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Paper 11
Entered: July 24, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MICRON TECHNOLOGY, INC.,
Petitioner,

v.

PRESIDENT AND FELLOWS OF HARVARD COLLEGE,
Patent Owner.

Case IPR2017-00666
Patent 8,334,016 B2

Before CHRISTOPHER L. CRUMBLEY, JON B. TORNQUIST, and CHRISTOPHER M. KAISER, *Administrative Patent Judges.*

TORNQUIST, *Administrative Patent Judge*.

DECISION
Denying Institution of *Inter Partes* Review
37 C.F.R. § 42.108

I. INTRODUCTION

Micron Technology, Inc. ("Petitioner") filed a Petition (Paper 1, "Pet.") requesting *inter partes* review of claims 1–3 and 5–10 of U.S. Patent No. 8,334,016 B2 (Ex. 1001, "the '016 patent"). The President and Fellows of Harvard College ("Patent Owner") filed a Preliminary Response to the Petition (Paper 8, "Prelim. Resp.").

We have authority to determine whether to institute an *inter partes* review. 35 U.S.C. § 314; 37 C.F.R. § 42.4(a). The standard for instituting an *inter partes* review is set forth in 35 U.S.C. § 314(a), which provides that an *inter partes* review may not be instituted "unless the Director determines . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition."

After considering the Petition and the Preliminary Response, we determine that Petitioner has not demonstrated a reasonable likelihood of prevailing with respect to claims 1–3 and 5–10 of the '016 patent on the asserted grounds. Accordingly, we do not institute *inter partes* review.

A. Related Proceedings

The parties note that the '016 patent is at issue in *President and Fellows of Harvard College v. Micron Tech., Inc.*, 1:16-cv-11249 (D. Mass.), *President and Fellows of Harvard College v. GlobalFoundries U.S., Inc.*, 1:16-cv-11252 (D. Mass.), IPR2017-00663, and IPR2017-00664. Pet. 2; Paper 5, 1. The parties further note that related U.S. Patent No. 6,969,539 is at issue in both the above–noted district court proceeding and IPR2017-00662. Pet. 2; Paper 5, 1.

B. The ’016 Patent

The ’016 patent discloses “reagents for use in thin film deposition processes such as chemical vapor deposition (CVD) and atomic layer deposition (ALD).” Ex. 1001, 1:30–32.

“In CVD processes, a reactant vapor or vapor mixture is brought into contact with a heated surface on which a thin film is deposited.” *Id.* at 1:46–48. In an ALD process, “a metered amount of a first reactant component” is introduced into a deposition chamber to deposit a thin layer of this first reactant on a substrate. *Id.* at 20:57–60. Excess vapor is then removed from the chamber and a metered amount of a second reactant component is introduced into the deposition chamber where it “interacts with the already deposited layer of the first reactant.” *Id.* at 20:60–21:5. The ’016 patent explains that, because the surface reactions in the ALD process are “self-limiting,” the process may be used to provide a “reproducible layer of predictable composition” with “improved step coverage and thickness uniformity compared to CVD with mixed vapors.” *Id.* at 1:48–54, 20:64–67, 21:5–7.

In certain embodiments of the ’016 patent, metal or metalloid amides may be used as a reactant. *Id.* at 10:4–9. Table I of the ’016 patent provides a list of known amides for use in the disclosed ALD process, including tetrakis(dimethylamino)–, tetrakis(diethylamino)–, and tetrakis(ethylmethylamino)–hafnium and zirconium. *Id.* at Table I.

C. Illustrative Claim

Claim 1, reproduced below, is the only indendent claim in the ’016 patent and is illustrative of the challenged claims:

> 1. A process for making an insulator in a microelectronic device, the process comprising:

introducing a first reactant component into a deposition chamber;

introducing a second reactant component into the deposition chamber; and

alternately repeating introducing the first reactant component and the second reactant component into the deposition chamber;

wherein deposition of the first reactant component and the second reactant component are self-limiting;

wherein said first reactant component comprises a metal alkylamide;

wherein said second reactant component interacts with the deposited first reactant component to form the insulator; and

wherein said insulator comprises oxygen and the metal from the metal alkylamide.

Ex. 1001, 30:9–26.

