Trials@uspto.gov
571-272-7822

Paper 68
Entered: June 23, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.,
MICRON TECHNOLOGY, INC., and SK HYNIX, INC.,
Petitioner,

v.

ELM 3DS INNOVATIONS, LLC,
Patent Owner.

Case IPR2016-00386 Patent 8,653,672 B2
Case IPR2016-00387 Patent 8,841,778 B2
Case IPR2016-00388 Patent 7,193,239 B2

Before GLENN J. PERRY, BARBARA A. BENOIT, and FRANCES L. IPPOLITO, *Administrative Patent Judges*.

BENOIT, *Administrative Patent Judge*.

DECISION
Final Written Decision
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

These *inter partes* reviews, instituted pursuant to 35 U.S.C. § 314, challenge the patentability of certain claims of U.S. Patent Nos. 8,653,672 B2 ("the '672 patent"), 8,841,778 B2 ("the '778 patent"), and 7,193,239 B2 ("the '239 patent),[1] each of which shares the same written description. All of the challenged patents are owned by Elm 3DS Innovations, LLC ("Patent Owner"). We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. This Decision is issued concurrently with a Final Written Decision in IPR2016-00393, which also challenges the patentability of claims 10−12, 18−20, 60−63, 67, 70−73, and 77 of the '239 patent.

For the reasons discussed herein, Petitioner has *not* shown by a preponderance of the evidence that the challenged claims in any of the challenged patents are unpatentable.

A. Procedural History

In IPR2016-00386, Petitioner filed a Petition seeking *inter partes* review of certain claims of the '672 patent and we instituted a review. IPR386-Paper 1 ("IPR386-Petition" or "IPR386-Pet."); IPR386-Paper 14 ("IPR386-Institution Decision" or "IPR386-Inst. Dec."). In IPR2016-00387, Petitioner filed a Petition seeking *inter partes* review of certain claims of the '778 patent, and we instituted a review. IPR387-Paper 1 ("IPR387-Petition"

[1] The challenged patent is Exhibit 1001 in each proceeding. Citations may be preceded by "IPR386" to designate IPR2016-00386, "IPR387" to designate IPR2016-00387, or "IPR388" to designate IPR2016-00388.

or "IPR387-Pet."); IPR387-Paper 13 ("IPR387-Institution Decision" or "IPR387-Inst. Dec."). In IPR2016-00388, Petitioner filed a Petition seeking *inter partes* review of certain claims of the '239 patent, and we instituted a review. IPR388-Paper 4 ("IPR388-Petition" or "IPR388-Pet."); IPR388-Paper 11 ("IPR388-Institution Decision" or "IPR388-Inst. Dec."). In our Decisions to Institute, we did not agree with Patent Owner that the Petitions were barred under 35 U.S.C. § 315(b) because, according to Patent Owner, the Office lacked authority to treat certain days on which the Office experienced an emergency situation, such that many of its online and information technology systems were shut down, as federal holidays. IPR386-Inst. Dec. 4–5; IPR387-Inst. Dec. 3–4; IPR388-Inst. Dec. 4–5. Patent Owner has not raised this issue subsequent to institution in any of the three proceedings.

In response to an order to clarify the claim construction standard to be applied in each proceeding (IPR386-Paper 18; IPR387-Paper 16; IPR388-Paper 14), Patent Owner certified that each of the challenged patents in these three proceedings would expire prior to the deadline for issuing a final written decision and, therefore, contended that the claim construction standard set forth in *Phillips v. AWH Corp*., 415 F.3d 1303 (Fed. Cir. 2005), should be applied (IPR386-Paper 23; IPR387-Paper 21; IPR388-Paper 19). Petitioner concurred with Patent Owner's contention. IPR386-Paper 25; IPR387-Paper 23; IPR388-Paper 21. We agreed with the parties and issued an order indicating that the *Phillips* claim construction standard should be

applied in each of these three proceedings. IPR386-Paper 28; IPR387-Paper 26; IPR388-Paper 24.

Subsequent to institution, Patent Owner filed a Patent Owner Response to the Petition in each case. IPR386-Paper 55 ("IPR386-PO Resp."); IPR387-Paper 50 ("IPR387-PO Resp."); IPR388-Paper 47 ("IPR388-PO Resp."). Petitioner filed a Reply to Patent Owner's Response to the Petition in each case. IPR386-Paper 61 ("IPR386-Pet. Reply"); IPR387-Paper 56 ("IPR387-Pet. Reply"); IPR388-Paper 53 ("IPR388-Pet. Reply").

We held a consolidated hearing for the *inter partes* reviews. A transcript of the oral hearing is included in the record of each proceeding. IPR386-Paper 67; IPR387-Paper 62; IPR388-Paper 59 (collectively "Tr.").

B. Related Matters

As required by 37 C.F.R. § 42.8(b)(2), each party identifies various judicial or administrative matters that would affect or be affected by a decision in this proceeding. IPR386-Pet. 1–2; IPR386-Paper 9 (Patent Owner's Mandatory Notices); IPR387-Pet. 1–2; IPR387-Paper 8 (Patent Owner's Mandatory Notices); IPR388-Pet. 1–2; IPR388-Paper 7 (Patent Owner's Mandatory Notices). Petitioner indicates that the challenged patents are involved in the following United States District Court proceedings: *Elm 3DS Innovations, LLC v. Samsung Elecs. Co.*, No. 1:14-cv-01430 (D. Del.); *Elm 3DS Innovations, LLC v. Micron Tech., Inc.*, No. 1:14-cv-01431 (D. Del.); and *Elm 3DS Innovations, LLC v. SK Hynix Inc.*, No. 1:14-cv-01432 (D. Del.).

The ’239 patent, which is challenged in IPR2016-00388, also is the subject of *inter partes* review IPR2016-00393. Additionally, patents related to the challenged patent are the subjects of petitions filed in IPR2016-00389 (U.S. Patent No. 8,035,233); IPR2016-00390 (U.S. Patent No. 8,629,542); IPR2016-00391 (U.S. Patent No. 8,796,862); IPR2016-00394 (U.S. Patent No. 8,410,617); IPR2016-00395 (US Patent No. 7,504,732); IPR2016-00687 (U.S. Patent No. 8,928,119); IPR2016-00691 (U.S. Patent No. 7,474,004); IPR2016-00708 (U.S. Patent No. 8,907,499); IPR2016-00770 (U.S. Patent No. 8,907,499); and IPR2016-00786 (U.S. Patent No. 8,933,570). We also note that Petitioner filed two additional petitions requesting *inter partes* review of U.S. Patent No. 8,791,581 (IPR2016-00703 and IPR2016-00706) for which we did not institute a review.

C. The Written Description of the Challenged Patents[2]

The challenged patents identify Glenn J. Leedy as sole inventor of the claimed subject matter. The patents each claim the benefit of the filing date of April 4, 1997 through a series of continuation or divisional applications. Accordingly, the patents share a common written description.

The patents generally relate to a three-dimensional structure (3DS) for integrated circuits that allows for physical separation of memory circuits and control logic circuits on different layers. Ex. 1001, Abstract. Figure 1a is reproduced below.

[2] For brevity, citations to the written description refer to the ’672 patent at issue in IPR2016-00386.

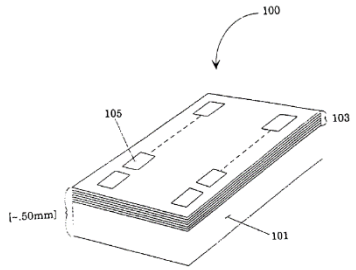


Figure 1a

Figure 1a shows 3DS memory device 100 having a stack of integrated circuit layers with a "fine-grain inter-layer vertical interconnect" between all circuit layers. *Id.* at 3:64–67. Layers shown include controller circuit layer 101 and memory array circuit layers 103. *Id.* at 4:17–19. The written description discloses that "each memory array circuit layer is a thinned and substantially flexible circuit with net low stress, less than 50 μm and typically less than 10 μm in thickness." *Id.* at 4:22–24. The written description further discloses that the "thinned (substantially flexible) substrate circuit layers are preferably made with dielectrics in low stress (less than 5×10^8 dynes/cm^2) such as low stress silicon dioxide and silicon nitride dielectrics as opposed to the more commonly used higher stress dielectrics of silicon oxide and silicon nitride used in conventional memory circuit fabrication." *Id.* at 8:45–50.

Figure 1b is reproduced below.

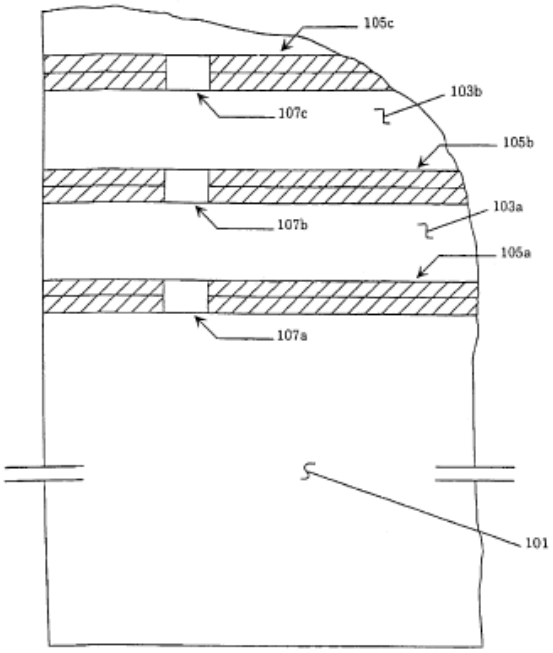


Figure 1b

Figure 1b of written description shows a cross-section of a 3DS integrated circuit with metal bonding interconnect between thinned circuit layers. *Id*. at 3:38–40. Bond and interconnect layers 105a, 105b, 105c are shown between circuit layers 103a and 103b. *Id.* at Fig. 1b. The written description discloses that pattern 107a, 107b, 107c in the bond and interconnect layers 105a, 105b, 105c defines the vertical interconnect contacts between the integrated circuit layers and serves to electrically isolate these contacts from each other and the remaining bond material. *Id.* at 4:11–15. Additionally, the written description teaches that the pattern takes the form of voids or dielectric filled spaces in the bond layers. *Id.* at 4:15–16.

Further, the written description teaches that the "term fine-grained inter-layer vertical interconnect is used to mean electrical conductors that pass through a circuit layer with or without an intervening device element and have a pitch of nominally less than 100 µm. . . ." *Id.* at 3:67–4:4. The fine-grained inter-layer vertical interconnect functions to bond together various circuit layers. *Id.* at 4:5–7.

D. Instituted Grounds of Unpatentability

We instituted *inter partes* reviews of the challenged patents based on Petitioner's asserted grounds involving the following references:[3] (i) U.S. Patent No. 5,202,754, issued April 13, 1993 (Ex. 1004, "Bertin '754"); (ii) U.S. Patent No. 5,354,695, issued Oct. 11, 1994 (Ex. 1006, "Leedy '695"); (iii) U.S. Patent No. 5,162,251, issued Nov. 10, 1992 (Ex. 1005, "Poole"); (iv) Yu, et al., *Real-Time Microvision System with Three-Dimensional Integration Structure*, Proceedings of the 1996 IEEE/SICE/RSJ International Conference on Multisensor Fusion and Integration for Intelligent Systems, 1996 (Ex. 1009, "Yu"); and (v) U.S. Patent No. 5,627,106, issued May 6, 1997 (Ex. 1008, "Hsu").

We instituted *inter partes* reviews of the challenged patents based on 35 U.S.C. § 103[4] on the particular following grounds:

---

[3] The prior art references have the same exhibit numbers in each proceeding.
[4] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), revised 35 U.S.C. § 103, effective March 16, 2013. Because the challenged patent was filed before March 16, 2013, we refer to the pre-AIA version of § 103 in this decision.

Case	References	Claims Challenged
IPR2016-00386	Bertin ’754, Poole, and Leedy ’695	Claims 17, 18, 22, 84, 95, 129–132, 145, 146, and 152
IPR2016-00386	Yu and Leedy ’695	Claims 17, 18, 22, 84, 95, 129–132, 145, 146, and 152
IPR2016-00387	Bertin ’754 and Leedy ’695	Claims 1, 2, 8, 14, and 52
IPR2016-00387	Bertin ’754, Poole, and Leedy ’695	Claims 2, 8, 31, 32, 44, 46, and 52–54
IPR2016-00387	Hsu and Leedy ’695	Claims 1, 2, 8, 14, 31, 32, 44, 46, and 52–54
IPR2016-00388	Yu and Leedy ’695	Claims 10–12, 18–20, 60–63, 67, 70–73, and 77

IPR386-Inst. Dec. 40; IPR387-Inst. Dec. 34; IPR388-Inst. Dec. 28.

II. DISCUSSION[5]

A. Principles of Law

1. Principles of Claim Construction

The patents challenged in these three proceedings have expired. *See* IPR386-Paper 23 (Patent Owner’s Notice of Patent Expiration indicating the ’672 patent would expire on April 4, 2017); IPR387-Paper 21 (indicating that the ’778 patent would expire on April 4, 2017), IPR388-Paper 19 indicating that the ’239 patent would expire on April 4, 2017. For claims of an expired patent, the Board’s claim construction analysis is similar to that of a district court. *See In re Rambus, Inc.*, 694 F.3d 42, 46 (Fed. Cir. 2012); *see, e.g.*, IPR386-Paper 28 (determining a district court-type claim

[5] The discussion in this section, unless otherwise noted, addresses issues relevant to IPR2016-00386, IPR2016-00387, and IPR2016-00388.

construction approach following *Phillips* is to be applied during IPR2016-IPR00386, IPR2016-00387, and IPR2016-00388). In this context, claim terms "are generally given their ordinary and customary meaning" as understood by a person of ordinary skill in the art in question at the time of the invention. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc). "In determining the meaning of the disputed claim limitation, we look principally to the intrinsic evidence of record, examining the claim language itself, the written description, and the prosecution history, if in evidence." *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 469 F.3d 1005, 1014 (Fed. Cir. 2006) (citing *Phillips*, 415 F.3d at 1312–17). Extrinsic evidence, such as expert testimony and dictionary definitions, can be helpful but is "less significant than the intrinsic record in determining the legally operative meaning of claim language." *Phillips*, 415 F.3d at 1317. Also, extrinsic evidence is to be considered within the context of the intrinsic evidence. *Id.* A claim term may be construed contrary to its ordinary and customary meaning only "under two circumstances: '(1) when a patentee sets out a definition and acts as [its] own lexicographer, or (2) when the patentee disavows the full scope of a claim term either in the specification or during prosecution.'" *Aventis Pharma S.A. v. Hospira, Inc.*, 675 F.3d 1324, 1330 (Fed. Cir. 2012) (quoting *Thorner v. Sony Computer Entm't Am. LLC*, 669 F.3d 1362, 1365 (Fed. Cir. 2012)); *Hill-Rom Svcs, Inc. v. Stryker Corp.*, 755 F.3d 1367, 1371 (Fed. Cir. 2014).

In each proceeding, we construe the challenged claims according to these principles.

2. Principles of Law Concerning Demonstrating Unpatentability

To prevail in challenging Patent Owner's claims, Petitioner must demonstrate by a preponderance of the evidence that the claims are unpatentable. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). "In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")). This burden never shifts to Patent Owner. *See Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (citing *Tech. Licensing Corp. v. Videotek, Inc.*, 545 F.3d 1316, 1326–27 (Fed. Cir. 2008)) (discussing the burden of proof in *inter partes* review). Furthermore, Petitioner cannot satisfy its burden of proving obviousness by employing "mere conclusory statements." *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016).

Petitioner asserts that certain claims of the challenged patents are unpatentable under 35 U.S.C. § 103(a) as obvious over various combinations of references. A claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time of the invention to a person having ordinary skill in the art. *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the

scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). Consideration of the *Graham* factors "helps inform the ultimate obviousness determination." *Apple v. Samsung Elecs. Co.*, 839 F.3d 1034, 1048 (Fed. Cir. 2016) (en banc).

B. Level of Ordinary Skill

In determining whether an invention would have been obvious at the time it was made, 35 U.S.C. § 103 requires us to resolve the level of ordinary skill in the pertinent art at the time of the invention. *Graham*, 383 U.S. at 17. "The importance of resolving the level of ordinary skill in the art lies in the necessity of maintaining objectivity in the obviousness inquiry." *Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714, 718 (Fed. Cir. 1991). The person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. *In re GPAC, Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995). Factors that may be considered in determining the level of ordinary skill in the art include, but are not limited to, the types of problems encountered in the art, the sophistication of the technology, and educational level of active workers in the field. *GPAC*, 57 F.3d at 1579. In a given case, one or more factors may predominate. *Id.* Generally, it is easier to establish obviousness under a higher level of ordinary skill in the art. *Innovention Toys, LLC v. MGA Entm't, Inc.*, 637 F.3d 1314, 1323 (Fed. Cir. 2011) ("A less sophisticated level of skill

generally favors a determination of nonobviousness . . . while a higher level of skill favors the reverse.").

Petitioner, with support of its declarant Paul D. Franzon, Ph.D., contends that one of ordinary skill in the art at the time of the inventions of the challenged patents "would have had at least a B.S. degree in electrical engineering, material science, or equivalent thereof, and at least 3–5 years of experience in the relevant field, e.g., semiconductor processing." IPR386-Pet. 5 (citing Ex. 1002 ¶¶ 52–53); *see* IPR387-Pet. 4 (citing Ex. 1002 ¶¶ 52–53); IPR388-Pet. 4 (citing Ex. 1002 ¶¶ 52–53). According to Dr. Franzon, his testimony as to the level of ordinary skill is based on considering "the types of problems encountered in the art, prior art solutions to those problems, the rapidity with which innovations are made, the sophistication of the technology, and the educational level of active workers in the field." IPR386-Ex. 1002 ¶ 53; *see* IPR387-Ex. 1002 ¶ 53; IPR388-Ex. 1002 ¶ 53. Patent Owner did not propose expressly a particular level of ordinary skill. *See, e.g., generally* IPR386 PO Resp.; IPR386 Ex. 2166 (Patent Owner's expert's declaration). At the oral hearing, however, Petitioner indicated that there did not seem to be any dispute as to the correct level of ordinary skill. Tr. 112:11–14 ("I don't think there was any dispute about whether [Dr. Franzon's proposed level of ordinary skill] was the correct level of skill, although Patent Owner can correct me.").

Having reviewed the prior art asserted in these proceedings (*see, e.g.*, Exs. 1004–07, 1009, 2160[6]), we determine that the level of ordinary skill proposed by Petitioner's declarant is consistent with the challenged patents and the referenced prior art, and we adopt that definition of the level of ordinary skill in the art for the purposes of the analysis below.

C. Disclosures of Prior Art References[6]

1. Disclosure of Bertin '754

Bertin '754 is a United States Patent that describes an improvement to a known multichip package as shown in its "prior art" Figure 1, reproduced below.

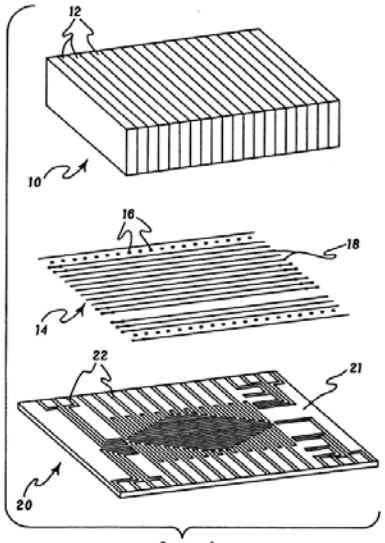


fig. 1
(PRIOR ART)

[6] The exhibit numbers for the asserted prior art references are the same in IPR2016-00386, IPR2016-00387, and IPR2016-00388.

Bertin '754's Figure 1 is an exploded perspective view of a basic prior art multichip package. Ex. 1004, 2:43–44.

Bertin '754 describes "[a] fabrication method and resultant three-dimensional multichip package having a densely stacked array of semiconductor chips." *Id.* at Abstract. More specifically, Bertin '754 relates to a method for fabricating a three-dimensional multichip package having a densely stacked array of semiconductor chips interconnected at least partially by means of a plurality of metallized trenches in the semiconductor chips. Ex. 1004, 1:10-15. Figure 3a is reproduced below.

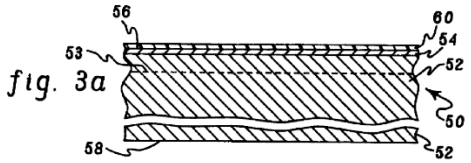


fig. 3a

Referring first to FIG. 3a of Bertin '754, which depicts a three-dimensional multichip package, processing begins with semiconductor device 50 (preferably comprising a wafer) having substrate 52 and active layer 54, which is typically positioned at least partially therein. Layer 54 may be totally or partially defused into substrate 52 and/or partially or totally built up from substrate 52 using *conventional semiconductor processing techniques* known to those skilled in the art. *Id.* at 3:50–57 (emphasis added). Layer 54 is adjacent to first, upper planar surface 56 of device 50. *Id.* at 3:57–58. Second, lower planar surface 58 of stacked chip 50 is positioned substantially parallel to first planar surface 56. *Id.* at 3:59–60. Stacked chip 50 includes semiconductor "substrate 52" (*id.* at 3:50–4:3), which is thinned to 20 μm or less (*id*. at 3:25–46, 5:10–22). Bertin '754

further teaches that "dielectric layer 60, for example, SiO_2, is grown over active layer 54 of device 50." *Id.* at 3:60–62, Fig. 3a. Additionally, Bertin '754 teaches that the multichip package includes vertical electrical interconnections (e.g., metallized trenches) that pass completely through substrates 52. *Id.* at Abstract, 1:62–2:12, 4:11–52, Figs. 3c, 3b, 3e, 3g.

2. Disclosure of Leedy '695

Leedy '695 is a United States Patent naming Glenn J. Leedy as sole inventor and titled "Membrane Dielectric Isolation IC Fabrication." Ex. 1006 [54], [76]. In its Abstract, the patent indicates that the disclosed integrated circuits are fabricated "from flexible membranes formed of very thin low stress dielectric materials, such as silicon dioxide or silicon nitride, and semiconductor layers." *Id.* at Abstract. Leedy '695 is incorporated by reference into the written description of the '672, '778, and '239 patents (and the entire Elm 3DS patent family). IPR386-Ex. 1001, 2:21–23 ("Assembling die in a stacked or three dimensional (3D) manner is disclosed in [Leedy '695] of the present inventor, incorporated herein by reference."); IPR387-Ex. 1001, 2:21–23; IPR388-Ex. 1001, 2:34–36. Leedy '695 discloses forming a "tensile low stress dielectric membrane" on a semiconductor layer as part of its integrated circuit structure. *Id.* at 1:53–58. Leedy '695 defines "[l]ow stress . . . relative to the silicon dioxide and silicon nitride deposition made with the Novellus equipment as being less than 8×10^8 dynes/cm^2 (preferably 1×10^7 dynes/cm^2) in tension." *Id.* at 11:33–37. Additionally, Leedy '695 discloses two chemical vapor deposition (CVD) process recipes for manufacturing "structurally enhanced

low stress dielectric circuit membranes." *Id.* at 11:51–65.

