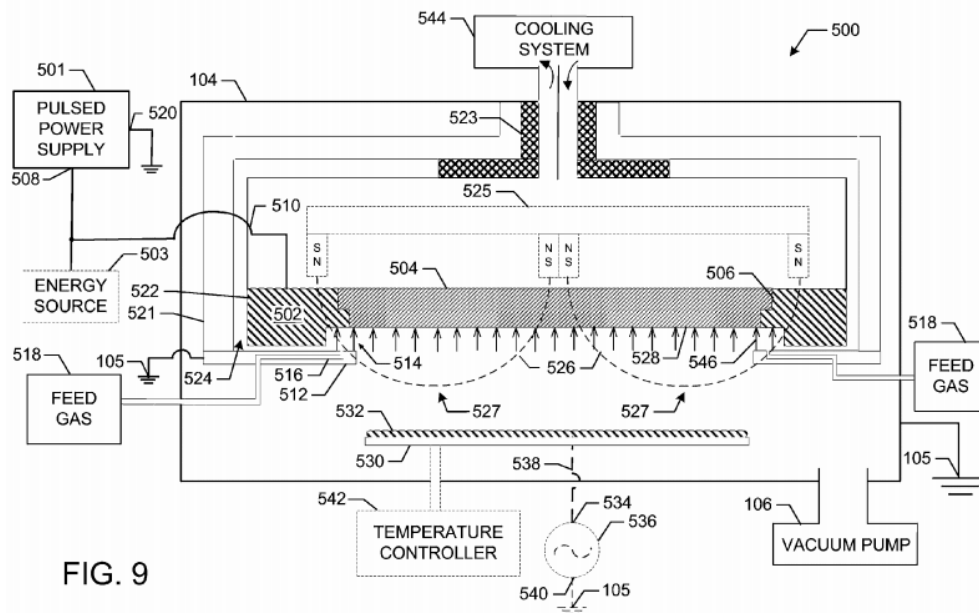


FIG. 9

As shown in Figure 9, ring-shaped anode 512 is positioned in vacuum chamber 104, which contains the plasma, “proximate to” cathode assembly 502, to form gap 514 between the anode and cathode assembly. *Id.* at 19:4–5, 27–30. Gap 514 can measure between about 1.0 cm and 12.0 cm wide. *Id.* at 19:30–31. The Specification further provides:

The gap 514 can also promote increased homogeneity of the plasma by controlling a gas flow through the gap. The anode 512 can include a plurality of feed gas injectors 516 that inject feed gas into the gap 514. In the embodiment shown, the feed gas injectors 516 are positioned within the anode 512. The feed gas injectors 516 are coupled to one or more feed gas sources 58.

Id. at 19:33–39.

Given this disclosure in the '155 patent, we agreed with Zond and identified the corresponding structure for performing the recited function—“supplying a feed gas proximate to the anode and cathode assembly”—to be a gas source and conduits for delivering gas to a location proximate to the anode and cathode assembly. The parties do not challenge any aspect of our claim construction as to this term. PO Resp. 18–32; Reply 4–8. Upon review of the present record, we discern no reason to change our claim construction.

2. *“means for generating a voltage pulse that forms a plasma between the anode and the cathode”*

In our Decision on Institution, we observed that the recited function for this claim element is “generating a voltage pulse that forms a plasma between the anode and the cathode.” Dec. 12. Zond asks us to clarify the scope of the stated function in light of the requirement that the pulse “form” a plasma. PO Resp. 20. Zond asserts that:

Every one of the examples of the invention in the '155 patent . . . show[s] a voltage pulse that first forms a plasma (i.e., creates a plasma where none existed) and then increases an ionization rate so that the formation of a strongly-ionized plasma occurs without forming an arc. Accordingly, the function of the claimed means is to generate a pulse that *forms* a plasma, meaning that the pulse must ignite a feed gas to create the plasma.

PO Resp. 21.

Gillette asserts that the Specification of the '155 patent teaches that the voltage pulse can form weakly-ionized plasma and strongly-ionized plasma, and that “even if a plasma had already been ignited, application of a

voltage pulse to the existing plasma can *form additional* plasma that did not exist previously.” Reply 8 (citing Ex. 1101, 2:10–17, 2:25–27, Figs. 6A, 6B, 7A, 7B, 10; Ex. 1124 ¶¶ 38–44 (Dr. John C. Bravman’s Declaration)). Gillette points out that the next element in claim 17 refers to the same voltage pulse, and states that it is used in the “formation” of a strongly-ionized plasma, confirming that “forms a plasma” refers to both weakly- and strongly-ionized plasma. *Id.*; Ex. 1124 ¶ 42; *see also* PO Resp. 21, n.36 (stating claim 17 “also uses the word ‘form’ to refer to the birth of a strongly-ionized plasma, because the claimed ‘strongly’ ionized plasma is not created until the ion density is increased to create the conditions of a ‘strongly-ionized’ plasma.”). Gillette agrees with, and utilizes, our construction set forth in our Decision on Institution to analyze the ground in the trial. Reply 8 (stating “Board’s originally adopted construction is correct”); Ex. 1124 ¶¶ 43–44.

