

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LAM RESEARCH CORP.,

Petitioner,

v.

INPRIA CORP.,

Patent Owner.

Case No. IPR2024-00033

Patent No. 9,823,564

**PETITIONER'S OPPOSITION TO
PATENT OWNER'S MOTION TO AMEND**

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603 F.3d 935, 941 (Fed. Cir. 2010).....7

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37 C.F.R. §42.121 1

37 C.F.R. §42.121(a)(2)(ii) 1

LIST OF EXHIBITS

Exhibit	Description	Previously Submitted
1001	U.S. Patent No. 9,823,564 (“’564 patent”)	X
1002	Expert Declaration of Karey Holland, Ph.D. (“Holland Declaration”)	X
1003	U.S. Patent Publication No. 2011/0293888 (“’888 publication”)	X
1004	U.S. Application No. 12/850,867 Prosecution History (“’867 application PH”)	X
1005	U.S. Application No. 61/350,103 (“’103 provisional”)	X
1006	Declaration Sylvia Hall-Ellis, Ph.D. Regarding Authenticity and Public Availability (“Hall-Ellis Declaration”)	X
1007	’564 Patent Prosecution History (“’564 patent PH”)	X
1008	Stowers, Jason K. <i>Direct patterning of solution deposited metal oxides</i> . Oregon State University, 2008 (“Stowers 2008”)	X
1009	U.S. Patent No. 10,782,610 Prosecution History (“’610 patent PH”)	X
1010	Stowers, Jason, and Douglas A. Keszler. <i>High resolution, high sensitivity inorganic resists</i> . Microelectronic Engineering 86.4-6 (2009): 730-733 (“Stowers 2009”)	X
1011	Complaint for <i>Inpria Corp. v. Lam Research Corp.</i> , 1-22-cv-01359	X
1012	Jouve, A., et al. <i>Overcoming pattern collapse of ultra high resolution dense lines obtained with EUV resists</i> . Advances in Resist Technology and Processing XXII. Vol. 5753. SPIE, 2005 (“Jouve”)	X
1013	Stowers, Jason, Alan Telecky, and Andrew Grenville. <i>Imageable oxides: new solutions for resist</i> . EUVL Symposium. 2010, available at https://euvl_symposium.lbl.gov/pdf/2010/pres/RE-08.pdf	X

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1014	Telecky, Alan, et al. <i>Photopatternable inorganic hardmask</i> . Journal of Vacuum Science & Technology B 28.6 (2010): C6S19-C6S22 (“Telecky 2010”)	X
1015	Summons for <i>Inpria Corp. v. Lam Research Corp.</i> , 1-22-cv-01359	X
1016	Amador et al. <i>Patterning chemistry of HafSO_x resist</i> . Advances in Patterning Materials and Processes XXXI. Vol. 9051. SPIE, 2014	X
1017	Reserved	X
1018	Decker, Shawn R. <i>On the Properties and Characteristics of Solution Processed Hafnium Based Thin-Films from Aqueous Precursors</i> . Oregon State University, 2017	X
1019	Oleksak et al. <i>Evaluation of Thermal and Radiation Induced Chemistries of Metal Oxo–Hydroxo Clusters for Next-Generation Nanoscale Inorganic Resists</i> . ACS Applied Nano Materials 1.9 (2018): 4548-4556	X
1020	Reserved	X
1021	U.S. Patent No. 7,773,365	X
1022	Stowers et al. <i>Directly patterned inorganic hardmask for EUV lithography</i> . Extreme Ultraviolet (EUV) Lithography II. Vol. 7969. SPIE, 2011 (“Stowers 2011”)	X
1023	Reserved	X
1024	Trikeriotis et al. <i>Development of an inorganic photoresist for DUV, EUV, and electron beam imaging</i> . Advances in Resist Materials and Processing Technology XXVII. Vol. 7639. SPIE, 2010 (“Trikeriotis”) (Library Version)	X
1025	Matsuzawa et al. <i>Theoretical estimation of absorption coefficients of various polymers at 13nm</i> . Journal of Photopolymer Science and Technology 12.4 (1999): 571-576.	X
1026	Puurunen et al. <i>Hafnium oxide films by atomic layer deposition for high-κ gate dielectric applications: Analysis of the density of nanometer-thin films</i> . Applied Physics Letters 86.7 (2005).	X

Exhibit	Description	Previously Submitted
1027	Ober and Giannelis. <i>New oxide nanoparticle extreme-UV photoresists achieve high sensitivity</i> . SPIE Newsroom (2014): 2-4.	X
1028	<i>Curriculum Vitae</i> of Sylvia D. Hall-Ellis, Ph.D.	X
1029	<i>Curriculum Vitae</i> of Karey L. Holland, Ph.D.	X
1030	Anderson, Jeremy T., et al. <i>Solution-processed HafSOx and ZircSOx inorganic thin-film dielectrics and nanolaminates</i> . Advanced Functional Materials 17.13 (2007): 2117-2124 (“Anderson”)	X
1031	Trikeriotis et al. <i>Development of an inorganic photoresist for DUV, EUV, and electron beam imaging</i> . Advances in Resist Materials and Processing Technology XXVII. Vol. 7639. SPIE, 2010 (“Trikeriotis”) (Electronic Version)	X
1032	Deposition Transcript of Jason Stowers, Ph.D. (October 11, 2024)	X
1033	Deposition Transcript of Sanjay K. Banerjee, Ph.D. (September 27, 2024)	
1034	Oleksak RP & Herman GS, <i>Characterization of High-Resolution HafSOx Inorganic Resists</i> . Proc. SPIE 9048, Extreme Ultraviolet (EUV) Lithography V, 90483H (2014).	
1035	Trakhtenberg S et al., <i>Non-Catalytic Photo-Induced Immobilization Process In Polymer Films, in Physico-Chemical Phenomenia in Thin Films & At Solid Surfaces</i> (Trakhtenberg, L, Lin, S; Ilegbusi, eds. 2007)	
1036	Krysak, Marie E., et al., <i>Investigation of Novel Inorganic Resist Material for EUV Lithography</i> . Proc. SPIE 9048, Extreme Ultraviolet (EUV) Lithography V, 904805 (2014) (“Krysak”)	
1037	Brainard, Robert L, <i>Photoresists for EUV Lithography, in EUV Litogarphy</i> (Bakshi, V. Ed. 2018)	
1038	International Application Publication No. WO2008/082448 (“Keszler”)	

