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Paper 42
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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

ZOND, LLC,
Patent Owner.

Case IPR2014-00726[1]
Patent 6,896,773 B2

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

CHANG, *Administrative Patent Judge*.

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

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[1] Case IPR2014-01481 has been joined with the instant *inter partes* review.

I. INTRODUCTION

The Gillette Company (“Gillette”) filed a Petition requesting an *inter partes* review of claims 21–33 and 40 of U.S. Patent No. 6,896,773 B2 (Ex. 1101, “the ’773 patent”). Paper 3 (“Pet.”). Patent Owner Zond, LLC (“Zond”) filed a Preliminary Response. Paper 7 (“Prelim. Resp.”). Upon consideration of the Petition and Preliminary Response, we instituted the instant trial on October 10, 2014, pursuant to 35 U.S.C. § 314. Paper 8 (“Dec.”).

Subsequent to institution, we granted the 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 IPR2014-01481 with the instant trial (Paper 15), and also granted a Joint Motion to Terminate with respect to TSMC (Paper 31).[2] Zond filed a Response (Paper 27 (“PO Resp.”)), and Gillette filed a Reply (Paper 33 (“Reply”)). Oral hearing[3] was held on June 16, 2015, and a transcript of the hearing was entered into the record. Paper 41 (“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 21–33 and 40 of the ’773 patent are unpatentable under 35 U.S.C. § 103(a).

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[2] In this Decision, we refer to The Gillette Company (the original Petitioner) and Fujitsu as “Gillette,” for efficiency.

[3] The oral arguments for the instant review and Case IPR2014-00580 were consolidated.

A. Related District Court Proceedings

Gillette indicates the ’773 patent was asserted in *Zond, LLC v. The Gillette Co.*, No.1:13-CV-11567-DJC (D. Mass.), and identifies other proceedings in which Zond asserted the claims of the ’773 patent. Pet. 1.

B. The ’773 Patent

The ’773 patent relates to a method and an apparatus for high-deposition sputtering. Ex. 1101, Abs. At the time of the invention, sputtering was a well-known technique for depositing films on semiconductor substrates. *Id.* at 1:5–6. According to the ’773 patent, conventional magnetron sputtering systems deposit films with relatively low uniformity. *Id.* at 1:53–54. Although film uniformity can be increased by mechanically moving the substrate and/or magnetron, the ’773 patent indicates such systems are relatively complex and expensive to implement. *Id.* at 1:54–57. The’773 patent states that conventional magnetron sputtering systems also have relatively poor target utilization (how uniformly the target material erodes during sputtering) and a relatively low deposition rate (the amount of material deposited on the substrate per unit of time). *Id.* at 1:57–66. To address these issues, the ’773 patent discloses a plasma sputtering apparatus that creates a strongly-ionized plasma from a weakly-ionized plasma using a pulsed power supply. *Id.* at Abs. According to the ’773 patent, “[t]he strongly-ionized plasma includes a first plurality of ions that impact the sputtering target to generate sufficient thermal energy in the sputtering target to cause a sputtering yield of the sputtering target to be non-linearly related to a temperature of the sputtering target.” *Id.*

C. Illustrative Claims

Of the challenged claims, claims 21 and 40 are independent. Claims 22–33 depend directly from claim 21. Claims 21 and 40, reproduced below, are illustrative:

> 21. A method for high deposition rate sputtering, the method comprising:
>
> ionizing a feed gas to generate a weakly-ionized plasma proximate to a cathode assembly that comprises a sputtering target; and
>
> applying a voltage pulse to the cathode assembly to generate a strongly-ionized plasma from the weakly-ionized plasma, an amplitude and a rise time of the voltage pulse being chosen so that ions in the strongly-ionized plasma generate sufficient thermal energy in the sputtering target to cause a sputtering yield to be non-linearly related to a temperature of the sputtering target, thereby increasing a deposition rate of the sputtering.
>
> 40. A sputtering source comprising:
>
> means for ionizing a feed gas to generate a weakly-ionized plasma; and
>
> means for increasing the density of the weakly-ionized plasma to generate a strongly-ionized plasma having a density of ions that generate sufficient thermal energy in the sputtering target to cause a sputtering yield to be non-linearly related to a temperature of the sputtering target.

Ex. 1101, 22:21–33, 24:17–25.

D. Prior Art Relied Upon

Gillette relies upon the following prior art references:

Wang	US 6,413,382 B1	July 2, 2002	(Ex. 1103)
Lantsman	US 6,190,512 B1	Feb. 20, 2001	(Ex. 1108)
Kawamata	US 5,958,155	Sept. 28, 1999	(Ex. 1109)

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. 1102) ("Mozgrin").

Interaction of Low-Temperature Plasma With Condensed Matter, Gas, and Electromagnetic Field in (III) ENCYCLOPEDIA OF LOW-TEMPERATURE PLASMA (V.E. Fortov ed., 2000) (Ex. 1104) ("Fortov").[4]

A.A. Kudryavtsev and V.N. Skrebov, *Ionization Relaxation in a Plasma Produced by a Pulsed Inert-Gas Discharge*, 28 SOV. PHYS. TECH. PHYS. 30–35 (Jan. 1983) (Ex. 1106) ("Kudryavtsev").

W. Ehrenberg and D.J. Gibbons, ELECTRON BOMBARDMENT INDUCED CONDUCTIVITY AND ITS APPLICATIONS, 8–122 (1981) (Ex. 1125) ("Ehrenberg").

E. Grounds of Unpatentability

We instituted the instant trial based on the following grounds of unpatentability (Dec. 39):

Claim(s)	**Basis**	**References**
21, 22, 26–33, and 40	§ 103	Mozgrin and Fortov
24 and 25	§ 103	Mozgrin, Fortov, and Lantsman
23	§ 103	Mozgrin, Fortov, and Kudryavtsev

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[4] Fortov is a Russian-language reference (Ex. 1110). The citations to Fortov are to the certified English-language translation submitted by Gillette (Ex. 1104).

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."). 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).

"weakly-ionized plasma" and "strongly-ionized plasma"

Claim 21 recites "applying a voltage pulse to the cathode assembly to generate a *strongly-ionized plasma* from the *weakly-ionized plasma*." Ex. 1101, 22:26–28 (emphases added). During the pre-trial stage of this proceeding, Zond submitted its constructions for the claim terms "a weakly-ionized plasma" and "a strongly-ionized plasma." Prelim. Resp. 19–

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

20. In our Decision on Institution, we adopted Zond's proposed constructions, in light of the Specification, as the broadest reasonable interpretations. Dec. 9–10; *see, e.g.*, Ex. 1101, 13:31–33 ("strongly-ionized plasma 268 having a large ion density being formed").