Referring to Figure 8, Leedy '695 discloses a three dimensional circuit membrane. *Id.* at 4:43. Figure 8 is reproduced below.

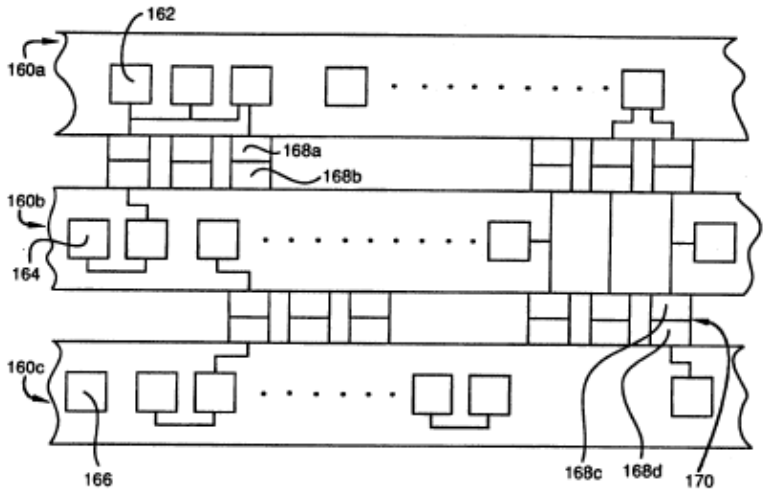


Fig_8

Figure 8 shows the vertical bonding of two or more circuit membranes to form a three dimensional circuit structure. *Id.* at 16:38–40. Interconnection between circuit membranes 160a, 160b, 160c including SDs 162, 164, 166 is by compression bonding of circuit membrane surface electrodes 168a, 168b, 168c, 168d (pads). *Id.* at 16:40–43. Bonding 170 between MDI circuit membranes is achieved by aligning bond pads 168c, 168d (typically between 4 μm and 25 μm in diameter) on the surface of two circuit membranes 160b, 160c and using a mechanical or gas pressure source to press bond pads 168c, 168d together. *Id.* at 16:43–49.

3. Disclosure of Poole

Poole is a United States Patent that describes techniques for making charge-coupled devices, which are thinned to allow illumination of the

backside of the device to improve quantum efficiency and UV spectral response. Ex. 1005, Abstract, 1:8–11. It describes a two-step method for thinning the backside of a silicon semiconductor substrate that includes integrated circuitry previously formed on the front side. *Id.* at Abstract, 1:7–18, 3:12–25. First, "[t]he bulk silicon is thinned to 75 μm with a 700 micro-grit aluminum oxide abrasive" (*id.* at 3:21–25; *see also id.* at Abstract, 3:33–34, 5:60–6:35), and "is then thinned and polished to 10 μm using 80 nm grit colloidal silica" (*id.* at 3:21–25; *see also id.* at Abstract, 3:33–34, 6:37–46). The result is a surface "almost totally free of work damage." *Id.* at 5:64–65; *see also id.* at 3:44–46.

4. Disclosure of Yu

Yu is a paper published in the proceedings of a technical conference sponsored by IEEE Industrial Electronics Society, the IEEE Robotics and Automation Society, the Society of Instrument and Control Engineers, and the Robotics Society of Japan. Ex. 1009, 3. Yu describes a three-dimensional integrated circuit structure for implementing a real-time microvision system. Ex. 1009, 831–32. "The system consists of a number of 2D LSIs vertically stacked using 3D LSI technology. . . ." *Id.* at 832. Yu's Figure 1 is reproduced below.

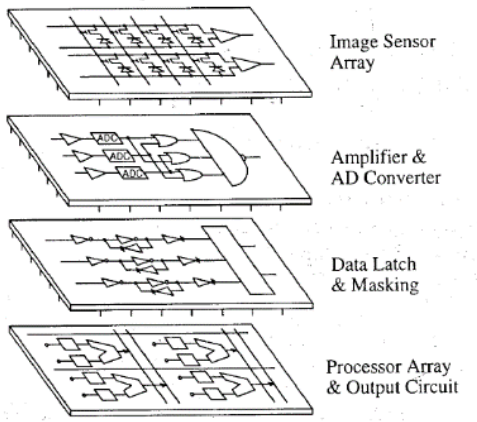


Figure 1: Basic concept of real-time microvision system with 3D integration structure

Figure 1 shows a basic concept of a real-time microvision system with a 3D integration structure.

In Yu's microvision system, substrates are ground and polished to thin the substrates to about 30 microns. *Id.* at 831–32 ("The Si substrate of the 2D-LSI which has the basic circuits is ground and polished to make thin wafer."); *id.* at Abstract ("In fabrication, grinding and chemical-mechanical polishing techniques are used to thin the wafer to 30 μm."). Wafers then are bonded together using a combination of conductive microbumps and a UV-hardening adhesive. *Id.* at 834–35 ("The thinned wafer is bonded to a thick wafer using In/Au micro-bumps with the minimum size of 5 μm x 5 μm and UV hardening adhesive layer with thickness of 1 μm by forcing the z direction pressure after careful wafer alignment."). The microbumps connect to buried interconnect structures that form vertical interconnects between vertically stacked circuitry. *Id.* at Fig. 8. Figure 1 shows a basic concept of a real-time microvision system with a 3D integration structure.

In Yu's microvision system, substrates are ground and polished to thin the substrates to about 30 microns. *Id.* at 831–32 ("The Si substrate of the 2D-LSI which has the basic circuits is ground and polished to make thin wafer."); *id.* at Abstract ("In fabrication, grinding and chemical-mechanical polishing techniques are used to thin the wafer to 30 μm."). Wafers then are bonded together using a combination of conductive microbumps and a UV-hardening adhesive. *Id.* at 834–35 ("The thinned wafer is bonded to a thick wafer using In/Au micro-bumps with the minimum size of 5 μm x 5 μm and UV hardening adhesive layer with thickness of 1 μm by forcing the z direction pressure after careful wafer alignment."). The microbumps connect to buried interconnect structures that form vertical interconnects between vertically stacked circuitry. *Id.* at Fig. 8.

5. Disclosure of Hsu

Hsu is a United States Patent that relates generally to a "method of connecting three-dimensional integrated circuit chips using trench technology." Ex. 1008, Abstract, 1:8–11. Referring to Figures 2–8, Hsu's fabrication process starts with etching deep trenches 16 on silicon substrate 10, which Hsu indicates can be composed of monocrystalline silicon. *Id.* at 2:50–61. Hsu's integrated circuits consist of "one master chip and some subordinate chips." *Id.* at 1:20–21. According to Hsu, the master chip and subordinate chip each consist of a semiconductor substrate, preferably composed of monocrystalline silicon. *Id.* at 2:51–54, 3:42–45. These chips can be "stacked by interconnection through [a] pad window [. . .] during integrated circuit processing." *Id.* at 1:28–31. Hsu further describes that the

"bottom surface of the [subordinate] substrate is ground and polished so that only a thin portion of the substrate remains." *Id.* at 3:21–23.

II. IPR2016-00386[7]—CLAIM CONSTRUCTION AND GROUNDS OF UNPATENTABILITY

In its IPR2016-00386 Petition, Petitioner contends (i) claims 17, 18, 22, 84, 95, 129–132, 145, 146, and 152 are unpatentable under 35 U.S.C. § 103 over Bertin '754, Poole, and Leedy '695 and (ii) claims 17, 18, 22, 84, 95, 129–132, 145, 146, and 152 are unpatentable under 35 U.S.C. § 103 over Yu and Leedy '695. Pet. 17–42, 46–57. Patent Owner opposes Petitioner's contentions. PO Resp. 1–3, 36–66.

A. Illustrative Claim of the Challenged Patent

Of the challenged claims in IPR2016-00386, claims 17, 84, and 129 are independent. Prior to institution, Patent Owner statutorily disclaimed claims 143, 144, and 151 (Ex. 2140), and we did not institute an *inter partes* review of claims 143, 144, and 151 on any ground. *See* 37 C.F.R. § 107(e) (prohibiting institution of an *inter partes* review based on disclaimed claims). Claim 145, however, depends from claim 144, which, in turn, depends from claim 143. Claim 145, therefore, requires all the limitations recited in disclaimed claims 143 and 144. *See* 35 U.S.C. § 112 (d) ("A claim in dependent form shall be construed to incorporate by reference all the limitations of the claim to which it refers."). Similarly, claim 152 depends

[7] Unless otherwise noted, references to papers and exhibits in this section refer to those of record in IPR2016-00386.

from disclaimed claim 151 and so requires all the limitations recited by that claim. Accordingly, we will include a discussion of the limitations recited in disclaimed claims 143, 144, and 151 as necessary to our discussion of this asserted ground. Claim 17 is illustrative of the claimed subject matter:

> 17. An integrated circuit structure comprising:
>
> a first substrate having topside and bottomside surfaces, wherein the topside surface of the first substrate supports interconnect contacts;
>
> a substantially flexible semiconductor second substrate having topside and bottom-side surfaces, wherein at least one of the topside surface and the bottom-side surface of the second substrate supports interconnect contacts, and wherein the bottom-side surface of the second substrate is formed by removing semiconductor material from the second substrate and is smoothed or polished after removal of the semiconductor material; and
>
> conductive paths between the interconnect contacts supported by the topside surface of the first substrate and the interconnect contacts supported by the second substrate; wherein the first substrate and the second substrate overlap fully or partially in a stacked relationship; and
>
> wherein at least one of:
>
> i.) the first and second substrates are bonded together in fixed relationship to one another at least predominantly with metal, or at least predominantly with silicon- based dielectric material and metal; and
>
> ii.) the integrated circuit structure further comprises a low-stress silicon-based dielectric material having a stress of $5x10^8$ dynes/cm^2 tensile or less.

Ex. 1001, 14:57–15:12 (paragraphing added).

B. Claim Construction: "Substantially Flexible"[8]

A central issue in these three proceedings is the construction of "substantially flexible."[9] Each of the challenged claims in this proceeding recites "a substantially flexible semiconductor substrate" (independent claim 84) or "a substantially flexible semiconductor second substrate" (independent claims 17, 129 and 143, from which challenged claims 145, 146, and 152 indirectly depend). Ex. 1001, 14:60–61 (claim 17), 24:6 (claim 84), 30:40 (claim 129), 32:50 (claim 143).

Petitioner contends the proper construction[10] of "substantially flexible [] semiconductor substrate" is "a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed." Pet. 9. In the Decision to Institute, we "preliminarily construe[d] 'substrate is substantially flexible' as 'a semiconductor substrate

---

[8] The term "substantially flexible" is at issue in thirteen of the Elm 3DS *inter partes* reviews: IPR2016-00386 ('672 patent), IPR2016-00387 ('778 patent), IPR2016-00388 ('239 patent), IPR2016-00390 ('542 patent), IPR2016-00391 ('862 patent), IPR2016-00393 ('239 patent), IPR2016-00394 ('617 patent), IPR2016-00395 ('732 patent), IPR2016-00687 ('119 patent), IPR2016-00691 ('004 patent), IPR2016-00708 ('499 patent), IPR2016-00770 ('499 patent), and IPR2016-00786 ('570 patent).

[9] *See, e.g.*, Pet. 9–13; PO Resp. 48–57; Pet. Reply 30–31; Tr. 5:7–66:13 (arguing claim construction issues).

[10] In its Petition, Petitioner asserted the construction of the term is the same under both the broadest reasonable construction standard and under the *Phillips* standard. IPR386-Pet. 9 n.6; Tr. 13:8–11 (Petitioner's counsel indicating that for substantially flexible the "construction would be the same under [broadest reasonable interpretation] and *Phillips*."); *see* Tr. 11:21–13:16.

that ha[d] been thinned to a thickness of less than 50 μm.'" Inst. Dec. 13. We also stated that the claim construction "may change as a result of the record developing during trial." *Id.* "We note[d], for example, that Patent Owner ha[d] not yet filed its response under 37 C.F.R. § 42.120 or any new testimonial evidence." *Id.*

In its Patent Owner Response, Patent Owner contends that the claim term "substantially flexible" carries its ordinary meaning and that the two exceptions for construing a claim term otherwise—(1) when the patentee sets out a definition of the claim term and (2) when the patentee disavows the full scope of the claim term either in the specification or during prosecution—do not apply here. PO Resp. 49–50 (citing *Aventis Parma S.A. v. Hospira, Inc.*, 675 F.3d 1324, 1330 (Fed. Cir. 2012) ("[W]e will only interpret a claim term more narrowly than its ordinary meaning under two circumstances: 1) when a patentee sets out a definition and acts as [its] own lexicographer, or 2) when the patentee disavows the full scope of a claim term either in the specification or during prosecution." (citation and internal quotation marks omitted))). Patent Owner contends that, based on dictionary definitions of substantial and flexible that the proper construction of "substantially flexible" is its ordinary and customary meaning—"largely able to bend without breaking." *Id.* at 51 (citing Ex. 2165).

Petitioner, in its Reply to the Patent Owner Response, argues that Patent Owner's proffered construction ignores "an express definition from the intrinsic record," which cannot be superseded by a general-purpose dictionary. Pet. Reply 30; *see also id.* (Petitioner indicating that Patent

Owner "asserts that 'substantially flexible' should be construed as 'largely able to bend without breaking. . . . [Patent Owner] defined "substantially flexible" in the patent specification."). Petitioner maintains its position that the intrinsic record purportedly includes a definition in the specification that was "confirmed" by Patent Owner during the prosecution of a related patent. *Id*. (citing Ex. 1001, 9:3–6, 3:5–8, 4:22–24; Pet. 10–11). Petitioner further contends that Patent Owner's proffered construction is ambiguous and, therefore, should be rejected. *Id.* at 31.

"In determining the meaning of the disputed claim limitation, we look principally to the intrinsic evidence of record, examining the claim language itself, the written description, and the prosecution history, if in evidence." *DePuy Spine*, 469 F.3d at 1014. For the reasons set forth below, we determine that "substantially flexible" in the context of the challenged patent means "largely able to bend without breaking."

1. Analysis of the Claim Language

We begin our analysis with the language of the claims. *Phillips*, 415 F.3d at 312 ("It is a bedrock principle of patent law that the claims of a patent define the invention to which the patentee is entitled the right to exclude." (quotation marks and citation omitted)). Claim 17 recites, in relevant part, "[a]n integrated circuit structure comprising . . . a substantially flexible semiconductor second substrate having topside and bottom-side surfaces . . . wherein the bottom-side surface of the second substrate is formed by removing semiconductor material from the second substrate and is smoothed or polished after removal of the semiconductor material."

Claim 17, thus, describes how the bottom-side surface of the substantially flexible substrate is formed—by removing semiconductor material from the second substrate and is smoothed or polished after removal of the semiconductor material. The language of the claim, however, does not contextually define "substantially flexible." This reasoning applies to the other independent claims—challenged claims 84 and 129, as well as independent claim 143 (from which challenged dependent claims 144, 145, and 152 depend)—at issue.

Furthermore, we agree with Patent Owner that "substantially flexible" cannot be read out of the claims, which would result if Petitioner's proposed construction were adopted. *See* PO Resp. 52–53 (citing *Digital-Vending Services Int'l LLC v. University of Phoenix, Inc.*, 672 F.3d 1270 (Fed. Cir. 2012) (rejecting claim construction that would render a claim term meaningless); *Cat Tech. LLC v. TubeMaster, Inc.*, 528 F.3d 871, 885 (Fed. Cir. 2008) (refusing to adopt a claim construction that would render a claim limitation meaningless); *Phillips v. AWH Corp.*, 415 F.3d at 1314).

First, Petitioner's proposed construction of "substantially flexible semiconductor substrate" includes polishing, which effectively would read "is . . . polished after removal of the semiconductor material" out of claim 17. *See Stumbo v. Eastman Outdoors, Inc.*, 508 F.3d 1358, 1362 (Fed. Cir. 2007) (rejecting claim constructions that render phrases in claims superfluous).

Similarly, challenged independent claim 129 recites "the second surface of the second substrate is formed by removal of semiconductor

material from the second substrate and is smoothed or polished after removal of the semiconductor material." The plain language of claim 129 requires that the claimed "semiconductor second substrate" be both "substantially flexible" and that it be thinned and smoothed or polished. Thus, adopting Petitioner's proposed construction that also requires substantially flexible to include both thinning and polishing would effectively read out the limitations to removing material (a way of thinning) and polishing.

In addition, a substantially flexible semiconductor substrate need not necessarily be thinned and polished. As Petitioner's expert, Dr. Franzon, explains, there are a number of factors that, within the context of semiconductor processing, determine the flexibility of a semiconductor substrate. Ex. 1002 ¶ 71 (identifying examples of factors as the type of semiconductor substrate, the crystal orientation of the material, and the physical dimensions of the substrate). This further weighs against adopting Petitioner's proposed construction that a substantially flexible semiconductor substrate is narrowly limited only to semiconductor substrates that are thinned and polished.

2. Analysis of the Written Description

We next turn to the written description. *See Phillips*, 415 F.3d at 1313 ("Importantly, the person of ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification"). The written description uses the claim term "substantially flexible" as well as the term "rigid" to describe semiconductor substrates. In

introducing 3DS memory device fabrication methods, the written description indicates that the two principal fabrication methods have a common objective of bonding "a number of circuit substrates onto a *rigid* supporting or common substrate." Ex. 1001, 7:16–23 (emphasis added). In apparent contrast, the written description describes an example of a 3DS memory stack as having "a thinned and substantially flexible circuit" as follows:

> The 3DS memory stack is typically organized as a controller circuit 101 and some number of memory array circuit layers 103, typically between nine (9) and thirty-two (32), but there is no particular limit to the number of layers. The controller circuit is of nominal circuit thickness (typically 0.5 mm or greater), but each memory array circuit layer is a *thinned* and *substantially flexible* circuit with net low stress, less than 50 μm and typically less than 10 μm in thickness. Conventional I/O bond pads are formed on a final memory array circuit layer for use with conventional packaging methods.

IPR386-Ex. 1001, 4:17–26 (emphases added). We understand these specification passages to mean that "flexible" and "rigid" have distinct meanings. And, moreover, we understand the passages to suggest that flexible and rigid are opposite characteristics of semiconductor substrates.

The written description also uses the term "substantially flexible" in the context of discussing ways of achieving substantially flexible semiconductor substrates by thinning. In the Summary of the Invention section, the written description also describes four features of the 3DS memory technology, including thinning to a certain thickness to form a substantially flexible substrate:

> 3. Thinning of the memory circuit to less than about 50 μm in thickness forming a substantially flexible substrate with planar

> processed bond surfaces and bonding the circuit to the circuit stack while still in wafer substrate form.

IPR386-Ex. 1001, 3:5–8. Also, the written description describes a fabrication sequence for a 3DS memory device, such as the example device shown in Figure 1a. Ex. 1001, 8:63–67. The fabrication sequence includes Step 2A:

> Grind the backside or the exposed surface of the second circuit substrate to a thickness of less than 50 μm and then polish or smooth the surface. The thinned substrate is now a substantially flexible substrate.

Ex. 1001, 9:3–6. These passages suggest that grinding or thinning are ways of achieving a "substantially flexible" substrate, but are not necessarily the only ways to achieve a "substantially flexible" substrate. *See* Ex. 1001, 12:46–54 (indicating embodiments disclosed in the written description are examples and are not intended to restrict the scope of the claims).

3. Analysis of Extrinsic Evidence: Dictionary Definitions

Next, we consider extrinsic evidence to discern how one of ordinary skill in the art would have understood the term "substantially flexible" in the context of the patent specification. *Phillips*, 415 F.3d at 1317 (indicating extrinsic evidence, such as dictionaries and expert opinions, may be considered); *id.* at 1319 (indicating extrinsic evidence should be considered in the context of the intrinsic evidence).

Patent Owner proffers general-purpose dictionary definitions of "flexible" as "able to bend without breaking; pliable" and "substantial" as "true in large part" to support its contention that one of ordinary skill in the

art would understand the claim term "substantially flexible" as "largely able to bend without breaking." PO Resp. 51 (citing Ex. 2165[11]).

"In some cases, the ordinary meaning of claim language as understood by a person of skill in the art may be readily apparent even to lay judges, and claim construction in such cases involves little more than the application of the widely accepted meaning of commonly understood words." *Phillips*, 415 F.3d at 1314. "In such circumstances, general purpose dictionaries may be helpful." *Id.* After considering the arguments and weighing the evidence presented by both parties, including the evidence concerning the complexity of integrated circuit fabrication, we determine a general-purpose dictionary is helpful in understanding the meaning of the term "substantially flexible" in the context of the challenged claims and written description.

In large measure, this is because Petitioner does not rely on testimony of its expert Dr. Franzon as to how one of ordinary skill in the art would have understood "substantially flexible semiconductor substrate" in view of the specification. *See generally* Pet. 9–13 (proposing construction without discussing Dr. Franzon's declaration testimony (Ex. 1002)). Rather,

---

[11] *The Oxford American Dictionary of Current English* 298, 810 (1999). We note that the earliest effective filing date claimed by the '672 patent is April 4, 1997. Given the general-purpose nature of the dictionary, it seems unlikely that the definitions of "flexible" or "substantial" would have changed in the intervening two years. Nor has Petitioner contested the use of this dictionary or argued that the usage of these terms changed in those intervening two years.

Petitioner cites, without discussing, one or two paragraphs of Dr. Franzon's declaration to support Petitioner's position that "substantially flexible" is a term of degree. Pet. 12 (citing Ex. 1002 ¶¶ 70–71), 13 (citing Ex. 1002 ¶ 71). Moreover, Dr. Franzon testifies that he had "been asked to consider and have applied Petitioner's construction in my analysis." Ex. 1002 ¶ 72. Thus, in these particular circumstances in which the specification gives little guidance and Petitioner's expert applies Petitioner's construction that is narrow on its face, we rely on a general purpose dictionary definition, proffered by Patent Owner, to understand the ordinary and customary meaning of "substantially flexible."

