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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte APPLIED MATERIALS, INC.[1]
Appellant

Appeal 2015-005753
Application 13/713,578
Technology Center 2800

Before JEFFREY W. ABRAHAM, CHRISTOPHER L. OGDEN, and MONTÉ T. SQUIRE, *Administrative Patent Judges*.

OGDEN, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellants appeal under 35 U.S.C. § 134(a) from the Examiner's final decision[2] rejecting claims 1, 3–8, 10–12, and 14–20 in the above-identified application. We have jurisdiction pursuant to 35 U.S.C. § 6(b).

We affirm-in-part and issue a new ground of rejection.

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[1] Applied Materials, Inc. is the applicant under 37 C.F.R. ¶ 1.46 (2012), and is identified as the real party in interest, *see* Appeal Brief 3, Dec. 10, 2014 [hereinafter Appeal Br.]. The listed inventors are David Thompson and Jeffrey W. Anthis.

[2] Office Action, July 11, 2014 [hereinafter Final Action].

BACKGROUND

Appellants' invention relates to depositing films on a substrate using a tantalum precursor. Spec.[3] ¶ 2. Independent claims 1 and 11 are representative:

1. A method of depositing a film on a surface of a semiconductor wafer by atomic layer deposition, the method comprising:
exposing the surface of the semiconductor wafer to alternating flows of a first precursor comprising $TaCl_xR_{5-x}$, $TaBr_xR_{5-x}$, or TaI_xR_{5-x}, wherein R is a C_1–C_5 alkyl ligand, and a second precursor comprising an aluminum-containing compound sequentially, wherein x has a value in the range of 1 to 4.

11. A method of depositing a film, the method comprising exposing a substrate surface to flows of a first precursor comprising $TaCl_5$ coordinated to a ligand, wherein the ligand comprises an amine ligand, and a second precursor comprising an aluminum-containing compound.

Appeal Br. 31.

[3] Substitute Specification, Dec. 13, 2012 [hereinafter Spec.].

The Examiner maintains the following grounds of rejection:

I. Claims 1, 3–6, and 10 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Li[4] in view of Machida[5] and Millward.[6] Final Action 3–5; Answer 2–4.

II. Claims 7 and 8 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Li in view of Machida, Millward, and Kamath.[7] Final Action 5–6; Answer 4.

III. Claims 11, 12, and 14–19 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Li in view of Jayaratne.[8] Final Action 6–7; Answer 5.

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[4] Dong Li et al., U.S. Patent Application Pub. No. US 2009/0315093 A1 (published Dec. 24, 2009) [hereinafter Li].

[5] Machida Hideaki et al., Japanese Patent Application Pub. No. JP2000-103796 A (published Apr. 11, 2000) [hereinafter Machida]. The Examiner cites an "English Abstract," Final Action 3, and a "machine translation of the original reference," Answer 2, but these documents were not entered into the prosecution history of this application. Appellants have also reproduced an English version of the Abstract of Machida, as well as an English translation of part of paragraph 16. *See* Appeal Br. 15; Reply Br. 6.

[6] Dan Millward et al., U.S. Patent Application Pub. No. US 2011/0071316 A1 (published Mar. 24, 2011) [hereinafter Millward].

[7] Arvind Kamath et al., U.S. Patent Application Pub. No. US 2011/0017997 A1 (published Jan. 27, 2011) [hereinafter Kamath].

[8] Kumudini C. Jayaratne et al., *Imido Complexes Derived from the Reactions of Niobium and Tantalum Pentachlorides with Primary Amines: Relevance to the Chemical Vapor Deposition of Metal Nitride Films*, 35 Inorganic Chemistry 4910 (1996) [hereinafter Jayaratne].

IV. Claim 20 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Li in view of Jayaratne and Chizhikova.[9] Final Action 7–8; Answer 5.