We agree with Gillette that “forms a plasma” is not limited to forming the *initial* plasma, but also encompasses formation of additional plasma, which is consistent with the Specification of the ’155 patent and claim 17 as noted by Gillette above. We, therefore, continue to construe the function of the “means for generating a voltage pulse that forms a plasma between the anode and the cathode” in light of the Specification as “means for generating a voltage pulse that forms a plasma between the anode and the cathode.”

Gillette submits that the corresponding structure for the recited function is “the power supply of Fig. 10 and the accompanying text.” Pet. 6. Zond originally proposed the structure to be “an energy store such as shown [in Figures 10–13 of the ’155 patent] for storing sufficient energy to

generate a pulse to form a strongly ionized plasma, and switching mechanisms for controllably releasing the stored energy as a voltage pulse, and equivalent structures.” Prelim. Resp. 12. In light of Zond’s newly proposed construction of the term “forms,” Zond now proposes the corresponding structure to be “an energy store and switching mechanism that are coupled to a cathode and anode assembly that is filled with feed gas (not a pre-existing plasma).” *Id.* at 22.

Figures 10–13 illustrate schematic diagrams for admitted prior art pulsed power supplies. *See* Ex. 1101, Figs. 10–13 (identifying figures as “prior art”). The descriptions of the pulsed power supplies shown in Figures 10–13 have, in common, a structure to store energy and to release that energy as a voltage pulse that forms a plasma between the anode and the cathode. *See* Prelim. Resp. 12;⁴ Ex. 1101, 21:14–36 (describing pulsed power supply 552 in Figure 10 as including input voltage 554 that charges a bank of capacitors 556, and a parallel bank of high-power solid state switches 558 to release energy stored in capacitors 562 through structures that provide voltage pulses across outputs that are coupled to a cathode and an anode); *id.* at 21:37–67 (describing pulsed power supply 602 in Figure 11 as including capacitors and switches for providing power to a magnetic compression network); *id.* at 22:1–16 (describing pulsed power supply in Figure 12 as including a Blumlein generator and a very fast high-power

⁴ The Patent Owner Preliminary Response and the Patent Owner Response cite to exhibits as being in the 1000 range rather than the 1100 range, for example, the ’155 patent as exhibit 1001 rather than 1101. We will refer to the 1100 range for the exhibits.

switch to discharge the charge through a plasma load); *id.* at 22:17–29 (describing pulsed power supply in Figure 13 as including capacitors and switches to discharge stored energy from capacitors).

Given this disclosure in the ’155 patent and our identification of the function performed by this means clause to encompass formation of weakly and strongly-ionized plasma, we continue to identify the corresponding structure for performing the recited function—“generating a voltage pulse that forms a plasma between the anode and the cathode”—to be an energy store, such as a capacitor, for storing sufficient energy to generate a pulse to form a plasma and switching mechanisms for releasing the stored energy as a voltage pulse. Dec. 13–14. We decline to limit the corresponding structure to “a cathode and anode assembly that is filled with feed gas (not pre-existing plasma)” because the claim language for this element is not so limited.

3. *“means for controlling an amplitude and a rise time of the voltage pulse to increase an ionization rate of sputtered material atoms 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”*

In our Decision on Institution, we observed that the recited function for this claim element is “controlling an amplitude and a rise time of the voltage pulse to increase an ionization rate of sputtered material atoms 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.” Dec. 14. We also identified the corresponding structure for performing the recited function—“controlling an amplitude and a rise time

of the voltage pulse to increase an ionization rate of sputtered material atoms 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”—to be a power supply that is programmed to cause emission of pulses having a shape that achieves the claimed function. *Id.* at 16.

Subsequent to institution, Zond seeks a further clarification of our construction in light of our comparison of our construction to the prior art. PO Resp. 23–32.⁵ Zond takes issue with our claim construction as not encompassing the broadest reasonable interpretation. *Id.* at 24. 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.*

⁵ Zond contends that our use of Figure 3 of the ’155 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. 23–24. 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. 28–29. As Gillette acknowledges, both Figure 3 and Figure 8 of the ’155 patent, which Zond asserts describes “the compelling advantages of combining *voltage amplitude* control with *voltage rise time* control,” PO Resp. 17, 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 6–7. 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, 13:44–56, 18:40–50; Reply 7.

