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Moser Taboada / Applied Materials, Inc.
1030 Broad Street
Suite 203
Shrewsbury, NJ 07702

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BAND, MICHAEL A	

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llinardakis@mtiplaw.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE
THE PATENT TRIAL AND APPEAL BOARD

Ex parte ALAN RITCHIE,[1]
John C. Forster, and Muhammad Rasheed

Appeal 2018-007785
Application 13/798,021
Technology Center 1700

Before BRADLEY R. GARRIS, MARK NAGUMO, and
MICHAEL G. McMANUS, *Administrative Patent Judges*.

NAGUMO, *Administrative Patent Judge*.

DECISION ON APPEAL

Applied Materials, Inc. ("Ritchie") timely appeals under 35 U.S.C. § 134(a) from the Final Rejection[2] of all pending claims 6, 8–14, and 16–20. We have jurisdiction. 35 U.S.C. § 6. We reverse.

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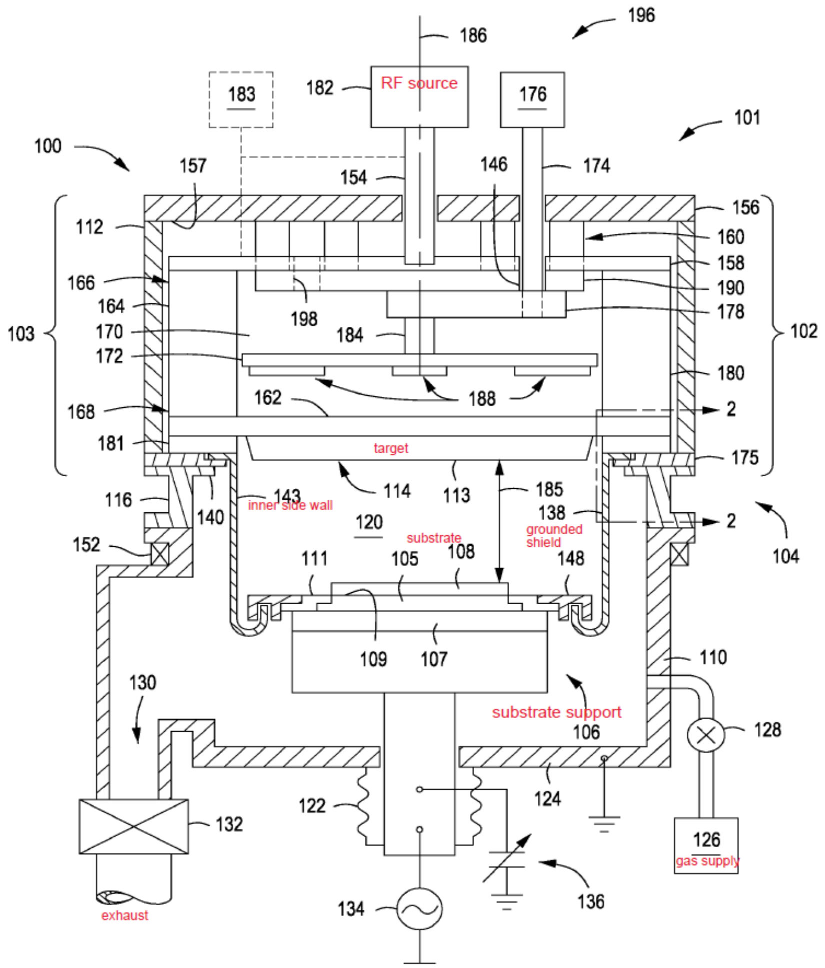
[1] The applicant under 37 C.F.R. § 1.46 (Application Data Sheet, filed 12 March 2013), and hence the appellant under 35 U.S.C. § 134, is the real party in interest, identified as Applied Materials, Inc. (Appeal Brief, filed 27 March 2018 ("Br."), 3.)

[2] Office Action mailed 8 September 2017 ("Final Rejection"; cited as "FR").

OPINION

A. Introduction[3]

The subject matter on appeal relates to physical vapor deposition (PVD) processing equipment. (Spec. 1 [0001].) An example of a PVD apparatus **100**[4] is shown in Figure 1, below.



