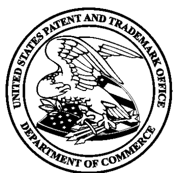

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte SUBHADEEP KAL, NIHAR MOHANTY,
ANGELIQUE D. RALEY, AELAN MOSDEN, and SCOTT W. LEFEVRE[1]

Appeal 2019-006576
Application 15/191,956
Technology Center 1700

Before CATHERINE Q. TIMM, DONNA M. PRAISS, and
CHRISTOPHER C. KENNEDY, *Administrative Patent Judges*.

KENNEDY, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal under 35 U.S.C. § 134(a) from the Examiner's decision rejecting claims 1, 3–15, 17, and 19–21.[2] An oral hearing was held on August 25, 2020. We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM IN PART.

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[1] We use the word "Appellant" to refer to "applicant" as defined in 37 C.F.R. § 1.42. The Appellant identifies the real party in interest as Tokyo Electron Limited. Appeal Br. 1.

[2] In the Examiner's Answer, the Examiner withdraws the rejection of claim 16. Ans. 10.

BACKGROUND

The subject matter on appeal relates to methods for the dry removal of a material on a microelectronic workpiece, such as a semiconductor. *E.g.*, Spec. ¶¶ 1, 7, 21; Claim 1. Claim 1 is reproduced below from page 23 (Claims Appendix) of the Appeal Brief (some formatting added):

> 1. A method for the dry removal of a material on a microelectronic workpiece, comprising:
>
> receiving a workpiece having a multi-layer mask that includes: (i) a patterned layer and (ii) a surface exposing a target layer composed of silicon and either (1) organic material or (2) both oxygen and nitrogen;
>
> placing the workpiece in a processing chamber consisting of a dry, non-plasma etch chamber and locating the workpiece on a workpiece holder; and
>
> operating the dry, non-plasma etch chamber to selectively remove at least a portion of the target layer from the workpiece by performing the following:
>
> > exposing the surface of the workpiece to a chemical environment containing a gaseous mixture that includes N, H, and F at a first workpiece setpoint temperature to chemically alter a surface region of the target layer and to chemically alter a depth within the target layer such that, after the exposing, the target layer includes a chemically altered surface region and a chemically altered depth within the target layer, wherein the N, H, and F are introduced to the dry, non-plasma etch chamber simultaneously,
> >
> > establishing the surface of the workpiece at the first workpiece setpoint temperature by flowing a heat transfer

> fluid through the workpiece holder at a first fluid setpoint temperature;
>
> monitoring, by a temperature sensing device, a temperature of the workpiece holder; and
>
> after establishing the surface of the workpiece at the first workpiece setpoint temperature, elevating the temperature of the workpiece to a second workpiece setpoint temperature by adjusting a flow rate of the heat transfer fluid flowing through the workpiece holder based on the monitored temperature of the workpiece holder by the temperature sensing device, wherein prior to elevating the temperature of the workpiece to the second workpiece setpoint temperature, the target layer includes the chemically altered surface region and the chemically altered depth within the target layer, and elevating the temperature of the workpiece to the second workpiece setpoint temperature volatilizes and selectively removes the chemically altered surface region and the chemically altered depth of the target layer without removing the patterned layer.

ANALYSIS

Claims 1, 3–15, 17, and 19–21 stand rejected under 35 U.S.C. § 103 as unpatentable over Tang (US 8,501,629 B2, issued Aug. 6, 2013), Wang (US 2014/0308818 A1, published Oct. 16, 2014), and Tabuchi (WO 2014/014127 A1, published Jan. 23, 2014[3]). The Appellant presents separate arguments only as to claims 1 and 17. *See generally* Appeal Br. We address those claims below. The remaining claims on appeal will stand or fall with claim 1.

After review of the cited evidence in the appeal record and the opposing positions of the Appellant and the Examiner, we determine that the

[3] The Examiner relies on corresponding U.S. Publication No. 2015/0176928 A1, published June 25, 2015, as an English language translation.