D. The Asserted Grounds of Unpatentability

Petitioner contends claims 1–3 and 5–10 of the '016 patent are unpatentable based on the following grounds (Pet. 29–66):[1]

References	Basis	Claim(s) Challenged
Vaartstra[2] and Min[3]	§ 103	1
Vaartstra, Min, and Ma[4]	§ 103	2, 3, 6, 7, 9, and 10

[1] Petitioner also relies on a declaration from Dr. Sanjay Banerjee (Ex. 1003).
[2] U.S. Patent No. 6,159,855, issued Dec. 12, 2000 (Ex. 1005).
[3] Jae–Sik Min, et al., *Atomic Layer Deposition of TiN Films by Alternate Supply of Tetrakis(ethylmethylamino)–Titanium and Ammonia*, 37 JAPANESE J. OF APPLIED PHYSICS, No. 9A, 1998, pp. 4999–5004 (Ex. 1006).
[4] U.S. Patent No. 6,200,866 B1, issued Mar. 13, 2001 (Ex. 1007).

References	Basis	Claim(s) Challenged
Vaartstra, Min, Ma, and Bradley[5]	§ 103	5
Vaartstra, Min, Ma, and Shin[6]	§ 103	8

Petitioner asserts Min, Shin, and Bradley are prior art under 35 U.S.C. § 102(b) and Vaartstra and Ma are prior art under §102(e). Pet. 22 n.11, 24 n.13, 26 n.14, 27 n.15, 28 n.16 (noting that Shin was published on January 28, 1997). Patent Owner does not challenge the prior art status of these references at this stage of the proceeding.

II. ANALYSIS

A. Claim Construction

In an *inter partes* review, "[a] claim in an unexpired patent shall be given its broadest reasonable construction in light of the specification of the patent in which it appears." 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2142 (2016) (upholding the use of the broadest reasonable interpretation standard). In determining the broadest reasonable construction, we presume that claim terms carry their ordinary and customary meaning. *See In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). A patentee may define a claim term in a manner that differs from its ordinary meaning; however, any special definitions must be

[5] D.C. Bradley and M.H. Gitlitz, *Metallo-organic Compounds Containing Metal–Nitrogen Bonds. Part IV. Infared and Nuclear Magnetic Resonance of Dialkylamido–derivatives of Titanium, Vandium, Zirconium, Niobium, Hafnium, Tantalum, and Thorium*, J. OF THE CHEMICAL SOCIETY (A), 1969, pp. 980–984 (Ex. 1008).
[6] Korean Patent No. 0156980, published Jan. 28, 1997 (Ex. 1009).

set forth in the specification with reasonable clarity, deliberateness, and precision. *See In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994).

Petitioner and Patent Owner do not assert that any claim terms of the '016 patent require construction. Pet. 21; Prelim. Resp. 15. Upon review, we do not need to construe any terms of the '016 patent for purposes of this Decision. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) ("[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.").

B. Obviousness of Claim 1 over Vaartstra and Min

Petitioner contends the subject matter of claim 1 would have been obvious over the combination of Vaartstra and Min. Pet. 29–50.

1. Vaartstra

Vaartstra discloses the chemical vapor deposition of multi–metallic films using at least two metalloamide compounds of the formula $M(NR_2)$, "wherein M is a metal, N is nitrogen, and R is independently selected from hydrogen and carbon." Ex. 1005, 1:6–9, 3:61–64, 4:54–57. Exemplary compounds identified in Vaartstra for use in the disclosed process include "tetrakis–(diethylamido)–zirconium" and "tetrakis–(dimethylamido)–zirconium." *Id.* at 6:50–51.

In the disclosed process, a metalloamide mixture "of at least two metalloamide compounds (i.e., at least two metal amide precursors)" is vaporized and transferred to a deposition chamber in the presence of both a carrier gas and one or more reactant gases. *Id.* at 10:33–11:2, 11:39–45. If an oxide layer is desired, the reactant gas will be in the form of oxygen, nitrous oxide, water vapor, or ozone. *Id.* at 11:8–10. Within the deposition chamber, the vaporized multi-metallic metalloamide mixture impinges upon

a heated substrate "and decomposes thereon to form the desired multi-metallic layer." *Id.* at 12:28–30.

2. Min

Min discloses the use of tetrakis(ethylmethylamino)-titanium (TEMAT) and ammonia in an ALD process to form a TiN film. Ex. 1006, 4999–5000. According to Min, the use of these components in an ALD process results in TiN films "with improved conformality," which is "crucial for the interconnection of metals in ultralarge-scale integrated circuits." *Id.* at 4999.