Accordingly, we determine that the ordinary and customary meaning of "substantially flexible" in the context of the challenged patent is "largely able to bend without breaking." Moreover, both parties seem to recognize that the term "substantially" is used in patents as a drafting technique to accommodate minor variations. Tr. 14:6–7 (Petitioner's counsel indicating that "Dr. Franzon [Petitioner's expert] said substantially introduces some *wiggle* room.") (emphasis added); PO Resp. 56 (quoting *Verve v. Crane Cams,* 311 F.3d 1116, 1120 (Fed. Cir. 2002) ("Expressions such as "substantially" are used in patent documents when warranted by the nature of the invention, in order to accommodate the minor variations that may be appropriate to secure the invention.")); *see, e.g., Ecolab Inc. v. Envirochem, Inc*., 264 F.3d 1358, 1367 (Fed. Cir. 2001) (explaining that "like the term 'about,' the term 'substantially' is a descriptive term commonly used in

patent claims to avoid a strict numerical boundary to the specified parameter") (citation omitted).

4. Whether Ordinary and Customary Meaning Applies: Purported Definition in Written Description

Petitioner contends that the ordinary and customary meaning of "substantially flexible" should not apply. First, Petitioner contends that the description of a method of forming a substantially flexible substrate by grinding rises to the level of a definition of substantially flexible. In other words, Petitioner contends that the inventor acted as a lexicographer and defined substantially flexible so as to deviate from the ordinary and customary meaning of the term. Pet. 10–11 (quoting Ex. 1001, 9:3–6). We disagree.

"To act as its own lexicographer, a patentee must 'clearly set forth a definition of the disputed claim term' other than its plain and ordinary meaning." *Thorner v. Sony Computer Entm't Am. LLC*, 669 F.3d 1362, 1365 (Fed. Cir. 2012) (quoting *CCS Fitness, Inc. v. Brunswick Corp.*, 288 F.3d 1359, 1366 (Fed. Cir. 2002)). "It is not enough for a patentee to simply disclose a single embodiment or use a word in the same manner in all embodiments, the patentee must 'clearly express an intent' to redefine the term." *Id.* (quoting *Helmsderfer v. Bobrick Washroom Equip., Inc.*, 527 F.3d 1379, 1381 (Fed. Cir. 2008)).

Petitioner relies on an example in the written description of how a "substantially flexible" semiconductor substrate may be achieved in a particular embodiment shown in Figure 1a:

> Grind the backside or the exposed surface of the second circuit substrate to a thickness of less than 50 μm and then polish or smooth the surface. The thinned substrate is now a substantially flexible substrate.

Ex. 1001, 9:3–6. (Step 2A in a method for 3DS memory device fabrication). As discussed above, this passage describes a way to achieve a substantially flexible substrate. We discern no clear intent to set forth a definition of the claim term. The indication that a process performed on a thinned substrate results in a substantially flexible semiconductor substrate defines a way to achieve a substantially flexible semiconductor substrate and does not define what a substantially flexible substrate is.

To the contrary, the written description explicitly states that "[t]he presently disclosed embodiments are therefore considered in all aspects to be illustrative and not restrictive" and continues by indicating that "[t]he scope of the invention is indicated by the appended claims rather than the foregoing description." *Id.* at 12:46–54.

Accordingly, the written description does not define the claim term "substantially flexible semiconductor substrate."

5. Whether Ordinary and Customary Meaning Applies: Purported Prosecution History Disavowal

Second, Petitioner further argues that Patent Owner (then, Applicant) confirmed this purported definition during examination of related patents and applications. Pet. 10–11. Specifically, Petitioner cites to responses provided by Patent Owner during examination of U.S. Patent Application

Nos. 12/497,652 ("the '652 application"), 12/497,653[12] ("the '653 application"), and 13/734,874 ("the '874 application). As such, Petitioner argues exclusively from the examination of these applications—not the prosecution history of the '672 patent at issue here. Even so, "[t]he prosecution history of a related patent can be relevant if, for example, it addresses a limitation in common with the patent" at issue. *Advanced Cardiovascular Sys., Inc. v. Medtronic, Inc.*, 265 F.3d 1294, 1305 (Fed. Cir. 2001).

(a) Prosecution History of the '652 and '874 Applications

Petitioner contends that identical statements made by the patent applicant during examination of the '652 application and the '653 application indicate Patent Owner "clearly and unmistakably defined 'substantially flexible' when used to modify the 'semiconductor substrate,' and expressed an intent to define the term." Pet. 11 (citing *Tempo Lighting, Inc. v. Tivoli, LLC*, 742 F.3d 973, 977–78 (Fed. Cir. 2014)).

Specifically, Petitioner relies on the following statement made during examination:

> A substantially flexible semiconductor substrate **may be achieved** by grinding until considerably thin, **for example** to a

[12] Petitioner does not explain how the purportedly related '652 and '653 applications are related to the challenged patent. Those applications are not identified in the '672 patent as being related and are not identified in the related matters identified by the Petitioner. *See generally* Pet. 2; Ex. 1001 [60]. Presumably, the patent applications share the same written description as the challenged '672 patent.

> thickness of less than 50 microns, and polishing the resulting surface.

Ex. 1021, 2 (regarding the ’652 application); Ex. 1022, 2 (regarding the ’653 application) (emphasis added). The statement itself indicates that the described grinding and polishing is an example of one way to achieve a substantially flexible substrate. As such, the cited statement does not evidence a clear and unmistakable intent to limit the scope of the term “substantially flexible semiconductor substrate,” as Petitioner contends. *See Aventis*, 675 F.3d at 1330 (requiring “a clear and unmistakable disavowal of claim scope” in the prosecution history to narrow the customary and ordinary meaning of a claim term).

(b) Prosecution History of the ’874 Application

Petitioner relies on a third prosecution history excerpt—a statement made by Applicant during examination of the ’874 application that issued as U.S. Patent No. 8,907,499 (“the ’499 patent”) and claims priority to the challenged ’672 patent. Pet. 10. The Examiner objected to the use of the term “substantially” in the limitation “substantially flexible” recited by independent claims 1, 14, 26, and 30 in the application. Ex. 1018, 3. According to the Examiner, the term “substantially” rendered the claims unclear, resulting in claims that “do not clearly set for[th] the metes and bounds of the patent protection desired.” *Id.*

Petitioner notes that Applicant overcame the objection by arguing that “substantially flexible” is unambiguous because it is “clearly explained in the [S]pecification.” Pet. 10 (citing Ex. 1019, 10). Petitioner relies on the

following language of the Applicant as defining substantially flexible:

> With respect to the language "substantially flexible," the meaning of this phrase as used in the claims is clearly explained in the specification including, **for example**, at page 18, lines 1-3.[13] As described in this passage, a semiconductor substrate is caused to be substantially flexible by thinning it to 50 microns or less and polishing or smoothing the thinned semiconductor substrate to relieve stress. The phrase "substantially flexible" is used in the claims **consistent** with this description, which is unambiguous.

Pet. 10–11 (quoting Ex. 1019, 9) (emphasis added).

The passage at issue is the same one discussed previously—"[g]rind the backside or the exposed surface of the second circuit substrate to a thickness of less than 50 μm and then polish or smooth the surface. The thinned substrate is now a substantially flexible substrate." Ex. 1001, 9:3–6. As discussed previously, this passage describes a way to achieve a substantially flexible semiconductor. In its response to the Examiner, Applicant indicated that the "phrase 'substantially flexible' is used in the claims consistent with this description, which is unambiguous." Ex. 1019, 9. We conclude that Petitioner has not demonstrated that this statement rises to the level of a clear disavowal of claim scope. *See Aventis*, 675 F.3d at 1330 (requiring "a clear and unmistakable disavowal of claim scope" in the prosecution history to narrow the customary and ordinary meaning of a claim term).

---

[13] The portion of the application cited by the Applicant (i.e., page 18, lines 1–3) corresponds to Ex. 1001, 9:3–6. *Compare* Ex. 1020, 18:1–3 (application as filed), *with* Ex. 1001, 9:3–6.

For these reasons, we determine that Petitioner has not shown that Patent Owner, during the examination of the '874 application (that issued as the '499 patent), defined "substantially flexible" and made a clear and unmistakable disavowal of claim scope.

6. Purported Ambiguity of "Substantially Flexible"

Petitioner also contends that its proposed construction of "substantially flexible semiconductor [] substrate" as "a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed" is necessary because otherwise this term would be indefinite because "substantially flexible" is a term of degree.[14] Pet. 9. We, however, agree with Patent Owner that "substantially" is amenable to construction. PO Resp. 56–57 (citing *Verve v. Crane Cams*, 311 F.3d 1116, 1120 (Fed. Cir. 2002); *Cordis Corp. v. MedtronicAVE, Inc.*, 339 F.3d 1352, 1360 (Fed. Cir. 2003) ("substantially uniform thickness" construed as "of largely or approximately uniform thickness"); *Anchor Wall Sys., Inc. v. Rockwood Retaining Walls, Inc.*, 340 F.3d 1298, 1311 (Fed. Cir. 2003) ("generally parallel" construed as "some amount of deviation from exactly parallel"); *Playtex Prods., Inc. Procter & Gamble Co.*, 400 F.3d 901, 907 (Fed. Cir. 2005)). In addition, as discussed above, we agree with Patent Owner that general-purpose dictionary definitions of "substantially" and "flexible" provide the ordinary and customary meaning of the terms.

[14] We recognize that *inter partes* reviews are limited to grounds that could be raised under section 102 or 103. *See* 35 U.S.C. § 311(b).

Furthermore, to resolve the dispute between the parties as to the patentability of the challenged claims, we need not decide the range of "substantially flexible" semiconductor substrates that the claim term encompasses. Only those terms which are in controversy need to be construed, and only to the extent necessary to resolve the controversy. *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999). We are able to determine whether the Petitioner has met its burden to show whether the challenged claims are unpatentable by a preponderance of the evidence without resorting to speculation as to the scope of the challenged claims.

Applying these principles, we also do not agree with Petitioner's position that Patent Owner's proposed construction should be rejected because it uses the term "largely able." Pet. Reply 31; *see also Cordis Corp. v. Medtronic AVE, Inc.*, 339 F.3d 1352, 1360 (Fed. Cir. 2003) ("substantially uniform thickness" construed as "of largely or approximately uniform thickness").

7. Claim Construction of "Substantially Flexible Semiconductor Substrate"

Having considered the parties' arguments and weighed the parties' evidence bearing on claim construction of "substantially flexible semiconductor substrate," we do not agree with Petitioner that "a substantially flexible semiconductor substrate" should be construed as "a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed." *See* Pet. 9. Rather, we agree with Patent Owner's position that one of ordinary skill in the art in the

context of the challenged patent would understand "substantially flexible" to have the customary and ordinary meaning of "largely able to bend without breaking." Therefore, we determine that "a substantially flexible semiconductor substrate" within the context of the patent is "a semiconductor substrate that is largely able to bend without breaking." Thus, Petitioner must establish that the substrate of the prior art combinations on which the claim challenges are made must provide a substrate that is largely able to bend without breaking.

8. Other Claim Terms

To the extent it is necessary for us to expressly construe other claim terms in this decision for IPR2016-00386, we do so below in the context of analyzing whether the prior art renders the challenged claims unpatentable.

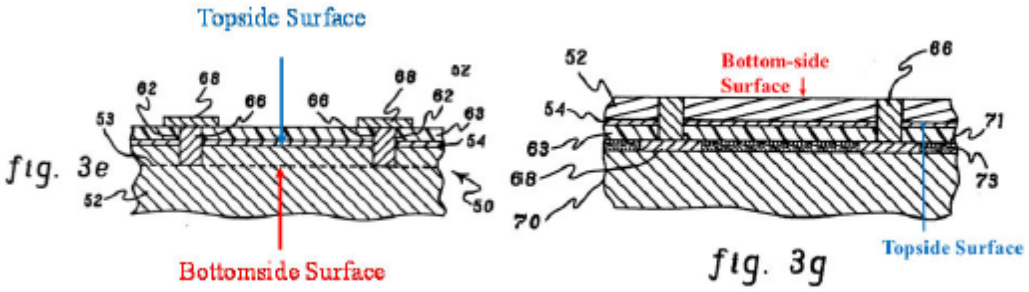
C. Asserted Ground of Obviousness over Bertin '754, Poole, and Leedy '695

Having considered the parties' arguments and weighed the parties' evidence cited therein, and for the reasons set forth below, we determine that Petitioner has *not* demonstrated by a preponderance of the evidence that claims 17, 18, 22, 84, 95, 129–132, 145, 146, and 152 are unpatentable under 35 U.S.C. § 103 over Bertin '754, Poole, and Leedy '695.

1. Petitioner's Contentions

Petitioner relies on Bertin '754 for describing most of the limitations recited in the challenged claims. Pet. 17 ("Bertin teaches or suggests all but a few features recited in the Challenged Claims, as construed by Petitioner."). For example, regarding independent claim 17, Petitioner relies

on one of the stacked chips of Bertin '754's "three-dimensional multichip package having a densely stacked array of semiconductor chips" as the recited "a first substrate having topside and bottomside surfaces, wherein the topside surface of the first substrate supports interconnect contacts." *Id.* at 23–24 (quoting Ex. 1004, 1:10–15). Petitioner provides the following annotated figures from Bertin '754 to explain its combination. *Id.* at 24 (depicting annotations of Bertin '754's Figs. 3e, 3f and noting that Fig. 3f depicts a "flipped over" chip).



Petitioner indicates that Bertin '754's substrate 52 has top-side and bottom-side surfaces as shown in Figures 3e and 3f. *Id.*

Petitioner relies on a combination of Bertin '754, Leedy '695, and Poole for conveying to one of ordinary skill in the art the recited "second substrate." *Id.* at 24–29. In particular, Petitioner relies on another one of Bertin '754's stacked chips 50 for most of the "second substrate" limitations. *Id.* Petitioner relies upon Poole's description of a two-step thinning process, which includes a grinding (or lapping) step followed by a chemical mechanical polishing ("CMP") step: "The bulk silicon is thinned to 75 µm with a 700 micro-grit aluminum oxide abrasive and is then thinned and polished to 10 µm using 80 nm grit colloidal silica." *Id.* at 26–27 (citing

Ex. 1005 at 3:19−25, *see also id.* at Abstract, 3:12−47, 4:21−25, 5:60−7:2, 7:51−68, 8:21−24). For the dielectric conforming to the required stress limitation (5 x 10^8 dynes/cm^2), Petitioner relies on Leedy '695. *Id.* at 30.

2. "Substantially Flexible Semiconductor [] Substrate"

As noted previously, each of the challenged claims in this proceeding requires "a substantially flexible semiconductor substrate" (independent claim 84) or "a substantially flexible semiconductor second substrate" (independent claims 17, 129, and 143, from which each of challenged claims 145, 146, and 152 indirectly depends). Ex. 1001, 14:60–61 (claim 17), 24:6 (claim 84), 30:40 (claim 129), 32:50 (claim 143).

In its Petition, Petitioner presents arguments that claims 17, 18, 22, 84, 95, 129–132, 145, 146, and 152 would have been obvious over Bertin '754, Poole, and Leedy '695 using its proposed narrow construction of a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed. *See, e.g.*, Pet. 9, 24–27 (arguments for independent claim 17). Petitioner also indicates that the challenged claims would have been obvious under two alternative constructions: "(i) a substrate that has been thinned to a thickness *of less than 50 μm* or (ii) that has been thinned to a thickness of *150 μm or less*." Pet. 13, 58–59. According to Petitioner, the challenged claims "are unpatentable for the same reasons discussed in Grounds [of obviousness over Bertin '754, Poole, and Leedy '695 and of obviousness over Yu and Leedy '695], because . . . each contain prior art that teaches or suggests a

semiconductor substrate that has been thinned to a thickness of less than 50 μm." Pet. 58–59.

In response to the Petition, Patent Owner argues that the ordinary and customary meaning of "substantially flexible semiconductor [] substrate" is "a semiconductor substrate that is largely able to bend without breaking" and is the proper claim construction. As discussed previously, we agree with Patent Owner.

In its Reply to Patent Owner's Response, Petitioner contends that Patent Owner's "response is premised on an incorrect claim construction of 'substantially flexible'" and "[u]nder a proper construction, [Patent Owner] offers no rebuttal to the conclusion that the 'substantially flexible' limitations are met." Pet. Reply 2–3; 30–31 (arguing that the "Board should reject Patent Owner's newly proposed construction"). Tellingly, Petitioner does not address in its Reply how the claims as Patent Owner construes them would have been obvious over the asserted prior art. *See generally* Pet. Reply. Rather, although Petitioner argues that the prior art shows a particular thinning of a substrate, Petitioner does not argue that the combination of Bertin '754, Poole, and Leedy '695 would have conveyed to one of ordinary skill in the art a substrate that is (largely) able to bend without breaking, which is required by the construction of substantially flexible semiconductor substrate.

In essence, Petitioner argues that Bertin '754 discloses a semiconductor substrate that has been thinned to less than 50 μm and so discloses a substantially flexible semiconductor substrate as required by the

claims. A preponderance of the evidence establishes, however, that, in the context of semiconductor substrates, mere thinning is not the same as flexibility—being able to bend without breaking. We find that "thinning" does not equate to "flexibility" because thinning does not account for materials and the processing steps acting on those materials.

The Examiner, during the prosecution history of the now-abandoned '652 application, agreed that flexibility is not the equivalent of mere thinning. Ex. 2168, 4 (The Examiner indicating that "Bertin also fails to specifically teach wherein at least one of the first and second circuit layers is substantially flexible."). Neither party disputes this characterization of the Examiner's statement. PO Resp. 35–36 (Patent Owner indicating that the "Examiner agreed that flexibility is not the equivalent of mere thinning." (quoting Ex. 2168, 4)); Tr. 24:23–25:1 (Petitioner's counsel agreeing with Patent Owner's characterization that the Examiner agreed that flexibility is not the equivalent of mere thinning).

Moreover, Petitioner's expert, Dr. Franzon, also testifies that the flexibility of a semiconductor substrate depends on a number of factors, only one of which is the physical dimensions of the substrate—width and thickness. Ex. 1002 ¶ 71. Specifically, Dr. Franzon stated:

> In the context of semiconductor processing, the flexibility of a semiconductor substrate depends on a number of factors, including, for example, the type of semiconductor substrate (e.g., while silicon and gallium arsenide are both semiconductors, they have different elastic moduli), the crystal orientation of the material (e.g., {100} and {111} silicon wafers have different elastic moduli) and the physical dimensions of the substrate (e.g., width and thickness).

Ex. 1002 ¶ 71; *see also* Tr. 33:8–24 (Patent Owner's counsel at oral hearing discussing Dr. Franzon's testimony about the factors on which flexibility of a semiconductor substrate depends); Tr. 64:16–65:11 (Petitioner's counsel responding to Patent Owner's argument about Dr. Franzon's testimony regarding the various factors that would be considered to determine whether something is flexible). Common sense also supports a conclusion that thickness is not the only factor that determines whether a material is flexible. After all, a thicker piece of rubber is more flexible than a thinner potato chip.

In addition, Petitioner's counsel asserted at the oral hearing that the asserted art shows bendability in addition to thinning because the asserted "prior [art] mirrors the prior [preferred] embodiment." Tr. 175:21-176:2; Petitioner's counsel, however, did not point to sufficient evidence to support its position that the prior art mirrors the preferred embodiment in the challenged patent. *See generally* Tr. 175:13–180:16. For example, Petitioner's counsel contended that Dr. Franzon's testimony that the limitations are met by the prior art supports its position. Tr. 178:20–22 (Asking "is there any evidence of record that any of the combinations that you propose would be the same as the preferred embodiment"?); Tr. 180:8–10 (Petitioner's counsel responding that "[i]t's Dr. Franzon's testimony that those limitations are met by the prior art, and it's the prior art itself, lining up with the claims."). Dr. Franzon, however, testifies that he was given Petitioner's proposed construction of "a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or

smoothed" and he "applied Petitioner's construction in [his] analysis." Ex. 1002 ¶ 72. Nor did Petitioner's counsel identify with particularity any portion of the asserted prior art that "mirrors" the preferred embodiment in the challenged patent, nor even identify what preferred embodiments Petitioner's counsel had in mind as being mirrored by the prior art.

We are mindful that Petitioner has the burden "to show with particularity why the patent it challenges is unpatentable." *Harmonic*, 815 F.3d at 1363 (citing 35 U.S.C. § 312(a)(3)). Accordingly, we are not persuaded that Petitioner has demonstrated by a preponderance of the evidence that the prior art embodiments mirror the preferred embodiment in the challenged patent and, therefore, the prior art shows bendability. Furthermore, Petitioner's counsel at the oral hearing confirmed that Petitioner's Reply to Patent Owner's claim construction position is that "first and foremost their claim construction is improper because it is indefinite, so in drafting the reply, . . . we couldn't figure out how to apply their construction to the prior art, so the claim construction portion of the reply explains why their construction is incorrect." Tr. 176:7–12.

Petitioner also relies on Poole's teaching of a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed. Pet. 26. Petitioner relies on Poole's two-step grinding process in which "[t]he bulk silicon is thinned to 75 μm . . . and is then thinned and polished to 10 μm." Pet. 27. Thus, Petitioner relies on thinness to produce a substantially flexible semiconductor substrate. As discussed previously, without explaining particular materials,

conditions, and other context, relying upon thinness alone does not establish that Poole's substrate satisfies the claim requirement of "substantially flexible." Thus, Petitioner has not sufficiently explained why Poole's thinning and polishing would have satisfied the "substantially flexible" claim requirement.

For these reasons, we determine that Petitioner has not demonstrated by a preponderance of the evidence that the combination of Bertin '754's substrate of less than 50 μm and Poole's polishing would have conveyed to one of ordinary skill in the art the "substantially flexible semiconductor second substrate," as recited in claim 17 (Pet. 26–27).

For the substantial flexibility requirement in the other challenged claims, Petitioner relies on its arguments concerning claim 17. Pet. 35 (independent claim 84); Pet. 38–39 (independent claim 129); Pet. 44 (disclaimed independent claim 143 from which challenged claims 145, 146, and 152 depend); Pet. 30–34, 36–38, 40–42 (discussing challenged dependent claims that depend from independent claims 17, 84, and 129).

This reason alone is sufficient for us to conclude that Petitioner does not satisfy its burden to establish that claims 17, 18, 22, 84, 95, 129–132, 145, 146, and 152 are unpatentable. There is, however, an additional independent and separate reason as set forth below for our conclusion that Petitioner does not satisfy this burden.