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. Dec. 9–10. Therefore, for purposes of this Final Written Decision, we construe, in light of the Specification of the '773 patent, the claim term "a weakly-ionized plasma" as "a plasma with a relatively low peak density of ions," and the claim term "a strongly-ionized plasma" as "a plasma with a relatively high peak density of ions."

Means-Plus-Function Claim Elements

The parties identify two claim elements recited in claim 40 as means-plus-function elements, invoking 35 U.S.C. § 112, ¶ 6.[6] Pet. 5–6; Prelim. Resp. 21–24. We agree that those claim elements are written in means-plus-function form and fall under § 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. *See Personalized Media Commc'ns, LLC v. Int'l Trade Comm'n*, 161 F.3d 696, 703–04 (Fed. Cir. 1998) (using the term "means for" in a

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[6] Section 4(c) of the 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 '773 patent has a filing date before September 16, 2012 (effective date), we refer to the pre-AIA version of § 112 in this Decision.

claim creates a rebuttable presumption that the drafter intended to invoke § 112 ¶ 6); *Sage Prods., Inc. 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*, 344 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 to the function recited in the claim. *B. Braun Med., Inc. 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).

Upon review of the parties' contentions and the Specification, we set forth our claim constructions in the Decision on Institution for the means-plus-function elements identified by the parties. Dec. 12–15. Neither party challenges any aspect of our claim constructions as to these claim elements. *See* PO Resp. 14–15; Reply 1–2. Based on this entire record, we also discern no reason to modify our claim constructions at this juncture. For convenience, our claim constructions are reproduced in the table below:

Means-Plus-Function Claim Elements	**Corresponding Structures**
"means for ionizing a feed gas to generate a weakly-ionized plasma"	A power supply electrically connected to a cathode assembly and an anode. *See*, Ex. 1101, 6:21–7:16, 7:52–60, 10:8–42, 11:22–26, 20:10–25, Figs. 4–6; Dec. 12–13.
"means for increasing the density of the weakly-ionized plasma"	A cathode assembly, an anode, and a pulsed power supply electrically coupled to the cathode assembly and anode. *See*, Ex. 1101, 6:22–52, 10:31–41, Figs. 4–6; Dec. 13–15.

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 1262. 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 asserted grounds of unpatentability in accordance with the above-stated principles.

C. Obviousness over Mozgrin and Fortov

Gillette asserts that claims 21, 22, 26–33, and 40 are unpatentable under 35 U.S.C. § 103(a) as obvious over the combination of Mozgrin and Fortov. Pet. 23–36. In its Petition, Gillette explains how the combination of the prior art technical disclosures collectively meets each claim limitation and articulates a rationale to combining the teachings. *Id*. Gillette also submitted a Declaration of Mr. Richard DeVito (Ex. 1105) to support its Petition, and a Declaration of Dr. John C. Bravman (Ex. 1127) to support its Reply to Zond's Patent Owner Response.

Zond responds that the combination of Mozgrin and Fortov does not disclose every claim element. PO Resp. 37–44, 50–52. Zond also argues that there is insufficient reason to combine the technical disclosures of Mozgrin and Fortov. *Id*. at 26–29. To support its contentions, Zond proffers a Declaration of Dr. Larry D. Hartsough (Ex. 2005).

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 Mozgrin and Fortov, and then we address the parties' contentions in turn.

Mozgrin

Mozgrin discloses experimental research conducted on high-current low-pressure quasi-stationary discharge in a magnetic field. Ex. 1102, 400, Title. In Mozgrin, pulse or quasi-stationary regimes are discussed in light of the need for greater discharge power and plasma density. *Id.* Mozgrin discloses a planar magnetron plasma system having cathode 1, anode 2 adjacent and parallel to cathode 1, and magnetic system 3, as shown in Figure 1(a) (reproduced below). *Id.* at 400–01. Mozgrin also discloses a power supply unit that includes a pulsed discharge supply unit and a system for pre-ionization. *Id.* at 401–02, Fig. 2. For pre-ionization, an initial plasma density is generated when the square voltage pulse is applied to the gas. *Id.*

Figure 3(b) of Mozgrin is reproduced below:

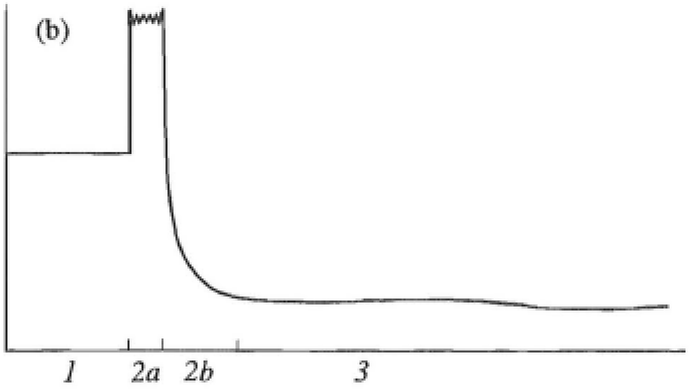


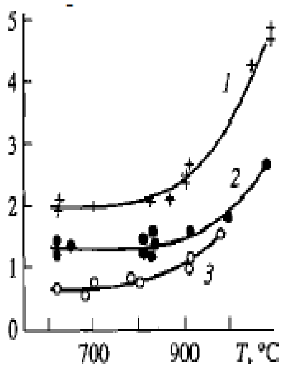
Figure 3(b) of Mozgrin illustrates an oscillogram of voltage of the quasi-stationary discharge. *Id.* at 402. In Figure 3(b), Part 1 represents the voltage of the stationary discharge (pre-ionization stage); Part 2 displays the square voltage pulse application to the gap (Part 2a), where the plasma density grows and reaches its quasi-stationary value (Part 2b); and Part 3 displays the discharge current growing and attaining its quasi-stationary value. *Id*. More specifically, the power supply generates a square voltage with rise times of 5–60 µs and durations of as much as 1.5 ms. *Id.* at 401.

Mozgrin further discloses the current-voltage characteristic of the quasi-stationary plasma discharge that has four different stable forms or regimes: (1) pre-ionization stage (*id*. at 401–02); (2) high-current magnetron discharge regime, in which the plasma density exceeds 2×10^{13} cm^{-3}, appropriate for sputtering (*id*. at 402–04, 409); (3) high-current diffuse discharge regime, in which the plasma density produces large-volume uniform dense plasmas $\eta_1 \approx 1.5 \times 10^{15}$ cm^{-3}, appropriate for etching (*id*.); and (4) arc discharge regime (*id*. at 402–04). *Id*. at 402–409, Figs. 3–7.