In the Appeal Brief, Appellant presents distinct arguments for only claims 1, 10, 7 and 8 (as a group), 11, and 20. *See* Appeal Br. 14–30. Because Appellant argues claims 7 and 8 as a group, *see id.* at 22–24, we select claim 7 as the basis of our decision relating to this group, and claim 8 stands or falls with claim 7. *See* 37 C.F.R. § 41.37(c)(1)(iv) (2013). Claims 3–6 depend from claim 1, and claims 12 and 14–19 depend from claim 11. *See* Appeal Br. 31–32. Appellant does not advance any additional arguments with respect to these dependent claims. *See* Appeal Br. 19–20, 27. For the above reasons, we limit our discussion to claims 1, 10, 7, 11, and 20.

DISCUSSION

Claim 1

Li teaches the production of a metal carbide film on a substrate using "a first reactant that includes a metal source chemical and a second reactant that includes an aluminum hydrocarbon compound" using "atomic layer deposition (ALD) processes." Li ¶¶ 12–13. Li teaches that the metal source chemical can be a tantalum halide of any of the formulas "$TaBr_w$, $TaCl_z$, and TaI_z, where w . . . and z are numbers from 1 to 5." *Id.* ¶ 51; *see also id.* ¶¶ 32, 46, 51, p. 9 (claims 1, 6, 8).

[9] S.M. Chizhikova et al., *Study of the Thermal Decomposition of Niobium and Tantalum Chloride–Organic Complexes*, 5 Izvestiya Akademii Nauk SSSR, Metally 64 (1980) [hereinafter Chizhikova].

The Examiner cites Li as teaching the limitations of claim 1, except that Li does not teach that the tantalum source chemical has the formula $TaCl_xR_{5-x}$, $TaBr_xR_{5-x}$, or TaI_xR_{5-x}, where R is a C_1–C_5 alkyl ligand and x ranges from 1 to 4. *See* Final Action 3. However, the Examiner finds that Machida teaches a genus of tantalum source chemicals for use in forming barrier films that includes the genus of tantalum precursor chemicals set forth in Appellant's claim 1. *See id.* at 3–4; Answer 2–3. Although Machida refers to use of the precursors in chemical vapor deposition (CVD), *see* Appeal Br. 15 (quoting Machida, Abstract (English translation)), the Examiner finds that metal containing complexes that include organic ligands can be used in both CVD and ALD processes in order to form metal-containing layers. *See* Final Action 4 (citing Millard ¶¶ 6, 70–95). Thus, the Examiner finds that in depositing tantalum-aluminum films, CVD and ALD methods may be used interchangeably with respect to the tantalum precursors disclosed in Machida. *See* Answer 3. In light of these findings, the Examiner concludes that it would have been obvious to a person of ordinary skill in the art to use Machida's tantalum precursors as the tantalum source chemicals used in the ALD process described by Li. *See* Final Action 4; Answer 3.[10]

Appellant argues that the Examiner provided insufficient "technical findings or arguments[] as to what a person of ordinary skill in the art would

[10] The Examiner alternatively concludes that the statement in the preamble of claim 1 that the film is deposited by ALD is not entitled to patentable weight, and that claim 1 is therefore obvious in view of the teachings of Li and Machida. *See* Answer 3. Because we affirm the Examiner's decision to reject claim 1 based on the combined teachings of Li, Machida, and Millward, we need not address the Examiner's alternative ground of rejection.

achieve by modifying the references." Appeal Br. 14. This is because, according to Appellant, Machida does not teach that the disclosed tantalum precursors form deposited layers that have "excellent barrier properties," as the Examiner's findings indicate. *See id.* at 14–15 (quoting Final Action 4). Appellant also argues that "the alleged benefit [of excellent barrier properties] is related to a property of the ***Ta-containing layers***, and fails to identify anything related to using a $TaCl_xR_{5-x}$, $TaBr_xR_{5-x}$, or TaI_xR_{5-x}, precursor." *Id.* at 15.