3. Low Tensile Stress Dielectric Substitution

Another central issue is whether one of ordinary skill in the art would have had reason to combine Bertin '754 with Leedy '695 in the manner

proposed by Petitioner to arrive at the claimed invention and would have had a reasonable expectation of success of doing so. Particularly at issue is whether "the integrated circuit structure further comprises a low-stress silicon-based dielectric material having a stress of $5x10^8$ dynes/cm^2 tensile or less," as required by independent claim 17, independent claim 84, independent claim 129, dependent claim 145 from which claim 146 depends, and dependent claim 152. For this feature, Petitioner's combination relies on Bertin '754's dielectric layer 60 that has interconnect insulators, which do not have the required tensile stress, in combination with the "disclosure of Leedy '695." Pet. 30 (citing Ex. 1004, 3:50–62, 4:30–33; Ex. 1002 ¶ 112, 17e[15]).

At the heart of this issue is whether Petitioner has demonstrated by a preponderance of the evidence a reason why one of ordinary skill in the art would have substituted the dielectric material of Leedy '695 and would have had a reasonable expectation of success of doing so. This substitution would require substituting at least some portions of Leedy '695's fabrication techniques in which integrated circuit elements are formed on a low tensile stress dielectric membrane for some of the conventional fabrication process

---

[15] Notably, Petitioner merely cites Dr. Franzon's nearly four-page claim chart for this element, without otherwise discussing or summarizing it. Board rules prohibit incorporating by reference arguments from one document into another document. 37 C.F.R. § 42.6(a)(3); *see Cisco Sys., Inc. v. C-Cation Techs., LLC*, Case IPR2014-00454, slip op. at 7–10 (PTAB August 29, 2014) (Paper 12) (Informative) (not considering arguments in declaration that were not made in the Petition but only incorporated by reference).

steps of Bertin '754.[16]

For the reasons that follow, we determine that Petitioner has not demonstrated by a preponderance of the evidence that one of ordinary skill in the art would have a reason to combine the references in the manner proposed by Petitioner to arrive at the claimed invention and would have had a reasonable expectation of success of doing so.

When an obviousness determination relies on the combination of two or more references, as here, there must be some suggestion or motivation to combine the references. *WMS Gaming, Inc. v. Int'l Game Tech.*, 184 F.3d 1339, 1355 (Fed. Cir. 1999); s*ee also Dome Patent L.P. v. Lee*, 799 F.3d 1372, 1380 (Fed. Cir. 2015) ("If all elements of a claim are found in the prior art, as is the case here, the factfinder must further consider the factual questions of whether a person of ordinary skill in the art would be motivated to combine those references, and whether in making that combination, a person of ordinary skill would have had a reasonable expectation of success."). It is axiomatic that an asserted ground of obviousness must demonstrate articulated reasoning with rational underpinning to support the legal conclusion of obviousness. *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006); *see KSR Int'l v. Teleflex Inc.*, 550 U.S. 398, 418 (2007) (quoting *In re Kahn*). Mere conclusory statements are not sufficient. *In re Kahn*, 441

[16] Like the article of footwear at issue in *Nike v. Adidas*, 812 F.3d 1326, 1336 (Fed. Cir. 2016) in which three processes of producing a shoe were analyzed to determine obviousness, we discuss the fabrication processes of Bertin '754 and Leedy '695 in the context of determining whether the claimed integrated circuit would have been obvious.

F.3d at 988. Furthermore, "[c]are must be taken to avoid hindsight reconstruction by using 'the patent in suit as a guide through the maze of prior art references, combining the right references in the right way so as to achieve the result of the claims in suit.'" *Grain Processing Corp. v. Am. Maize-Prods. Co.*, 840 F.2d 902, 907 (Fed. Cir. 1988) (quoting *Orthopedic Equip. Co. v. United States*, 702 F.2d 1005, 1012 (Fed. Cir. 1983)).

a. Complexity of Integrated Circuit Fabrication

Without question, fabrication of integrated circuits is complex technology. No less than four prior art text books, ranging from 600 pages to nearly 850 pages and describing the fabrication of integrated circuits, have been provided as background references, principally in support of the declaration testimony of Alexander D. Glew, Ph.D., Patent Owner's expert. Ex. 1040 (Wolf et al., *Silicon Processing for the VLSI Era, Volume 1– Process Technology* (1986)); Ex. 2146 (Wolf, *Silicon Processing for the VLSI Era, Volume 2 – Process Integration* (1990)); Ex. 2159 (W. R. Runyan & K. E. Bean, *Semiconductor Integrated Circuit Processing Technology* (1990)); Ex. 2162 (*Multi-Chip Module Technologies and Alternatives: The Basics* (Daryl Ann Doane & Paul D. Franzon eds., 1993)). Also of record are two other background references of around 100 pages and 650 pages. Ex. 2169 (*Handbook of Semiconductor Manufacturing Technology* (Robert Doering & Yoshio Nishi eds., 2nd ed. 2008); Ex. 2158 (Peter van Zant, *Microchip Fabrication* (4th ed., 2000)).

Patent Owner, with liberal citations to those references, other prior art references, and declaration testimony of its expert explaining the same,

explains how integrated circuits are fabricated to illustrate the complexity of the process and the detailed planning and decisions required for fabrication. PO Resp. 3–30. The explanation stresses the detailed planning and decisions required to establish a fabrication process for an integrated circuit. *Id.* According to Dr. Glew, integrated circuit fabrication is a "complex manufacturing process . . . that can be generally divided into four distinct stages: (1) material preparation; (2) wafer preparation; (3) wafer fabrication; and (4) packaging. Ex. 2166 ¶ 23 (citing Ex. 2158, 13[17,18]); *see also* PO Resp. 5 (citing Ex. 2166 ¶ 23; Ex. 2158, 13). In the second stage, the semiconductor material is first formed into a silicon crystal with specific electrical and structural parameters, and then sliced into thin disks called "wafers." PO Resp. 6 (citing Ex. 2166 ¶ 25; Ex. 2158, 13–14). Most helpful is the explanation of different techniques for producing and layering dielectrics (PO Resp. 16–30), including growing dielectrics using thermal oxidation (PO Resp. 18–19), depositing dielectrics (PO Resp. 19), and a

---

[17] We follow Patent Owner's practice of citing to page numbers of the text, rather than the pagination of Exhibit 2158.

[18] We recognize that the text cited by Dr. Glew (Ex. 2158) is the fourth edition and has publication dates of 1984, 1997, and 2000. Dr. Glew relies on this text as supporting his testimony and recognizes the earliest effective filing date claimed by the challenged patent of April 4, 1997. Ex. 2166 ¶ 104. Petitioner does not contend that Dr. Glew's reliance on this text is in error or that Dr. Glew's summary of integrated circuit fabrication is faulty. Nor does Petitioner contend that the general explanation of integrated circuit fabrication found in the text, and used by Dr. Glew to support his testimony, changed between the 1997 edition of the text and the later edition.

comparison of thermal chemical vapor deposition (PO Resp. 20) with plasma-enhanced chemical vapor deposition (PO Resp. 21).

We understand from the testimony of Dr. Glew and reference citations that a typical fabrication of a semiconductor integrated circuit may include thousands of process steps (Ex. 2166 ¶¶ 29–30 (citing Ex. 2158, 14, 29–31, 71)). Explaining different techniques for producing and layering dielectrics, Dr. Glew explains that "different dielectric materials are layered throughout the fabrication process, with each dielectric layer having a different location, each being created at a different stage, and each serving a different specific purpose." Ex. 2166 ¶ 61 (citing Ex. 2158, 72–73, 79, 81–82); *see* PO Resp. 16 (citing Ex. 2166 ¶ 61); *see generally* PO Resp. 16–30 (discussing different techniques for producing and layering dielectrics). Dr. Glew continues:

> These dielectrics can be produced and layered using a large number of techniques, and the particular technique used will greatly impact the properties of the resulting dielectric (and, therefore, its usefulness for any particular dielectric layer and purpose). For example, dielectric silicon dioxide layers can be produced and applied in hundreds of different ways, each resulting in a silicon dioxide with different properties (and potential uses). (Ex. 2158 at 154; Ex. 2146 at 225, 306; Ex. 2159 at 55).

Ex. 2166 ¶ 62. Thus, selecting a dielectric material involves choosing particular fabrication techniques that are part of an overall fabrication process for a particular integrated circuit.

b. Contentions of Petitioner

Petitioner contends that one of ordinary skill in the art would have reason to substitute Leedy '695's low tensile stress dielectric for Bertin '754's dielectric layer 60 and the interconnect insulators. Pet. 17–19. Petitioner also contends that one of ordinary skill in the art would have expected success combining the teachings of Bertin '754 and Leedy '695. Pet. 19–20. We address Petitioner's contentions in turn.

(b)(i) Reason to Substitute

In support of its contention that it would have been obvious to one of ordinary skill in the art to substitute Leedy '695's low tensile stress dielectric for Bertin '754's dielectric layer 60 and the interconnect insulators (which do not have the required tensile stress), Petitioner first contends that the Office already found that the combination of Bertin '754 and Leedy '695 teaches or suggests these features during prosecution of related applications. Pet. 17–18 (citing Ex. 1033–1036). Petitioner, however, does not acknowledge, much less address adequately, the significant difference in the record before the Office, which lacked the testimonial evidence of the Petitioner's expert, Paul D. Franzon, Ph.D. (Ex. 1002 (declaration); Ex. 2164 (deposition transcript)) and testimonial evidence of Patent Owner's expert, Alexander D. Glew, Ph.D. (Ex. 2166 (declaration)).

Second, Petitioner asserts that "[o]ne of ordinary skill would have looked to Leedy '695 to improve the teachings of Bertin ['754]" because "both are directed to the improvement of [integrated circuits] and recognize the central role the fabrication process plays in facilitating this

improvement" and "[b]oth disclosures seek to achieve high density [integrated circuits] (e.g., 3D [integrated circuits])." Pet. 18 (citing Ex. 1004, 1:7–2:31; Ex. 1006, Abstract, 1:38–1:67, 2:9–2:14, 3:56–4:13, 45:49–45:49, 47:31–47:33; Ex. 1002 ¶¶ 100–102). We recognize that "if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill." *KSR*, 550 U.S. at 417. Here, however, Petitioner's testimony is conclusory without explaining what types of improvements in 3D integrated circuits would have motivated one of ordinary skill in the art to make Petitioner's proposed substitution of Leedy '695's dielectric in Bertin '754's device. *In re Nuvasive*, 842 F.3d 1376, 1383 (Fed. Cir. 2016) (holding conclusory statements insufficient if not supported by a reasoned explanation) (citing *In re Lee*, 277 F.3d 1338, 1342 (Fed. Cir. 2002) ("The factual inquiry whether to combine references must be thorough and searching.")).

In addition, Petitioner merely cites to three paragraphs of Dr. Franzon's declaration testimony without further discussing or explaining the relevance of the testimony. Pet. 18 (citing Ex. 1002 ¶¶ 100–102). Even setting aside the issue of whether such bare citation of paragraphs is a violation of our prohibition against incorporation by reference,[19] Dr. Franzon's testimony does not sufficiently support Petitioner's position.

[19] 37 C.F.R. § 42.6(a)(3) (prohibiting incorporation by reference from one document to another).

First, Dr. Franzon's testimony does not expressly support Petitioner's specific proposed *substitution of Bertin '754's dielectric layer 60 and the interconnect insulators*. Pet. 17–18 (citing Ex. 1002 ¶¶ 91–102). Rather, Dr. Franzon's testimony is more general—"a person of ordinary skill in the art would have been motivated by these advantages [identified in Leedy '695 and an advantage of using plasma-enhanced chemical vapor deposition techniques] to implement the low-stress dielectric deposition techniques disclosed by Leedy '695 *to the stacked integrated circuit structures disclosed in each of Bertin '754 (alone or in combination with Poole) and Yu*." Ex. 1002 ¶ 100 (emphasis added). Second, Dr. Franzon's testimony in paragraph 102 is conclusory. Ex. 1002 ¶ 102 (asserting "[a] person of ordinary skill in the art would have been encouraged to combine Leedy '695 with Bertin (alone or in combination with Poole) and Yu because they are in the same technological field of three-dimensional integration and address similar challenges relating to the stacking of integrated circuit devices" (citing Exs. 1006, 1004, 1009)). Although "any need or problem known in the field of endeavor at the time of the invention and addressed by the patent can provide a reason for combining the elements in the manner claimed" (*KSR*, 550 U.S. at 420), Dr. Franzon's single sentence assertion lacks specifics as to what those similar challenges are, and he only provides a list of citations to various references without further explanation or analysis as to how those citations support his assertion. We weigh Dr. Franzon's testimony accordingly. *See In re Acad. of Sci. Tech Ctr.*, 367 F.3d 1359, 1368 (Fed. Cir. 2004) ("[T]he Board is entitled to weigh the declarations and

conclude that the lack of factual corroboration warrants discounting the opinions expressed in the declarations."); *see also* 37 C.F.R. § 42.65(a) ("Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight."). Third, with regard to the cited paragraphs of Dr. Franzon's declaration, paragraph 101 of Dr. Franzon's declaration indicates that "Leedy '695 discloses using [plasma-enhanced chemical vapor deposition], which was a commonly available deposition technique that *could have been used* in place of the techniques for growing or depositing dielectrics described in Bertin and Yu to obtain the predictable result of stacked integrated circuits having low tensile stress dielectrics." Ex. 1002 ¶ 101 (emphasis added). Testimony that one of ordinary skill in the art *could have used* the techniques is not sufficient to support Petitioner's contention that one of ordinary skill in the art would have had a reason to combine the references as proposed by Petitioner in the manner of the claimed invention. *In re Giannelli*, 739 F.3d 1375, 1380 (Fed. Cir. 2014) (indicating that the Board should have determined whether it would have been obvious to modify the prior art apparatus to arrive at the claimed invention and finding the mere capability to do so insufficient). Similarly, Dr. Franzon's testimony in paragraph 101 that one of ordinary skill in the art would have reasonably expected success does not support Petitioner's contention that "[o]ne of ordinary skill would have looked to Leedy '695 to improve the teachings of Bertin ['754]."

Petitioner's third contention is that "Leedy '695 also provides express motivations for modifying Bertin's process and device to incorporate

Leedy '695's low tensile stress dielectric material." Pet. 18–19.

Specifically, Petitioner contends:

> *Leedy '695* explains that low tensile stress is important because otherwise "surface flatness and membrane structural integrity will in many cases be inadequate for subsequent device fabrication steps or the ability to form a sufficiently durable free standing membrane." Ex. 1006 at 5:63-6:5; Ex. 1002 at ¶ 98.

Pet. 18. Petitioner's reliance on reasons that low tensile stress is important for Leedy '695's process for constructing Leedy '695's low tensile stress dielectric membranes has minimal probative value in supporting Petitioner's contention regarding using Leedy '695's dielectric material in Bertin '754's dielectric layer 60 and interconnect insulators created by Bertin '754's process relying on a conventional, rigid substrate. This is because Petitioner does not explain sufficiently why or how the importance of low tensile stress for Leedy '695's process for constructing low tensile stress dielectric membranes bears on why one of ordinary skill in the art would have substituted Leedy '695's dielectric material for Bertin '754's dielectric layer 60 and interconnect insulators.

Petitioner also contends:

> As discussed above, *Leedy '695* describes processes for depositing silicon oxide or silicon nitride dielectric material, preferably having a tensile stress of 1×10^7 dynes/cm^2. Ex. 1006 at 11:33– 37; Ex. 1002 at ¶ 99. *Leedy '695* explains that the described low tensile stress dielectrics can advantageously be used to insulate circuit devices and interconnect metallization, while at the same time increasing structural integrity and durability. Ex. 1006 at Abstract, 1:53–62, 2:9–31, 2:66–3:3, 3:56–4:13, 30:36–42, 45:49–46:26, 46:52–47:33, Figs. 32a–32d. *Leedy '695* also explains that such dielectrics

> advantageously have lower stress than thermally grown oxides, like those in *Bertin*. *Id*. at 6:30–33.

Pet. 18–19. Petitioner characterizes Leedy '695's teaching to be about low tensile stress dielectrics. The citations relied on by Petitioner, however, discuss advantages of its low tensile stress dielectric flexible membrane or its membrane dielectric isolation fabrication techniques. *See, e.g.,* Ex. 1006, Abstract ("In another version, the flexible membrane is used as support and electrical interconnect for conventional integrated circuit die bonded thereto, with the interconnect formed in multiple layers in the membrane."); 1:53–62 ("In accordance with the invention, an integrated circuit is formed on a tensile low stress dielectric membrane comprised of one layer or a partial layer of semiconductor material in which are formed circuit devices and several layers of dielectric and interconnect metallization. Also, a structure in accordance with the invention is a tensile member of semiconductor material in which are formed circuit devices with multiple layers of tensile low stress dielectric and metallization interconnect on either side of the semiconductor membrane."); 2:9–31 (describing objectives of its membrane dielectric isolation fabrication techniques); 2:66–3:3 (indicating "the combination of the use of low stress *free standing dielectric films* with the appropriate processing qualities and membrane or thin film single crystalline (monocrystalline), polycrystalline or amorphous semiconductor substrate formation that provides much of the advantage of the [membrane dielectric isolation integrated circuit] fabrication process . . ."); 3:56–4:11 (listing thirteen benefits of "fabricating an [integrated circuit] with the [membrane dielectric isolation] process . . . over prior art methods . . .").

The probative value of Petitioner's argument is diminished because Petitioner credits Leedy '695's low tensile stress dielectric *material* with the benefits disclosed by Leedy '695 for its membrane dielectric isolation *process* for fabricating integrated circuits.

(b)(ii) Expected Success

Petitioner contends that Leedy '695 uses plasma-enhanced chemical vapor deposition to deposit the low tensile stress dielectric material and that plasma-enhanced chemical vapor deposition was a well-known technique with advantages and "could have been used in place of the dielectric growing techniques described in Bertin to obtain the predictable result of stacked [integrated circuits] having low tensile stress dielectrics." Pet. 19–20 (citing *KSR*, 550 U.S. at 415–21; Ex. 1002 ¶¶ 98–102). Petitioner's conclusion is insufficiently supported. The fact that plasma-enhanced chemical vapor deposition was well-known, commonly available, and has recognized advantages does not sufficiently support Petitioner's conclusion in view of the complexities of integrated circuit fabrication.

Furthermore, Petitioner's assertion that "dielectrics can be easily used in place of other dielectrics" (Pet. 19) is not supported by the record. Petitioner's citations to Leedy '695 (Ex. 1006, 6:30–33, 8:59–64) do not on their face, without explanation, support Petitioner's position. Petitioner's citation to column six indicates: "[t]hermally formed silicon dioxide forms as a strongly compressive film and most deposited dielectrics currently in use form typically with compressive surface stress." Ex. 1006, 6:30–33. Petitioner's citation to column eight similarly requires further explanation

regarding how it supports Petitioner's assertion that "dielectrics can be easily used in place of other dielectrics" (Pet. 19): "[t]he thermal oxide isolation created by the LOCOS[20] method may change the net tensile surface stress of the semiconductor (substrate) membrane layer. The deposition of low stress dielectric films on either side of the semiconductor layer prior to LOCOS processing will offset most compressive effects of the oxide formation." Ex. 1006, 8:59–64. The fact that Leedy '695 discloses that the use of a particular method—LOCOS—could be used in either of its two recipes for membrane dielectric isolation fabrication does not, without more, suggest that Leedy '695's dielectrics "could be easily" used in place of other dielectrics.

Even setting aside the fact that Petitioner cites but does not discuss its expert's testimony,[21] Dr. Franzon does not explain how the cited portions of Leedy '695 show "its dielectrics can be easily used." The fact that plasma-enhanced chemical vapor deposition was a well known process capable of providing TSV insulation (Ex. 1002 ¶ 99) does not in itself indicate that Leedy '695's alternative processes "could have been easily used" in place of Bertin '754's techniques, particularly in view of the complexities of integrated circuit fabrication. Dr. Franzon testifies that Leedy '695 explains its membrane can be used with "most of the established integrated processing methods for the fabrication of circuit devices and interconnect

[20]LOCOS (LOCal Oxidation of Silicon) isolation method." Ex. 1006, 8:43.
[21] 37 C.F.R. § 42.6(a)(3) (prohibiting incorporation by reference from one document to another).

metallization" or its membrane "is compatible with most higher temperature [integrated circuit] processing techniques." Ex. 1002 ¶ 101. Again, for purposes of addressing Petitioner's arguments, we overlook the fact that Petitioner cites to this testimony without discussing it in its Petition. Dr. Franzon's testimony, while indicating Leedy '695's *membrane* can be used with some conventional methods, does not adequately support Petitioner's contention that "dielectrics can be easily used in place of other dielectrics" (Pet. 19). Thus, we conclude that Petitioner's citation to Dr. Franzon's testimony is unavailing. Pet. 19 (citing Ex. 1002 ¶¶ 99–102).

Moreover, as discussed in detail below, both Dr. Franzon and Dr. Glew agree that dielectrics have different properties and different methods of forming dielectrics in integrated circuit fabrication result in dielectrics having different properties. *See, e.g.*, Ex. 2164 (Dr. Franzon deposition transcript), 69:17–19 (Q. Do the different methods result in different properties of the dielectrics? A. Yes."); Ex. 2166 (Dr. Glew's declaration) ¶ 139 (Identifying eighteen properties[22] of dielectrics; testifying that one of ordinary skill in the art would consider many of those factors

[22] Dr. Glew identifies the following properties of dielectrics: dielectric constant, breakdown of field strength, leakage, surface conductance, moisture absorption or permeability to moisture, stress, adhesion to aluminum, adhesion to other dielectric layers, stability, etch rate, permeability to hydrogen, amount of incorporated electrical charge or dipoles, amount of impurities, quality of step coverage, thickness and uniformity of the film, ability to provide good doped uniformity across a wafer, defect density, and amount of residual constituents that "outgas" during later processing. Ex. 2166 ¶ 139.

when choosing a dielectric); *see also* PO Resp. 59–60 (discussing Dr. Franzon's and Dr. Glew's testimony); *see also* Ex. 2146 (Wolf Volume 2), 195 (Table 4.4 listing eighteen desired properties of interlevel dielectrics); PO Resp. 33 (citing Ex. 2146, 195); Tr. 125:12–17 (Patent Owner's counsel referencing Ex. 2146, 195 (table of eighteen properties)). Dr. Franzon acknowledges dielectric properties should be considered when selecting a dielectric. Ex. 2164 (Dr. Franzon deposition transcript), 59:25–60:2, 61:10–13, 79:25–80:3, 91:8–12; Ex. 2164, 78:23–79:1 (Dr. Franzon testifies that "[t]here is likely quite a long list of factors that go into choosing between them [dielectrics], and an engineer would weigh those using his knowledge and skills."). This weighs against a finding that one of ordinary skill in the art would have had expected success substituting Leedy '695's low tensile stress dielectric material for Bertin '754's dielectric layer 60 and interconnect insulators.