{Figure 1 shows a PVD processing apparatus (annotations added)}

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[3] Application 13/798,021, *Methods and apparatus for reducing sputtering of a grounded shield in a process chamber*, filed 12 March 2013. We refer to the "'021 Specification," which we cite as "Spec."

[4] Throughout this Opinion, for clarity, labels to elements are presented in bold font, regardless of their presentation in the original document.

PVD apparatus **100** comprises chamber body **104** fitted with target **114**, which faces substrate **108** held on substrate support **106**. (Spec. 5 [0016]–[0017].) Various gases may be supplied to the lower part of chamber body **104** from gas source **126**, and exhaust port **130** is used to maintain the desired pressure inside the chamber. (*Id.* at 6 [0019].) Grounded shield **138** comprises inner wall **143** disposed between target **114** and substrate support **106** (*id.* at 7 [0022]), surrounding first volume **120**, and extending below a top surface of substrate support **106** and returning upwardly, forming a u-shaped portion at the bottom of the shield (*id.* at 10 [0029]). For the "short throw" process chambers of interest in this appeal, the ratio of the diameter of target **114** to the diameter of substrate **108** is about 1.4, and the ratio of the diameter of the target **114** to the height[5] of grounded shield **138** is "about 4.1 to about 4.3." (*Id.* at 7 [0022].)

RF power source **182** applies RF power to target **114** to eject material to be sputter coated on substrate **108**. (Spec. 17 [0051].) The RF power also forms a plasma in first volume **120** at a desired frequency and pressure, which is said to "allow[] for a high deposition rate within the short throw

[5] The Specification does not appear to provide a precise definition of the term "height of the grounded shield." The clearest description reads, "[t]he grounded shield **138** comprises an inner wall **143** disposed between the target **114** and the substrate support **106**. The height of the shield **138** depends upon the distance **185** between the target **114** and the substrate **108**. The distance **185** between the target **114** and the substrate **108**, and correspondingly, the height of the shield **138**, is scaled based on the diameter of the substrate **108**." (Spec. 7 [0022].) This passage suggests, but does not require, that the height of the shield corresponds roughly to the distance between the target and the substrate.

process chamber while maintaining high ionization levels." (*Id.*) The Specification teaches that short throw process chambers provide higher deposition rates than long throw chambers. (*Id.* at 7–8 [0023].)

According to the ′021 Specification, a "dark space region," also referred to as a "sheath region," exists between a plasma and the surrounding surfaces. (Spec. 1 [0002].) As the frequency of the radio frequency (RF) exciting source increases, the plasma density increases and the sheath width decreases. (*Id.*) The inventors discovered that under certain circumstances, "the plasma potential can be in the region of a few tens to a few hundred volts positive with respect to the grounded shield." (*Id.*) In the words of the Specification, "[t]his potential difference coupled with the high plasma-ion density can cause undesirable sputtering of the grounded shield," leading to contamination of the chamber and the substrate. (*Id.*)

