

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LAM RESEARCH CORP.,
Petitioner,

v.

INPRIA CORP.,
Patent Owner.

Case IPR2025-00309
Patent No. 11,537,048

**PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 11,537,048**

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PETITIONER’S EXHIBIT LIST

Exhibit	Description
1001	U.S. Patent No. 11,537,048 (“’048 Patent”)
1002	‘048 Patent Prosecution History
1003	Expert Declaration of Seán Barry, Ph.D. (“Barry Declaration”)
1004	<i>Curriculum Vitae</i> of Seán Barry, Ph.D.
1005	U.S. Patent No. 8,536,068 (“Weidman”)
1006	U.S. Patent Application No. 2017/0102612 (“Meyers”)
1007	U.S. Patent No. 9,328,416 (“Dhas”)
1008	B. Cardineau, et al., <i>Photolithographic properties of tin-oxo clusters using extreme ultraviolet light (13.5 nm)</i> , Microelectronic Engineering 127 (2014) 44-50 (“Cardineau”)
1009	K. Molloy, <i>Precursors for the formation of tin(IV) oxide and related materials</i> , J. Chem. Research (Oct. 2008) 549-554 (“Molloy”)
1010	<i>Inpria Corp. v. Lam Research Corp.</i> , No. 1-22-cv-01359, Dkt. No. 199, Joint Claim Construction Brief (D. Del. Oct. 18, 2024)
1011	R. Del Re, <i>Molecular organometallic resists of tin and tellurium</i> , Legacy Theses & Dissertations (2009 - 2024), 1370 (Jan. 1, 2015)
1012	J. Son, et al., <i>Acid-Stable Peroxonitobophosphate Clusters To Make Patterned Films</i> , Chemistry - A European Journal, 21(18) (Apr. 27, 2015)
1013	J. Jiang, <i>Organic Inorganic Photoresist And Laser Induced Heating Process For Next Generation Lithography</i> (July 2015)
1014	R Del Re, et al., <i>Low-line edge roughness extreme ultraviolet photoresists of organotin carboxylates</i> , Journal of Micro/Nanolithography, MEMS, and MOEMS, Vol. 14, Issue 4, 043506 (Nov. 9, 2015),

1015	R. Del Re, et al., <i>Low-LEP Tin Carboxylate Photoresists using EUV</i> , Extreme Ultraviolet (EUV) Lithography VI (2015).
1016	Maeng et al., <i>Atomic Layer Deposition of Ta-Based Thin Films: Reactions of Alkylamide Precursor with Various Reactants</i> , J. Vacuum Sci. & Technol. B 24:2276 (2006)
1017	November 2024 email chain between Alison Patitucci and Elsevier
1018	Summons for <i>Inpria Corp. v. Lam Research Corp.</i> , 1-22-cv-01359
1019	Declaration of Alison Patitucci
1020	PCT published Application WO 2020263750 (“Berney”)

I. INTRODUCTION

Lam Research Corporation (“Petitioner”) petitions for *inter partes* review of claims 1-20 of U.S. Patent No. 11,537,048 to Stephen T. Meyers, et al. (“’048 patent,” EX1001) to Inpria Corporation (“Inpria”). This Petition is supported by Dr. Barry’s expert declaration (EX1003) and accompanying exhibits.

The ’048 patent concerns organotin oxide hydroxide compositions used in high-resolution lithography. These materials enable low-dose patterning through solution-based or vapor deposition processes, making them suitable for Ultraviolet (UV), electron beam, and extreme ultraviolet (EUV) applications.

During prosecution, Inpria argued that the cited prior art *Maeng* reference (incorporated-by-reference) failed to disclose the claimed apparatus. Yet, when confronted with a lack of structure for means-plus-function (“MPF”) limitations, Inpria improperly added a modified figure from *Maeng* and a new accompanying description, asserting that *Maeng* provided the very structure they earlier claimed it failed to disclose. Inpria should not benefit from its contradictory positions that misled the Examiner into allowing the application. While improperly added subject matter cannot be a basis for unpatentability at the PTAB, this issue directly impacts whether the patent is entitled to its earliest claimed priority date. If not, then the patent is unpatentable over a combination of its own earlier publication in the same family and other vapor deposition prior art that disclose the MPF structures. And

even if the patent were somehow entitled to its earliest claimed priority date, it remains unpatentable for several additional grounds detailed herein.

II. MANDATORY NOTICES

A. Real Party-in-Interest (§ 42.8(b)(1))

Petitioner is the sole real-party-in-interest.

B. Related Matters (§ 42.8(b)(2))

Inpria has asserted claims of infringement based on the '048 Patent against Petitioner. *Inpria Corp. v. Lam Research Corp.*, 1:22-cv-01359 (D. Del.). This Petition is timely, having been filed within one year of service of the complaint. EX1018.

C. Identification of Counsel (§ 42.8(b)(3))

Petitioner designates Dion M. Bregman (Reg. No. 45,645) as lead counsel, and Michael J. Lyons (Reg. No. 37,386), Ahren C. Hsu-Hoffman (Reg. No. 50,862), and Alison P. Patitucci (Reg. No. 73,370) as back-up counsel.

Service of any documents may be made at Morgan, Lewis & Bockius LLP,, 1400 Page Mill Rd., Palo Alto, CA 94304 (Telephone: 650.843.4000; Fax: 650.843.4001). Petitioner consents to email service at: MLB-Lam-IPR-Team@morganlewis.com.

D. Service (§ 42.8(b)(4))

This Petition is being served by Priority Mail Express to the correspondence

address of record for the '048 Patent: CHRISTENSEN, FONDER, DARDI & HERBERT PLLC, 11322 86th Ave. N., Maple Grove, MN 55369.

III. POWER OF ATTORNEY (§ 42.10(B))

Petitioner's Power of Attorney is filed in accordance with 37 C.F.R. § 42.10(b).

IV. GROUNDS FOR STANDING (37 C.F.R. § 42.204(A))

Petitioner certifies that the '048 Patent is available for IPR and that the Petitioner is not barred or estopped from requesting this IPR on the grounds identified herein.

V. FEES (§ 42.15(a))

The required fee is paid under § 42.103, and the Commissioner is hereby authorized to charge all fees pertaining to this matter to Deposit Account No. 50-0310 (Order No. 134507-8004).

VI. CLAIMS AND GROUNDS

Ground	Basis	Reference(s)	Claims
1	§ 103	Dhas and Cardineau	1-6, 8-20
2	§ 103	Dhas, Cardineau, and Molloy	7
3	§ 103	Weidman and Cardineau	1-5, 8-20
4	§ 103	Weidman, Cardineau, Molloy	6, 7

VII. DETAILED EXPLANATION

A. Level of Skill

A suitable POSA would have at least a graduate degree, e.g., M.Sc. or Ph.D.,

in a relevant discipline such as in chemistry, materials science, chemical engineering, physics, or an equivalent field, and 2-3 years of experience in research, design, development and/or testing of resist materials. EX1003 ¶23.

B. Claim Construction

Without conceding compliance with 35 U.S.C. § 112, the following MPF constructions apply solely to the '048 Patent petitions.¹ Claims 1, 4, and 12 include numerous MPF “structure” terms that are unsupported by definite structure, as required by §112(6). Even if Inpria argues these terms fall outside §112(6), the prior

¹ This approach has been approved. *See Spherix Inc. v. Matal*, 703 F. App'x 982, 983 (Fed. Cir. 2017) (approving proposal of patent owner's interpretations); *DraftKings Inc. v. AG 18, LLC*, IPR2022-01447, Paper 12 at 24-25 (Mar. 14, 2023) (“Whether Petitioner's equivocation concerning the (in)definiteness of the Module Terms successfully preserves an indefiniteness defense ... is a potential issue to be decided later by a different tribunal. We merely conclude, based on the facts presented in this case at this time, that the Petition is not procedurally defective in its proposed construction of the Module Terms.”); *Target Corp. v. Proxicom Wireless, LLC*, IPR2020-00904, Paper 11 at 12 (Nov. 10, 2020) (“Petitioner's alternative pleading before a district court is common practice, especially where it concerns issues outside the scope of [IPR].”).

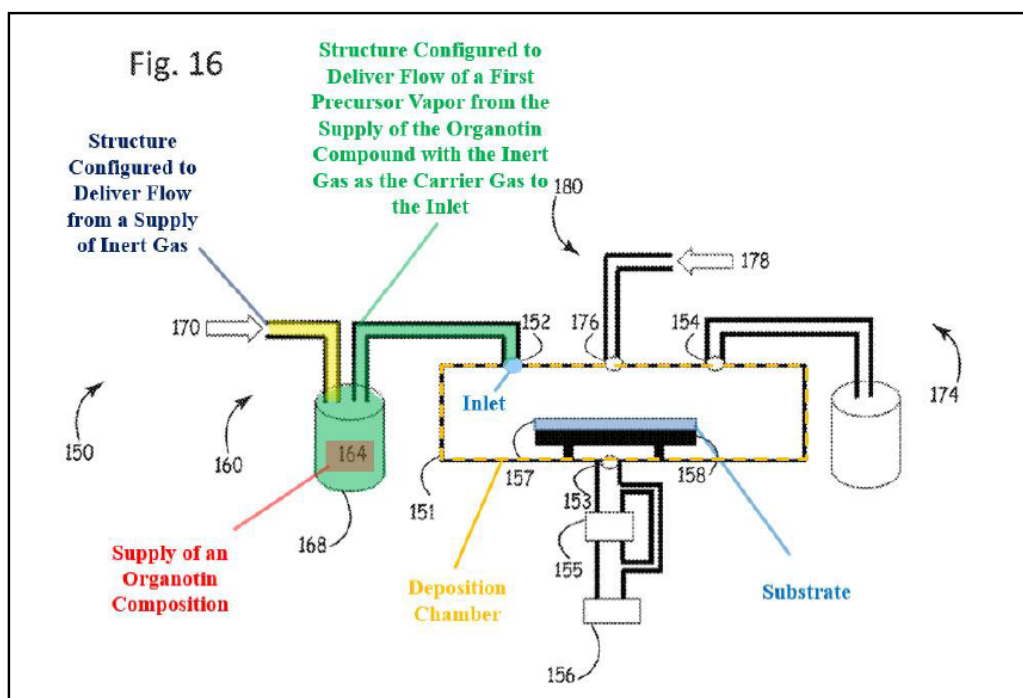
art still teaches the claimed limitations. *Analog Devices, Inc. v. Xilinx, Inc.*, IPR2020-01625, Paper 43 at 11-12 (PTAB Apr. 14, 2022).

The presumption against §112(6) is overcome because “structure” and “configuration” are generic placeholders, lacking definite structure. *See Williamson v. Citrix Online, LLC*, 792 F.3d 1339, 1348-50 (Fed. Cir. 2015). These terms act as structural stand-ins, equivalent to “means.” EX1003 at ¶25.

1. “structure configured to deliver flow from a supply of inert gas” (claim 1)

Function: “to deliver flow from a supply of inert gas.”

Structure: For this Petition only, Petitioner partially agrees with Inpria’s district court identification of the alleged structure as tied to Figure 16: a **conduit** to “supply of inert gas 170” and equivalents thereof, but this structure need not include the “vessel 168,” which is a distinct structure that does not perform the function of delivering inert gas. EX1010 at 31 (citing EX1001 at 19:19-23, Fig. 16). Inpria’s annotated version of Figure 16 (below) from the parallel district court proceedings purports to show “Structure Configured to Deliver Flow from a Supply of Inert Gas” annotated in yellow with accompanying dark blue text (left).



Id. at 32.

If Figure 16 was new matter, as discussed in Section VII.C, then the structure without regard to Figure 16, but based on Inpria’s arguments in the district court proceedings, is a **conduit** (like a pipe) to supply inert gas, e.g., a conduit between an interconnected vessel (like a vaporization chamber) and a supply of inert gas, and equivalents thereof. *See id.* at 30, 39. Either way, the term means a **conduit**, or equivalents, for supplying an inert gas.

2. “structure configured to deliver flow of a first precursor vapor from the supply of the organotin compound with the inert gas as a carrier gas to the inlet ...” (claim 1)

Function: “to deliver flow of a first precursor vapor from the supply of the organotin compound with the inert gas as a carrier gas to the inlet.”

Structure: For this Petition only, Petitioner relies on Inpria’s identification of the alleged structure as tied to Figure 16: “**conduit** extending from the vessel 168 to the inlet 152” and equivalents thereof. EX1010 at 40. Inpria’s annotated version of Figure 16 (above) purports to show the structure with green annotations and text. The claimed structure, however, does not include the supply of the organotin compound itself, but only the conduit.

If Figure 16 was new matter, as discussed in Section VII.C, then Petitioner relies on Inpria’s identification of the alleged structure without regard to Figure 16: “a POSITA would have understood that the claimed ‘structure’ is a **class of structures for delivering flow**, *i.e.*, an interconnected vessel (such as a vaporization chamber, as recited in claim 4) and conduit (such as a pipe)” and equivalents thereof. *Id.* at 30; *see id.* at 39 (“The claim language itself thus conveys a well-known class of structure to a POSA: an interconnected vessel (like a vaporization chamber) and a conduit (like a pipe).”). Again, the claimed structure, however, does not include the interconnected vessel supply of the organotin compound itself, but only the class of structures for delivering flow.

Stated differently, the term means (i) a **conduit** for performing the claimed function, or (ii) a **class of structures for delivering flow** and equivalents thereof.

3. “structure to deliver a second precursor vapor comprising water, hydrogen peroxide...capable of reacting with the composition in the first precursor vapor...” (claim 1)

Function: “to deliver a second precursor vapor comprising water, hydrogen peroxide...capable of reacting with the composition in the first precursor vapor.”

Structure: The corresponding structure is, as shown in Figure 16, a **conduit** 174 to deliver a “second precursor vapor comprising water, hydrogen peroxide or a combination thereof”, e.g., to inlet 154 of deposition chamber 151, and equivalents thereof. EX1001 at 19:23-25, Fig. 16.

If Figure 16 was new matter, as discussed in Section VII.C, then the structure without regard to Figure 16 but based on Inpria’s arguments in the parallel proceedings is a **conduit** (like a pipe) for delivering a “second precursor vapor comprising water, hydrogen peroxide or a combination thereof” and equivalents thereof. See EX1010 at 30, 39. Either way, the term means a **conduit** for performing the claimed functions and equivalents thereof.

4. **“configuration providing for selection of the pressure and/or the temperature in the deposition chamber” (claim 10)**

Function: “selection of the pressure and/or the temperature in the deposition chamber.”

Structure: For this Petition only, the corresponding structure is best understood as a first and second vessel and/or a controller for selecting the pressure and/or the temperature in the deposition chamber, and equivalents thereof. See EX1001, 20:1-10 (“By **controlling** [first and second] vessel **temperatures**, inert gas

flow rate, and total system **pressure**, vapor-phase $\text{RSn}(\text{NR}'_2)_3$ and H_2O are transported independently to a chamber....”).

5. “one or more vapor inputting structures” (claim 12)

Function: “vapor inputting”

Structure: For this Petition only, based on Inpria’s arguments in the parallel proceedings, the corresponding structure the recited “vapor inputting structures” (“VIS”) is best understood as, per Figure 16, as inlet 154 or inlet 176 connecting a deposition chamber 151 to a source of vapor and equivalents thereof. EX1001, 19:23-27.

If Figure 16 was new matter, then the structure without regard to Figure 16 but based on Inpria’s arguments in the district court proceedings is an **inlet** connecting a deposition chamber to a source of vapor and equivalents thereof. *See, e.g.*, EX1010, 30, 39. Either way, the term means an **inlet** for inputting a vapor and equivalents thereof.

C. The ’048 Patent

The Challenged Claims of the ’048 Patent lack support in the original specification filed on August 6, 2020, or earlier applications, and therefore are not entitled to those filing dates. To address rejections for insufficient support for MPF claim terms, Inpria introduced new Figure 16 and related text in amendments dated January 20, 2021, and April 5, 2021, adding material not present in the original

specification in violation of 35 U.S.C. § 132. Inpria's reliance on altered incorporated-by-reference prior art (*Maeng*) for support is unsubstantiated, as confirmed by Dr. Barry. EX1003, ¶¶30-33. While Petitioner asserts the earliest valid priority date is January 20, 2021, it accepts **October 13, 2015**, as the earliest possible date for this Petition only and demonstrates the claims are unpatentable regardless.

D. Asserted Prior Art

US8,536,068 to Weidman, et al. ("**Weidman**") (EX1005) is prior art under post-AIA §102(a)(1).

