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571-272-7822

Paper 31
Date: September 30, 2020

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTEL CORPORATION, GLOBALFOUNDRIES U.S., INC.,
MICRON TECHNOLOGY, INC. and
SAMSUNG ELECTRONICS COMPANY, LTD.[1],
Petitioner,

v.

DANIEL L. FLAMM,
Patent Owner.

IPR2017-00279
Patent RE40,264 E

Before CHRISTOPHER L. CRUMBLEY, JO-ANNE M. KOKOSKI, and KIMBERLY McGRAW, *Administrative Patent Judges*.

CRUMBLEY, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

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[1] Samsung Electronics Company, Ltd. was joined as a party to this proceeding via a Motion for Joinder in IPR2017-01749.

I. INTRODUCTION

In this *inter partes* review, instituted pursuant to 35 U.S.C. § 314, Intel Corporation, GLOBALFOUNDRIES U.S., Inc., Micron Technology, Inc. and Samsung Electronics Company, Ltd. (collectively "Petitioner") challenge the patentability of claims 13–26, 64, and 65 of U.S. Patent No. RE40,264 E (Ex. 1001, "the '264 patent"), owned by Daniel L. Flamm ("Patent Owner").

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision, issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73, addresses issues and arguments raised during trial. For the reasons discussed below, we determine that Petitioner has shown by a preponderance of the evidence that claims 13–26, 64, and 65 of the '264 patent are unpatentable.

A. Procedural History

On December 2, 2016, Intel Corporation, GLOBALFOUNDRIES U.S., Inc., and Micron Technology, Inc. filed a Petition requesting an *inter partes* review of claims 13–26, 64, and 65 of the '264 patent. Paper 2 ("Pet."). Patent Owner filed a Preliminary Response. Paper 8. On June 13, 2017, we instituted an *inter partes* review of the challenged claims. Paper 9 ("Decision on Institution" or "Dec. on Inst."). Subsequent to institution, Samsung Electronics Company, Ltd. filed a petition and motion for joinder with the instant proceeding. *Samsung Electronics Company, Ltd. v. Daniel L. Flamm,* IPR2017-01749, Papers 1, 3. On September 15, 2017, we granted Samsung's petition and motion for joinder, joining Samsung as a petitioner to this *inter partes* review.[2] Paper 12, 7.

Thereafter, Patent Owner filed a Patent Owner Response (Paper 13, "PO Resp.") and Petitioner filed a Reply (Paper 14, "Pet. Reply"). In support of their respective arguments, Petitioner relies upon the declaration testimony of Dr. John Bravman (Exs. 1006 and 1025) and Patent Owner relies upon the declaration testimony of Dr. Daniel L. Flamm[3] (Ex. 2001).

Oral hearing was requested by both parties. Papers 15, 16. A consolidated oral hearing for this proceeding and Cases IPR2017-00280, IPR2017-00281, and IPR2017-000282, involving the same parties and the '264 patent, and Cases IPR2017-00391, IPR2017-00392, and IPR2017-00406, involving the same parties and unrelated patents, was held on March 7, 2018. A transcript of the consolidated hearing has been entered into the record. Paper 28 ("Tr.").

B. Related Proceedings

Petitioner reports that the Patent Owner asserted the '264 patent in five proceedings in the Northern District of California (Case Nos. 5:16-cv-01578-BLF, 5:16-cv-1579-BLF, 5:16-cv-1580-BLF, 5:16-cv-1581-BLF, and 5:16-cv-02252-BLF), and that Lam Research Corporation has filed a

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[2] Pursuant to 35 U.S.C. § 316(a)(11) and 37 C.F.R. § 42.100(c), which provide that the time for issuing a final written decision may be adjusted by the Board in the case of joinder, the time in this proceeding has been adjusted to the date of this Decision.

[3] Daniel L. Flamm is both the Patent Owner and Patent Owner's declarant in this proceeding.

declaratory judgment action against Patent Owner on the ’264 patent (N.D. Cal. Case No. 5:15-cv-01277-BLF). Pet. 2.

Petitioner also challenged certain claims of the ’264 patent in IPR2017-00280, IPR2017-00281, and IPR2017-00282, and the Board has issued a final written decision in each case. The parties also identified nine other IPR petitions for review of the ’264 patent, filed by Lam Research Corporation or Samsung, none of which are currently pending. *See* Pet. 2; Prelim. Resp. 1–2 (identifying IPR2015-01759 (institution denied); IPR2015-01764 (terminated-settled); IPR2015-01766 (institution denied); IPR2015-01768 (terminated-settled); IPR2016-00468 (institution denied); IPR2016-00469 (institution denied); and IPR2016-00470 (institution denied); IPR2016-01510 (institution denied) and; IPR2016-01512 (Final Written Decision – challenged claims unpatentable)).

C. The ’264 Patent

The ’264 patent, titled “Multi-Temperature Processing,” relates generally to methods and systems for controlling the heating and cooling time of a substrate (e.g., wafer) during plasma processing in a single processing chamber. *See, e.g.,* Ex. 1001, 1:18–21. A “plasma etching apparatus according to the present invention” is shown in Figure 1 of the ’264 patent, reproduced below. *Id.* at 2:66–67.

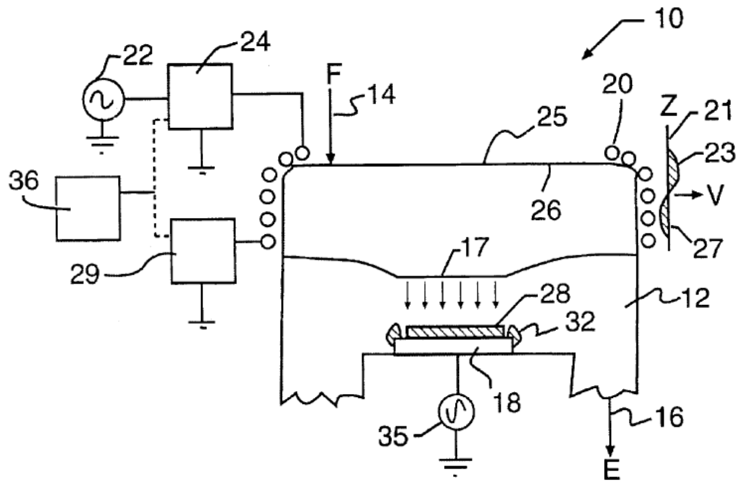

FIG. 1

Figure 1 above illustrates a plasma etching apparatus having chamber 12 and a substrate holder (product support chuck or pedestal 18) for holding a substrate (product 28, such as a wafer to be etched). *Id.* at 3:24–25, 3:32–33, 3:40–42. The substrate holder, which is thermally coupled to the substrate, "can rapidly change its temperature." *Id.* at 3:51–55. The '264 patent discloses that the upper surface of the substrate holder is generally made of a material having desirable heat transfer characteristics and may be made using a low thermal mass, high conductivity material. *Id.* at 15:40–45. The thermal mass of the substrate holder is "selected . . . to facilitate changing the temperature of the substrate to be etched" such that this change may be made "within a characteristic time period to process a film." *Id*. at 2:51–56.

One embodiment of a temperature control system according to the invention is shown in Figure 7 below. *Id.* at 3:11–13, 15:65–67.

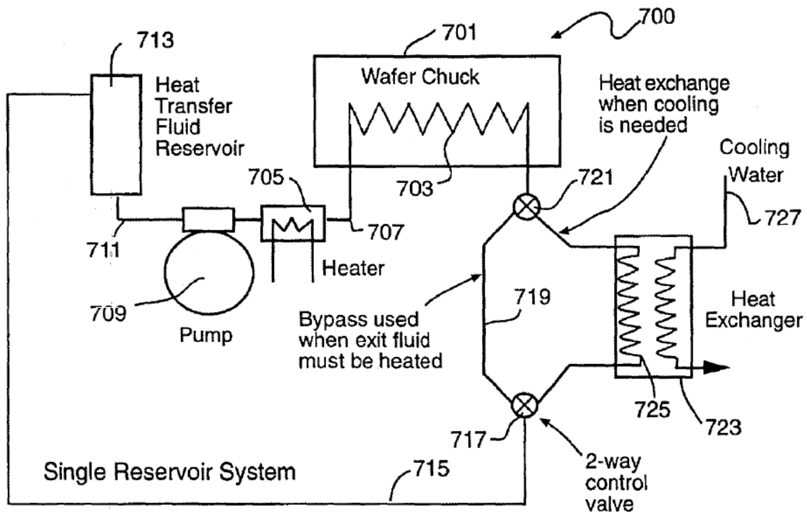

Fig. 7

Figure 7, shown above, depicts a temperature control system having substrate holder (also called "wafer chuck" or "wafer holder") 701, heater 705, heat transfer fluid reservoir 713, and heat exchanger 723. *Id.* at 15:65–16:8. Fluid is "pumped from the reservoir through the heating unit, which selectively sets the temperature of the fluid." *Id.* at 16:9–11. The fluid "transfers energy in the form of heat to the wafer holder to a desirable temperature." *Id.* at 16:14–16. In another embodiment, the fluid can also be cooled using heat exchanger 723. *Id.* at 16:20–21. In a specific embodiment, "system 700 operates in a manner to program a process temperature of the substrate holder." *Id.* at 16:28–30. An electrical heater heats the fluid to a desired temperature, which is "determined by comparing the desired wafer or wafer chuck set point temperature to a measured wafer of wafer chuck temperature." *Id.* at 16:36–41.

A microprocessor based system can be used to control the temperature of the substrate holder by selectively turning elements of the system (e.g., heater, fluid reservoir) on or off. *Id.* at 17:1–9. For example, if the measured temperature of the wafer or chuck is below the desired temperature "a suitable control algorithm such as a proportional controller or a proportional-integral-derivative ('PID') controller algorithm increases the temperature by supplying more power to the heater." *Id.* at 16:41–46. "The heat exchanger, fluid flow rate, coolant-side fluid temperature, heater power, chuck, etc. should be designed using conventional means to permit the heater to bring the fluid to a setpoint temperature and bring the temperature of the chuck and wafer to predetermined temperatures within specified time intervals and within specified uniformity limits." *Id*. at 16:60–67.

The '264 patent states that conventional processing of resist layers, which is performed at low temperatures in order to help prevent rupturing of cross-linked layers and contaminative particulate matter, requires excessive time and lower throughput. *Id.* at 2:17–26. The '264 patent states that the present invention overcomes these disadvantages by removing the ion implanted layer at a lower temperature followed by rapidly removing a majority of resist at a higher temperature. *See id.* at 2:26–30. For example, a "sequence of temperature changes" may be employed to avoid "various types of processing damage to the device and material layers." *Id.* at 2:34–37. Figure 10, shown below, illustrates a simplified process according to the invention. *Id.* at 18:58–59.

