

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

THE GILLETTE COMPANY, FUJITSU SEMICONDUCTOR
LIMITED, and FUJITSU SEMICONDUCTOR AMERICA, INC.,
Petitioner,

v.

ZOND, LLC,
Patent Owner.

Case IPR2014-00578¹
Patent 6,896,775 B2

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

TURNER, *Administrative Patent Judge.*

FINAL WRITTEN DECISION

Inter Partes Review

35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

The Gillette Company (“Gillette”) filed a Petition requesting *inter partes* review of claims 1–29 of U.S. Patent No. 6,896,775 B2 (“the ’775

¹ IPR2014-01494 has been joined with IPR2014-00578.

Patent”). Paper 9 (“Pet.”)². Patent Owner Zond, LLC (“Zond”) filed a Preliminary Response. Paper 11 (“Prelim. Resp.”). We instituted the instant trial on October 15, 2014, pursuant to 35 U.S.C. § 314. Paper 13 (“Dec.”).

Subsequent to institution, we granted a revised Motion for Joinder filed by Taiwan Semiconductor Manufacturing Company, Ltd., TSMC North America Corp., (collectively, “TSMC”), Fujitsu Semiconductor Limited, and Fujitsu Semiconductor America, Inc. (collectively, “Fujitsu”), joining Case IPR2014-01494 with the instant trial (Paper 17), and also granted a Joint Motion to Terminate with respect to TSMC (Paper 46). Zond filed a Response (Paper 39 (“PO Resp.”)), and Gillette³ filed a Reply (Paper 48 (“Reply”)). Oral hearing⁴ was held on May 26, 2015, and a transcript of the hearing was entered into the record. Paper 58 (“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 1–29 of the ’775 Patent are unpatentable under 35 U.S.C. § 103(a).

A. Related District Court Proceedings

The parties indicate that the ’775 Patent was asserted in *Zond, LLC v. Advanced Micro Devices, Inc.*, No.1:13-cv-11567-DJC (D. Mass.), and

² We refer generally to the Revised Petition filed in response to defects noted in the Notice of Filing Date Accorded the Petition (Paper 4).

³ We refer to Gillette and Fujitsu collectively as “Gillette” herein.

⁴ The hearings for this review and IPR2014-00604 were consolidated.

identify other proceedings in which Zond asserted the '775 Patent. Pet. 1; Paper 7.

B. The '775 Patent

The '775 Patent relates to methods and apparatus for generating magnetically enhanced plasma. Ex. 1001, Abs. At the time of the invention, sputtering was a well-known technique for depositing films on semiconductor substrates. *Id.* at 1:14–25. The '775 Patent indicates that prior art magnetron sputtering systems deposit films having low uniformity and poor target utilization (the target material erodes in a non-uniform manner). *Id.* at 3:34–44. To address these problems, the '775 Patent discloses that increasing the power applied between the target and anode can increase the uniformity and density in the plasma. *Id.* at 3:45–56. However, increasing the power also “can increase the probability of generating an electrical breakdown condition leading to an undesirable electrical discharge (an electrical arc) in the chamber 104.” *Id.*

According to the '775 Patent, forming a weakly-ionized plasma substantially eliminates the probability of establishing a breakdown condition in the chamber when high-power pulses are applied between the cathode and anode. *Id.* at 7:4–15. Once the weakly-ionized plasma is formed, high-power pulses are applied between the cathode and anode to generate a strongly-ionized plasma from the weakly-ionized plasma. *Id.* at 7:16–24. The '775 Patent also discloses that the provision of the feed gas to the plasma allows for homogeneous diffusion of the feed gas in the

weakly-ionized plasma and allows for the creation of a highly uniform strongly-ionized plasma. *Id.* at 5:59–67.

C. Illustrative Claims

Of the challenged claims, claims 1 and 15 are the only independent claims. Claims 2–14 and 16–29 depend, directly or indirectly, from claims 1 or 15. Claims 1 and 15, reproduced below, are illustrative:

1. A magnetically enhanced plasma processing apparatus comprising:

an anode;

a cathode that is positioned adjacent to the anode and forming a gap there between;

an ionization source that generates a weakly-ionized plasma proximate to the cathode;

a magnet that is positioned to generate a magnetic field proximate to the weakly-ionized plasma, the magnetic field substantially trapping electrons in the weakly-ionized plasma proximate to the cathode;

a power supply that produces an electric field across the gap, the electric field generating excited atoms in the weakly-ionized plasma and generating secondary electrons from the cathode, the secondary electrons ionizing the excited atoms, thereby creating a strongly-ionized plasma comprising a plurality of ions; and

a voltage supply that applies a bias voltage to a substrate that is positioned proximate to the cathode, the bias voltage causing ions in the plurality of ions to impact a surface of the substrate in a manner that causes etching of the surface of the substrate.