Photolithographic properties of tin-oxo clusters using extreme ultraviolet light (13.5 nm, by Brian Cardineau, et al. ("**Cardineau**") (Ex 1008)—a named inventor on the '048 Patent—was publicly available online by no later than April 24, 2014, and the print version was published on September 5, 2014, according to its publisher Elsevier. EX1008; EX1019, ¶¶1-3. Cardineau is prior art under at least post-AIA §102(a)(1) because it was available online by no later than April 24, 2014, and the print version published September 5, 2014. Articles published as early as January 2015 cite Cardineau, thereby further corroborating its 2014 publication date. *See* EX1019, ¶¶1-3.

U.S. Patent No. 9,328,416 to Dhas, et al. ("**Dhas**") (Ex1007), which was filed January 17, 2014, and published July 23, 2015, is prior art under at least post-AIA §102(a)(1).

Finally, *Precursors for the formation of tin(IV) oxide and related materials* by Kieran C. Molloy (“**Molloy**”) (EX1009), published online on October 1, 2008 and in print on October 7, 2008, and is prior art under at least post-AIA §102(a)(1).

E. Ground 1: Claims 1-6 And 8-20 Are Obvious Over Dhas and Cardineau

As shown below, Dhas’s vapor deposition system alone or combined with Cardineau discloses or suggests each limitation of claims 1-20 of the ’048 Patent. Thus, Dhas, alone or combined with Cardineau, anticipates or renders obvious those claims. EX1003, 198.

1. Claim 1

a. Preamble: “system comprising”

Dhas discloses a system, i.e., an “**apparatus** for preparing a reaction chamber and depositing materials on substrates.” EX1007, 1:18-20; EX1003, ¶199. Cardineau also discloses methods of preparing photoresists by spincoating organotins onto substrates. EX1008,48; EX1003, ¶199.

b. “deposition chamber having an interior isolated from the ambient atmosphere”

Dhas’s reaction chamber process station has “**process chamber** body 802 for maintaining a low pressure environment” as shown in Figure 8 below. EX1007 at 19:65-20:4. A POSA would understand that to maintain a low-pressure environment

versus ambient atmosphere, the process chamber's interior is isolated from the ambient atmosphere. EX1003, ¶200.

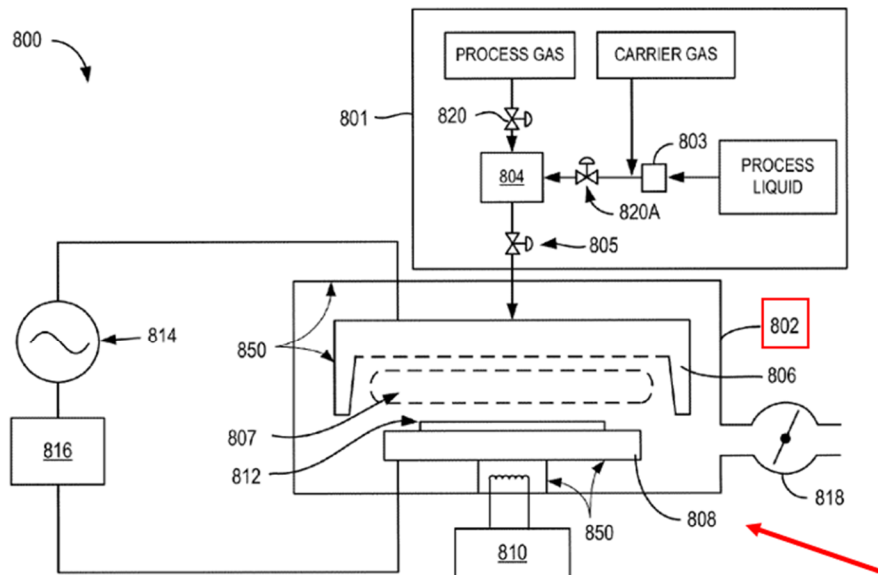


FIG. 8

EX1007, Figure 8 (annotated).

- c. “substrate within the interior of the deposition chamber configured to receive a deposition on a surface of the substrate”

Dhas discloses a “**substrate 812 in the process station 800.**” *Id.*, 23:36-37.

The substrate “is introduced to the process station 800...to be used for **depositing film on the substrate 812.**” *Id.*, 23:39-42. “Showerhead 806 distributes process gases toward substrate 812.” *Id.*, 21:5-6. A POSA would understand that if films are

deposited on Dhas's substrates, they can receive a deposition on their surface.

EX1003, ¶201.

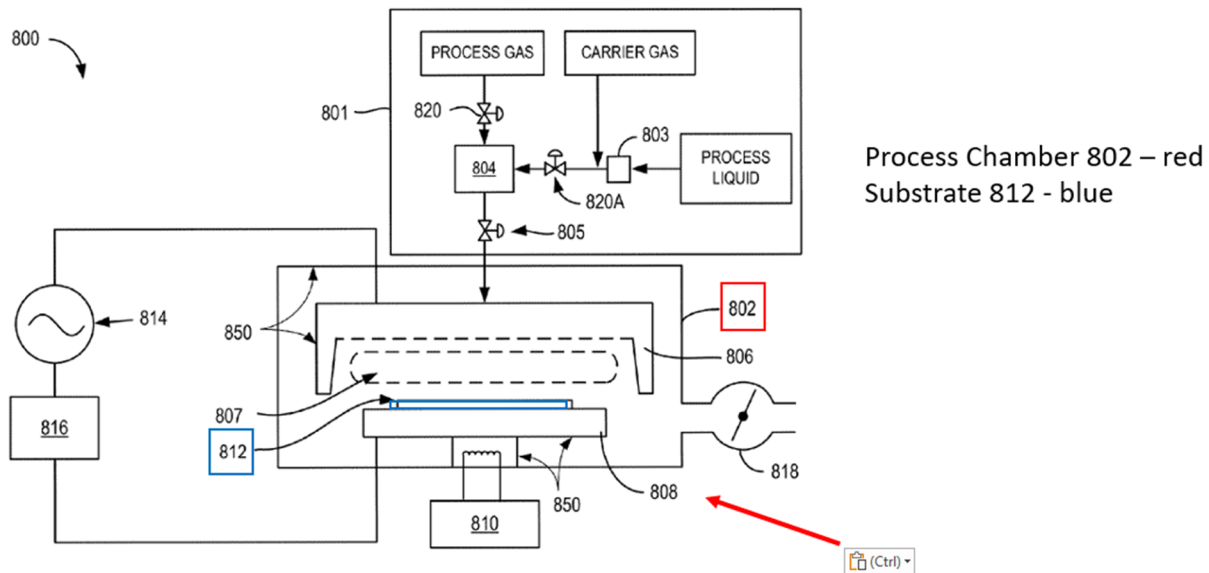


FIG. 8

EX1007, Figure 8 (annotated).

d. “the substrate is maintained at a temperature of less than 200° C”

In Dhas, “temperature of the substrate may be maintained between about 180-550°C,” which overlaps with the claimed temperature. EX1007, 17:12-13.

This anticipates the claimed range of “less than 200° C.” This is true “even where the prior art range only partially or slightly overlaps with the claimed range.”

Genentech, Inc. v. Hospira, Inc., 946 F.3d 1333, 1338 (Fed. Cir. 2020).

If Dhas's claimed ranges do not anticipate, they at least render the claim obvious. "Once the patent challenger has established, through overlapping ranges, its prima facie case of anticipation, 'the court must evaluate whether the patentee has established that the claimed range is critical to... the claimed invention.'" *UCB, Inc. v. Actavis Labs. UT, Inc.*, 65 F.4th 679, 687 (2023). The '048 Patent does not disclose embodiments using the claimed range, and the specification includes only vague statements about the claimed temperature. *E.g.*, EX1001, 20:5, 20:14-30; EX1003, ¶¶ 202-205.

e. "an inlet into the deposition chamber"

Dhas's **"apparatus may include a reaction chamber having one or more inlets for delivering gas phase reactants."** EX1007, 3:16-24. And Dhas's heated injection module has a conduit leading to a reaction chamber, as shown in Figure 7 below.² *Id.*, 19:43-52 (discussing conduit 706); EX1003, ¶206.

² Dhas discloses that Figure 8 incorporates Figure 7: "The vaporization point 803 may be the heated injection module shown in FIG. 7, for example." EX1007, 20:21-11.

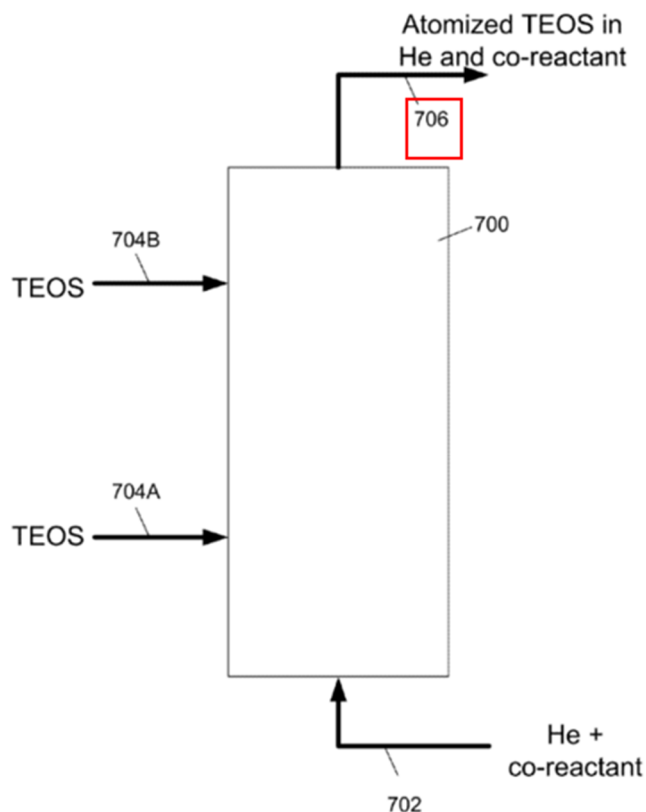


FIG. 7

Id., Figure 7 (annotated).

f. “structure configured to deliver flow from a supply of an inert gas”

Petitioner refers to the MPF discussion in Section VII.B. Dhas’s **conduit 702** (Figure 7) delivers “helium [an inert gas] and optional co-reactant.” *Id.*, 19:27-30. Dhas discloses “...flowing a liquid reagent and helium into a heated injection module at certain flow rates to atomize/vaporize the liquid reagent, **and flowing the vaporized stream to the reaction chamber.**” *Id.*, 22:63-67; EX1003, ¶¶207-210.

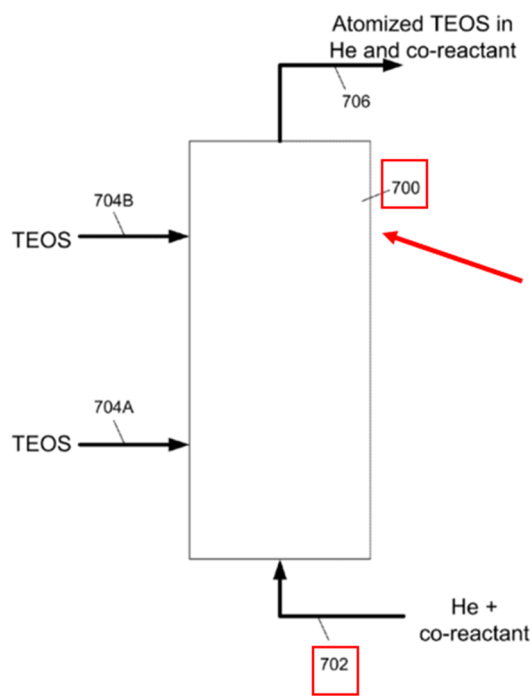


FIG. 7

Id., Figure 7 (annotated).

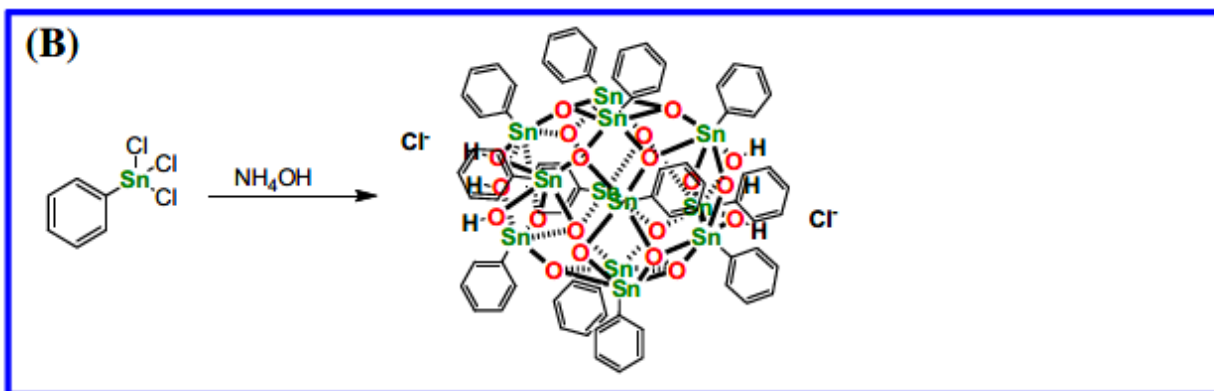
- g. “a supply of an organotin composition comprising a compound described by the formula RSnX_3 , where R is an organic ligand with 1-31 carbon atoms and is bound to Sn with a metal-carbon bond”**

Although Dhas does not teach a supply of an organotin composition described by the formula RSnX_3 , Dhas teaches depositing organometallics with water. EX1007, 17:61-18:30. And Dhas discloses exposing a photoresist to UV light. *Id.*, 26:31-47.

Cardineau discloses using tin compounds as EUV photoresists given tin's higher EUV absorbance. Cardineau discloses that tin has higher optical densities than carbon, and resists based on tin-oxo clusters should “provide superior

lithographic performance based on more efficient utilization of the EUV photons to give better sensitivity and lower shot noise.” EX1008, 45. Cardineau also discloses the importance of EUV in microelectronics: “Extreme ultraviolet (EUV, 13.5-nm wavelength) lithography is thought to be the next imaging technology for fabricating microelectronic devices....” *Id.*, 44.

Cardineau’s tin-oxo clusters are prepared from the organotin trichlorides “[a]llyltin trichloride,” “[b]utyltin trichloride,” and “[p]henyltin trichloride.” *Id.*, 49. These are compounds “represented by the formula $R\text{SnX}_3$ wherein R is an organic ligand with 1-31 carbon atoms bound to Sn with a metal-carbon bond” and X is Chloro (Cl). *Id.*, 44 (“[E]valuation of thin films of tin-oxo clusters $[(R\text{Sn})_{12}\text{O}_{14}(\text{OH})_6]\text{X}_2$, Fig. 1A) using extreme ultraviolet light (EUV, 13.5 nm).”).



Id., Fig. 6B, 48.

As EUV lithography gained prominence over UV lithography, a POSA would have been motivated to modify Dhas to work with Cardineau’s chemistry. EX1003,

¶215. The references are also analogous, both relating to the same subject matter as the '048 Patent—i.e., forming photoresists. *Id.* A POSA also would have been motivated to use Cardineau's precursors for more reliable coating, and to use tin precursors to achieve superior lithographic performance, improved sensitivity, and lower shot noise of films as Cardineau discloses. EX1008, 45; *Id.*

Finally, a POSA would have reasonably expected Cardineau's precursors to successfully form a photoresist in Dhas's apparatus, which teaches depositing organometallics with water, since Cardineau teaches an organometallic (organotin) that reacts with components of water such as hydroxyl groups to form tin clusters. EX1003, ¶211-216; EX1008, 44, ("[H]ydrolysis of the organotin trichloride using ammonium hydroxide proved the most successful."), 48 ("Hydrolysis of phenyltin trichloride using ammonium hydroxide produces a soluble polymeric material which shows evidence that it is the tin cluster.").

- h. "wherein X is selected from the group consisting of alkylamido or dialkylamido ($\text{—NR}^1\text{R}^2$, where R^1 and R^2 are independently hydrocarbon groups with 1-10 carbon atoms or hydrogen), siloxo ($\text{—OSiR}^1\text{R}^2\text{R}^3$, where R^1 , R^2 , R^3 are independently hydrocarbon groups with 1-10 carbon atoms), silylamido ($\text{—N(SiR}^1_3\text{)(R}^2\text{)}$, where R^1 and R^2 are independently hydrocarbon groups with 1-10 carbon atoms), disilylamido ($\text{—N(SiR}^1_3\text{)(SiR}^2_3\text{)}$ where R^1 and R^2 are independently hydrocarbon groups with 1-10 carbon atoms), alkoxo and aryloxo (—OR , where R is an alkyl or aryl group with 1-10 carbon atoms), azido (—N_3), alkynido ($\text{—C}\equiv\text{C—}$)**

C≡CR, where R is a hydrocarbon group with 1-9 carbon atoms), amidato (—NR¹(COR²) where R¹ and R² are independently hydrocarbon groups with 1-7 carbon atoms or hydrogen), amidinato (—NR¹C(NR²)R³) where R¹ and R² are independently hydrocarbon groups with 1-8 carbon atoms or hydrogen), imido (—N(COR¹)(COR²), where R¹ and R² are independently hydrocarbon groups with 1-8 carbon atoms or hydrogen), or fluorinated analogues thereof, or combinations thereof” (hereinafter, “X group limitation”)

Dhas discloses “[i]n certain cases, the deposited film contains **metal**,” and exemplary metal-containing films include “**metal alkoxides**.” EX1007, 17:61-18:1. Dhas also discloses specific examples of metal-containing precursors that include alkoxo ligands: “Further examples of metal-containing precursors that may be employed include...**tetraethoxytitanium**...” *Id.*, 18:5-10.