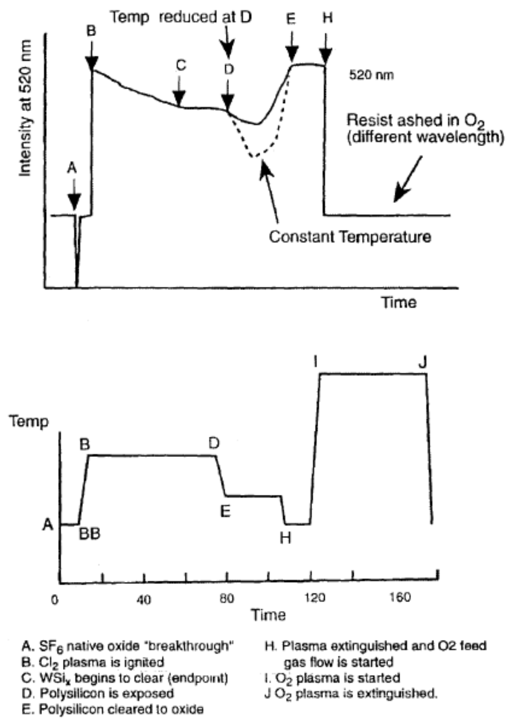

Fig. 10

The process shown in Figure 10 above plots changes in temperature against processing time. *See id.,* Fig. 10; *see also id.* at 18:58–19:64 (providing details of the process shown in Figure 10). For example, during the isotropic breakthrough step (time A through BB), an SF_6 plasma is used to remove native oxide at a low temperature, such as room temperature. *Id.* at 18:63–66, Fig. 10. At the end of this step, at time BB, the control program increases within several seconds to a higher steady state value at time B. *Id.* at 19:8–10. The tungsten silicide layer is then etched at a constant temperature until the layer is breached. *Id.* at 19:10–15. At point D, the wafer temperature is gradually reduced in order to achieve a slower and more anisotropic polysilicon etching step. *Id.* at 19:36–28.

D. Illustrative Claim

Of the challenged claims, only claim 13 is independent, and is reproduced below, with bracketed letters added to designate the steps of the method:

> 13. A method of etching a substrate in the manufacture of a device, the method comprising:
>
> [a] placing a substrate having a film thereon on a substrate holder in a chamber, the substrate holder having a selected thermal mass;
>
> [b] setting the substrate holder to a selected first substrate holder temperature with a heat transfer device;
>
> [c] etching a first portion of the film while the substrate holder is at the selected first substrate holder temperature;
>
> [d] with the heat transfer device, changing the substrate holder temperature from the selected first substrate holder temperature to a selected second substrate holder temperature; and
>
> [e] etching a second portion of the film while the substrate holder is at the selected second substrate holder temperature;
>
> [f] wherein the thermal mass of the substrate holder is selected for a predetermined temperature change within a specific interval of time during processing; the predetermined temperature change comprises the change from the selected first substrate holder temperature to the selected second substrate holder temperature, and the specified time interval comprises the time for changing from the selected first substrate holder temperature to the selected second substrate holder temperature.

Ex. 1001, 20:50–21:10.

E. Instituted Grounds

We instituted an *inter partes* review of all claims challenged in the Petition on the following grounds of unpatentability, each alleging obviousness of the claims under 35 U.S.C. § 103(a):

Claim(s) Challenged	References
13–16, 18–19, 21–23, 64, 65	Muller[4], Matsumura,[5] Anderson,[6] Hinman[7]
19, 20	Muller, Matsumura, Anderson, Hinman, Wright[8]
17	Miller, Matsumura, Anderson, Hinman, Kikuchi[9]
24–26	Miller, Matsumura, Anderson, Hinman, Moslehi[10]
13–16, 18–23, 64, 65	Kadomura[11], Matsumura, Anderson, Hinman

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[4] U.S. Patent 5,605,600 to Muller et al., issued Feb. 25, 1997 (Ex. 1002).

[5] U.S. Patent 5,151,871 to Matsumura et al., issued Sept. 29, 1992 (Ex. 1003).

[6] U.S. Statutory Invention Registration No. H1145 to Anderson, published Mar. 2, 1993 (Ex. 1011).

[7] U.S. Patent No. 3,863,049 to Hinman, issued Jan. 28, 1975 (Ex. 1010).

[8] D.R. Wright et al., A Closed Loop Temperature Control System for a Low-Temperature Etch Chuck, Advanced Techniques for Integrated Processing II, Vol. 1803 (1992) (Ex. 1008).

[9] U.S. Patent 5,226,056 to Kikuchi et al., issued July 6, 1993 (Ex. 1004).

[10] U.S. Patent 5,192,849 to Moslehi, issued Mar. 9, 1993 (Ex. 1009).

[11] U.S. Patent 6,063,710 to Kadomura et al., filed Feb. 21, 1997 and issued May 16, 2000 (Ex. 1005).

Claim(s) Challenged	References
17	Kadomura, Matsumura, Anderson, Hinman, Kikuchi
24–26	Kadomura, Matsumura, Anderson, Hinman, Moslehi
15	Kadomura, Matsumura, Anderson, Hinman, Muller

II. DISCUSSION

A. Principles of Law

To prevail in challenging Patent Owner's claims, Petitioner must demonstrate by a preponderance of the evidence that the claims are unpatentable. 35 U.S.C. § 316(e) (2012); 37 C.F.R. § 42.1(d) (2016). A claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time of the invention to a person having ordinary skill in the art. *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations.[12] *See Graham v. John*

[12] The record does not contain evidence or argument of objective evidence of non-obviousness.

Deere Co., 383 U.S. 1, 17–18 (1966). The level of ordinary skill in the art may be reflected by the prior art of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001).

B. Level of Ordinary Skill in the Art

Citing its declarant, Petitioner contends that a person of ordinary skill in the art at the relevant time would have had (i) a Bachelor's degree in chemical engineering, materials science engineering, electrical engineering, physics, chemistry, or a similar field, and three or four years of work experience in semiconductor manufacturing or related fields; or (ii) a Master's degree in chemical engineering, materials science engineering, electrical engineering, physics, chemistry, or a similar field, and two or three years of work experience in semiconductor manufacturing or related fields; or (iii) a Ph.D. in chemical engineering, materials science engineering, electrical engineering, physics, chemistry, or a similar field. Pet. 19–20 (citing Ex. 1006 ¶¶ 21).

Patent Owner does not contest Petitioner's description of the level of ordinary skill in its Response. Based on our review of the '264 patent, the cited prior art, and the testimony of the parties' declarants, we agree with Petitioner's assessment of the level of ordinary skill in the art and apply it for purposes of this Decision. *See Okajima*, 261 F.3d at 1355 (explaining that specific findings regarding ordinary skill level are not required "where the prior art itself reflects an appropriate level and a need for testimony is not shown").

C. Claim Construction

The ’264 patent is expired.[13] For claims of an expired patent, the Board’s claim interpretation is similar to that of a district court. *See In re Rambus, Inc.*, 694 F.3d 42, 46 (Fed. Cir. 2012). Claim terms are given their ordinary and customary meaning as would be understood by a person of ordinary skill in the art at the time of the invention, and in the context of the entire patent disclosure. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Only those terms in controversy need to be construed, and only to the extent necessary to resolve the controversy. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co*., 868 F.3d 1013, 1017 (Fed. Cir. 2017) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

For purposes of our Decision on Institution, we construed two claim terms appearing in the challenged claims. Dec. on Inst. 10–11. First, we construed *selected thermal mass* to mean “thermal mass selected by selecting the mass of the substrate holder, the material of the substrate holder, or both.” *Id*. at 10. Second, we adopted Petitioner’s proposed

[13] Neither party disputes that the ’264 patent is expired. The earliest patent application referenced for the benefit of priority under 35 U.S.C. § 120 for the ’264 patent was filed on December 4, 1995, and the patent has no term extensions. The term of the ’264 patent, therefore, expired no later than December 4, 2015. *See* 35 U.S.C. § 154(a)(2) (2012 & Supp. III 2015) (stating that the term of a patent grant ends twenty (20) years from the date on which the application for the patent was filed in the United States, “or, if the application contains a specific reference to an earlier filed application or applications under section 120, 121, 365(c), or 386(c), from the date on which the earliest such application was filed”).

construction of *thermal mass . . . selected for a predetermined temperature change within a specific interval of time* as meaning "the material and/or mass of the substrate holder are chosen to effect a predetermined change in substrate holder temperature from a selected first temperature to a selected second temperature within a specific time period." *Id*. at 11. During the instituted trial, neither party disagreed with these constructions; nor did either party ask that we construe additional claim terms. We, therefore, leave our prior constructions in place unaltered.

D. Priority Date for the Challenged Claims of the '264 Patent

The '264 patent is a reissue of U.S. Patent No. 6,231,776 B1, which issued from U.S. Patent Application No. 09/151,163 ("the '163 application") filed on September 10, 1998. Ex. 1001, code [64]. The '163 application claims priority to both (1) U.S. Provisional Application No. 60/058,650 ("the '650 provisional application"), filed on September 11, 1997 and (2) U.S. Patent Application No. 08/567,224 ("the '224 application"), filed on December 4, 1995. *Id.* at [60], [63], [64], 1:11–15.

Petitioner contends that the challenged claims of the '264 patent are not entitled to claim priority to a filing date any earlier than the September 11, 1997 filing date of the '650 provisional application, and, therefore, each of the asserted references qualify as prior art to the challenged claims. *See* Pet. 9. Specifically, Petitioner contends that the '264 patent is not entitled to claim priority to the December 4, 1995 filing date of the '224 application because the '224 application fails to disclose a chuck having a "thermal mass" or selecting that thermal mass to change a temperature "within a specific interval of time" as required by independent claim 13. *Id.* at 9 (citing Ex. 1006 ¶¶ 30–31).

Patent Owner has not introduced any evidence or argument that the '224 application provides written description support for the challenged independent claim. *See generally* PO Resp. Nor does Patent Owner contend that any of the asserted references are not prior art to the '264 patent. Evaluating Petitioner's unchallenged arguments, we determine that the challenged claims of the '264 patent are not entitled to claim priority to the December 4, 1995 filing date of the '224 application. As a consequence, we find that Kadomura, which was filed on February 21, 1997, and the remaining asserted references, each of which issued before the September 11, 1997 filing date of the '650 provisional application, qualify as prior art to the challenged claims of the '264 patent. *See Tech. Licensing Corp. v. Videotek, Inc.,* 545 F.3d 1316, 1327 (Fed. Cir. 2008) (stating that the patent owner has the burden of production to make a claim of priority that the challenged claims are entitled to a filing date prior to the date of the alleged prior art).

E. Obviousness of Claims 13–16, 18, 19, 21–23, 64, and 65 over Muller, Matsumura, Anderson, and Hinman

Petitioner contends that claims 13–16, 18, 19, 21–23, 64, and 65 are unpatentable under 35 U.S.C. § 103(a), as they would have been obvious over the combined disclosures of Muller, Matsumura, Anderson, and Hinman. Pet. 22–45. We summarize the disclosures of each reference and Petitioner's proposed combination below, before turning to our analysis of the parties' arguments.

1. Muller

Muller is directed to methods of shaping etch profiles by controlling wafer temperature using an electrostatic chuck and coolant circulating through a cathode and by changing the pressure of the gas filled in the gaps between the wafer and the cathode. Ex. 1002, code (54), (57), 1:7–12, 1:44–64, 4:51–5:25. Figure 4 of Muller, which depicts an example of an apparatus used to accomplish the multi-temperature etching methods, is reproduced below.