15. A method of magnetically enhanced plasma processing, the method comprising:

ionizing a feed gas to generate a weakly-ionized plasma proximate to a cathode;

generating a magnetic field proximate to the weakly-ionized plasma, the magnetic field substantially trapping electrons in the weakly-ionized plasma proximate to the cathode;

applying an electric field across the weakly-ionized plasma that excites atoms in the weakly-ionized plasma and that generates secondary electrons from the cathode, the secondary electrons ionizing the excited atoms, thereby creating a strongly-ionized plasma comprising a plurality of ions; and

applying a bias voltage to a substrate that is positioned proximate to the cathode, the bias voltage causing ions in the plurality of ions to impact a surface of the substrate in a manner that causes etching of the surface of the substrate.

Ex. 1001, 21:45–67, 22:46–64.

D. Prior Art Relied Upon

Based on the instituted grounds, Gillette relies upon the following prior art references:

Lantsman	US 6,190,512	Feb. 20, 2001	(Ex. 1025)
Wang	US 6,413,382	July 2, 2002	(Ex. 1008)
Kouznetsov	US 2005/0092596	May 5, 2005	(Ex. 1004)

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. 1002) (hereinafter “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. 1003) (hereinafter “Kudryavtsev”).

N. Li et al., *Enhancement of Aluminum Oxide Physical Vapor Deposition with a Secondary Plasma*, 149 Surface and Coatings Tech. pp. 161–170 (2002) (Ex. 1010) (hereinafter “Li”).

E. Grounds of Unpatentability

We instituted the instant trial based on the following grounds of unpatentability (Dec. 29):

Claim(s)	Basis	References
1–7, 9–16, 18–26, 28, and 29	§ 103(a)	Wang, Mozgrin, and Kudryavtsev
8	§ 103(a)	Wang, Mozgrin, Kudryavtsev, and Kouznetsov
17	§ 103(a)	Wang, Mozgrin, Kudryavtsev, and Lantsman
27	§ 103(a)	Wang, Mozgrin, Kudryavtsev, and Li

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, 1275–79 (Fed. Cir. 2015) (“Congress implicitly approved the broadest reasonable interpretation standard in enacting the AIA,”⁵ and “the standard was properly adopted by PTO regulation.”). Significantly, claims are not interpreted in a vacuum but are

⁵ The Leahy-Smith America Invents Act, Pub. L. No. 112–29, 125 Stat. 284 (2011) (“AIA”).

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).

Claim 1 recites “the electric field generating excited atoms in the weakly-ionized plasma and generating secondary electrons from the cathode, the secondary electrons ionizing the excited atoms, thereby creating a strongly-ionized plasma,” with claim 15 reciting a similar limitation. During the pre-trial stage of this proceeding, the parties submitted their constructions for the claim terms “a weakly-ionized plasma” and “a strongly-ionized plasma.” Pet. 5; Prelim. Resp. 14. In our Decision on Institution, we adopted Zond’s proposed constructions, in light of the Specification, as the broadest reasonable interpretation. Dec. 7–9.

In addition, we considered a specific construction for “ionizing a feed gas,” recited in claim 15, but we were not persuaded that the claim term required a specific construction, and instead relied on its ordinary and customary meaning as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *Id.* at 10.

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 these claim terms. *Id.* at 7–10. Therefore, for purposes of this Final Written Decision, we construe, in light of the Specification, the claim term “a weakly-ionized plasma” as “a plasma with a relatively low peak density of ions,” the claim term “a strongly-ionized plasma” as “a plasma with a relatively high peak density of ions,” and provide no explicit construction for “ionizing a feed gas.”

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; *Translogic*,

504 F.3d at 1259. We analyze the asserted grounds of unpatentability in accordance with the above-stated principles.

C. Claims 1–7, 9–16, 18–26, 28, and 29—Obviousness over the Combination of Wang, Mozgrin, and Kudryavtsev

Gillette asserts that claims 1–7, 9–16, 18–26, 28, and 29 are unpatentable under 35 U.S.C. § 103(a) as obvious over the combination of Wang, Mozgrin, and Kudryavtsev. Pet. 36–57. 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. Richard DeVito (Ex. 1011). Gillette also submitted a Declaration of Dr. John Bravman (Ex. 1031) to support its Reply to Zond’s Patent Owner Response.

Zond responds that the combinations of prior art do not disclose every claim element. PO Resp. 35–59. Zond also argues that there is insufficient reason to combine the technical disclosures of Wang, Mozgrin, and Kudryavtsev. *Id.* at 16–35. To support its contentions, Zond proffers a Declaration of Dr. Larry D. Hartsough (Ex. 2006).

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.