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1039	R. Chang & K Goldsby, <i>Chemistry</i> (11th ed. 2013) (excerpts).	
1040	Expert Declaration of Karey Holland, Ph.D.	
1041	Declaration of Heather Stewart	
1042	Email from Brad Engelbert, Cataloging & Government Documents Manager of Oregon State University, to Risa L. Murphy, Morgan, Lewis & Bockius (August 13, 2024)	
1043	Declaration of Patrick Franzen	
1044	Fallica et al., <i>Absorption Coefficient of Metal-Containing Photoresists in the Extreme Ultraviolet</i> , J Micro/Nanolith. MEMS MOEMS 17(2), 023505 (2018)	
1045	Reserved	
1046	Kirchauer, Heinrich, <i>Photolithography Simulation</i> , Vienna University of Technology, 1998 (available at https://www.iue.tuwien.ac.at/phd/kirchauer/diss.html) (excerpt)	
1047	Schnabel, Wolfram, <i>Polymers & Electromagnetic Radiation: Fundamentals & Practical Applications</i> (2014).	

I. INTRODUCTION

Patent Owner's (PO) Contingent Motion to Amend (Paper 20, "Mot.") should be denied. PO's substitute claims 13-23 fail to comply with §112, and are invalid in view of the prior art. Proposed amended claim 19 also fails to meet the requirement of 35 U.S.C. §316(d) and 37 C.F.R. §42.121.

II. THE PROPOSED AMENDED CLAIMS DO NOT MEET THE REQUIREMENTS UNDER 37 C.F.R. § 42.121 OR 35 U.S.C. § 316(D)

An amendment "may not enlarge the scope of the claims of the patent or introduce new matter." 35 U.S.C. §316(d)(3); 37 C.F.R. §42.121(a)(2)(ii). Here, PO amends claim 8, which claimed a "metal ion to [] ligand ratio of at least 2," with substitute claim 19, which claims a "ratio of [] ligands to metal ion of at least about 2." Mot. at 7. PO's proposed amendment is improper because it "enlarge[s] the scope" of the claim being amended (here, claim 8). This new claim 19 covers ratios outside the scope of the original claim—therefore, enlarging the scope of claim 8. For example, claim 19 would cover a ratio of "ligands to metal ion[s]" of 2 to 1 or 3 to 1, which is equivalent to a "metal ion to [] ligand ratio" of 1 to 2, or 1 to 3. EX1040 ¶¶140-142. These ratios would not be covered by original claim 8's metal ion to ligand ratio of at least 2. EX1040 ¶¶141-142. Thus, PO's amendment enlarges the claim scope.

III. THE PROPOSED SUBSTITUTE CLAIMS FAIL TO MEET THE REQUIREMENTS OF SECTION 112

Substitute claims must comply with 35 U.S.C. §112. *See e.g., Euro-Pro Operating LLC v. Acorne Enters., LLC*, IPR2014-00351, Paper 38 at 36-37 (PTAB July 9, 2015). Here, the proposed substitute claims are invalid for lack of written description, lack of enablement, and indefiniteness.

Many of the Section 112 issues with the substitute claims stem from one problem: the inventors of the '564 patent described, at most, use of a coating material using hafnium or zirconium ions with hydrogen peroxide ligands. But instead of claiming that, PO attempts to claim a broad genus of coatings using *any* metal ions with *any* suitable ligands—a genus that the specification does not disclose or enable.

A. Claims 13-23 Are Improper Due to Lack of Written Description

A specification must “reasonably convey[] to those skilled in the art that the inventor had possession of the claimed subject matter as of the filing date.” *Ariad Pharm. Inc. v. Eli Lilly & Co.*, 598 F.3d 1336, 1351 (Fed. Cir. 2010) (en banc). “When a patent claims a genus using functional language to define a desired result, ‘the specification must demonstrate that the applicant has made a generic invention that achieves the claimed result.’” *AbbVie Deutschland GmbH & Co., KG v. Janseen Biotech, Inc.*, 759 F.3d 1285, 1299 (Fed. Cir. 2014). “[W]ritten description of a broad genus requires description not only of the outer limits of the genus but also of either *a representative number of members of the genus* or *structural features*

common to the members of the genus, in either case with enough precision that a relevant artisan can...recognize the members of the genus.” *Regents of Univ. of Minn. v. Gilead Scis., Inc.*, 61 F.4th 1350, 1356 (Fed. Cir. 2023).

1. Claims 13-15 and 17-23: “Radiation Sensitive Ligands”

Claim 13 uses functional language to claim a broad genus of compounds based on the desired result—*i.e.*, “ligands” that have the function of being “radiation sensitive.” Mot. at 6. Proposed substitute claims 14-15 and 17-23 do not include any limitations that restrict the broad genus of “radiation sensitive ligands” claimed as part of claim 13. *See* Mot. at 6-8. The specification neither describes a representative number of species nor common structural features to provide adequate written description for claims 13-15 and 17-23.