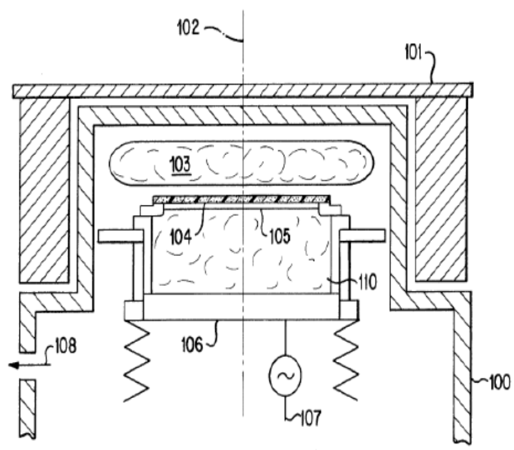


FIG. 4

Figure 4 depicts wafer 104, electrostatic chuck 105, cathode 106, and gas filled gap 110 between cathode 106 and wafer 104. *Id.* at 4:38–41, 4:51–55.

Muller teaches that the change in taper angle of etched trenches correlates with increasing wafer temperature during the etching processes. *Id.* at 3:33–66, Figs. 1, 2. Muller explains that changing pressure of the gas filled in the gaps between the wafer and cathode, which can be accomplished in a very short period of time, results in an immediate effect on wafer temperature. *Id.* For example, wafer temperature can be increased by approximately 50ºC over a time of "several seconds" during etching. *Id.* at 4:64–5:25, 5:41–48.

In one example, Muller teaches performing an initial etch at either 125ºC or 145ºC. *Id.* at 3:45–52, 3:56–66. The two etching temperature examples correspond to the use of two different coolant temperatures. For example, use of a cathode coolant at 10ºC results in a wafer temperature of approximately 125°C, while use of a cathode coolant at 30ºC results in a wafer temperature of approximately 145ºC. *Id.* at 3:45–52. Figure 3 below shows the wafer temperature at the two cathode coolant temperatures as a function of time.

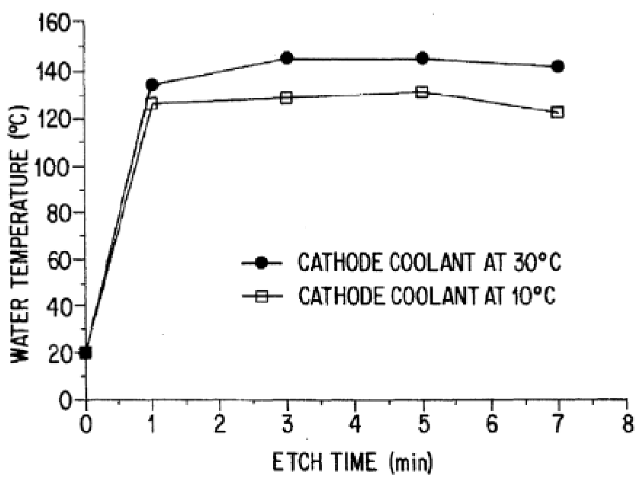


Figure 3 depicts a graph illustrating the change in wafer temperature for various coolant temperatures as a function of etch time. *Id.* at 3:56–63.

In another example of an etching process, the gas-filled gap is pressurized for a first time period, and then the pressure in the gap is rapidly changed to a second pressure for a second period of time. *Id.* at 4:64–5:3. Then, the gas pressure underneath the chuck is changed to increase wafer temperature by 50ºC in "several seconds" during etching. *Id.* at 4:64–5:25, 5:41–48. In this example, using a 30°C coolant, the initial pressure is maintained for 70 seconds, after which the gap pressure is decreased for the remaining 6 minutes of etch time. *Id.* at 5:26–33.

2. Matsumura

Matsumura generally relates to heat-processing semiconductor wafers and, in particular, to controlling the temperature of a semiconductor wafer during processing. *See* Ex. 1003, 1:8–13; *see also id.* at 2:60–65 (stating one objective is to provide a "simpler method of heat-processing semiconductor devices whereby temperatures of the semiconductor devices can be controlled at devices-heating and -cooling times so as to accurately control their thermal history curve").

Matsumura's temperature control system uses a central processing unit ("CPU") having a PID controller that stores "as a predetermined recipe, information showing a time-temperature relationship and applicable for either heating [a wafer] to a predetermined temperature for a predetermined period of time or cooling the [wafer] from a predetermined temperature over a predetermined period of time." *See id.* at 3:1–7, 5:64–6:6, 8:56–62; *see also id.* at [57] (stating a "control system controls either the heating of the wafer or the cooling thereof, or both, in accordance with the detected temperature signal and the [stored] information").

An example of a predetermined recipe is shown in Figure 9 below. *See id.* at 8:56–57.

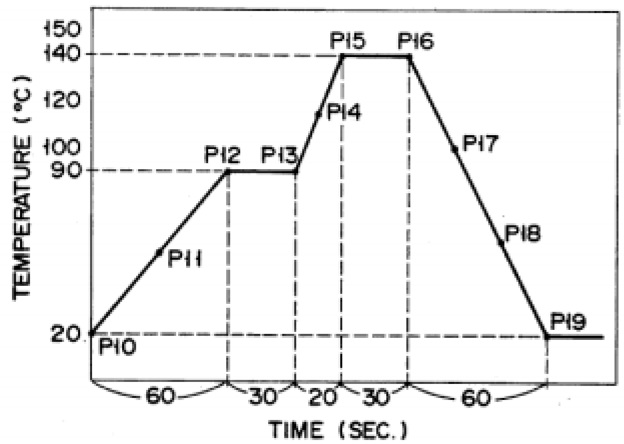
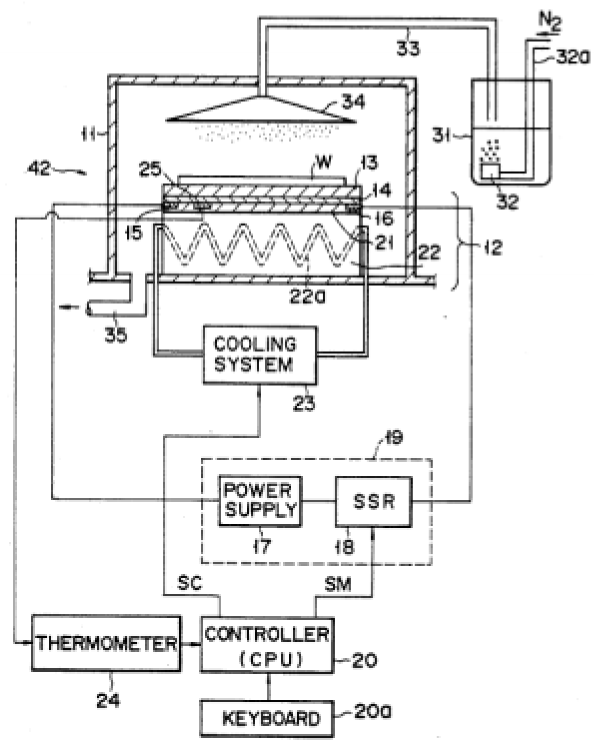


FIG. 9

Figure 9, shown above, is a diagram showing a "recipe relating to a thermal history curve of a wafer-stage," showing temperature as a function of time. *Id.* at 4:42–43; *see also id.* at 8:56–68 (stating "Points P10 to P19 shown in figure 9 are set in the recipe to surely reproduce the thermal history curve of the wafer"). The information "relating to temperatures and times at these points P10 to P19 is inputted as a command temperature table to the CPU." *Id.* at 8:59–62.

Figure 5A, reproduced below, is a schematic diagram of an adhesion unit included in a resist processing system of Matsumura that includes wafer stage 12 for heating and cooling wafer W in accordance with recipes inputted into a CPU. *See id.* at 4:28–29, 5:13–17, 6:6–9.



F I G. 5A

Figure 5A depicts adhesion unit 42 having wafer-stage 12 that can heat and cool the semiconductor wafers (e.g., wafer W). *Id.* at 5:14–16. Recipes, including heating and other conditions, are inputted to the CPU by keyboard 20a. *Id.* at 6:6–9. Thermometer 24, which has thermal sensor 25 attached to thin film 14, is attached to a control system 20. *See id.* at 5:57–6:4. Based on the recipe and temperature detecting signal, control system 20 controls the amount of coolant supplied from the cooling system to cooling jacket 22 under stage 12 and the current applied to conductive thin film 14 to raise the temperature of the wafer. *Id.* at 5:64–6:61.

Matsumura states that, although "the present invention has been applied to the adhesion and baking processes for semiconductor wafers in the above-described embodiments . . . , it can also be applied to any of the ion implantation, [chemical vapor deposition ('CVD')], etching and ashing processes." *Id.* at 10:3–7.

3. Anderson

Anderson generally relates to the field of semiconductor manufacturing devices and, in particular, to chucks for controlling wafer temperature. Ex. 1011, 1:10–12. Anderson discloses that, in order to achieve maximum throughput of a tool in certain high energy processes, such as plasma processes that include plasma etching, it is "imperative" that a wafer be set to its operating temperature as soon as possible and, once the operating temperature has been reached, to remove the process that generates heat for the wafer in a controlled manner. *Id*. at 2:60–65. For instance, Anderson discloses that, in one embodiment employing a low thermal mass heater, a chuck may be heated from room temperature to an operating temperature of 100º to 500ºC in a matter of seconds. *Id*. at 6:24–28.

4. Hinman

Hinman is directed to an improved temperature control system for use in controlling the temperature of small volumes of liquid undergoing analysis in a centrifugal chemistry analyzer. Ex. 1010, code (57), 1:4–9. Specifically, Hinman notes that rapidly applying heat to a sample may result in "overshoot" in which the temperature rises above the desired range, while insufficient heat may result in a lower than desired temperature. *Id*. at 1:26–36, Fig. 3 (curve B showing overshoot, curve A showing insufficient heat).

Hinman addresses this problem, in part, by heating the samples in cuvettes located in a ring member that has a substantially larger thermal mass than the liquid in the cuvettes. *Id*. at 2:41–45. The heat stored in the ring member permits a cuvette temperature change from about 15°–20°C to about 25°–40°C within 20–40 seconds, which Hinman notes can be achieved through the use of a ring member having a thermal mass of about 5–20 times the thermal mass of the liquid samples. *Id*. at 2:53–62. Hinman provides two examples of ring members with the appropriate thermal mass, an aluminum ring member of about 1 kg, and a copper ring member of about 2.5 kg, and provides exemplary calculations of their thermal masses. *Id*. at 2:65–3:6.

5. The Proposed Combination

Petitioner provides detailed analysis setting forth how the combined disclosures of Muller, Matsumura, Anderson, and Hinman teach or suggest all limitations of independent claim 13, and relies on the testimony of Dr. Bravman in support thereof. Pet. 29–37. Petitioner contends that Muller discloses a method of etching a substrate using a substrate holder in a chamber, as well as the use of two different etch temperatures during the etching process. *Id*. at 29–30, 32–40. Petitioner also relies on Matsumura's disclosure of a "predetermined recipe" for changing etch temperature over time as teaching two-temperature etching, as well as a temperature change over a predetermined time, and contends that it would have been obvious to combine "Matsumura's substrate holder heater and temperature sensor, control system, and predetermined recipe process with Muller's tool to carry out Muller's multi-temperature process." *Id.* at 33–35.