We recognize that one of ordinary skill in the art is "a person of ordinary creativity, not an automaton." *KSR*, 550 U.S. at 420–21 ("The idea that a designer hoping to make an adjustable electronic pedal would ignore Asano because Asano was designed to solve the constant ratio problem makes little sense. A person of ordinary skill is also a person of ordinary creativity, not an automaton."). Considering the complex field of integrated circuit fabrication and taking into account the level of ordinary skill in that art as set forth by Petitioner, there is insufficient evidence of record to conclude that ordinary creativity would support a conclusion that one of ordinary skill in the art would have had expected success by substituting

Leedy '695's dielectric material for Bertin '754's dielectric layer 60 and interconnect insulators. This is particularly true in view of the significant differences between Leedy '695's membrane dielectric isolation process and Bertin '754's process using thermal oxidation and conventional, rigid substrates to fabricate integrated circuits. Moreover, in his deposition testimony, Dr. Franzon responded to many questions about dielectrics by indicating research would be needed to answer the particular question, which weighs against a finding that one of ordinary skill would have a reasonable expectation of success in substituting Leedy '695's dielectric. *See*, *e.g.*, Ex. 2164, 71:9–73:17 ("Q. Do you consider oxidation to be a growth or a deposition?" A. I haven't researched that answer to the question. Thermal oxidation [requires] oxygen atoms in contact with the surface, at least, in order to grow the thermal oxide. But there's a lot of variance on thermal oxide techniques that I haven't researched. Q. And can you give me an example of some variants in thermal oxide techniques? A. One example that comes to mind is a wet oxide deposition versus a dryer one. Q: And does a wet oxide deposition versus a drier one cause different arrangements of the bonds in silicon dioxide? A: I haven't researched the answer to that question. . . . Q: Do you know if wet oxide versus dry oxide would affect the dielectric constant of silicon dioxide? A. I haven't researched the answer to that question. Q. Do you know if PDCVD [sic] would result in a different dielectric constant than thermal oxide? A. I haven't researched the answer to that question.") We are not suggesting that a reasonable expectation of success in the complex field of integrated circuit fabrication would preclude

one of ordinary skill in the art from researching aspects of making the combination. Rather, we find the number of Dr. Franzon's responses that research is required weighs against Petitioner's conclusory assertions in this regard, which were discussed previously. *See, e.g.*, Ex. 2164, 71:9–73:17, 73:18–74:4, 24:6–22, 65:10–14, 129:7–9, 130:17–25, 134:20–25; Pet. 19–20.

c. Contentions of Patent Owner

Patent Owner opposes, relying on declaration testimony from Dr. Glew. Patent Owner contends one of ordinary skill in the art would not have been motivated to use the Leedy '695 dielectric but rather would understand that the Leedy '695 dielectric could not be used in the manner proposed by Petitioner. *See, e.g.*, PO Resp. 2–3, 36–48, 58–63. More specifically, Patent Owner contends that Petitioner overlooks that "[d]ielectrics have different requirements, characteristics, and behaviors depending on how they are being used and how they are made, so that one cannot simply replace another." PO Resp. 2. Patent Owner further contends that Leedy '695's dielectric, because it is made by plasma-enhanced chemical vapor deposition (or PECVD), "cannot be deposited on silicon without damaging it, does not meet the required purity level [of Bertin '754's process] and cannot withstand high temperatures without changing its form." PO Resp. 2–3.

In Reply, Petitioner contends, without support of expert testimony or citation to law, that "the lack of disclosure of 'tensile' dielectrics or how to make a [low tensile stress dielectric, aside from incorporating a § 102(b)

reference, indicates that it was trivial to substitute Leedy '695's [low tensile stress dielectrics] in place of other dielectrics. Pet. Reply 2. We disagree with Petitioner—one does not necessarily follow from the other.

Similarly, we disagree with Petitioner's conclusory position that the technical obstacles to incorporating Leedy '695's dielectric into prior art integrated circuits (such as Bertin's) are not addressed by Leedy '695 and are not "real or the challenged claims would not be enabled." Pet. Reply 2–3; *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016) (Petitioner cannot satisfy its burden of proving obviousness by employing "mere conclusory statements."). Leedy '695 sets forth sixty-four pages of figures and more than forty-six columns of text to describe his membrane dielectric isolation integrated circuit fabrication techniques and did not also need to explain in detail specific ways to substitute its techniques for those in a conventional integrated circuit fabrication process. Notably, Petitioner's position is based on attorney argument. Accordingly, we determine Petitioner's conclusory assertions in its Reply are insufficient to overcome Patent Owner's well-reasoned and supported arguments.

Petitioner and Patent Owner dispute what is meant by front-end and back-end processing steps. *See, e.g.*, PO Resp. 23–29 (discussing front-end and back-end dielectrics); Pet. Reply 3–16 (discussing purported use of plasma-enhanced chemical vapor deposition in front-end of the line), 25–26 (arguing Bertin '754's dielectrics are used in front-end of the line). We are not persuaded that resolving this issue is necessary to resolve the issue of whether one of ordinary skill in the art would have had reason to combine

the asserted references in the manner proposed by Petitioner to arrive at the claimed invention and would have had a reasonable expectation of success of doing so. *See Dome Patent*, 799 F.3d at 1380. Even assuming that Leedy '695 dielectrics are used in the front-end of the line and Bertin's dielectrics could be used in the front-end of the line (as Petitioner contends), this does not explain, as Petitioner must, why one of ordinary skill in the art would have combined the references in the manner proposed by Petitioner to arrive at the claimed invention and would have reasonable expectation of success in doing so. The mere capability of combining Leedy '695's plasma-enhanced chemical vapor deposition process to deposit low tensile stress dielectric material in place of Bertin '754's thermal oxidation process of growing dielectric material is not our inquiry. Rather our inquiry is whether Petitioner has demonstrated by a preponderance of the evidence that one of ordinary skill in the art would have had a reason to do so. *See*, *e.g.*, *In re Giannelli*, 739 F.3d 1375, 1380 (Fed. Cir. 2014) ("In the context of the claimed rowing machine, however, the mere capability of pulling the handles is not the inquiry that the Board should have made; it should have determined whether it would have been obvious to modify the prior art apparatus to arrive at the claimed rowing machine.").

d. Expert Testimony

Within the context of the complexities of integrated circuit fabrication, both sides present evidence regarding the presence or absence of a motivation to substitute Leedy '695's low tensile stress dielectric material for Bertin '754's dielectric layer 60 and interconnect insulators.

(d)(i) Consideration of Dielectric Properties

First, both experts agree that dielectrics have different properties and different methods of forming dielectrics in integrated circuit fabrication result in dielectrics having different properties. *See, e.g.*, Ex. 2164 (Dr. Franzon's deposition transcript), 69:17–19 (Q. Do the different methods result in different properties of the dielectrics? A. Yes."); Ex. 2166 (Dr. Glew's declaration) ¶ 139 (Identifying eighteen properties[23] of dielectrics; testifying that one of ordinary skill in the art would consider many of those factors when choosing a dielectric); *see also* PO Resp. 59–60 (discussing Dr. Franzon's and Dr. Glew's testimony). Notably, Dr. Franzon acknowledges dielectric properties that should be considered when selecting a dielectric: intrinsic stress, coefficient of thermal expansion, dielectric constant, conformity, deposition rate, etch rate, susceptibility to impurities, and propensity to cause pinholes. Ex. 2164 (Dr. Franzon's deposition transcript), 59:25–60:2, 61:10–13, 79:25–80:3, 91:8–12). Dr. Franzon further testifies that intrinsic stress, in turn, depends on a number of factors, such as deposition rate, deposition temperature, pressure in the deposition

---

[23] Dr. Glew identifies the following properties of dielectrics: dielectric constant, breakdown of field strength, leakage, surface conductance, moisture absorption or permeability to moisture, stress, adhesion to aluminum, adhesion to other dielectric layers, stability, etch rate, permeability to hydrogen, amount of incorporated electrical charge or dipoles, amount of impurities, quality of step coverage, thickness and uniformity of the film, ability to provide good doped uniformity across a wafer, defect density, and amount of residual constituents that "outgas" during later processing. Ex. 2166 ¶ 139.

chamber, incorporation of impurities during growth, grain structure from fabrication process defects. Ex. 2164, 63:1–7 (Dr. Franzon deposition transcript citing his report (Ex. 1022 ¶ 24)). Moreover, Dr. Franzon testifies that "[t]here is likely quite a long list of factors that go into choosing between them [dielectrics], and an engineer would weigh those using his knowledge and skills." Ex. 2164, 78:23–79:1; *see also* Ex. 2164, 77:13 ("Q. In your opinion, in Table 7, which of those are the best dielectric for use in semiconductor technology? . . . THE WITNESS: There are many factors that would go into that choice, including stress and other factors."). Dr. Franzon further testifies that the variety of factors that an engineer would consider "can be very context specific" and that "factors matter to different degrees, depending on the application, the materials, the other materials, the overall process flow, the overall process integration, the recipes, and so forth." Ex. 2164, 109:19–110:3. Furthermore, Dr. Franzon testifies that "[t]here is no single most important characteristic" of a dielectric in semiconductor technology. Ex. 2164, 65:15–20.

Yet, in marked contrast to Dr. Franzon's testimony concerning the variety of factors that an engineer would consider when selecting a dielectric for use in semiconductor fabrication and that there is no single most important characteristic of a dielectric in semiconductor technology, Petitioner contends that "[i]t would have been obvious to one of ordinary skill in the art to modify Bertin such that each of the dielectric layer 60 and the interconnect insulators constitutes a dielectric characterized by [a particular tensile stress] based on the disclosure of Leedy '695" (Pet. 17).

Petitioner's contention seems to suggest that the characteristic of tensile stress is the most important characteristic of a dielectric to be considered, which is counter to its expert's testimony. In addition, in contrast to Dr. Franzon's deposition testimony concerning the variety of context-specific factors that an engineer would consider when selecting a dielectric, Dr. Franzon's declaration testimony does not provide an analysis of such factors. Rather, Dr. Franzon's testimony summarizes the disclosure of Leedy '695 and the known use and advantage of using plasma-enhanced chemical vapor deposition techniques. Ex. 1002 ¶¶ 91–102.

Furthermore, Dr. Franzon's testimony does not expressly support Petitioner's specific proposed *substitution of Bertin '754's dielectric layer 60 and the interconnect insulators*. Pet. 17–18 (citing Ex. 1002 ¶¶ 91–102). Rather, Dr. Franzon's testimony is more general—"a person of ordinary skill in the art would have been motivated by these advantages [identified in Leedy '695 and an advantage of using plasma-enhanced chemical vapor deposition techniques] to implement the low-stress dielectric deposition techniques disclosed by Leedy '695 *to the stacked integrated circuit structures disclosed in each of Bertin '754 (alone or in combination with Poole) and Yu*." Ex. 1002 ¶ 100 (emphasis added).

We find Petitioner's statement that "[i]t would also have been obvious to one of ordinary skill in the art to *simply substitute* Leedy '695's low tensile stress dielectric material for the dielectrics disclosed in Bertin" (Pet. 19) to be contrary to the record as a whole.

(d)(ii) Weighing Expert Testimony

In general, we weigh Dr. Glew's testimony concerning the reasons why one of ordinary skill in the art would not have had reason to combine the references in the manner proposed by Petitioner more heavily than Dr. Franzon's declaration testimony that one of ordinary skill in the art would have done so and would have had an expectation of success. Dr. Franzon's testimony, in large measure, is that Leedy '695 identifies advantages of "the disclosed dielectric deposition techniques" (Ex. 1002 ¶ 98); that plasma-enhanced chemical vapor deposition was commonly available and was known to "advantageously provide" various benefits; and the references are in the same technological field and "address similar challenges relating to the stacking of integrated circuit devices." *See* Ex. 1002 ¶¶ 98, 99, 102; Pet. 17–20 (citing Ex. 1002 ¶¶ 91–102). Dr. Franzon's testimony, however does not adequately address why one of ordinary skill in the art would specifically use Leedy '695's fabrication process to make Bertin '754's integrated circuit having Leedy '695's low tensile stress dielectric as layer 60 and interconnect insulators, which is the combination on which Petitioner relies for the recited dielectric material characterized by the particular tensile stress claimed. *See* Pet. 17. Notably, too, Dr. Franzon does not specify or otherwise explain the "similar challenges relating to the stacking of integrated circuit devices" he refers to in his testimony. We, however, recognize that "any need or problem known in the field of endeavor at the time of the invention and addressed by the patent can provide a reason for combining the elements in the manner claimed." *KSR*,

550 U.S. at 420. Noting, however, that references are in the same general field and address similar unnamed challenges in the circumstances of this case—involving complex technology of integrated circuit fabrication, we conclude that Dr. Franzon's testimony about the benefits of Leedy '695's general process is insufficient to support Petitioner's position regarding dielectric substitution of particular structures in Bertin '754. *See In re Nuvasive*, 842 F.3d 1376, 1383 (Fed. Cir. 2016) (holding conclusory statements insufficient if not supported by a reasoned explanation (citing *In re Lee*, 277 F.3d 1338, 1342 (Fed. Cir. 2002) ("The factual inquiry whether to combine references must be thorough and searching.")); *InTouch Techs., Inc. v. VGO Commc'ns, Inc.*, 751 F.3d 1327, 1347 (Fed. Cir. 2014) ("While an analysis of any teaching, suggestion, or motivation to combine elements from different prior art references is useful in an obviousness analysis, the overall inquiry must be expansive and flexible.").

In contrast, Patent Owner relies on Dr. Glew's testimony, which is specific as to reasons why one of ordinary skill in the art would not have combined Leedy '695's fabrication process to make Bertin '754's integrated circuit having Leedy '695's low tensile stress dielectric as layer 60 and insulated interconnecting structures. Specifically, for example, Patent Owner relies on Dr. Glew's testimony that Bertin '754's "dielectric layer 60" was grown using thermal oxidation and could not be produced using plasma-enhanced chemical vapor deposition used by Leedy '695. PO Resp. 42–44. More specifically, Dr. Glew explains that, because Bertin '754's dielectric layer is *grown* as silicon dioxide (rather than

deposited using a chemical vapor deposition process), one of ordinary skill in the art would understand that Bertin '754's dielectric layer 60 was produced "using thermal oxidation to grow exposed silicon components into silicon dioxide." PO Resp. 42–43 (citing Ex. 2166 ¶ 127 (Dr. Glew's testimony citing Ex. 1004, 3:60–62, Ex. 2158 (Zant text), 102–103). In addition, Dr. Glew testifies that "because Bertin describes the silicon dioxide dielectric layer 60 as being grown directly over active silicon components (such as a silicon source, gate, or drain), one of ordinary skill also would understand that the dielectric layer 60 needs to be highly pure, which again would mean it was grown at high temperatures using thermal oxidation." PO Resp. 43 (citing Ex. 2166 ¶ 128; Ex. 1004, 3:60–4:3; Ex. 2158, 68–70; Ex. 2159, 54, 139). Dr. Glew further testified that one of ordinary skill in the art would understand that Bertin '754's dielectric layer 60 could not be deposited using plasma-enhanced chemical vapor deposition described by Leedy '695 "because the resulting dielectric would not (1) be sufficiently pure; (2) have the ability to adhere sufficiently to the semiconductor wafer; and (3) be able to withstand high temperatures of the remaining . . . steps[24] without changing its form." Ex. 2166 ¶ 130 (citing Ex. 2169, 29–30). Notably, Dr. Glew testifies that plasma-enhanced chemical vapor deposition

[24] As discussed earlier, although Petitioner and Patent Owner dispute what is meant by front-end and back-end processing steps, we are not persuaded that resolving this issue is necessary to resolve the issue of would have reason to combine the asserted references in the manner proposed by Petitioner to arrive at the claimed invention and one of ordinary skill in the art would have had a reasonable expectation of success of doing so.

(a known technique used by Leedy '695) cannot be used with Bertin '754's techniques because "positive ions present in the plasma can strike and damage the wafer and the exposed active components in and on its surface." Ex. 2166 ¶ 130 (citing Ex. 2159, 139).

Furthermore, Dr. Glew's testimony is supported by his well-reasoned explanation, liberal citations to background references, and liberal citations to asserted prior art. For example, Dr. Glew's declaration testimony cites three pages of the Zant text (Ex. 2158) and a page of the Runyan text (Ex. 2159) to support his statement that "if a silicon dioxide dielectric contacts circuit components, the silicon dioxide must be high-purity to not damage the circuit components." Ex. 2166 ¶ 128 (citing Ex. 2158, 68–70; Ex. 2159, 54). That statement, supported by two reference citations, in turn, supports Dr. Glew's conclusion: "[t]herefore, because Bertin describes the silicon dioxide dielectric layer 60 as being grown directly over active silicon components (such as a silicon source, gate, or drain), one of ordinary skill also would understand that the dielectric layer 60 needs to be highly pure, which again would mean it was grown at high temperatures using thermal oxidation." Ex. 2166 ¶ 128.

We also note the absence of further declaration testimony by Dr. Franzon opposing Dr. Glew's position or otherwise supporting Petitioner's Reply to Patent Owner's Response. For the reasons noted previously, because of the complexity of integrated circuit fabrication, expert testimony is critical to explaining why one of ordinary skill in the art would have had a reason to combine the references as the claims require.

Kinetic Concepts, Inc. v. Smith & Nephew, Inc., 688 F.3d 1342, 1369 (Fed. Cir. 2012) (indicating expert technology is not always required) (citing *Wyers v. Master Lock Co.*, 616 F.3d 1231, 1240 n.5 (Fed. Cir. 2010) ("However, as we [have] noted . . . 'expert testimony regarding matters beyond the comprehension of layperson is sometimes essential,' particularly in cases involving complex technology. In such cases, expert testimony may be critical, for example, to establish . . . the existence (or lack thereof) of a motivation to combine references." (internal citations omitted)) (alteration in original)). This is particularly true in view of Dr. Glew's well-reasoned and supported testimony. Petitioner's attorney-argument in its Reply consists of conclusory statements with insufficiently explained citations to Leedy '695 and other references and is insufficient to establish that one of ordinary skill in the art would have had reason to combine the references in the manner proposed by Petitioner. *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016) (a petitioner cannot satisfy its burden of proving obviousness by employing "mere conclusory statements").

For example, in Reply to Dr. Glew's testimony supporting Patent Owner Response, Petitioner's attorneys assert that plasma-enhanced chemical vapor deposition dielectrics are compatible with silicon substrates and high temperature processes. Pet. Reply 11–15 (citing Ex. 1082, 1006, 1088). We recognize that sometimes expert testimony is not always necessary. *See, e.g.*, *Kinetic Concepts*, 688 F.3d at 1369 (indicating expert technology is not always required). Because of the complexity of integrated circuit fabrication discussed above, attorney-argument addressing Dr.

Glew's well-reasoned and supported testimony is not sufficient to convince us that one of ordinary skill in the art would have had reason to combine the references in the manner proposed by Petitioner or would have had a reasonable expectation of success.

e. Conclusion

As described above, Petitioner in its Petition made arguments as to why one of ordinary skill in the art would have been motivated to combine Bertin '754 with Leedy '695 to achieve the purported claimed invention and would have had a reasonable expectation of success. Patent Owner provided well-reasoned argument based on testimonial evidence, background references, and prior art references identifying shortcomings in Petitioner's position. There is evidence from both sides regarding the presence or absence of a reason to combine Bertin '754 and Leedy '695 in the manner proposed by Petitioner to arrive at the claimed invention and regarding whether one of ordinary skill in the art would have had a reasonable expectation of success.

Here, Petitioner has the burden to show by a preponderance of the evidence a reason why one of ordinary skill in the art would have combined the prior art references to arrive at the invention and why one of ordinary skill in the art would have had a reasonable expectation of success in combining the references to meet the limitations of the claimed invention. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d); *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1367 (Fed. Cir. 2016) ("The reasonable expectation of success requirement refers to the likelihood of success in

combining the references to meet the limitations of the claimed invention. . . . [O]ne must have a motivation to combine [the references] accompanied by a reasonable expectation of achieving what is claimed in the patent-at-issue."). "In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")).

It is well-settled that identifying a reason to combine references is not confined to a "rigid or mandatory formula[]." *KSR*, 550 U.S. at 419; *see In re Nuvasive*, 842 F.3d 1376, 1383(Fed. Cir. 2016). Moreover, "[w]hile an analysis of any teaching, suggestion, or motivation to combine elements from different prior art references is useful in an obviousness analysis, the overall inquiry must be expansive and flexible." *InTouch Techs., Inc. v. VGO Commc'ns, Inc*., 751 F.3d 1327, 1347 (Fed. Cir. 2014). Furthermore, the inquiry cannot be met by conclusory statements but rather must be "thorough and searching." *See In re Nuvasive*, 842 F.3d 1376, 1383 (Fed. Cir. 2016) (holding conclusory statements insufficient if not supported by a reasoned explanation) (citing *In re Lee*, 277 F.3d 1338, 1342 (Fed. Cir. 2002) ("The factual inquiry whether to combine references must be thorough and searching."). Additionally, we must be careful not to allow hindsight reconstruction of references to reach the claimed invention without adequate explanation as to how or why the references would be combined to produce

the claimed invention. *See, e.g., Kinetic Concepts*, 688 F.3d at 1368 (quoting *Innogenetics, N.V. v. Abbott Labs.*, 512 F.3d 1363, 1374 n.3 ("We must still be careful not to allow hindsight reconstruction of the references to reach the claimed invention without any explanation as to how or why the references would be combined to produce the claimed invention.")).