These arguments do not persuade us that the Examiner reversibly erred in rejecting claim 1. In discussing the Examiner's findings with respect to Machida, the Examiner cited an "English Abstract,"[11] Final Action 3–4, and a "machine translation of the original reference." Answer 2. These documents were not entered into the prosecution history of this application. However, Appellant did not challenge these omissions prior to filing Appellant's Appeal or Reply briefs by petition under 37 § C.F.R. 1.181. Moreover, the record does not show that Appellant has been prejudiced by these omissions, because Appellant has reproduced its own English translation of the Machida Abstract in the briefs, *see* Appeal Br. 15; Reply Br. 5–6, and has discussed and quoted portions of the original Machida reference cited by the Examiner, *see* Reply Br. 6. *See* Appeal Br. 15; Reply Br. 6. Moreover, Appellant does not specifically challenge the Examiner's characterization that the original Machida reference teaches that

[11] The "English Abstract" used by the Examiner does not appear to be the English translation of the Abstract taken from the front page of the Machida publication, because the latter Abstract does not refer to "excellent barrier properties," as the Examiner indicated was taught by "the English Title and the Abstract of the paper." *See* Final Action 3–4.

the cited compounds have the "benefit of providing a better precursor material for Ta system barrier film formation for [a] Cu wiring system." Answer 2 (citing Machida ¶¶ 5, 6, 20); *see also* Reply Br. 5–6. Rather, Appellant argues that its own English translation of Machida "does not actually teach the benefit being relied upon" by the Examiner. Appeal Br. 15. The English version of the Machida Abstract that Appellant reproduces in the briefs, however, teaches "a Ta membrane-forming material that is useful as a chemical vapor deposition material for forming a Ta thin layer membrane of high quality." Appeal Br. 15 (quoting Machida Abstract (English translation)); Reply Br. 5. Therefore, we are not persuaded of error in the Examiner's determination that Machida teaches a reason for a person of ordinary skill in the art to have used Machida's tantalum precursors in forming barrier layers, or at least in forming high quality tantalum films on a substrate.

Appellant also argues that Machida teaches a class of tantalum precursors that is substantially larger than the genus described in claim 1, and that the Examiner has not provided a sufficient rationale for why a person of ordinary skill in the art would have selected the specific compounds used in the method of claim 1. *See* Appeal Br. 16; Reply Br. 6–11. In particular, Appellant notes that the class of compounds disclosed in Machida includes preferred compounds in which sulfur ligands are attached to the alkyl metal moiety. *See* Reply Br. 6 (citing Machida ¶ 16). Moreover, according to Appellant, Machida's general formula R_nTaX_{5-n}–L "provides for 30 different possible permutations," where "R can be 14 different categories of substituents," and in total, the class may include "billions of separate compound[s]." *Id.* at 6–8. However, as Appellant notes, Machida

teaches that "as a Ta system film formation material," several specific compounds are identified, including "CH_3TaCl_4, $(CH_3)_2TaCl_3$, [and] $(CH_3)_3TaCl_2$" and four other compounds with sulfur ligands. Reply Br. 6 (quoting Machida ¶ 16). Moreover, these compounds, including the three compounds without sulfur ligands, are described as "preferable." *See id.* Because Machida directs a person of ordinary skill in the art to at least three specific precursors within the scope of claim 1, Appellant's arguments do not persuade us of reversible error in the rejection.

Appellant also argues that the Examiner's reliance on Millward to establish that CVD and ALD are known alternatives is conclusory and lacks a sufficient technical basis to establish the rejection. *See* Appeal Br. 16–19; Reply Br. 8–10. Having carefully considered these arguments, we are not persuaded that the Examiner's reliance on Millward constitutes reversible error. In support of the rejection, the Examiner cites paragraphs 6 and 70–95 of Millward. *See* Final Action 4. These passages clearly support the Examiner's conclusion of obviousness by teaching that ALD is an alternative method to CVD, and preferable for the deposition process disclosed in Millward, *see* Millward ¶ 75, which involves the formation of metal-containing layers on a substrate from a metal precursor that has organic ligands, *see id.* ¶ 6. Moreover, Millward teaches that by a choice of deposition parameters, an ALD process can be modified to act like a pulsed CVD process, *see* Millward ¶ 84; *see also id.* ¶ 74; Answer 3 ("[I]t would have been obvious . . . to judiciously adjust and control the deposition parameters with these modified precursors during the ALD deposition . . . to achieve optimum benefits . . . ."). By a preponderance of the evidence on this record, we find that the Examiner has pointed to sufficient evidence and

has established a sufficient technical rationale to combine the teachings of Millward with Li and Machida.