Appellant has not identified reversible error in the Examiner's rejection of claim 1. Accordingly, we affirm that rejection for reasons set forth below, in the Final Action dated October 31, 2018, and in the Examiner's Answer dated July 3, 2019. However, as set forth below, we reverse as to claim 17.

Claim 1. The Examiner's rejection appears at pages 2–8 of the Final Action. Of particular relevance to the issues raised by the Appellant in this appeal, the Examiner finds that Tang discloses a SiConi™ etch process in which a workpiece with a target layer of silicon oxide is etched at a first temperature by being exposed to a chemical environment as recited by claim 1, resulting in the formation of by-products on the workpiece. Final Act. 3, 5. The Examiner finds that etching by exposure to a chemical environment that falls within the scope of the chemical environment recited by claim 1 corresponds to the "exposing" step of claim 1, and that the by-products formed by the etching correspond to the "chemically altered surface region" and "chemically altered depth within the target layer," as recited by claim 1. *Id.* at 3–5, 8. The Examiner finds that Tang discloses that those by-products are then removed by heating the workpiece to a second temperature, which sublimates the by-products. *Id.* at 5; Ans. 10.

The Examiner acknowledges that "Tang does not expressly disclose . . . a target layer composed of silicon and both oxygen and nitrogen." *Id.* at 3. The Examiner finds, however, that Wang teaches a similar SiConi™ etch process, and that Wang discloses that the silicon oxide in its process "may include minority concentrations of other elemental constituents such as nitrogen, hydrogen, carbon, and the like." *Id.* at 3–4. The Examiner determines:

> Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was filed to expect "Silicon oxide" may include minority concentrations of other elemental constituents such as nitrogen, hydrogen, carbon and the like since perfectly pure silicon oxide does not exist.

Id. at 4.

In view of those and other findings less relevant to the issues raised by the Appellant, the Examiner concludes that the subject matter of claim 1 would have been obvious to a person of ordinary skill in the art.

The Appellant argues that Tang's process does not "chemically alter a surface region of the target layer" and "chemically alter a depth within the target layer," as required by claim 1, because Tang's process actually *removes* the target layer and forms a *new* by-product layer that is subsequently removed via sublimation. Appeal Br. 9–12 ("Tang repeatedly makes clear that its method is not chemically altering an existing target layer, followed by removal of the chemically altered surface and depth of the target layer, but rather, Tang first performs a plasma etch removal, during which new by-products are formed, followed by sublimation removal of the by-products.").

Under the applicable claim interpretation standard (broadest reasonable construction consistent with the specification, *see In re ICON Health & Fitness, Inc*., 496 F.3d 1374, 1379 (Fed. Cir. 2007)), we are not persuaded of reversible error in the Examiner's determination that the prior art process falls within the scope of claim 1. Consistent with the Appellant's argument, we recognize that, in some instances, Tang uses language indicating that its target layer is removed and replaced with a different (by-product) layer, *e.g.*, Tang at 1:41–43 ("The SiConi™ process produces solid

by-products which grow on the surface of the substrate as substrate material is removed.”), 9:42–43 (using the word “accumulation” to describe by-products); *see also* Reply Br. 5.

However, when Tang describes in more detail how its process works, Tang’s description is consistent with the Examiner’s rejection. Tang explains that Tang’s effluent gaseous mixture, which includes N, H, and F, “react[s] readily with low temperature substrates” (i.e., chemically alters the substrates). Tang at 9:34–37. Tang goes on to disclose that the effluents “may react with a silicon oxide surface to form $(NH_4)_2SiF_6$, NH_3, and H_2O products.” *Id.* According to Tang, “[a] thin discontinuous layer of $(NH_4)_2SiF_6$ solid by-products is left behind on the substrate surface.” *Id.* at 9:39–41. That layer of solid by-products is then removed by sublimation when subjected to heat. *Id.* at 9:42–43, 55–59. Those disclosures indicate that, rather than physically removing a silicon oxide target layer and forming a completely new by-product layer, as argued by the Appellant, Tang’s effluents “react with” the silicon oxide target layer to yield a chemically altered layer. *Id.* at 9:34–41.

