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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte XIKUN WANG, ANDREW NGUYEN, CHANGHUN LEE,
XIAOMING HE, and MEIHUA SHEN

Appeal 2017-007271
Application 13/174,090
Technology Center 1700

Before JAMES C. HOUSEL, JULIA HEANEY, and BRIAN D. RANGE,
Administrative Patent Judges.

HOUSEL, Administrative Patent Judge.

DECISION ON APPEAL

Pursuant to 35 U.S.C. § 134(a), Appellants appeal from the
Examiner’s decision rejecting claims 1–10 and 21–30. We have jurisdiction
over the appeal under 35 U.S.C. § 6(b).

We AFFIRM.

1 Our decision refers to the Specification (Spec.) filed June 30, 2011, the
Examiner’s Final Office Action (Final Act.) dated April 26, 2016,
Appellants’ Appeal Brief (Br.) filed September 26, 2016, and the
Examiner’s Answer (Ans.) dated December 27, 2016.
2 According to Appellants, the real party in interest is Applied Materials, Inc.
Br. 3.
STATEMENT OF THE CASE

The invention relates to in-situ cleaning and conditioning of plasma processing chambers in the electronics manufacturing industry (Spec. ¶ 2). Appellants disclose that as feature sizes of microelectronic devices shrink, elemental contamination originating from processing equipment, such as those designed to perform plasma etching, becomes more detrimental to device performance (id. ¶ 3). To prevent plasma interaction with processing chamber materials that might transfer contaminants to the workpiece, Appellants disclose that a chamber coating comprising SiOₓ may be deposited with a first plasma process onto a chamber surface prior to loading the workpiece into the chamber to isolate them from the plasma (id. ¶ 4, 7). However, in order to reduce particulate defects from the coating shedding onto the workpiece, Appellants provide an in-situ, low-pressure chamber clean including an NF₃-based plasma to remove in-situ deposited SiOₓ coatings (id. ¶ 6).

Claim 1, reproduced below from the Claims Appendix to the Appeal Brief, is illustrative of the subject matter on appeal.

1. A plasma processing method comprising:
   depositing, with a first plasma process that includes at least a silicon-containing source gas combined with an oxidizing source gas, and wherein no fluorine containing gas is included in the first plasma process, a coating comprising SiOₓ onto a chamber surface of a chamber, wherein x is greater than zero;
   etching a workpiece in the chamber with a second plasma process, wherein the second plasma process is different than the first plasma process;
   removing the workpiece from the chamber; and
   performing a clean of the chamber surface with a third
plasma process after removing the workpiece, wherein the third plasma process comprises a plasma clean utilizing a first process gas including NF₃.

Independent claim 21 similarly recites a plasma processing method, wherein a process pressure of the first plasma process is less than that of the second plasma process.

REJECTIONS

The Examiner maintains, and Appellants request our review of, the following grounds of rejection:

1. Claims 1–10 and 21–30 under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement;

2. Claims 1–7, 9, 10, 21–27, 29, and 30 under 35 U.S.C. § 103(a) as unpatentable over Richardson in view of Shen, Mori, Brand, and Wang; and

3. Claims 8 and 28 under 35 U.S.C. § 103(a) as unpatentable over Richardson in view of Shen, Mori, Brand, and Wang, and further in view of Baek.

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3 Richardson et al., US 2006/0130873 A1, published June 22, 2006 (“Richardson”).
4 Shen et al., US 2008/0057729 A1, published March 6, 2008 (“Shen”).
9 It appears that the Examiner inadvertently omitted Wang from this rejection statement, since Wang is relied on to reject the claims from which claims 8 and 28 depend. As will become clear later in this Decision, this omission is harmless error.
ANALYSIS

Rejection 1

The Examiner rejects claims 1–10 and 21–30 under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement, on the basis that the limitation in claim 1, “wherein no fluorine containing gas is included in the first plasma process,” lacks support in the Specification (Ans. 2). The Examiner notes the Specification discloses “a silicon-containing source gas, such as but not limited to SiCl₄, is employed with an oxidizing source gas, such as but not limited to O₂ and N₂O” (id., quoting Spec. ¶ 24). The Examiner finds that this disclosure not only does not exclude a fluorine containing gas, but it also emphasizes that the silicon-containing source gas is not limited to SiCl₄ (id.).