Fortov

Fortov is a Russian-language encyclopedia of plasma physics. Ex. 1104, 1. The cited portion of Fortov is directed to interaction of plasma with condensed matter and, more particularly, to sputtering. *Id*. at 3–4. Fortov discloses the non-linear relationship between the target temperature and the sputtering yield Y above temperature T_0. *Id.* at 16. According to Fortov, Y is the coefficient of sputtering, “defined as the relation of the number of sputtered atoms of a target to the number of bombarding ions (atoms)," which "depends on the type of ions (its atomic number Z_i and mass M_i)." *Id.* at 6.

Figure VI.1.315 of Fortov is reproduced below.



Pic. VI.1.315. Sputtering coefficient of cuprum being bombarded by the ions of Ar^+ with the energy of 400 eV, from the temperature: 1 — electrolytic copper, 2 — rolled copper, 3 — cuprum monocrystal, facet (101)

Figure VI.1.315 of Fortov describes the sputtering coefficient of copper (cuprum) being bombarded by ions of Ar^+ with the energy of 400 eV, from the temperature: 1 — electrolytic copper, 2 — rolled copper, 3 — single crystal copper (cuprum monocrystal), facet (101). *Id.* at 9. According to Fortov, at a temperature less than T_1, coefficient Y is not actually dependent on the temperature, and at $T \approx T_1$, Y starts to grow rapidly, concurrently with growth of temperature. *Id.* Fortov further explains temperature T_1 is sometimes defined according to the empirical relation $T_1 = .7\ T_m$ where T_m is the melting temperature, though in some cases, e.g., for tin (stannum) $T_1 > T_m$ and $T_1 = U/40k$ (k is Boltzmann constant; U is the energy of sublimation correlated to one atom). *Id.* at 7, 9. Temperature T_1 depends on the type, energy, and density of ion flow. *Id.* at 9.

Ionizing a feed gas

Zond disputes that "ionizing a feed gas to generate a weakly-ionized plasma near a cathode assembly" is taught by the combination of Mozgrin and Fortov. Resp. 38–40, 43–44.

Gillette takes the position that Mozgrin in combination with Fortov discloses "ionizing a feed gas to generate a weakly-ionized plasma proximate to a cathode assembly that comprises a sputtering target," as recited in claim 21, "exposing the feed gas to one of a static electric field, an AC electric field, a quasi-static electric field, a pulsed electric field, [etc.]," as recited in claim 28, and a "means for ionizing a feed gas to generate a weakly-ionized plasma," as recited in claim 40. Pet. 23–31, 33–34. According to Gillette, Mozgrin discloses using a power supply to generate a weakly-ionized plasma with density less than 10^{12} ions/cm^3 from the feed gas. *Id*. at 23–25 (citing Ex. 1102, 400–02, Figs. 1–6).

Figure 1 of Mozgrin is reproduced below.

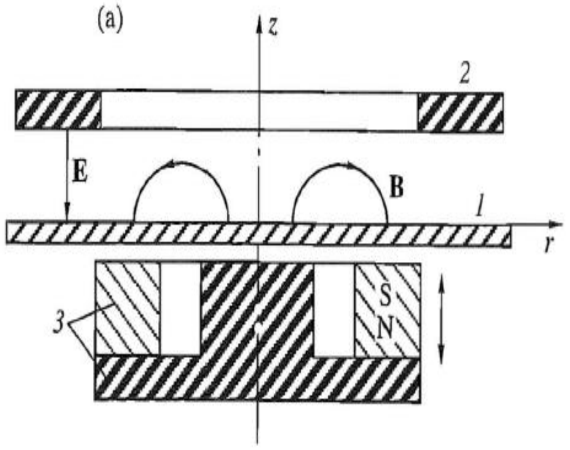


Figure 1(a) of Mozgrin

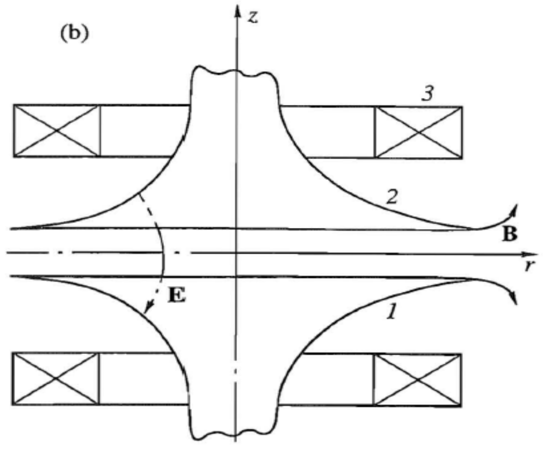


Figure 1(b) of Mozgrin

Figure 1 of Mozgrin illustrates two types of systems: (1) a planar magnetron system, as shown in Figure 1(a); and (2) a shaped-electrode magnetron system, as shown in Figure 1(b). Ex. 1102, 401. Each system comprises cathode 1, anode 2, and magnetic system 3. *Id*. Gillette points out that Mozgrin's magnetron systems generate a plasma from a feed gas, such as argon and nitrogen, between and proximate to the anode and cathode, as shown in Mozgrin's Figure 1. Pet. 24; Ex. 1102, 400–02 ("The [plasma] discharge had an annular shape and was adjacent to the cathode."). As shown in Figure 1(a) of Mozgrin, electric field *E* is formed between the anode and cathode. Ex. 1102, 401.

Zond counters that Mozgrin does not disclose "ionizing a *feed gas* to generate a weakly-ionized plasma near a cathode assembly." PO Resp. 38–40, 43–44 (emphasis added). Zond argues that Mozgrin teaches a *static* gas and not a feed gas, as required by claims 21, 28, and 40. *Id*. As support, Dr. Hartsough testifies that Mozgrin does not teach a *feed gas* because Mozgrin discloses that the discharge gap was filled up with either neutral or pre-ionized gas using four needle valves prior to generating plasma. Ex. 2005 ¶ 133.

Upon review of the record before us, we are not persuaded by Zond's arguments and expert testimony. Rather, we determine that Gillette's contentions are supported by a preponderance of the evidence.