Although Dhas does not disclose **tin** precursor compounds having alkoxo (alkoxide) substituents, Cardineau discloses using tin compounds as EUV photoresists given tin’s higher EUV absorbance. Cardineau explains that “tin and oxygen readily absorb EUV photons with optical densities that are 10.5 and 1.7 times greater than carbon” and “these higher optical densities should allow resists based on these tin-oxo clusters to better utilize the EUV photons that are used in EUV lithography to provide superior lithographic performance based on more efficient

utilization of the EUV photons to give better sensitivity and lower shot noise.”
EX1008, 45.

Cardineau also discloses organotins having ligands X that are alkoxo groups (alkoxo is —OR, where R is an alkyl group with 1-10 carbon atoms): “[t]in clusters have been synthesized by...the controlled hydration of...**butyltin trialkoxide**...” *Id.*, 47 (citations omitted). A POSA would have been motivated to use an organotin with an alkoxo ligand of Cardineau in Dhas’s apparatus because Dhas discloses metal alkoxides as a precursor for metal-containing films, and to use tin precursors to achieve superior lithographic performance, improved sensitivity and lower shot noise of films as Cardineau discloses. EX1003, ¶¶217-219.

- i. **“structure configured to deliver flow of a first precursor vapor from the supply of the organotin compound with the inert gas as a carrier gas to the inlet”**

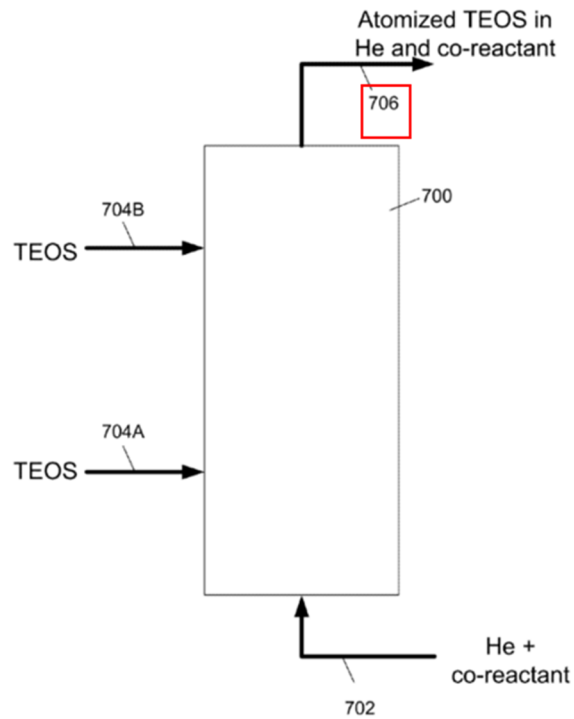
Petitioner refers to the MPF discussion in Section VII.B. Dhas discloses that liquid reagent vapors can be delivered with a carrier gas, such as argon (i.e. an inert gas). EX1007, 22:63-67. Although Dhas does not specifically disclose organotins, Cardineau (which is analogous art) discloses organotin precursors for resists. EX1008, 49.

Dhas’s **heated injection module 700** delivers helium (an inert gas) and a reactant, as shown in Figure 7. EX1007, 19:27-29. Additionally, Dhas’s

“instructions may include **flowing a liquid reagent and helium into a heated injection module at certain flow rates to atomize/vaporize the liquid reagent, and flowing the vaporized stream to the reaction chamber.**” *Id.*, 22:63-67; *id.*, 19:43-52.

Dhas’s “apparatus may include **a reaction chamber having one or more inlets for delivering gas phase reactants**, a heated injection module coupled with the inlet for vaporizing and/or atomizing liquid phase reactants...and a controller configured to perform any of the methods disclosed herein.” *Id.*, 3:16-24. Additionally, Dhas’s “[s]howerhead 806 distributes process gases toward substrate 812,” and Figure 8 shows “substrate 812 is located beneath showerhead 806” and “on a pedestal 808.” *Id.*, 21:5-8. Dhas further shows a conduit and valve in Figure 8. *Id.*, Figure 8.

Thus, this combination discloses a structure to deliver a first precursor vapor (e.g., Dhas’s precursor reactant vapor) from the supply of the organotin compound (e.g., Cardineau’s organotin compound from Dhas’s injection module 700) with the inert gas as a carrier gas (e.g., Dhas’s argon or helium) to the inlet. EX1003, ¶¶220-228.



EX1007, Figure 7 (annotated).

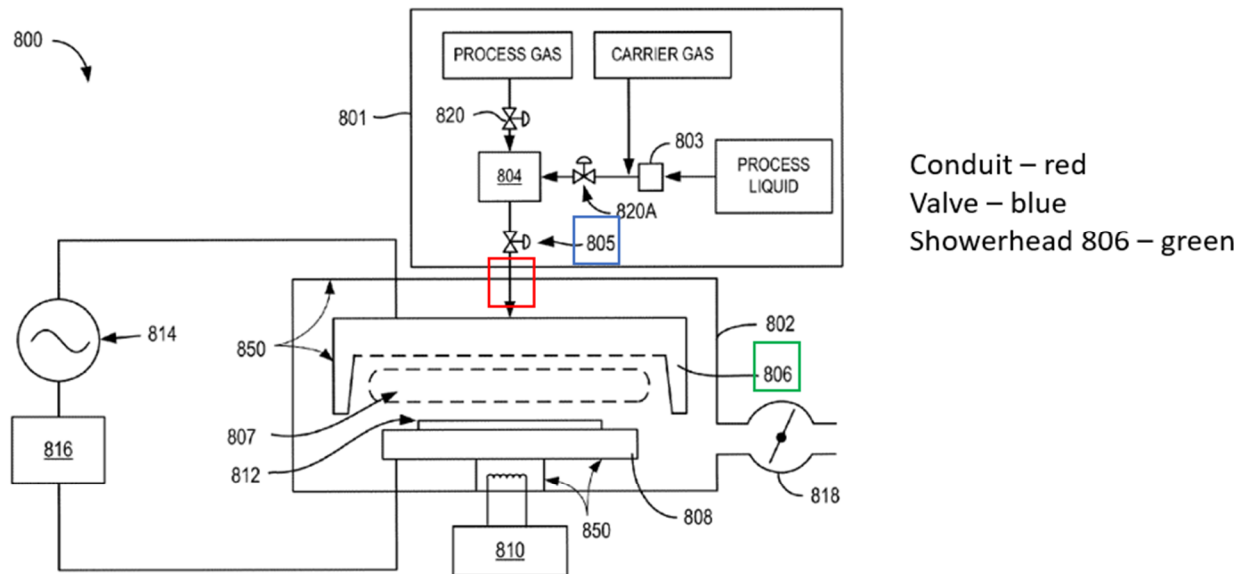


FIG. 8

Id., Figure 8 (annotated).

j. “to provide for formation of an organotin layer on the substrate surface within the deposition chamber”

Although Dhas does not disclose deposited organotin-containing films, it discloses deposited metal-containing films. *Id.*, 17:61-65 (stating “the deposited film contains **metal**” and providing “[e]xamples of metal-containing films”).

Cardineau using tin compounds for EUV photoresists given tin’s higher EUV absorbance. Cardineau explains that “[b]oth **tin** and oxygen readily absorb EUV photons with optical densities that are 10.5 and 1.7 times greater than carbon” such that “these higher optical densities should allow resists based on these tin-oxo clusters to better utilize the EUV photons that are used in EUV lithography to provide superior lithographic performance based on more efficient utilization of the EUV photons to give better sensitivity and lower shot noise.” EX1008, 45.

A POSA would have been motivated to use Cardineau’s tin precursors to form an organotin layer on the substrate surface in Dhas’s chamber to achieve superior lithographic performance, improved sensitivity and lower shot noise of films as Cardineau discloses. EX1003, ¶¶226-228.

k. “structure to deliver a second precursor vapor comprising water, hydrogen peroxide or a combination thereof capable of reacting with the composition in the first precursor vapor”

Petitioner refers to the MPF discussion in Section VII.B. Dhas's **"apparatus may include a reaction chamber having one or more inlets for delivering gas phase reactants,** a heated injection module coupled with the inlet for vaporizing and/or atomizing liquid phase reactants, an outlet for removing materials from the reaction chamber, a plasma generation source for exposing the reaction chamber to plasma, and a controller configured to perform any of the methods disclosed herein."

EX1007, 3:16-24.

Dhas discloses "vaporization point 803" "for vaporizing liquid reactant to be supplied to mixing vessel 804" and which may be a "heated injection module." *Id.*, 20:18-22, Fig. 7. Dhas's "instructions may include **flowing a liquid reagent and helium into a heated injection module at certain flow rates to atomize/vaporize the liquid reagent, and flowing the vaporized stream to the reaction chamber.**" *Id.*, 22:63-67. Dhas discloses that "oxygen-containing co-reactants include water." *Id.*, 17:61-18:30, 19:27-30. And Dhas's "mixing vessel inlet valves 820 may control introduction of process gases to mixing vessel 804." *Id.*, 20:14-16. Additionally, Dhas's conduits connect the process gas to mixing vessel 804, and vaporization point 803 to mixing vessel 804, and a conduit and a valve 805 to the chamber, as shown in Figure 8 below. EX1003, ¶¶229-232.

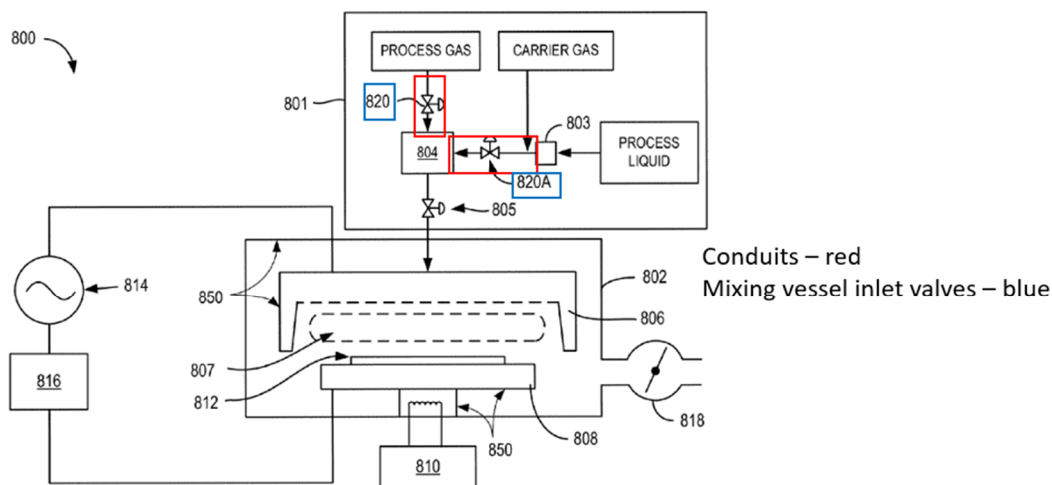


FIG. 8

EX1007, Figure 8 (annotated).

- I. **“under conditions in the deposition chamber to form a composition with non-volatile components and a volatile component comprising hydrolysis reaction product with X”**

Dhas forms a composition with non-volatile components (chemisorbed molecules of “first film precursor P1”) and a volatile component (“gas phase” and “physisorbed P1”). EX1007, 6:39-46.

Dhas teaches depositing organometallics with water. *Id.*, 17:61-18:30 (“the deposited film contains **metal**,” exemplary precursors may include “**organometallics**, etc.,” “**metal-containing precursors** will include the metal that is desired to be incorporated into the film,” embodiments may use “a variety of co-reactants” that “are often, but not always...**oxygen-containing reactants**,” including

“**water**”). And Dhas’s “reactants are delivered separately” for “some PEALD reactions” with “a purge or sweep... after delivery of one or more of the reactants to remove residual reactants from the chamber.” *Id.*, 10:2-5.

Dhas does not disclose that the non-volatile components include an organotin. However, a POSA would be motivated to use Cardineau’s organotin precursors, as they react with water components to form tin clusters. EX1008, 44, 48.

A POSA would have understood that the hydrolysis of Cardineau’s organotin trichlorides would displace a X ligand (chloride), and would have reasonably expected Cardineau’s precursors to successfully react with water as disclosed in Dhas to provide a non-volatile component that includes an organotin (i.e., “tin clusters”) and a volatile component comprising hydrolysis reaction product with X (chloride) since Cardineau teaches that the organotin precursors react with components of water to form tin clusters. EX1003, ¶¶233-235.

m. “wherein the substrate is configured with a surface to receive the non-volatile components of the composition.”

Dhas’s “substrate surface, including a population of surface active sites, is exposed to a gas phase distribution of a first film precursor (P1),” and a POSA would understand that molecules of first film precursor P1 constitute non-volatile components. EX1007, 6:39-46 (“**Some molecules of P1 may form a condensed phase atop the substrate surface**, including chemisorbed species and physisorbed

molecules of P1. **The reactor is then evacuated to remove gas phase and physisorbed P1 so that only chemisorbed species remain**”); EX1003, ¶236.

While Dhas does not specify that the composition with non-volatile components includes an organotin (though it mentions organometallics), Cardineau shows organotin precursors react with water components, like hydroxyl groups, to form tin clusters. EX1008, 44, 48. A POSA would have understood that the hydrolysis of Cardineau’s organotin trichlorides would displace a X ligand (chloride), and would have reasonably expected that Cardineau’s precursors would successfully react with water as disclosed in Dhas to provide a non-volatile component that includes an organotin (i.e., “tin clusters”) and a volatile component comprising hydrolysis reaction product with X (chloride) since Cardineau teaches the organotin precursors react with components of water to form tin clusters. EX1003, ¶237.

2. Claim 2

Claim 2 depends on claim 1 and recites “the substrate comprises a **silicon wafer**.” In Dhas, the terms “wafer,” “wafer substrate,” and “partially fabricated integrated circuit” are interchangeable. EX1007, 5:40-42. In Dhas, “‘partially fabricated integrated circuit’ can refer to a **silicon wafer** during any of many stages of integrated circuit fabrication thereon.” *Id.*, 5:42-45; EX1003, ¶238.

3. Claim 3

Claim 3 depends on claim 1 and recites “the inert gas comprises nitrogen or argon.” Dhas discloses that inert gases include argon (Ar): “the chamber clean chemicals include fluorine-containing species, for example NF_3 that may be optionally mixed with **inert gas such as He or Ar.**” *Id.*, 18:64-67; EX1003, ¶239.

4. Claim 4

- a. **“the structure configured to deliver flow comprises an aerosol generator configured to generate an aerosol from a liquid comprising the organotin compound, a vaporization chamber configured to receive an injection of organotin compound, a flash evaporator configured to evaporate the organotin compound, or a bubbler configured for bubbling an inert carrier gas through a liquid comprising the organotin compound”**

Claim 4 depends from claim 1.³ Dhas discloses an aerosol generator or vaporization chamber (heated injection module): “by **atomizing** the liquid reagent...in the **heated injection module**...for delivering the liquid reagent to the reaction chamber...” EX1007, 1:45-49. Dhas also discloses “**a bubbler**” “for vaporizing the liquid reagent” where “carrier gas (e.g., helium or helium mixed with a co-reactant) is bubbled through a container holding the liquid reagent,” and, “[a]s **the bubbles travel through the liquid reagent, some amount of the liquid**

³ Petitioner preserves right to argue indefiniteness of claim 4.

reagent vaporizes and is carried out with the carrier gas.” *Id.*, 19:53-57; EX1003, ¶240.

b. “wherein the deposition on the surface of the substrate comprises chemical vapor deposition.”

Dhas discloses that “in some embodiments, a process station may be switchable between an ALD mode, a CFD mode, and **a CVD process mode.**” EX1007, 24:4-6; EX1003, ¶241.