The Examiner further finds that one skilled in the art would recognize that a fluorine-containing gas may be used to deposit a SiOₓ-based coating, citing Abdelgadir¹⁰ for teaching a plasma process for silicon oxide deposition, wherein oxygen reacts with SiF₄ to form SiO₂ (Ans. 8). The Examiner finds that the skilled artisan would also recognize that just because a gas is suitable for etching does not imply it cannot be used for deposition, citing Nakaya¹¹ for teaching SiF₄ for plasma etching of silicon oxide (id.). The Examiner additionally finds that the skilled artisan would further recognize that deposition may occur during etching, citing Wang and Shen for teaching deposition of a silicon oxide coating during etching of a silicon substrate (id. at 8–9). Accordingly, the Examiner determines that the skilled artisan would reasonably conclude that a fluorine-containing gas could be used in the first plasma process.

¹⁰ Abdelgadir et al., US 6,274,933 B1, issued August 14, 2001 (“Abdelgadir”).
artisan would not interpret the phrase, “[f]luorine-based process gases are well-suited for etching most inorganic chamber coatings, particularly the exemplary SiO$_x$-based coatings,” from the Specification as implying that fluorine-containing gas should be avoided when depositing the SiO$_x$-based coating of claims 1 and 21 (id. at 9).

Appellants argue that those skilled in the art would recognize that the deposition process for producing the SiO$_x$ coating onto a chamber surface utilizes a silicon-containing source gas, including SiCl$_4$ as one example of such a gas (Br. 7–8). Appellants contend that when the Specification used the phrase, “such as but not limited to,” before listing SiCl$_4$, Appellants allow for other silicon-containing source gasses known in the art that, with an oxidizing source gas, form a SiO$_x$ coating (id. at 8). Appellants urge that the Specification teaches that fluorine-based process gases are well-suited for etching most inorganic chamber coatings, particularly SiO$_x$-based coatings, thereby teaching that the presence of a fluorine-based gas in the first plasma process would result in removal of the SiO$_x$ coating being deposited (id.). As such, Appellants argue that the explicit teaching of the etching effect of fluorine-based gases on SiO$_x$ coatings conveys to those skilled in the art that Appellants had possession of the limitation in question (id.).

“[The written description] inquiry is a factual one and must be assessed on a case-by-case basis.” Purdue Pharma L.P. v. Faulding, Inc., 230 F.3d 1320, 1323 (Fed. Cir. 2000). “In order to satisfy the written description requirement, the disclosure as originally filed does not have to provide in haec verba support for the claimed subject matter at issue.” Id. Nonetheless, the disclosure must convey with reasonable clarity to those
skilled in the art that the Inventors were in possession of the invention as claimed. *Id.*, (“Put another way, one skilled in the art, reading the original disclosure, must immediately discern the limitation at issue in the claims.”).

Appearance of a claim in the Specification in *ipsis verbis* does not guarantee that the written description requirement is satisfied, see, e.g., *Enzo Biochem, Inc. v. Gen-Probe Inc.*, 323 F.3d 956, 968 (Fed. Cir. 2002), nor does a failure to meet that standard require a finding that a claim does not comply with the written description requirement. *In re Edwards*, 568 F.2d 1349, 1351-52 (Fed. Cir. 1978). All that is required is that the Specification demonstrate to a person of ordinary skill in the art that the Inventors were in possession of the invention. *Carnegie Mellon Univ. v. Hoffmann-La Roche Inc.*, 541 F.3d 1115, 1122 (Fed. Cir. 2008).