At the outset, Zond's argument and expert testimony 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). Essentially, Zond and its expert are construing the claim term "feed gas" to require a *constant flow of* gas. We note that each of independent claims 21 and 40 recites "a feed gas," and not "a *flowing* feed gas," as alleged by Zond. *See* Ex. 1101, 22:23–25, 24:18–

19. The claim term "a feed gas" does not require a constant flow of gas, because the term does not imply necessarily the flow of gas. Construing the claim term "a feed gas" as a *constant flow* of gas, as argued by Zond, would import a limitation improperly from the Specification into the claims. *See Van Geuns*, 988 F.2d at 1184.

In any event, even if the claims at issue here were to require such a limitation, we observe that the combination of Mozgrin and Fortov would render the claimed subject matter recited in the limitation obvious. As Gillette points out, Mozgrin discloses generating "high-current [plasma] discharge in wide ranges of discharge current (from 5 A to 1.8 kA) and operating pressure (from 10^{-3} to 10 torr) using various gases (Ar, N_2, SF_6, He, and H_2)." Pet. 24; Ex. 1102, 402. Mr. DeVito testifies during his cross-examination that Mozgrin suggests using a constant flow of gas in order to maintain a constant pressure during the plasma process and to yield high deposition rates. Ex. 2010, 84:13–85:1.

Zond's allegation and expert testimony that using four needle valves is an indication that Mozgrin's feed gas is "a static gas" also is of no moment. PO Resp. 39; Ex. 2005 ¶ 133. Dr. Bravman testifies that it was well-known in the art at the time of the invention that needle valves provide a *continuous flow* of gas. Ex. 1127 ¶ 48. As an example to support his testimony, Dr. Bravman cites to Ehrenberg, a book published in 1981, which states that "while still pumping, argon gas is allowed to enter the bell-jar [chamber] through a needle valve. . . . This continuous flow method tends to sweep away any impurities" (Ex. 1125, 81). Ex. 1127 ¶ 48.

We credit the testimony of Mr. DeVito (Ex. 2010, 84:13–85:2) and Dr. Bravman (Ex. 1127 ¶ 48), as their explanations are consistent with the prior art of record. Given the evidence before us, we are persuaded that one of ordinary skill in the art at the time of the invention would have recognized that Mozgrin's system supplies a constant flow of feed gas into the chamber during the plasma processing, and, therefore, Mozgrin's feed gas need not be a "static gas," as alleged by Zond.

Mozgrin also discloses that the plasma discharge volume is generated between the electrodes (the anode and cathode assembly), and that the gap between the electrodes is about *10 mm*—falling squarely within the range of *3–100 mm*, disclosed in the '773 patent (Ex. 1101, 10:23–24). Ex. 1102, 401. Moreover, Mozgrin explicitly states that the plasma discharge is adjacent to the cathode. *Id*. Therefore, one of ordinary skill in the art would have recognized that Mozgrin's plasma is generated proximate to both the anode and the cathode assembly.

For the foregoing reasons, we are persuaded that Gillette has demonstrated, by a preponderance of the evidence, that the combination of Mozgrin and Fortov discloses "ionizing a feed gas to generate a weakly-ionized plasma proximate to a cathode assembly that comprises a sputtering target," as recited in claim 21, "exposing the feed gas to one of a static electric field, an AC electric field, a quasi-static electric field, a pulsed electric field, [etc.]," as recited in claim 28, and a "means for ionizing a feed gas to generate a weakly-ionized plasma," as recited in claim 40.

<u>Voltage pulse</u>

Claim 21 recites:

> applying a *voltage pulse* to the cathode assembly to generate a strongly-ionized plasma from the weakly ionized plasma, an *amplitude and a rise time of the voltage pulse being chosen* so

> that ions in the strongly-ionized plasma generate sufficient thermal energy in the sputtering target *to cause a sputtering yield to be non-linearly related to a temperature* of the sputtering target, thereby increasing a deposition rate of the sputtering

Ex. 1101, 22:26–33 (emphases added). Claim 40 recites a similar element. *Id*. at 24:20–26.

In its Response, Zond argues that the combination of Mozgrin and Fortov does not teach or suggest the aforementioned "voltage pulse" limitation, as required by claims 21 and 40. PO Resp. 40–43. In particular, Zond alleges that Mozgrin does not disclose "any attempt to achieve a sputtering yield to be non-linearly related to a temperature of the sputtering target." *Id*. at 41; Ex. 2005 ¶ 137. Zond also contends that Fortov does not disclose "how to generate sufficient target thermal energy to cause the sputtering yield to be non-linear with target temperature." PO Resp. 42; Ex. 2005 ¶ 139.

We are not persuaded by Zond's arguments. Nonobviousness cannot be established by attacking references individually where, as here, the ground of unpatentability is based upon the teachings of a combination of references. *In re Keller*, 642 F.2d 413, 426 (CCPA 1981). Rather, the test for obviousness is whether the combination of references, taken as a whole, would have suggested the patentees' invention to a person having ordinary skill in the art. *In re Merck & Co.,* 800 F.2d 1091, 1097 (Fed. Cir. 1986).

As Gillette points out (Pet. 26–27, 36), Mozgrin discloses applying a voltage pulse that has a rise time 5–60 μs and duration of 1.5 ms, in between the anode and cathode, to generate a strongly-ionized plasma from a weakly-ionized plasma. Ex. 1102, 402 ("Part 1 in the voltage oscillogram [as shown in Figure 3(b)] represents the voltage of the stationary discharge (pre-ionization stage).”), 401 (“This initial density [of 10^9–10^{11} cm^{-3} range] was sufficient for plasma density to grow when the square voltage pulse was applied to the gap.”), 409 (“The implementation of the high-current magnetron discharge (regime 2) in sputtering . . . plasma density (exceeding 2 x 10^{13} cm^{-3}).”), Figs, 1, 3). Gillette directs our attention to the Declaration of Mr. DeVito, who testifies that one of ordinary skill in the art reading Mozgrin “would have understood that controlling discharge parameters, such as the current or the characteristics of the pulse (e.g., duration, amplitude and rise time), could have been performed to cause the plasma to remain in the region 2 that is useful for sputtering.” Pet. 28–29; Ex. 1105 ¶ 121 (citing Ex. 1102, 403–04, Figs. 5a, 7). Furthermore, Zond’s expert witness, Dr. Hartsough, confirms that Mozgrin delivers a voltage pulse, which has parameters, such as amplitude, rise time, and pulse width, to the weakly-ionized plasma, for increasing the density of ions in the plasma. Ex. 1124, 77:20–79:6. Indeed, Mozgrin selects the pulse characteristics with the goal of increasing plasma density. Ex. 1102, 400–01.

Gillette also relies upon Fortov to disclose a non-linear relationship between the sputtering yield and the temperature of the target (Cu (copper) in argon plasma). Pet. 27–31 (citing Ex. 1104, 9, 16, Pic. VI.1.315).

