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Filed on behalf of: Fujitsu Semiconductor Limited and Fujitsu Semiconductor America, Inc.
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UNITED STATES PATENT AND TRADEMARK OFFICE

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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FUJITSU SEMICONDUCTOR LIMITED AND
FUJITSU SEMICONDUCTOR AMERICA, INC.
Petitioner

v.

ZOND, INC.
Patent Owner

Case IPR_____

# PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 6,853,142 CHALLENGING CLAIMS 1, 3-10, 12, 15, 17-20 AND 42 UNDER 35 U.S.C. § 312 AND 37 C.F.R. § 42.104

# TABLE OF CONTENTS

## TABLE OF AUTHORITIES

# I. MANDATORY NOTICES

## A. Real Party-in-Interest

Fujitsu Semiconductor Limited and Fujitsu Semiconductor America, Inc. are the real parties-in-interest ("Petitioner").

## B. Related Matters

Zond has asserted U.S. Patent No. 6,853,142 ("'142 Patent") (Ex. 1001) against numerous parties in the District of Massachusetts, 1:13-cv-11570-RGS (*Zond v. Intel*); 1:13-cv-11577-DPW (*Zond v. AMD, Inc., et al*); 1:13-cv-11581-DJC (*Zond v. Toshiba Am. Elec. Comp. Inc.*); 1:13-cv-11591-RGS *(Zond v. SK Hynix, Inc.)*; 1:13-cv-11625-NMG (*Zond v. Renesas Elec. Corp*.); 1:13-cv-11634-WGY (*Zond v. Fujitsu, et al.*); and 1:13-cv-11567-DJC (*Zond v. Gillette, Co.*). Petitioner is also filing additional Petitions for *Inter Partes* review in several patents related[1] to the '142 Patent.

The below-listed claims of the '142 Patent are presently the subject of a substantially identical petition for *inter partes* review styled *Intel Corporation v. Zond, Inc.*, which was filed March 13, 2014 and assigned Case No. IPR2014-00494. Petitioner will seek joinder with that *inter partes* review under 35 U.S.C. § 315(c), 37 C.F.R. §§ 42.22 and 42.122(b).

[1] The related patents, e.g., name the same alleged inventor.

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## II. CERTIFICATION OF GROUNDS FOR STANDING

Petitioner certifies pursuant to Rule 42.104(a) that the patent for which review is sought is available for *inter partes* review and that Petitioner is not barred or estopped from requesting an inter partes review challenging the patent claims on the grounds identified in this Petition.

## III. OVERVIEW OF CHALLENGE AND RELIEF REQUESTED

Pursuant to Rules 42.22(a)(1) and 42.104(b)(1)-(2), Petitioner challenges claims 1, 3-10, 12, 15, 17-20 and 42 of the '142 Patent.

### A. Prior Art Patents and Printed Publications

The following references are pertinent to the grounds of unpatentability explained below: [2]

1. D.V. Mozgrin, *et al*, High-Current Low-Pressure Quasi-Stationary Discharge in a Magnetic Field: Experimental Research, Plasma Physics Reports, Vol. 21, No. 5, pp. 400-409, 1995 ("Mozgrin" (Ex. 1003)), which is prior art under 102(b).

2. U.S. Pat. No. 6,190,512 ("Lantsman" (Ex. 1004)), which is prior art under 102(b).

3. U.S. Pat. No. 6,413,382 ("Wang" (Ex. 1005)), which is prior art under 102(a) and (e).

### B. Grounds for Challenge

Petitioner requests cancellation of claims 1, 3-10, 12, 15, 17-20 and 42 of the '142 Patent as unpatentable under 35 U.S.C. §103. This Petition, supported by the declaration of Dr. Uwe Kortshagen ("Kortshagen Decl." (Ex. 1002))[3] filed herewith, demonstrates that there is a reasonable likelihood that Petitioner will prevail with

[2] The '142 Patent issued prior to the America Invents Act (the "AIA"). Accordingly, Petitioner has chosen to use the pre-AIA statutory framework to refer to the prior art.

[3] Dr. Kortshagen has been retained by Petitioner. The declaration at Ex. 1002 is a copy of Dr. Kortshagen's declaration filed in IPR2014-00494, discussed above.

respect to at least one challenged claim and that each challenged claim is not patentable.[4] *See* 35 U.S.C. § 314(a).

## IV. BRIEF DESCRIPTION OF TECHNOLOGY

### A. Plasma

A plasma is a collection of ions, free electrons, and neutral atoms. Kortshagen Decl. ¶ 21 (Ex. 1002). The negatively charged free electrons and positively charged ions are present in roughly equal numbers such that the plasma as a whole has no overall electrical charge. The "density" of a plasma refers to the number of ions or electrons that are present in a unit volume. Kortshagen Decl. ¶ 21 (Ex. 1002).[5]

Plasma had been used in research and industrial applications for decades before the '142 patent was filed. Kortshagen Decl. ¶ 22 (Ex. 1002). For example, sputtering is an industrial process that uses plasmas to deposit a thin film of a target

[4] The term "challenged claims" as used herein refers to claims 1, 3-10, 12, 15, 17-20 and 42 of the '142 Patent. Petitioner seeks to invalidate the remaining claims of the '142 Patent in separate petitions.

[5] The terms "plasma density" and "electron density" are often used interchangeably because the negatively charged free electrons and positively charged ions are present in roughly equal numbers in plasmas that do not contain negatively charged ions or clusters. Kortshagen Decl. ¶ 21, FN1 (Ex. 1002).

material onto a surface called a substrate (e.g., silicon wafer during a semiconductor manufacturing operation). *See also* Kortshagen Decl. ¶ 22 (Ex. 1002). Ions in the plasma strike a target surface causing ejection of a small amount of target material. Kortshagen Decl. ¶ 22 (Ex. 1002). The ejected target material then forms a film on the substrate. Kortshagen Decl. ¶ 22 (Ex. 1002).

Under certain conditions, electrical arcing can occur during sputtering. Kortshagen Decl. ¶ 23 (Ex. 1002). Arcing is undesirable because it causes explosive release of droplets from the target that can splatter on the substrate. Kortshagen Decl. ¶ 23 (Ex. 1002). The need to avoid arcing while sputtering was known long before the '142 Patent was filed. Kortshagen Decl. ¶ 23 (Ex. 1002).

**B. Ions and Excited Atoms**

Atoms have equal numbers of protons and electrons. Kortshagen Decl. ¶ 24 (Ex. 1002). Each electron has an associated energy state. Kortshagen Decl. ¶ 24 (Ex. 1002). If all of an atom's electrons are at their lowest possible energy state, the atom is said to be in the "ground state." Kortshagen Decl. ¶ 24 (Ex. 1002).

On the other hand, if one or more of an atom's electrons is in a state that is higher than its lowest possible state, then the atom is said to be an "excited atom." Kortshagen Decl. ¶ 25 (Ex. 1002). Excited atoms are electrically neutral– they have equal numbers of electrons and protons. Kortshagen Decl. ¶ 25 (Ex. 1002). A collision with a free electron (e-) can convert a ground state atom to an excited atom.

Kortshagen Decl. ¶ 25 (Ex. 1002). For example, the '142 Patent uses the following equation to describe production of an excited argon atom, Ar*, from a ground state argon atom, Ar. *See* '142 Patent at 10:12 (Ex. 1001).

$$Ar + e^- \rightarrow Ar^* + e^-$$

An ion is an atom that has become disassociated from one or more of its electrons. Kortshagen Decl. ¶ 26 (Ex. 1002). A collision between a free, high energy, electron and a ground state or excited atom can create an ion. Kortshagen Decl. ¶ 26 (Ex. 1002). For example, the '142 Patent uses the following equations to describe production of an argon ion, $Ar^+$, from a ground state argon atom, Ar, or an excited argon atom, $Ar^*$. *See* '142 Patent at 3:1 and 9:14 (Ex. 1001).

$$Ar + e^- \rightarrow Ar^+ + 2e^-$$

$$Ar^* + e^- \rightarrow Ar^+ + 2e^-$$

The production of excited atoms and ions was well understood long before the '142 patent was filed. Kortshagen Decl. ¶ 27 (Ex. 1002).

## V. OVERVIEW OF THE '142 PATENT

### A. Summary of Alleged Invention of the '142 Patent

The '142 Patent describes generating a plasma by applying an electrical pulse in a manner that allegedly reduces the probability of arcing. More specifically, the claims of the '142 Patent are generally directed to generating a, so called, "weakly-ionized plasma" and then applying an electrical pulse to increase the density of that

plasma so as to form a "strongly-ionized plasma." The weakly-ionized plasma is claimed to reduce the probability of forming an electrical breakdown condition.

Specific claims are directed to further operational details such as supplying a feed gas to the plasma, characteristics of the electrical pulse, generating a magnetic field and the type of power supply used.

### B. Prosecution History

The first substantive office action rejected all independent claims as anticipated. *See* 10/07/03 Office Action at 3 (Ex. 1007). The applicant then amended every independent claim to require "***the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition in the chamber***" or similar limitations. *See* 03/08/04 Resp. (Ex. 1008).

Following that amendment, the claims were allowed. The Notice of Allowance explicitly recites these limitations as the examiner's reasons for allowance. 03/29/04 Allowance at 2 ("The prior art neither discloses nor suggests … the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition in the chamber such as required by claims 1, 22, 43, 44…10 and 33.") (Ex. 1009). However, as explained in detail below, and contrary to the Examiner's reasons for allowance, the prior art addressed herein teaches those and all other limitations of the challenged claims. Kortshagen Decl. ¶ 31 (Ex. 1002).

# VI. OVERVIEW OF THE PRIMARY PRIOR ART REFERENCES

## A. Summary of the Prior Art

As explained in detail below, limitation-by-limitation, there is nothing new or non-obvious in the challenged claims of the '142 Patent. Kortshagen Decl. ¶ 32 (Ex. 1002).

## B. Overview of Mozgrin[6]

Mozgrin teaches forming a plasma "without forming an arc discharge." Kortshagen Decl. ¶ 33 (Ex. 1002). Fig. 7 of Mozgrin, copied below, shows the current-voltage characteristic ("CVC") of a plasma discharge. As shown, Mozgrin divides this CVC into four distinct regions.

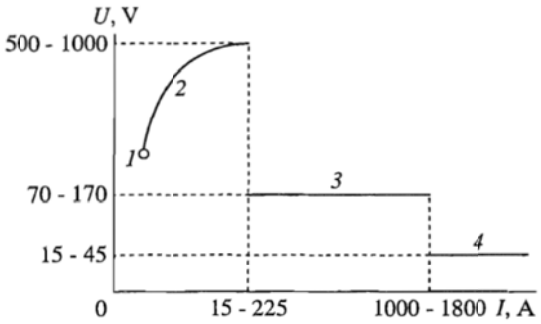


**Fig. 7.** Generalized ampere-voltaic characteristic CVC of quasi-stationary discharge.

Mozgrin calls region 1 "pre-ionization." Mozgrin at 402, right col, ¶ 2 ("Part 1 in the voltage oscillogram represents the voltage of the stationary discharge (***pre-ionization stage***)." (emphasis added)) (Ex. 1003). *See also* Kortshagen Decl. ¶ 36 (Ex. 1002).

Mozgrin calls region 2 "high current magnetron discharge." Mozgrin at 409, left col, ¶ 4 ("The implementation of the ***high-current magnetron discharge*** (regime 2)…" (emphasis added)) (Ex. 1003). *See also* Kortshagen Decl. ¶ 37 (Ex.

[6] Mozgrin is art of record, but was not substantively applied during prosecution.

1002). Application of a high voltage to the pre-ionized plasma causes the transition from region 1 to 2. Kortshagen Decl. ¶ 37 (Ex. 1002). Mozgrin teaches that region 2 is useful for sputtering. Mozgrin at 403, right col, ¶ 4 ("Regime 2 was characterized by an intense cathode sputtering…") (Ex. 1003). *See also* Kortshagen Decl. ¶ 37 (Ex. 1002).