Where “the art is unpredictable...disclosure of more species is necessary to adequately show possession of the entire genus.” *Synthes USA, LLC v. Spinal Kinectics, Inc.*, 734 F.3d 1332, 1344 (Fed. Cir. 2013). Here, the “radiation sensitive ligands” found in the claims are part of a highly unpredictable art. Chemical properties can be highly variable and difficult to predict—including whether any given ligand would be “radiation sensitive.” EX1040 ¶145. The case law confirms it. *In re Marzocchi*, 439 F.2d 220, 223-24 (CCPA 1971); *In re Fisher*, 427 F.2d 833, 839 (CCPA 1970) (contrasting predictable mechanical and electrical elements with unpredictable chemical reactions).

There are practically an infinite number of potential ligands that could be “radiation sensitive.” EX1040 ¶146. Yet the specification discloses only one species of a “radiation sensitive ligand”: ligands with peroxide groups. EX1001, 5:45-47, 6:9-14. Where the art is unpredictable, as here, disclosing a single species is insufficient to support generic claims. *Juno Therapeutics, Inc. v. Kite Pharma, Inc.*, 10 F.4th 1330, 1340-42 (Fed. Cir. 2021) (no written description where patent “discloses only one CD19-specific scFv” but claimed “genus of functional CD19-specific scFvs”); *AbbVie*, 759 F.3d at 1300; *see Enzo Biochem, Inc. v. Gen-Probe Inc.*, 323 F.3d 956, 967 (Fed. Cir. 2002) (specification’s lack of “a sufficient number of species” failed to show “the inventors...had possession of the breadth of the genus, as opposed to merely one or two such species”).

Claim 13-15 and 17-23 also lack written description because they do not disclose “common structural features of the claimed [] genus” that “identify which [candidates] would function as claimed.” *Juno*, 10 F.4th at 1336; *see AbbVie*, 759 F.3d at 1301 (explaining it is “difficult to establish” the “structure-function correlation” when art is “highly unpredictable”). Here, the specification simply identifies peroxide ligands as being “radiation sensitive ligands” and provides a few examples of suitable inorganic peroxide ligands. *E.g.*, EX1001, 12:22-33. Nowhere does the specification disclose any structure-function correlation between a ligand’s structure and its functionality as “radiation sensitive.” EX1040 ¶148.

Since the '564 patent fails to disclose either a representative number of species or the common structural features of “radiation sensitive ligands,” claims 13-15 and 17-23 lack written description support and are unpatentable.

2. Claims 13-23: “Metal Ions with Radiation Sensitive Ligands” and “Coating Material” Where “Radiation Alters the Chemical Properties”

Additional terms further complicate matters. First, the claims use the term “metal ions with radiation sensitive ligands.” Mot. at 6. But combining metal ions with various ligands may affect whether those ions are “radiation sensitive.” EX1040 ¶149. That is, while a ligand may be radiation sensitive on its own or in combination with certain metal ions, it may lack radiation sensitivity when combined with other metal ions. EX1040 ¶149. Second, the claims require that a “coating material”—made of metal ions with ligands—has a specific function requiring “radiation [to] alter[] the chemical properties” of the coating material. Mot. at 6.

These functional limitations lack written description. The only examples of “metal ions with radiation sensitive ligands” in the specification are hafnium or zirconium ions with hydrogen peroxide ligands. EX1001, 21:12-23:41; EX1040 ¶150. Material coatings made from these two combinations are also the only examples of “coating materials” with chemical properties altered by radiation.

EX1001, 21:12-23:41.¹ The specification fails to disclose any structure-function correlation between a metal ion/ligand combination's structure and the functionality of the ligand as "radiation sensitive." EX1040 ¶150. Similarly, while the '564 patent teaches some methods for increasing radiation absorption (EX1001, 11:21-42), it does not teach any structure correlating to whether a specific coating material will be altered by radiation. EX1040 ¶153-154. In both cases, there is no description of which potential candidates will "function as claimed." *Juno*, 10 F.4th at 1336.

Since the '564 patent fails to disclose either a representative number of species or the common structural features of the identified limitations, claims 13-23 lack written description support and are unpatentable.

B. Claims 13-23 Are Unpatentable Because the Full Scope of the Claims Is Not Enabled

"In unpredictable art areas, [the Federal Circuit] has refused to find broad generic claims enabled by specifications that demonstrate the enablement of only one or a few embodiments and do not demonstrate with reasonable specificity how

¹ While the specification notes that different ions can affect the absorption of radiation, and that "absorption of a sufficient amount of radiation" can chemically affect the coating material, the specification fails to provide any examples of coating materials whose chemical properties are actually changed by radiation exposure other than the hafnium or zirconium peroxide materials. EX1040 ¶153.

to make and use other potential embodiments across the full scope of the claim.” *PPG Indus., Inc. v. Guardian Indus. Corp.*, 75 F.3d 1558, 1564 (Fed. Cir. 1996); *see also ALZA Corp.*, 603 F.3d 935, 941 (Fed. Cir. 2010). “A claim is not enabled when, ‘at the effective filing date of the patent, one of ordinary skill in the art could not practice their full scope without undue experimentation.’” *Idenix Pharms. LLC v. Gilead Scis. Inc.*, 941 F.3d 1149, 1154 (Fed. Cir. 2019) (quoting *Wyeth & Cordis Corp. v. Abbott Labs.*, 720 F.3d 1380, 1384 (Fed. Cir. 2013)).

Enablement requires more than simply providing POSAs a “research assignment[.]” to “create a wide range of candidate[s]” and “then screen each to see which happen to” have the claimed functionality. *Amgen Inc. v. Sanofi*, 598 U.S. 594, 614 (2023). A mere “starting point” from which POSAs must “engage in an iterative, trial-and-error process to practice the claimed invention,” as presented by the substitute claims, is not enabling. *Wyeth*, 720 F.3d at 1386.