Fortov’s Formula 10.7 is reproduced below:

$$\begin{gathered} Y_\tau = \mathrm{const}\frac{\tau}{\sqrt{T_0 + \Delta T_\mathrm{m}}}\exp\left(-\frac{U}{T_0 + \Delta T_\mathrm{m}}\right), \\ \tau = \frac{R^2}{k}\left(\frac{T_0 + \Delta T_\mathrm{m}}{U}\right)^2, \end{gathered} \qquad (10.7)$$

Ex. 1104, 16.

Fortov discloses that, based on Formula 10.7 (reproduced below), the sputtering yield *Y* "increases with the increase of target temperature T_0, meanwhile, the relation $Y(T_0)$ has an exponential character which explains the thermal dependence of the sputtering yield" as shown in Figure VI.1.315. Ex. 1104, 16, Pic. VI.1.315. The Specification of the '773 patent also uses the same formula to establish that, when the sputtering target temperature reaches a sufficiently high temperature (T_0), the sputtering yield increases at a non-linear rate. Ex. 1101, 18:64–19:18.

Both Fortov and Mozgrin describe the use of a copper cathode in argon plasma as a suitable system for sputtering. Ex. 1104, 9, 16, Pic. VI.1.315; Ex. 1102, 406, Table 1. Mr. DeVito testifies that one of ordinary skill in the art would have been motivated to combine the teachings of Mozgrin and Fortov, because "[a]pplying the teaching of Fortov to Mozgrin would be to use known processes to achieve Fortov's predictable result of greater sputtering yield." Ex. 1105 ¶ 125.

Given the evidence before us, we are persuaded that the combination of Mozgrin and Fortov teaches the aforementioned "voltage pulse" limitation of claims 21 and 40.

Rationale to Combine

In its Response, Zond further argues that it would not have been obvious to combine Mozgrin with Fortov to achieve the claimed invention with a reasonable expectation of success. PO Resp. 26–29, 43. Specifically, Zond alleges that Gillette failed to provide any evidence that the contradictory teachings of Mozgrin and Fortov, regarding when sputtering occurs, would have led an artisan to achieve the particular sputtering yield required by the claims. *Id*. at 27–29. According to Zond, Fortov discloses sputtering over a large range of plasma densities, whereas "Mozgrin's voltage pulse creates a direct transition from a weakly-ionized plasma to Mozgrin's regime 3," which produces no sputtering of the cathode. *Id*.

We are not persuaded by Zond's arguments, as they narrowly focus on Mozgrin's regime 3, and fail to consider Mozgrin's regime 2 that is dedicated to sputtering. It is well-settled that, when evaluating claims for obviousness, "the prior art as a whole must be considered." *In re Hedges*, 783 F.2d 1038, 1041 (Fed. Cir. 1986).

As Gillette points out (Pet. 23–27), Mozgrin explicitly states that, in regime 2, the voltage pulse that generates a strongly-ionized plasma from the weakly-ionized plasma is appropriate for sputtering. Ex. 1102, 402, 406, 409 ("The implementation of the high-current magnetron discharge (regime 2) in sputtering . . . provides an enhancement in . . . plasma density (exceeding 2×10^{13} cm^{-3})."), Figs., 1, 3). Mozgrin also discloses specific process parameter ranges that are more efficient for sputtering in regime 2. *Id*. Therefore, contrary to Zond's assertion that Mozgrin's voltage pulse creates a direct transition to regime 3, one of ordinary skill in the art reading Mozgrin would have been able to select the pulse characteristics and parameter ranges to generate a strongly-ionized plasma in regime 2 that is dedicated to sputtering. Upon consideration of Mozgrin and Fortov, as a whole, we do not share Zond's view that there are contradictory teachings between Mozgrin and Fortov that would dissuade one of ordinary skill in the art from combining the prior art teachings to achieve Fortov's non-linear increase in sputtering yield.

As noted above, Mr. DeVito testifies that one of ordinary skill in the art would have been motivated to combine the teachings of Mozgrin and Fortov, because "[a]pplying the teaching of Fortov to Mozgrin would be to use known processes to achieve Fortov's predictable result of greater sputtering yield." Ex. 1105 ¶ 125. More specifically, Mr. DeVito explains that it would have been obvious to apply a voltage pulse to generate a strongly-ionized plasma from the weakly-ionized plasma in Mozgrin, increasing "the density of ions in the strongly-ionized plasma to generate sufficient thermal energy in the sputtering target [so as] to increase the sputtering yield to a point where 'it starts to grow rapidly in a non-linear way with the growth of temperature,' as taught by Fortov." Ex. 1105 ¶¶ 123–125. Zond's expert, Dr. Hartsough, confirms that a person having ordinary skill in the art would have been motivated to increase sputtering yield in a sputtering process. Ex. 1124, 53:13–17. The Admitted Prior Art (Ex. 1101, 1:5–2:4, 2:47–5:60) indicates that "increasing the sputtering yield typically will increase the deposition rate," and, at the time of the invention, "[s]puttering systems are generally calibrated to determine the deposition rate under certain operating conditions." *Id*. at 2:57–58, 4:48–49. Upon consideration of the evidence in this record, we credit Mr. DeVito's testimony (Ex. 1105 ¶¶ 123–125) as it is consistent with the prior art of record.

For the reasons stated above, we determine that Gillette has demonstrated, by a preponderance of the evidence, that combining the technical disclosures of Mozgrin and Fortov is merely a predictable use of prior art elements according to their established functions—an obvious improvement. *See KSR*, 550 U.S. at 417 ("[I]f a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.”). Therefore, we are persuaded that Gillette has articulated a reason with rational underpinning as to why a person having ordinary skill in the art at the time of the invention would have found it obvious to combine the teachings of Mozgrin and Fortov.

For the foregoing reasons, we are persuaded that Gillette has demonstrated, by a preponderance of the evidence, that the combination of Mozgrin and Fortov would render obvious the aforementioned “voltage pulse” limitations, as recited in claims 21 and 40.

Evaporate a portion of the target surface layer

Claim 29 depends directly from claim 21, and further recites “the ions in the strongly-ionized plasma causes at least a portion of a surface layer of the sputtering target to evaporate.” Ex. 1101, 22:62–64.

