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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte BHADRI N. VARADARAJAN, BO GONG,
and ZHE GUI

Appeal 2018-001444
Application 14/616,435¹
Technology Center 2800

Before DONNA M. PRAISS, JEFFREY R. SNAY, and BRIAN D. RANGE,
Administrative Patent Judges.

RANGE, *Administrative Patent Judge.*

DECISION ON APPEAL

SUMMARY

Appellant appeals under 35 U.S.C. § 134(a) from the Examiner's decision rejecting claims 1–16, 18, and 19. We have jurisdiction. 35 U.S.C. § 6(b).

We AFFIRM-IN-PART.

¹ Appellant is the Applicant, Novellus Systems, Inc., which, according to the Appeal Brief, is also the real party in interest. Appeal Br. 3. Appellant also notes that in June of 2012, Novellus Systems, Inc. merged with Lam Research Corporation and is a wholly owned subsidiary of Lam Research Corporation. *Id.*

STATEMENT OF THE CASE²

Appellant describes the invention as relating to formation of silicon carbide films. Spec. ¶ 2. The films can be used in manufacturing semiconductor devices. *Id.* ¶ 26. Claim 1, reproduced below with formatting added for readability and emphasis added to certain key recitations, is illustrative of the claimed subject matter:

1. A method of depositing a silicon carbide film on a substrate, the method comprising:
 - (a) providing the substrate to a reaction chamber;
 - (b) flowing one or more silicon-containing precursors to the substrate, wherein each of the one or more silicon-containing precursors have
 - (i) one or more silicon-hydrogen bonds and/or silicon-silicon bonds,
 - (ii) one or more silicon-carbon bonds, silicon-nitrogen bonds, and/or silicon-oxygen bonds,
 - (iii) no carbon-oxygen bonds, and
 - (iv) no carbon-nitrogen bonds;
 - (c) flowing a source gas into a plasma source;
 - (d) generating, from the source gas, radicals of hydrogen in the plasma source;
 - (e) flowing the radicals of hydrogen onto the substrate, wherein all or at least 90% of the radicals are radicals of hydrogen in the ground state that react with the one or more silicon-containing precursors under conditions that break the silicon-containing precursor's silicon-hydrogen bonds or silicon-silicon bonds but preserve the**

² In this Decision, we refer to the Final Office Action dated February 22, 2017 (“Final Act.”), the Appeal Brief filed May 19, 2017 (“Appeal Br.”), the Examiner’s Answer dated September 22, 2017 (“Ans.”), and the Reply Brief filed November 22, 2017 (“Reply Br.”).

silicon-containing precursor's silicon-carbon bonds, silicon-nitrogen bonds, and/or silicon-oxygen bonds; and

(f) forming, from the reaction, a silicon oxycarbide (SiOC) film, silicon nitricarbide (SiNC) film, or silicon oxynitricarbide (SiONC) film on the substrate, wherein the one or more silicon-containing precursors include an alkylcarbosilane, a siloxane, a silazane, or any combination thereof when forming SiOC film, SiNC film, or SiONC film, wherein the SiOC film, SiNC film, or SiONC film has a conformality of at least 90%.

Appeal Br. 20 (Claims App.).

REFERENCES

The Examiner relies upon the prior art below in rejecting the claims on appeal:

Bicker et al. ("Bicker")	US 2010/0075077 A1	Mar. 25, 2010
Mallick et al. ("Mallick")	US 2010/0081293 A1	Apr. 1, 2010

A. M. Wróbel & A. Walkiewicz-Pietrzykowska, *Oligomerization and Polymerization Steps in Remote Plasma Chemical Vapor Deposition of Silicon—Carbon and Silica Films from Organosilicon Sources*, 13 CHEM. MATER. 1884–95 (2001) ("Wróbel").

REJECTIONS

The Examiner maintains the following rejections on appeal:

Rejection 1. Claim 11 under 35 U.S.C. § 112 as failing to comply with the enablement requirement. Final Act. 2.³

³ The Examiner cites *In re Mayhew*, 527 F.2d 1229 (CCPA 1976), when addressing Appellant's arguments concerning obviousness of claim 1. Ans. 3–4 (stating that Appellant's argument "suggests that the disclosure does not enable one of ordinary skill in the art to practice the invention"). The

Rejection 2. Claims 1–5, 10–16, and 19 under 35 U.S.C. § 103 as unpatentable over Mallick, in view of Wróbel and Bicker. *Id.* at 4–11.⁴

Rejection 3. Claims 6–9 under 35 U.S.C. § 103 as unpatentable over Mallick, in view of Wróbel and Bicker, and further in view of Xiao. *Id.* at 11–13.