Wang

Wang discloses a power pulsed magnetron sputtering apparatus for generating a very high plasma density. Ex. 1008, 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:

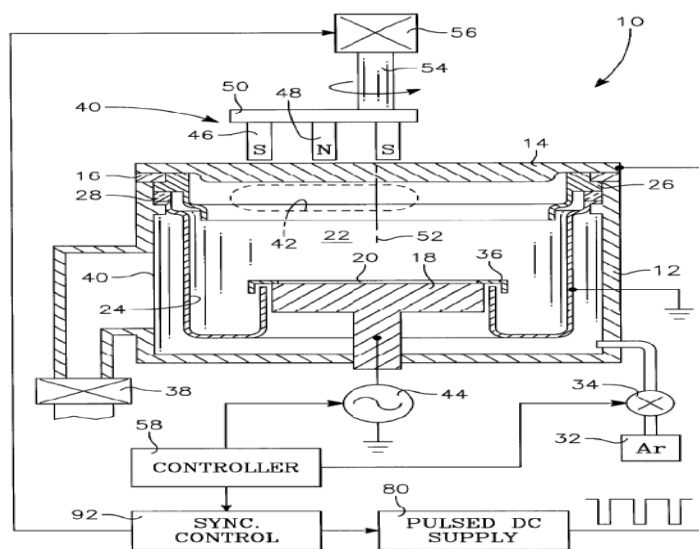


Fig. 1 of Wang illustrates its magnetron sputtering apparatus.

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, from argon gas feed 32 through mass flow controller 34, which ionizes a substantial fraction of the sputtered particles into positively charged metal ions and also increases the sputtering rate. *Id.* at 4:5–34. 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. Wang also incorporates Fu (Ex. 1014; *see* Ex. 1008, 1:42–49), which Gillette argues discloses a magnetron sputtering system with a gap between the anode and cathode, at the top, that is similar to that described in the '775 Patent and Mozgrin. Pet. 36–37 (citing Ex. 1014, Fig. 1).

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

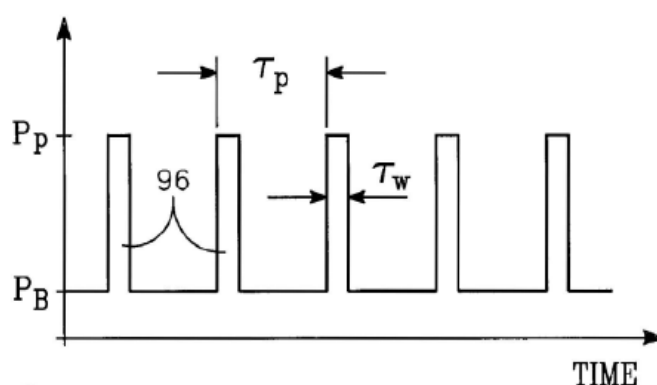


FIG. 6

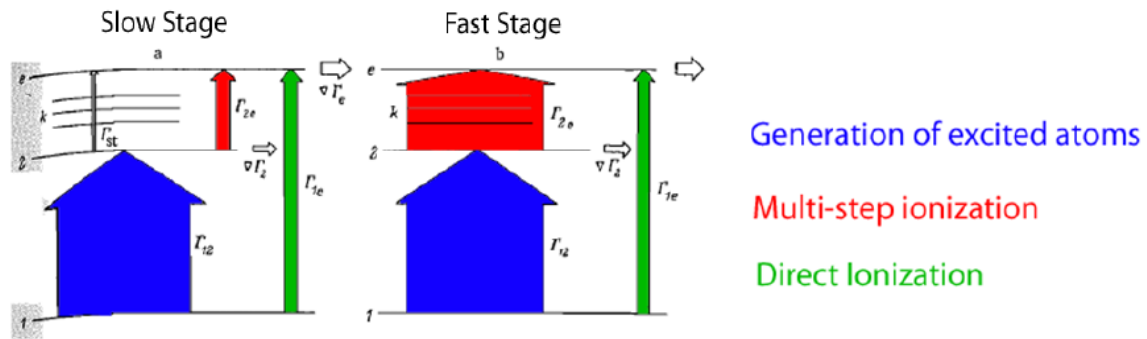
Fig. 6 of Wang illustrates a representation of applied pulses.

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 . Ex. 1008, 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. 1011 ¶¶ 150–156; *see also* Pet. 38–40.

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. 1003, Abs., Figs. 1, 6.

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



Annotated Fig. 1 of Kudryavtsev illustrates stages of ionization.

As shown in annotated 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 notes that under certain conditions multi-step ionization can be the dominant ionization process. Ex. 1011 ¶ 81; Pet. 41.

Specifically, Kudryavtsev discloses:

For nearly stationary n_2 [excited atom density] values . . . *there is 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. 1003, 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.” *Id.* at Abs., Fig. 6.

Rationale to Combine References

Gillette notes that Mozgrin provides for a similar system to that described in Wang (Pet. 37), and that Mozgrin cites to Kudryavtsev such that it would have been obvious to have operated with a high-density plasma to produce secondary electrons, in accordance with Kudryavtsev. Pet. 44. Gillette also argues that the similarities between the systems of Wang and Mozgrin would have made it obvious to have used the system of Wang for etching, as taught by Mozgrin. Pet. 44 (citing Ex. 1002, 403).

Additionally, Gillette argues that it would have been obvious to combine Wang and Kudryavtsev because Kudryavtsev generally discloses the characteristic of ionization whenever a field is applied suddenly to a weakly ionized gas. Pet. 41 (citing Ex. 1003, 34, right col, ¶ 4). The applied pulses of Wang, discussed above, would act to generate suddenly an electric field, and one of ordinary skill reading Wang would have been motivated to consider Kudryavtsev to further appreciate the effects of applying Wang’s pulse. *Id.*

The parties’ dispute mainly centers on whether Gillette has articulated a reason with rational underpinning why one with ordinary skill in the art would have combined the prior art teachings. Zond argues that Gillette fails to demonstrate that one with ordinary skill in the art would have combined

the systems of Wang, Mozgrin, and Kudryavtsev to achieve the claimed invention with reasonable expectation of success or predictable results. PO Resp. 16–35.