Here, the ’564 patent’s specification does not enable the full scope of the claims, due to the limitation requiring “metal ions with radiation sensitive ligands.” Mot. at 6. As identified above in Section III.A.2, the claims cover a combination of “metal ions with radiation sensitive ligands,” but the ’564 patent provides examples of only two working combinations—hafnium or zirconium ions with hydrogen peroxide ligands. EX1001, 21:12-23:41. By claiming all “metal ions with radiation sensitive ligands,” the ’564 patent does nothing more than provide a POSA with a

research assignment to test all combinations of metal ions and ligands in hopes of determining if the combination results in a material comprising “metal ions with radiation sensitive ligands.” *See* EX1033, 156:9-160:12. This testing is a lengthy and arduous process and amounts to undue experimentation. *Id.*; *see* EX1040 ¶¶159-162. Thus, claims 13-23 are not enabled and are unpatentable.

Similarly, the specification does not enable the full scope of “coating materials” where “radiation alters the chemical properties.” Mot. at 6. As explained above in Section **Error! Reference source not found.**, the specification only discloses two coating materials with the claimed functional requirement (i.e., “radiation alters the chemical properties”—namely, coating materials made of hafnium or zirconium with hydrogen peroxide ligands. EX1001, 21:12-23:41. Thus, substitute claim 13 simply provides a POSA with a research challenge of making all potential material coatings and testing them to determine whether radiation alters the coating’s chemical properties. EX1040 ¶¶162.; *see* EX1033, 159:13-160:12. This is not an enabling disclosure.

C. Claims 13-23: a Thickness of “About 25 nm” is Indefinite

The indefiniteness standard requires each claim “to be cast in clear—as opposed to ambiguous, vague, indefinite—terms.” *In re Packard*, 751 F.3d 1307, 1313 (Fed. Cir. 2014). The term “about” is indefinite where the specification fails to give sufficient guidance to construe the magnitude of variation permitted. *See*

Amgen, Inc. v. Chugai Pharm. Co., Ltd., 927 F.2d 1200, 1217–18 (Fed. Cir. 1991);
Synthes (USA) v. Smith & Nephew, Inc., 547 F. Supp. 2d 436 (E.D. Pa. 2008).

Here, claim 13’s limitation directed to “about 25 nm” is indefinite, rendering claims 13-23 unpatentable. The ’564 patent fails to provide any guidance to a POSA in determining the range of thicknesses would fall within “about 25 nm,” as is confirmed by the USPTO and expert testimony. EX1040 ¶¶163-168.

First, during the ’564 patent’s prosecution, the PO included claims directed to a material coating thickness range that included “about 30 nm.” EX1007, 404. The Examiner rejected the claims and explained that “about” was indefinite because it “is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and [a POSA] would not be reasonably apprised of the scope of the invention.” *Id.* at 489; *see id.* at 495-497. While the PO stated that it disagreed with the examiner’s rejection, it ultimately removed “about.” *Id.* at 504. Thus, the scope of “about” is unclear. Second, PO’s expert was questioned at length regarding “about 25 nm,” EX1033, 85:16-135:14, and Dr. Banerjee repeatedly insisted that a POSA would know the scope of “about,” *id.* at 92:17-93:15. But when questioned on this, Dr. Banerjee was unable to answer whether any particular value would fall inside or outside that scope. *See e.g., id.* at 91:8-13, 115:2-116:3, 121:7-

11, 123:19-126:16.² This is consistent with the indefiniteness of “about 25 nm.”

D. Claims 13-14 and 16-23 Are Improper Because the Term “Metal Ions” Is Indefinite

“[A] patent must be precise enough to afford clear notice of what is claimed, thereby appris[ing] the public of what is still open to them.” *Teva Pharms. USA, Inc. v. Sandoz, Inc.*, 789 F.3d 1335, 1341 (Fed. Cir. 2015); *Howmedica Ostenics Corp. v. Tranquil Prospects, Ltd.*, 401 F.3d 1367, 1371 (Fed. Cir. 2005) (“A claim is indefinite if its legal scope is not clear enough that a [POSA] could determine whether a particular [product or method] infringes or not.”).

Here, the term “metal ions” is indefinite because a POSA would not understand its scope with reasonable certainty. The term “metal ions” as used in claim 13, simply refers to ions of a “metal” element. EX1040 ¶169.; Mot. at 6 (claiming “the metal of the metal ions”). Accordingly, a POSA would understand

² During this testimony, counsel for the PO repeatedly asked for a break—despite Dr. Banerjee’s willingness to continue—going so far as to instruct Dr. Banerjee to walk out of the room mid-questioning. EX1033, 96:20-97:4, 99:15-103:22, 110:13-111:16. Yet, despite this forced break in during this line of questioning, Dr. Banerjee remained unable to identify any meaningful scope of “about.” *Id.*, 115:2-116:3, 121:7-11, 123:19-126:16. Dr. Banerjee eventually testified that “in a broad sense ‘about’ means ‘approximate.’” *Id.*, 119:4-10.

the meaning of “metal” to be those elements identified as such on the periodic table. EX1040 ¶¶170-172. But the specification and claims obfuscate the meaning of “metal” by using it to reference elements that a POSA would understand to be non-metals and metalloids. EX1040 ¶¶173-175. Specifically, the ’564 patent refers to elements such as boron, silicon, and antimony as metals, even though a POSA would know that those elements are metalloids. EX1001, 10:65-11:42; EX1040 ¶173. Similarly, the specification refers to phosphorous as a metal, even though a POSA would know phosphorous as a non-metal. *Id.*

Having eschewed the conventional understanding of the term “metal,” PO nevertheless failed to provide a clear definition that would allow a POSA to determine whether any particular metalloid or non-metal element qualifies as a “metal” as that term is used in the patent, rendering the term indefinite.

E. Claims 18 and 23: Indefinite Terms of Degree

For a term of degree to be definite, “the patent must provide ‘some standard for measuring that degree’ such that the claim language ‘provide[s] enough certainty to one of skill in the art when read in the context of the invention.’” *GE Lighting Sols., LLC v. Lights of Am. Inc.*, 663 F. App’x 938, 940 (Fed. Cir. 2016). Otherwise, the claim scope “depends on the unpredictable vagaries of any one person’s opinion” and is indefinite. *Biosig Instruments, Inc. v. Nautilus, Inc.*, 783 F.3d 1374, 1381 (Fed. Cir. 2015).