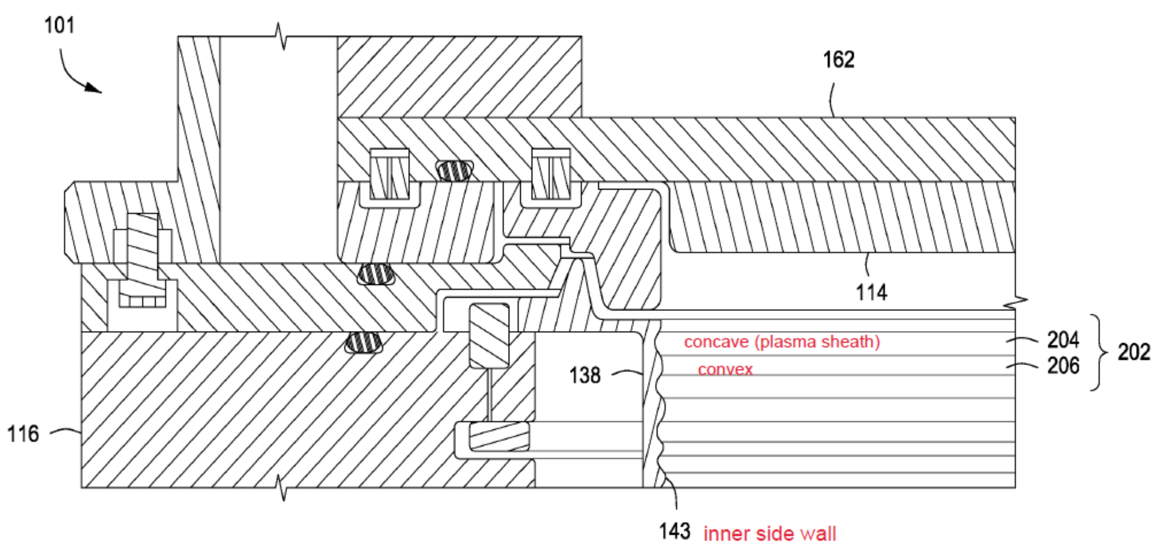
The inventors discovered that the voltage between target **114** (the powered electrode) and grounded shield **138** (the grounded electrode) depends "on the ratio of the surface area of the shield **138** to the surface area of the target **114**" (Spec. 8 [0024]), with the smaller electrode having the higher voltage (*id.*). In the words of the Specification, "[t]ypically, the surface area of the target **114** is larger than the surface area of the shield **138** resulting in a greater voltage upon the shield **138**, and in turn, resulting in the undesired sputtering of the shield." (*Id.*)[6] The inventors discovered further "that a ratio of the surface area of the shield **138** to the surface area

[6] Ritchie attempted, with partial success, to correct typographical errors in the original Specification in a series of three amendments during prosecution.

of the target **114** of about 1 to about 1.5 advantageously minimizes or prevents the sputtering of the shield **138**." (*Id.* at 9 [0024].)

The Specification teaches, however, that the increase in area of the shield cannot be obtained simply by increasing the height of the shield, due to the desired ratio of the diameter of target **114** to the height of the shield **138**. (Spec. 9 [0025].) Moreover, according to the Specification, the diameter of shield **138** cannot be increased enough to prevent sputtering, due to physical constraints on the size of the processing chamber. (*Id.*)

The solution found by the inventors is to provide shield **138** with "a plurality of waves **202** comprising a concave portion **204** and a concave portion **206**." (Spec. 9 [0026].) According to the Specification, the surface area of shield **138** can be increased "by about 50% while maintaining the same overall height of the shield **138**." (*Id.*) This arrangement is illustrated in Figure 2, reproduced below.



{Figure 2 shows waves on the inner wall of grounded shield **138**}

The Specification teaches that "[t]he concave portion **204** of the waves **202** are sized to advantageously allow the plasma sheath to form within the concave portion **204** of each wave **202**." (Spec. 10 [0027].) Thus, the size of the concave portions will depend on the RF frequencies used for processing, and increasing or decreasing the number of waves **202** in shield **138** "allows for the flexibility of controlling the plasma potential (*e.g.*, the voltage on the shield) without changing the distance **185** between the target **114** and the substrate **108**." (*Id.*) The Specification discloses that for RF frequencies of interest (about 27–162 MHz), "the period of the wave **202** is about 6 mm to about 20 mm." (*Id.*)

In the words of the Specification, "[t]he inventive apparatus may advantageously allow for an increased deposition rate in a PVD chamber, without the contamination caused by the sputtering of the grounded shield." (Spec. 17 [0052].)

Claim 6 is representative and reads:

A substrate processing apparatus [**100**], comprising:

a chamber body [**104**] having a substrate support [**106**] disposed therein;

a target [**114**] coupled to the chamber body [**104**] opposite the substrate support [**106**];

an RF power source [**182**] to form a plasma within the chamber body [**104**]; and

a grounded shield [**138**] *having an inner sidewall* [**143**] *including a plurality of waves* [**202**] *disposed between the target* [**114**] *and the substrate support* [**106**];

wherein a ratio of a diameter of the target [**114**] *to a height of the grounded shield* [**138**] *is about 4.1 to about 4.3*, and

wherein a ratio of a surface area of inner facing surfaces of the inner sidewall [**143**] *to a surface area of a*

> *principal surface of the target* [**114**] *is about 1 to about 1.5*.