With respect to claim 13's requirement that the substrate holder have a selected thermal mass, Petitioner relies on Anderson's disclosure of a substrate holder having a low thermal mass heater, and notes that Anderson teaches that the use of the low thermal mass heater permits temperature change from 100° to 500°C in a matter of seconds. *Id*. at 30. Petitioner argues that "it was well known to select a low thermal mass substrate holder material for rapid temperature changes" and that the math used to calculate the thermal mass of an object was also well-known. *Id*. at 31. Therefore, Petitioner concludes, it would have been obvious in view of Anderson to use a substrate holder with a selected thermal mass in the device of Muller. *Id*.

Finally, claim 13 also requires that the thermal mass of the substrate holder be selected for "a predetermined temperature change with a specific interval of time during processing." In our prior decisions addressing claim 13 of the '264 patent, we found the prior art lacking this limitation, because, like Anderson, the cited prior art only required a low thermal mass, not that the thermal mass is selected to achieve a chosen change in temperature over a specific period of time. *See, e.g.,* Ex. 1017, 17–18. Petitioner relies on Hinman to disclose this limitation, arguing that Hinman describes "how to preselect the thermal mass of a material in a chemical analyzer's 'temperature control system' to effectuate predetermined temperature changes within a specific interval." Pet. 33, 40–41. Specifically, Hinman discloses that its metal ring member should have a thermal mass selected to be 5–20 times the thermal mass of the sample, in order to change from a "cold" temperature of 15°–20°C to a desired temperature of 25°–40°C within 20 to 40 seconds. Ex. 1010, 2:41–3:6. Hinman proceeds to supply exemplary calculations for a ring of aluminum or copper, concluding that a 1 kg aluminum ring or 2.5 kg copper ring would have an appropriate thermal mass. *Id*.

Given this disclosure, Petitioner concludes that it would have been obvious in view of Anderson and Hinman to select the precise thermal mass of the substrate holder used in Muller, to achieve a predetermined temperature change of a specific interval of time. Pet. 41–42. Petitioner argues that a person of ordinary skill in the art would have had reason to use Hinman's teachings to calculate the precise thermal mass of the substrate holder taught by Anderson, to address the goal of throughput in semiconductor wafer processing as addressed by both Muller and Anderson. *Id*. at 42–43.

6. Analysis of Independent Claim 13

Petitioner's arguments that the prior art, combined as above, would meet all elements of claim 13 are largely uncontested. Patent Owner only addresses with particularity claim elements [a] and [f], as well as the reason to combine the references. On the remaining claim elements [b]–[e], we have reviewed Petitioner's undisputed arguments, and find them supported by the evidence of record. We adopt Petitioner's analysis as to these claim elements. *See* Pet. 25–33.

For example, we agree with Petitioner that Muller discloses setting the substrate holder to a selected first substrate holder temperature of 125ºC or

145ºC (element [b]). Ex. 1002, 3:45–52, 4:64–5:25, 6:54–65, Fig. 3. Matsumura also teaches a substrate holder including an embedded heater and thermometer, and using predetermined "recipes" to heat a wafer using the substrate holder to a first temperature. Ex. 1003, 3:1–7, 5:32–33, 8:20–22, Figs. 8–9. We also agree with Petitioner's analysis, supported by the testimony of Dr. Bravman, as to why a person of ordinary skill in the art would have combined Muller's tool with Matsumura's substrate holder heater and temperature sensor, control system, and predetermined recipe process to carry out Muller's multi-temperature process. Pet. 34–36; Ex. 1006 ¶¶ 178–182.

We also agree that Muller teaches using a second, higher etching temperature of 175ºC or 195ºC, as required by element [e]. Ex. 1002, 3:34–52, 5:17–25, 5:43–47, 6:3–10; Ex. 1006 ¶ 74. We find that a person of ordinary skill in the art would have applied Matsumura's disclosure of changing the temperature between the first and second temperatures (element [d]) using its heater and predetermined recipes to achieve the two-temperature etching process of Muller. Ex. 1003, 3:1–7, 5:32–33, 8:20–22, Figs. 8–9; Ex. 1006 ¶ 188.

As to element [a], it is undisputed that Muller discloses placing a wafer on an electrostatic chuck in a processing chamber, and that this meets "placing a substrate having film thereon on a substrate holder in a chamber." Ex. 1002, 4:38–44. We agree. But Patent Owner disputes that the substrate holder has a "selected thermal mass." PO Resp. 5–8. As noted above, for this aspect of the claim, Petitioner relies on Anderson, which discloses that its substrate holder has a "low thermal mass" heater. Ex. 1011, 6:24–28.

Petitioner emphasizes Anderson's disclosure that the low thermal mass of the heater permits a temperature change from 100º to 500ºC in a matter of seconds. Pet. 23–24. According to Petitioner, this would have motivated the skilled artisan to use a low thermal mass heater (which is a "selected thermal mass") in the substrate holder of Muller, in order to permit rapid temperature changes. *Id.* at 24.

Patent Owner contends that the term "thermal mass" in Anderson "means something completely different from that in the '264 patent." PO Resp. 5–6. We fail to see how that is the case, as Patent Owner provides little reasoning to support its assertions beyond citations to Dr. Flamm's declaration, which largely repeat the bare assertions of the Response. *See* Ex. 2001 ¶ 8. In any event, we disagree with Patent Owner's characterization. Anderson's reference to "low thermal mass" is nearly identical to that in the '264 patent, which states that a "low thermal mass" material can be used as the upper surface of the substrate holder. Ex. 1001, 15:40–45. The term appears to have the same meaning in both disclosures, as both Anderson and the '264 patent discuss that this low thermal mass permits rapid temperature change of the substrate holder. *See id*. at 2:37–41, 2:51–56; Ex. 1011, 6:24–28. It is unclear why Patent Owner contends that these meanings are "completely different."

Patent Owner also argues that "Anderson's objective is to maintain the operating temperature (not change any temperature)" and uses latent heat of vaporization to achieve this. PO Resp. 6. As just discussed, this is not the case, as Anderson notes that "due to the low thermal mass heater employed," its device "is capable of heating the chuck . . . in a matter of seconds." Ex. 1011, 6:24–28. While other aspects of Anderson may be concerned with maintaining operating temperature, and may use latent heat of vaporization to do so, that does not detract from Anderson's disclosure of thermal mass and its effect on heating.

Similarly, we find unpersuasive Patent Owner's argument that Anderson causes a rapid temperature change prior to processing, while the '264 patent is concerned with "tight control while changing wafer temperature during processing." *Id.* Petitioner does not rely on Anderson to teach temperature control during processing, nor is this a requirement of element [a] that we are analyzing here. Anderson is relied on for its disclosure of selecting a thermal mass; the temperature control during processing, as noted above, is provided by the combination of Muller with Matsumura.

Patent Owner argues that a person of ordinary skill in the art would not have combined Anderson with Muller. PO Resp. 7. We disagree. Patent Owner focuses on the fact that Muller's chuck requires cooling, not heating like the Anderson substrate, and that Anderson does not disclose etching a substrate at two temperatures during processing. *Id.* On the first point, we note that Muller discloses, for example, that the "temperature of the wafer may be increased by approximately 50º C. over a time of several seconds." Ex. 1002, 5:23–25. But even if it were the case that Muller discloses cooling only, we fail to see how the direction of the temperature change would make Anderson's thermal mass disclosure inapplicable. Muller emphasizes accomplishing a temperature change in a very short time. *Id*. at 5:21–23 ("the effect on the temperature of the wafer is immediate").

And thermal mass is not a directional property—an object with low thermal mass will both heat and cool quickly. No matter the direction of Muller's temperature change, we find that a person of ordinary skill would have found Anderson's teaching regarding low thermal mass, and how it facilitates rapid temperature change, applicable to Muller's chuck. Pet. 31–32; Ex. 1006 ¶¶ 44–45, 116–118, 175).

On Patent Owner's second argument, it is beside the point that Anderson does not disclose etching at two temperatures during processing. Petitioner is not relying on the reference for this disclosure[14]; nor is two-temperature processing relevant to Petitioner's articulated reason to combine Anderson with the other references. Rather, Muller and Matsumura are alleged to disclose this aspect of the claim, and Petitioner persuasively explains how the thermal mass of the chuck facilitates rapid temperature change. It is unclear why Patent Owner contends that the lack of two-temperature processing in Anderson makes its thermal mass disclosure inapplicable to Muller and Matsumura.

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[14] This is a common theme throughout Patent Owner's Response: Patent Owner frequently criticizes Petitioner's reliance on a prior art disclosure to satisfy a certain element of a claim, because the reference does not teach some other, completely separate aspect of the claim. This argument is not persuasive here, or any of the other times Patent Owner raises it, as it focuses on the reference in isolation, rather than as a part of the combination that Petitioner is proposing. *See In re Keller,* 642 F.2d 413, 426 (C.C.P.A. 1981) ("one cannot show non-obviousness by attacking references individually where, as here, the rejections are based on combinations of references.").

Finally, Patent Owner contends that Anderson does not disclose selecting a thermal mass of a *substrate holder*, because the reference instead states that its *heater* has a low thermal mass. PO Resp. 11–14. Patent Owner previously made this argument in its Preliminary Response (*see* Prelim. Resp. 3–4); it is no more persuasive here when evaluated on a full record. As shown in Figure 1 of Anderson, heating layer 15 is disposed on top of chuck 11 and between insulating layers 13 and 14; wafer 20 is positioned onto upper insulating layer 14. Ex. 1011, 5:41–62. We find that heating layer 15 is part of the substrate holder of Anderson, and as such, modifying the thermal mass of the heater would necessarily affect the overall thermal mass of the substrate holder. This finding is supported by the disclosure of the ’264 patent itself, which only describes selecting the thermal mass of a portion of the substrate holder, namely the upper surface of the substrate holder. *See* Ex. 1001, 15:40–48 (“the upper surface [of the substrate holder] is made using a low thermal mass, high conductivity material”). Thus, the ’264 patent acknowledges that altering the thermal mass of a portion of a structure would necessarily alter the overall thermal mass of that structure.

Turning to element [f], Patent Owner argues that neither Hinman nor Anderson teach that the thermal mass is selected for a predetermined temperature change within a specific interval of time. PO Resp. 8–11. Patent Owner also contends that Hinman cannot be combined with Anderson, Muller, and Matsumura, because it is nonanalogous art and the combination would be inoperable. *Id*. at 15–20. We take each of these arguments in turn.

Patent Owner asserts that Hinman is "irrelevant." *Id*. at 9 ("Respondent is at a loss to know where even to begin to enumerate the differences and highlight its remoteness."). Patent Owner then lists a number of aspects of the device of Hinman that allegedly separate it from the claimed invention. For example, Patent Owner points out that Hinman concerns heating a cuvette of liquid, and uses a preheated ring having a thermal mass to raise the temperature of the liquid in the cuvette. *Id*. at 10. Patent Owner also notes Hinman's focus on the relationship between the thermal mass of the ring and the liquid, so that the "thermal mass of the ring [] can prevent its own temperature from changing significantly, yet be able to change the temperature of the liquid before processing." *Id*. Patent Owner contrasts this with the use of thermal mass in the '264 patent, which is said to be for the "opposite purpose." *Id*.