Any negative limitation or exclusionary proviso must have basis in the original disclosure. The mere absence of a positive recitation is not basis for an exclusion. On the other hand, a lack of literal basis in the Specification for a negative limitation may not be sufficient to establish a *prima facie* case for lack of descriptive support. *Ex parte Parks*, 30 USPQ2d 1234, 1236 (BPAI 1993). If alternative elements are positively recited in the Specification, they may be explicitly excluded in the claims. *See In re Johnson*, 558 F.2d 1008, 1019 (CCPA 1977) (“[the] specification, having described the whole, necessarily described the part remaining.”); *see also Ex parte Grasselli*, 231USPQ 393 (BPAI 1983), aff’d mem., 738 F.2d 453 (Fed. Cir. 1984). In describing alternative features, Appellants need not articulate advantages or disadvantages of each feature in order to later exclude the alternative features. *See Inphi Corporation v. Netlist, Inc.*, 805 F.3d 1350, 1356–57 (Fed. Cir. 2015).
Here, the limitation in question is a negative limitation, specifically excluding fluorine containing gas in the first plasma process. We find that the Specification discloses a first plasma process that deposits a SiOₓ coating on a chamber surface, as well as a second different plasma process that etches a workpiece in the chamber and a third plasma process utilizing NF₃ as a first process gas that cleans the chamber surface (Spec. ¶ 7, 8). In addition, the Specification teaches that other fluorine-based gases, such as SiF₆ and CF₄, may be used as the first process gas to clean the chamber surface, and that fluorine-based process gases are well-suited for etching most inorganic chamber coatings, including the SiOₓ coating deposited on the chamber surface (id. ¶ 27). Thus, the Specification provides a reason to exclude fluorine-based gases from the SiOₓ deposition process. See Santarus, Inc. v Par Pharm., Inc., 694 F.3d 1344, 1351 (Fed. Cir. 2012).

Notwithstanding this reason to exclude, the Examiner finds that Abdelgadir, Nakaya, Wang, and Shen are evidence that the ordinary artisan would have understood that fluorine containing gases, while well-suited for etching SiOₓ coatings, also form such coatings (Ans. 8, citing Abdelgadir, Nakaya, Wang, and Shen). We note Abdelgadir teaches forming a fluorosilicate glass layer, a silicon oxyfluoride (FₓSiOᵧ), via high-density plasma chemical vapor deposition (HDP-CVD) by adding SiF₄ to silane (SiH₄), O₂, and argon gases (Abdelgadir 2:6–19). Nakaya, Wang, and Shen show redeposition of etched material removed during the etching process on the sidewalls of a substrate or workpiece, but do not teach deposition of an SiOₓ layer on a chamber surface in a first plasma process prior to a second different plasma process for etching a workpiece in the chamber.
Accordingly, the Examiner has not established by a preponderance of the evidence that one skilled in the art would have understood that Appellants were not in possession of the process of claims 1 and 21, comprising the exclusion of fluorine-containing gases from the first plasma process for depositing a SiO\textsubscript{x} layer on a chamber surface.

**Rejection 2**

The Examiner rejects claims 1–7, 9, 10, 21–27, 29, and 30 under 35 U.S.C. § 103(a) as unpatentable over Richardson in view of Shen, Mori, Brand, and Wang. Appellants do not argue the claims separately, instead focusing on the common limitations of claims 1 and 21 only. We, therefore, select claim 1 in addressing the issues raised by Appellants’ arguments. Remaining claims 2–7, 9, 10, 21–27, 29, and 30 stand or fall with claim 1.

We review the appealed rejection for error based upon the issues identified by Appellants and in light of the arguments and evidence produced thereon. *Ex parte Frye*, 94 USPQ2d 1072, 1075 (BPAI 2010) (precedential) *cited with approval in In re Jung*, 637 F.3d 1356, 1365 (Fed. Cir. 2011) (“[I]t has long been the Board’s practice to require an applicant to identify the alleged error in the examiner’s rejections. . . .”). After considering the evidence presented in this Appeal and each of Appellants’ arguments, we are not persuaded that Appellants identify reversible error. Thus, we affirm the Examiner’s rejection for the reasons expressed in the Answer. We add the following primarily for emphasis.

The Examiner finds Richardson teaches a plasma processing method comprising etching a shallow trench isolation (STI) in a workpiece in a plasma chamber with a first plasma process, followed by performing a
wafer-less auto-clean (WAC) of the chamber surface with a second plasma process after removing the workpiece using a NF₃ source gas (Ans. 2–3). The Examiner finds that Richardson is silent regarding the detail of the STI etching (id. at 3). However, the Examiner finds that Shen teaches a method for STI etching in a plasma chamber comprising plasma etching a silicon substrate, which causes an overburden redeposition material on a wall of the substrate, etching the redeposition material using a fluorine-containing gas, forming an oxide layer on the substrate, and cyclically repeating the plasma etching, redeposition etching, and oxide forming steps to incrementally etch the silicon layer until the desired trench depth is reached (id. at 3–4).