We find Petitioner's arguments regarding its proposed combination to be incomplete. In the context of these cases, it is insufficient to propose incorporating "the material" of Leedy '695 without providing sufficient detail as to the combined process to produce the claimed combination. In the complex technology of semiconductor fabrication, merely asserting that the low tensile stress dielectric material of Leedy '695 would be incorporated as dielectric layer 60 and interconnect insulators of Bertin '754 is insufficient. Petitioner has not explained sufficiently how one of ordinary skill in the art would have had reasonable expectation of success of incorporating the low tensile stress dielectric material of Leedy '695 into Bertin '754's integrated circuit, without adequately explaining the changes in Bertin '754's process required to do so. We recognize that it is axiomatic that bodily incorporation is not required. *See, e.g., In re Mouttet*, 686 F.3d 1322, 1332 (Fed. Cir. 2012) ("It is well-established that a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of the elements."). To be clear, we are not suggesting that Petitioner must explain how Leedy '695's entire membrane dielectric isolation process could be included in Bertin '754's integrated circuit fabrication process, duplicating the thermal oxidation growing of

layer 60 with Leedy '695's plasma-enhanced chemical vapor deposition of its low tensile stress dielectric material. Rather, we find Petitioner's explanation to be incomplete because it does not adequately explain how Bertin '754's fabrication process would be changed to use Leedy '695's dielectric material, which is formed in a quite different manner than Bertin '754's dielectric layer 60. This is necessary, at least, to support a conclusion that one of ordinary skill in the art would have had reasonable expectation of success of using Leedy '695's dielectric material in place of Bertin '754's layer 60 and interconnect insulators.

In the particular circumstances of this case, with its complex technology of integrated circuit fabrication and Leedy '695's robust written description articulating general advantages of its low tensile stress dielectric membrane and its membrane dielectric isolation process, we are not persuaded that Petitioner has met its burden to provide sufficient articulated reasoning with rational underpinning to support Petitioner's conclusion of obviousness.

Accordingly, having considered the Petition, Patent Owner's Response, and Petitioner's Reply, as well as the relevant evidence discussed in those papers, we determine that Petitioner has not met its burden to demonstrate by a preponderance of the evidence that a person of ordinary skill in the art would have had reason to combine the asserted references to arrive at the claimed invention or that a person of ordinary skill would have had a reasonable expectation of success in making the combination proposed by Petitioner.

D. Asserted Ground of Obviousness over Yu and Leedy '695

Having considered the parties' arguments and weighed the parties' evidence cited therein, and for the reasons set forth below, we determine that Petitioner has not demonstrated by a preponderance of the evidence that claims 17, 18, 22, 84, 95, 129–132, 145, 146, and 152 are unpatentable under 35 U.S.C. § 103 over Yu and Leedy '695 ("the Yu ground" or "the IPR386 Yu ground"). Pet. 46–57.

1. Petitioner's Contentions

In general, Petitioner relies on Yu's microvision system with a 3D integration structure as describing most of the limitations recited in the challenged claims. *Id.* at 46 ("Yu teaches or suggests all but a few of the features recited in the Challenged Claims."). For example, regarding independent claim 17, Petitioner relies on Yu's description of the "thick wafer" illustrated as the base wafer for disclosing the recited first substrate. *Id.* at 48. For the recited substantially flexible semiconductor substrate, Petitioner relies on Yu's "thinned wafer" that supports interconnect contacts, which (according to Petitioner) Yu refers to as "In/Au microbumps" on its topside surface. *Id.* at 49.

Petitioner acknowledges that Yu does not disclose expressly that "its dielectric is characterized by a tensile stress of about 5 x 10^8 dynes/cm^2 or less." *Id.* at 46. For that limitation and similarly to Petitioner's asserted ground of obviousness over Bertin '754, Poole, and Leedy '695 ("the Bertin '754 ground"), Petitioner relies on Leedy '695. *See, e.g.*, *id.* at 46–48. Unlike the Bertin '754 ground that relies on Poole for describing

polishing after removing semiconductor material, however, the Yu ground relies on Yu (not Poole) as teaching polishing. *See, e.g.*, *id.* at 17 (providing an overview of the Bertin '754 ground), 46–47 (providing an overview of the Yu ground), 60 (describing differences between the Bertin '754 ground and the Yu ground). *See generally id.* at 17–43 (the Bertin '754 ground), 46–57 (the Yu ground).

2. "Substantially Flexible Semiconductor [] Substrate"

Similarly to Petitioner's arguments regarding its combination of Bertin '754, Poole, and Leedy '695, Petitioner presents arguments that claims 17, 18, 22, 84, 95, 129–132, 145, 146, and 152 would have been obvious over Yu and Leedy '695 using its proposed narrow construction of a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed. *See, e.g.*, Pet. 9, 48–49 (arguments for independent claim 17). As with the Bertin '754 ground, Petitioner also indicates that the challenged claims would have been obviousness under two alternative constructions: "(i) a substrate that has been thinned to a thickness of less than 50 μm or (ii) that has been thinned to a thickness of 150 μm or less." Pet. 13, 58–59. According to Petitioner, the challenged claims "are unpatentable for the same reasons discussed in Grounds [of obviousness over Yu and Leedy '695], because . . . each contain prior art that teaches or suggests a semiconductor substrate that has been thinned to a thickness of less than 50 μm." Pet. 58–59. Petitioner relies on Yu's "thinned wafer" as conveying to one of ordinary skill in the art the recited "substantially flexible semiconductor substrate" because Yu grinds

and polishes the wafer to "thin the wafer to 30 μm." Pet. 49 (citing Ex. 1009, 831, 834, Fig. 9).

As discussed previously, we agree with Patent Owner's proposed construction for "substantially flexible semiconductor substrate" as "a semiconductor substrate that is largely able to bend without breaking." In Reply, Petitioner does not contend that Yu discloses the recited substantially flexible semiconductor substrate as construed by Patent Owner. As discussed previously with respect to Bertin '754, a preponderance of the evidence establishes, however, that, in the context of semiconductor substrates, mere thinning is not the same as flexibility—being able to bend without breaking.

Accordingly, we determine that Petitioner has not demonstrated by a preponderance of the evidence that the combination of Yu's thinned substrate of less than 30 μm would have conveyed to one of ordinary skill in the art the "substantially flexible semiconductor second substrate," as recited in claim 17 (Pet. 48–49). For the substantial flexibility requirement in the other challenged claims, Petitioner relies on its arguments concerning claim 17. Pet. 52 (independent claim 84); Pet. 53 (independent claim 129); Pet. 55–56 (disclaimed independent claim 143 from which challenged claims 145, 146, and 152 depend); Pet. 50–51, 52–53, 54–55, 56–57 (discussing challenged dependent claims that depend from independent claims 17, 84, 129, and 143).

This reason alone is sufficient for us to conclude that Petitioner does not satisfy its burden to establish that claims 17, 18, 22, 84, 95, 129–132,

145, 146, and 152 are unpatentable as obvious over Yu and Leedy '695. There is, however, yet an additional independent and separate reason as set forth below for our conclusion that Petitioner does not satisfy this burden.

3. Low Tensile Stress Dielectric Substitution

Petitioner contends that one of ordinary skill in the art would have had reason "to modify the processes and device in Yu such that the dielectrics used therein would be characterized by the [required] tensile stress based on the disclosure of Leedy '695.'" Pet. 46–47.

As an initial matter, we note that much of Dr. Franzon's testimony on which Petitioner relies relates to both Bertin '754 and Yu, which we have addressed above in the context of Bertin '754. *See, e.g.*, Ex. 1002 ¶ 99 ("It was also well known that [plasma-enhanced chemical vapor deposition] is a conformal deposition process capable of coating TSV sidewalls, like those disclosed in Bertin and Yu, to provide TSV insulation."); ¶ 100 ("Thus, a person of ordinary skill in the art would have been motivated by these advantages to implement the low-stress dielectric deposition techniques disclosed by Leedy '695 to the stacked integrated circuit structures disclosed in each of Bertin (alone or in combination with Poole) and Yu."); ¶ 101 ("One of ordinary skill in the art would have reasonably expected success combining the teachings of Leedy '695 with the teachings of each of Bertin (alone or in combination with Poole) and Yu. . . . Leedy '695 discloses using [plasma-enhanced chemical vapor deposition], which was a commonly available deposition technique that could have been used in place of the techniques for growing or depositing dielectrics described in Bertin and Yu

to obtain the predictable result of stacked integrated circuits having low tensile stress dielectrics."); ¶ 102 ("A person of ordinary skill in the art would have been encouraged to combine Leedy '695 with each of Bertin (alone or in combination with Poole) and Yu to obtain the predictable result of stacked integration circuits having low tensile stress dielectrics."). We see no arguments or evidence from Petitioner that would demand a different result with regard to Yu.

Petitioner provides three purported reasons. First, similar to its arguments concerning combining Leedy '695 with Bertin '754, Petitioner argues that one reason an ordinarily skilled artisan would have combined Leedy '695 with Yu is because Leedy '695 uses "a conformal chemical vapor deposition (CVD) process"; would reduce "the probability of cracking and warpage due to elevated stress in the vias"; and Leedy '695's low tensile stress dielectric would be able to withstand a wide range of processing techniques and processing temperatures." Pet. 47 (citing Ex. 1002 ¶¶ 99–100); *compare* Pet. 47, *with* Pet. 19.

For substantially similar reasons to those discussed previously, Dr. Franzon's testimony in paragraphs 99 and 100 does not support sufficiently a conclusion that one of ordinary skill in the art would have combined the references in the manner proposed by Petitioner. First, Dr. Franzon's conclusion is too general in that it addresses: "the stacked integrated circuit structures disclosed in . . . *Yu*." Ex. 1002 ¶ 100. Dr. Franzon's testimony in paragraph 99 is that the chemical vapor deposition processes of Leedy '695 were well-known and advantages of the

technique were well known. Ex. 1002 ¶ 99. As discussed above, this reasoning is insufficient, in view of the complex technology of integrated circuit fabrication and the well-reasoned and well-supported opposing testimony of Patent Owner's expert, Dr. Glew.

Second, Petitioner contends that one of ordinary skill in the art would have reasonably expected success in combining the references in the manner proposed by Petitioner. Specifically, Petitioner contends:

> Leedy '695 discloses fabrication techniques for low-stress dielectric films compatible with "most of the established integrated processing methods for *KSR*, 550 U.S. at 402-03.52; *see also id*. at 1:32-33. In light of *Leedy '695's* teaching of deposition recipes using common tools (*id*. at 11:51-65; Ex. 1002 at ¶99), a person of ordinary skill would have reasonably expected success when applying Leedy '695's deposition techniques to the stacked IC structure disclosed in Yu. Ex. 1002 at ¶¶99, 103; *KSR*, 550 U.S. at 402-03.

Pet. 47. As discussed previously, we do not agree that such broad statements are sufficient to support a conclusion of reasonable expectation of success in view of the complexity of integrated circuit fabrication and the well-reasoned and well-supported opposing testimony of Patent Owner's expert, Dr. Glew. We also note that Dr. Franzon's testimony in paragraph 103 (which Petitioner cites as support for its argument) does not address whether one of ordinary skill in the art would have had a reasonable expectation of success. *See* Ex. 1002 ¶ 103.

As discussed above in the context of the combination of Bertin '754 and Leedy '695, we do not agree with Petitioner's third reason—"because the references are in the same field of technology and attempt to address the

same problem of vertically integration [integrated circuit] devices." Pet. 48 (citing Ex. 1002 ¶ 102). As discussed above, noting that references are in the same general field and address similar unnamed challenges in this case involving complex technology of integrated circuit fabrication and in view of the well-reasoned and well-supported opposing testimony of Patent Owner's expert, we conclude that Dr. Franzon's testimony is insufficient to support Petitioner's position regarding dielectric substitution in Yu. *Nuvasive*, 842 F.3d 1376, 1383 (Fed. Cir. 2016) (holding conclusory statements insufficient if not supported by a reasoned explanation).

For reasons substantially similar to those discussed above, we also are not persuaded by Petitioner's assertion that "[i]t would have been obvious to combine Leedy '695 with Yu because it involves the substitution of one known element for another—Leedy '695's low stress dielectric for the dielectric of Yu—to yield predictable results with known benefits." Pet. 48 (citing Ex. 1002 at ¶¶99-103, 127; *KSR*, 550 U.S. at 401). As discussed above, the record does not support Petitioner's statement that the substitution of one dielectric for another is easily accomplished. Rather, more evidence regarding the substitution is needed to support sufficiently a conclusion that a dielectric substitution yields predicable results with known benefits. As discussed previously, both experts agree that dielectrics have different properties and different methods of forming dielectrics in integrated circuit fabrication result in dielectrics having different properties.

For these reasons, we determine that Petitioner has not demonstrated by a preponderance of the evidence that one of ordinary skill in the art

(i) would have a reason to combine Yu and Leedy '695 in the manner proposed by Petitioner to arrive at the claimed invention and (ii) would have had a reasonable expectation of success of doing so.

E. IPR2016-00386 Conclusion

Based on determinations of (1) the scope and content of the asserted prior art references, (2) differences between the subject matter of the challenged claims and the disclosures of the asserted prior art references, and (3) the level of ordinary skill in the art[25] (*Graham*, 383 U.S. at 17–18), and for reasons discussed above, we determine that Petitioner has *not* demonstrated by a preponderance of the evidence that the subject matter of any of the challenged claims would have been obvious under 35 U.S.C. § 103.

F. IPR2016-00386 Order

Accordingly, it is:

ORDERED that claims 17, 18, 22, 84, 95, 129–132, 145, 146, and 152 of U.S. Patent No. 8,653,672 have *not* been shown to be unpatentable;

FURTHER ORDERED that this decision be entered as the Final Written Decision in IPR2016-00386; and

FURTHER ORDERED that, because this is a final written decision, parties to the proceedings seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

---

[25] Patent Owner does not proffer any objective evidence of nonobviousness for us to consider.

III. IPR2016-00387[26]—CLAIM CONSTRUCTION AND GROUNDS OF UNPATENTABILITY

In its IPR2016-00387 Petition, Petitioner contends (i) claims 1, 2, 8, 14, and 52 are unpatentable under 35 U.S.C. § 103 over Bertin '754 and Leedy '695; (ii) claims 2, 8, 31, 32, 44, 46, and 52–54 are unpatentable under 35 U.S.C. § 103 over Bertin '754, Poole, and Leedy '695; and (iii) claims 1, 2, 8, 14, 31, 32, 44, 46, and 52–54 are unpatentable under 35 U.S.C. § 103 over Hsu and Leedy '695. Pet. 15–57. Patent Owner opposes Petitioner's contentions. PO Resp. 1–3, 36–67.

A. Illustrative Claim of the Challenged Patent

Of the claims in the '778 patent challenged in IPR2016-00387, claims 1, 8, and 14 are independent. Claims 1 and 2 are illustrative of the claimed subject matter:

> 1. A circuit layer comprising:
>
> a semiconductor substrate that is of one piece and monocrystalline;
>
> interconnect conductors passing vertically through the semiconductor substrate; and
>
> silicon-based dielectric insulators passing vertically through the semiconductor substrate around the vertical interconnect conductors, the silicon-based dielectric insulators having a stress of less than $5x10^8$ dynes/cm^2 tensile.

Ex. 1001, 12:58–67 (paragraphing added).

> 2. The circuit layer of claim 1, further comprising:

[26] Citations in this section refer to papers and exhibits of record in IPR2016-00387.

> a silicon-based dielectric film on the semiconductor substrate and having a stress of less than $5x10^8$ dynes/cm^2 tensile;
>
> wherein the semiconductor substrate is substantially flexible.

Ex. 1001, 13:1–6.

B. Claim Construction:

As noted previously, the '778 patent at issue in this proceeding has expired and, therefore, our claim construction analysis is similar to that of a district court using the *Phillips* standard.

1. "Substantially Flexible"

Of the eleven challenged claims in this proceeding, all but independent claims 1 and 14 require a semiconductor substrate that is substantially flexible. For example, claims 2 and 52 each recites "the semiconductor substrate is substantially flexible," and independent claim 8 recites "a monocrystalline semiconductor substrate . . . that is . . . substantially flexible." Ex. 1001, 13:5–6 (claim 2), 13:28–30 (claim 8), 17:52 (claim 52).

As one would expect, Petitioner proposes the same construction of "substantially flexible" when used to modify "semiconductor substrate" as Petitioner does in IPR2016-00386—"a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed." Pet. 9–10. Petitioner presents the same arguments and discusses substantially the same evidence in this proceeding as discussed previously with respect to the claim construction of "substantially flexible semiconductor substrate" in IPR2016-00386. *Compare* Pet. 9–12, *with* IPR386-Pet. 9–12.

Similarly, Patent Owner in opposition also repeats its contentions made in IPR2016-00386—that "substantially flexible" should be given its ordinary and customary meaning, which is "largely able to bend without breaking." PO Resp. 24; *compare* PO Resp. 53–55, *with* IPR386-PO Resp. 50–53. Patent Owner again contends that "substantially flexible" was not clearly and unambiguously specially defined (*compare* PO Resp. 55–57, *with* IPR386-PO Resp. 53–55) and that "substantially" is not indefinite (*compare* PO Resp. 57–58, *with* IPR386-PO Resp. 56–57). And, Petitioner presents substantially the same arguments in its Reply. *Compare* Pet. Reply 30–31, *with* IPR386-Pet. Reply 30–31.

For the reasons discussed above with respect to "substantially flexible" in IPR2016-00386, we adopt Patent Owner's position that one of ordinary skill in the art in the context of the challenged patent would understand "substantially flexible" to have the customary and ordinary meaning of "largely able to bend without breaking." Therefore, we determine that "semiconductor substrate that is substantially flexible" within the context of the patent is "a semiconductor substrate that is largely able to bend without breaking." Thus, Petitioner must establish that the substrate of the prior art combinations on which the claim challenges are made must provide a substrate that is largely able to bend without breaking.

Independent claim 8 is directed to "[a] substantially flexible circuit layer," as are its dependent claims 44 and 46. Petitioner contends that "a substantially flexible circuit layer" should be construed as "a circuit layer having a semiconductor substrate that has been thinned to a thickness of less

than 50 μm and subsequently polished or smoothed, and where the dielectric material used in processing the semiconductor substrate must have a stress of $5x10^8$ dynes/cm^2 tensile or less." Pet. 12. Notably, Petitioner argues that "a substantially flexible circuit layer" has an additional requirement to that of a substantially flexible semiconductor substrate. Also, Petitioner assumes that the preamble of "[a] substantially flexible circuit layer" is a limitation but does not explain why. *See* Pet. 13. A preamble does not necessarily limit the scope of a claim. *See Tom-Tom, Inc. v. Adolph*, 790 F.3d 1315, 1323 (Fed. Cir. 2015) (indicating "whether to treat a preamble as a claim limitation is determined on the facts of each case in light of the claim as a whole and the invention described in the patent" (citing *Bicon, Inc. v. Straumann Co.*, 441 F.3d 945, 952 (Fed. Cir. 2006))).

For the reasons discussed below, we determine that Petitioner has not shown by a preponderance of the evidence that claims 8, 44, and 46 are unpatentable. Accordingly, we need not determine whether the recitation of "a substantially flexible circuit layer" in the preamble of claims 8, 44, and 46 is a limitation or, if so, the construction of "a substantially flexible circuit layer."

2. Other Claim Terms

To the extent it is necessary for us to expressly construe other claim terms in this decision for IPR2016-00387, we do so below in the context of analyzing whether the prior art renders the challenged claims unpatentable.

C. Asserted Ground of Obviousness over Bertin '754 and Leedy '695 (With or Without Poole)

Having considered the parties' arguments and weighed the parties' evidence cited therein, and for the reasons set forth below, we determine that Petitioner has *not* demonstrated by a preponderance of the evidence that claims 1, 2, 8, 14, and 52 are unpatentable under 35 U.S.C. § 103 over Bertin '754 and Leedy '695, or claims 2, 8, 31, 32, 44, 46, and 52–54 are unpatentable under 35 U.S.C. § 103 over Bertin '754, Poole, and Leedy '695.

Similarly to Petitioner's contentions regarding Bertin '754 and Leedy '695 in IPR2016-00386, Petitioner contends that Bertin '754 describes most of the limitations required by claims 1, 2, 8, 14, 31, 32, 44, 46, and 52–54. Pet. 20. Petitioner relies on Leedy '695's low tensile stress dielectric and Poole's two-step thinning process. Pet. 20, 32. Petitioner contends it would have been obvious to one of ordinary skill in the art "to modify the processes and device in Bertin '754 such that each of the dielectric layer 60 and the interconnect insulators constitutes a dielectric characterized by a tensile stress of about than $5x10^8$ dynes/cm^2 tensile stress or less." Pet. 20.

1. Low Tensile Stress Dielectric Substitution

Many of the challenged claims in both IPR2016-00386 and IPR2016-00387 require dielectric material having a certain tensile stress and the written description is the same in both challenged patents. Again Petitioner relies on testimony of Dr. Franzon, and Patent Owner relies on testimony of Dr. Glew. It is not surprising then that Petitioner and Patent Owner each

present substantially similar arguments and evidence, including evidence as to the complexity of integrated circuit fabrication discussed with respect to IPR2016-00386 (*see, e.g.,* PO Resp. 3–30) and evidence that both experts agree that dielectrics have different properties and different methods of forming dielectrics in integrated circuit fabrication result in dielectrics having different properties (*see, e.g.*, Ex. 2164 (Dr. Franzon's deposition transcript); Ex. 2166 (Dr. Glew's declaration) ¶ 148 (discussing eighteen properties of dielectrics). Even so, these are separate proceedings with separate records.

Petitioner contends that Office already found that the combination of Bertin '754 and Leedy '695 teaches or suggests these features during prosecution of related applications. Pet. 20 (citing Ex. 1033–1036). Second, Petitioner asserts that "one of ordinary skill would have been encouraged to look to the teachings in Leedy '695 to improve the teachings in Bertin ['754]" because they are "both directed to the improvement of integrated circuits and recognize the central role the fabrication process plays in facilitating this improvement" and "both disclosures seek to achieve high density integrated circuits, including 3D integrated circuits." Pet. 20–21 (citing Ex. 1004, 1:7–15, 1:55–2:31; Ex. 1006, Abstract, 2:9–14, 45:49–59, 47:31–33; Ex. 1002 ¶¶ 109–114). Petitioner's third contention is that "Leedy '695 also provides express motivations for modifying Bertin's processes and device to incorporate Leedy '695's low tensile stress dielectric material." Pet. 21–23.

Regarding the requisite reasonable expectation of success, Petitioner contends, as it does in IPR2016-00386, that plasma-enhanced chemical vapor deposition was well-known, commonly available, and has recognized advantages (Pet. 22–23) and "dielectrics can be easily used in place of other dielectrics" (Pet. 22).

For the reasons discussed previously with regard to Petitioner's proposed combination of Bertin '754 and Leedy '695 (alone or with Poole), we determine that Petitioner has not demonstrated by a preponderance of the evidence that a person of ordinary skill in the art would have had reason to combine the asserted references to arrive at the claimed invention or that a person of ordinary skill would have had a reasonable expectation of success in making the combination proposed by Petitioner.