Additionally, we observe that it is unclear why the combined prior art—which involves the exposure of a workpiece falling within the scope of claim 1 to a chemical environment falling within the scope of claim 1—would not yield the result recited by claim 1, i.e., a chemically altered surface region of the target layer and a chemically altered depth within the target layer. At oral argument,[4] the Appellant identified Tang’s use of “plasma effluents” as a potentially material difference between Tang and

[4] A transcript of the hearing will be added to the publicly accessible file history when available.

claim 1, which recites a "non-plasma etch chamber." But, as discussed below, the Specification expressly defines the term "non-plasma" in a way that encompasses Tang's process. *See* Spec. ¶ 20. The Specification expressly contemplates a chemical environment created by "a remote plasma generator . . . arranged to supply the dry, non-plasma etch chamber with . . . F, N, or H." *Id.* ¶ 33.

Thus, although we acknowledge some support in the record for the Appellant's position, we find that the record as a whole supports the Examiner's finding that a person of ordinary skill would have understood the process of the combined prior art to yield a "chemically altered surface region" and a "chemically altered depth within the target layer" as recited by claim 1.

In the Reply Brief, the Appellant emphasizes the fact that the claim recites that both a "surface region" of the target layer *and* a "depth within" the target layer must be "chemically altered." *E.g.*, Reply Br. 3. The Appellant does not identify any requirement for how deep the recited "depth within" must be, and, under its broadest reasonable interpretation, the claim language appears to encompass even minimal depths such that the "thin discontinuous layer," formed when Tang's effluent gases react with Tang's target layer, falls within the scope of claim 1. A "thin . . . layer" is reasonably understood as a having both a surface and at least some minimal (i.e., "thin") depth, indicating that both the surface of Tang's target layer and at least some minimal "depth within" Tang's target layer are chemically altered by reaction with Tang's effluent gases.

The Appellant also argues that Tang's process "relies upon plasma to etch the target layer" and, therefore, falls beyond the scope of the term "non-plasma etch chamber" recited by claim 1. Appeal Br. 12, 15.

That argument is not persuasive for the reasons explained by the Examiner in the Answer. *See* Ans. 11 (explaining that the Appellant's Specification defines the term "non-plasma" in a way that encompasses Tang's process). Although the Appellant files a Reply Brief, the Appellant does not address or otherwise attempt to show error in that reasoning.

The Appellant also argues that the Examiner has not shown that Tang's target layer includes "silicon and either (1) organic material or (2) both oxygen and nitrogen," as required by claim 1. Appeal Br. 17–18. Specifically, the Appellant argues that Wang teaches only that silicon oxide "may" include carbon or nitrogen; not that carbon or nitrogen is "necessarily present." *Id.* The Appellant also argues that Wang's disclosure that carbon or nitrogen may be present is not "a global definition of the term silicon oxide, but rather" is a disclosure "as to how that term is to be understood within" Wang. *Id.*

That argument is not persuasive of reversible error. As noted above, both Tang and Wang disclose SiConi™ etch processes. *See, e.g.*, Tang at Abstract; Wang ¶¶ 3, 17. Tang discloses the use of silicon oxide workpieces. *E.g.*, Tang Fig. 1 (element 130), 1:35. Wang also discloses the use of silicon oxide workpieces, *e.g.*, Wang at Abstract, ¶ 6, and Wang discloses that silicon oxide workpieces in its SiConi™ etch process "may include minority concentrations of other elemental constituents such as nitrogen, hydrogen, carbon and the like," *id.* ¶ 53.