As to the composition of the oxide layer, the Examiner finds that although Shen is silent on its composition, Shen teaches that this layer is formed by oxidation of a silicon substrate and, therefore, it is obvious that this layer is silicon oxide (Ans. 4). Further, although Shen is silent as to whether the etching of the redeposition material comprises a plasma, such would have been obvious to use a plasma for this process because Shen teaches use of the same fluorine-containing gases for this redeposition etch as used in the substrate etch step (id.). The Examiner further finds that while Shen’s second plasma may include a fluorine-containing gas, other halogen-containing gases are disclosed and an oxygen-containing gas may be included (id. at 5).

The Examiner concludes that it would have been obvious, in routine experimentation, to perform Richardson’s STI etch using Shen’s method, given that Richardson fails to disclose the details of the STI etch and Shen teaches an STI etch method that advantageously controls profile and dimension features (Ans. 4). The Examiner then finds that the resulting
modified method of Richardson would comprise, sequentially, loading a first substrate, etching the substrate with a first plasma that forms a redeposition material, etching the same substrate with a second plasma to remove the redeposition material, forming the oxidation layer, etching the substrate using a third plasma that forms a second redeposition material, cyclically repeating these steps until the desired trench depth is reached, removing the substrate from the plasma chamber, performing WAC with the fourth plasma, and repeating these steps for a plurality of substrates (id.).

The Examiner finds that the first plasma, in the first cycle, is equivalent to the first plasma process of claims 1 and 21 (Ans. 5). The Examiner next finds that the second and fourth plasmas are equivalent to the second and third plasma processes, respectively, of claims 1 and 21 (id.). The Examiner notes that because claims 1 and 21 do not require the SiOx-based coating be on the chamber surface during the etching step with the second plasma, the second and third plasmas in the first or any subsequent cycles may be considered the second plasma process of claims 1 and 21 (id.). Alternatively, the Examiner finds that the third plasma may be considered the first plasma process, and either the second or third plasma in subsequent cycles may be considered the second plasma process, of claims 1 and 21 (id.). Further, the Examiner finds that because the third plasma etches the substrate and redeposits material and is used in separate cycles, the third plasma in separate cycles is different (id.).

With regard to the use of a silicon-containing source gas and an oxidizing source gas as the first plasma, the Examiner finds Mori teaches a method of forming a deep trench in a silicon substrate using a plasma comprising a gas such as SiF₄ or SiCl₄ mixed with oxygen to form highly
accurate trenches with no bowing (Ans. 5). The Examiner also finds Brand teaches forming an STI by etching a silicon substrate using a gas comprising \( \text{H}_2/\text{Cl}_2/\text{SiCl}_4 \) (id.). The Examiner concludes, therefore, that it would have been obvious to use a \( \text{SiCl}_4/\text{O}_2 \) mixture in the first and third plasmas in Shen’s STI etching process because Shen teaches the plasma comprises a halogen-containing gas and a silicon-containing gas, Mori teaches such a \( \text{SiCl}_4/\text{O}_2 \) mixture forms highly accurate trenches with no bowing, and Brand teaches use of \( \text{SiCl}_4 \) for STI etching (id. at 5–6).

With regard to the step of deposition of a SiO\(_x\) coating on a surface of the chamber, the Examiner finds that because of Shen’s use of a substrate bias power up to 300 W, “some silicon oxide material inevitably is sputtered off the silicon oxide layer (layer 508 in Fig. 5C that is formed in step 206) during the plasma etching in step 204 or step 208, and deposit[s] on the chamber surface” (Ans. 6). In addition, the Examiner finds that a plasma of \( \text{SiCl}_4 \) and \( \text{O}_2 \) would also inevitably comprise silicon and oxygen ions, that the etching of the silicon oxide in steps 204 and 208 of Shen inevitably produces silicon and oxygen ions in the plasma, and that these ions inevitably react with each other and form SiO\(_x\) molecules, at least some of which deposit on the chamber surface exposed to the plasma, which the Examiner finds is confirmed by Wang (id.).