Mozgrin calls region 3 "high current diffuse discharge." Mozgrin at 409, left col, ¶ 5, ("The ***high-current diffuse discharge*** (regime 3)…" (emphasis added)) (Ex. 1003). *See also* Kortshagen Decl. ¶ 38 (Ex. 1002). Increasing the current applied to the "high-current magnetron discharge" (region 2) causes the plasma to transition to region 3. Kortshagen Decl. ¶ 38 (Ex. 1002). Mozgrin also teaches that region 3 is useful for etching, i.e., removing material from a surface. Mozgrin at 409, left col, ¶ 5 ("The high-current diffuse discharge (regime 3) is useful … Hence, it can enhance the efficiency of ionic etching…") (Ex. 1003). *See also* Kortshagen Decl. ¶ 38 (Ex. 1002).

Mozgrin calls region 4 "arc discharge." Mozgrin at 402, right col, ¶ 3 ("…part 4 corresponds to the high-current low-voltage ***arc discharge***…" (emphasis added)) (Ex. 1003). *See also* Kortshagen Decl. ¶ 39 (Ex. 1002). Further increasing the applied current causes the plasma to transition from region 3 to the "arc discharge" region 4. Kortshagen Decl. ¶ 39 (Ex. 1002).

Within its broad disclosure of a range of issues related to sputtering and etching, Mozgrin describes arcing and how to avoid it. Kortshagen Decl. ¶ 40 (Ex. 1002).

### C. Overview of Wang[7]

Wang discloses a pulsed magnetron sputtering device having an anode (24), a cathode (14), a magnet assembly (40), a DC power supply (100) (shown in Fig. 7), and a pulsed DC power supply (80). *See* Wang at Figs. 1, 7, 3:57-4:55; 7:56-8:12 (Ex. 1005). *See also* Kortshagen Decl. ¶ 41 (Ex. 1002). Fig. 6 (annotated and reproduced below) shows a graph of the power Wang applies to the plasma. Kortshagen Decl. ¶ 41 (Ex. 1002). The lower power level, $P_B$, is generated by the DC power supply 100 (shown in Fig. 7) and the higher power level, $P_P$, is generated by the pulsed power supply 80. *See* Wang 7:56-64 (Ex. 1005); *see also* Kortshagen Decl. ¶ 41 (Ex. 1002). Wang's lower power level, $P_B$, maintains the plasma after ignition and application of the higher power level, $P_P$, raises the density of the plasma. Wang at 7:17-31 ("The background power level, $P_B$, is chosen to exceed the minimum power necessary to support a plasma... [T]he

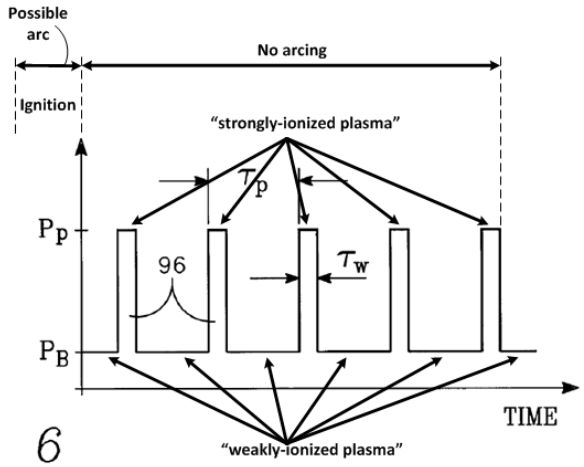

FIG. 6

[7] Wang is art of record, but was not applied substantively during prosecution.

application of the high peak power, $P_P$, quickly causes the already existing plasma to spread and increases the density of the plasma.") (Ex. 1005). *See also* Kortshagen Decl. ¶ 41 (Ex. 1002). Wang applies the teachings of Mozgrin in a commercial, industrial plasma sputtering device. Kortshagen Decl. ¶ 41 (Ex. 1002).

### D. Overview of Lantsman

Like Mozgrin and Wang, Lantsman relates to plasma sputtering systems. Lantsman at Title ("Soft Plasma Ignition in Plasma Processing Chambers") (Ex. 1004); 1:6-8 ("This invention relates to reduction of device damage in plasma processes, including DC (magnetron or non-magnetron) sputtering, and RF sputtering.") (Ex. 1004). *See also* Kortshagen Decl. ¶ 42 (Ex. 1002). Also like Mozgrin and Wang, Lantsman is concerned with generating a plasma while avoiding arcing. Lantsman at 1:51-59 ("Furthermore, arcing which can be produced by overvoltages can cause local overheating of the target, leading to evaporation or flaking of target material into the processing chamber and causing substrate particle contamination and device damage…. Thus, it is advantageous to avoid voltage spikes during processing whenever possible.") (Ex. 1004). *See also* Kortshagen Decl. ¶ 42 (Ex. 1002).

Lantsman also teaches supplying the feed gas during the entirety of the plasma processing. Lantsman at 3:9-13 ("[A]t the beginning of processing, this switch is closed and gas is introduced into the chamber. When the plasma process is

completed, the gas flow is stopped….") (Ex. 1004); 4:36-38 ("To end processing, primary supply 10 is disabled, reducing the plasma current and deposition on the wafer. Then, gas flow is terminated….") (Ex. 1004). *See also* Kortshagen Decl. ¶ 43 (Ex. 1002).

Lantsman was not art of record during the prosecution of the '142 Patent. Kortshagen Decl. ¶ 44 (Ex. 1002).

## VII. CLAIM CONSTRUCTION

A claim in *inter partes* review is given the "broadest reasonable construction in light of the specification." 37 C.F.R. § 42.100(b). Any claim term that lacks a definition in the specification is therefore also given a broad interpretation.[8] *In re ICON Health & Fitness, Inc.*, 496 F.3d 1374, 1379 (Fed. Cir. 2007). The following discussion proposes constructions of and support therefore of those terms. Any claim terms not included in the following discussion are to be given their broadest reasonable interpretation in light of the specification as commonly understood by those of ordinary skill in the art. Moreover, should the Patent Owner, in order to avoid the prior art, contend that the claim has a construction different from its

[8] Petitioner adopts the "broadest reasonable construction" standard as required by the governing regulations. 37 C.F.R. § 42.100(b). Petitioner reserves the right to pursue different constructions in a district court, where a different standard is applicable.

broadest reasonable interpretation, the appropriate course is for the Patent Owner to seek to amend the claim to expressly correspond to its contentions in this proceeding. *See* 77 Fed. Reg. 48764 (Aug. 14, 2012).

**A. "weakly-ionized plasma" and "strongly-ionized plasma"**

The challenged claims recite "weakly-ionized plasma" and "strongly-ionized plasma." These terms relate to the density of the plasma, i.e., a weakly-ionized plasma has a lower density than a strongly-ionized plasma. Kortshagen Decl. ¶ 46 (Ex. 1002). With reference to Fig. 3, the '142 Patent describes forming a weakly-ionized plasma between times $t_1$ and $t_2$ by application of the low power 302 and then goes on to describe forming a strongly-ionized plasma by application of higher power 304. '142 Patent at 11:32-38; 12:9-16 (Ex. 1001). The '142 Patent also provides exemplary densities for the weakly-ionized and strongly-ionized plasmas. *See* '142 Patent at claim 17 ("wherein the peak plasma density of the weakly-ionized plasma is less than about $10^{12}$ $cm^{-3}$"); claim 18 ("wherein the peak plasma density of the strongly-ionized plasma is greater than about $10^{12}$ $cm^{-3}$") (Ex. 1001).

Thus, the proposed construction for "weakly-ionized plasma" is "a lower density plasma." Likewise, the proposed construction for "strongly-ionized plasma" is "a higher density plasma."

Petitioner's proposed construction is consistent with the position the Patent Owner has taken in other jurisdictions. For example, the Patent Owner, when faced

with a clarity objection during prosecution of a related European patent application, argued that "it is [sic] would be entirely clear to the skilled man, not just in view of the description, that a reference to a 'weakly-ionised plasma' in the claims indicates a plasma having an ionisation level lower than that of a 'strongly-ionized plasma' and there can be no lack of clarity." 04/21/08 Response in EP 1560943 (Ex. 1014).

## VIII. SPECIFIC GROUNDS FOR PETITION

Pursuant to Rule 42.104(b)(4)-(5), the below sections, and as confirmed in the Kortshagen Decl. ¶ 49 (Ex. 1002), demonstrate in detail how the prior art discloses each and every limitation of claims 1, 3-10, 12, 15, 17-20 and 42 of the '142 Patent, and how those claims are rendered obvious by the prior art.

### A. Ground I: Claims 1, 3-10, 12, 15, 17-20 and 42 are obvious in view of the combination of Mozgrin and Lantsman

The claim chart that Petitioner served on Feb. 11, 2014 in its ongoing litigation involving the Petitioner and the Patent Owner, showing that claims 1, 3-10, 12, 15, 17-20 and 42 are obvious in view of the combination of Mozgrin and Lantsman, is submitted hereto as Exhibit 1015 (Ex. 1015). Dr. Kortshagen has reviewed the claim chart and agrees with it. Kortshagen Decl. ¶ 51 (Ex. 1002).

#### 1. Independent claim 1

##### *a) The preamble*

Claim 1 begins, "[a]n apparatus for generating a strongly-ionized plasma in a chamber." As shown in Fig. 1, Mozgrin teaches generating plasma in "two types of

devices: a planar magnetron and a system with specifically shaped hollow electrodes." Mozgrin at Fig. 1; 400, right col, ¶ 4. (Ex. 1003). *See also* Kortshagen Decl. ¶ 52 (Ex. 1002). The densities in Mozgrin's regions 1-3 are summarized below.

- Region 1: $10^9 – 10^{11}$ $cm^{-3}$.[9]
- Region 2: exceeding $2x10^{13}$ $cm^{-3}$.[10]
- Region 3: $1.5x10^{15}cm^{-3}$.[11]

Mozgrin generates a strongly-ionized plasma in both regions 2 and 3. Kortshagen Decl. ¶ 53 (Ex. 1002). The density in those regions matches the exemplary density given for a strongly-ionized plasma in the '142 Patent. '142 Patent at claim 18 ("wherein the peak plasma density of the strongly-ionized plasma

[9] Mozgrin at 401, right col, ¶2 ("For pre-ionization… the initial plasma density in the $10^9 – 10^{11}$ $cm^{-3}$ range.") (Ex. 1003).

[10] Mozgrin at 409, left col, ¶ 4 ("The implementation of the high-current magnetron discharge (regime 2) in sputtering…plasma density (exceeding 2 x $10^{13}$ $cm^{-3}$).") (Ex. 1003).

[11] Mozgrin at 409, left col, ¶5 ("The high-current diffuse discharge (regime 3) is useful for producing large-volume uniform dense plasma $n_i \cong 1.5x10^{15}$ $cm^{-3}$…") (Ex. 1003).

is greater than about $10^{12}$ $cm^{-3}$"") (Ex. 1001). *See also* Kortshagen Decl. ¶ 53 (Ex. 1002).

Finally, Mozgrin generates a strongly-ionized plasma in a chamber. For example, Mozgrin states "[t]he gas from the discharge volume was pumped out; minimal residual gas pressure was about 8 x $10^{-6}$ torr." Mozgrin at 401, left col, ¶ 3 (Ex. 1003). That is, Mozgrin pumped the gas out to achieve a desired base pressure within the chamber. *See also* Mozgrin at Figs. 1 and 6 (Ex. 1003). *See also* Kortshagen Decl. ¶ 54 (Ex. 1002).

***b) Limitation (a)***

(1) "an ionization source that generates a weakly-ionized plasma from a feed gas"

The '142 Patent uses the terms "weakly-ionized plasma" and "pre-ionized plasma" synonymously. '142 Patent at 5:18-19 ("The weakly-ionized plasma is also referred to as a pre-ionized plasma.") (Ex. 1001). Mozgrin's power supply (shown in Fig. 2) generates a pre-ionized plasma in Mozgrin's region 1. Mozgrin at 402, right col, ¶2 ("Figure 3 shows typical voltage and current oscillograms.… Part I in the voltage oscillogram represents the voltage of the stationary discharge (pre-ionization stage).") (Ex. 1003). *See also* Kortshagen Decl. ¶ 55 (Ex. 1002).