In particular, Zond contends that Gillette does not take into consideration the substantial, fundamental structural differences between the systems of Wang, Mozgrin, and Kudryavtsev—e.g., pressure, chamber geometry, gap dimensions, and magnetic fields. *Id.* at 25–35 (citing *e.g.*, Ex. 1002, 401; Ex. 1003, 32, 34, Fig. 3; Ex. 1008, 3:16–22, 60–61, 5:26–27, 43–48, 52–54, 8:41–42; Ex. 2006 ¶¶ 60, 67–72). Additionally, even if a combination was somehow made, Zond argues that it would differ significantly from the system disclosed in the '775 Patent. *Id.*

In its Reply, Gillette responds that Zond's arguments focus on bodily incorporating one system into the other. Reply 5–8. Gillette also responds that Mozgrin demonstrates that the teachings of Kudryavtsev can be successfully applied in different systems with different geometries and conditions. *Id.* at 7–8. Upon consideration of the evidence before us, we are persuaded by Gillette's contentions.

We 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. 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, it was known that increasing the sputter etching rate was desirable and that all three references are directed to that

same common goal. Ex. 1031 ¶¶ 68, 71. Additionally, Kudryavtsev's model on plasma behavior is not intended to be limited to a particular type of plasma apparatus. *Id.* ¶ 72. Indeed, Kudryavtsev discloses a study of the ionization relaxation in plasma when the external electric field suddenly increases. *Id.* Specifically, Kudryavtsev discloses that “the *electron density increases explosively* in time due to accumulation of atoms in the lowest excited states.” Ex. 1003, 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).

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 for improving sputtering and manufacturing processing. Ex. 1031 ¶ 73. Dr. Bravman further explains that such an artisan would have known how to apply Kudryavtsev's model to Wang's system by making any necessary changes to accommodate the differences through routine experimentation. *Id.* ¶¶ 73–74. Mozgrin cites to Kudryavtsev and discloses that in “[d]esigning the unit, we took into account the dependences which had been obtained in [Kudryavtsev] of ionization relaxation on pre-ionization parameters, pressure, and pulse voltage amplitude.” Ex. 1002, 401. Dr. Bravman also explains that this illustrates that one with ordinary skill in the art at the time of the invention was capable of applying the teachings of Kudryavtsev to magnetron sputtering systems, such as Wang's. Ex. 1031 ¶

75. On this record, we credit Dr. Bravman's testimony (*id.* ¶¶ 68–77) because his explanations are consistent with the prior art of record.

For the foregoing reasons, we are persuaded that Gillette has articulated a reason with rational underpinning why one with ordinary skill in the art would have combined Wang, Mozgrin, and Kudryavtsev as indicated in the Petition.

Substrate Positioned Proximate to the Cathode

Claim 1 recites, in part, “a voltage supply that applies a bias voltage to a substrate that is positioned proximate to the cathode,” and claim 15 recites, in part, “applying a bias voltage to a substrate that is positioned proximate to the cathode.” Zond argues that Gillette fails to address this requirement of those claims, and that any combination of Wang, Mozgrin, and Kudryavtsev would result in a system with a significant distance between the anode and the cathode, and an even larger distance from cathode to the sputter target. PO Resp. 36–39.

The problem with Zond's argument arises from determining the meaning of “proximate” in claims 1 and 15. At the Oral Hearing, Zond's counsel stated:

MR. FAHMI: Well, I think if you are looking for an exact measurement, Your Honor, that *you are not going to find it necessarily in the patent*, and it is going to be specified with respect to the other parameters of the system. You know, these systems don't exist in a vacuum. They -- pardon the pun -- *they exist with relative spacings between the elements in order to achieve the result*, in this case the etching result that is specified.

So I think you have to examine the teaching as a whole to understand that what the inventor was trying to achieve was a system in which the high-density plasma could affect that etching, and by maintaining the proximity that's how it was done.

Tr. 48 (emphases added). As such, it is clear that Zond has acknowledged that the '775 Patent provides no specific definition for “proximate” and that “proximate” is determined by whether the system can achieve the desired result of etching of the surface of the substrate.

“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) (citing *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 (A person of ordinary skill [in the art] is also “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.”).

In the instant case, we are persuaded that Wang, Mozgrin, and Kudryavtsev are all directed to plasma processing and that any substrate upon which that processing would be accomplished would need to be “proximate” to the cathode. Any combination of the systems disclosed in

Wang, Mozgrin, and Kudryavtsev would also have a substrate proximate to the cathode as well to provide plasma processing. To place a substrate in a non-proximate location would, according to Zond's statements, not allow that system to affect etching and would frustrate its intended purpose. Therefore, we are persuaded that placement of a substrate so that it is positioned proximate to the cathode would have been obvious to one of ordinary skill in the art in view of Wang, Mozgrin, and Kudryavtsev. Additionally, we are not persuaded that the distances disclosed in those cited references must be incorporated *exactly* into any system formed from the combination.