(Claims App., Br. 9; some formatting, and emphasis added.)

Remaining independent claim 14 is similar, but is broader in that the ratio of the target diameter to the height of the grounded shield "is about 4," and is narrower in that each of the concave portions must allow a plasma sheath to form within the concave portion in a range of specified RF frequencies and chamber pressures. (Claims App., Br. 10.)

The Examiner maintains the Final Rejection and enters a new ground of rejection over the same references, based on a new interpretation of the height of the shield[7, 8]:

> Claims 6, 8–14, and 16–20 stand rejected under 35 U.S.C. § 103(a) in view of the combined teachings of Sasaki[9] and Murugesh.[10]

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[7] Examiner's Answer mailed 22 May 2018 ("Ans.").

[8] Because this application was filed before 16 March 2013, the effective date of the America Invents Act, we refer to the pre-AIA version of the statute.

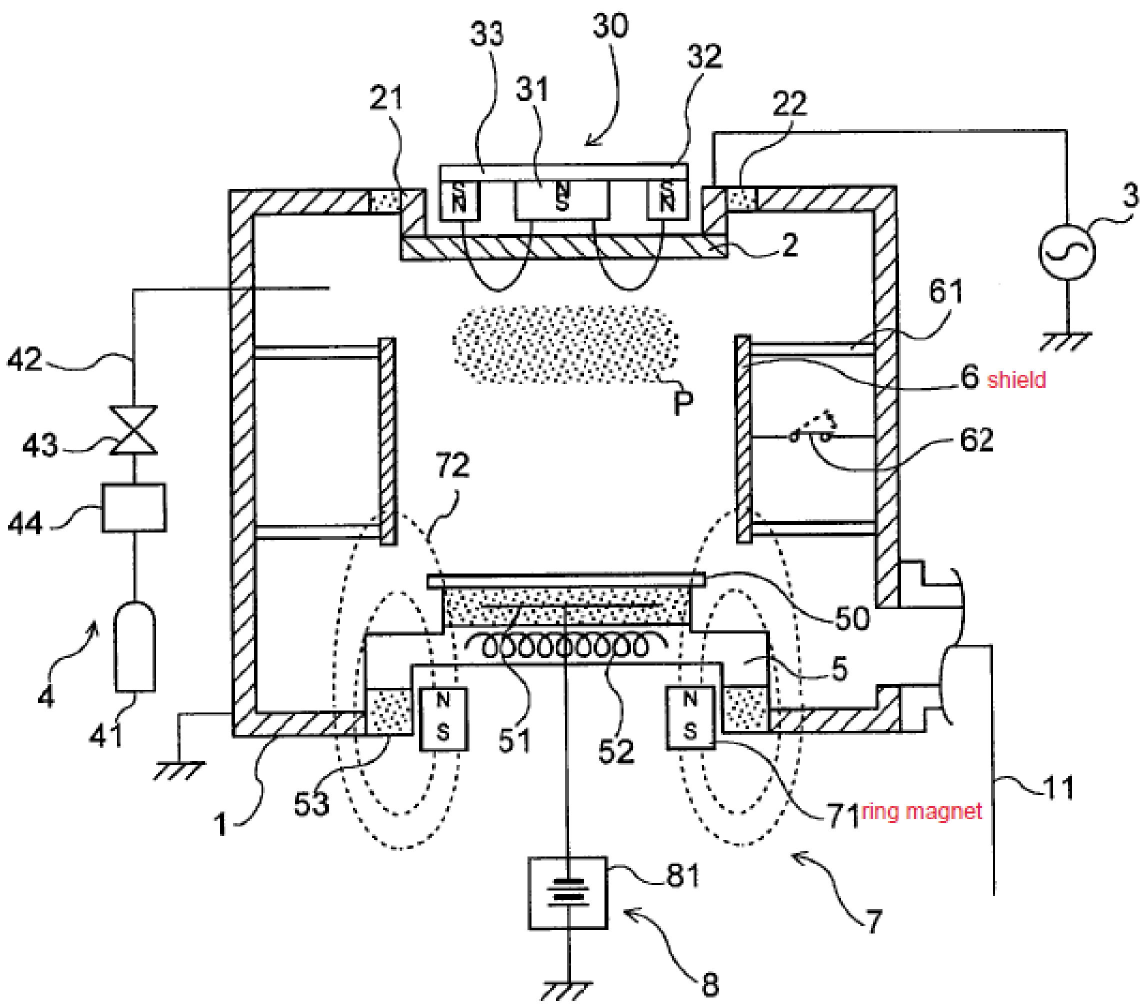
[9] Masao Sasaki and Kiyohiko Funato, *Ionizing sputtering method*, U.S. Patent No. 6,444,099 B1 (2002).