Appellants argue that Shen’s etching process does not include the deposition of a coating on a chamber surface as recited in claims 1 and 21 (Br. 11). In particular, Appellants contend that Shen removes the redeposition layer from the substrate at step 205 using a cleaning etch operation (id.). As such, according to Appellants, Shen removes the redeposition material each time it is formed (id.).
Appeal 2017-007271  
Application 13/174,090

Appellants further argue that, because there would not be any silicon-based residues on the chamber surfaces during formation of the oxidation layer in Shen’s process, the Examiner’s finding that the formation of the oxidation layer would inevitably form some SiO$_x$ on the chamber surface is incorrect (Br. 12). Appellants assert that removal of redeposition material in step 205 would remove any silicon containing substance from the chamber surfaces, thereby preventing formation of a SiO$_x$ coating thereon (id.). In addition, Appellants contend that Shen fails to describe the formation of the oxidation layer as a plasma process as required by claims 1 and 21 (id. at 12–13). Appellants urge that Shen forms the oxide layer simply by exposing the substrate to an oxygen-containing gas without the need for a plasma (id. at 130). Finally, Appellants argue that Wang’s etching process requires the presence of fluorine, which is excluded from the first plasma process of claims 1 and 21 (Br. 13–14).

Appellants’ arguments are not persuasive of reversible error. Appellants state their understanding of the rejection is that the Examiner considers STI etching residue or redeposition material to be equivalent to the recited SiO$_x$ coating deposited in the first plasma process of claims 1 and 21 (Br. 9). Appellants further state they understand the Examiner suggests that a coating is formed on the walls of the chamber during the etching steps and during formation of the oxidation layer based on the Examiner’s finding that, since the walls of the chamber are exposed to the plasma, deposition of etching residue or redeposition material thereon would be inevitable (id. at 10). We note Appellants do not challenge the Examiner’s findings that Shen’s process inevitably or inherently forms SiO$_x$ coatings on a chamber surface during the etching steps 204 and 208. We further note that although
Appellants argue that Shen repeatedly removes these coatings in step 205, Appellants fail to argue or explain the significance of this point. As the Examiner notes (Ans. 10), claims 1 and 21 do not require that the coating be present during the etching step or, indeed, during any other step. Thus, claims 1 and 21 do not exclude the removal of the SiOx coating each time it is formed as would be the case in Shen’s process.

Further, while Appellants appear to be correct that Shen’s oxidation step would not form a SiOx coating on the chamber surface because the redeposition cleaning step would have been expected to have removed any silicon present thereon, the Examiner states that it is the redeposition material formed in steps 204 and 208, and not the oxidation step 206, that correspond to the deposition of a SiOx coating on the chamber surface (Ans. 9–10).

Finally, as to Appellants’ argument that Wang’s etching process requires the presence of fluorine, we note the Examiner relies on Mori and Brand as teaching that the use of a silicon-containing source gas such as SiCl₄ and an oxidizing gas, without the inclusion of a fluorine-containing gas, was known for etching STI structures in silicon substrates. Appellants fail to respond to or otherwise address the Examiner’s findings with regard to Mori and Brand. Moreover, Wang clearly discloses the use of plasma etching gases, many of which do not include fluorine (Wang ¶ 37), thereby supporting the Examiner’s position.

Accordingly, for the reasons given in the Examiner’s Answer and above, we sustain the Examiner’s obviousness rejection of claims 1–7, 9, 10, 21–27, 29, and 30.
The Examiner rejects claims 8 and 28 under 35 U.S.C. § 103(a) as unpatentable over Richardson in view of Shen, Mori, Brand, and Wang, and further in view of Baek. Appellants do not challenge or otherwise address this rejection, instead relying on the arguments raised against independent claims 1 and 21. Because those arguments are not persuasive as discussed above, we likewise sustain this rejection.

DECISION

Upon consideration of the record, and for the reasons given above and in the Appeal Brief, the decision of the Examiner rejecting claims 1–10 and 21–30 under 35 U.S.C. § 112, first paragraph, for lack of an adequate written description is reversed.

However, for the reasons given above and in the Examiner’s Answer, the decision of the Examiner rejecting claims 1–7, 9, 10, 21–27, 29, and 30 as unpatentable over the combination of Richardson, Shen, Mori, Brand, and Wang, and rejecting claims 8 and 28 over this combination further in view of Baek, is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1).

AFFIRMED