Claim 18 includes a term of degree that requires the coating material to have “high absorption...relative to conventional radiation-based resists.” Mot. at 7. Similarly, claim 23 includes a term of degree requiring the coating material to be “effectively patterned.” *Id.* at 7-8. These limitations are indefinite.

The '564 patent provides no guidance on how to determine if a material coating has “high absorption” when compared to conventional resists. EX1040 ¶¶178-180. Nor is there any disclosure of what “conventional resists” to use for such a comparison, how many “conventional resists” must be used for a comparison, or what constitutes “high absorption” compared to such resists. *Id.*; EX1033, 168:1-169:10 (explaining that “conventional resists” are “presumably those...used prior to EUV coming into vogue” or could also refer to “organic compositions” although “there are a few others that.... are inorganic”), 175:17-176:3; 169:15-170:6 (admitting that the meaning of “high” will “depend on the context”), 171:3-173:11 (answering, when asked what “high absorption” meant, that “I don’t think there’s a hard number”). Similarly, the '564 patent provides no guidance on how to determine whether a coating material can be “effectively patterned.” EX1040 ¶183. Instead, such a determination is necessarily subjective, leading to uncertain claim scope. *Id.* Given the lack of any guidance on how to determine the scope of these terms of degree, claims 18 and 23 are indefinite.

F. Claims 13-23 Are Improper as Mixed-Claim Types, Combining Structural Elements with a Method Step

When a single claim is directed to an apparatus or article, but requires a method step, the claim is indefinite. *IPXL Holdings, LLC v. Amazon.com, Inc.*, 430 F.3d 1377 (Fed. Cir. 2005). Such a claim is indefinite because “it is unclear whether infringement [] occurs when one creates a system...or whether infringement occurs when the user actually” uses the system to perform the method step. *Id.* at 1384.

Here, *device claims* 13-23 are invalid because they are directed to a structure (a substrate with a coating material) that requires certain *method steps* to be performed on the substrate, including “*exposure* of the coating material to...radiation” (claim 13) and “*heat[ing]* to temperatures from 45° C. to 150° C” (claim 20). Mot. at 6-7; EX1040 ¶¶184-187.

Further compounding the indefiniteness is the lack of any claimed structure that performs the claimed method steps. Although an apparatus claim with functional language used to describe capabilities *of the claimed structure* may survive indefiniteness, an apparatus claim that recites a functional or method step that is not performed by any claimed structure is necessarily indefinite. *Bardy Diagnostics, Inc. v. Vital Connect, Inc.*, No. 1-22-cv-00351-CJB at 1 (D. Del. Jul. 19, 2024) (D.I. 122) (“[W]hen such functionality is performed not by the claimed apparatus but instead by some unclaimed structure, that would render the claim indefinite.”); *In re Katz Interactive Call Processing Pat. Litig.*, 639 F.3d 1303 (Fed. Cir. 2011).

Here, the claimed structure is a substrate with a material coating. EX1040 ¶184. Yet, the claimed method steps of “exposure” and “heat[ing]” are performed by unclaimed structures (*e.g.*, a EUV source). EX1040 ¶¶184-187. Because the method steps are performed by unclaimed structures, claims 13-23 are indefinite.

IV. THE PROPOSED SUBSTITUTE CLAIMS ARE NOT PATENTABLE IN VIEW OF THE PRIOR ART

Inpria has proposed only a single amendment to the independent claim: that the coating material has an average thickness of “**about 25 nm.**” Mot. at 6. Inpria also proposes amended claim 19, which amends the ratio of metal to radiation sensitive ligands. *Id.* Inpria argues that the “substitute claims introduce limitations not found in the prior art.” *Id.* § IV.C. Inpria is incorrect. EX1040, ¶¶129-138. As described Lam’s Petition and contemporaneous Reply to Patent Owner’s Response, the claims are anticipated or rendered obvious by Stowers 2008 (Grounds 2-4) and Trikeriotis (Ground 5). Inpria’s proposed amendments do not resolve invalidity.

A. Inpria’s Proposed New Limitations Are Taught By Stowers 2008

Inpria does not dispute, and therefore concedes, that the new thickness (“about 25 nm” in sole independent claim 13) and ratio limitation (dependent claim 19) in the proposed amended claims are found in Stowers 2008. Rather, Inpria merely asserts that Stowers 2008 is “not prior art.” Mot. at 10. Yet, as explained in Lam’s contemporaneous Reply to Patent Owner’s Response, OSU failed to place a one-year embargo on Stowers 2008, which is evidenced by ProQuest’s January 2009

publication of Stowers 2008. Reply at 9-10; EX1041, ¶¶4-8. Stowers 2008 is therefore prior art to the '564 patent. 35 U.S.C. §102(b) (pre-AIA).

Stowers 2008 provides clear disclosure that that HafSO_x and ZircSO_x materials can be “deposited in films ranging in thickness from **2 to 500 nm**.” EX1008 at 18. While this range is dispositive, a POSA also would have been motivated to reduce Stowers 2008’s 30 nm thickness to avoid pattern collapse (EX1009, 265 (“Stowers [2008] described coatings with thicknesses from 30 to 35 nm in Chapter 3.”)); EX1040, ¶¶130-132; EX1012, 8. Accordingly, it would have been obvious to reduce the 30 nm thickness disclosed in Stowers 2008 to 25 nm to reduce pattern collapse. EX1040, ¶¶130-132. Substitute claim 13 is therefore not patentable over Stowers 2008.