Based on the evidence before us, we are persuaded that Gillette has demonstrated, by a preponderance of evidence, that the combination of Wang, Mozgrin, and Kudryavtsev discloses a substrate that is positioned proximate to the cathode.

The Steps of Claim 15 Require a Specific Order

Claim 15 recites steps of "ionizing a feed gas to generate a weakly-ionized plasma," and "generating a magnetic field proximate to the weakly-ionized plasma." Zond argues that the Petition is deficient because it fails to demonstrate the method steps of claim 15 in their required, recited order, because the magnetic field in Wang is always on and not generated later, after the formation of the weakly-ionized plasma. PO Resp. 39–42.

Gillette responds that Zond's expert, Dr. Hartsough, acknowledges that claim 15 covers embodiments where the magnetic field is applied prior to feed gas being ionized to form the weakly-ionized plasma. Reply 4–5

(citing Ex. 1001, Figs. 12A, 13A; Ex. 1030, 87:6–18). Gillette also cites to its own expert, Dr. Bravman to support its interpretation of claim 15. Reply 5 (citing Ex. 1031 ¶¶ 97–100). We agree with Gillette’s arguments.

During Oral Hearing, counsel for Zond acknowledged Dr. Hartsough’s testimony and did not dispute that the steps of claim 15 do not require a specific order, but continued to emphasize that if Gillette believed a specific order was required and did not make that case in its Petition, the Petition continues to be deficient. Tr. 50–51. We are not persuaded, however, that a petition must be judged according to its own incorrect metrics. Rule 42.104(b)(4) requires that the petition “must specify where each element of the claim is found in the prior art patents or printed publications relied upon.” 37 C.F.R. § 42.104(b)(4). Often, a petition must consider multiple theories of claim construction, and to fault a petition for not adequately supporting a theory we find to be incorrect is inappropriate. Although we should consider correct theories not adequately supported in a petition to weigh against institution or against unpatentability, we are not persuaded that incorrect theories, not espoused in a petition, should be held against that petition.

In the instant case, there appears to be no dispute that the steps of claim 15 need not be performed in the recited order, and we agree. Therefore, we do not find Zond’s arguments to be persuasive. Further, based on the evidence before us, we are persuaded that Gillette has demonstrated, by a preponderance of evidence, that the combination of Wang, Mozgrin, and Kudryavtsev discloses all of the steps of claim 15.

Forming a Gap Between Cathode and Adjacent Anode

Claim 1 recites, in part, “a cathode that is positioned adjacent to the anode and forming a gap there between.” Zond argues that because “*Wang* does not teach that any plasma is positioned between its cathode 14 and grounded shield anode 24,” *Wang* cannot teach the claimed gap. PO Resp. 44. Zond also argues that the floating shield precludes a finding that the cathode is positioned adjacent to the anode, as required by claim 1. *Id.* Zond continues that citations to “*Fu*” (U.S. Patent No. 6,306,265) and “*Chiang*” (U.S. Patent Application No. 09/414,614 (Ex. 2009)), incorporated by reference in *Wang*, further suggest that an interposed grounded shield would have been the anode-cathode geometry that a person of ordinary skill in the art would have looked to and would not meet the requirements of claim 1. *Id.* at 44–47 (citing Ex. 2006 ¶ 78).

Gillette, in response, counters that the testimony of Zond’s expert, Dr. Hartsough, is inconsistent. Reply. 2–4. Dr. Hartsough indicates that the claim term “adjacent” must be construed as “meaning next to and with nothing in between,” and that *Wang*, however combined, does not comport with that definition (Ex. 2006 ¶ 71). However, during his deposition testimony (Ex. 1030, 74:7–76:8), he acknowledged that a partially introduced electrode between a cathode and an anode *would* still allow for the cathode and anode to meet the meaning of “adjacent.” *Id.* The modified figure presented to Dr. Hartsough is reproduced below.

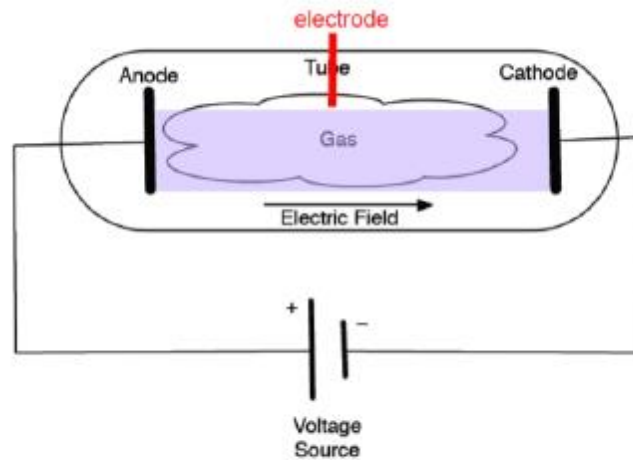


Figure 3: Simplified plasma system

Modified Fig. 3 from Dr. Hartsough's Declaration.