[10] Laxman Murugesh and Abhijit Desai, *Chamber component having grooved surface with depressions*, U.S. Patent Application Publication 2005/0284372 A1 (2005).

B. Discussion

The Board's findings of fact throughout this Opinion are supported by a preponderance of the evidence of record.

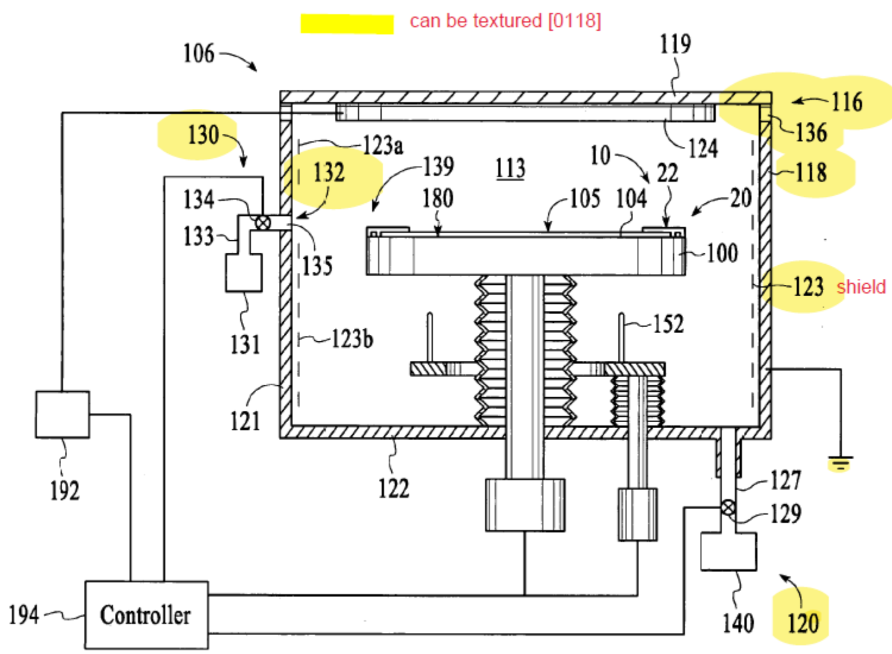
The Examiner finds that Sasaki describes a substrate processing apparatus, shown in Figure 1, shown below, that meets many of the limitations of the representative claim.



{Sasaki Figure 1 shows an apparatus for ionizing sputtering (annotations added)}

However, the Examiner finds that Sasaki does not teach or suggest a grounded shield with waves or the ratio of the diameter of the target to the height of the grounded shield being about 4.1 to about 4.3, or the ratio of the surface area of the inner facing surfaces of the inner sidewall to the area of the principal surface of the target of 1 to 1.5. (FR, para. bridging 5–6.) Rather, the embodiments described by Sasaki have a ratio of the diameter of the target to a height of the ground shield to be about 6.3, and a ratio of the surface area of the grounded shield to the surface area of a principal surface of the target of about 0.61. (*Id.* at para. bridging 4–5.)