5. Claim 5

Claim 5 depends on claim 1 and recites that “the second precursor vapor comprises water vapor.” In Dhas, a co-reactant such as oxygen passes through the heated injection module, and Figure 7 represents “a heated injection module 700” used for “deposition using TEOS and a co-reactant such as oxygen. The helium and **optional co-reactant are delivered through conduit 702.**” . *Id.*, 19:27-30. Dhas also discloses that “oxygen-containing co-reactants include...**water**....” *Id.*, 17:61-18:30, EX1003, ¶242.

6. Claim 6

Claim 6 depends on claim 1 and recites “further comprising a flow comprising a third precursor vapor comprising a composition represented by the formula ML_v , where v is $2 \leq v \leq 6$ and L is an oxidizable ligand or a ligand having a hydrolysable M-

L bond or a combination thereof, and M is a metal selected from groups 2-16 of the periodic table.”

In Dhas, “more than one recipe may be used to deposit material on substrates within a single reaction chamber.” EX1007, 2:42-44. Dhas discloses “a method for depositing film on a substrate” that includes the step of “**flowing a second source gas into the reaction chamber...to thereby deposit a second film on the substrate, where the second source gas includes a second reagent that is liquid at room temperature....**” *Id.*, 2:1-14. And Dhas’s deposited film “contains metal.” *Id.*, 17:61. “Metal-containing precursors include...**tetrakis-dimethylamido titanium....**,” *id.*, 18:5-10, which is a compound of formula ML_v , where v is 4, dimethylamido is a ligand having a hydrolysable M-L bond, and M is titanium, which is a metal selected from group 4 of the periodic table. EX1003, ¶244. A POSA would understand that dimethylamido is a dialkylamido⁴. *Id.* Accordingly, Dhas teaches a flow comprising a third precursor vapor (i.e., “second source gas”) comprising a composition represented by the formula ML_v (i.e., “tetrakis-dimethylamido titanium”). *Id.*; EX1003, ¶¶243-244.

⁴ The ’048 patent acknowledges that dialkylamido ligands are suitable for CVD applications. EX1001, 8:60-9:5.

7. Claim 8

Claim 8 depends on claim 1 and recites that “the interior has a pressure from about 0.01 Torr to about 25 Torr.” Dhas discloses that, during the conditioning layer deposition process, **“the reaction chamber pressure will typically be between about 1-10 Torr, for example between about 2-4 Torr.”** *Id.*, 13:59-61; EX1003, ¶245.

8. Claim 9

Claim 9 depends on claim 1 and recites that “the interior has a temperature from about 40° C to about 175° C.”⁵ The lower limit of Dhas’s temperature range (180° C) overlaps with the upper limit of claim 9’s temperature range (“**about** 175 °C”), as 180° C is about 175° C. EX1007, 13:61-63 (“The temperature of the substrate may be maintained between about 180-550° C.”).

Although the disclosed temperature in Dhas of 180°C is slightly above 175°C, a small difference of ±5°C falls within the claim’s “about” qualifier. EX1003, ¶247. Even so, “a prima facie case of obviousness exists where the claimed ranges or amounts do not overlap with the prior art but are merely close. *Titanium Metals Corp. of Am. v. Banner*, 778 F.2d 775, 783 (Fed. Cir. 1985). This is particularly true where “[t]he proportions are so close that prima facie one skilled in the art would

⁵ Petitioner preserves right to argue indefiniteness of claim 9 as a mixed claim type.

have expected them to have the same properties.” *Id.*, 779. A POSA would expect similar properties at 175°C or 180°C (EX1003, ¶247), and the ’048 Patent’s use of “about” supports this reasonable assumption. *Id.*

Moreover, the difference amounts to a routine optimization based on differences in the respective materials used. *Id.*, ¶248; *see In re Aller*, 220 F.2d 454, 456 (CCPA 1955).

Even so, Weidman’s “**chamber or the substrate may be heated to a temperature of less than about 500° C., for example, about 400° C. or less**, such as within a range **from about 50° C. to** about 400° C., and in other embodiments less than about 300° C., less than about 200° C., or **less than about 100°.**” EX1005, 9:20-26. Accordingly, POSA familiar with Weidman would have known to use these lower temperatures. EX1003, ¶¶246-249.

9. Claim 10

Claim 10 depends on claim 1 and recites “comprising a configuration providing for selection of the pressure and/or the temperature in the deposition chamber.” Petitioner refers to the MPF discussion in Section VII.B.

Dhas’s **system controller 950** can adjust parameters that “may relate to process conditions, including “temperature” and “pressure.” including temperature. EX1007, 25:61-65. And Dhas’s “reaction chamber process station 800” has “a process chamber body 802 for maintaining a low-pressure environment.” *Id.*, 19:65-

20:2, Fig. 8. Thus, for Dhas+Cardineau, Dhas discloses this limitation. EX1003, ¶¶250-255.

10. Claim 11

Claim 11 depends on claim 1 and recites “the flow comprises a vapor.”⁶ Dhas discloses that “the instructions may include **flowing a liquid reagent and helium into a heated injection module at certain flow rates to atomize/vaporize the liquid reagent, and flowing the vaporized stream to the reaction chamber.**” *Id.*, 22:63-67. Thus, for Dhas+Cardineau, Dhas discloses the flow from a supply of the inert gas (i.e., “flowing a liquid reagent and helium”) includes a vapor (i.e., “vaporized stream”). EX1003, ¶¶256-257.

11. Claim 12

Claim 12 depends on claim 1 and recites “the structure configured to deliver flow comprises one or more [VIS].”⁷ Petitioner refers to the MPF discussion in Section VII.B.

Dhas’s inlet valves can control the flow of process gases. EX1007, 20:14-16. Dhas’s “reactant delivery system 801 includes a **mixing vessel 804** for blending and/or conditioning process gases **for delivery to showerhead 806,**” and “[o]ne or

⁶ Petitioner preserves right to argue indefiniteness of claim 11.

⁷ Petitioner preserves right to argue indefiniteness of claim 12.

more **mixing vessel inlet valves 820** may control introduction of process gases to **mixing vessel 804.**” *Id.*, 20:14-16. Figure 8 shows that gases can flow from the mixing vessel 804 through valve 805 into process chamber body 802 to showerhead 806 via a conduit. Thus, Dhas discloses this limitation. EX1003, ¶¶258-260.

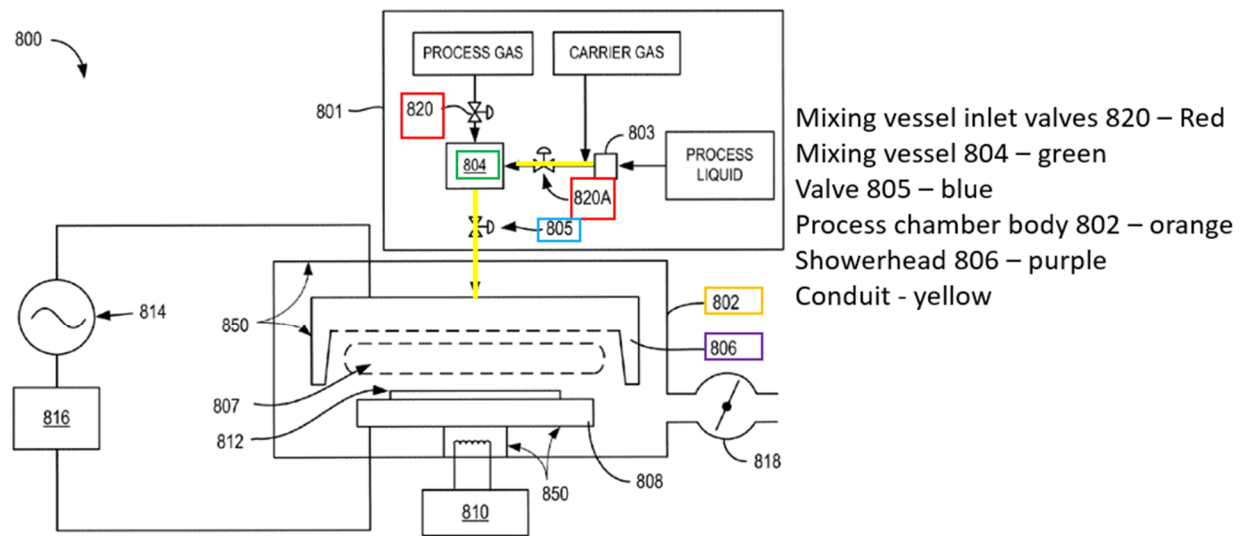


FIG. 8

Id., Figure 8 (annotated).

12. Claim 13

Claim 13 depends on claim 12 and recites “the [VIS] provide for control of the flow.” Petitioner refers to the MPF discussion in Section VII.B.

Dhas’s “[o]ne or more mixing vessel inlet valves 820 may control introduction of process gases to mixing vessel 804,” as shown in Figure 8 below. *Id.*, 20:14-16. Therefore, Dhas’s VIS (i.e., “one or more mixing vessel inlet valves 820”) provide

for control of the flow (i.e., “may control introduction of process gases”). EX1003, ¶¶245.

Additionally, Dhas’s “system 801 includes a **mixing vessel 804** for...process gases **for delivery to showerhead 806**,” and “[o]ne or more **mixing vessel inlet valves 820** may control introduction of process gases to **mixing vessel 804**.” *Id.*, 20:14-16. Figure 8 below shows that gases can flow from vessel 804 through valve 805 into chamber 802 to showerhead 806 via a conduit. EX1003, ¶¶ 261-263.

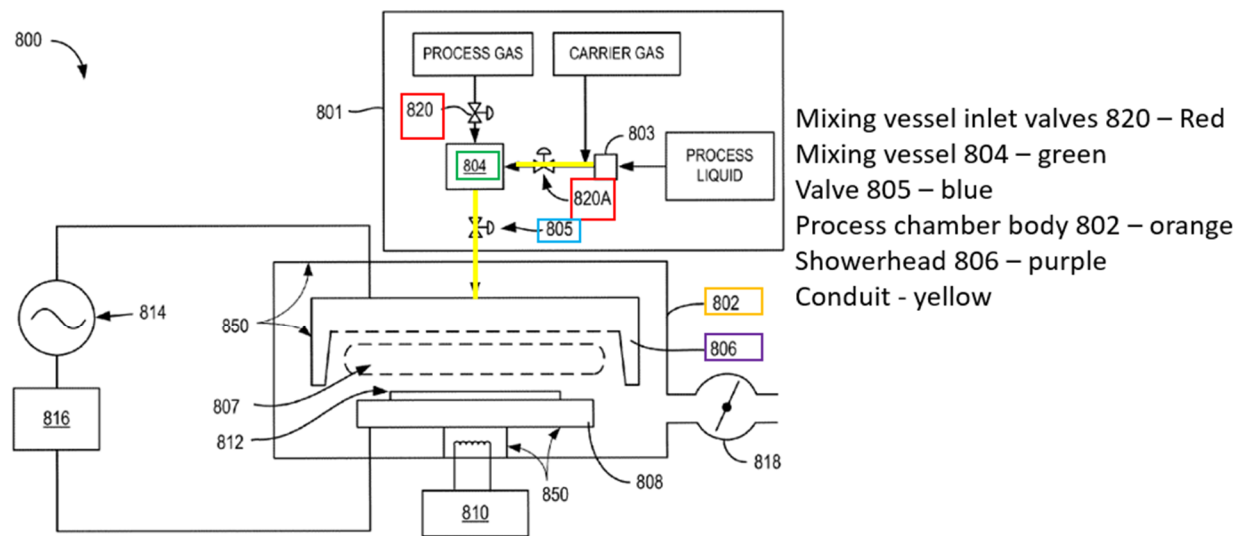


FIG. 8

Id., Figure 8 (annotated).

13. Claim 14

Claim 14 depends on claim 1 and recites “a first [VIS] is configured to deliver a first vapor flow and a second [VIS] is configured to deliver a second vapor flow at the same time.” Petitioner refers to the MPF discussion in Section VII.B.

Dhas’s “[p]rocess station 800” may be operated in CVD mode and has “[o]ne or more mixing vessel inlet valves 820” (i.e., first and second VIS) to “control introduction of process gases to mixing vessel 804,” as shown below. *Id.*, 20:10-16, 24:2-6.

Dhas’s flow of first reactant (first vapor flow) and flow of co-reactant (second vapor flow) are delivered at the same time: “Where a CVD reaction is desired, the first reactant (e.g., TEOS) and optional co-reactant (e.g., oxygen) are flowed into the reaction chamber at least partially at the same time,...” *Id.*, 14:55-65, Figure 5; EX1003, ¶267.

Dhas’s “system 801 includes a **mixing vessel 804** for...gases **for delivery to showerhead 806**...[and] **inlet valves 820** may control introduction of process gases to **mixing vessel 804**.” *Id.*, 20:14-16. Figure 8 shows gases can flow from mixing vessel 804 through valve 805 into process chamber body 802 to showerhead 806 via a conduit. EX1003, ¶¶268; *id.* ¶¶264-268.

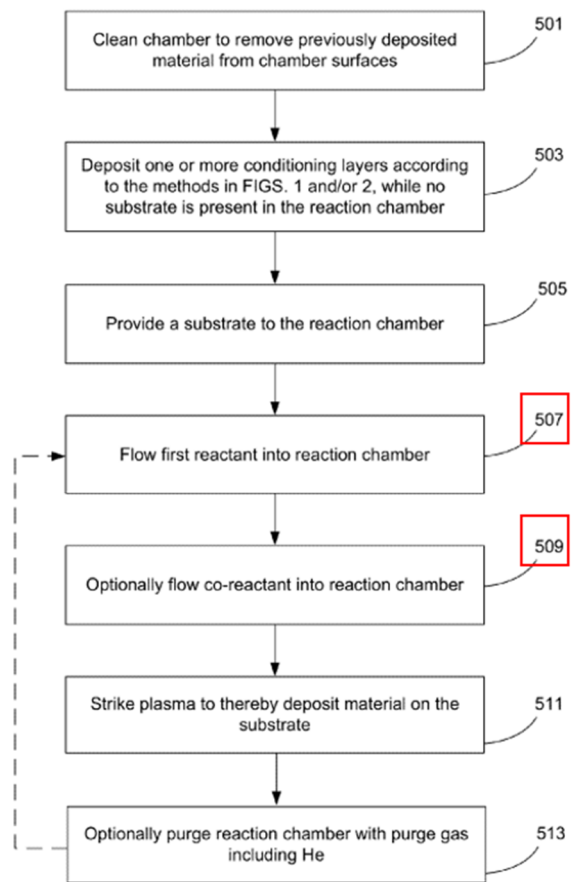


FIG. 5

Id., Figure 5 (annotated).

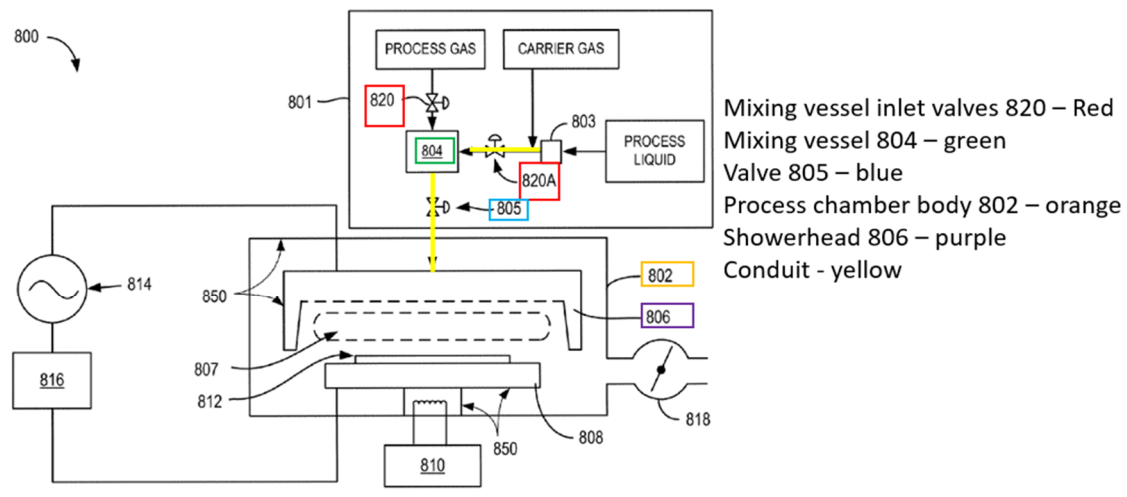


FIG. 8

Id., Figure 8 (annotated).

14. Claim 15

Claim 15 depends on claim 1 and recites “a first [VIS] is configured to deliver a first vapor flow and a second [VIS] is configured to deliver a second vapor flow, wherein the first vapor flow and the second vapor flow are sequential.” Petitioner refers to the MPF discussion in Section VII.B.