Moreover, the density of Mozgrin's pre-ionized plasma matches the exemplary density for weakly-ionized plasma given in the '142 Patent. '142 Patent at claim 17 ("wherein the peak plasma density of the ***weakly-ionized plasma is less***

***than about $10^{12}$ $cm^{-3}$***") (emphasis added) (Ex. 1001); Mozgrin at 401, right col, ¶2 ("[f]or ***pre-ionization***, we used a stationary magnetron discharge; … provided the initial ***plasma density in the $10^{9}$ – $10^{11}$ $cm^{-3}$ range***.") (Ex. 1003) (emphasis added). *See also* Kortshagen Decl. ¶ 56 (Ex. 1002).

Mozgrin also teaches generating its plasma from feed gasses such as Argon and Nitrogen. Mozgrin at 400, right col, ¶ 3 ("We investigated the discharge regimes in ***various gas mixtures*** at $10^{-3}$ – 10 torr…") (emphasis added); 402, ¶ spanning left and right cols ("We studied the high-current discharge in wide ranges of discharge current…and operating pressure…***using various gases (Ar, $N_2$, $SF_6$, and $H_2$)*** or their mixtures of various composition…") (emphasis added) (Ex. 1003). *See also* Kortshagen Decl. ¶ 57 (Ex. 1002).

> (2) "the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition in the chamber"

Mozgrin states "pre-ionization was not necessary; however, in this case, the probability of discharge transferring to arc mode increased." Mozgrin at 406, right col, ¶3 (Ex. 1003). Thus, Mozgrin teaches that failing to make the weakly-ionized plasma increases the probability of arcing and that creation of the weakly-ionized plasma (Mozgrin's region 1) reduces "the probability of developing an electrical breakdown condition in the chamber." Kortshagen Decl. ¶ 58 (Ex. 1002).

(a) The Patent Owner mischaracterized Mozgrin during prosecution of the related U.S. Pat. No. 7,147,759

The '142 Patent (Ex. 1001) and the '759 Patent (Ex. 1010) name the same inventor and are owned by a common assignee. Both patents are asserted in related litigation. During prosecution of the '759 Patent, the Patent Owner argued that Mozgrin does not teach "without forming an arc." *See* 05/02/06 Resp. of '759 Patent file history at 2, 5, 7 and 13-16 (Ex. 1011). However, the Patent Owner was wrong. Kortshagen Decl. ¶ 59 (Ex. 1002). Mozgrin does teach "without forming an arc" as required by the '759 patent as well as "reducing the probability of developing an electrical breakdown condition" as required by the '142 patent. *Id.* (Ex. 1002).

As shown in Mozgrin's Fig. 7, if voltage is steadily applied, and current is allowed to grow, the plasma will eventually transition to the arc discharge region (Mozgrin's region 4). However***, if the current is limited, the plasma will remain in the arc-free regions 2 (sputtering) or 3 (etching)***. *Id.* at ¶ 60 (Ex. 1002).

Mozgrin is an academic paper and it explores all regions, including the arc discharge region, so as to fully characterize the plasma. *Id.* at ¶ 61 (Ex. 1002). ***But Mozgrin's discussion of arcing does not mean that arcing is inevitable.*** *Id.* (Ex. 1002). ***Rather, Mozgrin's explanation of the conditions under which arcing occurs provides a recipe for avoiding arcs***. *Id.* (Ex. 1002). Mozgrin explicitly notes that arcs can be avoided. *See* Mozgrin at 400, left col, ¶ 3 ("Some experiments on

magnetron systems of various geometry showed that discharge regimes ***which do not transit to arcs*** can be obtained even at high currents.") (emphasis added) (Ex. 1003). *See also* Kortshagen Decl. ¶ 61 (Ex. 1002).

One of ordinary skill would understand that the arc discharge region should be avoided during plasma generation that is used for applications such as sputtering or etching. *Id.* at ¶ 62 (Ex. 1002). For example, Plasma Etching: An Introduction, by Manos and Flamm ("Manos"), a well-known textbook on plasma processing, which was published in 1989, over a decade before the '142 Patent was filed, states that "***arcs***…***are a problem***…" Manos at 231 (emphasis added) (Ex. 1006).

One of ordinary skill would further understand that Mozgrin's arc region can be avoided, such as by generating a weakly-ionized plasma as explained above. Kortshagen Decl. ¶ 63 (Ex. 1002). Mozgrin's determination of conditions that cause transition to the arc regime is useful because it teaches one of ordinary skill how to avoid arcs. *Id.* (Ex. 1002).

Specifically, one of ordinary skill reading Mozgrin would understand that controlling discharge parameters, such as by generating the weakly-ionized plasma, causes the plasma to remain in the arc-free regions 2 (sputtering) or 3 (etching). *See* Mozgrin at 406, right col, ¶3 (Ex. 1003). *See also* Kortshagen Decl. ¶ 64 (Ex. 1002).

***c) Limitation (b)***

> (1) "a power supply that supplies power to the weakly-ionized plasma though [sic] an electrical pulse applied across the weakly-ionized plasma"

Mozgrin's Fig. 3(b) shows a voltage pulse, which is an "electrical pulse," generated by the "high-voltage supply unit" of Mozgrin's power supply (shown in Mozgrin's Fig. 2 (Ex. 1003)). *Id.* at ¶ 65 (Ex. 1002). Region 1 of Mozgrin's Fig. 3(b) represents the voltage used for pre-ionization, corresponding to generation of the weakly-ionized plasma. Mozgrin at 402, right col, ¶ 2 ("Part 1 in the voltage oscillogram represents the voltage of the stationary discharge (pre-ionization stage).") (Ex. 1003). *See also* Kortshagen Decl. ¶ 65 (Ex. 1002). Region 2a of Mozgrin's Fig. 3(b) represents a voltage pulse that is applied across, and supplies power to, the weakly-ionized plasma. Mozgrin at 401, left col, ¶ 4 ("[A]pplying a square voltage pulse to the discharge gap ***which was filled up with*** either neutral or ***pre-ionized gas***.") (emphasis added) (Ex. 1003). *See also* Kortshagen Decl. ¶ 65 (Ex. 1002).

> (2) "the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma"

Mozgrin's voltage pulse has both a magnitude and a rise time. *Id.* at ¶ 66 (Ex. 1002). Table 1 of Mozgrin shows the parameters, including voltage, used in Mozgrin's region 2. Mozgrin at 406, right col, ¶ 2 ("Table 1 presents parameter ranges corresponding to regime 2.") (Ex. 1003). As shown in Mozgrin's Table 1,

the voltage in region 2 was controlled in a series of experiments to be in sub-ranges of 260-1100 Volts (e.g., in one experiment being controlled to 260-990 Volts). Mozgrin at 406, Table 1 (Ex. 1003). *See also* Kortshagen Decl. ¶ 66 (Ex. 1002). Mozgrin's voltage pulse therefore has a magnitude. *Id.* (Ex. 1002). Mozgrin's voltage pulse also has a rise time. Mozgrin at 401, right col, ¶ 1 ("[t]he power supply was able to deliver square voltage and current pulses with [rise] times (leading edge) of 5 – 60 μs ….") (Ex. 1003). *See also* Kortshagen Decl. ¶ 66 (Ex. 1002).

Mozgrin's applied voltage pulse increases the plasma density from $10^9 – 10^{11}$ $cm^{-3}$ in region 1 to greater than $10^{13}$ $cm^{-3}$ in regions 2 and 3. *Id.* at ¶ 67 (Ex. 1002). Mozgrin therefore teaches generating a strongly-ionized plasma. *Id.* (Ex. 1002).

Because Mozgrin's pulse created a strongly-ionized plasma, its magnitude and rise time were sufficient to generate a strongly-ionized plasma. *Id.* at ¶ 68 (Ex. 1002).

***d) Limitation (c)***

(1) "a gas line that supplies feed gas"

Use of gas feed lines in sputtering chambers was notoriously well known before the '142 Patent. *Id.* at ¶ 69 (Ex. 1002). To illustrate examples of gas feed lines in typical sputtering systems, Fig. 3-13 of Ohring (Ex. 1012) and Fig. 3-1 of Smith (Ex. 1013) are copied below. Ohring and Smith are both well-known text

books and represent background knowledge that one of ordinary skill would have in mind while reading Mozgrin. Kortshagen Decl. ¶ 69 (Ex. 1002).

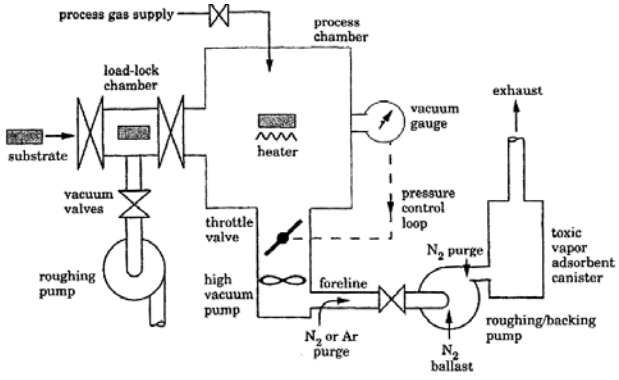


Figure 3.1 Typical vacuum-system components for thin-film deposition.

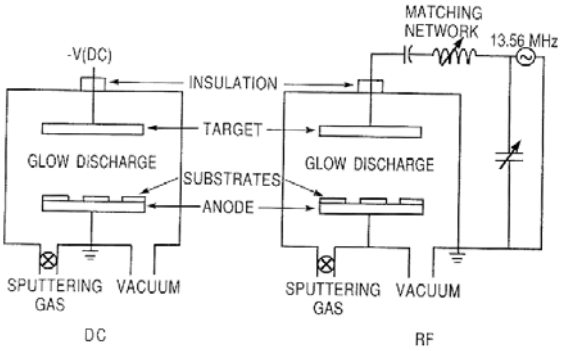


**Figure 3-13.** Schematics of simplified sputtering systems: (a) dc, (b) RF.

Both Figs. show a chamber that is connected to both (a) a source of sputtering (or "process") gas via a gas line and (b) a vacuum pump. *Id.* at ¶ 70 (Ex. 1002). Further, both Figs. show a valve in the gas line for controlling the flow of gas into the chamber. *Id.* (Ex. 1002). Smith describes the valve as follows, "Process gasses and vapors are metered into the chamber through mass flow-controlled supply lines…." Smith at 35, ¶2 (Ex. 1013). Use of gas feed lines, gas control valves, and vacuum pumps are so notoriously well known, they are often omitted from references related to plasma and sputtering. Kortshagen Decl. ¶ 70 (Ex. 1002). They need not be discussed in references because those of ordinary skill know that they are there. *Id.* (Ex. 1002).

Also, the Patent Owner admitted that use of gas feed lines was known in the art. '142 Patent at 2:21-34 ("FIG. 1 illustrates a cross-sectional view of a ***known plasma generating apparatus 100***…. ***A feed gas from feed gas source 109, such as***

***an argon gas source, is introduced into the vacuum chamber 104 through a gas inlet 110***. The gas flow is controlled by a valve 112.") (emphasis added) (Ex. 1001); Fig. 1 (Ex. 1001). *See also* Kortshagen Decl. ¶ 71 (Ex. 1002).

Mozgrin discloses "[A]pplying a square voltage pulse to the discharge gap ***which was filled up with*** either neutral or ***pre-ionized gas***." Mozgrin at 401, left col, ¶ 4 (emphasis added) (Ex. 1003). Lantsman also discloses providing a gas during processing. Lantsman at 5:39-42 ("Sometime thereafter, gas flow is initiated and the gas flow and pressure (trace 48) begin to ramp upwards toward normal processing levels."); Fig. 6 (Ex. 1006). *See also* Kortshagen Decl. ¶ 72 (Ex. 1002). One of ordinary skill would have understood that Mozgrin and Lantsman used a gas line and valve, such as those illustrated in Ohring and Smith, for controlling the exchange of gas into and out of the plasma chamber. *Id.* (Ex. 1002).