For example, Dr. Franzon's testimony, which Petitioner cites but does not discuss, does not expressly support Petitioner's specific proposed *substitution of Bertin '754's dielectric layer 60 and the interconnect insulators*. *See* Ex. 1002 ¶ 112 (concluding various advantages would have motivated one of ordinary skill in the art "to implement the low-stress dielectric deposition techniques disclosed by Leedy '695 to the stacked integrated circuit structures disclosed in each of Bertin (alone or in combination with Poole) and Hsu."; Ex. 1002 ¶ 109 (concluding one of ordinary skill in the art "would have been motivated to modify the teachings of each of Bertin (alone or in combination with Poole) and Hsu to implement the silicon oxide or silicon nitride deposition processes disclosed by

Leedy '695—which result in the deposition of dielectric material having tensile stress of preferably $1x10^7$ dynes/cm^2—for several reasons.").

In addition, having considered the expert testimony discussed in the Petition, Patent Owner Response, and Petitioner's Reply regarding reason to combine and expectation of success, we determine Patent Owner's expert, Dr. Glew, to be more credible and with better evidentiary support than Dr. Franzon's testimony, and we weigh the expert testimony accordingly. Dr. Glew's testimony is well-reasoned and better supported by factual corroboration. In many cases, Dr. Franzon's testimony is conclusory.

For example, Ex. 1002 ¶ 114 (asserting "[a] person of ordinary skill in the art would have been encouraged to combine Leedy '695 with Bertin (alone or in combination with Poole) and Hsu because they are in the same technological field of three-dimensional integration and address similar challenges relating to the stacking of integrated circuit devices" (citing Exs. 1006, 1004, 1009)). Although "any need or problem known in the field of endeavor at the time of the invention and addressed by the patent can provide a reason for combining the elements in the manner claimed" (*KSR*, 550 U.S. at 420), Dr. Franzon's single sentence assertion lacks specifics as to what those similar challenges are, and he only provides a list of citations to various references without further explanation or analysis as to how those citations support his assertion. *See In re Acad. of Sci. Tech Ctr.*, 367 F.3d 1359, 1368 (Fed. Cir. 2004) ("[T]he Board is entitled to weigh the declarations and conclude that the lack of factual corroboration warrants discounting the opinions expressed in the declarations."); *see also*

37 C.F.R. § 42.65(a) ("Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.").

Each of the challenged claims requires a particular tensile stress for which Petitioner relies on the combination of Bertin '754 and Leedy '695 for which Petitioner has not demonstrated by a preponderance of the evidence that one of ordinary skill in the art would have combined and would have had a reasonable expectation of success in doing so. This reason alone is sufficient to conclude that Petitioner does not satisfy its burden to establish claims 1, 2, 8, 14, 31, 32, 44, 46, and 52–54 are unpatentable as obvious over Bertin '754 and Leedy '695 (with or without Poole). There is, however, an additional independent and separate reason as set forth below for our conclusion that Petitioner does not satisfy this burden with respect to claims 2, 8, 31, 32, 44, 46, and 52–54 (but not independent claims 1 and 14).

2. A Semiconductor Substrate that is Substantially Flexible

As noted previously, of the eleven challenged claims in this proceeding, all but independent claims 1 and 14 require a semiconductor substrate that is substantially flexible. In its Petition, Petitioner presents arguments that claims 2, 8, 31, 32, 44, 46, and 52–54 would have been obvious over Bertin '754 and Leedy '695 (with Poole) using its proposed narrow construction of a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed. *See, e.g.*, Pet. 35–36 (discussing claim 2), 39 (discussing claim 8 by relying on its claim 2 contentions), 40–41 (discussing claim 31 relying on its claim 2

contentions), 43 (discussing claim 52 relying on its claim 2 contentions), 43 (discussing claim 53 relying on its claim 31 contentions).

Petitioner also indicates that the challenged claims would have been obviousness under two alternative constructions: "(i) a substrate that has been thinned to a thickness of less than 50 μm or (ii) that has been thinned to a thickness of 150 μm or less." Pet. 13, 58–59. According to Petitioner, the challenged claims "are still unpatentable in view of" the asserted grounds Pet. 58.

In response to the Petition, Patent Owner argues that the ordinary and customary meaning of "substantially flexible semiconductor [] substrate" is "a semiconductor substrate that is largely able to bend without breaking" and is the proper claim construction. As discussed previously, we agree with Patent Owner.

In its Reply to Patent Owner's Response, Petitioner contends that Patent Owner's "response is premised on an incorrect claim construction of 'substantially flexible'" and "[u]nder a proper construction, [Patent Owner] offers no rebuttal to the conclusion that the 'substantially flexible' limitations are met." Pet. Reply 3, 30–31 (opposing Patent Owner's proposed construction). Tellingly, Petitioner does not address in its Reply how the claims as Patent Owner construes them would have been obvious over the asserted prior art. *See generally* Pet. Reply. Rather, although Petitioner argues that the prior art shows a particular thinning of a substrate, Petitioner does not argue that the combination of Bertin '754, Poole, and Leedy '695 would have conveyed to one of ordinary skill in the art a

substrate that is (largely) able to bend without breaking, which is required by the construction of substantially flexible semiconductor substrate.

In essence, here as in IPR2016-00386, Petitioner argues that Bertin '754 discloses a semiconductor substrate that has been thinned to less than 50 μm and so discloses a substantially flexible semiconductor substrate as required by the claims. A preponderance of the evidence establishes, however, that, in the context of semiconductor substrates, mere thinning is not the same as flexibility—being able to bend without breaking. Substantially the same evidence that we found convincing in IPR2016-00386 is of record here: (i) uncontested evidence that the Examiner, during the prosecution history of the now-abandoned '652 application, agreed that flexibility is not the equivalent of mere thinning (Ex. 2168, 4; Tr. 24:23–25:1 (Petitioner's counsel agreeing with Patent Owner's characterization that the Examiner agreed that flexibility is not the equivalent of mere thinning)) and (ii) Dr. Franzon testifies that the flexibility of a semiconductor substrate depends on a number of factors, only one of which is the physical dimensions of the substrate—width and thickness (Ex. 1002 ¶ 71).

Similarly, we are not persuaded that Poole's teaching a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed would have taught or suggest a semiconductor substrate that is substantially flexible (Pet. 36).

Thus, for the reasons discussed previously with regard to differences between the asserted prior art and the claimed substantial flexibility, we determine that Petitioner has not met its burden to demonstrate that the

references combined in the manner proposed by Petitioner would have conveyed to one of ordinary skill in the art the requisite semiconductor substrate that is substantially flexible.

D. Asserted Ground of Obviousness over Hsu and Leedy '695

Having considered the parties' arguments and weighed the parties' evidence cited therein, and for the reasons set forth below, we determine that Petitioner has *not* demonstrated by a preponderance of the evidence that claims 1, 2, 8, 14, 31, 32, 44, 46, and 52–54 are unpatentable under 35 U.S.C. § 103 over Hsu and Leedy '695.

1. Petitioner's Contentions

In general, Petitioner relies on Hsu's integrated circuit consisting of a master chip and subordinate chips as describing most of the limitations recited in the challenged claims. Pet. 44 ("Hsu discloses all but a few of the features recited in claims 1, 2, 8, 14, 31, 32, 44, 46, and 52–54."). For example, regarding independent claim 1, Petitioner relies on Hsu's description of "a semiconductor substrate 10, preferably composed of monocrystalline silicone" for the "semiconductor substrate that is of one piece and monocrystalline," as recited in claim 1. *Id.* at 48 (citing Ex. 1008, 2:54–56, 3:45–47, Figs. 3, 4, 7; Ex. 1002 ¶ 136, 1a).

For the recited "silicon-based dielectric insulators," Petitioner relies on a combination of Hsu and Leedy '695. Pet. 49–50. Petitioner relies on Hsu's description of a "silicon dioxide film 18 . . . formed on the entire surface of the substrate" 10 for the required "silicon-based dielectric

insulators passing vertically through the semiconductor." *Id.* at 49. For a dielectric of the tensile stress required by claim 1, Petitioner relies on Leedy '695's "processes for depositing silicon oxide or silicon nitride dielectric films having tensile strength of preferably 1 x 10^7 dynes/cm^2 that are compatible with conventional integrated circuit fabrication methods." *Id.* (citing Ex. 1006 at 11:33–37, 45:49– 46:26; *id.* at 1:53–58, 2:40–45, 3:9–11, 7:1–9:63, 9:28–31, 11:25–65, 47:46–51, 48:45–50). Petitioner contends that "providing Leedy '695's low tensile stress dielectric as the layer 18 of Hsu teaches or suggests" this limitation. *Id.* at 50 (citing Ex. 1002 ¶ 136, 1c).

For claim 2, Petitioner relies on the thickness of Hsu's thinned and polished substrate to disclose the requisite semiconductor substrate that is substantially flexible. Pet. 50–51. Petitioner contends that "Hsu discloses this limitation under Petitioner's proposed construction." Pet. 51.

2. Low Tensile Stress Dielectric Substitution

Regarding a reason one of ordinary skill in the art would have had to combine Hsu and Leedy '695 such that "Hsu's dielectric layer 18 is a dielectric characterized by a tensile stress of 5x10^8 dynes/cm^2 or less based on Leedy '695" (Pet. 44) and whether one of ordinary skill in the art would have had a reasonable expectation of success, Petitioner presents similar arguments to those presented regarding its combination of Bertin '754 and Leedy '695. *Compare* Pet. 44–47 (regarding Hsu and Leedy '695), *with* Pet. 20–23 (regarding Bertin '754 and Leedy '695).

First, Petitioner presents the general argument that "Hsu and Leedy '695 are both directed to improving integrated circuits through improved fabrication techniques." *Compare* Pet. 44–45 (citing Ex. 1002 ¶ 114), *with* Pet. 20–21 (citing Ex. 1002 ¶ 114). In the complex technology of integrated circuit fabrication, Dr. Franzon's testimony in paragraph 114 is too general in asserting the reason of "they are in the same technological field of three-dimensional integration and address similar challenges relating to the stacking of integrated circuit devices" without discussing, for instance, what particular challenges would be addressed. Ex. 1002 ¶ 114. Although Dr. Franzon lists a string of citations, he does not explain or otherwise reference those citations. We find Petitioner's contention here to be insufficient for substantially similar reasons we found parallel arguments to be insufficient with regard to Bertin '754 and Leedy '695.

Second, Petitioner relies on purported express motivations of Leedy '695 (Pet. 45), which we have found insufficient in the context of combining Bertin '754 and Leedy '695. Here, too, Petitioner does not explain sufficiently why or how the importance of low tensile stress for Leedy '695's process for constructing low tensile stress dielectric membranes bears on why one of ordinary skill in the art would have substituted Leedy '695's dielectric material for Hsu's layer 18. Moreover, as discussed in detail previously, Petitioner characterizes Leedy '695's teaching to be about low tensile stress dielectrics. The citations by Petitioner, however, discuss advantages of its low tensile stress dielectric flexible membrane or its membrane dielectric isolation fabrication

techniques. Here, too, the probative value of Petitioner's argument is diminished because Petitioner credits Leedy '695's low tensile stress dielectric *material* with the benefits disclosed by Leedy '695 for its membrane dielectric isolation *process* for fabricating integrated circuits.

We also find Petitioner's contention (Pet. 45–46) that plasma-enhanced chemical vapor deposition was well-known, commonly available, and has recognized advantages does not sufficiently support Petitioner's conclusion in view of the complexities of integrated circuit fabrication, as discussed previously. Petitioner contends that:

> considerable similarities between Leedy '695 and Hsu's teachings [of forming a silicon dioxide film 18 for insulation using APVCD] indicate that those of skill in the art were aware of the use of silicon dioxide dielectric layers and their placement over silicon substrates in the fabrication of integrated circuits. Ex. 1002 at ¶¶ 113–14. This constitutes a motivation to look to other references that discuss formation of silicon dioxide layers in integrated circuit, such as Leedy '695 695, for other attributes and deposition methods of these layers. *KSR*, 550 U.S. at 402; Ex. 1002 at ¶¶ 113–14.

Pet. 47.

Although Petitioner cites to Dr. Franzon's declaration for support, Dr. Franzon's declaration testimony is unavailing. The cited portion of Dr. Franzon's testimony (Ex. 1002 ¶¶ 113–14) does not discuss Hsu's use of APVCD, the implications of Hsu's disclosure on one of ordinary skill in the art's awareness of using use of silicon dioxide dielectric layers, or a purported motivation to look to other references as Petitioner contends. As discussed previously, in this complex technology area of integrated circuit fabrication, expert testimony is critical. *Kinetic Concepts*, 688 F.3d at 1369

(citing *Wyers v. Master Lock Co.*, 616 F.3d 1231, 1240 n.5 (Fed. Cir. 2010) ("However, as we [have] noted . . . 'expert testimony regarding matters beyond the comprehension of layperson is sometimes essential,' particularly in cases involving complex technology. In such cases, expert testimony may be critical, for example, to establish . . . the extistence (or lack thereof) of a motivation to combine references." (internal citations omitted)) (alteration in original)). Thus, we find Petitioner's contention to have minimal probative value.

In addition, Petitioner's reasoning that the similarity of the references "constitutes a motivation to look to other references" seems inadequate on its face. Even if true, that statement does not provide a reason would pick out these particular references and combine them to arrive at the claimed invention. *Cf. Personal Web Techs., LLC v. Apple, Inc.*, 848 F.3d 987, 993–94 (Fed. Cir. 2017) (concluding "that reasoning seems to say no more than that a skilled artisan, once presented with the two references, would have understood that they could be combined. And that is not enough: it does not imply a motivation to pick out those two references and combine them to arrive at the claimed invention (citing *Belden Inc. v. Berk–Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015) ("[O]bviousness concerns whether a skilled artisan not only could have made but would have been motivated to make the combinations or modifications of prior art to arrive at the claimed invention.")).

Similarly, in view of the complex technology involved in integrated circuit fabrication and, particularly in view of the agreement of both experts

that dielectrics have different properties and different methods of forming dielectrics in integrated circuit fabrication result in dielectrics having different properties (as discussed previously), we determine that Petitioner's contentions and Dr. Franzon's broad conclusions (Pet. 45–47; Ex. 1002 ¶¶ 111, 113–14) that one of ordinary skill in the art would have reasonable expectation of success to be insufficient to meet Petitioner's burden, which requires a preponderance of evidence. For example, as discussed previously, we find Petitioner's contention that "Leedy '695 thus discloses that its dielectrics *can be easily used* in place of other dielectrics" to be insufficiently supported by the evidence of record.

Accordingly, having considered the Petition, Patent Owner's Response, and Petitioner's Reply, as well as the relevant evidence discussed in those papers, we determine that Petitioner has not met its burden to demonstrate by a preponderance of the evidence that a person of ordinary skill in the art would have reason to combine the asserted references to arrive at the claimed invention or that a person of ordinary skill would have had a reasonable expectation of success in making the combination proposed by Petitioner.

3. A Semiconductor Substrate That Is Substantially Flexible

As noted previously, claims 2, 8, 31, 32, 44, 46, and 52–54 (but not independent claims 1 and 14) require a semiconductor substrate that is substantially flexible. Petitioner presents arguments that claims 2, 8, 31, 32, 44, 46, and 52–54 would have been obvious over Hsu and Leedy '695 using its proposed narrow construction of a semiconductor substrate that has been

thinned to a thickness of less than 50 μm and subsequently polished or smoothed. *See, e.g.*, Pet. 50–51. Specifically, with regard to claim 2, Petitioner contends that Hsu discloses that its semiconductor substrate has a thickness of less than 50 μm and subsequently "polishing to a thickness just larger than the 'about 10 μm' depth of the trenches." Pet. 50–51 (citing Ex. 1008, 2:61–62).

As noted previously, a preponderance of the evidence establishes, however, that, in the context of semiconductor substrates, mere thinning is not the same as flexibility—being able to bend without breaking.

Thus, for the reasons discussed previously, we determine that Petitioner has not met its burden to demonstrate that the references combined in the manner proposed by Petitioner would have conveyed to one of ordinary skill in the art the requisite semiconductor substrate that is substantially flexible.

E. Claims 44, 46, 53, and 54

Claim 46 depends from claim 44, which, in turn, depends from independent claim 8 that recites, among other limitations, "a monocrystalline semiconductor substrate . . . that . . . is thinned and substantially flexible" and "a silicon-based dielectric film on the semiconductor substrate, the silicon-based dielectric film having a stress of less than $5x10^8$ dynes/cm^2 tensile." Claim 44 additionally recites "the semiconductor substrate is thinned and polished or smoothed such that the semiconductor substrate is substantially flexible." Claim 46 further recites "the semiconductor substrate is thinned to a thickness of less than 50 microns."

Petitioner contends, in its Petition, that Hsu's polishing and thinness meet the substantially flexible limitation in independent claim 8 (Pet. 50–51) as well as meet the additional limitations recited in claims 44 and 46 (Pet. 56). Similarly, with regard to Bertin '754 and Poole, Petitioner contends, in its Petition, that Bertin '754 and Poole's thinning and polishing meet the substantially flexible limitation in independent claim 8 (Pet. 39) as well as meet the additional limitations recited in claims 44 and 46 (Pet. 42–43). Claims 53 and 54 closely parallel the limitations and dependency recited in claims 44 and 46, except that claim 53 depends from 52, which recites "the semiconductor substrate is substantially flexible" and which depends from independent claim 51 which requires dielectrics "having a stress of less than $5x10^8$ dynes/cm^2 tensile."

As discussed previously, in its Reply to Patent Owner's Response that proposed "substantial flexibility" with regard to a semiconductor substrate should be construed by its ordinary and customary meaning of "largely able to bend without breaking," Petitioner maintains its position with regard to claim construction and does not argue that under Patent Owner's proposed construction any of the claims—including dependent claims 44, 46, 53, or 54—are unpatentable. *See* Pet. Reply 30–31. At the oral hearing, Petitioner's counsel did not argue or otherwise discuss claims 44, 46, 53, or 54 with particularity, much less explaining how these either or both of claims would be unpatentable even under Patent Owner's construction. *See generally* Tr.

"In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic*, 815 F.3d at 1363 (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")). Furthermore, the Board is not permitted to make arguments that the Petitioner could have made but did not. *In re Magnum Oil*, 829 F.3d 1364, 1381 (Fed. Cir. 2016) (indicating that the Board is not free "to adopt arguments on behalf of petitioners that could have been, but were not, raised by the petitioner during an IPR. Instead, the Board must base its decision on arguments that were advanced by a party, and to which the opposing party was given a chance to respond.").

F. IPR2016-00387 Conclusion

As discussed above, and in relation to similar arguments and evidence in IPR2016-00386, and also in the particular circumstances of this case, with its complex technology of integrated circuit fabrication and robust written description of Leedy '695 articulating general advantages of its low tensile stress dielectric membrane and its membrane dielectric isolation process, we are not persuaded that Petitioner has met its burden to provide sufficient articulated reasoning with rational underpinning to support Petitioner's combinations.

Similarly to our conclusions in IPR2016-00386, we find Petitioner's arguments regarding combination to be incomplete. In the context of these cases, it is insufficient to propose incorporating "the material" of Leedy '695

without providing sufficient detail as to the combined process to produce the claimed combination. In the complex technology of semiconductor technology, merely asserting that the low tensile strength dielectric material of Leedy '695 would be incorporated as dielectric layer 60 and interconnect insulators of Bertin '754 or as dielectric layer 18 of Hsu is insufficient. Petitioner has not explained sufficiently how one of ordinary skill in the art would have had reasonable expectation of success of incorporating low tensile strength dielectric material of Leedy '695 into Bertin '754's integrated circuit or Hsu's integrated circuit, without adequately explaining the process changes of Bertin '754 or Hsu required to do so.

Based on determinations of (1) the scope and content of the asserted prior art references, (2) differences between the subject matter of the challenged claims and the disclosures of the asserted prior art references, and (3) the level of ordinary skill in the art[27] (*Graham*, 383 U.S. at 17–18), and for reasons discussed above, we determine that Petitioner has *not* demonstrated by a preponderance of the evidence that the subject matter of any of the challenged claims would have been obvious under 35 U.S.C. §103 for the reasons discussed above.

[27] Patent Owner does not proffer any objective evidence of nonobviousness for us to consider.

G. IPR2016-00387 Order

Accordingly, it is:

ORDERED that claims 1, 2, 8, 14, 31, 32, 44, 46, and 52–54 of U.S. Patent No. 8,841,778 have *not* been shown to be unpatentable in IPR2016-00387;

FURTHER ORDERED that this decision be entered as the Final Written Decision in IPR2016-00387; and

FURTHER ORDERED that, because this is a final written decision, parties to the proceedings seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

IV. IPR2016-00388[28]—CLAIM CONSTRUCTION AND GROUNDS OF UNPATENTABILITY

In its IPR2016-00388 Petition, Petitioner contends claims 10–12, 18–20, 60–63, 67, 70–73, and 77 are unpatentable under 35 U.S.C. § 103 over Yu and Leedy ’695. Pet. 3, 19–53. Patent Owner opposes Petitioner’s contentions. PO Resp. 1–3, 53–62.

A. Illustrative Claim of the Challenged Patent

Of the claims in the ’239 patent challenged in IPR2016-00388, claims 60 and 70 are independent. Prior to institution, Patent Owner statutorily disclaimed claims 1, 13, 46, and 47 under 35 U.S.C. § 253(a). Ex. 2139. Among other claims, Petitioner challenged claims 1 and 13 in its Petition;

[28] Citations in this section refer to papers and exhibits of record in IPR2016-00388.

however, we did not institute an *inter partes* review of disclaimed claims 1 and 13. *See* 37 C.F.R. § 107(e) (prohibiting institution of a *inter partes* review based on disclaimed claims).

Challenged claims 10–12 depend from disclaimed independent claim 1 and challenged claims 18–20 depend from disclaimed independent claim 13. Challenged claims 10–12 and 18–20, therefore, require all the limitations recited in the disclaimed independent claim from which those dependent claims respectively depend. *See* 35 U.S.C. § 112 (d) ("A claim in dependent form shall be construed to incorporate by reference all the limitations of the claim to which it refers."). Accordingly, we will include a discussion of the limitations recited in disclaimed claim 1 and 13 as necessary to our discussion of this asserted ground. Claim 60 is illustrative of the claimed subject matter:

> 60. An integrated circuit structure comprising:
>
> a plurality of semiconductor dice, each die having an integrated circuit formed thereon, said dice being stacked in layers, wherein at least one of the plurality of dice is substantially flexible, and wherein at least one of the plurality of dice has at least one of polycrystalline active circuitry formed thereon, reconfiguration circuitry formed thereon, and passive circuitry formed thereon; and
>
> between adjacent dice, a bonding layer bonding together the adjacent dice, the bonding layer bonding first and second substantially planar adjacent surfaces of the adjacent dice, with at least one or more portions of the bonding layer being located other than at the edges of the adjacent dice.