Stowers 2008 also discloses the amended **ligand to metal** ratio of at least 2 (*i.e.*, at least 2:1). EX1040, ¶¶135-138. The ratio of peroxide (ligand) to hafnium (metal ion) in Stowers 2008 is 0.75:1. EX1008, 68; EX1040, ¶136. Stowers 2008 disclosed that the addition of peroxide in the films allows the films to act as photoresists. EX1008, 143 (adapted materials to be photoresists by “changing the chemistries to a peroxide based system”); EX1040, ¶136. The peroxide content of the films is therefore a result-effective variable that a POSA would modify to optimize the sensitivity of the film. EX1040, ¶¶135-138. Thus, the optimization of the result-effective peroxide content is “within the grasp of” a POSA. *In re Applied*

Materials, 692 F.3d 1289, 1296 (Fed. Cir. 2012); *see also Pfizer Inc. v. Sanofi Pasteur Inc.*, 94 F.4th 1341, 1347-48 (Fed. Cir. 2024); *In re Aller*, 220 F.2d 454, 456 (C.C.P.A. 1955) (“[I]t is not inventive to discover the optimum or workable ranges [of disclosed general conditions] by routine experimentation.”). Substitute claim 19 is therefore not patentable.

B. Inpria’s Proposed New Limitations Are Taught By Trikeriotis

Inpria argues that Trikeriotis is not prior art. Mot. at 8. Yet, as explained in Lam’s contemporaneous Reply to Patent Owner’s Response, the document itself shows a date of “22-24 February 2010,” and a declaration from the publisher shows that Trikeriotis was published online on 25 March 2010 and in print on 3 May 2010. Trikeriotis is therefore prior art to the ’564 patent. 35 U.S.C. §102(a) (pre-AIA).

Trikeriotis discloses that “film thicknesses ranging from 30 nm to 200 nm can be easily achieved.” EX1024, 18. Inpria cherry picks out of context statements from Trikeriotis to argue a POSA would have been motivated only to create “thicker films,” not thinner films. Mot. at 11. Although Trikeriotis was testing a variety of film thicknesses, including those thicker than 30 nm, Trikeriotis explained that “[t]he trend of ever decreasing feature sizes in subsequent lithography generations is paralleled by the **need to reduce resist thickness** to prevent pattern collapse.” EX1024, 15. This confirms a POSA’s understanding that film thickness should be reduced to avoid pattern collapse. *E.g.*, EX1012, 8 (“pattern collapse depends on the

pattern height”); EX1040, ¶¶133-134. It would therefore have been obvious to reduce the Trikeriotis film thickness by just 5 nm to a thickness of about 25 nm.

Substitute claim 13 is therefore not patentable over Trikeriotis.

V. PROPOSED AMENDED CLAIMS 13-18 AND 20-23 ARE ANTICIPATED BY KESZLER (EX1038) AND PROPOSED AMENDED CLAIM 19 IS RENDERED OBVIOUS BY KESZLER (NEW GROUNDS).

Keszler published on July 10, 2008. EX1038, 1. Keszler is therefore prior art to the '564 patent under pre-AIA §102(b). Keszler is an International Application Publication which names Oregon State University as an applicant and names Doulas Keszler, Jason Stowers (who are each inventors of the '564 patent), Jeremy Anderson, Peter Hersh, and Stephen Meyers as inventors. *Id.* Keszler discloses hafnium or zirconium films, which it refers to as HafSOx or ZircSOx. *Id.*, 5:4-9. Keszler explains that the hafnium or zirconium oxy hydroxy compounds can be used in a photoresist layer for patterning a device. *Id.*, 6:16-25. As shown in detail below, Keszler discloses each and every limitation of (and therefore anticipates) proposed amended claims 13-18 and 2-23 and renders obvious proposed amended claim 19.

A. Independent Claim 13

1. Preamble: “structure comprising a substrate and a coating material on a surface of the substrate”

Keszler discloses “patterning a device using a photoresist” by “providing a **structure**” which comprises a “resist layer.” EX1038, 4:16-25. Example 4 of

Keszler discloses that “thin **films** were deposited on **silica substrates**” by spin coating precursor solutions onto the substrate. *Id.*, 40:8-20. Similarly, Example 7 disclose “**inorganic film** containing peroxide or related coordinating species is spin-cast, liquid misted, or ink-jet printed onto **an appropriate substrate**.” *Id.*, 42:8-10. A POSA would have understood that the films are “coatings” on the surface of a “substrate.” EX1040, ¶¶90-91. Keszler therefore discloses the preamble.

2. “coating material comprises metal ions with radiation sensitive ligands”

Keszler discloses that the “resist layer typically includes disclosed **hafnium** and/or **zirconium** oxy hydroxy compounds.” EX1038, 4:16-25. In Example 4, Keszler discloses precursor solutions comprising hafnium (“Hf”) or zirconium (“Zr”) ions and peroxide (“H₂O₂”) ligands. *Id.*, 38:6-63. Consistent with Keszler’s description of HfOCl₂ and ZrOCl₂ as “metal ion[s],” a POSA would understand that because HfOCl₂ and ZrOCl₂ are in aqueous solutions, they exist as HfO⁺² and ZrO⁺² cations. EX1040, ¶¶93-94. Indeed, Keszler explains that “the **metal-containing cation** may be provided using an aqueous solution of a hafnium oxy halide, such as hafnium oxy chloride (HfOCl₂ (aq)).” EX1038, 12:34-13:1.

Keszler discloses that the peroxide in the precursor solution of Keszler Example 4 is a radiation sensitive ligand. EX1038, 28:9-12. A POSA would understand that the hydrogen peroxide (H₂O₂) of the precursor solutions of Keszler Example 4 are “peroxide” (O₂²⁻) and that because inclusion of the peroxide into the

precursor solutions provides a “new lithographic patterning method,” the peroxides are “radiation sensitive ligands.” EX1040, ¶¶96. Because the precursor solutions in Keszler are spin-coated to make films, it follows that the resulting films also contain metal ions and the radiation-sensitive peroxide ligands. EX1040, ¶¶95.