> (2) "to the strongly-ionized plasma, the feed gas diffusing the strongly-ionized plasma, thereby allowing additional power from the pulsed power supply to be absorbed by the strongly-ionized plasma"

It would have been obvious to one of ordinary skill to continue to add and remove (i.e., exchange) the feed gas in Mozgrin during production of the strongly-ionized plasma (i.e., during either of regions 2 or 3). *Id.* at ¶ 73 (Ex. 1002). Such exchange of the feed gas into and out of Mozgrin's chamber would have both diffused the strongly-ionized plasma and allowed additional power from Mozgrin's repeating voltage pulses to be absorbed by the strongly-ionized plasma as required

by claim 1[12]. *See* Mozgrin at ¶ spanning pp. 403-404 ("The … repetition frequency was 10 Hz….") (Ex. 1003). *See also* Kortshagen Decl. ¶ 73 (Ex. 1002). One of ordinary skill would have further understood that there is nothing inventive about this portion of claim 1 – it merely recites the natural consequence of exchanging gas during processing, e.g., by adding gas to balance gas withdrawn by the vacuum system. *Id.* (Ex. 1002).

Lantsman explicitly discloses supplying the feed gas during the entirety of the plasma processing. Lantsman at 3:9-13 ("[A]t the beginning of processing, this switch is closed and gas is introduced into the chamber. When the plasma process is completed, the gas flow is stopped….") (Ex. 1004); 4:36-38 ("To end processing, primary supply 10 is disabled, reducing the plasma current and deposition on the wafer. Then, gas flow is terminated….") (Ex. 1004). *See also* Kortshagen Decl. ¶ 74 (Ex. 1002).

Fig. 6 of Lantsman further clarifies that gas flows into the chamber throughout the plasma processing. *Id.* at ¶ 75 (Ex. 1002). In Figure 6, trace 48 indicates when gas is flowing into the chamber. Lantsman at 5:39-42 ("Sometime

[12] The continuous exchange of gas into and out of the magnetron chamber diffuses the plasma, results in higher rate of plasma generation and higher power absorption, compared to discharges without gas exchange. Kortshagen Decl. ¶ 73 FN8 (Ex. 1002)

thereafter, gas flow is initiated and the gas flow and pressure (trace 48) begin to ramp upwards toward normal processing levels.") (Ex. 1004). *See also*

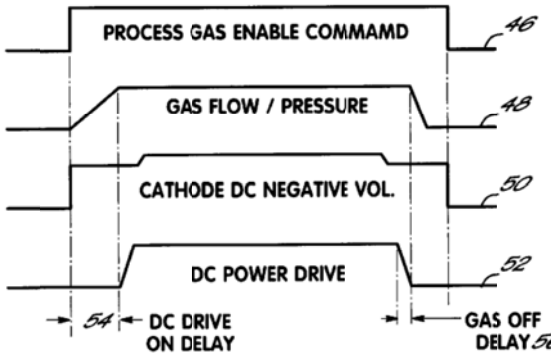

FIG. 6

Kortshagen Decl. ¶ 75 (Ex. 1002). As shown in Fig. 6 by trace 48 and reference characters 54 and 56, gas flow ramps up at the beginning of processing and ramps down at the conclusion of processing. See Lantsman at 5:42-45 (Ex. 1004). *See also* Kortshagen Decl. ¶ 75 (Ex. 1002).

Lantsman discloses both pre-ionization and deposition phases as part of its processing, and teaches that gas flows into the chamber during the entirety of that processing. *See* Lantsman at 2:48-51 ("This secondary power supply 'pre-ignites' the plasma so that when the primary power supply is applied, the system smoothly transitions to final plasma development and deposition.") (Ex. 1004). *See also* Kortshagen Decl. ¶ 76 (Ex. 1002).

Lantsman's pre-ionization corresponds to Mozgrin's region 1 and Lantsman's deposition corresponds to Mozgrin's region 2. *Id.* at ¶ 77 (Ex. 1002). It would have been obvious to one of ordinary skill to continue to apply the feed gas during Mozgrin's regions 1 and 2 as taught by Lantsman. *Id.* (Ex. 1002). Such a continuous introduction of feed gas balances gas withdrawn by the vacuum system

(e.g., as shown above in the drawings from Ohring and Smith) so as to maintain a desired pressure. *Id.* (Ex. 1002).

One of ordinary skill would have been motivated to combine Mozgrin and Lantsman. *Id.* at ¶ 78 (Ex. 1002). Both Mozgrin and Lantsman are directed to sputtering using plasma. *See* Mozgrin at 409, left col, ¶ 4 ("The implementation of the high-current magnetron discharge (regime 2) in sputtering or layer-deposition technologies provides an enhancement in the flux of deposited materials and plasma density….") (Ex. 1003); *see also* Lantsman at 1:6-8 ("This invention relates to reduction of device damage in plasma processes, including DC (magnetron or non-magnetron) sputtering, and RF sputtering.") (Ex. 1004). *See also* Kortshagen Decl. ¶ 78 (Ex. 1002). Both references also relate to sputtering systems that use two power supplies, one for pre-ionization and one for deposition. *See* Lantsman at 4:45-47 ("[T]he secondary [power] supply 32 is used to pre-ignite the plasma, whereas the primary [power] supply 10 is used to generate deposition.") (Ex. 1004); *See* Mozgrin at Fig. 2. [*showing the "high-voltage supply unit" and the "stationary discharge supply unit*"] (Ex. 1003). *See also* Kortshagen Decl. ¶ 78 (Ex. 1002).

Moreover, both Mozgrin and Lantsman are concerned with generating plasma while avoiding arcing. *See* Mozgrin at 400, right col, ¶ 3 ("The main purpose of this

work was to study experimentally a high-power noncontracted[13] quasi-stationary discharge in crossed fields of various geometry and to determine their parameter ranges.") (Ex. 1003); *see also* Lantsman at 1:51-59 ("Furthermore, arcing which can be produced by overvoltages can cause local overheating of the target, leading to evaporation or flaking of target material into the processing chamber and causing substrate particle contamination and device damage…. Thus, it is advantageous to avoid voltage spikes during processing whenever possible.") (Ex. 1004). *See also* Kortshagen Decl. ¶ 79 (Ex. 1002).

Summarizing, Mozgrin and Lantsman relate to the same application. *Id.* at ¶ 80 (Ex. 1002). Further, one of ordinary skill would have been motivated to use Lantsman's continuous gas flow in Mozgrin so as to maintain a desired pressure in the chamber. *Id.* (Ex. 1002). Finally, use of Lantsman's continuous gas flow in Mozgrin would have been a combination of old elements in which each element behaved as expected. *Id.* (Ex. 1002).

Accordingly, the combination of Mozgrin and Lantsman teach the claimed "gas line…," performing the function of "diffusing the strongly-ionized plasma with additional feed gas thereby allowing the strongly-ionized plasma to absorb additional energy from the power supply." *Id.* at ¶ 81 (Ex. 1002).

[13] "Noncontracted" discharge means formation of plasma without arcing. Kortshagen Decl. ¶ 79, FN 11 (Ex. 1002).

In summary, the chart below identifies how claim 1 of the '142 Patent is rendered unpatentable by the combination of Mozgrin and Lantsman.

| | |
|---|---|
| 1. An apparatus for generating a strongly-ionized plasma in a chamber, the apparatus comprising: | *See, e.g.,* Mozgrin at 406 at Table 1; 407 at Table 2; 409, left col, ¶¶ 4-5 (Ex. 1003) |
| an ionization source that generates a weakly-ionized plasma from a feed gas, the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition in the chamber; | *See, e.g.,* Mozgrin at 400, right col, ¶ 3; 401, right col, ¶2; 402, right col, ¶ 2; 402, ¶ spanning left and right cols; 406, right col, ¶3 (Ex. 1003)<br><br>See, e.g., Mozgrin at Fig. 7; 400, left col, ¶ 3; 400, right col, ¶ 1; 403, left col, ¶ 2; 404, left col, ¶ 4; 406, right col, ¶ 3 (Ex. 1003). |
| a power supply that supplies power to the weakly-ionized plasma though an electrical pulse applied across the weakly-ionized plasma, the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma; and | *See, e.g.,* Mozgrin at Figs. 2, 3; 401, left col, ¶ 4; 401, right col, ¶ 1; 402, right col, ¶ 2; 403, right col, ¶4; 406, right col, ¶ 2; Table 1; 409, left col, ¶ 4 (Ex. 1003) |
| a gas line that supplies feed gas to the strongly-ionized plasma, the feed gas diffusing the strongly-ionized plasma, thereby allowing additional power from the pulsed power supply to be absorbed by the strongly-ionized plasma. | *See, e.g.,* Lantsman at Fig. 6; 1:6-8; 1:51-59; 2:48-51; 3:9-13; 4:36-38; 4:45-47; 5:39-45 (Ex. 1004).<br><br>*See, e.g.,* Mozgrin at Fig. 2; 400, right col, ¶ 3; 409, left col, ¶ 4 (Ex. 1003). |

2. Independent claim 10

***a) The preamble***

The preamble of claim 10 reads "[a] method for generating a strongly-ionized plasma in a chamber." The preamble of claim 10 is taught by Mozgrin as explained above with respect to the preamble of claim 1. Kortshagen Decl. ¶ 83 (Ex. 1002).

***b) Limitation (a)***

Limitation (a) of claim 10 reads "ionizing a feed gas to form a weakly-ionized plasma that reduces the probability of developing an electrical breakdown condition in the chamber" and is taught by Mozgrin as explained above with respect to limitation (a) claim 1. *Id.* at ¶ 84 (Ex. 1002).

***c) Limitation (b)***

Limitation (b) of claim 10 reads "supplying power to the weakly-ionized plasma by applying an electrical pulse across the weakly-ionized plasma, the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma" and is taught by Mozgrin as explained above with respect to limitation (b) of claim 1. *Id.* at ¶ 85 (Ex. 1002).

***d) Limitation (c)***

Limitation (c) of claim 10 reads "diffusing the strongly-ionized plasma with additional feed gas thereby allowing the strongly-ionized plasma to absorb additional energy from the power supply" and is taught by the combination of Mozgrin and Lantsman as explained above with respect to limitation (c) of claim 1. *Id.* at ¶ 86 (Ex. 1002).

In summary, the chart below identifies how claim 10 of the '142 Patent is rendered unpatentable by the combination of Mozgrin and Lantsman.

| | |
|---|---|
| 10. A method for generating a strongly-ionized plasma in a chamber, the method comprising: | *See, e.g.,* Mozgrin at 406 at Table 1; 407 at Table 2; 409, left col, ¶¶ 4-5 (Ex. 1003) |
| ionizing a feed gas to form a weakly-ionized plasma that reduces the probability of developing an electrical breakdown condition in the chamber; | *See, e.g.,* Mozgrin at 400, right col, ¶ 3; 401, right col, ¶2; 402, right col, ¶ 2; 402, ¶ spanning left and right cols; 406, right col, ¶3 (Ex. 1003)<br><br>See, e.g., Mozgrin at Fig. 7; 400, left col, ¶ 3; 400, right col, ¶ 1; 403, left col, ¶ 2; 404, left col, ¶ 4; 406, right col, ¶ 3 (Ex. 1003). |
| supplying power to the weakly-ionized plasma by applying an electrical pulse across the weakly-ionized plasma, the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma; and | *See, e.g.,* Mozgrin at Figs. 2, 3; 401, left col, ¶ 4; 401, right col, ¶ 1; 402, right col, ¶ 2; 403, right col, ¶4; 406, right col, ¶ 2; Table 1; 409, left col, ¶ 4 (Ex. 1003) |
| diffusing the strongly-ionized plasma with additional feed gas thereby allowing the strongly-ionized plasma to absorb additional energy from the power supply. | *See, e.g.,* Lantsman at Fig. 6; 1:6-8; 1:51-59; 2:48-51; 3:9-13; 4:36-38; 4:45-47; 5:39-45 (Ex. 1004).<br><br>*See, e.g.,* Mozgrin at Fig. 2; 400, right col, ¶ 3; 409, left col, ¶ 4 (Ex. 1003). |

3. Dependent claims 3-9, 12, 15, 17-20 and 42

**Claims 3 and 12** depend from claims 1 and 10, respectively. Claim 3 recites "wherein the gas line supplies additional feed gas that exchanges the weakly-ionized plasma while applying the electrical pulse across." Claim 12 recites "further comprising exchanging the weakly-ionized plasma with additional feed gas."