In its Response, Zond argues that Mozgrin does not teach that evaporation occurs during sputtering. PO Resp. 50–52. Zond also alleges that, although Fortov indicates “sputtering was reviewed as evaporation in a particular model of thermal evaporation,” it does not indicate that “sputtering is a form of evaporation or that evaporation occurs during sputtering.” *Id.*

We are not persuaded by Zond’s arguments. Zond again attempts to establish nonobviousness by attacking references individually. *Keller*, 642 F.2d at 426. As Gillette points out, both Mozgrin and Fortov describe argon plasma sputtering using copper as the cathode material. Pet. 30;

Ex. 1102, 406; Ex. 1104, 9, Pic. VI.1.315. Fortov discloses that sputtering yield is related in a non-linear manner to the temperature of the sputtering target when the temperature of the target is greater than 0.7 times the melting temperature of the target. Ex. 1104, 9, Pic. VI.1.315. Gillette also notes that Fortov teaches that "[i]n the model of thermal evaporation the sputtering is reviewed as evaporation." Pet. 34; Ex. 1104, 16. Mr. DeVito testifies that "[b]ecause of the high heat required to heat the surface of the cathode to the temperature where the sputtering yield is non-linearly related to the temperature of the target, at least a portion of the surface layer of the sputtering target will evaporate." Ex. 1105 ¶ 136. Based on the disclosures of Mozgrin and Fortov, Dr. Bravman testifies that one of ordinary skill in the art would have understood that "more evaporation occurs with increasing temperature," and, therefore, it would have been obvious to combine Mozgrin and Fortov "to achieve evaporation conditions that would lead to increased sputtering," as taught by Fortov. Ex. 1127 ¶¶ 127–28; Ex. 2010, 64:19–65:14. We credit the testimony of Mr. DeVito and Dr. Bravman as the testimony is consistent with the prior art of record.

For the reasons stated above, we determine that Gillette has demonstrated, by a preponderance of the evidence, that the combination of Mozgrin and Fortov would have suggested that "the ions in the strongly-ionized plasma causes at least a portion of a surface layer of the sputtering target to evaporate," as recited in claim 29.

Conclusion

With respect to dependent claims 22, 26, 27, and 30–33, Zond essentially relies upon the same arguments presented in connection with independent claim 21. PO Resp. 26–29, 37–44. We addressed those arguments above, and found them unavailing. Upon review of Gillette's contentions and supporting evidence (Pet. 23–36) and, for the foregoing reasons, we conclude that Gillette has demonstrated, by a preponderance of the evidence, that claims 21, 22, 26–33, and 40 are unpatentable over the combination of Mozgrin and Fortov.

D. Obviousness over Mozgrin, Fortov, and Lantsman

Gillette asserts that claims 24 and 25 are unpatentable under § 103(a) as obvious over the combination of Mozgrin, Fortov, and Lantsman. Pet. 47–50. Each of claims 24 and 25 depends directly from claim 21, and further adds a limitation. For the reasons discussed above, we are persuaded that the combination of Mozgrin and Fortov renders the subject matter of claim 21 obvious. We address the parties' contentions in connection with the additional limitations recited in dependent claims 24 and 25, in turn below, after a brief summary of Lantsman.

Lantsman

Lantsman discloses a plasma processing system. Ex. 1108, Abs. The system is applicable to magnetron and non-magnetron sputtering and RF sputtering systems. *Id*. at 1:6–8. Lantsman also discloses that "at the beginning of processing . . . gas is introduced into the chamber" and "[w]hen the plasma process is completed, the gas flow is stopped." *Id*. at 3:10–13.

This is illustrated in Figure 6 of Lantsman reproduced below:

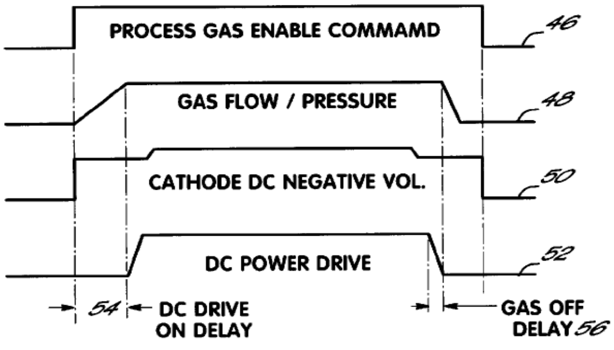


FIG. 6

Figure 6 of Lantsman shows that the gas flow is initiated, and the gas flow and pressure begin to ramp upwards toward normal processing levels for the processing stage. *Id.* at 5:39–42. As also illustrated, gas continues flowing during the entire processing stage. *Id.* at 5:30–58.

Diffusing the plasma with a volume of the feed gas

Claim 24 recites "diffusing the weakly-ionized plasma with a volume of the feed gas while ionizing the volume of the feed gas to create additional weakly-ionized plasma," and claim 25 recites "diffusing the strongly-ionized plasma with a volume of the feed gas while applying the voltage pulse to the cathode assembly to generate additional strongly-ionized plasma from the volume of the feed gas." Ex. 1101, 22:43–51.

Gillette asserts that the combination of Mozgrin, Fortov, and Lantsman would have rendered these limitations obvious. Pet. 47–50. Zond opposes and advances several arguments. PO Resp. 29–33, 44–48.

First, Zond and its expert argue that Mozgrin does not disclose a "feed gas," but rather a "static gas." *Id.*; Ex. 2005 ¶ 146. This argument is essentially the same one Zond and its expert advanced with respect to independent claim 21. We addressed this argument previously in our discussion as to claim 21, and found it unavailing. In particular, the evidence before us suggests that Mozgrin uses a constant flow of gas in order to maintain a constant pressure during the plasma process and to yield high deposition rates. *See, e.g.*, Ex. 1102, 402; Ex. 2010, 84:13–85:2. As discussed above, contrary to Zond's assertion and expert testimony that using four needle valves is an indication that Mozgrin's feed gas is "a static gas" (PO Resp. 39; Ex. 2005 ¶ 133), Dr. Bravman testifies that it was well-known in the art at the time of the invention that needle valves provide a continuous flow of gas (Ex. 1127 ¶ 48), citing Ehrenberg, which states that "while still pumping, argon gas is allowed to enter the bell-jar [chamber] through a needle valve. . . . This continuous flow method tends to sweep away any impurities" (Ex. 1125, 81). We credit the testimony of Dr. Bravman over Zond's expert testimony, as we find the explanations proffered by Dr. Bravman to be more consistent with the prior art teachings (*see, e.g.*, Ex. 1125, 81). *Yorkey v. Diab*, 601 F.3d 1279, 1284 (Fed. Cir. 2010) (finding Board has discretion to give more weight to one item of evidence over another "unless no reasonable trier of fact could have done so").