Moreover, the Keszler Example 4 precursor solutions contain the same components as the precursor solutions used to make the coating materials in the Examples of the '564 patent (i.e., HfOCl_2 or ZrOCl_2 , H_2O_2 and H_2SO_4) and other publications discussing the photosensitivity of the peroxide ligands in HfSOx and ZrSOx . EX1040, ¶¶97-100. Any differences in the precursor solutions or processing conditions are immaterial. *Id.* Accordingly, because the '564 patent and other post-priority publications describe that the peroxide in the precursor solution is a radiation sensitive ligand (i.e., an inherent property of the material), EX1001, 6:9-10, the peroxide in the precursor solution of Keszler is also a radiation sensitive ligand. *See Alcon Rsch., Ltd. v. Apotex Inc.*, 687 F.3d 1362, 1369 (Fed. Cir. 2012) (analyzing inherency based on the disclosure of the “patent itself”).

3. “coating material has an average thickness of about 25 nm”

Keszler discloses depositing the precursor solutions as “a thin film (from about 1 nm to about 100 nm).” EX1038, 32:3-15. For example, Example 4’s precursor solutions can produce “films as thin as about 2 nm.” *Id.* 40:1-2. Indeed, by

varying the concentration of the metal ion in the precursor solution, Keszler formed films having thicknesses “from 3 to **25 nm.**” *Id.* 40:13-14.

4. “wherein exposure of the coating material to UV, EUV and/or electron-beam radiation alters the chemical properties of the coating material creating an exposed coating material with differential dissolution rates between exposed and un-exposed regions of the coating material”

Keszler discloses that that patterns are formed by changing the chemical structure of the resist layer via radiation, which creates a coating material with differential dissolution rates between exposed and un-exposed regions:

Patterns can be formed using a positive or negative photoresist...For positive resists, the resist layer 1016 is **exposed** to an energy source, such as **UV** light, wherever the underlying material is to be removed. In these resists, exposure to the UV light **changes the chemical structure** of the resist layer 1016 so that it becomes **more soluble**....

Id. 28:15-21; *see also id.* at 8:1-12.

As described above, the Keszler Example 4 precursor solutions are the same in all material aspects to those in the Examples of the '564 patent and other publications discussing the mechanism of HafSO_x and ZircSO_x photosensitivity. EX1040, ¶¶97-100. Thus, because the '564 patent and other post-priority publications show radiation breaks the peroxide bond of the HafSO_x and ZircSO_x resists, which induces condensation causing a difference in solubility between the exposed and unexposed regions, radiation exposure must also cause a chemical

change resulting in differential dissolution in the Keszler HfSO_x and ZrSO_x resists. EX1040, ¶105-108.

B. Proposed Substitute Dependent Claims 14-23

Claim 14: Proposed claim 14 depends on claim 13 and recites that “the metal ions comprise metal suboxide ions.” The ’564 patent defines “metal suboxide cations” as “polyatomic cations with a metal element and covalently bonded oxygen atoms,” such as HfO^{+2} and ZrO^{+2} . EX1001, 5:47-49, 10:62-64. Keszler further discloses that “the metal containing ion may comprise a **metal suboxide**.” EX1038, 13:20-21. As Keszler notes, the $\text{HfOCl}_2 \cdot 8\text{H}_2\text{O}$ or $\text{ZrOCl}_2 \cdot 8\text{H}_2\text{O}$ in the precursor solutions are “metal ion[s]” *Id.* 38:6-63. Consistent with Keszler’s description, a POSA would understand that HfOCl_2 and ZrOCl_2 exist in solution as HfO^{+2} and ZrO^{+2} , respectively. EX1040, ¶109. Thus, Keszler’s “metal ions comprise metal suboxide ions.” *Id.*

Claim 15: Proposed claim 15 depends on claim 13 and recites that “the metal of the metal ions comprises . . . Zr, [or] . . . Hf.” Keszler’s films include HfO^{+2} and ZrO^{+2} cations and therefore comprises Zr or Hf. Section IV.B; EX1040, ¶111.

Claim 16: Proposed claim 16 depends on claim 13 and recites that “the radiation sensitive ligands comprise peroxide ligands.” Keszler’s films include **peroxide** as the radiation sensitive ligand. Section IV.A; EX1040, ¶112.

Claim 17: Proposed claim 17 depends on claim 13 and recites that the “coating material further comprises polyatomic anions.” The Keszler precursor solution of Example 4 comprises H_2SO_4 . EX1038, 38:6-63. Keszler further explains that the films may comprise “a polyatomic anion, such as sulfate (SO_4^{2-}), [which] may be provided using an aqueous solution of sulfuric acid (H_2SO_4 (aq)). *Id.* 13:1-2. Consistent with Keszler’s description, a POSA would understand that H_2SO_4 exists in solution as SO_4^{2-} , which is a polyatomic anion. EX1040, ¶113. Accordingly, the Keszler films “further comprises polyatomic anions.” *Id.*

Claim 18: Proposed claim 18 depends on claim 13 and recites that the “coating material has high absorption of EUV radiation relative to conventional radiation-based resists.” The HfSOx and ZrSOx films are materially the same as those in the ’564 patent. EX1040, ¶¶97-100, 116. Thus, Keszler’s HfSOx films must necessarily have “high absorption of EUV radiation relative to conventional radiation-based resists,” per the ’564 patent. EX1001, 8:67-9:2, 11:26-27.