The Examiner finds (FR 3) that Murugesh describes a substrate processing chamber[11] illustrated in Figure 3, shown below with annotations



{Murugesh Figure 3 shows a substrate processing chamber. The highlighted elements can be textured (grooved) (Murugesh 2 [0018])}

indicating which components are suggested for having textured (grooved) surfaces, including a shield **123** (*id.* (citing Murugesh 2 [0018])) having a

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[11] The chamber is said to be for processing substrates with an "energized gas." (Murugesh 2 [0018].) Murugesh discloses sputtering with a plasma. (*Id.* at 6 [0045].)

height that is extended below the substrate support and covers an entire sidewall of the chamber body to protect the wall from the energized process gas (*id.* (citing Murugesh 6, [0044]–[0045])). The Examiner finds that Murugesh discloses a "period [**r**] for each groove [**64**] is 7 mm." (*Id.* (citing Murugesh 5 [0039], referring to Figure 4, not reproduced here.)) The Examiner (FR 3) relies on Murugesh Figures 1B and 5 (not reproduced here) for disclosure of alternating convex and concave portions, as Figure 4 discloses only what Ritchie would likely call adjacent convex portions. According to Murugesh, the grooves provide "areas for the process deposits to collect, and allow residues to 'run down' into the grooves **64** for collection." (Murugesh 5 [0037].)

The Examiner concludes that it would have been obvious to use a wavy shield in place of the shield disclosed by Sasaki, and to extend the wavy shield to cover the entire wall, as taught by Murugesh, in order to gain the advantages taught by Murugesh. (FR 4.) The Examiner demonstrates, based on modifications of a cropped version of Figure 1 of Sasaki (FR 5), extensions of the height of the shield by about 75%. In the Examiner's Answer, the Examiner provides a more detailed analysis, responding to certain criticisms expressed by Ritchie in the Appeal Brief. (Ans. 5.)

Ritchie argues, *inter alia*, that Sasaki teaches that shield **6** should have a smaller diameter than the target. (Br. 5, last para., through 6, 2d full para. (citing Sasaki col. 8, ll. 42–67.); Reply 4, 3d para., through 5.) Thus, Ritchie urges, there is no basis to expand the diameter of the shield to the walls of the chamber, as taught by Murugesh. (Br. 5, first partial paragraph, last sentence; Reply 5, first partial paragraph, last sentence.)

Review of Sasaki supports Ritchie's arguments. Sasaki reports that "it seems that the plasma density rises because the shield **6** makes the plasma **P** formation space smaller, or because it prevents the diffusion of the plasma, or for some other such reason." (Sasaki col. 8, ll. 57–60.) Sasaki teaches that, "[f]rom the standpoint of making the space in which the plasma P is formed smaller, it is better for the shield **6** to have a smaller diameter." (*Id.* at ll. 61–63.) If shield **6** is too small, however, "it will hinder the flight of the sputter particles from the target **2** to the substrate **50**." (*Id.* at ll. 63–65.) Sasaki concludes, "[t]he diameter of the shield **6** should be equivalent to the diameter of the target **2**, and should at the least be about 90% of the diameter of the target **2**." (*Id.* at ll. 65–67.)

The Examiner has not provided a credible explanation, supported by evidence of record, of how a shield having the form taught by Murugesh, with a diameter larger than the target, could have been adapted to the substrate processing apparatus taught by Sasaki. Such a modification would appear to render Sasaki's apparatus inoperable for its intended purpose—a result long held to be incompatible with obviousness. *In re Fritch*, 972 F.2d 1260, 1265 n.12 (Fed. Cir. 1992), citing *In re Gordon*, 733 F.2d 900, 902 (Fed. Cir. 1984).

The Examiner makes no findings regarding the disclosure or obviousness of the further limitations recited in independent claim 14 or in the dependent claims that cure this flaw. We therefore reverse the appealed rejection.

C. Conclusion

The rejection of claims 6, 8–14, and 16–20 is reversed.

In summary:

Claims Rejected	35 U.S.C. §	Reference(s)/Basis	Affirmed	Reversed
6, 8–14, 16–20	103	Sasaki and Murugesh		6, 8–14, 16–20

REVERSED