Second, Zond argues that Lantsman is silent with regard to diffusing the plasma with a feed gas while ionizing the feed gas to create additional plasma. PO Resp. 45–46; Ex. 2005 ¶ 146. As Dr. Bravman explains, however, adding feed gas into the plasma chamber, where the plasma is generated, "will naturally diffuse and intermingle with other gas particles within the plasma." Ex. 1127 ¶ 106. Zond's expert witness, Dr. Hartsough, confirms that "if the feed gas diffuses, it intermingles with the particles of the plasma, then that means . . . the plasma density would be diffused." Ex. 1124, 35:25–36:20.

Finally, Zond argues that Lantsman does not provide any details as to the configuration of a gas supply, and that Gillette fails "to provide experimental data or other objective evidence indicating that a skilled artisan would have been motivated to combine Lantsman's dual DC power supply system with the pulsed power supply system of Mozgrin." PO Resp. 29–33, 45–46; Ex. 2005 ¶¶ 71–72. Zond and its expert also contend that Gillette does not take into consideration the substantial, fundamental differences between Lantsman's DC power system and Mozgrin's system, and the contradictory sputtering teachings of Mozgrin and Fortov. PO Resp. 29–33, 45–46; Ex. 2005 ¶¶ 71–72.

We previously addressed Zond's arguments and expert testimony regarding the combination of Mozgrin and Fortov in the discussion concerning claim 21, and found them unpersuasive. Rather, we conclude that Gillette has articulated a sufficient rationale to combine the teachings of Mozgrin and Fortov.

As to combining Lantsman with Mozgrin and Fortov, we also are not persuaded by Zond's arguments and expert testimony, because they improperly predicate on bodily incorporating Lantsman's entire system into Mozgrin's system. "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 with ordinary skill in the art is "a person of ordinary creativity, not an automaton," and "in many cases . . . will be able to fit the teachings of multiple patents together like pieces of a puzzle.").

Here, Gillette does not propose to combine Lantsman's DC power supply system with Mozgrin's system. *See* Pet. 47–50. More importantly, Gillette is not relying on Lantsman for disclosing a pulsed power supply, but rather for teaching a continuous gas flow controller. *Id*.

As noted by Gillette, the use of a gas flow controller in a sputtering plasma chamber was well-known in the art at the time of the invention, as evidenced by Lantsman. Pet. 47–48; Ex. 1108, 3:9–13, 4:32–38, 5:39–45, Fig. 6. Lantsman discloses a gas flow controller and explains that the feed gas flows into the chamber throughout the entire plasma process including the pre-ionization and sputtering deposition phases. Ex. 1108, 2:48–51, 3:9–13, 4:32–38, 5:39–45, Fig. 6. In fact, the Admitted Prior Art discloses a known magnetron plasma system that uses a gas valve for controlling the flow of the feed gas. Ex. 1101, 3:34–37, Fig. 1. Zond and its expert recognize that Mozgrin's system uses needle valves to control the gas flow, and, as explained by Ehrenberg, needle valves are known to provide continuous gas flow during a plasma process. Ex. 1125, 81; Ex. 1127 ¶ 48; PO Resp. 39; Ex. 2005 ¶ 133.

One of ordinary skill in the art, in light of Lantsman, would have used a gas flow controller with Mozgrin's system to maintain a desired pressure in the chamber, and to maintain a continuous flow of feed gas in Mozgrin, diffusing the plasma and generating additional plasma during the entire process, as required by claims 24 and 25. As discussed above, Mozgrin discloses generating a weakly-ionized plasma from a feed gas proximate to the anode and cathode, and then generating a strongly-ionized plasma for sputtering deposition of a film. Ex. 1102, 402, 406, 409. We agree with Gillette that it would have been obvious to continue adding the feed gas in Mozgrin during the production of the plasma in light of Lantsman. Pet. 48–50; Ex. 1105 ¶¶ 181–87; Ex. 1108, 2:48–51, 3:9–13, 4:32–38, 5:39–45, Fig. 6. Mr. DeVito testifies that it also was well-known at the time of the invention to supply feed gas during a sputtering process. Ex. 1105 ¶ 180. Mr. DeVito further testifies that one of ordinary skill in the art, in light of Lantsman, would have used a continuous gas flow controller within Mozgrin's system so as to maintain a desired pressure in the chamber, and that such continuous flow of gas would diffuse the plasma to generate additional plasma. *Id.* ¶¶ 181–87. We credit Mr. DeVito's testimony (*id.*), as it is consistent with Lantsman and other prior art of record.

Based on the evidence before us, we are persuaded that the use of Lantsman's continuous gas flow controller within Mozgrin's system is an obvious combination of old elements with each performing the same function it had been known to perform. *See KSR*, 550 U.S. at 417. Consequently, we determine that Gillette has demonstrated, by a preponderance of the evidence, that the combination of Mozgrin, Fortov, and Lantsman teaches or suggests the limitations recited in claims 24 and 25.

Gillette also has articulated a reason with rational underpinning why one of ordinary skill in the art would have combined the technical teachings of Mozgrin, Fortov, and Lantsman.

Conclusion

For the foregoing reasons, we conclude that Gillette has demonstrated, by a preponderance of the evidence, that claims 24 and 25 are unpatentable over Mozgrin, Fortov, and Lantsman.

E. Obviousness over Mozgrin, Fortov, and Kudryavtsev

Gillette asserts that claim 23 is unpatentable under § 103(a) as obvious over the combination Mozgrin, Fortov, and Kudryavtsev. Pet. 55–59. Claim 23 depends directly from claim 21, and further recites "the voltage pulse applied to the cathode assembly generates excited atoms in the weakly-ionized plasma and generates secondary electrons from the sputtering target, the secondary electrons ionizing the excited atoms, thereby creating the strongly-ionized plasma." Ex. 1101, 22:38–43.

In its Response, Zond argues that Gillette fails to "provide any objective evidence that a skilled artisan would have been motivated to combine the cylindrical tube system without a magnet of Kudryavtsev with the Mozgrin magnetron system." PO Resp. 33–37 (citing Ex. 2005 ¶¶ 75–77). In particular, Zond and its expert witness contend that Gillette does not take into consideration the substantial, fundamental structural differences between the systems of Mozgrin and Kudryavtsev—e.g., pressure, chamber geometry, gap dimensions, and magnetic fields. *Id*. at 34–37; Ex. 2005 ¶¶ 75–77. Zond also argues that Gillette fails to provide experimental data or other objective evidence to show that Mozgrin's system as modified would produce the claimed result. *Id*. at 36–37 (citing *Epistar v. Trs. of Boston Univ.*, Case IPR2013-00298 (PTAB Nov. 15, 2013) (Paper 18)).