Zond asserts that Gillette’s declarant, Mr. Richard DeVito, agrees that this limitation requires a target *voltage* level or set point. *Id.* at 25 (citing Ex. 2102, 173:14–174:20). Zond also utilizes the Eronini⁶ 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. 25–27. Zond concludes that

The proper interpretation of the claim function requires that the claimed means for controlling an *amplitude* and *rise* time of the voltage pulse is directed to specifically controlling these parameters to desired levels or set points such as shown in the specification, and not to a mere variation or manipulation that may occur incidental to the control of another variable, such a power. In other words, the function of the claimed means is not a mere variation or manipulations in voltage that may occur as a supply *controls power* to a target level. It is the control of voltage amplitude and rise time to target levels or set points as explained in the specification.

Id. at 27. Therefore, Zond construes the function as follows:

Claim Language at Issue	Proposed Construction
Controlling and amplitude and rise time of the voltage pulse to increase an ionization rate of sputtered ion material atoms so that a rapid increase in electron density and a formation of a strongly ionized plasma occurs without forming an arc ...”	Directing or restraining the controlled variables of voltage amplitude and voltage rise time to target levels to cause an increase an ionization rate of sputtered ion material atoms so that a rapid increase in electron density and a formation of a strongly ionized plasma occurs without forming an arc.

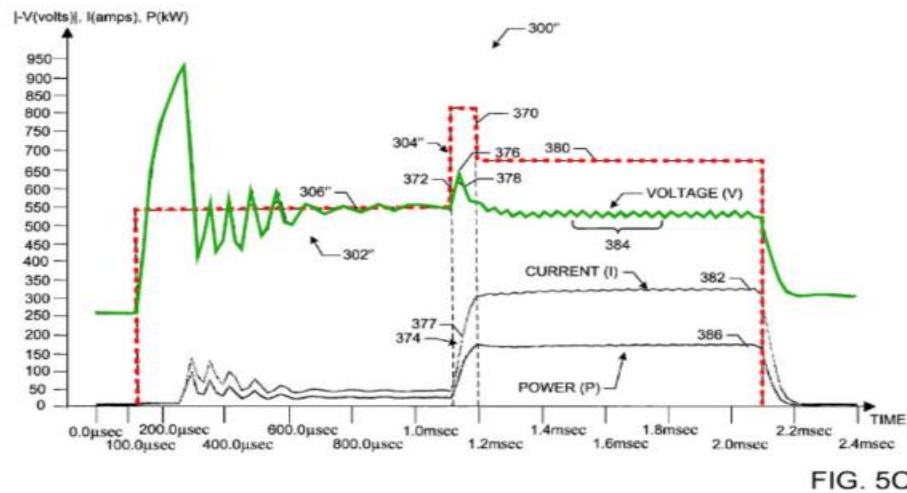
⁶ Eronini Umez-Eronini, SYSTEM DYNAMICS AND CONTROL 10–13 (1999) (Ex. 2010).

Zond points to Figure 5C of the '155 patent as exemplary of a power supply programmed to direct the voltage amplitude to successive target levels or set points 306, 370, 380. PO. Resp. 28. Zond states 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*.” *Id.* at 30. Therefore, according to Zond, the claimed control function requires that the amplitude and rise time variables be the controlled variables, and not manipulated incidental to some other process variable, such as power. *Id.* at 30–31.

Gillette counters that Zond’s newly proposed construction is unsupported by the Specification of the '155 patent. Reply 5. For instance, Gillette asserts that the '155 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 for the function of the means element.

Dr. Bravman testifies that Figure 5C of the '155 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 '155 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''.



Annotated Figure 5C of the '155 patent (Ex. 1001): Target voltage pulse is shown in dotted red line and the actually generated voltage pulse is shown in green.

Ex. 1124 ¶ 56. We also agree with Dr. Bravman that for every figure in the '155 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. 17), the actual generated voltage pulse deviates significantly from the desired target voltage pulse. See Ex. 1124 ¶¶ 55–57. Therefore, based on the Specification of the '155 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.” Ex. 1026 ¶ 58.

We continue to construe the recited function for this claim element as “controlling an amplitude and a rise time of the voltage pulse to increase an ionization rate of sputtered material atoms 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.”

Gillette submits that the corresponding structure for that recited function should be defined in relation to the pulsed power supply in Figure 12 because this is the only example where controlling amplitude and rise time is described. Pet. 6 n.3. Therefore, in referring to Figure 12 of the '155 patent, Gillette asserts that the corresponding structure is “a pulsed power supply 652 with a Blumlein generator 654 that ‘can deliver short duration high voltage pulses with a fast rise time and a relatively flat top.’” *Id.* at 6.

Using its unsupported construction of the function of the means element, Zond asserts that the corresponding structure that performs the claimed function “is a programmable power supply that *controls* the voltage amplitude and voltage rise time by selecting under program control a target voltage level and a selected energy output mode” PO Resp. 32.