In Min, the disclosed layers are deposited on a SiO_2 substrate via alternate supply of TEMAT and NH_3 in a reactor, with an inert Argon (Ar) pulse used to purge the reactor between each step. *Id.* Figure 2 of Min shows this gas switching method:

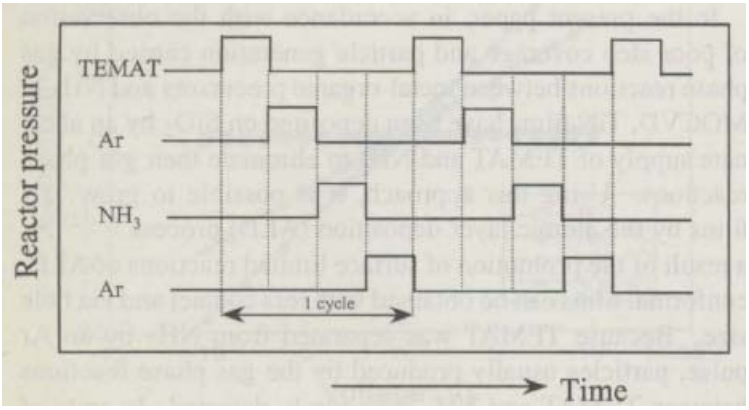


Figure 2 shows the sequential injection of gas reactants in Min. As shown in Figure 2, the reactants of Min are injected into the reactor in the following order: "TEMAT vapor pulse, Ar purge gas pulse, NH_3 gas pulse and Ar purge gas pulse." *Id.* These four pulses define one cycle and may be repeated multiple times to achieve a desired film thickness. *Id.* at 4999, 5001, Abstract.

Min explains that at temperatures of 175º C and 200º C, film thickness per cycle is saturated[7] at around 0.5 nm/cycle. *Id.* at 5001. "After saturation level is reached, film thickness per cycle remains constant, and saturation level is independent of both the TEMAT pulse time and the substrate temperature." *Id.* According to Min, these results indicate that the process is "self-limiting," which is a "distinct characteristic" of ALD processes. *Id.*

3. Obviousness of Claim 1 over Vaartstra and Min

Petitioner contends the combination of Vaartstra and Min discloses the subject matter of claim 1 and that one of ordinary skill in the art would have had multiple reasons to combine the two references. Pet. 31–38. First, Petitioner contends that one of ordinary skill in the art would have sought to use Vaartstra's precursors in Min's ALD process in order to provide precise control over film thickness and to achieve a stoichiometric film. *Id.* at 39–40, 42–43. According to Petitioner, precise control over film thickness was necessary "to control leakage currents in metal oxide films" and the ability to deposit stoichiometric films was "paramount" in many semiconductor applications. *Id.* at 39–40, 43 (noting numerous known benefits of ALD, including the ability to precisely control film thickness and uniformity).

Vaartstra indicates, however, that the disclosed CVD process already allows for "strict control" of the "thickness of the formed layer" and provides a stoichiometric film "within tight specifications." Ex. 1005, 1:49–52 (noting that metalorganic chemical vapor deposition is "particularly

[7] The '016 patent explains that "[n]ormally, in an ALD process, the dose of precursor" delivered "is chosen to be large enough to cause the surface reactions to go to completion (also called 'saturation')." Ex. 1001, 22:22–26.

advantageous . . . because it allows for strict control of the thickness of the formed layer"), 2:39–45 (explaining that Vaartstra's CVD process provides "multi–metallic films having metal stoichiometries within tight specifications"); Prelim. Resp. 26–27. Thus, on this record, we agree with Patent Owner that Petitioner has not explained sufficiently why one of ordinary skill in the art would have sought to use Vaartstra's precursors in Min's process "to achieve a goal that has already been achieved" in Vaartstra. Prelim. Resp. 26.

To the extent Petitioner proposes modifying Vaartstra by applying Min's ALD process, Petitioner does not identify any advantages in doing so that are not already present in Min. Pet. 43 ("A POSA would further have understood that Min's ALD process with TEMAT provides these benefits."). In short, regardless of whether the combination is analyzed as using Vaartstra's precursors in Min's ALD process, or as modifying Vaartstra's process from a CVD process to Min's ALD process, Petitioner has not shown why this modification would provide any benefit over Min's ALD process using TEMAT.

Petitioner also contends that a person of ordinary skill in the art would have sought to use Vaartstra's components in the ALD process of Min in view "of the similarities of the respective precursors and Vaartstra's teaching that the same precursors can be used to form both an oxide and a nitride." Pet. 40. We are not persuaded by this argument because, at best, it demonstrates an expectation of success that the two references could be successfully combined, not why one of ordinary skill in the art would have sought to do so. *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007) (noting that it is "important to identify a reason that would have prompted a

person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does"); *Belden Inc. v. Berk–Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015) ("[O]bviousness concerns whether a skilled artisan not only *could have made* but *would have been motivated to make* the combinations or modifications of prior art to arrive at the claimed invention.").