Similar to the analysis above with respect to “proximate,” we further find that the '775 Patent provides no specific definition for “adjacent.” Additionally, even if we adopt Dr. Hartsough's definition of “adjacent,” we are not persuaded that the partial imposition of the grounding shield in Wang renders the cathode and anode non-adjacent in Wang. We further concur with Gillette that Wang discloses an anode and a cathode having a gap formed there between that comports with claim 1.

Based on the evidence before us, we are persuaded that Gillette has demonstrated, by a preponderance of evidence, that the combination of Wang, Mozgrin, and Kudryavtsev discloses a cathode that is positioned adjacent to the anode and forming a gap there between.

“Quasi-Static” Electric Field

Claims 2 and 18 recite, in part, that the electric field is a quasi-static electric field. Zond argues that Gillette fails to make a proper comparison

between the characteristic time of electric field variation and collision time because Gillette instead compares the pulse width of a power pulse with a collision time. PO Resp. 49–50. Zond argues that the latter is faulty because “[t]here is no indication in *Wang* that the voltage is constant during any part of the power pulse as even *Wang* recognizes that the idealized pulses shown in Figures 4 and 6 are not what are actually applied.” *Id.* at 50 (citing Ex. 2006 ¶ 83; Ex. 1008, 5:24–27, 7:41–45).

As shown in Figure 7 of Wang, pulsed DC power supply 80 produces a series of voltage pulses, and portions of the voltage pulses are constant. Ex. 1008, 7:57–61. It is clear from Figure 7 of Wang that Wang’s system is designed to maintain the amplitude of the voltage pulses. Based on the evidence in this record, we are persuaded that one with ordinary skill in the art would have recognized that Wang discloses portions of voltage pulses are constant. Given that it is the voltage pulses that provide the electric field, the constant portion necessarily would be quasi-static if it is longer than the collision time. As was explained in the Petition, the pulse width (i.e., 5 μ s) is greater than the calculated collision time (i.e., 1.88 μ s). Pet. 46–47.

Additionally, even if Wang presented only idealized pulses with constant voltage periods, we remain persuaded that this would be sufficient to guide one of ordinary skill in the art to maintain the constant voltage period for sufficient time to be considered quasi-static. Based on the evidence before us, we are persuaded that Gillette has demonstrated, by a preponderance of evidence, that the combination of Wang, Mozgrin, and Kudryavtsev discloses the use of a quasi-static electric field in an etching system.

Choosing the Rise Time

Claim 4 recites, in part, that “a rise time of the electric field is chosen to increase an ionization rate of the excited atoms in the weakly-ionized plasma.” Zond argues that Gillette’s arguments with respect to claim 4 are conclusory and not supported by Wang. PO Resp. 50–52. Zond continues that merely because an applied voltage pulse has an associated rise time, as in Wang, that does not mean that the rise time was somehow chosen to increase the ionization rate of the excited atoms in the weakly-ionized plasma, as required by claim 4.

Gillette argues that one of ordinary skill in the art would have recognized from the teachings of Wang that certain parameters, such as the rise time of a voltage pulse, could be chosen to achieve the purpose of higher plasma density. Reply 13. Also, Gillette argues that claim 4 recites an intended use that will not limit the scope of the claim. *Id.* at 14; *see Boehringer Ingelheim Vetmedica, Inc. v. Schering-Plough Corp.*, 320 F.3d 1339, 1345 (Fed. Cir. 2003). We agree with Gillette.

We are not persuaded by Zond’s arguments because “a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of elements.” *Mouttet*, 686 F.3d at 1332. Wang selects pulse characteristics and reactors with the goal of “producing a high fraction of ionized sputtered particles,” which “has long been exploited in high-density plasma.” Ex. 1008, 1:7–8, 30–37. As discussed above, Kudryavtsev discloses that, when applying a voltage pulse to generate a strongly-ionized plasma from a weakly-ionized plasma, the ionization rate will increase. Ex. 1004, 31–32. Given these disclosures, we are persuaded that one of ordinary skill in the art would have understood that the parameter

of the rise time of a voltage pulse could be controlled to increase the ionization rate, and that it would have been obvious to select the rise time to achieve the goals of the cited references.

Based on the evidence before us, we are persuaded that Gillette has demonstrated, by a preponderance of evidence, that the combination of Wang, Mozgrin, and Kudryavtsev discloses controlling the voltage pulses and selecting a rise time of the voltage pulses to increase an excitation rate of ground state atoms.

Location of Strongly Ionized Plasma

Claim 21 recites, in part, that “the strongly-ionized plasma [is] substantially uniform in an area adjacent to the surface of the substrate,” and claim 24 recites similarly that “the strongly-ionized plasma is substantially uniform proximate to a surface of the substrate.” Zond argues that Wang teaches that its strongly ionized plasma is confined to the high density plasma (“HDP”) region adjacent the sputtering target, which is considerably distant from the substrate and will not result in plasma that is uniform throughout. PO Resp. 54–56. We do not agree.