We are not persuaded by Zond's arguments. Zond's reliance on its interpretation of *Epistar*, a non-precedential Board decision, is misplaced. Zond's arguments predicate on bodily incorporating Kudryavtsev's entire system into Mozgrin's system. *See Mouttet*, 686 F.3d at 1332. Moreover, Zond improperly attempts to tie Kudryavtsev's model on plasma characteristics to the particular dimensions and components of the apparatus used in the experiments that support Kudryavtsev's model. In fact, 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*." Ex. 1106, 34 (emphasis added).

As discussed above, Mozgrin discloses applying a voltage pulse between the cathode and anode in a magnetron plasma system to generate a strongly-ionized plasma from a weakly-ionized plasma. Ex. 1102, 402, 409, Fig. 3(b). Mr. DeVito testifies that one of ordinary skill in the art would have recognized that "secondary electrons are necessarily generated" in Mozgrin's plasma formed in regime 2 for sputtering, because it was known that secondary electrons are released from the target "by the inelastic collision of impacting ions to the target." Ex. 1105 ¶¶ 202–03. Indeed, the Admitted Prior Art explains that "secondary electrons . . . are produced by ion bombardment of the target surface." Ex. 1101, 1:34–36.

As Gillette notes, Kudryavtsev discloses the effect of secondary electrons on the ionization of the excited atoms in a multiple-step ionization process that generates a strongly-ionized plasma from a weakly-ionized plasma using a voltage pulse. Pet. 57–58; Ex. 1106, Abs., Fig. 1. Specifically, Kudryavtsev discloses a multi-step ionization plasma process, exciting the ground state atoms to generate excited atoms, and then ionizing the excited atoms. Ex. 1106, Abs., Figs. 1, 6.

Figure 1 of Kudryavtsev illustrates the atomic energy levels during the slow and fast stages of ionization, and is reproduced below, with annotations added by Gillette (Pet. 57):

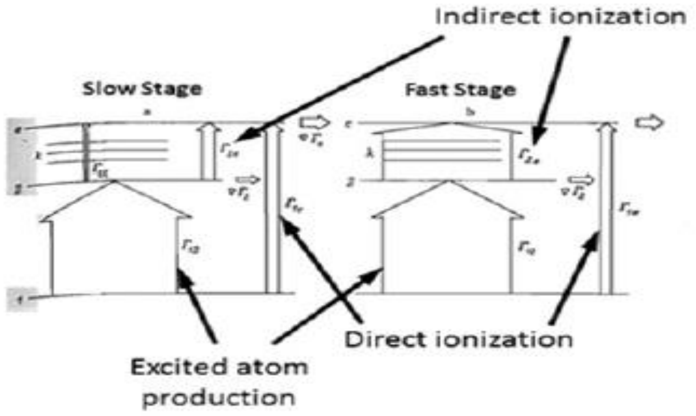


Figure 1a Figure 1b

As shown in annotated Figure 1 of Kudryavtsev, ionization occurs with a "slow stage" (Figure 1a) followed by a "fast stage" (Figure 1b). Ex. 1106, 31. During the initial slow stage, direct ionization provides a significant contribution to the generation of plasma ions from the ground state. Mr. DeVito explains that, once the density of excited atoms becomes sufficiently high, the multi-step ionization, shown in Figure 1b of Kudryavtsev as the fast stage, becomes the dominant ionization process. Ex. 1105 ¶ 204. Kudryavtsev discloses that the ionization increases rapidly once multi-step ionization becomes the dominant process. Ex. 1106, Abs. ("It is shown that the *electron density increases explosively in time due to accumulation of atoms in the lowest excited states*.") (emphasis added).

Mr. DeVito also explains that Kudryavtsev discloses, in Equation (1), that one of the factors that leads to the increase in plasma density includes the collision of excited atoms with secondary electrons. Ex. 1105 ¶¶ 205–06 (citing Ex. 1106, 30). We credit Mr. DeVito's testimony (Ex. 1105 ¶¶ 204–06), as it is consistent with Kudryavtsev's disclosure.

Furthermore, Mr. DeVito testifies that a person having ordinary skill in the art would have found it obvious to combine Mozgrin with Kudryavtsev, as Mozgrin itself cites Kudryavtsev. Ex. 1105 ¶ 207. Indeed, as Gillette notes, not only would a person having ordinary skill in the art have combined Mozgrin with Kudryavtsev, Mozgrin explicitly states that in "[d]esigning the unit, [Mozgrin's authors] took into account the dependencies which had been obtained in [Kudryavtsev] of ionization relaxation on pre-ionization parameters, pressure, and pulse voltage amplitude." Pet. 58–59; Ex. 1102, 401. 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 Mozgrin's magnetron sputtering system with a reasonable expectation of success. Moreover, Dr. Bravman explains that such an artisan would have known how to apply Kudryavtsev's model to Mozgrin's system by making any necessary changes to accommodate the differences through routine experimentation. Ex. 1127 ¶ 71. Based on the evidence before us, we credit the testimony of Mr. DeVito and Dr. Bravman (Ex. 1105 ¶ 207; Ex. 1127 ¶ 71) because their explanations are consistent with the prior art of record.

For the reasons stated above, we are persuaded Gillette has demonstrated, by a preponderance of the evidence, that the combination of Mozgrin, Fortov, and Kudryavtsev discloses "the voltage pulse applied to the cathode assembly generates excites atoms in the weakly-ionized plasma and generates secondary electrons from the sputtering target, the secondary electrons ionizing the excited atoms, thereby creating the strongly-ionized plasma," as recited in claim 23. Gillette also has articulated a reason with rational underpinning why one of ordinary skill in the art would have combined the teachings of Mozgrin, Fortov, and Kudryavtsev.

Accordingly, we determine that Gillette has demonstrated, by a preponderance of the evidence, that claim 23 is unpatentable over Mozgrin, Fortov, and Kudryavtsev.

III. CONCLUSION

For the foregoing reasons, we conclude that Gillette has demonstrated, by a preponderance of the evidence, that claims 21–33 and 40 of the '773 patent are unpatentable based on the following grounds of unpatentability:

Claim(s)	**Basis**	**References**
21, 22, 26–33, and 40	§ 103	Mozgrin and Fortov
24 and 25	§ 103	Mozgrin, Fortov, and Lantsman
23	§ 103	Mozgrin, Fortov, and Kudryavtsev

IV. ORDER

In consideration of the foregoing, it is

ORDERED that claims 21–33 and 40 of the '773 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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