These arguments are not persuasive. It is unclear why Patent Owner contends that Hinman's purpose is "opposite" to the use of thermal mass in the '264 patent, especially as would be relevant to the disclosure upon which Petitioner relies. The only potential "opposite" aspect of Hinman is that its ring is selected to have a high thermal mass so that stored heat may be used to change the temperature of the analyte, while the '264 patent (and Anderson) disclose using low thermal mass substrate holders. But this ignores a key aspect of Hinman and Petitioner's reliance on it. Hinman discloses not only that the thermal mass of its ring should be high, but that the analyte should have a low thermal mass. Ex. 1010, 3:3–4 ("ratio of the thermal mass of the ring to the liquid would be about 20"). This is because Hinman desires to heat the analyte quickly, from 15º–20º C to 25º–40º C, within a specific period of time, 20 to 40 seconds. *Id*. at 2:52–59; *see also id*. at 3:4–10 (advising against coating the cuvette in any substance that "introduces significant thermal resistance" such that the "desired temperature increase is not unduly delayed."). Rather than being "opposite," both Hinman and the '264 patent (as well as Anderson) disclose that the thing whose temperature will be changed quickly—Hinman's anaylte, or the '264 patent's substrate holder—should have a selected low thermal mass to achieve this end.

Patent Owner also argues that Hinman is "opposite" to the '264 patent because the purpose of the Hinman ring is "to indirectly heat and maintain a small amount of liquid sample at a single constant temperature for processing." PO Resp. 10. Once again, Patent Owner is focusing on an aspect of the reference that Petitioner does not rely on. While Hinman does disclose a system for maintaining the temperature of the analyte within an acceptable range, this disclosure comes after the discussion of the high thermal mass ring, and involves the application of hot air from a heater controlled by a circuit. Ex. 1010, 3:41–4:62. While the thermal mass of the ring may contribute to the stability of this system, Hinman does not restrict the utility of the ring to only maintaining temperature. As discussed above, and as Patent Owner admits, the Hinman ring is preheated and the latent heat used to quickly raise the temperature of the analyte cuvette. This is the disclosure in Hinman that Petitioner asserts would be adapted to the system of Muller, and Patent Owner's focus on other aspects of Hinman is not persuasive.

Patent Owner asserts that Hinman "fails to teach the objective of changing the temperature of anything during processing." PO Resp. 10. Again, this is not Petitioner's argument, and the combination does not depend on Hinman disclosing temperature change during processing. Petitioner's reliance on Hinman is to disclose the concept of selecting a thermal mass to facilitate a particular rate of temperature change (*see* Pet. 40–41), and we find that the reference would have disclosed this to a person of ordinary skill in the art.

Patent Owner also argues that Hinman is nonanalogous art to the claimed invention. PO Resp. 15–19. As Patent Owner correctly notes, art is analogous if it is either: (1) from the same field of endeavor as the claimed invention; or (2) reasonably pertinent to the problem faced by the inventor. *Id.* at 15–16 (citing MPEP § 2141.01(a)). As we find below that Hinman satisfies the second prong of this test, we need not address Patent Owner's arguments regarding field of endeavor.

A reference is "reasonably pertinent" to a problem if it "logically would have commended itself to an inventor's attention in considering his problem." *In re Icon Health and Fitness, Inc.*, 496 F.3d 1374, 1379–80 (Fed. Cir. 2007) (quoting *In re Clay*, 966 F.2d 656, 658, 23 USPQ2 1058, 1061 (Fed. Cir. 1992)). Petitioner argues that Hinman and the '264 patent address the same problem, namely "controlling temperature to increase throughput." Reply 5; Ex. 1025 ¶¶ 45, 48. Patent Owner disagrees, alleging that the '264 patent is "concerned with achieving or improving etch selectivity in a high throughput etch process for semiconductor processing," and that this is different than the problems addressed by the prior art. PO Resp. 18.

In defining the problem addressed by the inventor, the specification of the challenged patent is often instructive. Here, the ’264 patent notes that prior art substrate etching processes used “batch” modes in which etching was done at a single temperature, and that the invention improves upon these processes by providing a multi-stage etching process using different temperatures. Ex. 1001, 1:65–2:11. As such, the invention allegedly overcame disadvantages of prior art processes, which required lowered throughput and etch rate in order to avoid excessive damage to a workpiece. *Id*. at 2:11–14. Despite Patent Owner’s arguments, we cannot agree that etch selectivity, as opposed to throughput, is the problem addressed by the ’264 patent. As Dr. Bravman points out, “[t]he specification of the ’264 patent is devoid, however, of description of improved or high selectivity processes or explanation of how the purported invention achieves both high selectivity and high etch rates.” Ex. 1025 ¶ 46. This is in contrast to the specification’s direct statement that the invention “overcomes serious disadvantages of prior art methods *in which throughput and etching rate were lowered* in order to avoid excessive device damage.” Ex. 1001, 2:11–14 (emphasis added). It is clear to us that the problem faced by the ’264 patent is one of throughput and etching rate.

The applicability of the cited prior art, including Hinman, to addressing this problem is also evident. Dr. Bravman testifies that both Anderson and Muller recognize the importance of throughput in etching processes, and the effect temperature changes have on throughput. Ex. 1006

¶ 130. For example, Anderson states that "[f]or maximum throughput of the tool . . . it is imperative that the wafer be brought up to its operating temperature as quickly as possible and . . . remove the process generated heat from the wafer in a controlled manner." Ex. 1011, 2:60–65. In addition, Matsumura states that its "recipes" for controlling processing temperature over time allows the "heat curve of temperature-raising and lowering periods [to be] controlled, as a result [] the throughput of wafers increase." Ex. 1003, 7:50–53.

The prior art, therefore, recognized a link between the control of substrate holder temperature and the throughput of the etching process, the very problem addressed by the inventor of the '264 patent. With this in mind, Hinman's disclosure of controlling temperature change using the thermal mass of an apparatus would have been considered pertinent by the person of ordinary skill in the art. Ex. 1025 ¶ 48. This is especially the case in view of Anderson's disclosure that thermal mass is a relevant variable in the throughput of an etching process.

Finally, Patent Owner objects to the combination of Anderson with Hinman, contending that the person of ordinary skill would have considered the combination inoperative. PO Resp. 20. The basis for this argument is the fact that Hinman teaches that its ring must have a large thermal mass, while Anderson discloses that the thermal mass of its substrate heater must be low. *Id*. We do not find this persuasive, as it relies on an overly mechanistic conception of the combination of the prior art. As Petitioner correctly observes, the proposed combination is not to directly incorporate the ring of Hinman into the substrate holder of Anderson. Reply 9. Rather, Hinman discloses the concept of selecting a thermal mass in order to achieve a particular rate of temperature change, and even suggests that the thermal mass of the cuvette (the object whose temperature should be changed at the desired rate) should have a low thermal mass. This is directly applicable to the disclosure of Anderson, which is that a substrate holder having a low thermal mass is advantageous because it allows rapid temperature changes. There is no suggestion in the prior art that combining the disclosures of the references in this manner—as opposed to the bodily incorporation of Hinman's ring into Anderson that Patent Owner suggests—would be inoperable.

In view of the entire record developed at trial, we conclude that there is no obstacle to combining the references in the manner Petitioner proposes, and find that a person of ordinary skill in the art would have had reason to make the combination to realize the advantages discussed above. We find credible the testimony of Dr. Bravman on these issues. Specifically, we find that a person of ordinary skill in the art would have had reason to use the control mechanism and recipes of Matsumura in the system of Mueller to control its multi-temperature process over time, because such a combination would have provided advantages in more precisely controlling the temperature of the wafer during processing. Ex. 1006 ¶¶ 85–94. We also find that the skilled artisan would have looked to Anderson's teaching of the advantages of using a low thermal mass substrate holder to provide for rapid temperature changes. *Id*. ¶ 116. And finally, the person of ordinary skill would have looked to Hinman's disclosure of the relationship between thermal mass and temperature change over time to choose the appropriate thermal mass for the temperature changes on Matsumura's recipes. *Id.* ¶¶ 128–130. Such a combination would have been within the level of ordinary skill in the art, and would have had a reasonable expectation of success. As combined, the references teach all elements of independent claim 13. Patent Owner has provided us with no evidence of objective indicia of nonobviousness. For these reasons, we conclude that claim 13 would have been obvious over the combined disclosures of Muller, Matsumura, Anderson, and Hinman.

7. Analysis of Dependent Claims 14–16, 18, 19, 21–23, 64, and 65

Petitioner contends that claims 14–16, 18, 19, 21–23, 64, and 65, each of which depend from independent claim 13, would have been obvious over the combination of Muller, Matsumura, Anderson, and Hinman. Pet. 36–38. Patent Owner does not separately address Petitioner's explanations and supporting evidence with respect to these dependent claims, aside from relying on its arguments regarding claim 13 that we addressed above. PO Resp. 20 ("Based upon the arguments associated with claim 13, dependent claims 14–16, 18–19, 21–23, and 64–65 are patentable and non-obvious over the combined disclosures of Muller, Matsumura, Anderson, and Hinman.").

We have reviewed Petitioner's unchallenged arguments and evidence, and determine that Petitioner has shown where each of the limitations of claims 14–16, 18, 19, 21–23, 64, and 65 are taught by Muller, Matsumura, Anderson, and Hinman, and has articulated a sufficient rationale for combining the teachings of the prior art. We agree with and adopt Petitioner's analysis on these points. Pet. 37–45.

For example, we agree with Petitioner that Muller teaches that the compositions of the first and second-etched portions of the film are different as required by claim 14. Ex. 1002, 3:34–52, 4:6–24, 5:17–20, 6:3–10; Ex. 1006 ¶¶ 204, 206–07. Muller discloses that its change in temperature is an in-situ process during the etching, as required by claim 15. Ex. 1002, 3:45–52, 4:68–5:3, 5:17–25, 5:33–48; Ex. 1006 ¶ 210. Regarding claim 16, which requires that the etching take place in a substantially constant plasma environment, we agree with Petitioner that this limitation is taught by Muller's disclosure that the power level and pressure within the chamber is kept constant during the etching process. Ex. 1002, 4:46–50, 5:34–48; Ex. 1006 ¶ 212. Our findings as to the remaining dependent claims are similar, and we adopt Petitioner's unchallenged contentions. Pet. 40–45.

Accordingly, we determine that Petitioner has proven by a preponderance of the evidence that the additional limitations of the dependent claims are present in the asserted combination of prior art references. Given that we found above that a person of ordinary skill in the art would have combined the references in the manner proposed, we conclude that the dependent claims would have been obvious over the combined disclosures of Muller, Matsumura, Anderson, and Hinman.

F. Obviousness of Claims 19 and 20 over Muller, Matsumura, Anderson, Hinman, and Wright

Petitioner challenges claims 19 and 20 as unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Muller, Matsumura, Anderson, Hinman, and Wright. Pet. 45–47. Claim 19 depends from claim 13 and further requires that the etching temperatures correspond to substrate holder temperatures and that the etching temperatures are in a “known relationship” to the substrate holder temperatures. Claim 20 depends from claim 19 and further requires that the etching temperatures are within 1°C of the substrate holder temperatures.