Moreover, a publication by Jason Stowers and Douglas Keszler (inventors of both Keszler and the ’564 patent) reports that metal oxide sulfate (MSOx), such as HfSOx and ZrSOx , have 4-x more EUV absorption compared to “conventional polyhydroxystyrene” resists. EX1022, 3; EX1040, ¶114. This is consistent with reports that EUV absorption increases with density of materials. EX1025, 4; EX1002, ¶136; *see also* EX1040, ¶¶115-116. Thus, HfSOx and ZrSOx would

have a “high absorption of EUV radiation relative to conventional radiation-based resists.” EX1040, ¶¶114-116.

Claim 19: Proposed claim 19 depends on claim 13 and recites that the structure has a “molar concentration ratio of radiation sensitive ligands to metal ion of at least 2.” Keszler discloses a precursor solution comprising HfOCl_2 or ZrOCl_2 , with H_2O_2 and H_2SO_4 to form photoresists. EX1038, 32:14-15. Keszler Example 4’s precursor solution comprises a molar concentration ratio of ligand to metal of 0.7:1. EX1040, ¶125. Keszler discloses that the peroxide allows the films to act as photoresists. EX1038, 28:9-12 (inclusion of peroxide provides a “new lithographic patterning method.”); EX1040, ¶126. The peroxide content of the films is therefore a result-effective variable that a POSA would modify to optimize the sensitivity of the film. EX1040, ¶¶135-138. The optimization of the result-effective peroxide content is “within the grasp” of a POSA. *Applied Materials*, 692 F.3d at 1296; *see also* Pfizer, 94 F.4th at 1347-48; *Aller*, 220 F.2d at 456.

Claim 20: Proposed claim 20 depends on claim 13 and recites that the “coating material has been heated to temperatures from 45 C. to 150 C.” The Keszler films in Example 4 were heated “at 125 °C for 1-2 minutes.” EX1038, 40:17-19. Similarly, the Keszler films in Example 7 were “heated at modest temperatures of less than 100 °C” before exposure. *Id.* at 44:11-12. EX1040, ¶117.

Claim 21: Proposed claim 21 depends on claim 13 and recites that “following exposure an exposed coating region is insoluble in an aqueous solvent.” A POSA would understand claim 21 to recite a **negative tone resist**. EX1040, ¶118. Keszler discloses that the “resist may be a positive resist or a negative resist.” EX1038, 6:26. Keszler explains that the exposed portions of the negative tone resists are “insoluble in acid,” which is an aqueous solvent. *Id.* 29:2-5, 32:25-27; EX1040, ¶119.

Claim 22: Proposed claim 22 depends on claim 13 and recites that “following exposure an exposed coating region is soluble in an organic solvent.” A POSA would understand claim 22 to recite a **positive tone resist**. EX1040, ¶120. Keszler discloses that the “resist may be a positive resist or a negative resist.” EX1038, 6:26. And, as described above, the Keszler Example 4 precursor solutions are the same in all material aspects to those in the '564 patent's Examples. EX1040, ¶¶97-100, 121. Thus, because the '564 patent describes that HfSOx and ZrSOx may be a positive tone resist when an organic solvent is used as the developer, the exposed region of the Keszler films must be soluble in an organic solvent. EX1040, ¶121.

Claim 23: Proposed claim 19 depends on claim 13 and recites that the “coating material can be effectively patterned with UV radiation or EUV radiation at a dose of no more than 100 mJ/cm^2 .” Keszler discloses that the HfSOx materials were patterned with an “electron beam at dose levels ranging from greater than $0 \text{ } \mu\text{C/cm}^2$ to at least $400 \text{ } \mu\text{C/cm}^2$ ” and could be patterned as “at dose levels as low as

2 $\mu\text{C}/\text{cm}^2$.” EX1038, 33:13-18. A dose of 2 $\mu\text{C}/\text{cm}^2$ corresponds to a UV radiation or EUV radiation at a dose of no more than 100 mJ/cm^2 as confirmed by the ’564 patent (EX1001, (“The method can comprise irradiating a layer of coating material with extreme ultraviolet light at a dose of no more than about 100 mJ/cm^2 or an electron beam at a dose equivalent to no more than about 300 $\mu\text{C}/\text{cm}^2$ at 30 kV”)) and articles from Jason Stowers and Douglas Keszler (inventors of both Keszler and the ’564 patent) (EX1022, (explaining an EUV dose of 249 $\mu\text{C}/\text{cm}^2$ corresponds to an UV dose of 25 mJ/cm^2)). EX1040, ¶¶122-124. Accordingly, the HfSO_x and ZrSO_x films of Keszler are “can be effectively patterned with UV radiation or EUV radiation at a dose of no more than 100 mJ/cm^2 .” *Id.*

VI. CONCLUSION

Proposed substitute claims 13-23 are improper and unpatentable. Claim 19 enlarges claim scope, so does not meet the requirements of 35 U.S.C. § 316(d). Claims 13-23 also fail to comply with the written description, enablement, and definiteness requirements of Section 112, making them unpatentable. Finally, claims 13-23 are anticipated or obvious in view of the prior art. For these reasons, PO’s Motion to Amend should be denied.

Dated: October 23, 2024

Respectfully Submitted,

/ Dion M. Bregman /

Dion M. Bregman, Reg. No. 45,645

Counsel for Petitioner

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6(e)(4), it is hereby certified that on October 23, 2024 an electronic copy of this PETITIONER’S OPPOSITION TO PATENT OWNER’S MOTION TO AMEND was served via email to Patent Owner’s counsel of record in this proceeding:

Naveen Modi (naveenmodi@paulhastings.com)
Phillip Citroen (phillipcitroen@paulhastings.com)
Eric Dittmann (ericdittmann@paulhastings.com)
Isaac Ashkenazi (isaacashkenazi@paulhastings.com)
Paul Anderson (paulanderson@paulhastings.com)
Daniel Zeilberger (danielzeilberger@paulhastings.com)
Michael Wolfe (michaelwolfe@paulhastings.com)

Dated: October 23, 2024 / *Dion M. Bregman* /
Dion M. Bregman, Reg. No. 45,645