The Specification of the '155 patent describes the pulsed power supply as generating waveforms that create and sustain the high-density plasma with current-voltage characteristics in the high-current regime. Ex. 1101, 5:58–62. This power supply “can be programmed to generate voltage pulses having various shapes.” *Id.* at 6:11–12. Figures 5A through 5C reflect “measured data 300, 300”, and 300” of other illustrative multi-stage voltage pulses 302, 302', and 302" generated by the pulsed power supply.” *Id.* at 2:7–9, 11:55–57. The desired pulse shapes from the pulsed power supply are shown superimposed in dotted lines 304, 304', and 304" that show idealized rectangular pulses. *Id.* at 11:57–61, Figs. 5A–5C.

Given this disclosure in the '155 patent, we continue to identify the corresponding structure for performing the recited function—“controlling an amplitude and a rise time of the voltage pulse to increase an ionization rate

of sputtered material atoms 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”—to be a power supply that is programmed to cause emission of pulses having a shape that achieves the claimed function. See Dec. 16.

4. *“means for sustaining the strongly-ionized plasma for greater than 200 μ sec”*

In our Decision on Institution, we observed that the recited function for this claim element is “sustaining the strongly-ionized plasma for greater than 200 μ sec.” Dec. 16. Gillette submitted that the corresponding structure for that recited function is “a pulsed power supply configured to meet the following two conditions: (1) the rise time of the voltage in a transient regime must be sufficient to shift the electron energy distribution of the initial plasma to higher energies to generate ionizational instability that drives the plasma into a transient non-steady state condition; and (2) supplying a sufficient amount of uninterrupted power to drive the plasma from the transient non-steady state to a strongly-ionized state.” Pet. 7. Zond proposed that the corresponding structure is “a specially programed controller that is programed to include a stage similar to stage 380 [shown in Figure 5C] for sustaining the strongly-ionized plasma, and equivalents.” Prelim. Resp. 18.

We found that although the parties used different verbiage to describe the corresponding structure, both parties pointed to descriptions of a high-current regime for sustaining the strongly-ionized plasma. See Ex. 1101, 13:64–67; 15:22–25. We were persuaded, however, that Gillette provided a

more accurate construction for inclusion of all corresponding structure as found in the express descriptions provided in the Specification of the '155 patent.

In explaining Figure 5A, the Specification of the '155 patent provides that:

In order to sustain a strongly-ionized plasma in the high-current regime corresponding to the current-voltage characteristic 154 of FIG. 2 [shown above on page 4] at least two conditions must be satisfied. The first condition is that the rise time of a voltage in a transient region must be sufficient to shift the electron energy distribution of the initial plasma to higher energies to generate ionizational instability that drives the plasma into a transient non-steady state condition. The second condition is that the pulsed power supply must supply a sufficient amount of uninterrupted power to drive the plasma from the transient non-steady state to a strongly-ionized state corresponding to the current-voltage characteristic 154 of FIG. 2.

Ex. 1101, 13:44–56. Figure 5A also shows a duration of about 1.0 msec for the high-power stage 320, in which there is a sufficient amount of uninterrupted power to drive the weakly-ionized plasma from the transient non-steady state to a strongly-ionized state. *See id.* at 13:64–14:4, Fig. 5A.

Given this disclosure in the '155 patent, we identified the corresponding structure for performing the recited function—“sustaining the strongly-ionized plasma for greater than 200 μ sec”—to be a pulsed power supply configured to meet the following two conditions: (1) the rise time of the voltage in a transient regime must be sufficient to shift the electron energy distribution of the initial plasma to higher energies to generate ionizational instability that drives the plasma into a transient non-steady state condition; and (2) supplying a sufficient amount of uninterrupted

power to drive the plasma from the transient non-steady state to a strongly-ionized state. *See* Dec. 17. The parties do not challenge our claim construction as to this term. PO Resp. 18–32; Reply 4–8. Upon review of the present record, we discern no reason to change our claim construction.

5. “*strongly-ionized plasma*”

Independent claim 17 and dependent claim 19 recite “strongly-ionized plasma.” In its Preliminary Response, Zond proposed that the claim term “strongly-ionized plasma” should be construed as “a plasma with a relatively high peak density of ions.” Prelim. Resp. 19 (citing Ex. 1101, 7:13–14 (referring to strongly-ionized plasma as a “high-density plasma”); *id.* at 8:4–5 (stating “peak plasma density can be controlled by controlling the slope of the rise time of the voltage pulse”)). In the Decision on Institution, we adopted Zond’s proposed construction, in light of the Specification, as the broadest reasonable interpretation. Dec.18; Ex. 1101, 7:15–19. We construed the claim term “strongly-ionized plasma” as “a plasma with a relatively high peak density of ions.” Dec. 9.