Dhas’s “[p]rocess station 800,” which may be operated in ALD mode, has “[o]ne or more mixing vessel inlet valves 802” (a first and second VIS) to “control introduction of process gases to mixing vessel 804,” as shown in Figure 8 below. *Id.*, 20:10-16, 24:4-6.

Dhas’s “reactant delivery system 801 includes a **mixing vessel 804** for blending and/or conditioning process gases **for delivery to showerhead 806**,” and “**mixing vessel inlet valves 820** may control introduction of process gases to **mixing vessel 804**,” as shown in Figure 8 below. *Id.*, 20:14-16. Figure 8 below shows gases can flow from mixing vessel 804 through valve 805 into process chamber body 802 to showerhead 806 via a conduit.

Dhas’s first reactant (first vapor flow) and co-reactant (second vapor flow) are sequential. Where using an ALD reaction, “**operations 507 and 511 occur in a cyclic manner** such that the first reactant is delivered to the reaction chamber in 507 before the plasma is struck at 511,” and “**in operation 509 the co-reactant may be**

provided in a cyclic manner....” *Id.*, 14:65-15:7, Figure 5; *see also* EX1003, ¶¶269-272.

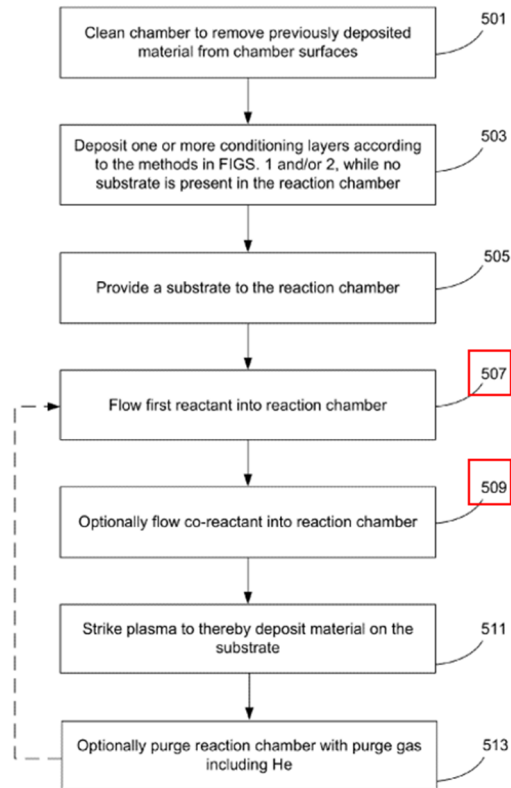


FIG. 5

Id., Figure 5 (annotated)

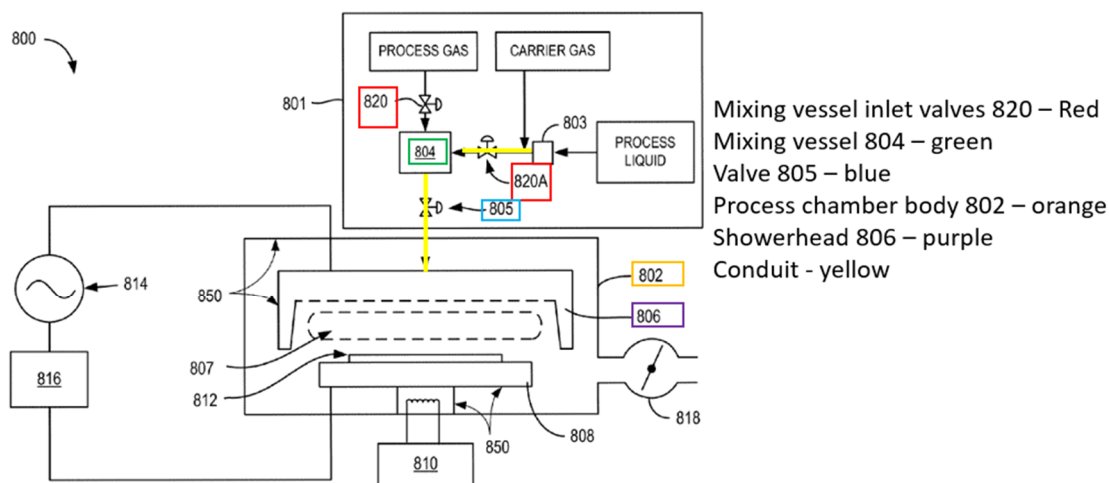


FIG. 8

Id., Figure 8 (annotated).

15. Claim 16

Claim 16 depends on claim 1 and recites “a first VIS is configured to deliver a first vapor flow and a second VIS is configured to deliver a second vapor flow, wherein the first vapor flow, the second vapor flow, and a third vapor flow are sequential.” Petitioner refers to the MPF discussion in Section VII.B.

Dhas’s “[p]rocess station 800” has “[o]ne or more mixing vessel inlet valves 820” (i.e., first and second VIS) to “**control introduction of process gases to mixing vessel 804,**” as shown in Figure 8 below. EX1007, 20:10-16.

Dhas’s “reactant delivery system 801 includes a **mixing vessel 804** for blending and/or conditioning process gases **for delivery to showerhead 806.** One or more **mixing vessel inlet valves 820** may control introduction of process gases to **mixing vessel 804,**” as shown in Figure 8 below. *Id.*, 20:14-16. Figure 8 shows

gases can flow from mixing vessel 804 through valve 805 into process chamber body 802 to showerhead 806 via a conduit. EX1003, ¶275.

Dhas discloses a third source gas (i.e, third vapor flow): “before providing a substrate to the reaction chamber, **flowing a third source gas** including a third reagent and helium into the reaction chamber and exposing the reaction chamber to a third plasma to thereby deposit a third film on surfaces of the reaction chamber while no substrate is present in the reaction chamber...” EX1007, 2:1-14.

Dhas’s flow of first reactant (first vapor flow) and flow of co-reactant (second vapor flow) are sequential, as discussed for the preceding claim. *Id.*, 14:65-15:7; *id.*, Fig. 5, 24:2-6. A POSA would understand that first vapor flow (flow of first reactant), the second vapor flow (flow of co-reactant), and the third vapor flow (i.e., “the third source gas”), are sequential. EX1003, ¶¶273-277.

A POSA would also understand that there are a limited number of obvious choices of continuous or alternating delivery methods, which would have been obvious-to-try. *Id.*, ¶278.

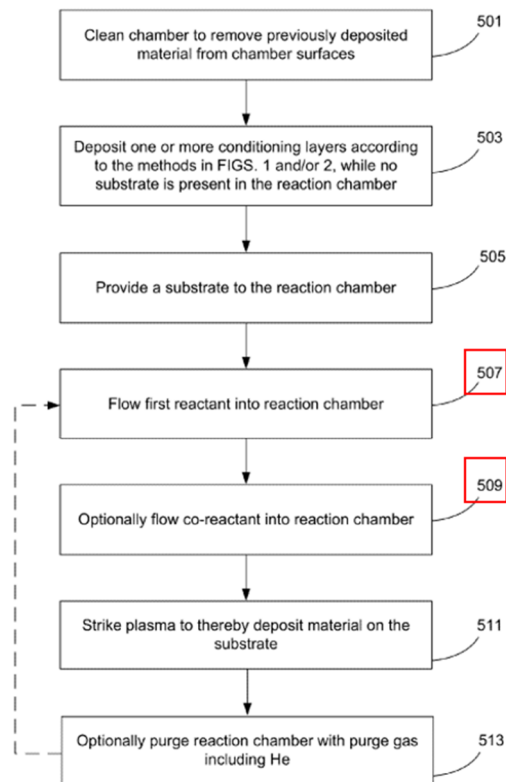


FIG. 5

Id., Figure 5 (annotated)

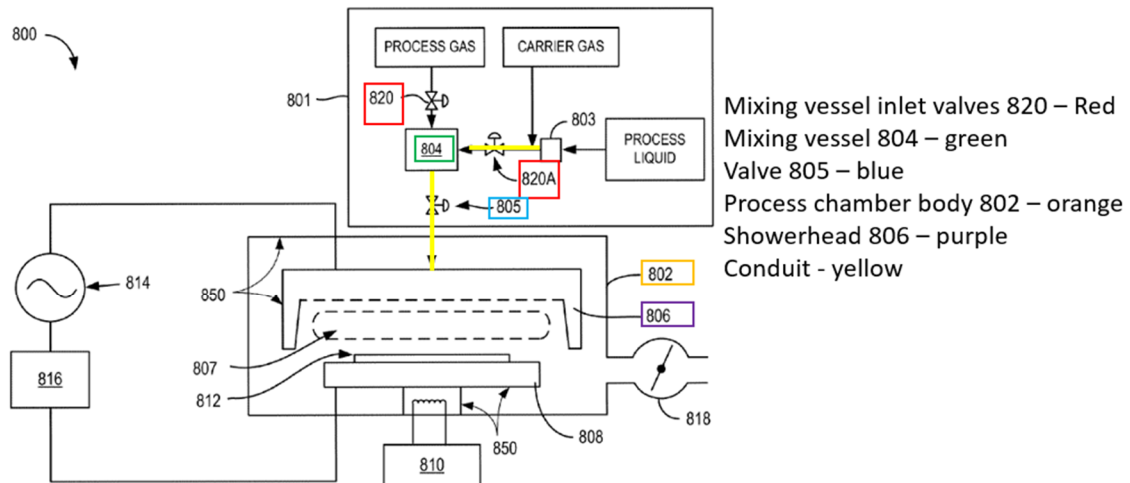


FIG. 8

Id., Figure 8 (annotated).

16. Claim 17

Claim 17 depends on claim 1 and recites “a first [VIS] is configured to deliver a first vapor flow and a second [VIS] is configured to deliver a second vapor flow, wherein the first vapor flow and the second vapor flow are at the same time and a third vapor flow is sequential.” Petitioner refers to the MPF discussion in Section VII.B.

Dhas’s “[p]rocess station 800 fluidly communicates with reactant delivery system 801 for delivering process gases to a distribution showerhead 806,” and “[o]ne or more mixing vessel valves 820 [i.e., a first vapor inputting structure and a second vapor inputting structure] may control introduction of process gases to mixing vessel 804,” as shown below. EX1007, 20:10-16.

Dhas’s “reactant delivery system 801 includes a mixing vessel 804 for blending and/or conditioning process gases for delivery to showerhead 806,” and “mixing vessel inlet valves 820 may control introduction of process gases to mixing vessel 804,” as shown below. *Id.*, 20:14-16. Figure 8 shows gases flow from vessel 804 through valve 805 into chamber 802 to showerhead 806 via a conduit. EX1003, ¶280.

Dhas discloses a third vapor flow: “flowing a third source gas including a third reagent and helium into the reaction chamber and exposing the reaction

chamber to a third plasma to thereby deposit a third film on surfaces of the reaction chamber while no substrate is present in the reaction chamber....” EX1007, 2:1-14.

Dhas’s flow of first reactant (first vapor flow) and flow of co-reactant (second vapor flow) are delivered at the same time using CVD: “first reactant (e.g., TEOS) and optional co-reactant (e.g., oxygen) are flowed into the reaction chamber...**at the same time....**” *Id.*, 14:55-65, Figure 5. Dhas’s “**processing station may be switchable between an ALD mode...and a CVD process mode.**” *Id.*, 24:2-6. Accordingly, a POSA would understand that the first vapor flow (flow of first reactant) and the second vapor flow (flow of co-reactant) are at the same time, and the third vapor flow (i.e., “third source gas”) is sequential. EX1003, ¶¶279-283.

A POSA would also understand that there are a limited number of obvious choices of continuous or alternating deliver methods, which would have been obvious-to-try. *Id.*, ¶284.

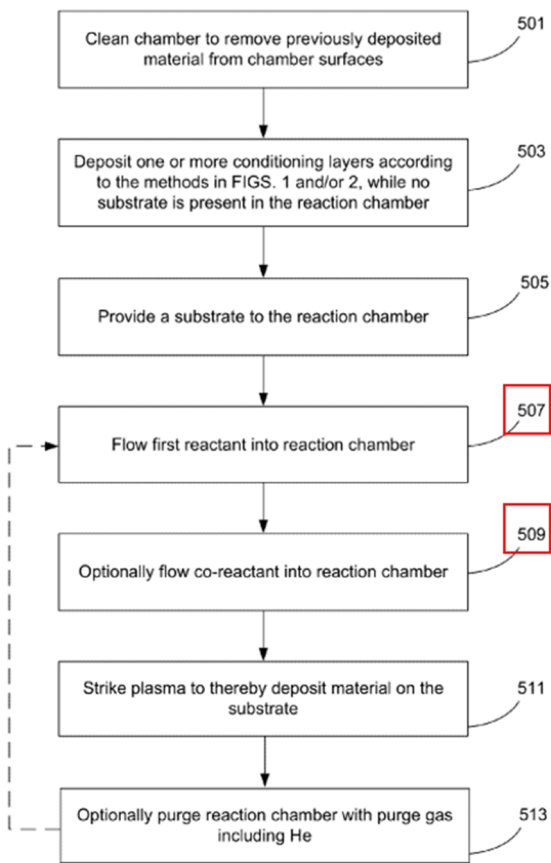


FIG. 5

Id., Figure 5 (annotated)

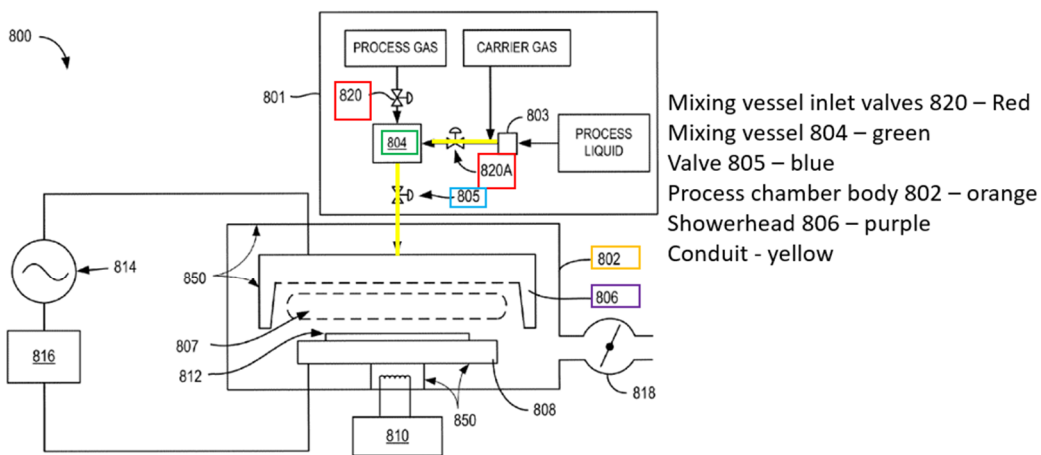


FIG. 8

Id., Figure 8 (annotated).

17. Claim 18

Claim 18 depends on claim 1 and recites “the interior has a temperature from about 45° C. to about 200° C.” Dhas’s substrate temperature “may be maintained between about 180-550°C,” which overlaps with the claimed temperature. *Id.*, 17:12-13. And a “reference that discloses an overlapping but different range than the claimed range can be anticipatory, even where the prior art range only partially or slightly overlaps with the claimed range.” *Genentech, Inc. v. Hospira, Inc.*, 946 F.3d 1333, 1338 (Fed. Cir. 2020). There is no evidence of claim 18’s range is critical to the claimed invention’s operability. *Id.*; *see* EX1003, ¶285.

18. Claim 19

Claim 19 depends on claim 1 and recites “X is alkylamido or dialkylamido.” Although Dhas does not specifically disclose organotin precursors that include alkylamido substituents, Dhas discloses metal precursors that include alkylamido substituents. EX1007, 17:65-18:1. Cardineau uses tin compounds for EUV photoresists given tin’s higher EUV absorbance, resulting in “superior lithographic performance...better sensitivity and lower shot noise.” EX1008, 45.

A POSA would have been motivated to use Cardineau’s organotin with Dhas’s alkylamido ligand in Dhas’s apparatus because Das teaches that precursors can include alkylamido ligands, and to use tin precursors to achieve Cardineau’s benefits. EX1003, ¶¶286-288.

19. Claim 20

Claim 20 depends on claim 1 and recites “X is alkoxo and aryloxo.” Although Dhas does not specifically disclose organotin precursors that include alkoxo substituents, Dhas discloses metal precursors that include alkoxide (alkoxo) substituents. EX1007, 17:65-18:1.

Cardineau uses tin compounds for EUV photoresists given tin’s higher EUV absorbance and superior lithographic performance. EX1008, 45.