We have considered Appellant's argument that Millward teaches away from the interchangeability of ALD and CVD in the context of using the Machida precursors and the ALD process of Li. *See* Appeal Br. 17–19. According to Appellant, "Millward teaches a person of ordinary skill in the art that the suitability of compounds for CVD and ALD vary depending on the different reactivities of the compounds," *id.* at 17 (citing Millward ¶ 90), and "Millward indicates that a compound that works for ALD may not work for CVD, and vice versa," *id.* at 19. While Millward teaches that some reagents suitable for ALD may not be suitable for CVD, *see* Millward ¶ 90, we are not persuaded that Millward teaches the reverse—that reagents like the Machida precursors that are suitable for CVD would not also be suitable for ALD. Nor has Appellant directed us to any other evidence on this record showing that a person of ordinary skill in the art would have expected that the substitution of organic ligands in a tantalum halide precursor would render the resulting precursor unsuitable for use in an ALD process.

Therefore, by a preponderance of the evidence on this record, we are not persuaded of reversible error in the Examiner's rejection of claim 1. For the same reasons, we are not persuaded of reversible error in the Examiner's rejections of claims 3–6.

Claim 10

As explained below, we issue a new ground of rejection that claim 10 is unpatentable under 35 U.S.C. § 112, paragraph 2, as failing to particularly point out and distinctly claim the subject matter that Appellant regards as the invention. A rejection based on prior art cannot be based on speculations

and assumptions. *See In re Wilson*, 424 F.2d 1382, 1385 (CCPA 1970); *In re Steele*, 305 F.2d 859, 862 (CCPA 1962). Therefore, we reverse, pro forma, the Examiner's decision to reject claim 10 under 35 U.S.C. § 103(a). Our decision to reverse the § 103 rejection should not be interpreted as taking any position on the merits of the rejection.

Claims 7, 11, and 20

Claim 7 requires that "the aluminum-containing compound comprises an alane-amine complex." Appeal Br. 31. The Examiner finds that Kamath teaches this limitation, *see* Final Action 5, and that it would have been obvious "to modify Li in view of Machida and Millward" and use an alane-amine complex "for the benefit of forming aluminum and nitrogen containing diffusion barriers as taught by Kamath in paragraph 24." Final Action 5–6. The Examiner also finds that a person of ordinary skill in the art would have been motivated by the "benefit of introducing extra nitrogen into the diffusion barrier to improve the barrier properties." Answer 5.

In rejecting independent claim 11, the Examiner cites Jayaratne as teaching a "Ta precursor comprising $TaCl_5$ coordinated to an amine ligand," and concludes that it would have been obvious to use this precursor "for the benefit of depositing TaN films by chemical vapor deposition process from a single source precursor as taught by Jayaratne under the Introduction in page 4910." Final Action 7. The Examiner also determines that a person of ordinary skill in the art would have been motivated by "the benefit of forming a predictable metal nitride film comprising carbon and aluminum." Answer 5.

Li's process relates to forming a metal carbide film. *See, e.g.*, Li ¶¶ 12, et seq. However, both Kamath and Jayaratne describe methods of

producing metal *nitride* films. *See, e.g.*, Kamath ¶ 24; Jayaratne 4910. The Examiner's grounds for rejecting claims 7 and 11 rely on the finding that a person of ordinary skill in the art would have been motivated to adapt Li's ALD process to form metal *nitride* films or metal carbide films enhanced by the addition of nitride. However, the Examiner has not set forth a persuasive rationale to explain how a person of ordinary skill in the art would have adapted the teachings of Li to produce a metal nitride or metal nitride-enhanced film, or why these combinations of prior art teachings would have led to predictable results.