Zond does not dispute that Wang’s strongly-ionized plasma located in region 42, as shown in Figure 1 of Wang, is substantially uniform. *Id.* Zond also does not dispute that “the unbalanced magnetic field will cause the HDP region to extend into the processing space 22” (*id.* at 55), thus potentially making it proximate to the substrate. Rather, Zond’s argument attempts to construe the claim term “proximate to the sputtering target” to require the

plasma to be generated across *the entire area* of the sputtering target at all times. *Id.*

Zond's arguments are not commensurate with the scope of the claims. *See In re Self*, 671 F.2d 1344, 1348 (CCPA 1982) (stating that limitations not appearing in the claims cannot be relied upon for patentability). Zond and its expert do not direct us to where the Specification sets forth a special definition, let alone explain why such a construction would be the broadest reasonable interpretation. PO Resp. 54–56; Ex. 2006 ¶¶ 88–89. Based on our review of the Specification, we discern nothing in claims 21 and 24 that would require the strongly-ionized plasma to be generated across the entire surface area of the substrate at all times.

Even if the claim requires the plasma to be substantially uniform across *the entire area* across the surface of the substrate, as urged by Zond, the combination of Wang, Mozgrin, and Kudryavtsev would have rendered such a limitation obvious. Zond's argument narrowly focuses on Wang's Figure 1 that shows the situation where the magnetron is *not rotating*. PO Resp. 54–56. In fact, Wang discloses another embodiment in which the *magnetron rotates* behind the target and moves the strongly-ionized plasma over the entire surface of the sputtering target, generating a substantially uniform plasma across the entire area proximate to the sputtering target. Ex. 1008, 4:46–51. Dr. Bravman's Declaration indicates that over time, the plasma would be uniform across the surface of the substrate based on the rotation of the magnetron. Ex. 1031 ¶¶ 116–118. We credit Dr. Bravman's testimony as it is consistent with Wang's disclosure.

Given the evidence in this record, we determine that Gillette has demonstrated, by a preponderance of evidence, that the combination of

Wang, Mozgrin, and Kudryavtsev would have suggested to one with ordinary skill in the art at the time of the invention generating a substantially uniform strongly-ionized plasma proximate to the substrate surface, as required by claims 21 and 24.

Chosen Volume between Anode and Cathode

Claim 9 requires that the volume between the anode and cathode be chosen to increase the ionization rate of excited atoms and molecules. Zond argues that none of the cited references discusses the impact of choosing that volume, and the equations in Kudryavtsev do not permit the selection of a volume based on its model. PO Resp. 56–58. Additionally, Zond argues that even if a volume were specifically chosen, the cited references would suggest a preference for longer gaps between anodes and cathodes, contrary to the disclosure of the '775 Patent. *Id.* We do not agree.

Gillette argues, as discussed similarly above, that one of ordinary skill in the art would have recognized from the teachings of Wang that certain parameters, such as the volume between the anode and cathode, could be chosen to achieve the purpose of higher plasma density. Reply 13. Also similarly, Gillette argues that claim 9 recites an intended use that will not limit the scope of the claim. *Id.* at 14. Indeed, nothing in claim 9 requires a specific spacing between the anode and cathode, nor does the claim require a specific ionization rate.

We are not persuaded by Zond's arguments because "a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of elements." *Moultet*, 686 F.3d at 1332.

Wang, incorporating Chiang by reference, recognizes that it was common to optimize certain parameters, including the volume between the anode and cathode, to achieve high-density plasma and desired sputtering results—e.g., depositing metals uniformly into high aspect-ratio via holes in advanced integrated circuits. Ex 1008, 1:42–51; Ex. 2009, 14:37–50 (“A series of tests were used to determine the combined effects of throw [which is the spacing between the target and substrate] and chamber pressure.”). As discussed above, Kudryavtsev discloses that, when applying a voltage pulse to generate a strongly-ionized plasma from a weakly-ionized plasma, the ionization rate will increase. Ex. 1004, 31–32.

Given the evidence before us, we are persuaded that Gillette has demonstrated, by a preponderance of evidence, that it would have been obvious, in light of Kudryavtsev, to adjust Wang’s anode and cathode assembly to increase the ionization rate of the excited atoms in the weakly-ionized plasma.

Applying Electric Field at Constant Power

Claim 16 requires application of “the electric field at a constant power.” Zond argues that “[n]owhere do Petitioners explain *how* a pulsed DC power supply applies an electric field at a constant power,” that Wang describes an idealized power pulse, and that the actual shape differs from what is illustrated. PO Resp. 58–59. Zond also argues that “one can expect that the power is not constant over this period.” *Id.* at 59.

Gillette responds that Dr. Hartsough, Zond’s expert, concedes that typical power supplies, such as described by Wang, operate the same as

those disclosed in the '775 Patent, i.e., Ex. 1001, Fig. 5. Reply 8–9 (citing Ex. 1030, 135:19–136:1, 149:17–150:20). Based on this, Gillette counters that Wang teaches applying pulses at both constant voltage and constant power, in specific regions. *Id.* We agree with Gillette.