Petitioner further contends that one of ordinary skill in the art would have understood that the use of "Vaartstra's metalloamide precursors" in "Min's ALD method" would merely constitute the use of known metalloamide precursors and oxidants in a known ALD process to achieve "predictable and beneficial" results. Pet. 43. In support of this argument, Petitioner contends it was known in the art that: ALD was desirable for forming metal oxides on gates and capacitors, that the reactivity, volatility, and thermal stability of Vaartstra's $M(NR_2)$ precursors made them "prime candidates for an ALD process," and that Min's TEMAT precursor belongs to the same genus of metal dialkylamides disclosed in Vaartstra. *Id.* at 42–44 (citing Ex. 1005, 10:66–11:10, 13:51–54; Ex. 1003 ¶¶ 50–53, 139).

A patent that "simply arranges old elements with each performing the same function it had been known to perform," and which yields "no more than one would expect from such an arrangement," is likely obvious. *KSR*, 550 U.S. at 417. Petitioner proposes, however, to apply the metal dialkylamides of Vaartstra in a manner that differs from that disclosed in Vaartstra (decomposition vs. deposition). Ex. 1003 ¶ 49 (distinguishing between CVD and ALD processes on the basis of the likelihood of thermal decomposition, which is higher in CVD processes); Ex. 1005, 1:28–45 (describing Vaartstra's process as "decomposition"); Ex. 1007, 5000

(describing ALD processes as occurring between 170 °C and 210 °C), 5001 (noting that self–decomposition of TEMAT occurs at 230 °C). In addition, the fact that the compounds of Vaartstra were known to have properties that might make them candidates for an ALD process does not explain why their use in Min's process would be either "beneficial" or would provide results superior to Min's TEMAT precursor. Moreover, to the extent one of ordinary skill in the art would have sought an oxide layer for use in semiconductor applications, Petitioner does not explain sufficiently why this artisan would not have simply switched from a nitriding reactant to an oxidizing reactant in Min. Thus, Petitioner's arguments demonstrate at most that Vaartstra's compounds might be applicable in Min, not *why* one of ordinary skill in the art would have sought to use them in Min.

Finally, Petitioner contends that one of ordinary skill in the art would have sought to use Vaartstra's metal dialkylamides in Min's ALD process, because ALD processes "may be carried out at a temperature lower than the temperature at which the metal dialkylamide may begin to thermally decompose." Pet. 44 n.19 (citing Ex. 1003 ¶¶ 49, 107). In support of this argument, Dr. Banerjee testifies that certain semiconductor components may not be thermally stable at the temperatures required in CVD processes. Ex. 1003 ¶¶ 34, 49. Vaartstra indicates, however, that the disclosed multi–metallic mixture may be applied successfully to a semiconductor substrate. Ex. 1005, 11:22–35, 12:27–29. Thus, it is not evident why the low temperatures of Min's ALD process would have caused one of ordinary skill in the art to implement Vaartstra's successful multi–metallic deposition process in Min's single precursor ALD process.

In view of the foregoing, we determine that Petitioner has not set forth sufficient articulated reasoning supported by factual underpinnings to explain why one of ordinary skill in the art would have sought to replace TEMAT in Min's process with the multi–metal alkylamide precursor mixtures of Vaartstra. Accordingly, Petitioner has not demonstrated a reasonable likelihood that claim 1 of the '016 patent would have been obvious over the combination of Vaartstra and Min set forth in the Petition.

C. The Remaining Vaartstra–Based Grounds

Petitioner contends dependent claims 2, 3, 6, 7, 9, and 10 would have been obvious over Vaartstra, Min, and Ma; claim 5 would have been obvious over Vaartstra, Min, Ma, and Bradley; and claim 8 would have been obvious over Vaartstra, Min, Ma, and Shin. Pet. 50–66. Petitioner does not allege that the addition of Ma, Bradley, or Shin provides an additional reason for the person of ordinary skill in the art to have combined Vaartstra and Min. *Id.*

Because claims 2, 3, and 5–10 each depend from claim 1, and because we have determined that Petitioner has not demonstrated sufficiently that claim 1 would have been obvious over Vaartstra and Min, Petitioner has also not demonstrated a reasonable likelihood that claims 2, 3, and 5–10 would have been obvious over the Vaartstra–based grounds set forth in the Petition.

III. CONCLUSION

Upon consideration of the Petition and the Preliminary Response, we conclude that Petitioner has not demonstrated a reasonable likelihood that

claims 1–3 and 5–10 of the ’016 patent would have been obvious over the recited prior art. Accordingly, we do not institute *inter partes* review.

IV. ORDER

It is hereby

ORDERED that *inter partes* review is not instituted.

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