Claim 20 depends from claim 11, and the Examiner's grounds for rejecting claim 20 do not cure the above deficiency. Because the Examiner has not established a prima facie case of obviousness with respect to claims 7, 11, and 20, we reverse the Examiner's decision to reject those claims. For the same reasons, we also reverse the Examiner's decision to reject claims 8, 12, and 14–19.

NEW GROUND OF REJECTION

We determine that claim 10 is unpatentable under 35 U.S.C. § 112, paragraph 2, as failing to particularly point out and distinctly claim the subject matter that Appellants regard as the invention, and we designate this as a new ground of rejection pursuant to 37 C.F.R. § 41.50(b).

Claim 10 depends from claim 1, and further requires that "the substrate surface is exposed to the first and second precursor concurrently or substantially concurrently." Appeal Br. 31. This language is not clearly consistent with claim 1, which is directed to "a method of depositing a film on a surface of a semiconductor wafer by atomic layer deposition," and

requires "exposing the surface of the semiconductor wafer to alternating flows of a first precursor . . . and a second precursor . . . sequentially." *Id.* The Specification describes an embodiment in which the precursors are exposed to the substrate "concurrently or substantially concurrently" as an "alternative" to an embodiment in which the precursors are exposed "sequentially or substantially sequentially." *See* Spec. ¶ 9; *accord id.* ¶ 12; *see also id.* ¶ 26 (describing the two embodiments as "variants" as to how the precursor flows vary in timing). Thus, claim 10 is ambiguous as to the timing of the precursor flows, and whether they are (substantially) sequential or concurrent. Because of this ambiguity, claim 10 is indefinite. *See Ex Parte Kenichi Miyazaki*, 89 USPQ2d 1207, 1211 (BPAI 2008) (precedential) ("An essential purpose of patent examination is to fashion claims that are precise, clear, correct, and unambiguous. Only in this way can uncertainties of claim scope be removed, as much as possible, during the administrative process." (quoting *In re Zletz*, 893 F.2d 319, 322 (Fed. Cir. 1989))).

This is a new ground of rejection pursuant to 37 C.F.R. § 41.50(b), which provides that "[a] new ground of rejection pursuant to this paragraph shall not be considered final for judicial review." Section 41.50(b) also provides as follows:

> When the Board enters such a non-final decision, the appellant, within two months from the date of the decision, must exercise one of the following two options with respect to the new ground of rejection to avoid termination of the appeal as to the rejected claims:
>
> (1) *Reopen prosecution.* Submit an appropriate amendment of the claims so rejected or new Evidence relating to the claims so rejected, or both, and have the matter reconsidered by the examiner, in which event the prosecution will be remanded to the examiner. The new ground of rejection is binding upon the

> examiner unless an amendment or new Evidence not previously of Record is made which, in the opinion of the examiner, overcomes the new ground of rejection designated in the decision. Should the examiner reject the claims, appellant may again appeal to the Board pursuant to this subpart.
>
> (2) *Request rehearing.* Request that the proceeding be reheard under § 41.52 by the Board upon the same Record. The request for rehearing must address any new ground of rejection and state with particularity the points believed to have been misapprehended or overlooked in entering the new ground of rejection and also state all other grounds upon which rehearing is sought.

Further guidance on responding to a new ground of rejection can be found in the Manual of Patent Examining Procedure § 1214.01.

DECISION

The Examiner's decision to reject claims 1 and 3–6 under 35 U.S.C. § 103(a) is affirmed.

The Examiner's decision to reject claims 7, 8, 10–12, and 14–20 under 35 U.S.C. § 103(a) is reversed.

Claim 10 is rejected under 35 U.S.C. § 112 paragraph 2, and this rejection is designated as a new ground of rejection pursuant to 37 C.F.R. § 41.50(b).

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

AFFIRMED-IN-PART; NEW GROUND OF REJECTION PURSUANT TO 37 C.F.R. § 41.50(b)