1. Wright

Wright discloses using two separate sensors to measure the temperature of a wafer and wafer holder. Ex. 1008, 321. Wright provides experimental data showing the correspondence of substrate and substrate holder temperatures, and that the temperatures were controlled to within ±1ºC. *Id*. at 324, Figs. 4–5. For example, Figure 4, reproduced below, shows the relationship between wafer temperature and chuck temperature:

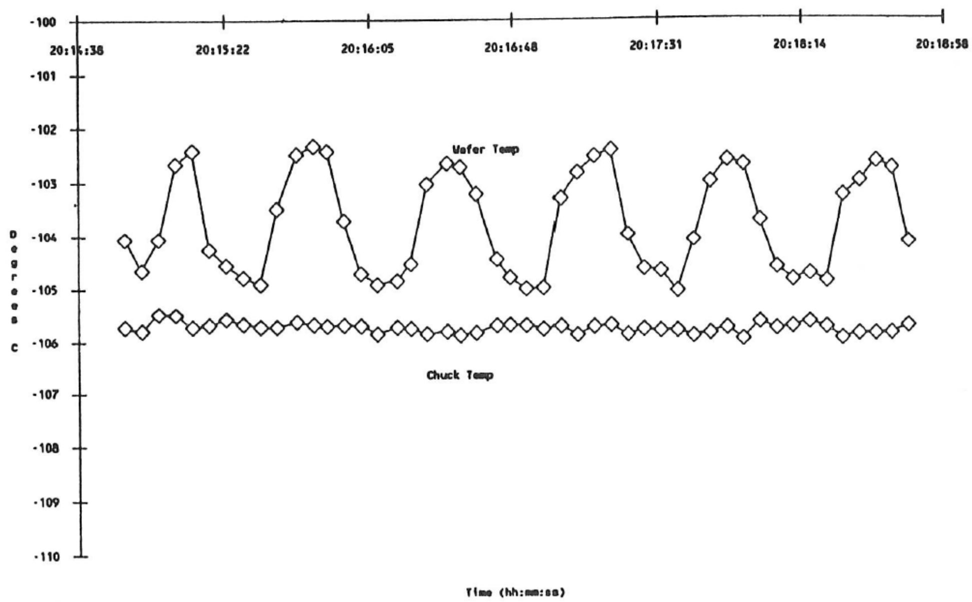

Figure 4 of Wright provides experimental results showing the relationship of wafer temperature (top line) to chuck temperature (bottom line) over time.

2. Analysis of Claims 19 and 20

Petitioner contends that, "[t]o the extent that the Muller-Matsumura system did not expressly disclose the temperature correspondence between substrate and substrate holder, Wright did." Pet. 46. In particular, Petitioner contends that the data in Figures 4 and 5 of Wright show a "known relationship" between the chuck (substrate holder) temperature and substrate temperature during etching as required by claim 19. *Id.* at 46–47. As for claim 20, Petitioner argues that controlling substrate and substrate holder temperatures within 1°C would have been routine optimization within the level of ordinary skill. *Id*. at 47. Petitioner contends that a person of ordinary skill in the art would have had reason to apply the experimental data of Wright to improve the etch process of Muller and Matsumura. *Id*. at 46–47.

In response, Patent Owner argues that Wright fails to teach the additional elements of claims 19 and 20, and that a person of ordinary skill in the art would not have combined Wright with the other references. PO Resp. 21–22. According to Patent Owner, "Wright's data show large temperature excursions between the wafer holder temperature and the wafer after the plasma is ignited and etching occurs." *Id*. at 22. Citing the testimony of Dr. Flamm, Patent Owner observes that the maximum difference between the chuck temperature and the wafer temperature is 3 ºC or more in Figure 4 and 25º C in Figure 5. *Id*. (citing Ex. 2001 ¶ 13).

We find that the combined prior art teaches the limitation of claim 19. First, as discussed above, we already determined that claim 19 would have been obvious over the combined teachings of Muller, Matsumura, Anderson, and Hinman, based on Petitioner's assertion that Muller's disclosure of a substrate thermally coupled to a substrate holder would have been understood to put the temperatures of the two in a "known relationship." Pet. 41; *see* Section II.E.7, *supra*. The addition of Wright cannot change our determination as to the obviousness of claim 19. Nevertheless, we also find that the experimental data of Wright establishes a "known relationship" between the etch temperature and the substrate temperature. Ex. 1008, 325 (Fig. 5). The fact that Wright shows that the temperature of the wafer fluctuates while the chuck stays constant does not mean that the relationship between the two is not "known." The '264 patent provides no indication that a "known relationship" requires that the difference between the two temperatures must remain constant.

Turning to claim 20, we agree with Petitioner that Wright discloses that the first etch temperature is within approximately one degree C of the first substrate holder temperature, and the second etch temperature is within approximately one degree C of the second substrate holder temperature. Pet. 47. Patent Owner's arguments to the contrary are based on the fact that the *maximum* difference shown in Wright is greater than one degree. *See* PO Resp. 22. But claim 20 does not require that the temperatures must always be within one degree of each other. Patent Owner points us to no portion of the '264 patent that states that the temperature cannot fluctuate somewhat during the etching steps, or that limits such fluctuations to one degree C.[15]

[15] Figure 10 of the '264 patent, which shows a plot of temperature versus time and indicates constant temperature, is not to the contrary. The

The only reference in the patent to "one degree Celsius" or uniformity of temperature is that the temperature must be uniform across the *surface* of the wafer, not over time during processing. *See* Ex. 1001, 15:29–34, 17:38–44. With this understanding, Petitioner's observation that Wright discloses that, "with respect to electrode/chuck temperature," the "system is capable of controlling to ±1ºC" and that "Wright included experimental results showing it had been done" is sufficient to meet the claim limitation." Pet. Reply 17 (citing Ex. 1008, 324, 326, Figs. 4–6, Tables A, B; Ex. 1025 ¶ 67).

Patent Owner also argues that, "Wright has great difficulty in controlling even one wafer temperature within 1 Degree C . . . let alone changing temperature from one predetermined value to another while maintaining a correspondence within 1 Degree C. as required by claim 20." PO Resp. 21. Patent Owner's basis for interpreting claim 20 as requiring *maintaining* a correspondence within one degree C is unclear, much less why such correspondence must be maintained *while changing temperature* between etch temperatures. The plain language of claim 20 is that the first and second *etch temperatures* are within approximately one degree C of the first and second substrate holders, respectively. There is nothing within the claim about the relationship between the temperatures when between etches.

In any event, we note that Wright's disclosure is broader than its experimental data on which Patent Owner focuses. Wright states that its

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specification makes clear that Figure 10 "shows a *simplified* process according to the present invention. This process is merely an illustration and should not limit the scope of the claims herein." Ex. 1001, 18:58–61 (emphasis added).

temperature can be controlled to ±1ºC. Ex. 1008, 324. And Wright concludes, based on its experimental data, that the system "provides reliable, tight temperature control (3σ as low as 0.6°C)." *Id*. at 326. We agree with Petitioner that these disclosures would teach a person of ordinary skill in the art that the "known relationship" between the temperatures should be within one degree C at some point during both etching steps.

Petitioner has also established that a person of ordinary skill in the art would have had reason to combine Wright with the other references that were combined in the prior ground. Again, we find Dr. Bravman's testimony on this issue credible, and find that a person of ordinary skill in the art would have incorporated the chuck and substrate temperature sensors of Wright into the system of Mueller to better control the processing temperature within the tolerances disclosed by Wright. Ex. 1006 ¶¶ 165–167. Patent Owner's argument that a person of ordinary skill in the art would not have combined Wright with the other references is based on the fact that Wright is directed to cooling a substrate by removing heat from the substrate holder, as opposed to the other references that teach heating a substrate. PO Resp. 22–23. But differences in the direction of the temperature change does not render inapplicable Wright's disclosure of temperature sensors, or the desirability of controlling the temperature within a range of ±1ºC. Patent Owner's arguments do not persuade us that a person of ordinary skill in the art would not have combined the references as proposed.

We find, based on the evidence of record, that the prior art discloses the additional elements of claims 19 and 20, and that a person of ordinary skill in the art would have had reason to combine the teachings of Muller, Matsumura, Anderson, and Hinman with the teaching of Wright. Accordingly, we determine that claims 19 and 20 would have been obvious over the combined teachings of Muller, Matsumura, Anderson, Hinman, and Wright.

G. Obviousness of Claim 17 over Muller, Matsumura, Anderson, Hinman, and Kikuchi

Petitioner challenges claim 17 as unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Muller, Matsumura, Anderson, Hinman, and Kikuchi. Pet. 48–50.

1. Kikuchi

Kikuchi is directed to methods for plasma ashing a resist film by initially controlling the temperature of the substrate below that at which explosion of the resist film occurs until after a surface portion of a resist film has been removed. Ex. 1004, code [57]. Kikuchi describes ashing a wafer's photoresist film at two sequential temperatures using either infrared heat lamp 5 or hot plate 7 to raise the temperature, and thermometers 10, 66 to measure the wafer and hot plate temperatures. *See, e.g., id.* at 1:56–2:3, 7:20–34, 7:62–68, 8:8–14, 11:6–9, Figs. 12, 13. Figure 1 of Kikuchi is reproduced below.

FIG.1 PRIOR ART

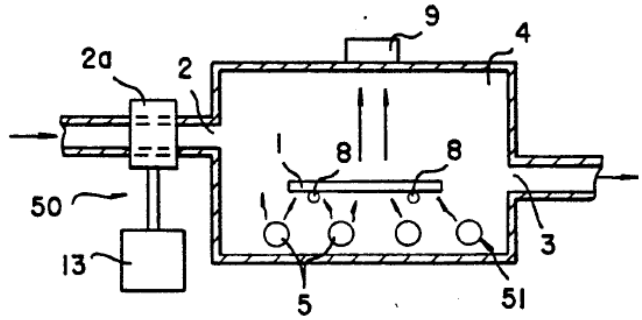

Figure 1 depicts a "conventional ashing method" in which a substrate is placed on rack 8 and is heated by infrared lamps 5 to a predetermined temperature in about 5 seconds (as shown by curve A in Figure 3). *Id.* at 1:56–60. The temperature of the substrate is controlled by infrared thermometer 9. *Id.* at 1:56–65, 4:62–63. Kikuchi explains that in this embodiment, it is difficult to coat the resist film 11 on only the front surface of substrate 1 as film will also be deposited on the rear surface of substrate 1. *Id.* at 2:47–61. Kikuchi states that if the substrate 1 is heated in contact with hot plate 7 to remove the resist film by ashing, hot plate 7 prevents the reactive radicals from working on that resist film and the resist film may remain on the rear surface of substrate 1. *Id.* at 2:61–67; Figs. 8, 9. Figure 11, shown below, depicts a sectional side view of an embodiment of the invention of Kikuchi.

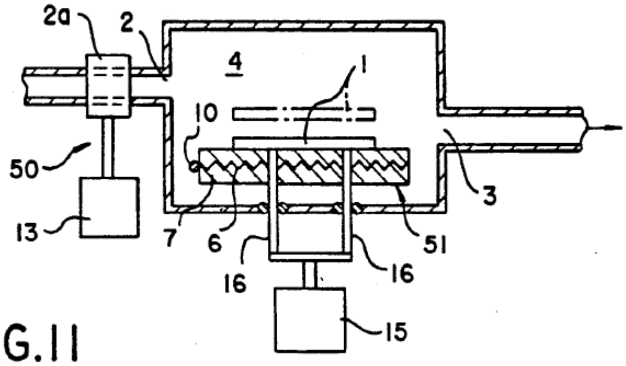

FIG.11

Figure 11 depicts a semiconductor substrate (wafer) 1, thermometer 10, pins 16, and heating means 51 having hot plate 7, inside of vacuum treatment chamber 4. *Id.* at 7:19–33. Kikuchi describes using the pins to suspend the substrate being ashed above the hot plate to remove a surface layer of photoresist, lowering pins 16 to place the substrate on the hot plate, and then raising the temperature to ash the remaining portion of the photoresist at a high temperature. *Id.* at 8:1–14; *see also* Ex. 1006 ¶ 86.