As shown in Figure 7 of Wang, pulsed DC power supply 80 produces a series of voltage pulses, and portions of the voltage pulses are constant. Ex. 1008, 7:57–61. Figure 6 of Wang depicts that portions of the power pulses are constant. Moreover, it is clear from Figures 6 and 7 of Wang that Wang's system is designed to maintain both the amplitude of the voltage pulses and the amplitude of the power pulses constant during the entire process. Based on the evidence in this record, we are persuaded that one of ordinary skill in the art would have recognized that Wang discloses: (1) portions of voltage and power are constant; and (2) the amplitude of the voltage pulses and the amplitude of the power pulses are constant.

Given the evidence in this record, we determine that Gillette has demonstrated, by a preponderance of evidence, that the combination of Wang, Mozgrin, and Kudryavtsev would have suggested to one with ordinary skill in the art at the time of the invention a pulsed power supply that generates a constant power, as required by claim 16.

Conclusion

For the foregoing reasons, we conclude that Gillette has demonstrated, by a preponderance of evidence, that claims 1–7, 9–16, 18–26, 28, and 29 are unpatentable over the combination of Wang, Mozgrin, and Kudryavtsev.

D. Claims 8, 17, and 27 – Obviousness over Wang, Mozgrin, and Kudryavtsev, in Combination with Kouznetsov, Lantsman, or Li

Gillette asserts that claims 8, 17, and 27 are unpatentable under 35 U.S.C. § 103(a) as obvious over Wang, Mozgrin, and Kudryavtsev, in combinations with Kouznetsov, Lantsman, or Li, respectively. Pet. 57–59. Based on our review, we are persuaded that Gillette has demonstrated the differences between Wang, Mozgrin, and Kudryavtsev, applied against the independent claims, and claims 8, 17, and 27 would have been obvious over the teachings of Kouznetsov, Lantsman, and Li. Zond does not directly dispute Gillette’s analysis with respect to claims 8 and 27, but does dispute the combination asserted against claim 17. PO Resp. 59–60. As discussed below, we do not find Zond’s arguments to be persuasive.

Claim 17 recites, in part, “applying the electric field at a constant voltage.” Zond argues Gillette has contended that the power is constant during the pulse τ_w , per Wang, but the current must rise because of Wang’s admitted drop in the plasma impedance during the pulse. *Id.* at 59 (citing Ex. 2006 ¶ 96). Additionally, Zond points out Lantsman discloses operation in constant power, constant voltage, or constant current modes, so that Wang’s disclosure of constant power precludes the use of constant voltage. *Id.* at 60 (citing Ex. 2006 ¶ 97). We do not agree.

As we discussed in our Decision to Institute (Dec. 23), Gillette asserts that Wang discloses its pulsed DC power supply produces a train of negative voltage pulses. Pet. 58 (citing Ex. 1008, 7:61–62). Gillette argues that one of ordinary skill in the art would have understood the pulses so produced to be at a constant voltage for the duration of the pulse. *Id.* at 58–59. As Gillette suggests, claim 17 requires a portion of the voltage generated by the

pulsed power supply to be constant, rather than requiring the voltage to be constant during the entire sputtering process, which is commensurate with the disclosure of the '775 Patent. Reply 9 (citing Ex. 1001, Fig. 5, illustrating regions of constant and non-constant voltage). In other words, we are not persuaded that claim 17 requires the electric field to be applied always at constant voltage, and Wang meets that limitation.

Additionally, we are not persuaded that Lantsman requires one of ordinary skill in the art to pick a single parameter to be held constant, as Zond alleges. PO Resp. 60. Furthermore, we are not persuaded that Lantsman limits the possibilities of operation as Zond alleges. Also, Lantsman would have informed one of ordinary skill in the art of possibilities and would not have confined such artisans to only specific choices. A person with ordinary skill in the art is “a person of ordinary creativity, not an automaton.” *KSR*, 550 U.S. at 420–21.

With respect to claims 8 and 27, we agree with Gillette’s analysis in the Petition (Pet. 57–59). For the foregoing reasons, we determine that Gillette has demonstrated, by a preponderance of evidence, that claims 8, 17, and 27 are unpatentable over Wang, Mozgrin, and Kudryavtsev, in combinations with Kouznetsov, Lantsman, or Li, respectively.

III. CONCLUSION

For the foregoing reasons, we conclude that Gillette has demonstrated, by a preponderance of the evidence, that claims 1–29 of the ’775 Patent are unpatentable based on the following grounds of unpatentability:

Claim(s)	Basis	References
1–7, 9–16, 18–26, 28, and 29	§ 103(a)	Wang, Mozgrin, and Kudryavtsev
8	§ 103(a)	Wang, Mozgrin, Kudryavtsev, and Kouznetsov
17	§ 103(a)	Wang, Mozgrin, Kudryavtsev, and Lantsman
27	§ 103(a)	Wang, Mozgrin, Kudryavtsev, and Li

IV. ORDER

In consideration of the foregoing, it is

ORDERED that claims 1–29 of the ’775 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.

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