Rejection 4. Claim 18 under 35 U.S.C. § 103 as unpatentable over Mallick, in view of Wróbel and Bicker, and further in view of Swanson. *Id.* at 13–14.

ANALYSIS

Rejection 1. The Examiner rejects claim 11 under 35 U.S.C. § 112 as failing to comply with the enablement requirement. Final Act. 2. We summarily sustain this rejection because Appellant does not address it. Appeal Br. 6–7 (not identifying this rejection as a ground to be reviewed on appeal).

Rejection 2. The Examiner rejects claims 1–5, 10–16, and 19 under 35 U.S.C. § 103 as unpatentable over Mallick, in view of Wróbel and Bicker. Final Act. 4. The Examiner finds that Mallick teaches a method of depositing oxygen doped silicon carbide comprising many of the recitations of claim 1. *Id.* at 4–5. The Examiner finds that Mallick does not explicitly teach that the radical species break Si-Si and Si-H bonds in silicon precursor layers. *Id.* at 5. The Examiner finds that Wróbel teaches using hydrogen

Examiner does not, however, raise an enablement rejection with respect to claim 1.

⁴ The Examiner does not reference claims 12 and 16 at page 4 of the Final Office Action, but the Examiner provides rejections of these two claims at pages 9–11.

radicals in a ground state to break Si-Si and Si-H bonds in silicon precursor layers. *Id.* The Examiner determines “[i]t would have been obvious to one of ordinary skill in the art . . . to add the invention of Wróbel, including using hydrogen radicals in the ground state in order to break the Si-Si and Si-H bonds of the silicon precursor layer of the invention of Mallick.” *Id.* at 6.

Appellant argues that a person of ordinary skill in the art would not have had reason to combine the teachings of Mallick and Wróbel. Appeal Br. 14. In particular, Appellant argues that Mallick teaches flowable dielectric layers used in a process for “bottom-up” filling. *Id.* (citing Dec. 8, 2016, Declaration of Mr. Bhadri Varadarajan ¶ 8 (“Varadarajan Decl.”)); *see* Mallick ¶¶ 19 (referring to formation of “a flowable dielectric on the substrate surface”), 27 (same). Appellant argues that using the Wróbel hydrogen radicals with Mallick “would lead to a deposited film that could be severely hydrogen-terminated, which would prevent deposition of a flowable film and thereby be in direct opposition to the teachings of Mallick.” *Id.* The sworn declaration of Mr. Varadarajan provides some factual support for this argument. Varadarajan Decl. ¶ 13.

The Examiner responds with one sentence: “this statement is unsubstantiated and is in disagreement with the prior art which teaches that hydrogenated silicon carbide films have low-dielectric constants (see US 20080277765^[5] [0052]).” Ans. 4; *see also* Final Act. 18 (responding to paragraph 13 of the Varadarajan Declaration by stating that Wróbel “is merely being relied upon to teach the obviousness of using radicals of

⁵ The Examiner is referring to Lane et al., US 2008/0277765 A1, Nov. 13, 2008 (“Lane”).

hydrogen in a ground state in order to break the same bonds as those revealed in Mallick”).

Although the Varadarajan Declaration is somewhat cursory, the Declaration nevertheless is evidence supporting Appellant’s argument. Reply Br. 9–10. The Examiner provides no technical reasoning why hydrogen-termination preventing flowability would not dissuade a person having ordinary skill in the art from combining the teachings of Mallick and Wróbel, does not explain how or whether paragraph 52 of Lane addresses the hydrogen-termination and flowability issue, and identifies no evidence rebutting the Varadarajan Declaration.

The preponderance of the evidence before us indicates that, because of hydrogen-termination potentially preventing dielectric flowability, a person of skill in the art would not have had reason to combine the teachings of Mallick and Wróbel. We, therefore, do not sustain the Examiner’s rejection of claim 1. For the same reason, we also do not sustain the Examiner’s rejection of the remaining claims subject to this rejection, which each depends from claim 1.

Rejections 3 and 4. These rejections address claims that depend from claim 1. The Examiner’s use of Xiao and Swanson do not cure the error addressed above. Final Act. 13–14. We, therefore, do not sustain these rejections.

DECISION

For the above reasons, we affirm the Examiner’s rejection of claim 11 under 35 U.S.C. § 112 as failing to comply with the enablement requirement. We reverse the remainder of the Examiner’s rejections.

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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