Kikuchi etched photoresist over a range of temperatures, with an initial step of 70°C–160°C and a rapid increase to 200°C over a time period of 5 to 10 seconds. *See, e.g.,* Ex. 1004, 2:37–46, 3:33–44, 5:46–54, Figs. 12, 13.

2. Analysis of Claim 17

Claim 17 depends from claim 13 and further requires that the etching of at least one of the portions of the film comprises radiation. Petitioner cites Kikuchi to teach this limitation, relying on Kikuchi's disclosure of an etch chamber that uses infrared lamps to heat a wafer. Pet. 48 (citing Ex. 1004, 7:25–31). Petitioner argues that a person of ordinary skill would have had reason to use the Kikuchi lamps to increase the rate of temperature change of the Muller process. *Id.* at 49.

Patent Owner argues that Kikuchi "teaches away" from Muller's process, and therefore a person of ordinary skill in the art would not have combined the references. PO Resp. 23. Specifically, Patent Owner points to a number of differences between the Kikuchi process and the Muller process, including that: Kikuchi is an ashing process, as opposed to the "deep trench ashing process" of Muller; that Kikuchi teaches a "plurality of supports" for moving the substrate in relation to the heat source; and that Kikuchi's source of heat (infrared lamps) is different than Muller's source of heat, which is its chuck. *Id*.

A reference teaches away if it criticizes, discredits, or otherwise discourages the solution claimed. *See In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004). In weighing the suggestive power of each reference, we must consider the degree to which one reference might accurately discredit another. *In re Young*, 927 F.2d 588, 591 (Fed. Cir. 1991). Here, Patent Owner, at best, points out differences between the processes of Kikuchi and Muller. There is no indication that either reference criticizes or otherwise discourages application of the other. Moreover, Patent Owner fails to explain why the differences it points out between the references (e.g., "ashing process" vs "deep trench silicon ashing process") are relevant to the combination Petitioner has proposed. As discussed above, Petitioner contends that one of ordinary skill in the art would have modified Muller's chamber to incorporate the infrared heating elements of Kikuchi to increase the potential rate of temperature change. Pet. 48–49. The fact that Muller heats with a chuck is not inconsistent with the notion that *additional* methods of heating, such as Kikuchi's infrared lamps, might improve the process. Furthermore, Patent Owner does not argue that a chamber that uses both infrared lamps and a chuck as heat sources would be inoperable. Indeed, Kikuchi's chamber uses both a heated substrate holder as well as infrared lamps. Ex. 1004, 7:32–34, 8:1–14. Accordingly, we are not persuaded that Kikuchi teaches away from Muller's process as Patent Owner contends.

Patent Owner does not contest that Kikuchi, when combined with Muller, Matsumura, Anderson, and Hinman, would teach all elements of claim 17. We find that Petitioner has carried its burden of proving so. In addition, we determine that a person of ordinary skill in the art would have had reason to combine the references as proposed. For these reasons, we conclude that claim 17 would have been obvious over the combined disclosures.

H. Obviousness of Claims 24–26 over Muller, Matsumura, Anderson, Hinman, and Moslehi

Petitioner challenges claims 24–26 as unpatentable under 35 U.S.C. § 103(a) as having been obvious over the combined disclosures of Muller, Matsumura, Anderson, Hinman, and Moslehi. Pet. 51–54. These claims are directed to certain aspects of the substrate holder, such as fluid passages or heating elements.

1. Moslehi

Moslehi discloses a low thermal mass electrostatic chuck (substrate holder) for use in plasma processing. Ex. 1009, code (57). According to

Moslehi, its substrate holder heats and cools a semiconductor wafer with rapid thermal transients over a wide range of temperatures, and "greatly enhances the performance and application domain" of the processing chamber. *Id*. at 4:44–52. The low thermal mass of the substrate holder is "for rapid semiconductor wafer heating and cooling." *Id*. at 4:55–57.

The plates that form the electrostatic chuck of Moslehi have grooves that form coolant tunnels used for flowing coolant through the chuck. *Id*. at 8:27–34, 9:1–17, Fig. 3. The chuck also comprises heating elements, namely "[m]ulti-zone resistive heaters" which provide heating uniformity. *Id.* at 11:30–36.

2. Analysis of Claims 24–26

In challenging the patentability of claims 24–26, Petitioner relies on Moslehi's disclosure of fluid passages and heating elements in its chuck, and argues that a person of ordinary skill in the art would have improved the Muller chuck by incorporating these features from Moslehi. Pet. 51–54. Patent Owner did not argue these claims separately. PO Resp. 24 ("Based upon the earlier arguments associated with claim 13, the combination of the cited art including Moslehi fails to teach claims 24–26.").

We have reviewed Petitioner's unchallenged arguments and evidence, and determine that Petitioner has shown where each of the limitations of claims 24–26 are taught by Muller, Matsumura, Anderson, Hinman, and Moslehi, and has articulated a sufficient rationale for combining the teachings of the prior art. We agree with and adopt Petitioner's analysis on these points. Pet. 51–54.

For example, claim 24 requires that the heat exchange region of the substrate holder includes at least two separate fluid passages, each configured to have an independent inlet and outlet. We find that Moslehi teaches these features. As discussed above, the Moslehi chuck includes coolant tunnels. Ex. 1009, 8:27–34, 9:1–17. Figure 3 of Moslehi shows two separate tunnels, each with an independent inlet and outlet. *Id*. at Fig. 3. As for claim 25, we find that Moslehi discloses multi-zone heaters (*id*. at 11:30–36), which meet the requirement for a plurality of heating elements. This disclosure also satisfies claim 26's requirement that the heating elements are configured to selectively heat one or more zones of the substrate holder. *Id*.

We find that, as Petitioner alleges, a person of ordinary skill in the art would have had reason to add the features of the Moslehi chuck to the substrate holder of the Muller, Matsumura, Anderson, and Hinman combination, to improve the performance of the heating and cooling of the substrate holder. Pet. 51–54; Ex. 1006 ¶¶ 153–55.

For these reasons, we find that Petitioner has proven by a preponderance of the evidence that the additional limitations of dependent claims 24–26 are present in the asserted combination of prior art references. Given that we found above that a person of ordinary skill in the art would have combined the references in the manner proposed, we conclude that claims 24–26 would have been obvious over the combined disclosures of Muller, Matsumura, Anderson, Hinman, and Moslehi.

I. Obviousness of Claims 13–16, 18–23, 64, and 65 over Kadomura, Matsumura, Anderson, and Hinman

Petitioner challenges claims 13–16, 18–23, 64, and 65 as unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, and Hinman. Pet. 54–74. Petitioner's contentions are similar to those provided in its grounds involving Muller, Matsumura, Anderson, and Hinman, except that in place of Muller's etch chamber Petitioner relies on the etch chamber of Kadomura.

1. Kadomura

Kadomura, titled "Method and Apparatus for Dry Etching with Temperature Control," discloses, *inter alia*, a multi-temperature process for etching portions of a semiconductor wafer. Ex. 1005, codes (54), (57). The etching tool of Kadomura shown in Figure 4 has a wafer stage for holding the wafer/substrate during processing, thermometer for measuring wafer temperature, and a control device, having a PID controller, for controlling the temperature of wafer based on temperature measurements from the thermometer. *See id*. at 11:36–59, 12:37–48, Fig. 4. Kadomura adjusts the wafer temperature by adjusting the temperature of wafer stage 12, using a heater or chiller 17. *See id*. at 10:7–10 (stating the change in temperature of specimen W is controlled by "the cooling means and the heater disposed to the stage 12"); *see also id*. at 12:37–38 (the "cooling degree for the specimen [] is controlled by the flow rate of the coolant supplied from the chiller"). The temperature sensed by "thermometer 18 is detected by a feed back control device (feed back control means) 25 comprising a [proportional-integral-derivative] PID controller." *Id*. at 12:39–43.

Kadomura explains that feed back control device 25 controls the cryogenic valve "to obtain a gas coolant flow rate previously determined by experiment or calculation based on the difference between the detected temperature and the predetermined temperature for the specimen." *Id*. at 12:43–49.

Kadomura discloses several examples of multi-temperature etch processes. For example, one process includes a first step of etching silicide and polysilicon at room temperature (20°C) and a second step of etching polysilicon at a lower temperature (-30°C). *Id*. at 6:18–7:7; Figs. 1A–1C. In between these etching steps, gases remaining in the diffusion chamber are exhausted and the etching gas used in the second step is introduced; the gas is stabilized and the inside of the diffusion chamber is controlled to a constant pressure. *Id*. at 6:36–44. During "a series of such operations, that is directly after the completion of the etching of the first step," gas coolant at -140°C from the chiller is supplied to the wafer stage to rapidly cool the wafer. *Id*. at 6:44–51. The temperature of the wafer reaches -30ºC "within a short period of time of about 30 sec by such rapid cooling." *Id*. at 6:52–55.

After completing these two steps, a heater within substrate holder stage 12 returns the wafer specimen temperature back up to 20ºC. *Id*. at 7:31–47. The tool then repeats the same two temperature etch process. *Id*. at 6:63–7:7, 7:31–47.

In another embodiment, the first etching step occurs at a low temperature (i.e., -30ºC) and the second etching step is applied at a much higher temperature (i.e., 50ºC). *Id*. at 9:54–10:27. A control mechanism for the cooling means and the heater disposed to the wafer stage are controlled to rapidly heat the specimen W between the etching steps. *See id*. at 10:7–10. The temperature of the wafer reaches 50ºC "within a short period of time of about fifty (50) seconds." *Id*. at 10:11–27.

According to Kadomura, one objective of the disclosed dry etching method is to apply an etching treatment that includes a plurality of steps to a specimen within the same processing apparatus, wherein the temperature of the specimen is changed between etching in a first step and etching in a second step. *Id*. at 2:65–3:5. Because the disclosed dry etching method conducts each of the etching treatments in the same processing apparatus, the time for changing the specimen temperature between the steps may be shortened. *Id.* at 4:46–49. Moreover, by conducting the change of specimen temperature within a short period of time, dry etching treatment may be applied without deteriorating the throughput. *Id.* at 4:49–54. Kadomura discloses several examples of multi-temperature etch processes, including etching silicide and polysilicon at room temperature (20°C) in a first step, followed by etching polysilicon at -30°C in a second step. *Id.* at 6:18–7:7. After completing those two steps, a heater within substrate holder stage 12 brought the holder back up to 20ºC before the tool repeated the same two temperature etch process. *Id.* at 6:63–7:7, 7:31–47. Kadomura also discloses etching polysilicon at higher temperatures because "radical reaction is promoted by increasing the specimen temperature (50°C)." *Id.* at 10:28–35.