A POSA would have been motivated to use an organotin with Cardineau’s alkoxo ligand in Dhas’s apparatus because Dhas teaches that precursors can include tin and alkoxo ligands, and to use tin precursors to achieve superior lithographic performance, improved sensitivity and lower shot noise of films as Cardineau discloses. EX1003, ¶¶289-291.

F. Ground 2: Claim 7 is Obvious Over Dhas, Cardineau, and Molloy

1. Claim 7

Claim 7, which depends on claim 6, recites that “the third precursor vapor comprises SnL_4 .”

Dhas+Cardineau+Molloy disclose each limitation of claims 1 and 6 for the reasons discussed above for Ground 4, which are expressly incorporated here.

Dhas+Cardineau+Molloy further disclose “the third precursor vapor comprises SnL_4 .” In Dhas, “more than one recipe may be used to deposit material

on substrates within a single reaction chamber.” EX1007, 2:42:44. And Dhas’s second source gas includes a second reagent for depositing a film on a substrate: **“flowing a second source gas into the reaction chamber and exposing the reaction chamber to a second plasma to thereby deposit a second film on the substrate, where the second source gas includes a second reagent that is liquid at room temperature...”** *Id.*, 2:1-14.

Although neither Dhas nor Cardineau disclose a compound of formula SnL_4 , a POSA would have known that compounds of formula SnL_4 were being used as precursors in vapor deposition techniques and would have had an expectation that the compositions of formula SnL_4 would successfully be included in a third precursor vapor. EX1003, ¶295. Molloy discloses organotin compounds for CVD purposes, including SnCl_4 a “precursor of choice” that provide films with desirable properties produced with high deposition rates and deposition temperatures as low as 30°C. EX1009, 549-550.

A POSA would understand the formula SnL_4 represents composition SnMe_4 , where M is tin (Sn; group 14 of the periodic table), v is 4, and L is methyl (Me), which is a ligand having a hydrolysable M-L bond. EX1003, ¶297.

A POSA would appreciate that the references are analogous art, and would have been motivated to combine them because Molloy teaches organometallic (e.g. organotin) precursors. EX1003, ¶¶292-298. A POSA would have been motivated to

select SnMe_4 (i.e., compound of formula SnL_4) for inclusion in the third vapor precursor to obtain a film with the desirable properties described by Molloy. *Id.* Finally, a POSA would have reasonably expected Molloy's precursors to successfully form a film using Dhas's apparatus since Molloy teaches that SnMe_4 is a precursor for vapor deposition ⁸ *Id.*

G. Ground 3: Claims 1-5 And 8-20 Are Obvious Over Weidman and Cardineau.

1. Claim 1

a. Preamble: "system comprising"

Weidman discloses "an apparatus for deposition of a film on a substrate," which is a system. EX1005, 8:41-42. Cardineau also discloses methods of preparing photoresists by spincoating organotin onto substrates. EX1008, 48; EX1003, ¶299.

b. "deposition chamber having an interior isolated from the ambient atmosphere"

⁸ As claim 6 does not require any timing or temporal requirements, the third precursor vapor could be introduced at the same time as the first precursor vapor and/or second precursor vapor or in a subsequent step. If introduced in a subsequent step, an intervening purge step would be administered and so the third precursor vapor would not affect any reaction between components of the first precursor vapor and second precursor vapor.

Weidman's "processing chamber or...**deposition chamber** may be pressurized at a pressure within a range from about 0.01 Torr to about 100 Torr." EX1005, 9:16-18. Weidman's "**chamber** or the substrate may be heated...." *Id.* 9:21-22. Because the deposition chamber may be heated and/or pressurized, a POSA would understand that the chamber is "isolated from the ambient atmosphere." EX1003, ¶300.

c. "**substrate within the interior of the deposition chamber configured to receive a deposition on a surface of the substrate**"

Weidman's "apparatus comprises a deposition chamber for atomic layer deposition on a film on a **substrate**," and "[t]he chamber comprises a process area for supporting a **substrate**." EX1005, 8:41-46. Weidman's "apparatus includes a first precursor inlet in fluid communication with a supply of a first precursor," *id.*, 8:47-49, and "[a] supply of a second precursor containing reactive, moieties cross-linkable with the substituents in the first precursor," *id.*, 8:52-56. According to Weidman, "[t]he apparatus include a radiation source or can be connected to a second apparatus for exposing the **deposited layer** radiation selected from EUV, far UV. X-ray and e-beam radiation such that upon exposure to the radiation, reactive, cross-linkable moieties present in the first precursor and second precursor in the **deposited layer** remain partially unreacted and soluble to developer solution." *Id.*,

8:63-9:3. Figure 1A (below) “shows substrate 100 with a deposited layer 110 on the substrate, formed by one or more ALD cycles.” *Id.*, 13:36-37; EX1003, ¶301.



d. “the substrate is maintained at a temperature of less than 200° C”

Weidman’s “chamber or...**substrate** may be **heated** to a temperature of ...**less than about 200° C**, or less than about 100°.” *Id.*, 9:21-26; EX1003, ¶302.

e. “an inlet into the deposition chamber”

Weidman’s “apparatus includes a first precursor inlet in fluid communication with a supply of a first precursor containing substituents with cross-linkable moieties,” *id.*, 8:47-49, and “[a] supply of a second precursor containing reactive, moieties cross-linkable with the substituents in the first precursor may be in fluid communication with the **first precursor gas inlet** or a separate **second precursor gas inlet**,” *id.*, 8:52-56. “The apparatus includes a **reactant gas inlet** in fluid communication with a supply of a reactant gas....” *Id.*, 8:49-52; EX1003, ¶303.

f. “structure configured to deliver flow from a supply of an inert gas”

Petitioner refers to the MPF discussion in Section VII.B.

Weidman's "processing chamber would include separate supplies of the A, B, and C reactants, along with a supply of carrier, purge **and inert gases** such as argon and nitrogen in fluid communication with gas inlets for each of the reactants and gases." EX1005, 8:48-52.

Weidman discloses an apparatus for performing vapor deposition that includes one or more inlets into the deposition chamber, *id.*, 8:47-61, and that "the various gases for the process may be pulsed into **an inlet** through a **gas channel**, from various holes or **outlets**, and into a **central channel**." *Id.*, 8:16-20. "Each inlet may be controlled by an appropriate **flow controller**...in communication with a central processing unit (CPU) that allows flow of each of the reactants to the substrate to perform a[n] ALD process." *Id.*, 7:53-56. And Weidman's "processing chamber would include separate supplies of the A, B, and C reactants, along with a **supply of** carrier, purge and **inert gases** such as **argon** and nitrogen in fluid communication with gas inlets for each of the reactants and gases" where "[t]he substrate...can be exposed to a metal-containing 'A' precursor gas or vapor formed by passing a **carrier gas** (for example, nitrogen or **argon**) through an ampoule of the precursor...can be delivered at any suitable flow rate..." EX1005, 11:66-12:6. Thus, Weidman discloses conduits like gas channels, outlets, central channels and conduits through flow controllers to supply an inert carrier gas to a vessel, e.g., from the source of the precursor. And Weidman+Cardineau discloses the claimed

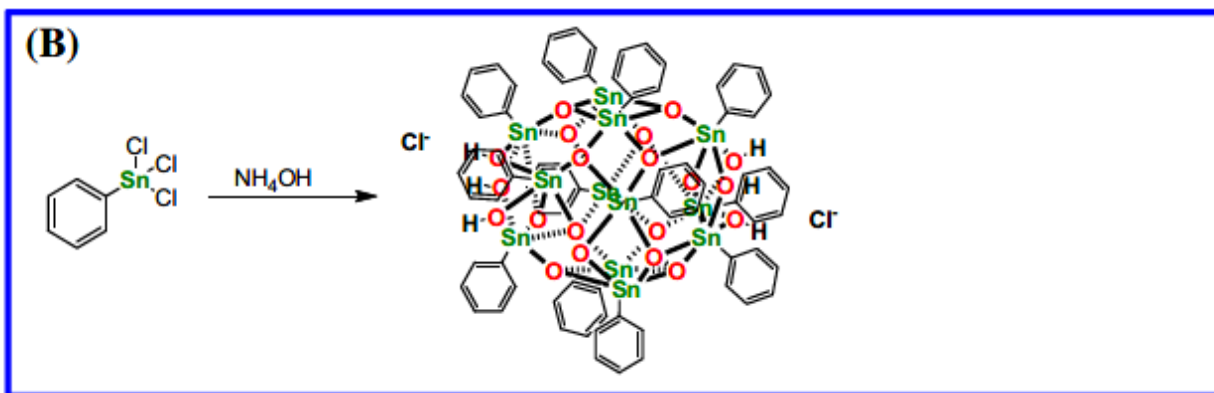
“structure [e.g., Weidman’s gas channels etc.] configured to deliver flow from a supply of an inert gas.” EX1003, ¶304-307.

- g. “a supply of an organotin composition comprising a compound described by the formula RSnX_3 , where R is an organic ligand with 1-31 carbon atoms and is bound to Sn with a metal-carbon bond”**

Weidman’s apparatus includes supplies of “A, B, and C reactants,” *id.*, 8:48-52, and “A” reactants can include a “metal oxide precursor,” *id.*, 9:29-31. Weidman’s “A” precursor includes a metal that is bonded to at least one substituent (i.e., chemical group): “Non-limiting examples of ‘A’ precursors include **volatile metal-containing compounds**, for example, compounds of silicon **or other main group or transition metals** bonded to at least one substituent which will be readily displaced upon reaction with surface bond species....” *Id.*, 9:44-57. And Weidman’s examples of substituents include “vinyl” or “alkyl” groups (i.e., “organic ligands”). *Id.* 3:29-33. And the metals may include tin. *Id.* 4:48-51.

Although Weidman discloses using tin precursors, it does not disclose that the “A” precursor is an organotin composition comprising a compound described by the formula RSnX_3 . Cardineau, however, uses tin compounds for EUV photoresists given tin’s higher EUV absorbance, resulting in superior lithographic performance, better sensitivity, and lower shot noise. EX1008, 45; EX1003, ¶308-309.

Cardineau's tin-oxo clusters are prepared from the organotin trichlorides "[a]llyltin trichloride," "[b]utyltin trichloride," and "[p]henyltin trichloride." *Id.*, 49. These are compounds "represented by the formula $R\text{SnX}_3$ wherein R is an organic ligand with 1-31 carbon atoms bound to Sn with a metal-carbon bond" and X is Chloro (Cl). *Id.*, 44 ("the synthesis and lithographic evaluation of thin films of tin-oxo clusters ($[(R\text{Sn})_{12}\text{O}_{14}(\text{OH})_6]\text{X}_2$, Fig. 1A) using extreme ultraviolet light (EUV, 13.5 nm).").



Id., 48.

A POSA would have been motivated to combine the references as related to the same subject matter as the '048 Patent—i.e., preparation of photoresists. EX1003, ¶311. A POSA would have been motivated to use Cardineau's precursors in Weidman's apparatus to achieve superior lithographic performance, improved sensitivity and lower shot noise of films as Cardineau discloses. *Id.*; EX1008, 45.

Although Cardineau discloses depositing the precursor compounds using spin coating, Weidman discloses that using a vapor deposition apparatus provides more reliable coating compared to spin-coating. EX1005, 4:64-5:11 (“**According to embodiments of the invention, “dry” deposition techniques such as Atomic Layer Deposition (ALD) provide the unique ability to assemble a film with not only atomic layer control of thickness but also the placement of reactive functionality that can survive the (mild) deposition conditions and create developer solubility (e.g., reactivity with aqueous developers) together with high sensitivity to EUV (and other radiation such as far UV, DUV and electron beam) involving cross-linking with the loss of solubility, thus allowing patterns to be developed.**”); *see also id.* 5:27-32. Thus, a POSA would have been motivated to use Cardineau’s precursors as the “supply of the precursors” in Weidman’s apparatus for more reliable coating. EX1003, ¶312.

A POSA would have reasonably expected Cardineau’s precursors to successfully form a photoresist layer in Weidman’s apparatus. *Id.*, ¶313. Cardineau teaches the organotin precursors react with components of water such as hydroxyl groups (i.e., are hydrolysable) to form tin clusters. EX1008, 44 , 48. And Weidman teaches water as a reactant. EX1005, 10:1-3 (“examples of ‘B’ reactants include ozone, H_2O , H_2O_2”); EX1003, ¶¶308-313

h. X Group Limitation

Although Weidman does not disclose organotins with alkoxo substituents, Weidman discloses that the precursor compounds can include metals with an alkoxo (alkoxide) substituent. EX1005, 18:16-22 (“the use of...alkoxides...as metal precursors”), 3:29-33 (“a silicon oxide based precursor containing one or more of...**alkoxides**,...which hydrolyze on exposure to water to form silanol substituents....” Weidman also discloses that “[s]pecific materials...include but are not limited to...**tin**....” *Id.*, 4:48-51.

Cardineau using tin compounds for EUV photoresists given tin’s higher EUV absorbance. Cardineau explains: “tin and oxygen readily absorb EUV photons with optical densities that are 10.5 and 1.7 times greater than carbon” such that “these higher optical densities should allow resists based on these tin-oxo clusters to better utilize the EUV photons that are used in EUV lithography to provide superior lithographic performance based on more efficient utilization of the EUV photons to give better sensitivity and lower shot noise.” EX1008, 45.

Cardineau also discloses organotins having ligands X that are alkoxo groups (alkoxo is —OR, where R is an alkyl group with 1-10 carbon atoms): “[t]in clusters have been synthesized by...the controlled hydration of butyltin trichloride, **butyltin trialkoxide** or butyltin trialkyne.” *Id.*, 47 (citations omitted). A POSA would have been motivated to use an organotin with an alkoxo ligand of Cardineau in Weidman’s

apparatus because Weidman teaches that precursors can include tin and alkoxo ligands, and in to order to achieve the improved EUV absorbance from tin compounds as Cardineau discloses. EX1003, ¶¶34-316.

- i. **“structure configured to deliver flow of a first precursor vapor from the supply of the organotin compound with the inert gas as a carrier gas to the inlet”**

Petitioner incorporates the MPF discussion from Section VII.B.

Weidman’s apparatus includes one or more inlets into the deposition chamber, EX1005, 8:47-61, and “the various gases...may be pulsed into an inlet through a **gas channel**, from various holes or outlets, and into a central channel.” *Id.*, 8:16-20. Weidman describes “[p]urge and inert gases such as argon and nitrogen in fluid communication with gas inlets for each of the reactants and gases,” and notes that “[e]ach inlet may be controlled by an appropriate flow controller...in communication with a central processing unit (CPU) that allows flow of each of the reactants to the substrate...” EX1005, 7:48-57. Weidman’s chamber has “separate supplies of the **A, B, and C reactants**, along with a **supply of carrier, purge and inert gases**...in fluid communication with gas inlets for each of the reactants and gases,” and “[t]he substrate...can be exposed to a metal-containing **“A” precursor** gas or vapor formed by passing a carrier gas...through an ampoule of the precursor...can be delivered at any suitable flow rate...” *Id.*, 11:65-12:2. Thus, Weidman discloses conduits like

gas channels, outlets, central channels, and conduits through flow controllers to supply precursor gases to the chamber. EX1003, ¶¶317-321. Thus, Weidman+Cardineau discloses structure (e.g., gas channels etc.) to deliver a first precursor vapor (e.g., Precursor A) from the supply of the organotin compound (e.g., the ampoule) with the inert gas as a carrier gas (e.g., argon) to the inlet. *Id.*

j. “to provide for formation of an organotin layer on the substrate surface within the deposition chamber”

Weidman discloses “‘A’ precursors includ[ing] **volatile metal-containing compounds**, for example, compounds of...**transition metals bonded to at least one substituent** which will be readily displaced upon reaction with surface bond species such as a hydroxyl group **such that the substituent originally on the precursor is lost as a volatile compound and the metal atom together with its remaining substituents become bonded to the surface.**” EX1005, 9:44-57. Weidman also discloses that “[t]he **flow of the “A” precursor gas** is stopped once the **metal-containing precursor has adsorbed onto all reactive surface moieties on the substrate surface.**” *Id.* 12:11-13. Weidman’s deposition chamber (“processing chamber”) includes a “substrate.” *Id.* 7:46-48. Weidman discloses the metals can include tin. *Id.* 4:48-51. Similarly, Cardineau discloses tin precursors for use as EUV photoresists having higher optical densities than carbon, and that form resists “to provide superior lithographic performance based on more efficient utilization of

the EUV photons to give better sensitivity and lower shot noise.” EX1008, 45. A POSA would have been motivated to use Cardineau’s tin precursors in Weidman’s apparatus to produce resists with improved sensitivity and lower shot noise. EX1003, ¶322.