Subsequent to institution, notwithstanding that neither Zond, nor its expert witness, expressly challenged our claim construction as to this term (PO Resp. 18–31; 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. 4–5. 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, and that the cross-examination testimony of Gillette’s declarant, Mr. DeVito, in which he is discussing our construction, confirms that he agrees that 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. Bravman, also confirms that weakly-ionized and strongly-ionized plasma are relative terms, as the ’155 patent uses overlapping ranges of plasma density to describe them (*see* Ex. 1124 ¶¶ 30–31 (citing Ex. 1101, 7:15–19)), 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.* ¶ 29. Dr. Bravman also notes that strongly-ionized plasma is the same as high-density plasma. *Id.* ¶ 32 (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 construction set forth in the Decision on Institution with respect to this claim term, which adopted Zond’s originally proposed construction. Dec. 18. Therefore, for purposes of this Final Written Decision, we construe, in light of the Specification, the claim term

“a strongly-ionized plasma” as “a plasma with a relatively high peak density of ions.”

6. “*without forming an arc*”

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

Specifically, Zond asserts that a key claim element 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. 5. Zond describes Figure 4 as set forth in the ’155 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 11, 13 (“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 15 (stating Figs 5A–5C show rapidly achieving a strongly-ionized plasma without arcing).

Finally, Zond identifies Figure 8 of the ’155 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. 17.

First, although Zond acknowledges that “Wang’s teachings of arc reduction during ignition are inapposite to the ’155 patent’s requirement of avoiding arcing during the rapid increase in electron density and a formation of the strongly-ionized plasma” (*id.* at 3–4), Zond faults Wang’s alleged teaching that arcing was unavoidable upon plasma ignition (*id.* at 17). Zond is attempting to import improperly a limitation not in the claims.

Independent claim 1 requires formation of a strongly-ionized plasma without forming an arc, but does not require the ignition or the formation of a weakly-ionized plasma occur without forming an arc. *See* Ex. 1101, 22:45–53; *Renishaw*, 158 F.3d at 1249; *E.I. du Pont de Nemours*, 849 F.2d at 1433.

The Specification of the ’155 patent contains only a few references to arcing. For instance, the Specification of the ’155 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, 4:9–18 (emphasis added). In describing Figure 2, the Specification of the '155 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.” Ex. 1101, 5:25–30.

The Specification of the '155 patent also describes other ways to reduce arcing. For instance, the '155 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. The Specification of the '155 patent states that “[t]he gap can reduce the probability that an electrical breakdown condition (i.e., arcing) will develop in the chamber 104.” *Id.* at 19:31–33, 20:36–37 (stating “[t]he 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. 1–17; *see also* Ex. 1121, 188–89 (Dr. Hartsough stating “[o]ne can’t say that an arc would never occur in a system like this”).

Here, nothing in the Specification indicates that *no* arcing occurs in the formation of the strongly-ionized plasma. Rather, it explicitly states that such a *probability* may be minimized or eliminated. Ex. 1101, 4:8–10. 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.

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. A prima facie case of obviousness is established when the prior art itself would appear to have suggested the claimed subject matter to a person of ordinary skill in the art. *In re Rinehart*, 531 F.2d 1048, 1051 (CCPA 1976). The level of ordinary skill in the art is 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 ground of unpatentability in accordance with the above-stated principles.

*C. Claims 17–19 – Obviousness over Wang, Kudryavtsev,
and Admitted Prior Art*

Gillette asserts that claims 17–19 are unpatentable under 35 U.S.C. § 103(a) as obvious over the combination of Wang, Kudryavtsev, and Applicant’s admitted prior art in the specification of the ’155 patent, namely, Figures 10–13 and their descriptions. Pet. 14–30. 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 declarations of Mr. DeVito (Ex. 1105) and Dr. Bravman (Ex. 1124). Pet. 14–30; Reply 9–15.

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. 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:

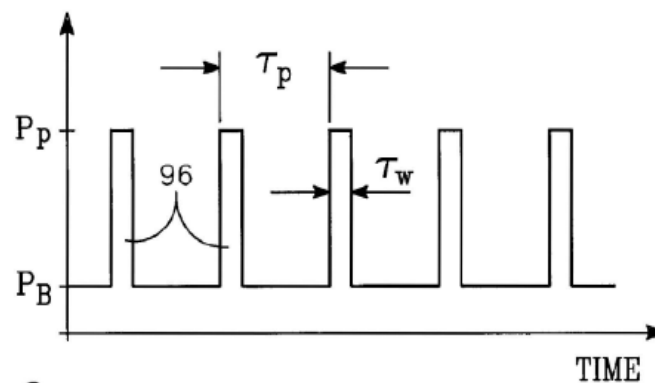


FIG. 6

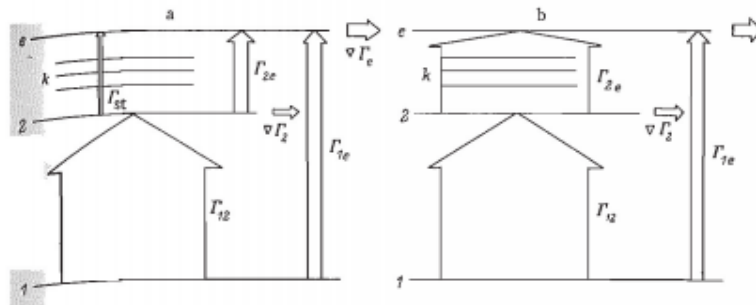
Figure 6 is a timing diagram of a method of pulsing the target of the reactor. As shown in Figure 6 of Wang, the target is maintained at background power level P_B between high power pulses 96 with peak power level P_P . *Id.* at 7:13–39. Background power level P_B exceeds the minimum

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.*; Ex. 1105 ¶ 86. According to Mr. DeVito, when the power level of Wang's pulse changes from the background power, P_B , to the peak power, P_p , the ionization rate of sputtered material increases such that a strongly-ionized plasma is formed. Ex. 1105 ¶ 115.

Kudryavtsev

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. 1108, 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. 1105 ¶ 117), and 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.

Id. (quoting Ex. 1108, 31, right col., ¶ 6 (emphasis added)). 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. 1108, 30, Abs., Fig. 6.

Means for Generating a Voltage Pulse that Forms a Plasma Between the Anode and the Cathode⁷

Zond asserts that Wang does not teach a means that generates a pulse that can form a plasma without arcing because in Figure 6 of Wang, a plasma was already formed before Wang’s power pulses were applied, and in Figure 4, where the power pulses ignite a plasma, the plasma arcs. PO Resp. 47–48. Zond also asserts that Kudryavtsev uses a pre-ionizing current to form a plasma, and only applies a pulse to the electrode after the plasma is formed. *Id.* at 54. Therefore, according to Zond, neither Wang nor

⁷ Zond does not challenge that Wang teaches a “means for supplying feed gas proximate to an anode and a cathode assembly.” Gillette addresses how this claim element is met by Wang. See Pet. 15–18; Ex. 1105 ¶¶ 105–110. We agree with Gillette’s analysis and are persuaded that Wang teaches this element.

Kudryavtsev discloses the claimed means for generating a “pulse that forms a plasma.”

Because we do not construe “forms” to be limited to forming the initial weakly-ionized plasma, but includes forming additional plasma, such as strongly-ionized plasma, Zond’s arguments are not well-taken. Under our construction of “means for generating a voltage pulse that forms a plasma between the anode and the cathode,” Wang or the admitted prior art provides such teaching. See Ex. 1101, 21:14–36; Ex. 1102, 1:42–46, 5:17–36; Ex. 1105 ¶¶ 111–112; Ex. 1124 ¶¶ 38–44, 77–81.

Means for Controlling an Amplitude or Rise Time of the Voltage Pulse

Gillette relies upon Wang to disclose all of the limitations recited in claims 17–19. Pet. 15–30; Ex. 1105 ¶¶ 104–136. Gillette relies on Kudryavtsev to provide further support for teaching “means for controlling an amplitude and a rise time of the voltage pulse to increase an ionization rate of sputtered material atoms 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.” Pet. 21–23. Gillette asserts,

[l]ike 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 16 (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 22 (citing Ex. 1105 ¶ 118). Gillette concludes that

One of ordinary skill would have been motivated to use Kudryavtsev's explosive ionization in Wang so as to increase plasma density and thereby increase the sputtering rate. Use of Kudryavtsev's teaching in Wang would have been a combination of old elements that yielded the predictable results of rapidly increasing the ionization rate and electron density, which is known to be a desirable result.

Id. at 22 (citing Ex. 1105 ¶ 118).

Gillette also relies on Figure 12 of the '155 patent, admitted prior art. PO Resp. 19–20. Gillette concludes that

[t]o the extent it is said that Wang or Kudryavtsev or the combination thereof does not disclose the structure of FIG. 12, one of ordinary skill in the art would have found it obvious to use the prior art pulsed power supply structure of FIG. 12 in Wang, because doing so would have been the use of a known structure for a known and predictable purpose.

Id. at 23–24.

Zond disputes that either Wang or Kudryavtsev teaches the claimed means for generating a strongly-ionized plasma. PO Resp. 33. 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. 50; Ex. 2014 ¶¶ 104–105.