As explained above with respect to limitation (c) of claim 1, Lantsman teaches supplying feed gas during the entirety of plasma processing. Kortshagen Decl. ¶ 89 (Ex. 1002). For the same reason that one of ordinary skill would have

added feed gas to the plasma in Mozgrin's region 2 (as explained above with respect to claim 1), one of ordinary skill would have also added feed gas to the plasma in Mozgrin's region 1. *Id.* (Ex. 1002). Mozgrin's region 1 has a weakly-ionized plasma and corresponds to Lantsman's pre-ionization phase. *Id.* (Ex. 1002). One of ordinary skill would have added feed gas to the plasma in Mozgrin's region 1 so as to maintain a desired pressure in the chamber. *Id.* (Ex. 1002). Such addition of gas would have exchanged the weakly-ionized plasma with additional feed gas. *Id.* (Ex. 1002). One of ordinary skill would have further understood that there is nothing inventive about claims 3 and 12 – they merely recite the natural consequence of exchanging gas during processing, e.g., by adding gas to balance gas withdrawn by the vacuum system. *Id.* (Ex. 1002). The combination of Mozgrin and Lantsman therefore teaches the limitations added by claims 3 and 12. *Id.* (Ex. 1002).

**Claim 4** depends from claim 1 and recites "wherein the power supply generates a constant power."

Fig. 4 of the '142 Patent shows voltage, current and power generated by the power supply and applied to the plasma. *See, e.g.,* '142 Patent, 12:47-51 (Ex. 1001). The lower portion of Fig.4 (which shows power on the Y-axis) shows a constant power segment between $t_1$ and $t_2$. '142 Patent, 12:66-67 ("Between time $t_1$ and time $t_2$, the voltage 326, the current 328, and the power 330 remain constant…."). Fig. 4

shows two other constant power segments between (a) $t_5$ and $t_6$ and (b) $t_6$ and $t_7$. Kortshagen Decl. ¶ 91 (Ex. 1002).

Figs. 3(b) and 3(a) of Mozgrin shows the voltage and current, respectively (both of which are nearly identical to that of Fig. 4 of the '142 Patent), generated by the power supply and applied to the plasma (Mozgrin's power supply is shown in Fig. 2). Mozgrin's Fig. 3 does not have a separate graph for power, but because power equals voltage times current, Mozgrin's Fig. 3 discloses the power generated by the supply[14]. Kortshagen Decl. ¶ 92 (Ex. 1002). As shown, the power applied to the plasma in Mozgrin's region 3 is constant (i.e., the voltage and current are both constant in that region). *Id.* (Ex. 1002). Therefore, Mozgrin teaches the limitation of claim 4, "wherein the power supply generates a constant power." *Id.* (Ex. 1002).

Moreover, Lantsman teaches that power supplies that generate constant power were well known. Lantsman at 1:22-24 ("***A typical DC power supply*** 10 includes a relatively sophisticated control system, designed to ***permit operation in constant power***, constant voltage, or constant current modes.") (emphasis added) (Ex. 1004). The combination of Mozgrin and Lantsman therefore also teaches the limitation of claim 4. Kortshagen Decl. ¶ 93 (Ex. 1002).

[14] Mozgrin's Fig. 3 represents measured data from an actual experiment, so the traces are not perfectly horizontal, as shown in the idealized Fig. 4 of the '142 Patent. Kortshagen Decl. ¶ 92, FN12 (Ex. 1002).

**Claim 5** depends from claim 1 and recites "wherein the power supply generates a constant voltage."

As noted above with respect to claim 4, Mozgrin discloses a power supply that generates a constant voltage, as illustrated in region 3 of Mozgrin's Fig. 3(b). Kortshagen Decl. ¶ 95 (Ex. 1002). Moreover, Lantsman teaches that power supplies that generate constant voltage were well known. Lantsman at 1:22-24 ("***A typical DC power supply*** 10 includes a relatively sophisticated control system, designed to ***permit operation in*** constant power, ***constant voltage***, or constant current modes.") (emphasis added) (Ex. 1004). The combination of Mozgrin and Lantsman therefore also teaches the limitation of claim 5. Kortshagen Decl. ¶ 95 (Ex. 1002).

**Claim 6** depends from claim 1 and recites "wherein the ionization source is chosen from the group comprising an electrode coupled to a DC power supply..."

Mozgrin explains that the stationary discharge supply unit of the power supply unit shown in Fig. 2 is a DC power supply. Mozgrin at 401, left col, ¶ 5 ("…The pre-ionization system provided direct current up to 0.3A and voltage up to 3 kV.") (emphasis added) (Ex. 1003). *See also* Kortshagen Decl. ¶ 97 (Ex. 1002). Moreover, either of the anode or cathode shown in Mozgrin's Fig. 1 satisfy the "electrode" limitation of claim 6. *Id.* (Ex. 1002).

**Claims 7 and 20** depend from claims 1 and 10, respectively. Claim 7 recites "further comprising a magnet that is positioned to generate a magnetic field

proximate to the weakly-ionized plasma, the magnetic field trapping electrons in the weakly-ionized plasma." Claim 20 recites "further comprising generating a magnetic field proximate to the weakly-ionized plasma, the magnetic field trapping electrons in the weakly-ionized plasma.

In Fig. 1 of Mozgrin, the magnets are labeled "3." *Id.* at ¶ 99 (Ex. 1002). The field generated by those magnets extends through the cathode "2," anode "1," and the space between them. Mozgrin at 401, left col, ¶ 1 ("The electrodes were immersed in a magnetic field of annular permanent magnets.") (Ex. 1003). *See also* Kortshagen Decl. ¶ 99 (Ex. 1002). Further, Mozgrin's magnetic field is proximate to the weakly-ionized plasma, because the weakly-ionized plasma is generated between the electrodes that were immersed in the magnetic field. *See* Mozgrin at 401, left col, ¶ 1 ("The [plasma] discharge had an annular shape and was ***adjacent to the cathode***.") (emphasis added) (Ex. 1003); 401, right col, ¶2 ("We found out that only the regimes with magnetic field strength not lower than 400 G provided the initial plasma density in the $10^{9}$-$10^{11}$ $cm^{-3}$ range.") (Ex. 1003). *See also* Kortshagen Decl. ¶ 99 (Ex. 1002).

The '142 Patent admits that prior art magnetrons trap electrons. '142 Patent at 1:41-43 [*in the Background of the Invention*] ("Magnetron sputtering systems use magnetic fields that are shaped to trap and concentrate secondary electrons…") (Ex. 1001). *See also* Kortshagen Decl. ¶ 100 (Ex. 1002). Like the prior art

acknowledged by the '142 Patent, Mozgrin's magnetic field traps electrons thereby enhancing collisions between electrons and gas particles. Mozgrin at 407, left col, ¶ 3 ("The action of ***the magnetic field serves*** only to limit the electron thermal conductivity and ***to provide collisions sufficient for efficient energy transfer from electrons to heavy particles***.") (emphasis added) (Ex. 1003). *See also* Kortshagen Decl. ¶ 100 (Ex. 1002). Therefore, Mozgrin teaches the limitations of claims 7 and 20. *Id.* (Ex. 1002).

**Claim 8** depends from claim 7 and recites "wherein the magnet comprises an electro-magnet." Fig. 1b of Mozgrin shows a shaped-electrode magnetron. Mozgrin at 401, right col, Fig. 1 caption, ("Fig. 1. Discharge device configurations: (a) planar magnetron; (b) shaped-electrode configuration…") (Ex. 1003). In Mozgrin's shaped-electrode magnetron, magnet 3 is an electro-magnet. Mozgrin at 401, left col, ¶ 2 ("The system with shaped electrodes involved two axisymmetrical electrodes 120 mm in diameter separated by about 10 mm, and immersed in a cusp-shaped ***magnetic field produced by oppositely directed multilayer coils***. The values of $B_{max}$ were controlled by coil current variation to range from 0 to 1000 G.") (emphasis added) (Ex. 1003). *See also* Kortshagen Decl. ¶ 101 (Ex. 1002).

**Claim 9** depends from claim 7 and recites "wherein the magnet is movable." Mozgrin discloses that "[t]o control the magnetic field strength at the cathode surface, we displaced the magnetic system along the axis z (Fig. 1)…" Mozgrin at

401, left col, ¶ 1 (Ex. 1003). Hence, Mozgrin discloses a movable magnet. *See also* Kortshagen Decl. ¶ 102 (Ex. 1002).

**Claim 15** depends from claim 10 and recites "further comprising selecting at least one of a pulse amplitude and a pulse width of the electrical pulse in order to cause the strongly-ionized plasma to be substantially uniform."

As discussed above with respect to claim 1, Mozgrin teaches using a pulse amplitude (or "magnitude") of the electrical pulse that is sufficient to generate the strongly-ionized plasma, such as in region 2. Kortshagen Decl. ¶ 104 (Ex. 1002).

Mozgrin further teaches generation of a strongly-ionized plasma that is uniform in region 2 near the cathode. Mozgrin, at 403, left col, last ¶ ("…being transferred to the high-current regime, the discharge expands over a considerably larger area of the cathode surface than it occupied in the stationary pre-ionization regime.") (Ex. 1003). *See also* Kortshagen Decl. ¶ 105 (Ex. 1002). One of ordinary skill would understand that such an expanded plasma discharge is substantially uniform. *Id.* (Ex. 1002). Mozgrin's voltage pulse also has a width, shown in region 2a of Fig. 3(b). Mozgrin at Fig. 3(b) (Ex. 1003). *See also* Kortshagen Decl. ¶ 105 (Ex. 1002).

Mozgrin's pulse, which was characterized by a particular amplitude and pulse width, produces a substantially uniform plasma. *Id.* at ¶ 106 (Ex. 1002). Mozgrin therefore teaches the limitation of claim 15. *Id.* (Ex. 1002).

**Claim 17** depends from claim 10 and recites "wherein the peak plasma density of the weakly-ionized plasma is less than about $10^{12}$ $cm^{-3}$."

Mozgrin's region 1, pre-ionized, plasma is the claimed "weakly-ionized plasma." Kortshagen Decl. ¶ 108 (Ex. 1002). Mozgrin's pre-ionized plasma has a density of $10^{9}$ – $10^{11}$ $cm^{-3}$, which satisfies the requirement of claim 17. Mozgrin at 401, right col. ¶ 2 ("For pre-ionization, … the initial plasma density [is] in the $10^{9}$ – $10^{11}$ $cm^{-3}$ range….") (Ex. 1003) . *See also* Kortshagen Decl. ¶ 108 (Ex. 1002).

**Claim 18** depends from claim 10 and recites "wherein the peak plasma density of the strongly-ionized plasma is greater than about $10^{12}$ $cm^{-3}$."

As explained above with respect to claim 1, the plasma in either of Mozgrin's region 2 or 3 corresponds to the claimed "strongly-ionized plasma." *Id.* at ¶ 110 (Ex. 1002). Mozgrin measured the density of the plasma in region 2 as exceeding $2x10^{13}$ $cm^{-3}$. Mozgrin at 409, left col, ¶ 4. (Ex. 1003). Mozgrin also measured the density of the plasma in region 3 as being as high as $1.5 \times 10^{15}$ $cm^{-3}$. Mozgrin at 409, left col, last ¶. (Ex. 1003). Both of those measured densities satisfy the limitation of claim 18. Kortshagen Decl. ¶ 110 (Ex. 1002).