Weidman+Cardineau therefore teaches the formation of an organotin layer on the substrate surface (i.e., metal-containing precursor has adsorbed onto all reactive surface moieties on the substrate surface”) within the deposition chamber (i.e., “processing chamber”). *Id.*

- k. **“structure to deliver a second precursor vapor comprising water, hydrogen peroxide or a combination thereof capable of reacting with the composition in the first precursor vapor”**

Petitioner refers to the MPF discussion in Section VII.B.

Weidman’s apparatus for performing vapor deposition includes one or more inlets into the deposition chamber, EX1005, 8:47-61, and “the various gases for the process may be pulsed into an inlet through a **gas channel**, from various holes or outlets, and into a central channel.” *Id.*, 8:16-20. Weidman’s apparatus includes supplies of A, B, and C reactants, where B reactant includes water or hydrogen peroxide. EX1005, 5:55-65, 8:48-52, 10:1-10, 16:4-7. Weidman’s B reactant is delivered to the substrate by passing a gas through an ampoule (*i.e.*, a structure configured to deliver a second precursor vapor). *Id.*, 12:38-41.

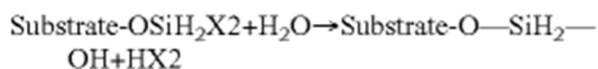
Although Weidman does not specifically disclose the reaction of water, hydrogen peroxide, or a combination thereof, with the organotin composition in the first precursor vapor, Cardineau teaches that the organotin precursors react with components of water such as hydroxyl groups (i.e. are hydrolysable) to form tin clusters. EX1008, 44 (), 48. Accordingly, a POSA would have reasonably expected Cardineau's precursors to successfully react with a second precursor vapor comprising water as disclosed in Weidman since Cardineau teaches that the organotin precursors react with components of water to form tin clusters. EX1003, ¶327.

Thus, Weidman+Cardineau discloses a structure (e.g., gas channels etc.) to deliver a second precursor vapor comprising water, hydrogen peroxide or a combination thereof capable of reacting with the composition in the first precursor vapor. *Id.*

I. “under conditions in the deposition chamber to form a composition with non-volatile components and a volatile component comprising hydrolysis reaction product with X”

Weidman discloses that “an ‘A’ precursor can be for example a volatile Hf or W alkoxide precursor coupled with a ‘B’ reactant such as ozone, H₂O, H₂O₂, a mixture of H₂O/H₂O₂, or some other EUV sensitive bridging ligand.” EX1005, 16:4-7. Per Weidman, “[n]on-limiting examples of ‘A’ precursors include volatile metal-

containing compounds, for example, compounds of silicon or other main group or transition metals bonded to at least one substituent which will be readily displaced upon reaction with surface bond species such as a hydroxyl group **such that the substituent originally on the precursor is lost as a volatile compound and the metal atom together with its remaining substituents become bonded to the surface.**” *Id.*, 9:44-57. And “[n]on-limiting examples of ‘B’ reactants include ozone, H₂O, H₂O₂,...” *Id.*, 10:1-5. As Weidman explains, “if B is simply water vapor, reaction with the remaining substituent X₂...can result in the formation of an Si—OH moiety with loss of a volatile byproduct HX₂.” *Id.*, 10:5-10.



Id., 10:12-13.

From this, a POSITA would understand Weidman to disclose, under conditions in the deposition chamber to form a composition with non-volatile components (i.e., “the metal atom together with its remaining substituents become bonded to the surface”) and a volatile component (i.e., “the substituent originally on the precursor is lost as a volatile compound”) comprising hydrolysis reaction product with X (i.e., “if B is simply water vapor, reaction with the remaining substituent X₂....can result in the formation of an Si—OH moiety with loss of a volatile byproduct HX₂). EX1003, ¶¶ 329-332.

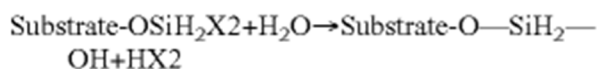
Although Weidman does not specifically disclose that the composition includes an organotin, Cardineau teaches that the organotin precursors react with components of water (such as hydroxyl groups) (i.e. are hydrolysable) to form tin clusters. *See* EX1008, 44, 48.

Accordingly, a POSA would have understood that the hydrolysis of Cardineau's organotin trichlorides would displace a X ligand (chloride), and would have reasonably expected Cardineau's precursors to successfully react with water per Weidman to provide a non-volatile component that includes an organotin (i.e., "tin clusters") and a volatile component comprising hydrolysis reaction product with X (chloride). EX1003 at ¶¶331-332.

m. **"wherein the substrate is configured with a surface to receive the non-volatile components of the composition."**

Weidman's "B" reactant reacts with the "A" precursor with loss of the volatile HX₂ byproduct. Weidman discloses that "[n]on-limiting examples of 'A' precursors include volatile metal-containing compounds, for example,...transition metals **bonded to at least one substituent which will be readily displaced upon reaction with surface bond species such as a hydroxyl group** such that the substituent originally on the precursor is lost as a volatile compound and the metal atom together with its remaining substituents become bonded to the surface." *Id.*, 9:44-57. And "[n]on-limiting examples of 'B' reactants include ozone, H₂O, H₂O₂..." *Id.*, 10:1-5.

“[I]f B is simply water vapor, reaction with the remaining substituent X₂ still attached to the silicon atom (already bonded to the surface as a result of its exposure to reactant ‘A’ in the previous step can result in the formation of an Si—OH moiety with loss of a volatile byproduct HX₂.” *Id.*, 10:5-10.



Id., 10:12-13,

A POSA would understand that the substrate receives the non-volatile components (i.e., not the volatile HX₂ byproduct). EX1003, ¶¶ 333-334.

Although Weidman does not disclose that the non-volatile components includes an organotin, Cardineau’s organotin precursors react with components of water such as hydroxyl groups (i.e. are hydrolysable) to form tin clusters to produce non-volatile components. *See* EX1008, 48. Accordingly, a POSA would have had a reasonable expectation that Cardineau’s precursors would successfully react with water as disclosed in Weidman to provide a non-volatile component that includes an organotin (i.e., “tin clusters”). EX1003 at ¶335.

2. Claim 2

Claim 2 depends on claim 1 and recites that “the substrate comprises a **silicon wafer**.” Weidman discloses that “[s]ubstrates on which embodiments of the invention may be useful include, but are not limited to semiconductor wafers, such

as crystalline silicon (e.g., Si<100> or Si<111>), silicon oxide, strained silicon, silicon germanium,...doped or undoped silicon wafers....” EX1005, 7:32-37; EX1003, ¶336.

3. Claim 3

Claim 3 depends on claim 1 and recites that “the inert gas comprises nitrogen or argon.” Weidman’s apparatus includes a supply of inert gases (e.g., argon and nitrogen) and an inlet to supply them to the deposition chamber. EX1005, 8:48-52; EX1003, ¶337.

4. Claim 4

- a. **“the structure configured to deliver flow comprises an aerosol generator configured to generate an aerosol from a liquid comprising the organotin compound, a vaporization chamber configured to receive an injection of organotin compound, a flash evaporator configured to evaporate the organotin compound, or a bubbler configured for bubbling an inert carrier gas through a liquid comprising the organotin compound”**

Claim 4 depends from claim 1.⁹ Weidman discloses the delivery of precursors using a carrier gas through a heated ampoule. EX1005, 11:65-12:2, 12:37-40. A POSA would know that passing a carrier gas through a heated ampoule—which is

⁹ Petitioner preserves right to argue indefiniteness of claim 4.

in effect a bubbler or vaporization chamber—is a common method for generating a reactant gas from a liquid. EX1003 at ¶338.

b. “wherein the deposition on the surface of the substrate comprises chemical vapor deposition.”

Weidman discloses a chamber that operates in both CVD and ALD modes to deposit resists. EX1005, 9:12-14; EX1003, ¶339.

5. Claim 5

Claim 5 depends on claim 1 and recites “the second precursor vapor comprises water vapor.” Weidman discloses water vapor as a “B” reactant. EX1005, 5:55-62; EX1003, ¶340.

6. Claim 8

Claim 8 depends on claim 1 and recites that “the interior has a **pressure from about 0.01 Torr to about 25 Torr.**” Weidman’s chamber “may be pressurized at a pressure within a range **from about 0.01 Torr to about 100 Torr....**” EX1005, 9:16-9:20; EX1003, ¶341.

7. Claim 9

Claim 9 depends on claim 1 and recites “the interior has a temperature from about 40° C. to about 175° C.”¹⁰ Weidman discloses “**the chamber or the substrate**

¹⁰ Petitioner preserves right to argue indefiniteness of claim 9 as a mixed claim type.

may be heated to a temperature...from about 50° C. to about 400° C....or less than about 100°.” EX1005, 9:20-26; EX1003, ¶342.

8. Claim 10

Claim 10 depends on claim 1 and recites “a **configuration** providing for selection of the pressure and/or the temperature...” Petitioner refers to the MPF discussion in Section VII.B.

Weidman’s “**substrate temperature and chemistry can be selected specifically...**” EX1005, 15:56-61; EX1003, ¶¶343-344. And Weidman’s CPU “**allows flow of each of the reactants to the substrate**” in the deposition chamber. EX1005, 7:52-57. A POSA would understand that the flow controller can select pressure by controlling reactant flow, and that the CPU could control the flow controllers and temperature. EX1003, ¶¶345-346.

9. Claim 11

Claim 11 depends on claim 1 and recites “the flow comprises a vapor.”¹¹ Weidman discloses that “[t]he substrate having active sites can be exposed to a **metal-containing “A” precursor gas or vapor formed by passing a carrier gas (for example, nitrogen or argon) through an ampoule of the precursor....**”

¹¹ Petitioner preserves right to argue indefiniteness of claim 11.

EX1005, 11:65-12:1. Weidman therefore discloses that the flow (i.e. “carrier gas”) comprises a vapor (i.e., “A” precursor vapor). EX1003, ¶347.

10. Claim 12

Claim 12 depends on claim 1 and recites “the structure configured to deliver flow comprises **one or more vapor inputting structures**.”¹² Petitioner refers to the MPF discussion in Section VII.B.

Weidman discloses “[a] processing chamber is configured to expose the substrate to a sequence of gases and/or plasmas” that includes “separate supplies of the A, B, and C reactants, along with a supply of carrier, purge and inert gases [and] **gas inlets for each of the reactants and gases**.” EX1005, 8:48-52. Weidman’s “[a]pparatus for deposition of a film on a substrate” includes a chamber, “a first precursor inlet in fluid communication with a supply of precursor,” and “a reactant gas inlet in fluid communication with a supply of a reactant gas....” *Id.*, 8:41-52; EX1003, ¶348-351.

11. Claim 13

Claim 13 depends on claim 12 and recites “the vapor inputting structures provide for control of the flow.” Petitioner refers to the MPF discussion in Section VII.B. “Each inlet” in Weidman “may be controlled by an appropriate **flow**

¹² Petitioner preserves right to argue indefiniteness of claim 12.

controller...in communication with a **[CPU]** that allows flow of each of the reactants to the substrate to perform a ALD process....” EX1005, 7:52-57; EX1003, ¶¶352-353.

12. Claim 14

Claim 14 depends on claim 1 and recites “a first [VIS] is configured to deliver a first vapor flow and a second [VIS] is configured to deliver a second vapor flow at the same time.” Petitioner refers to the MPF discussion in Section VII.B.

Weidman’s apparatus “includes a first precursor **inlet** in fluid communication with a supply of a first precursor containing substituents with cross-linkable moieties.” *Id.*, 8:47-49. And Weidman’s “‘A’, ‘B’, and purge gases can flow **simultaneously**, and the substrate and/or gas flow nozzle can oscillate such that the substrate is sequentially exposed to the A, purge, and B gases.” *Id.*, 6:17-21.

Thus, Wediman+Cardineau discloses a first VIS (e.g., gas inlet) is configured to deliver a first vapor flow and a second VIS (e.g., gas inlet) is configured to deliver a second vapor flow at the same time (e.g., “the ‘A’, ‘B’, and purge gases can flow simultaneously”). EX1003, ¶¶354-359.

13. Claim 15

Claim 15 depends on claim 1 and recites “a first [VIS] is configured to deliver a first vapor flow and a second [VIS] is configured to deliver a second vapor flow,

wherein the first vapor flow and the second vapor flow are sequential.” Petitioner refers to the MPF discussion in Section VII.B.

Weidman’s “method for forming a radiation sensitive photoresist on a substrate” includes “exposing a substrate sequentially to alternating pulses of a first precursor containing substituents with cross-linkable moieties and a reactant selected from...H₂O, H₂O₂...to form a deposited layer...” EX1005, claim 1. And Weidman’s “‘A’, ‘B’, and purge gases can flow simultaneously, and the substrate and/or gas flow nozzle can oscillate such that the substrate is **sequentially exposed** to the A, purge, and B gases as desired.” EX1005, 6:17-21.

Thus, Weidman+Cardineau discloses a first VIS (i.e., gas inlet) is configured to deliver a first vapor flow (i.e., “A” reactant) and a second VIS (i.e., gas inlet) is configured to deliver a second vapor flow (i.e., “B” reactant), wherein the first vapor flow (i.e., “A” reactant) and the second vapor flow (i.e., “B” reactant) are sequential (i.e., “alternating pulses” or “sequentially exposed”). EX, ¶¶360-365.

14. Claim 16

Claim 16 depends on claim 1 and recites “a first [VIS] is configured to deliver a first vapor flow and a second [VIS] is configured to deliver a second vapor flow, wherein the first vapor flow, the second vapor flow, and a third vapor flow are sequential.” Petitioner refers to the MPF discussion in Section VII.B.

Weidman's "processing chamber is configured to expose the substrate to **a sequence of gases and/or plasmas during the vapor deposition process,**" and "include[s] **separate supplies** of...reactants, along with a supply of carrier, purge and inert gases...**in fluid communication with gas inlets for each of the reactants and gases.**" EX1005, 7:46-52; *id.*, 8:47-61.

Weidman's "'A', 'B', and purge gases can flow simultaneously, and the substrate and/or gas flow nozzle can oscillate such that the substrate is **sequentially exposed**" to the gases. *Id.*, 6:17-21. According to Weidman, "a different type of second reactant (a 'D' reactant) may be utilized in a reaction sequence, in which 'B' and 'D' reactants are different to provide a reaction sequence in which the following pulsed ALD cycle is utilized A, B, C, D, A, B, C, D..." and "instead of pulsing the reactants, the gases can flow simultaneously from a gas delivery head or nozzle and the substrate and/or gas delivery head can be moved such that the substrate is **sequentially exposed** to the gases." *Id.*, 6:52-61; *see id.*, 9:29-42.

Thus, Weidman+Cardineu discloses a first VIS (i.e., gas inlet) is configured to deliver a first vapor flow (i.e., "A" precursor) and a second VIS (i.e., gas inlet) is configured to deliver a second vapor flow (i.e., "B" reactant), wherein the first vapor flow (i.e., "A" precursor), the second vapor flow (i.e., "B" reactant), and a third vapor flow (i.e., "C" precursor or "D" reactant) are sequential (i.e., "a sequence of gases and/or plasmas" and "sequentially exposed"). EX1003, ¶¶366-368.

A POSA would also understand that there are a limited number of obvious choices of continuous or alternating delivery methods, which would have been obvious-to-try. *Id.*, ¶¶369-372.

15. Claim 17

Claim 17 depends on claim 1 and recites “a first [VIS] is configured to deliver a first vapor flow and a second [VIS] is configured to deliver a second vapor flow, wherein the first vapor flow and the second vapor flow are at the same time and a third vapor flow is sequential.” Petitioner refers to the MPF discussion in Section VII.B.

Weidman’s “processing chamber is configured to expose the substrate to **a sequence of gases and/or plasmas during the vapor deposition process,**” and “[t]he processing chamber would include **separate supplies** of the A, B, and C reactants, along with a supply of carrier, purge and inert gases such as argon and nitrogen **in fluid communication with gas inlets for each of the reactants and gases.**” EX1005, 7:46-52. “Each inlet may be controlled by an appropriate flow controller such as a mass flow controller or volume flow controller in communication with a central processing unit (CPU) that allows flow of each of the reactants to the substrate to perform a ALD process....” *Id.*, 7:52-57; *id.*, 8:47-61.

Weidman’s “**the ‘A’, ‘B’, and purge gases can flow simultaneously,** and the substrate and/or gas flow nozzle can oscillate such that the substrate is **sequentially**

exposed to the A, purge, and B gases as desired.” EX1005, 6:17-21. Weidman teaches that “a different type of second reactant (a ‘D’ reactant) may be utilized in a reaction sequence...,” and “instead of pulsing the reactants, **the gases can flow simultaneously**...and/or gas delivery head can be moved [so] substrate is **sequentially exposed**.” *Id.*, 6:52-61; *see also id.*, 9:29-42.