Ex. 1001, 19:1–15.

B. Claim Construction:

As noted previously, the '239 patent at issue in this proceeding has expired and, therefore, our claim construction analysis is similar to that of a district court using the *Phillips* standard.

1. "Substantially Flexible Substrate"

Challenged claims 10–12 and 18–20, by virtue of their dependency from disclaimed independent claim 1 or 13, require a semiconductor substrate that is substantially flexible. Ex. 1001, 13:20–21 (claim 1 requiring "a substantially flexible substrate"), 13:65–67 (claim 13 requiring a substrate that "is a substantially flexible monolithic monocrystalline semiconductor substrate).

Petitioner proposes the same construction of "substantially flexible" when used to modify "substrate" or "monolithic monocrystalline semiconductor substrate" as Petitioner does in IPR2016-00386 when "substantially flexible" is used to modify "semiconductor substrate"—a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed." Pet. 9. Petitioner presents the same arguments and discusses substantially the same evidence in this proceeding as discussed previously with respect to the claim construction of "substantially flexible semiconductor substrate" in IPR2016-00386. *Compare* Pet. 9–13, *with* IPR386-Pet. 9–12.

Similarly, Patent Owner in opposition also repeats its contentions made in IPR2016-00386—that "substantially flexible" should be given its ordinary and customary meaning, which is "largely able to bend without

breaking." PO Resp. 47; *compare* PO Resp. 46–53, *with* IPR386-PO Resp. 50–57. Patent Owner again contends that "substantially flexible" was not clearly and unambiguously specially defined (*compare* PO Resp. 49–51, *with* IPR386-PO Resp. 53–55) and that "substantially" is not indefinite *compare* PO Resp. 52–53, *with* IPR386-PO Resp. 56–57). And, Petitioner presents substantially the same arguments in its Reply. *Compare* Pet. Reply 30–31, *with* IPR386-Pet. Reply 30–31.

For the reasons discussed above with respect to "substantially flexible" in IPR2016-00386, we adopt Patent Owner's position that one of ordinary skill in the art in the context of the challenged patent would understand "substantially flexible" to have the customary and ordinary meaning of "largely able to bend without breaking." Therefore, we determine that "a substrate that is substantially flexible" within the context of the patent is "a substrate that is largely able to bend without breaking." Thus, to prevail with regard to claims 10–12 and 18–20, Petitioner must establish that the substrate of the prior art combinations on which the claim challenges are made must provide a substrate that is largely able to bend without breaking.

2. "Substantially Flexible Die"

Challenged claims 60–63, 67, 70–73, and 77 require "at least one of the plurality of dice is substantially flexible" (required by claims 60–63 and 67) or "the die is substantially flexible" (required by claims 70–73 and 77) (hereinafter these limitations are referred to as "the substantially flexible die limitation"). Ex. 1001, 19:4–5 (claim 60), 20:8 (claim 70).

Petitioner contends that the substantially flexible die limitation should be construed as "an integrated circuit [circuit substrate] having a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed, and where the dielectric material used in processing the semiconductor substrate must have a stress of $5x10^8$ dynes/cm^2 tensile or less." Pet. 13 (alteration in original). Notably, Petitioner argues that the substantially flexible die limitation has an additional requirement to that of a substantially flexible substrate—"where the dielectric material used in processing the semiconductor substrate must have a stress of $5x10^8$ dynes/cm^2 tensile or less."

In support of its contention, Petitioner again relies on embodiments describing circuit layers:

> For example, the specification explains that each "circuit layer is a thinned and substantially flexible circuit with net low stress, less than 50 μm and typically less than 10 μm in thickness" (Ex. 1001 at 4:35-38), and that "[t]he thinned (substantially flexible) substrate circuit layers are preferably made with dielectrics in low stress (less than 5×10^8 dynes/cm^2)" (*id.* at 8:66-9:1).

Pet. 13–14.

Petitioner's argument is flawed in two respects. First, Petitioner does not explain how the examples discussing a *circuit layer* would limit a claim requiring a substantially flexible *die*. Second, "it is improper to read limitations from a preferred embodiment described in the specification—even if it is the only embodiment—into the claims absent a clear indication in the intrinsic record that the patentee intended the claims to be so limited." *GE Lighting Solutions, LLC v. AgiLight, Inc.*, 750 F.3d 1304, 1309 (Fed.

Cir. 2014) (quoting *Liebel–Flarsheim Co. v. Medrad, Inc.*, 358 F.3d 898, 913 (Fed. Cir. 2004)); *see Thorner v. Sony Computer Entm't Am. LLC*, 669 F.3d 1362, 1365 (Fed. Cir. 2012) ("It is not enough for a patentee to simply disclose a single embodiment or use a word in the same manner in all embodiments, the patentee must 'clearly express an intent' to redefine the term." (quoting *Helmsderfer v. Bobrick Washroom Equip., Inc.*, 527 F.3d 1379, 1381 (Fed. Cir. 2008))). We discern no clear intent to limit "a substantially flexible die" by this passage. This is true particularly in view of the statement in the written description explicitly states that "[t]he presently disclosed embodiments are therefore considered in all aspects to be illustrative and not restrictive" and continues by indicating that "[t]he scope of the invention is indicated by the appended claims rather than the foregoing description." Ex. 1001, 13:9–12 (the '239 patent).

Neither are we persuaded by Petitioner's contentions based on the prosecution of related applications for the reasons discussed previously, as well as the additional reason that Petitioner does not identify statements in the prosecution history of related patents concerning a substantially flexible *die*. *See e.g.*, Pet. 15 ("Accordingly, the Applicant clearly and unmistakably set forth a definition of the term "substantially flexible" when used to modify *integrated circuit layer* and expressed an intent to define the term.") (emphasis added); *see generally* Pet. 14–15.

Similarly to the reasons discussed previously in IPR2016-00386, we are not persuaded by Petitioner's arguments that "substantially flexible" must be construed as Petitioner proposes to avoid indefiniteness (Pet. 16).

Rather, similarly to the reasons discussed previously, we agree with Patent Owner that "substantially flexible" should be given its ordinary and customary meaning of "largely able to bend without breaking" and "the remaining limitations further specify how such flexibility may be achieved (by thinning and smoothing or polishing) (PO Resp. 49). Accordingly, the substantially flexible die limitation requires a die that is largely able to bend without breaking. Thus, to prevail with regard to claims 60–63, 67, 70–73, and 77, Petitioner must establish that a die or dice of the prior art combinations on which the claim challenges are made must provide a die that is (or dice that are, as required by the claims) largely able to bend without breaking.

3. Other Claim Terms

To the extent it is necessary for us to expressly construe other claim terms in this decision for IPR2016-00388, we do so below in the context of analyzing whether the prior art renders the challenged claims unpatentable.

C. Asserted Ground of Obviousness over Yu and Leedy '695

Having considered the parties' arguments and weighed the parties' evidence cited therein, and for the reasons set forth below, we determine that Petitioner has not demonstrated by a preponderance of the evidence that claims 10–12, 18–20, 60–63, 67, 70–73, and 77 are unpatentable under 35 U.S.C. § 103 over Yu and Leedy '695 ("the IPR388 Yu ground").

As with its IPR386 Yu ground, Petitioner contends in its IPR388 Yu ground that Yu teaches or suggests most of the limitations recited in the

challenged claims and relies on Leedy '695 for disclosing a dielectric with the required tensile stress. Pet. 19–20.

1. Low Tensile Stress Dielectric Substitution

Many of the challenged claims in both IPR2016-00386 and IPR2016-00388 require dielectric material having a certain tensile stress. Also, the written description is the same for both challenged patents. Again Petitioner relies on testimony of Dr. Franzon (Ex. 1102), and Patent Owner relies on testimony of Dr. Glew (Ex. 2166). It is not surprising then that Petitioner and Patent Owner each present substantially similar arguments and evidence, including evidence as to the complexity of integrated circuit fabrication discussed with respect to IPR2016-00386 (*see, e.g.*, PO Resp. 3–30) and evidence that both experts agree that dielectrics have different properties and different methods of forming dielectrics in integrated circuit fabrication result in dielectrics having different properties (*see, e.g.*, Ex. 2164 (Dr. Franzon's deposition transcript); Ex. 2166 (Dr. Glew's declaration) ¶ 132 (discussing eighteen properties of dielectrics). Even so, these are separate proceedings with separate records.

As with its IPR386 Yu ground, Petitioner contends in its IPR388 Yu ground that it "would have been obvious to one of ordinary skill . . . to modify the processes and device in Yu such that the dielectrics used therein would be characterized by the [required] tensile stress based on the disclosure of Leedy '695." *Compare* Pet. 19–20, *with* IPR386-Pet. 46–47. Petitioner provides the same three purported reasons as set forth with respect to the IPR382 Yu ground. Petitioner argues that:

> First, according to Leedy '695, a low tensile stress dielectric in a stacked [integrated circuit] device allows it "to withstand a wide range of [integrated circuit] processing techniques and processing temperatures (of at least 400 C.) without noticeable deficiency in performance." Ex. 1006 at 2:37–40.

Pet. 20; *compare* Pet. 20–21, *with* IPR386-Pet. 47 (repeating the substantially same sentences with regard to Petitioner's first reason). Two notable differences, however, are presented in this proceeding regarding Petitioner's first reason, than those presented in IPR2016-00386. One is that Petitioner quotes, rather than merely cites a portion of columns five and six from Leedy '695:

> If the membrane is not in tensile stress, but in compressive stress, surface flatness and membrane structural integrity will in many cases be inadequate for subsequent device fabrication steps or the ability to form a sufficiently durable free standing membrane.

Ex. 1006, 5:63–6:5; *compare* Pet.20 (quoting Ex. 1006, 5:63–6:5), *with* IPR386 Pet. 47 (citing quoting Ex. 1006, 5:63–6:5). Petitioner does not sufficiently explain the relevance of this quotation, which on its face is a general statement related to its integrated circuit fabrication process involving free standing membranes, to providing a reason to combine Leedy '695's dielectric material and deposition techniques with Yu's process.

In contrast to Petitioner's similar argument in IPR2016-00386, here, Petitioner states:

> That *Leedy '695* discloses a CVD [chemical vapor deposition] process is evident because the disclosed dielectric membranes are produced using a Novellus Systems Concept One apparatus, which is CVD equipment.

Pet. 20. Patent Owner has not contested that Leedy '695 discloses a chemical vapor deposition process; nor do we question such a disclosure. Thus, Petitioner's additional sentence provides little if any additional support to Petitioner's contentions (as compared with those presented in IPR2016-00386).

Second, Petitioner repeats its same cursory arguments as to why one of ordinary skill in the art would have a reasonable expectation of success that Petitioner proffered in IPR2016-00386—disclosure of "fabrication techniques for low-stress dielectric films compatible with 'most of the established integrated processing methods" (quoting Ex. 1006 11:51–65) and due to the "teaching of deposition recipes using common tools." Pet. 21; *compare* Pet. 21, *with* IPR386 Pet. 47. As explained with respect to IPR2016-00386, given the complex technology involved in integrated circuit fabrication and agreement from both experts that dielectrics have different properties and different methods of forming dielectrics in integrated circuit fabrication result in dielectrics having different properties, Petitioner's general assertions, which do not acknowledge or adequately consider this complexity, are insufficient to establish by a preponderance of the evidence that one of ordinary skill in the art would have a reasonable expectation of success in substituting Leedy '695's dielectric material of a certain tensile stress in Yu's integrated circuit. *See, e.g.*, Ex. 2164 (Dr. Franzon deposition transcript), 69:17–19 (Q. Do the different methods result in different properties of the dielectrics? A. Yes."); Ex. 2166 (Dr. Glew's declaration) ¶ 132 (identifying eighteen properties of dielectrics; testifying that one of

ordinary skill in the art would consider many of those factors when choosing a dielectric); *see also* PO Resp. 55–58 (discussing Dr. Franzon's testimony and Dr. Glew's testimony).

Third, Petitioner contends that one of ordinary skill in the art "would have found it obvious to combine Leedy '695 with Yu because the references are in the same field of technology and attempt to address the same problem of vertically integrating [integrated circuit] devices." Pet. 21; *see also* IPR386-Pet. 48 (stating the same nearly verbatim). In contrast to Petitioner's argument in IPR2016-00386, however, Petitioner here provides an additional statement:

> This is particularly true given that Yu focuses on the bonding technique [sic] than on the actual 2D-LSI manufacturing technique. Ex. 1102 at ¶ 97.

Pet. 21. Petitioner's statement is supported by Dr. Franzon's declaration testimony, which Petitioner cites without further discussing. *See* Pet. 21 (citing Ex. 1102 ¶ 97 (indicating "Yu . . . does not specify the details of the creation of the individual 2D-LSIs used to manufacture its 3D-LSI. [Ex. 1009, Abstract.] Thus, a person of skill in the art would be motivated by Yu's apparent reliance on conventional 2D [integrated circuit] manufacturing techniques to look to other references, such as Leedy '695, that specifically disclose such manufacturing techniques.")).

Because Dr. Franzon's testimony supports Petitioner's position, we accord Petitioner's argument some weight. Petitioner does not explain sufficiently, however, why one of ordinary skill in the art would have combined these two references to arrive at the claimed invention. Yu's lack

of focus on "the actual 2D-LSI manufacturing technique" does not imply a sufficient motivation to pick out these two references—Yu and Leedy '695—and combine them to arrive at the claimed invention. *Cf. Personal Web Techs., LLC v. Apple, Inc.*, 848 F.3d 987, 993–94 (Fed. Cir. 2017) (concluding "that reasoning seems to say no more than that a skilled artisan, once presented with the two references, would have understood that they could be combined (citing *Belden Inc. v. Berk–Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015) ("[O]bviousness concerns whether a skilled artisan not only could have made but would have been motivated to make the combinations or modifications of prior art to arrive at the claimed invention.")")).

For reasons substantially similar to those discussed above, we also are not persuaded by Petitioner's assertion that "[i]t would have been obvious to combine Leedy '695 with Yu because it involves the substitution of one known element for another—Leedy '695's low stress dielectric for the dielectric of Yu—to yield predictable results with known benefits." Pet. 21 (citing Ex. 1102 at ¶¶92–97; *KSR*, 550 U.S. at 401). As discussed above, the record does not support Petitioner's statement that the substitution of one dielectric for another, without more information about the substitution, is a substitution yielding predicable results with known benefits. As discussed previously, both experts agree that dielectrics have different properties and different methods of forming dielectrics in integrated circuit fabrication result in dielectrics having different properties.

For these reasons, we determine that Petitioner has not demonstrated by a preponderance of the evidence that one of ordinary skill in the art (i) would have had a reason to combine Yu and Leedy '695 in the manner proposed by Petitioner to arrive at the claimed invention and (ii) would have had a reasonable expectation of success of doing so.

This reason alone is sufficient for us to conclude that Petitioner does not satisfy its burden to establish that claims 10–12, 18–20, 60–63, 67, 70–73, and 77 are unpatentable as obvious over Yu and Leedy '695. There is, however, an additional independent and separate reason as set forth below for our conclusion that Petitioner does not satisfy this burden.

2. Substantially Flexible Substrate

Petitioner presents arguments that claims 10–12 and 18–20 would have been obvious over Yu and Leedy '695 using its proposed narrow construction of a semiconductor substrate that has been thinned to a thickness of less than 50 μm and subsequently polished or smoothed. *See, e.g.*, Pet. 24–26 (arguments for disclaimed independent claim 1 from which claims 10–12). As with various grounds asserted in IPR2016-00386 and IPR2016-00387, Petitioner also indicates that the challenged claims would have been obviousness under two alternative constructions: "(i) a substrate that has been thinned to a thickness of less than 50 μm or (ii) that has been thinned to a thickness of 150 μm or less." Pet. 16, 50–52. According to Petitioner, the challenged claims under these alternative claim consturctions "are unpatentable for the same reasons discussed in ground [of obviousness over Yu and Leedy '695], because [it] contains prior art that teaches or

suggests a semiconductor substrate that has been thinned to a thickness of less than 50 μm" and "shows how the prior art teaches or suggests a semiconductor substrate that has been thinned to a thickness of less than 50 μm and that dielectric materials used in processing the substrate that has [the requisite] stress." Pet. 51–52.

Petitioner relies on Yu's "thinned wafer" as conveying to one of ordinary skill in the art the recited "substantially flexible semiconductor substrate" because Yu grinds and polishes the wafer to "thin the wafer to 30 μm." Pet. 24–25 (citing Ex. 1009, 831, 834, Fig. 9).

As discussed previously, we agree with Patent Owner's proposed construction for "substantially flexible semiconductor substrate" as "a semiconductor substrate that is largely able to bend without breaking." In Reply, Petitioner does not contend that Yu discloses the recited substantially flexible semiconductor substrate as construed by Patent Owner. As discussed previously with respect to IPR2016-00386 and equally applicable on the record here, a preponderance of the evidence establishes, however, that, in the context of semiconductor substrates, mere thinning is not the same as flexibility—being able to bend without breaking.

Accordingly, we determine that Petitioner has not demonstrated by a preponderance of the evidence that Yu's thinned substrate of less than 30μm would have conveyed to one of ordinary skill in the art the "substantially flexible semiconductor second substrate," as recited in claim 1 from which claims 10–12 each depend. For the substantial flexibility requirement recited in disclaimed 13 from which claims 18–20 depend, Petitioner relies

on substantially similar arguments made concerning claim 1. Pet. 35 (relying on Yu's disclosure of a substrate thinned to the requisite thinness and polished for substantially flexible substrate limitation). We, therefore, for the same reasons determine that Petitioner has not demonstrated by a preponderance of the evidence that Yu's thinned substrate of less than 30μm would have conveyed to one of ordinary skill in the art the "substantially flexible substrate" required by claims 18–20.

Thus, for this additional and separate reason, we determine that Petitioner has not shown by a preponderance of the evidence that claims 10–12 and 18–20 are unpatentable.

3. Substantially Flexible Die

As discussed above, claims 60–63, 67, 70–73, and 77 require a substantially flexible die limitation. For this limitation in independent claim 60, from which claims 61–63 and 67 depend, Petitioner relies on Yu's thinned and polished 2D-LSI layers, as discussed above with respect to substantially flexible substrate limitations. Pet. 40–41 (citing Ex. 1009, 831–32, 834, Fig. 9). Similarly, for the substantially flexible die limitation in independent claim 70, from which claims 71–73 and 77 depend, Petitioner relies on Yu's "thinned wafers" as discussed above with respect to independent claim 60. Pet. 48.

For the reasons noted previously that mere thinning is not the same as flexibility, we determine that Petitioner has not shown by a preponderance of the evidence that Yu teaches or suggests the substantially flexible die required by claims 60–63, 67, 70–73, and 77. Thus, for this additional and

separate reason, we determine that Petitioner has not shown by a preponderance of the evidence that claims 60–63, 67, 70–73, and 77 are unpatentable.

D. IPR2016-00388 Conclusion

As discussed above in IPR2016-00386 and IPR2016-00387, and also in the particular circumstances of this case, with its complex technology of integrated circuit fabrication and robust written description of Leedy ’695 articulating general advantages of its low tensile stress dielectric membrane and its membrane dielectric isolation process, we are not persuaded that Petitioner has met its burden to provide sufficient articulated reasoning with rational underpinning to support Petitioner’s combinations.

Similarly to our conclusions in IPR2016-00386, we find Petitioner’s arguments regarding combining Leedy ’695 and Yu to be incomplete. In the context of these cases, it is insufficient to propose incorporating “the material” of Leedy ’695 without providing sufficient detail as to the combined process to produce the claimed combination. In the complex technology of semiconductor technology, merely asserting that the processes and device in Yu would be modified such that “the dielectrics used therein” would be characterized by the recited tensile stress “based on the disclosure of Leedy ’695” (Pet. 20) is insufficient. Petitioner has not explained sufficiently how one of ordinary skill in the art would have had reasonable expectation of success of incorporating low tensile strength dielectric material of Leedy ’695 into Yu’s integrated circuit, without adequately explaining the process changes of Yu’s process required to do so. Based on

determinations of (1) the scope and content of the asserted prior art references, (2) differences between the subject matter of the challenged claims and the disclosures of the asserted prior art references, and (3) the level of ordinary skill in the art[29] (*Graham*, 383 U.S. at 17–18), and for reasons discussed above, we determine that Petitioner has *not* demonstrated by a preponderance of the evidence that the subject matter of any of the challenged claims would have been obvious under 35 U.S.C. § 103 for the reasons discussed above.

E. IPR2016-00388 Order

Accordingly, it is:

ORDERED that claims 10–12, 18–20, 60–63, 67, 70–73, and 77 of U.S. Patent No. 87,193,239 have *not* been shown to be unpatentable in IPR2016-00388;

FURTHER ORDERED that this decision be entered as the Final Written Decision in IPR2016-00388; and

FURTHER ORDERED that, because this is a final written decision, parties to the proceedings seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

[29] Patent Owner does not proffer any objective evidence of nonobviousness for us to consider.

FOR PETITIONER:

John Kappos
Xin-Yi (Vincent) Zhou
Brian Cook
O'MELVENY & MYERS LLP
jkappos@omm.com
PTABMICRONELM@omm.com
PTABMICRONELM@omm.com

Naveen Modi
Allan Soobert
Phillip Citroen
PAUL HASTINGS LLP
PH Samsung ELM IPR@paulhastings.com
PH-Samsung-ELM-IPR@paulhastings.com
PH-Samsung-ELM-IPR@paulhastings.com

Jason Engel
Benjamin Weed
K&L GATES LLP
jason.engel.PTAB@klgates.com
Skhynix-Elm@klgates.com

FOR PATENT OWNER:

Cyrus A. Morton
Kelsey Thorkelson
ROBINS KAPLAN LLP
cmorton@robinskaplan.com
kthorkelson@robinskaplan.com

William A. Meunier
Michael T. Renaud
MINTZ, LEVIN, COHN, FERRIS, GLOVSKY AND POPEO, P.C.
wameunier@mintz.com
mtrenaud@mintz.com

James Carmichael
CARMICHAEL IP, PLLC
jim@carmichaelip.com