**Claim 19** depends from claim 10 and recites "wherein the ionizing the feed gas comprises exposing the feed gas to…an pulsed electric field…."

Fig. 1a of Mozgrin illustrates the electric field (labeled "E") for a planar magnetron. Mozgrin, at 401, Fig. 1 caption, ("Fig. 1. Discharge device

configurations: (a) planar magnetron;") (Ex. 1002). The voltage applied between the anode and cathode of that planar magnetron determines the electric field. Kortshagen Decl. ¶ 112 (Ex. 1002). The voltage pulse shown in region 2 of Mozgrin's Fig. 3 causes Mozgrin's electric field to be "pulsed" as required by claim 19. *Id.* (Ex. 1002). Moreover, Mozgrin teaches repeating its voltage pulse at a frequency of 10 Hertz. Mozgrin, at 403-404, right col, last paragraph of 403, left col, first paragraph of 404 ("The current pulse … repetition frequency was 10 Hz...") (Ex. 1003). *See also* Kortshagen Decl. ¶ 112 (Ex. 1002). Each repetition of Mozgrin's voltage pulse generates another pulse of Mozgrin's electric field and Mozgrin therefore teaches the "pulsed electric field" limitation of claim 19. *Id.* (Ex. 1002).

**Claim 42** depends from claim 1 and recites "wherein the power supply comprises the ionization source."

In claim 1, the "ionization source" generates the weakly-ionized plasma and the "power supply" generates the strongly-ionized plasma. As shown in Fig. 2, Mozgrin's power supply contains two distinct units: a stationary discharge supply unit for making the pre-ionized plasma and a high-voltage supply unit for applying pulses. Mozgrin at 401, left col, ¶5 ("Figure 2 presents a simplified scheme of the discharge supply system. The supply unit involved a pulsed discharge supply unit and a system for pre-ionization.") (Ex. 1003). *See also* Kortshagen Decl. ¶ 114 (Ex.

1002). Both of Mozgrin's units belong to a common power supply that supplies power to the cathode from a common point as shown in Fig. 2. *Id.* (Ex. 1002). Mozgrin therefore teaches the limitation of claim 42. *Id.* (Ex. 1002).

### B. Ground II: Claims 1, 3-7, 9, 10, 12, 15, 19, 20 and 42 are obvious in view of the combination of Wang and Lantsman

The claim chart that Petitioner served on Feb. 11, 2014 in its ongoing litigation involving the Petitioner and the Patent Owner, showing that claims 1, 3-7, 9, 10, 12, 15, 19, 20 and 42 are obvious in view of the combination of Wang and Lantsman, is submitted hereto as Exhibit 1016 (Ex. 1016). Dr. Kortshagen has reviewed the claim chart and agrees with it. Kortshagen Decl. ¶ 115 (Ex. 1002).

The technology described in Mozgrin has been implemented in a commercial grade sputtering system, such as is described in Wang, which is assigned to Applied Materials, Inc., one of the world's leading suppliers of sputtering tools. *Id.* at ¶ 116 (Ex. 1002).

#### 1. Independent claim 1

##### *a) The preamble*

Claim 1 begins, "[a]n apparatus for generating a strongly-ionized plasma in a chamber."

Wang generates a low density plasma during application of the background power, $P_B$, and a high density plasma during application of the peak power $P_P$. Wang at 7:17-31 ("The background power level, $P_B$, is chosen to exceed the

minimum power necessary to support a plasma... [T]he application of the high peak power, $P_P$, quickly causes the already existing plasma to spread and increases the density of the plasma.") (Ex. 1005). *See also* Kortshagen Decl. ¶ 118 (Ex. 1002). The high density plasma that Wang generates with the peak power, $P_P$, is a strongly-ionized plasma. *Id.* (Ex. 1002). Wang discloses that the background power, $P_B$, can be 1 kW and the peak power, $P_P$, can be 1000 times greater, i.e., 1 MW. Wang at 7:19-25; 7:28-30 (Ex. 1005); *see also* Kortshagen Decl. ¶ 118 (Ex. 1002). Wang also discloses that "highly ionized sputtering" occurs during application of the peak power $P_P$. Wang at 7:31-39 (Ex. 1005); *see also* Kortshagen Decl. ¶ 118 (Ex. 1002)

Finally, Wang's plasma is generated with a chamber, i.e., chamber 12 as shown in Fig. 1. (Ex. 1005). *See also* Kortshagen Decl. ¶ 119 (Ex. 1002).

(1) "an ionization source that generates a weakly-ionized plasma from a feed gas"

Wang teaches using feed gasses such as Argon and Nitrogen for forming its plasmas. *See, e.g.,* Wang at 4:5-6 ("A sputter working gas such as argon is supplied from a gas source 32…."); and 4:20-21 ("… a reactive gas, for example nitrogen is supplied to the processing space 22….") (Ex. 1005). *See also* Kortshagen Decl. ¶ 120 (Ex. 1002).

Wang generates a low density plasma with the background power, $P_B$, and a high density plasma with the peak power, $P_P$. Wang at 7:17-31 ("The background power level $P_B$ is chosen to exceed the minimum power necessary to support a

plasma... [T]he application of the high peak power $P_P$ quickly causes the already existing plasma to spread and increases the density of the plasma.") (Ex. 1005). Kortshagen Decl. ¶ 121 (Ex. 1002). Wang's low density plasma is generated using DC power supply 100, shown in Fig. 7. *See* Wang 7:56-64 (Ex. 1005); *see also* Kortshagen Decl. ¶ 121 (Ex. 1002). Wang's low density plasma causes little if any sputtering and the background power, $P_B$, used to generate it is 1000 times lower than the peak power, $P_P$. Wang at 7:19-25 ("Preferably, the peak power $P_P$ is at least 10 times the background power $P_B$ … and most preferably 1000 times to achieve the greatest effect of the invention. A background power $P_B$ of 1 kW [causes] little if any actual sputter deposition." (Ex. 1005). *See also* Kortshagen Decl. ¶ 121 (Ex. 1002).

The low density plasma that Wang generates with the background power, $P_B$ (which is 1000 times lower than the peak power), which causes little if any sputtering, is a weakly-ionized plasma. *Id.* at ¶ 122 (Ex. 1002).

> (2) "the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition in the chamber"

Wang teaches that maintaining the weakly-ionized plasma between the pulses reduces arcing, or breakdown conditions. Wang at 7:3-49 ("Plasma ignition, particularly in plasma sputter reactors, has a tendency to generate particles during the initial arcing, which may dislodge large particles from the target or chamber…

The initial plasma ignition needs be performed only once and at much lower power levels so that particulates produced by arcing are much reduced.") (Ex. 1005). *See also* Kortshagen Decl. ¶ 123 (Ex. 1002).

As shown in the annotated version of Fig. 6 above in Section VI.C, Wang teaches that arcing may occur during ignition, i.e., prior to the first pulse shown in Fig. 6, and that since the plasma need not be reignited thereafter, arcing will not occur during subsequent applications of the background and peak power levels, $P_B$ and $P_P$. *See* Wang at 7:25-28 ("As a result, once the plasma has been ignited at the beginning of sputtering prior to the illustrated waveform, no more plasma ignition occurs."). *See also* Kortshagen Decl. ¶ 124 (Ex. 1002). Wang therefore teaches that the weakly-ionized plasma reduces "the probability of developing an electrical breakdown condition." *Id.* (Ex. 1002).

***b) Limitation (b)***

(1) "a power supply that supplies power to the weakly-ionized plasma though [sic] an electrical pulse applied across the weakly-ionized plasma"

Fig. 7 of Wang shows a pulsed DC supply 80 that generates a train of voltage pulses. Wang at Fig. 7; 7:61-62 ("The pulsed DC power supply 80 produces a train of negative voltage pulses.") (Ex. 1005). *See also* Kortshagen Decl. ¶ 125 (Ex. 1002). Application of those voltage pulses to Wang's cathode 14 and anode 24 produces Wang's peak power pulses, $P_P$, which are applied to Wang's weakly-

ionized plasma, i.e., the plasma generated by the background power, $P_B$. *Id.* (Ex. 1002). Wang's power pulses, shown in Fig. 6, are "electrical pulses." *Id.* (Ex. 1002).

> (2) "the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma"

As explained above with respect to the preamble, the high density plasma that Wang generates with the peak power pulses, $P_P$, is a strongly-ionized plasma. *Id.* at ¶ 126 (Ex. 1002).

The voltage pulses disclosed in Wang have a magnitude and a rise time. Wang at 5:23-27 ("[The pulse's] exact shape depends on the design of the pulsed DC power supply 80, and significant rise times and fall times are expected.") (Ex. 1005). *See also Id.* at ¶ 127 (Ex. 1002).

Wang specifies that the background power $P_B$ can be 1 kW and that the peak power $P_P$ can be 1,000 times greater than the background power, i.e., 1 MW. Wang at 7:19-25 ("Preferably, the peak power $P_P$ is at least 10 times the background power $P_B$ … and most preferably 1000 times…. A background power $P_B$ of one kW will typically be sufficient….") (Ex. 1005). *See also* Kortshagen Decl. ¶ 128 (Ex. 1002). Wang's electrical pulses therefore have a magnitude of 1 MW. *Id.* (Ex. 1002).

Wang's pulse also has a rise time. Wang at 5:23-26 ("The illustrated pulse form is idealized. Its exact shape depends on the design of the pulsed DC power

supply 80, and significant rise times and fall times are expected.") (Ex. 1005). *See also* Kortshagen Decl. ¶ 129 (Ex. 1002).

Because Wang's pulse produce a strongly-ionized plasma, the magnitude and rise time of the pulse "is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma" as required by claim 1. *Id.* at ¶ 130 (Ex. 1002).

***c) Limitation (c)***

(1) "a gas line that supplies feed gas"

Fig. 1 of Wang shows a gas source 32 that supplies gas, such as argon, through a gas flow controller 34. *Id.* at ¶ 131 (Ex. 1002). As shown in Fig. 1, the gas is supplied by a "gas line." *Id.* (Ex. 1002).

(2) "to the strongly-ionized plasma, the feed gas diffusing the strongly-ionized plasma, thereby allowing additional power from the pulsed power supply to be absorbed by the strongly-ionized plasma"

As shown in Fig. 1, Wang's feed gas is supplied into the chamber with the strongly-ionized plasma. Wang at 4:5-6 ("A sputter working gas such as argon is supplied from a gas source 32 through a mass flow controller 34 to a region in back of the grounded shield 24.") (Ex. 1005); 4:8-10 ("The gas flows into the processing region 22 through a gap formed between the pedestal 18, the grounded shield 24, and a clamp ring or plasma focus ring 36 surrounding the periphery of the wafer 20.") (Ex. 1005). *See also* Kortshagen Decl. ¶ 132 (Ex. 1002).

One of ordinary skill would understand that Wang supplies the feed gas during the entirety of its processing. *Id.* at ¶ 133 (Ex. 1002). Fig. 1 of Wang shows a mass flow controller 34 for metering gas into the chamber. Wang at 4:51-55 ("A computerized controller 58 controls the … mass flow controller 34, as illustrated….") (Ex. 1005). *See also* Kortshagen Decl. ¶ 133 (Ex. 1002). As one of ordinary skill would understand, mass flow controllers are used in sputtering chambers like Wang's when it is desired to exchange gas into and out of a plasma chamber continuously throughout the process. *Id.* (Ex. 1002). This is because mass flow controllers are inaccurate during start up and ramp down – but they are accurate for maintaining a stable inflow that is balanced by the outflow of a vacuum system such as shown in Wang at 38. Wang at 4:11-12 ("A vacuum system 38 pumps the chamber….") (Ex. 1005). *See also* Kortshagen Decl. ¶ 133 (Ex. 1002). If Wang wanted to shut off the flow of gas during processing, one of ordinary skill would understand that Wang would have used a valve instead of a mass flow controller. Kortshagen Decl. ¶ 133 (Ex. 1002).