In its Reply, Gillette asserts that Zond concedes that all the elements in claim 17 are met by the prior art except “means that generates a pulse that can form a plasma without arcing” and “the means for controlling the amplitude and rise time of the voltage pulse.” Reply 2 (citing Ex. 1121 (Dr. Hartsough’s Deposition testimony), 80:23–81, 84:25–86:23, 87:15–21, 82:17–23, 196:19–197:1, 200:19–21). Gillette points to Dr. Hartsough’s testimony admitting that Figure 10 in the ’155 patent shows a prior art power supply that can generate voltage pulses according to the invention described in the ’155 patent. *Id.* at 3–4 (citing Ex. 1023, 84:25–86:23) (“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.”).

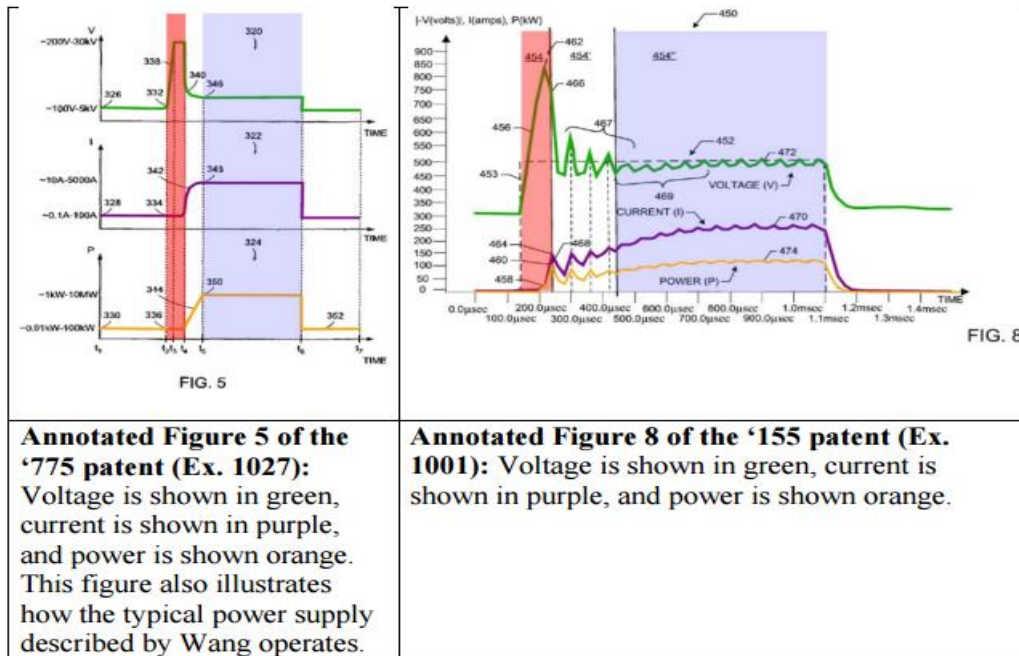
We start our analysis with where the parties appear to agree on what the prior art teaches. For instance, referring to Figure 1 of Wang set forth above, Wang discloses a pulsed magnetron sputtering device having an anode 24, a cathode 14, a movable magnet assembly 40, a DC power supply 100 (shown in Figure 7, not reproduced here), and a pulsed DC power supply 80. Ex. 1105 ¶ 85 (citing Ex. 1002, Figs. 1 and 7, 3:57–4:55, 7:56–8:12).

We find Zond’s contention that Wang focuses on *power* pulses throughout its disclosure, not a *voltage* pulse, is misplaced. See PO Resp. 33–37. 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. 23 (citing Ex. 1102, 7:61–62 (emphasis added), Fig. 7). Mr. DeVito explains that “[a]pplication of those voltage pulses to Wang’s cathode/target 14, with respect to the grounded anode 24, produces Wang’s peak power pulses, P_p .” Ex. 1105 ¶ 120.

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. 1124 ¶ 71. Therefore, to generate a power pulse, a power supply first provides a voltage pulse with a specific amplitude and rise time. *Id.* ¶ 72. 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.* ¶ 73 (quoting Ex. 1102, 5:32–35).

Dr. Bravman points to Dr. Hartsough’s testimony that Figure 5 of U.S. Patent No. 6,896,775 assigned to Zond, illustrates a typical power supply also as described in Wang. *Id.* ¶ 74 (citing Ex. 1122, 149:22–150:20). Dr. Bravman testifies that, in his opinion, Figure 5 of the ’775 patent behaves in nearly identical manner as Figure 8 of the ’155 patent, reproduced below with annotations by Dr. Bravman.