Thus, Weidman+Cardineu discloses a first VIS (i.e., gas inlet) is configured to deliver a first vapor flow (i.e., “A” precursor) and a second VIS (i.e., gas inlet) is configured to deliver a second vapor flow (i.e., “B” reactant) simultaneously, and a third vapor flow (i.e., “C” precursor or “D” reactant) is sequential. EX1003, ¶378.

A POSA would understand that there are a limited number of obvious choices of continuous or alternating delivery methods, which would have been obvious-to-try. *Id.*, ¶¶ 373-379.

16. Claim 18

Claim 18 depends on claim 1 and recites “the interior has a temperature from about 45° C. to about 200° C.” Weidman discloses “**the chamber or the substrate may be heated to a temperature of...less than about 200° C.**” EX1005, 9:20-26; EX1003, ¶380.

17. Claim 19

Claim 19 depends on claim 1 and recites “X is alkylamido or dialkylamido.” Although Weidman discloses precursors that include alkylamido substituents,

Weidman does not specifically disclose organotin precursors that include alkylamido substituents. EX1005, 18:16-22 (“...precursor selection and can include...for example the use of...**alkylamido** complexes as metal precursors and water vapor as the reactant.”). Weidman discloses that “[s]pecific materials according to one or more embodiments include but are not limited to...**tin**[.]” *Id.* 4:48-51.

Cardineau discloses using tin compounds as EUV photoresists given tin’s higher EUV absorbance, resulting in superior lithographic performance, better sensitivity, and lower shot noise. EX1008, 45.

A POSA would have been motivated to use an organotin with an alkoxo ligand of Cardineau in Weidman’s apparatus because the references are analogous art, and Weidman teaches that precursors can include tin and alkoxo ligands, and to use tin precursors to achieve Cardineau’s benefits. EX1003, ¶¶381-383.

18. Claim 20

Claim 20 depends on claim 1 and recites “X is alkoxo and aryloxo.” Although Weidman discloses precursors that include alkoxo substituents, Weidman does not specifically disclose organotin precursors that include alkoxo substituents. EX1005, 18:16-22. Weidman also discloses that “[s]pecific materials...include...**tin**[.]” *Id.*, 4:48-51.

Cardineau teaches using tin compounds for their higher EUV absorbance, resulting in superior lithographic performance, better sensitivity, and lower shot noise. EX1008, 45.

A POSA would be motivated to use Cardineau's organotin with an alkoxo ligand in Weidman's apparatus, as the references are analogous, Weidman discloses tin and alkoxo ligands, and Cardineau highlights the benefits of tin precursors and organotin. EX1003, ¶384-386.

H. Ground 4: Claims 6 And 7 Are Obvious Over Weidman, Cardineau, and Molloy.

1. Claim 6

Weidman+Cardineau+Molloy discloses claim 6, which depends on claim 1 and recites "a flow comprising a **third precursor vapor** comprising a composition represented by the formula **ML_v**, where v is $2 \leq v \leq 6$ and L is an oxidizable ligand or a ligand having a hydrolysable M-L bond or a combination thereof, and M is a metal selected from groups 2-16 of the periodic table." EX1003, ¶387-389.

Weidman+Cardineau+Molloy discloses each limitation of claim 1 for the reasons discussed above for Ground 5, which are incorporated here.

In Weidman, "[a]fter the second purge, a second metal-containing precursor gas or vapor is delivered to the substrate surface," and "[t]he metal-containing precursor can be an 'A' precursor...., or the metal-containing precursor can be a 'C'

precursor....” EX1005, 13:5-9. Further, “at least two different types of metal-containing (e.g., silicon) precursors can be utilized” with “the ‘C’ metal-containing precursor is different from the ‘A’ metal-containing precursor thereby providing ALD cycle A, B, C, B, A, B, C, B, A, B, C, B” *Id.*, 6:45-50, 6:52-55. Therefore, Weidman teaches a third precursor vapor (i.e., “second metal-containing precursor gas or vapor”).

Neither Weidman nor Cardineau discloses the formula ML_v , but a POSA would know ML_v compounds were common in vapor deposition and would have a reasonable expectation of success incorporating them as a third precursor vapor.. EX1003, ¶390.

Molloy discloses organotin compounds for CVD purposes, including $SnMe_4$, that provide films with desirable properties produced with high deposition rates and deposition temperatures as low as 30°C. EX1009, 549-550.

A POSA would further understand that $SnMe_4$ is a composition represented by the formula ML_v , where M is tin (Sn; group 14 of the periodic table), v is 4, and L is methyl (Me), which is a ligand having a hydrolysable M-L bond.

A POSA would appreciate that the references are analogous art and would have been motivated to combine them because Molloy teaches organometallic (e.g. organotin) precursors. A POSA would have been motivated to select $SnMe_4$ (i.e., compound of formula ML_v) for inclusion in the third vapor precursor obtain a film

with the desirable properties described by Molloy. Finally, a POSA would have had a reasonable expectation of success that Molloy's precursors could successfully form a film using Weidman's apparatus since Molloy teaches that SnMe_4 is a precursor for vapor deposition methods.¹³ EX1003, ¶¶391-393.

2. Claim 7

Weidman+Cardineau+Molloy discloses claim 7, which depends on claim 6 and recites that "the third precursor vapor comprises SnL_4 ." EX1003, ¶¶394-400.

Weidman+Cardineau+Molloy discloses each limitation of claims 1 and 6 for the reasons discussed for Ground 5, which are incorporated here.

In Weidman, "[a]fter the second purge, a second metal-containing precursor gas or vapor is delivered to the substrate surface," and "[t]he metal-containing precursor can be an 'A' precursor...., or the metal-containing precursor can be a 'C' precursor...." EX1005, 13:5-9. Further, "at least two different types of metal-

¹³ As claim 6 does not require any timing or temporal requirements, the third precursor vapor could be introduced at the same time as the first precursor vapor and/or second precursor vapor or in a subsequent step. If introduced in a subsequent step, an intervening purge step would be administered and so the third precursor vapor would not affect any reaction between components of the first precursor vapor and second precursor vapor.

containing (e.g., silicon) precursors can be utilized” with “the ‘C’ metal-containing precursor is different from the ‘A’ metal-containing precursor thereby providing ALD cycle A, B, C, B, A, B, C, B, A, B, C, B” *Id.*, 6:45-50; *see id.*, 6:52-55. Therefore, Weidman teaches a third precursor vapor (i.e., “second metal-containing precursor gas or vapor”).

Neither Weidman nor Cardineau discloses a compound of formula SnL_4 . However, a POSA would have known that such compounds were being used as precursors in vapor deposition techniques and provide films with enhanced properties. EX1003, ¶397. A POSA would have expected that such compositions could successfully be included in a third precursor vapor. *Id.*

Molloy discloses organotin compounds for CVD purposes, including SnMe_4 a “precursor of choice” in dual-source CVD processes that provide films with desirable properties produced with high deposition rates (“polycrystalline with a refractive index of 2.00–2.10, have visible-light transmission of 84% and resistivity of $0.6 \text{ } \Omega\text{cm}$ ” (citations omitted)) and deposition temperatures as low as 30°C . EX1009, 549-550.

A POSA would understand that SnMe_4 is a composition represented by the formula SnL_4 , where M is tin (Sn; group 14 of the periodic table) and L is methyl (Me), which is a ligand having a hydrolysable M-L bond. EX1003, ¶399. A POSA would appreciate that Weidman, Cardineau, and Molloy are analogous art, and

would have been motivated to combine the references because Molloy teaches organometallic (e.g. organotin) precursors. *Id.*, ¶400. A POSA would have been motivated to select SnMe₄ (i.e. a compound of formula SnL₄) for inclusion in the third vapor precursor to obtain a film with the desirable properties described by Molloy. *Id.* A POSA would reasonably expect that Molloy's precursors could form a film using Weidman's apparatus since Molloy teaches that SnMe₄ is a precursor for vapor deposition methods. *Id.*

VIII. DISCRETIONARY DENIAL IS INAPPROPRIATE

A. 35 U.S.C. § 325(d)

Section 325(d) denial would be improper because this Petition presents new prior art, grounds, and arguments not yet presented to the Office. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6, 8 (Feb. 13, 2020). None of the art at issue here was cited or relied upon during prosecution.

B. 35 U.S.C. § 314(a)

The Board should reject any argument for denial under 35 U.S.C. § 314(a), as the *Fintiv* factors favor institution.

Factor 1. This factor is neutral because “there is no evidence as to whether there will be a stay in the parallel case.” *Amazon v. Zentian*, IPR2023-01195, Paper 10 at 9 (Jan. 10, 2024).

Factor 2. Factor 2 is neutral. The scheduled trial date is more than a year away, much can change during that time, and the filing of a *Sotera* stipulation will avoid duplicative arguments in district court.¹⁴ EX2021. If it is delayed for any reason, this factor would favor institution. *Dish Network v. Broadband iTV*, IPR2020-01280, Paper 17 at 16 (PTAB Feb. 4, 2021) (“trial date is more than nine months away and much can change during this time”).

Factor 3. Although the district court held a *Markman* hearing on November 6, 2024, it has not yet construed terms of the '048 Patent, nor analyzed any prior art-based invalidity issues. Fact discovery will not close until February 26, 2025, and trial will not begin until at least December 15, 2025. EX1021, 4, 18.

Factor 4. This factor favors institution because this Petition challenges all claims of the '048 Patent, and thus is more extensive than the invalidity challenges that will be raised in district court. Also, the filing of a *Sotera* stipulation will avoid any duplicative arguments and conflicting decisions.

Factor 5. This factor favors institution or is neutral because “the parties in the parallel proceeding are not different from the parties [in the IPR].” *Amazon v. Zentian*, IPR2023-01195, Paper 10 at 9 (Jan. 10, 2024).

Factor 6. This Petition presents compelling merits, with no grounds previously considered by the Office or courts. *Cf. Comcast Cable Commn's, LLC v. Rovi Guides, Inc.*, IPR2019-00231, Paper 14 at 11 (PTAB May 20, 2019). Even if

Factors 1-5 favored denial (they do not), the Board should not discretionarily deny institution given the compelling merits presented here.

IX. CONCLUSION

Trial should be instituted, and the Challenged Claims cancelled.

Dated: December 13, 2024

Respectfully Submitted,

/ Dion M. Bregman /
Dion M. Bregman (Reg. No. 45,645)

LISTING OF CHALLENGED CLAIMS

Claim No.	Claim Language
1	A system comprising: a deposition chamber having an interior isolated from the ambient atmosphere; a substrate within the interior of the deposition chamber configured to receive a deposition on a surface of the substrate, wherein the substrate is maintained at a temperature of less than 200° C.; an inlet into the deposition chamber; structure configured to deliver flow from a supply of an inert gas; a supply of an organotin composition comprising a compound described by the formula RSnX_3, where R is an organic ligand with 1-31 carbon atoms and is bound to Sn with a metal-carbon bond and wherein X is selected from the group consisting of alkylamido or dialkylamido ($\text{—NR}^1\text{R}^2$, where R^1 and R^2 are independently hydrocarbon groups with 1-10 carbon atoms or hydrogen), siloxo ($\text{—OSiR}^1\text{R}^2\text{R}^3$, where R^1, R^2, R^3 are independently hydrocarbon groups with 1-10 carbon atoms), silylamido ($\text{—N}(\text{SiR}^1)_3(\text{R}^2)$, where R^1 and R^2 are independently hydrocarbon groups with 1-10 carbon atoms), disilylamido ($\text{—N}(\text{SiR}^1)_3(\text{SiR}^2)_3$ where R^1 and R^2 are independently hydrocarbon groups with 1-10 carbon atoms), alkoxo and aryloxo (—OR, where R is an alkyl or aryl group with 1-10 carbon atoms), azido (—N_3), alkynido ($\text{—C}\equiv\text{CR}$, where R is a hydrocarbon group with 1-9 carbon atoms), amidato ($\text{—NR}^1(\text{COR}^2)$ where R^1 and R^2 are independently hydrocarbon groups with 1-7 carbon atoms or hydrogen), amidinato ($\text{—NR}^1\text{C}(\text{NR}^2)\text{R}^3$ where R^1 and R^2 are independently hydrocarbon groups with 1-8 carbon atoms or hydrogen), imido ($\text{—N}(\text{COR}^1)(\text{COR}^2)$, where R^1 and R^2 are independently hydrocarbon groups with 1-8 carbon atoms or hydrogen), or fluorinated analogues thereof, or combinations thereof;

	structure configured to deliver flow of a first precursor vapor from the supply of the organotin compound with the inert gas as a carrier gas to the inlet to provide for formation of an organotin layer on the substrate surface within the deposition chamber; and structure to deliver a second precursor vapor comprising water, hydrogen peroxide or a combination thereof capable of reacting with the composition in the first precursor vapor under conditions in the deposition chamber to form a composition with non-volatile components and a volatile component comprising hydrolysis reaction product with X, wherein the substrate is configured with a surface to receive the non-volatile components of the composition.
2	The system of claim 1 wherein the substrate comprises a silicon wafer.
3	The system of claim 1 wherein the inert gas comprises nitrogen or argon.
4	The system of claim 1 wherein the structure configured to deliver flow comprises an aerosol generator configured to generate an aerosol from a liquid comprising the organotin compound, a vaporization chamber configured to receive an injection of organotin compound, a flash evaporator configured to evaporate the organotin compound, or a bubbler configured for bubbling an inert carrier gas through a liquid comprising the organotin compound, and wherein the deposition on the surface of the substrate comprises chemical vapor deposition.
5	The system of claim 1 wherein the second precursor vapor comprises water vapor.
6	The system of claim 1 further comprising a flow comprising a third precursor vapor comprising a composition represented by the formula ML_v , where v is $2 \leq v \leq 6$ and L is an oxidizable ligand or a ligand having a hydrolysable M-L bond or a combination thereof, and M is a metal selected from groups 2-16 of the periodic table.
7	The system of claim 6 wherein the third precursor vapor comprises SnL_4 .

8	The system of claim 1 wherein the interior has a pressure from about 0.01 Torr to about 25 Torr.
9	The system of claim 1 wherein the interior has a temperature from about 40° C. to about 175° C.
10	The system of claim 1 comprising a configuration providing for selection of the pressure and/or the temperature in the deposition chamber.
11	The system of claim 1 wherein the flow comprises a vapor.
12	The system of claim 1 wherein the structure configured to deliver flow comprises one or more vapor inputting structures.
13	The system of claim 12 wherein the vapor inputting structures provide for control of the flow.
14	The system of claim 1 wherein a first vapor inputting structure is configured to deliver a first vapor flow and a second vapor inputting structure is configured to deliver a second vapor flow at the same time.
15	The system of claim 1 wherein a first vapor inputting structure is configured to deliver a first vapor flow and a second vapor inputting structure is configured to deliver a second vapor flow, wherein the first vapor flow and the second vapor flow are sequential.
16	The system of claim 1 wherein a first vapor inputting structure is configured to deliver a first vapor flow and a second vapor inputting structure is configured to deliver a second vapor flow, wherein the first vapor flow, the second vapor flow, and a third vapor flow are sequential.
17	The system of claim 1 wherein a first vapor inputting structure is configured to deliver a first vapor flow and a second vapor inputting structure is configured to deliver a second vapor flow, wherein the first vapor flow and the second vapor flow are at the same time and a third vapor flow is sequential.

18	The system of claim 1 wherein the interior has a temperature from about 45° C. to about 200° C.
19	The system of claim 1 wherein X is alkylamido or dialkylamido.
20	The system of claim 1 wherein X is alkoxo and aryloxo.

CERTIFICATION OF COMPLIANCE WITH TYPE-VOLUME LIMITS

This Petition includes 13,953 words as counted by Microsoft Word and is therefore in compliance with the 14,000 word limit established by 37 C.F.R.

42.24(a)(1)(i). Accordingly, pursuant to 37 C.F.R. 42.24(d), lead counsel for the Petitioner hereby certifies that this Petition complies with the type-volume limits established for a petition requesting IPR.

Dated: December 13, 2024

Respectfully Submitted,

/ Dion M. Bregman /
Dion M. Bregman (Reg. No. 45,645)

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6(e)(4) and 42.105, lead counsel for Petitioner hereby certifies that on December 13, 2024, a copy of this Petition and all supporting exhibits were sent via Priority Mail Express to the correspondence address of record for the '048 patent:

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A courtesy copy of this Petition and all supporting documents were also served via email on December 13, 2024 on Patent Owner's counsel of record in the district court litigation against Lam Research Corp.:

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