Further, it would have been obvious to one of ordinary skill to continue to exchange the feed gas into and out of Wang's chamber during production of the strongly-ionized plasma (i.e., during the application of the high peak power $P_P$ pulses). *Id.* at ¶ 134 (Ex. 1002). Such exchange of the feed gas into and out of Wang's chamber would have both diffused the strongly-ionized plasma and allowed

additional power from Wang's repeating voltage pulses to be absorbed by the strongly-ionized plasma as required by claim 10.[15] *See* Wang at 5:66-67 ("It is anticipated that the pulse repetition frequency is best maintained around 50 to 500 Hz.") (Ex. 1005). *See also* Kortshagen Decl. ¶ 134 (Ex. 1002). One of ordinary skill would have further understood that there is nothing inventive about this portion of claim 10 - it merely recites the natural consequence of exchanging gas during processing, e.g., by adding gas to balance gas withdrawn by the vacuum system. Kortshagen Decl. ¶ 134 (Ex. 1002). As explained above with respect to Ground I, Lantsman explicitly discloses supplying the feed gas during the entirety of the plasma processing. *Id.* (Ex. 1002).

As was also explained above with respect to Ground I, Lantsman discloses both pre-ionization and deposition phases as part of its processing and gas flows into the chamber during the entirety of that processing. See Lantsman at 2:48-51 ("This secondary power supply 'pre-ignites' the plasma so that when the primary power supply is applied, the system smoothly transitions to final plasma development and deposition.") (Ex. 1005). *See also* Kortshagen Decl. ¶ 135 (Ex. 1002).

[15] The continuous exchange of gas into and out of the magnetron chamber diffuses the plasma, results in higher rate of plasma generation and higher power absorption, compared to discharges without gas exchange. Kortshagen Decl. ¶ 134, FN 13 (Ex. 1002).

Lantsman's pre-ionization corresponds to Wang's application of background power, $P_B$, and Lantsman's deposition corresponds to Wang's application of high peak power, $P_P$. *Id.* at ¶ 136 (Ex. 1002). It would have been obvious to one of ordinary skill to continue to exchange the feed gas during Wang's application of background power and high peak power, as taught by Lantsman. *Id.* (Ex. 1002). Such a continuous introduction of feed gas balances gas withdrawn by Wang's vacuum system 38 so as to maintain a desired pressure. *Id.* (Ex. 1002).

One of ordinary skill would have been motivated to combine Wang and Lantsman. *Id.* at ¶ 137 (Ex. 1002). Both Wang and Lantsman are directed to sputtering using plasma. *See* Wang at Title (Ex. 1005); 3:20-21 (Ex. 1005); *see also* Lantsman at 1:6-8 (Ex. 1004). *See also* Kortshagen Decl. ¶ 137 (Ex. 1002). Also, both references relate to sputtering systems that use two power supplies, one for pre-ionization and one for deposition. See Wang at Fig. 7 [*showing pulsed supply 80 and constant supply 100*] (Ex. 1005); *see also* Lantsman at 4:45-47 ("…the secondary [power] supply 32 is used to pre-ignite the plasma, whereas the primary [power] supply 10 is used to generate deposition.") (Ex. 1004). *See also* Kortshagen Decl. ¶ 137 (Ex. 1002). Moreover, as explained above with respect to Ground I, Lantsman is concerned with generating plasma while avoiding arcing. *Id.* (Ex. 1002). So is Wang. Wang at 7:3-49 (Ex. 1005). *See also* Kortshagen Decl. ¶ 137 (Ex. 1002).

Summarizing, Wang and Lantsman relate to the same application. *Id.* at ¶ 138 (Ex. 1002). Further, one of ordinary skill would have been motivated to use Lantsman's continuous gas flow in Wang so as to maintain a desired pressure in the chamber. *Id.* (Ex. 1002). Also, use of Lantsman's continuous gas flow in Wang would have worked well with Wang's mass flow controller 34 and would have been a combination of old elements in which each element behaved as expected. *Id.* (Ex. 1002). Finally, such a continuous flow of gas in Wang would diffuse the strongly-ionized plasma and allow additional power to be absorbed by the plasma as required by claim 1. *Id.* (Ex. 1002).

In summary, the chart below identifies how claim 1 of the '142 Patent is rendered unpatentable by the combination of Wang and Lantsman.

| | |
|---|---|
| 1. An apparatus for generating a strongly-ionized plasma in a chamber, the apparatus comprising: | *See, e.g.,* Wang at Fig. 1; 4:29-31; 7:19-22; 7:28-30 (Ex. 1005) |
| an ionization source that generates a weakly-ionized plasma from a feed gas, the weakly-ionized plasma reducing the probability of developing an electrical breakdown condition in the chamber; | *See, e.g.,* Wang at Figs. 1, 6; 4:5-8; 4:20-21; 7:3-6; 7:13-30; 7:47-49 (Ex. 1005) |
| a power supply that supplies power to the weakly-ionized plasma though an electrical pulse applied across the weakly-ionized plasma, the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma; and | *See, e.g.,* Wang at Figs. 6, 7; 5:23-26; 7:19-25; 7:28-30; 7:61-62 (Ex. 1005) |
| a gas line that supplies feed gas to the strongly-ionized plasma, the feed gas diffusing the strongly-ionized plasma, thereby allowing additional power from the pulsed power supply to be absorbed by the | *See, e.g.,* Wang at Title; Figs. 1, 7; 4:5-6; 4:8-12; 4:51-55; 7:3-49 (Ex. 1005)<br><br>*See, e.g.,* Lantsman at 1:6-8; 1:51- |

| | |
|---|---|
| strongly-ionized plasma. | 59 2:48-51; 4:45-47 (Ex. 1004) |

2. Independent claim 10

***a) The preamble***

The preamble of claim 10 reads "[a] method for generating a strongly-ionized plasma in a chamber" and is taught by Wang as explained above with respect to the preamble of claim 1. Kortshagen Decl. ¶ 140 (Ex. 1002).

***b) Limitation (a)***

Limitation (a) of claim 10 reads "ionizing a feed gas to form a weakly-ionized plasma that reduces the probability of developing an electrical breakdown condition in the chamber" and is taught by Wang as explained above with respect to limitation (a) of claim 1. *Id.* at ¶ 141 (Ex. 1002).

***c) Limitation (b)***

Limitation (b) of claim 10 reads "supplying power to the weakly-ionized plasma by applying an electrical pulse across the weakly-ionized plasma, the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma" and is taught by Wang as explained above with respect to limitation (b) of claim 1. *Id.* at ¶ 142 (Ex. 1002).

***d) Limitation (c)***

Limitation (c) of claim 10 reads "diffusing the strongly-ionized plasma with additional feed gas thereby allowing the strongly-ionized plasma to absorb additional energy from the power supply" and is taught by the combination of Wang and Lantsman as explained above with respect to limitation (c) of claim 1. *Id.* at ¶ 143 (Ex. 1002).

In summary, the chart below identifies how claim 10 of the '142 Patent is rendered unpatentable by the combination of Wang and Lantsman.

| | |
|---|---|
| 10. A method for generating a strongly-ionized plasma in a chamber, the method comprising: | *See, e.g.,* Wang at Fig. 1; 4:29-31; 7:19-22; 7:28-30 (Ex. 1005) |
| ionizing a feed gas to form a weakly-ionized plasma that reduces the probability of developing an electrical breakdown condition in the chamber; | *See, e.g.,* Wang at Figs. 1, 6; 4:5-8; 4:20-21; 7:3-6; 7:13-30; 7:47-49 (Ex. 1005) |
| supplying power to the weakly-ionized plasma by applying an electrical pulse across the weakly-ionized plasma, the electrical pulse having a magnitude and a rise-time that is sufficient to increase the density of the weakly-ionized plasma to generate a strongly-ionized plasma; and | *See, e.g.,* Wang at Figs. 6, 7; 5:23-26; 7:19-25; 7:28-30; 7:61-62 (Ex. 1005) |
| diffusing the strongly-ionized plasma with additional feed gas thereby allowing the strongly-ionized plasma to absorb additional energy from the power supply. | *See, e.g.,* Wang at Title; Figs. 1, 7; 4:5-6; 4:8-12; 4:51-55; 7:3-49 (Ex. 1005)<br><br>*See, e.g.,* Lantsman at 1:6-8; 1:51-59 2:48-51; 4:45-47 (Ex. 1004) |

3. Dependent claims 3-7, 9, 12, 14, 15, 19, 20 and 42

**Claims 3 and 12** depend from claims 1 and 10, respectively. Claim 3 recites "wherein the gas line supplies additional feed gas that exchanges the weakly-ionized

plasma while applying the electrical pulse across." Claim 12 recites "further comprising exchanging the weakly-ionized plasma with additional feed gas."

As explained above with respect to limitation (c) of claim 1, Lantsman teaches supplying feed gas during the entirety of plasma processing. Kortshagen Decl. ¶ 146 (Ex. 1002). Wang teaches supplying feed gas into Wang's processing region 22. *Id.* (Ex. 1002). In Wang, during application of the background power, $P_B$, processing region 22 has a weakly-ionized plasma that corresponds to Lantsman's pre-ionization phase. *Id.* (Ex. 1002). One of ordinary skill would have added feed gas during application of Wang's background power, $P_B$, as taught by Lantsman, so as to maintain a desired pressure in the chamber. *Id.* (Ex. 1002). Such an addition of gas would have exchanged the weakly-ionized plasma as required by claims 3 and 12. *Id.* (Ex. 1002). One of ordinary skill would have further understood that there is nothing inventive about claims 3 and 12 – they merely recite the natural consequence of exchanging gas during processing, e.g., by adding gas to balance gas withdrawn by the vacuum system. *Id.* (Ex. 1002). The combination of Wang and Lantsman therefore teaches the limitations of claims 3 and 12. *Id.* (Ex. 1002).

**Claim 4** depends from claim 1 and recites "wherein the power supply generates a constant power."

As explained above with respect to claim 4 in Ground I, Fig. 4 of the '142 patent shows constant power segments between (a) $t_1$ and $t_2$ (b) $t_5$ and $t_6$ and (c) $t_6$ and $t_7$. *Id.* at ¶ 148 (Ex. 1002). Wang's pulsed DC power supply 80 (shown in Wang's Figs. 1 and 7) generates a peak level power, $P_P$, which is constant for the duration of the pulse $\tau_w$, as shown in Fig. 6. *Id.* (Ex. 1002).

Moreover, Lantsman teaches that power supplies that generate constant power were well known. Lantsman at 1:22-24 ("***A typical DC power supply*** 10 includes a relatively sophisticated control system, designed to ***permit operation in constant power***, constant voltage, or constant current modes.") (emphasis added) (Ex. 1004). The combination of Wang and Lantsman therefore also teaches the limitation of claim 4. Kortshagen Decl. ¶ 149 (Ex. 1002).

**Claim 5** depends from claim 1 and recites "wherein the power supply generates a constant voltage."

Wang's "pulsed DC power supply 80 produces a train of negative voltage pulses." Wang at 7:61-62 (Ex. 1005). Application of those voltage pulses to Wang's cathode 14 and anode 24 produces Wang's peak power pulses, $P_P$. Kortshagen Decl. ¶ 151 (Ex. 1002). One of ordinary skill would have understood that Wang's voltage would be constant for at least a portion of the duration of the pulse $\tau_w$ so as to produce pulse $P_P$ of constant power. *Id.* (Ex. 1002).

Moreover, Lantsman teaches that power supplies that generate constant voltage were well known. Lantsman at 1:22-24 ("***A typical DC power supply*** 10 includes a relatively sophisticated control system, designed to ***permit operation in*** constant power, ***constant voltage***, or constant current modes.") (emphasis added) (Ex. 1004). The combination of Wang and Lantsman therefore teaches the limitation of claim 5. Kortshagen Decl. ¶ 152 (Ex. 1002).

**Claim 6** depends from claim 1 and recites "wherein the ionization source is chosen from the group comprising an electrode coupled to a DC power supply..."