We do not understand a finding that nitrogen and/or carbon are inherent in all silicon oxide workpieces to be necessary to the Examiner's rejection. *See* Reply Br. 9 (raising arguments about inherency). Rather, we understand the Examiner's findings to indicate that, because both Tang and Wang concern SiConi™ etch processes, and Wang discloses that silicon oxide target layers known to be suitable for such processes may include carbon and/or nitrogen, it would have been obvious to use a silicon oxide including carbon and/or nitrogen in Tang's process because it is simply the use of a known element (silicon oxide with carbon and/or nitrogen) according to its established function (target layer in a SiConi™ etch process). The use of known elements according to their established function typically does not result in nonobvious subject matter. *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416–21 (2007) ("The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." / "[W]hen a patent claims a structure already known in the prior art that is altered by the mere substitution of one element for another known in the field, the combination must do more than yield a predictable result."). Accordingly, we are not persuaded of reversible error in the Examiner's rejection on the basis of the Appellant's arguments concerning the presence of nitrogen and/or carbon in Tang's silicon oxide layer.

We have carefully considered the Appellant's arguments, but we are not persuaded of reversible error in the Examiner's rejection of claim 1. *See 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 . . . .").

Claim 17. Claim 17 depends from claim 1 and further recites, *inter alia*, that "the target layer comprises SiO_xN_y." In other words, whereas claim 1 requires only the presence of silicon and either organic material or oxygen/nitrogen in the target layer, claim 17 specifically requires the presence of the compound SiO_xN_y.

In the Final Action, the Examiner does not appear to specifically address claim 17, apparently finding (implicitly) that Wang's disclosure discussed above (i.e., that silicon oxide may include "elemental constituents such as nitrogen, hydrogen, carbon, and the like") adequately teaches or suggests the subject matter of claim 17. *See generally* Final Act.

In the Appeal Brief, the Appellant argues that "claim 17 requires the target layer to include a silicon oxynitride compound . . . in other words, a molecular structure of SiO_xN_y. . . . [T]here is no disclosure of SiO_xN_y in Tang or Wang." Appeal Br. 19–20 (emphases in original).

In the Examiner's Answer, the entirety of the Examiner's response is as follows: "As discussed above, 'Silicon oxide' may include minority concentrations of other elemental constituents such as nitrogen, hydrogen, carbon, and the like. Both Tang and Wang teach that SiConi.TM. process is a selective process meaning the etch selective relative [to] silicon is greater than unity (1)." Ans. 14.

In the Reply Brief, the Appellant argues that "Claim 17 does not merely recite that some nitrogen is present, but rather, that nitrogen is present in molecular form in SiO_xN_y . . . . Wang merely discloses that nitrogen could possibly be present, but fails to disclose or suggest the use of a compound of SiO_xN_y in Tang's process." Reply Br. 12.

"[T]he examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a *prima facie* case of unpatentability." *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992). The Examiner has failed to carry that burden as to claim 17. Merely identifying a disclosure in the prior art that silicon oxide may include "other elemental constituents" such as nitrogen is not adequate to show the presence of the specifically claimed compound, SiO_xN_y. That is particularly true here because, in the Appeal Brief, the Appellant specifically identifies that apparent deficiency in the Examiner's analysis, but in the Answer, the Examiner fails to offer any persuasive explanation as to how the relied-on disclosure of Wang teaches or suggests the specific compound recited by claim 17. The Examiner made no finding, for example, that, if nitrogen and silicon oxide are present together, they will necessarily and inherently react to form an SiO_xN_y compound. At the oral hearing, the Appellant argued that the record failed to establish that the presence of silicon oxide and nitrogen inherently and inevitably results in an SiO_xN_y compound. We agree that the present record does not establish inherency, and the Examiner has not otherwise provided adequate reasoning to support the Examiner's rejection.

On this record, a preponderance of the evidence does not support the Examiner's rejection of claim 17.

CONCLUSION

In summary:

Claims Rejected	35 U.S.C. §	References	Affirmed	Reversed
1, 3–15, 17, 19–21	103	Tang, Wang, Tabuchi	1, 3–15, 19–21	17

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

AFFIRMED IN PART