In the third embodiment discussed in relation to Figures 3A–3C, Kadomura discloses a method of fabricating polysilicon on a SiO_2 layer having a high step. *Id.* at 9:36–10:27. The main etching in the first step is applied at a low temperature (i.e., -30ºC), whereas the over etching in the second step is applied at a much higher temperature (i.e., 50ºC) within a short period of time of about fifty (50) seconds. *Id.* at 9:54–67, 10:11–27. According to Kadomura, the change in temperature of specimen W is controlled by "the cooling means and the heater disposed to the stage 12." *Id.* at 10:7–10. The functioning of the cooling means is controlled by thermometer 18, which is "connected for measuring the temperature of the specimen W." *Id.* at 11:48–51, 12:36–47.

2. Analysis of Claims 13–16, 18–23, and 64–65

Petitioner argues that a person of ordinary skill in the art would have improved Kadomura using the temperature sensor and recipes of Matsumura, and further recognized the importance of selecting a substrate holder having a low thermal mass to increase throughput as disclosed in Anderson. Pet. 55–56, 58–61. Furthermore, as with the prior ground involving Muller, Petitioner argues that a person of ordinary skill in the art would have used the disclosure of Hinman to select a thermal mass to achieve a predetermined temperature change of a specific interval of time. *Id*. at 65–67.

Patent Owner notes the similarity of the Kadomura, Matsumura, Anderson, and Hinman ground to the previously-discussed ground involving Muller. PO Resp. 24 ("Petition's contentions are similar to those provided in its grounds involving Muller, Matsumura, Anderson, and Hinman, except that in place of Muller's etch chamber Petitioners rely on the etch chamber of Kadomura."). For this reason, Patent Owner relies on the arguments made in relation to that ground in regard to claim 13, and contends that "the combination of the cited art including replacing Muller with Kadomura fails to teach claims 14–16, 18–23, 64, and 65."[16] *Id.* at 24–25.

We have reviewed the entirety of the record and find that Kadomura, like Muller, in combination with Matsumura, Anderson, and Hinman discloses all of the elements of independent claim 13, as well as dependent claims 14–16, 18–23, 64, and 65. We adopt Petitioner's contentions as to how each element of the challenged claims is taught by the combination. Pet. 54–74. We also adopt Petitioner's rationale for combining the references in the manner proposed. *Id*.

Patent Owner's arguments as to why certain elements of claims 13, 17, 19, and 20 are not taught by Matsumura, Anderson, or Hinman were discussed above in the context of the ground involving Muller as the primary reference. Replacing Muller's disclosures with those of Kadomura does not change our analysis as to these other references, and we rely on our analysis as set forth above.

For these reasons, we determine that Petitioner has proven by a preponderance of the evidence that the limitations of claim 13, as well as the additional limitations of the dependent claims, are present in the asserted combination of prior art references. We also find that a person of ordinary

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[16] Patent Owner does not state any opposition to Petitioner's analysis regarding whether claim 13 is taught by the combined references in this ground. *See* PO Resp. 24–25 (silent as to claim 13). Nevertheless, we have evaluated this ground as if Patent Owner opposed the ground as to claim 13 for the same reasons that it opposed the Muller ground discussed above.

skill in the art would have combined the references in the manner proposed. Accordingly, we conclude that claims 13–16, 18–23, 64, and 65 would have been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, and Hinman.

J. Obviousness of Claim 17 over Kadomura, Matsumura, Anderson, Hinman, and Kikuchi

Petitioner challenges claim 17 as unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, Hinman, and Kikuchi. Pet. 75–77. Petitioner's evidence as to the additional limitation of claim 17 is identical to that proffered for the ground involving Muller above; namely, Petitioner relies only on the disclosure of infrared lamps in Kikuchi. *Id*. We find Petitioner's arguments and evidence on this ground persuasive, for the same reasons set forth in the Muller ground above. Patent Owner does not provide any arguments in response distinct from those already set forth above. PO Resp. 25 ("For the same reasons that Kikuchi fails to teach claim 17 with Muller, Kikuchi has the same problems with Kadomura.[17]").

For the reasons set forth in the discussion of the Muller ground above, we find that all of the elements of claim 17 are disclosed by the combined references asserted by Petitioner, and adopt Petitioner's analysis. Pet. 75–77. We also find that a person of ordinary skill in the art would have

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[17] In the short discussion of the ground following this statement, Patent Owner repeatedly discusses the alleged reasons why Kikuchi cannot be combined with Muller, not Kadomura. We presume Patent Owner intended to refer to Kadomura instead, and have evaluated the arguments as such.

combined Kikuchi's infrared lamps with the disclosures of Kadomura, Matsumura, Anderson, and Hinman. Accordingly, we conclude that claim 17 would have been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, Hinman, and Kikuchi.

K. Obviousness of Claims 24–26 over Kadomura, Matsumura, Anderson, Hinman, and Moslehi

Petitioner contends claims 24–26 are unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, Hinman, and Moslehi. Pet. 77–81. Petitioner's evidence as to the additional limitation of claims 24–26 is identical to that proffered for the ground involving Muller above; namely, Petitioner relies only on the disclosure of the coolant tunnels and heaters in Moslehi. *Id*. We find Petitioner's arguments and evidence on this ground persuasive, for the same reasons set forth in the Muller ground above. Patent Owner does not provide any arguments in response distinct from those already set forth above. PO Resp. 25–26 ("Based upon the earlier arguments associated with claim 13, the combination of the cited art including Moslehi and replacement of Muller by Kadomura fails to teach claims 24-26.").

For the reasons set forth in the discussion of the Muller ground above, we find that all of the elements of claims 24–26 are disclosed by the combined references asserted by Petitioner, and adopt Petitioner's analysis. Pet. 77–81. We also find that a person of ordinary skill in the art would have combined Moslehi's improved chuck with the disclosures of Kadomura, Matsumura, Anderson, and Hinman. We conclude that claims

24–26 would have been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, Hinman, and Moslehi.

L. Obviousness of Claim 15 over Kadomura, Matsumura, Anderson, Hinman, and Muller

Petitioner challenges claim 15 as unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, Hinman, and Muller. Pet. 81–83. Claim 15 depends from claim 13, and further requires that the change from the first substrate holder temperature to the second substrate holder temperature is an in-situ process during the first portion etching and second portion etching. Petitioner notes that Kadomura discloses exhausting the etching gas between etching steps, and changing the temperature during the time used to exhaust the gas, whereas Muller instead uses the same gas and continues etching while changing the temperature. *Id*. at 81–82. Petitioner argues that a person of ordinary skill would have applied Muller's teachings on continuous etching to the process of Kadomura to increase throughput. *Id*.

Patent Owner argues that a person of ordinary skill in the art would not have combined Kadomura with Muller, because Muller's continuous deep trench etching process would be "compromised and not work" if combined with the multi-step process of Kadomura. PO Resp. 26. Patent Owner also contends that Muller's etch profile shaping "would be inoperable with Kadomura's teaching of exhausting the gas during processing." *Id*. Patent Owner also repeats its arguments associated with claim 13 relating to the combination of Muller with the cited art. *Id.* at 27.

Patent Owner's arguments are not persuasive. We have discussed above the arguments regarding claim 13 and the combination of Muller with Matsumura, Anderson, and Hinman. They are no more persuasive now, merely because Kadomura is also included in the combination. As for Patent Owner's contention that the process of Muller would be compromised or rendered inoperable by combining it with Kadomura, the sole evidentiary support cited for these propositions is the testimony of Dr. Flamm. *See id*. at 26–27 (citing Ex. 2001 ¶ 19). Dr. Flamm, however, provides no support for these contentions beyond his bare statements that are identical to those provided in the Response. *See* Ex. 2001 ¶ 19 ("Muller relates to a deep trench etching process, which would be compromised and not work, if combined with the multi-step process of Kadomura."). Without more explanation, or any reasoning why Dr. Flamm believes that the combination would be inoperable, we cannot give Dr. Flamm's testimony substantial weight. *See* 37 C.F.R. § 42.65(a) ("Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.").

We have reviewed Petitioner's arguments and evidence, and determine that Petitioner has shown where the additional limitation of claim 15 is taught by Kadomura, Matsumura, Anderson, Hinman, and Muller, and has articulated a sufficient rationale for combining the teachings of the prior art. We agree with and adopt Petitioner's analysis on these points. Pet. 81–83. For these reasons, we conclude that Petitioner has proven by a preponderance of the evidence that claim 15 would have been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, Hinman, and Muller.

M. Claims 27, 33, and 51

Patent Owner's Response concludes with two sections entitled "Claim 33 is Not Invalid" and "The Dependent Claims are Not Invalid." PO Resp. 27–28. In the former, Patent Owner sets forth claim 33 of the '264 patent and argues that "Petitioner's arguments do not even address the Claim 33 limitation of being an in-situ process wherein the plasma discharge is not a remote plasma." *Id*. at 27. And in the latter section, Patent Owner states that "Petitioners fail to show any basis to invalidate the independent claims challenged in this Petition, *i.e.*, claims 27 and 51. As a matter of law, the petition should also be denied as to all of the claims that depend from those claims." *Id*. None of claims 27, 33, or 51, however, have been challenged in this proceeding, nor are any of their dependent claims at issue. We, therefore, do not make any determination as to the patentability of these claims in this Decision.

III. CONCLUSION

Based on the evidence and arguments, Petitioner has demonstrated by a preponderance of the evidence that:

(1) claims 13–16, 18–19, 21–23, and 64–65 are unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Muller, Matsumura, Anderson, and Hinman;

(2) claims 19 and 20 are unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Muller, Matsumura, Anderson, Hinman, and Wright;

(3) claim 17 is unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Muller, Matsumura, Anderson, Hinman, and Kikuchi;

(4) claims 24–26 are unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Muller, Matsumura, Anderson, Hinman, and Moslehi;

(5) claims 13–16, 18–23, 64, and 65 are unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, and Hinman;

(6) claim 17 is unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, Hinman, and Kikuchi;

(7) claims 24–26 are unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, Hinman, and Moslehi; and

(8) claim 15 is unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Kadomura, Matsumura, Anderson, Hinman, and Muller.

IV. ORDER

Accordingly, it is

ORDERED that claims 13–26, 64, and 65 of U.S. Patent No. RE40,264 E are *unpatentable*; and

FURTHER ORDERED that, because this Decision is final, a party to the proceeding seeking judicial review of the Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

Claims	35 U.S.C. §	References	Claims Shown Unpatentable	Claims Not shown Unpatentable
13–16, 18–19, 21–23, 64–65	103(a)	Muller, Matsumura, Anderson, Hinman	13–16, 18–19, 21–23, 64–65	
19–20	103(a)	Muller, Matsumura, Anderson, Hinman, Wright	19–20	
17	103(a)	Miller, Matsumura, Anderson, Hinman, Kikuchi	17	
24–26	103(a)	Miller, Matsumura, Anderson, Hinman, Moslehi	24–26	
13–16, 18–23, 64–65	103(a)	Kadomura, Matsumura, Anderson, Hinman	13–16, 18–23, 64–65	
17	103(a)	Kadomura, Matsumura, Anderson, Hinman, Kikuchi	17	
24–26	103(a)	Kadomura, Matsumura, Anderson, Hinman, Moslehi	24–26	
15	103(a)	Kadomura, Matsumura, Anderson, Hinman, Muller	15	
Overall Outcome			13–26, 64, 65	

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