Wang explains that the power supply 100 connected to the cathode 14 is a DC power supply. Wang at 7:58 ("… DC power supply 100 is connected to the target 14.") (Ex. 1005); *see also* Fig. 7 (Ex. 1005). *See also* Kortshagen Decl. ¶ 154 (Ex. 1002). Moreover, the cathode 14 shown in Wang's Fig. 1 satisfies the "electrode" limitation of claim 6. *Id.* (Ex. 1002). Wang therefore teaches the limitation of claim 6. *Id.* (Ex. 1002).

**Claims 7 and 20** depend from claims 1 and 10, respectively. Claim 7 recites "further comprising a magnet that is positioned to generate a magnetic field proximate to the weakly-ionized plasma, the magnetic field trapping electrons in the weakly-ionized plasma." Claim 20 recites "further comprising generating a magnetic field proximate to the weakly-ionized plasma, the magnetic field trapping electrons in the weakly-ionized plasma.

As explained above with respect to claims 7 and 20 in Ground I, the '142 Patent admits that trapping electrons using magnetic fields was well known. '142 Patent at 1:41-43 [*in the Background of the Invention*] ("Magnetron sputtering systems use magnetic fields that are shaped to trap and concentrate secondary electrons….") (Ex. 1001). *See also* Kortshagen Decl. ¶ 156 (Ex. 1002).

Similarly, Wang discloses that "[a] small rotatable magnetron 40 is disposed in the back of the target 14 to create a magnetic field near the face of the target 14 which traps electrons from the plasma to increase the electron density." Wang at 4:23-27. (Ex. 1005). Wang's rotating magnet assembly forms a region of high density plasma, shown in Wang's Fig. 1 at 42.[16] Wang at 4:23-31 ("A small rotatable magnetron 40 … traps electrons from the plasma to increase the electron density. For charge neutrality, the ion density also increases, thus creating a region 42 of a high-density plasma (HDP)…") (Ex. 1005). *See also* Kortshagen Decl. ¶ 157 (Ex. 1002). Because it is created by the magnetron 40, Wang's HDP region 42 is proximate to the magnetic field. *Id.* (Ex. 1002). During application of Wang's

[16] Wang calls the region 42, which is proximate to the sputtering target, a "high density plasma" (HDP) because the magnets trap the electrons and increase the plasma density in that region. For the same reason, the plasma generated by background power, $P_{B,}$ is also trapped in the same region. Kortshagen Decl. ¶ 157 FN 16 (Ex. 1002).

background power level, $P_B$, the weakly-ionized plasma in region 42 is proximate to the magnetic field as required by claims 7 and 20. *Id.* (Ex. 1002).

**Claim 9** depends from claim 7 and recites "wherein the magnet is movable."

Wang discloses a rotating magnetron assembly. Wang at 4:23-24 ("A small ***rotatable*** magnetron 40 is disposed in the back of the target 14") (emphasis added) (Ex. 1005). *See also* Kortshagen Decl. ¶ 159 (Ex. 1002).

**Claim 15** depends from claim 10 and recites "further comprising selecting at least one of a pulse amplitude and a pulse width of the electrical pulse in order to cause the strongly-ionized plasma to be substantially uniform."

As explained above with respect to claim 1, Wang teaches using a magnitude/amplitude of the electrical pulse that generates a strongly-ionized plasma. Wang's pulses also have a pulse width, $\tau_w$, as shown in Fig. 6, and that pulse width again results in generation of Wang's strongly-ionized plasma. *Id.* at ¶ 161 (Ex. 1002).

Also, Wang teaches eroding the target "evenly" so as to provide a "uniform" sputter coating. Wang at 4:49-51 ("The rotation scans the HDP region 42 about the face of the target 14 to more ***evenly erode the target*** 14 and to produce a more ***uniform sputter coating*** on the wafer 20.") (emphasis added) (Ex. 1005). Wang's even target erosion occurs because Wang's strongly-ionized plasma is substantially uniform, at least within the HDP region. Kortshagen Decl. ¶ 162 (Ex. 1002).

The amplitude and width taught in Wang results in a substantially uniform strongly-ionized plasma. *Id.* at ¶ 163 (Ex. 1002). Wang therefore teaches the limitation of claim 15. *Id.* (Ex. 1002).

**Claim 19** depends from claim 10 and recites "wherein the ionizing the feed gas comprises exposing the feed gas to … an pulsed electric field...."

As shown in Wang's Fig. 7, Wang uses a low magnitude voltage to produce the background power $P_B$ and a higher magnitude voltage to produce the peak power $P_P$. Wang at 7:61-63 ("The pulsed DC power supply 80 produces a train of negative voltage pulses…."). *See also* Kortshagen Decl. ¶ 165 (Ex. 1002). Each of those voltages generates a different electric field between Wang's cathode 14 and its anode 24. *Id.* (Ex. 1002). Successive application of those voltage pulses produces a pulsed electric field. *Id.* (Ex. 1002). Moreover, as explained above with respect to claim 1, the application of those voltage pulses generates Wang's high-density sputtering plasma. Wang therefore teaches the "pulsed electric field" limitation of claim 19. *Id.* (Ex. 1002).

**Claim 42** depends from claim 1 and recites "wherein the power supply comprises the ionization source."

In claim 1, the "ionization source" generates the weakly-ionized plasma and the "power supply" generates the strongly-ionized plasma. *Id.* at ¶ 167 (Ex. 1002). In Wang, the supply 100 (shown in Fig. 7) generates the weakly-ionized plasma and

the pulsed supply 80 generates the strongly-ionized plasma. Wang at 7:57-63 ("A variable DC power supply 100 is connected to the target 14 … and supplies an essentially constant negative voltage to the target 14 corresponding to the background power $P_B$. The pulsed DC power supply 80 produces a train of negative voltage pulses….") (Ex. 1005). *See also* Kortshagen Decl. ¶ 167 (Ex. 1002). Both supplies 80 and 100 are part of a common power supply that supplies power to the cathode 14 from a common point as shown in Fig. 7. *Id.* (Ex. 1002). Therefore, Wang teaches the limitation of claim 42. *Id.* (Ex. 1002).

### C. Ground III: Claims 8, 17 and 18 are obvious in view of the combination of Wang, Lantsman and Mozgrin

The claim chart that Petitioner served on Feb. 11, 2014 in its ongoing litigation involving the Petitioner and the Patent Owner, showing that claims 8, 17 and 18 are obvious in view of the combination of Wang, Lantsman and Mozgrin, is submitted hereto as Exhibit 1017 (Ex. 1017). Dr. Kortshagen has reviewed the claim chart and agrees with it. Kortshagen Decl. ¶ 168 (Ex. 1002).

**Claim 8** depends from claim 7 and recites "wherein the magnet comprises an electro-magnet."

Wang does not explicitly disclose that its magnets, e.g., as shown in Fig. 1, can be electro-magnets. *Id.* at ¶ 170 (Ex. 1002). However, electro-magnets were well known and it would have been obvious to use them in Wang. *Id.* (Ex. 1002).

For example, as explained above with respect to claim 8 in Ground I, Mozgrin discloses electro-magnets. *Id.* (Ex. 1002).

Mozgrin and Wang both related to pulsed magnetron sputtering and it would have been obvious to use Mozgrin's electron magnet in Wang. *Id.* at ¶ 171 (Ex. 1002). Further, using Mozgrin's electro-magnet in Wang would have been a combination of old elements in which each element performed as expected. *Id.* (Ex. 1002).

**Claim 17** depends from claim 10 and recites "wherein the peak plasma density of the weakly-ionized plasma is less than about $10^{12}$ $cm^{-3}$."

One of ordinary skill would recognize that Wang's plasma, made with the background power, $P_B$, has the density specified by claim 17. *Id.* at ¶ 173 (Ex. 1002). Further, one of ordinary skill would expect Wang's pre-pulse plasma (generated with $P_B$) to have a density similar to that of Mozgrin's pre-pulse plasma. *Id.* (Ex. 1002). Mozgrin's pre-pulse plasma, in Mozgrin's region 1, has a density that is below $10^{12}$ $cm^{-3}$. Mozgrin at 401, right col, ¶2. ("We found out that only the regimes with magnetic field strength not lower than 400 G provided the initial plasma density in the $10^{9}$-$10^{11}$ $cm^{-3}$ range. This initial density was sufficient for the plasma density to grow when the square voltage pulse was applied to the gap.") (Ex. 1003). *See also* Kortshagen Decl. ¶ 173 (Ex. 1002). Further, as noted in Mozgrin, having a density in the $10^{9}$-$10^{11}$ $cm^{-3}$ range permitted the density to grow upon

application of the pulse. Mozgrin at 401, right col, ¶ 2 (Ex. 1003). *See also* Kortshagen Decl. ¶ 173 (Ex. 1002). One of ordinary skill reading Wang would be motivated to use a density in the $10^9$-$10^{11}$ $cm^{-3}$ range so that its plasma density would grow suitably upon application of Wang's pulse. *Id.* (Ex. 1002).

**Claim 18** depends from claim 10 and recites "wherein the peak plasma density of the strongly-ionized plasma is greater than about $10^{12}$ $cm^{-3}$."

One of ordinary skill would recognize that Wang's plasma, made with the peak power, $P_P$, has the density specified by claim 18. *Id.* at ¶ 175 (Ex. 1002). Further, as explained above with respect to claim 17, it would have been obvious to use the densities described in Mozgrin in Wang, e.g., so as to achieve desired sputtering. *Id.* (Ex. 1002).

## IX. CONCLUSION

Based on the foregoing, claims 1, 3-10, 12, 15, 17-20 and 42 of the '142 Patent recite subject matter that is unpatentable. The Petitioner requests institution of an *inter partes* review to cancel these claims.

Respectfully Submitted,

Date: May 30, 2014 /David O'Dell/

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## Table of Exhibits for U.S. Patent 6,853,142 Petition for *Inter Partes* Review

| Exhibit | Description |
|---|---|
| 1001 | U.S. Patent No. 6,853,142 ("'142 Patent") |
| 1002 | Kortshagen Declaration ("Kortshagen Decl.") |
| 1003 | D.V. Mozgrin, *et al*, High-Current Low-Pressure Quasi-Stationary Discharge in a Magnetic Field: Experimental Research, Plasma Physics Reports, Vol. 21, No. 5, 1995 ("Mozgrin") |
| 1004 | U.S. Patent No. 6,190,512 ("Lantsman") |
| 1005 | U.S. Pat. No. 6,413,382 ("Wang") |
| 1006 | Plasma Etching: An Introduction, by Manos and Flamm, Academic Press (1989) ("Manos") |
| 1007 | 10/07/03 Office Action |
| 1008 | 03/08/04 Response |
| 1009 | 03/29/04 Allowance |
| 1010 | U.S. Patent No. 7,147,759 ("'759 Patent") |
| 1011 | 05/02/06 Response of '759 Patent File History |
| 1012 | The Materials Science of Thin Films, by Ohring M., Academic Press (1992) ("Ohring") |
| 1013 | Thin-Film Deposition: Principles & Practice by Smith, D.L., McGraw Hill (1995) ("Smith") |
| 1014 | 04/21/08 Response in EP 1560943 |
| 1015 | Claim Chart Based on Mozgrin and Lantsman used in 1:13-cv-11570-RGS ("Claim Chart based on Mozgrin and Lantsman") |
| 1016 | Claim Chart Based on Wang and Lantsman used in 1:13-cv-11570-RGS ("Claim Chart based on Wang and Lantsman") |
| 1017 | Claim Chart Based on Wang, Lantsman and Mozgrin used in 1:13-cv-11570-RGS ("Claim Chart based on Wang, Lantsman and Mozgrin") |

## CERTIFICATE OF SERVICE

I hereby certify that on May 30, 2014, 2014, I caused a true and correct copy of the foregoing materials:

- Petition for Inter Partes Review of U.S. Patent No. 6,853,142 Under 35 U.S.C. § 312 and 37 C.F.R. § 42.104
- Exhibits 1001-1017
- List of Exhibits for Petition for Inter Partes Review of U.S. Patent No. 6,853,142 (Ex. 1001-1017)
- Power of Attorney

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