Id. ¶ 76. 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 ’155 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 teaches “means for controlling an amplitude and a rise time of the voltage pulse to increase an ionization rate of sputtered

material atoms 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. 51–54. Zond argues that because Wang admits arcing occurs upon plasma ignition with his power control technique and that Figure 6 of Wang, which uses a background power so arcing would be significantly *reduced*, but not eliminated, Wang does not teach the “lack of arcing” limitation. This particular argument of Zond is not well-taken because as we have stated in our claim construction, given the disclosure in the Specification of the ’155 patent, 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. 54–58. Zond points to the lack of teaching for Kudryavtsev’s specially designed electric circuit to shed light on any control of the amplitude and rise time of the voltage pulse. *Id.* at 55–57. Therefore,

according to Zond, Kudryavtsev does not teach the lack of forming an arc between the anode and cathode assembly. *Id.* at 57–58.

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 2–3 (citing Ex. 1102, 7:49–51; Ex. 1122, 89:8–24). Gillette also disagrees that Kudryavtsev causes an arc condition. *See* Ex. 1124 ¶¶ 83–84.

The evidence before us supports Gillette’s position by a preponderance of the evidence that the combination of Wang and Kudryavtsev discloses the claim feature. *See* Pet. 24 (citing Ex. 1105 ¶¶ 124–125). As Gillette notes, Wang explains that arcing may occur during plasma ignition before the first pulse shown in Figure 6. *Id.* (citing Ex. 1102, 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. 1102, 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:

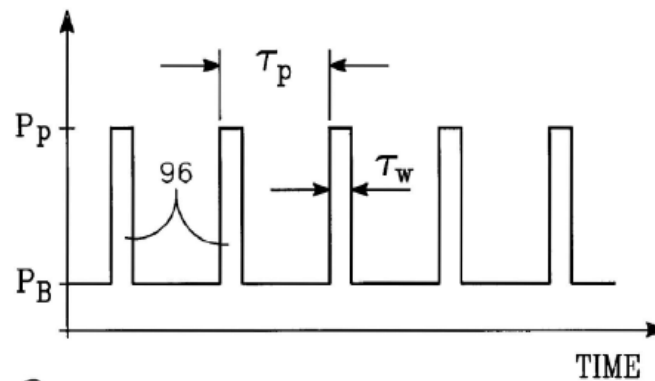


FIG. 6

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. 1102, 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, the likelihood of arcing would be significantly reduced during subsequent applications of the background and peak power levels, P_B and P_p .” Ex. 1105 ¶ 125.

We agree with Gillette that Wang teaches the avoidance of arcing, as Dr. Hartsough admits, and Kudryavtsev does not teach arcing as Zond asserts. See Ex. 1108, 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 teaches a means for controlling an amplitude and a rise time of the voltage pulse to increase an ionization rate of sputtered material atoms 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.

Rationale to Combine Wang and Kudryavtsev

Zond does not address specifically Gillette's proffered rationale to combine Wang and Kudryavtsev. 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 Mr. DeVito. Pet. 21–22; Ex. 1105 ¶¶ 117–119. Upon consideration of the evidence before us, we are persuaded by Gillette's contentions.

Dependent Claim 19⁸

Zond also asserts that claim 19's added requirement that the voltage pulse have a lifetime greater than about 200 µsecs, is not taught by Wang because Wang does not show the current and thus, no way exists to determine whether Wang's pulses sustain the plasma for the pulse duration.

⁸ Zond does not challenge that claim 18 is met by the prior art combination of the ground. Gillette supports its assertion that claim 18 is unpatentable over the prior art combination. See Pet. 25–30 (citing supporting evidence). We agree with Gillette and are persuaded that Gillette has demonstrated by a preponderance of the evidence that claim 18 is unpatentable over the combination of Wang, Kudryavtsev, and the admitted prior art.

PO Resp. 58–60. Gillette asserts that Wang teaches the added limitations of claim 19 because Dr. Hartsough admits that Wang’s typical power supplies can be schematically represented by Figure 5 of the ’755 patent, as set forth above. Reply 14–15.

As shown in Figure 5, Wang’s typical power supply sustains the current throughout the duration of Wang’s power pulse. Ex. 1124 ¶ 109. Also, as Mr. DeVito notes, Wang teaches that the pulse width can be as high as 1 ms, which is five times longer than the claim’s 200 µsecs. Ex. 1105 ¶ 133 (citing Ex. 1102, 5:45–48). We agree with Gillette’s arguments and credit the testimony of Dr. Hartsough, Dr. DeVito, and Dr. Bravman as consistent with the Specification of the ’155 patent and the knowledge of one of skill in the art.

III. CONCLUSION

For the foregoing reasons, we conclude that Gillette has demonstrated, by a preponderance of the evidence, that claims 17–19 of the ’155 patent are unpatentable over the combination of Wang, Kudryavtsev, and the admitted prior art.

IV. ORDER

In consideration of the foregoing, it is
ORDERED that claims 17–19 of the ’155 patent are held
unpatentable; and

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.

IPR2014-00479
Patent 8,125,155 B2

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