

Case IPR2021-01189
U.S. Patent No. 10,309,728

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LTI FLEXIBLE PRODUCTS, INC. D/B/A BOYD CORPORATION
Petitioner

v.

REGENTS OF THE UNIVERSITY OF CALIFORNIA
Patent Owner

Case IPR2021-01189

U.S. Patent No. 10,309,728
Title: TITANIUM-BASED THERMAL GROUND PLANE
Filing Date: 07/22/2014
Issue Date: 06/04/2019

BOYD'S NOTICE OF APPEAL

Mail Stop Patent Board
Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Under 35 U.S.C. §§ 141-144 and 319, and under 37 C.F.R. §§ 90.2 and 90.3, Petitioner LTI Flexible Products, Inc. d/b/a Boyd Corporation (“Boyd”) appeals to the United States Court of Appeals for the Federal Circuit from the Patent Trial and Appeal Board’s January 9, 2023 final written decision in Case IPR2021-01189 (Paper 44), and from all underlying findings, determinations, rulings, orders, and decisions regarding Case IPR2021-01189 and that final written decision. This notice of appeal is timely filed within 63 days of that final written decision. A copy of that final written decision is attached to this notice of appeal.

Per 37 C.F.R. § 90.2(a)(3)(ii), Boyd states that the issues on appeal may include, but are not limited to, the following issues:

1. The Board’s decision that Boyd had not proven that Claims 1-13 of U.S. Patent No. 10,309,728 are anticipated by *MacDonald* (Ex. 1007);
2. The Board’s decision that Boyd had not proven that Claims 2, 3, and 7 of the ’728 Patent would have been obvious over *MacDonald* in view of *Ding* (Ex. 1008);
3. The priority date of Claims 1-13 of the ’728 Patent;
4. The Board’s factual findings, conclusions of law, decisions to consider or refuse to consider arguments, decisions to admit or refuse evidence, or other determinations supporting or related to the foregoing issues; and

5. All other issues decided adversely to Boyd in any orders, decisions, rulings, and opinions.

In addition to filing this notice of appeal with the Patent Trial and Appeal Board, Boyd is concurrently electronically filing this notice of appeal with the United States Court of Appeals for the Federal Circuit with payment of the required docketing fee. Boyd is also concurrently filing this notice of appeal with the Director of the United States Patent and Trademark Office.

Dated: March 13, 2023

Respectfully submitted,

/kkm/

Kevin K. McNish (Reg. No. 65,047)

kkm-ptab@mcnishpllc.com

McNISH PLLC

254 Commercial Street, Suite 245

Portland, ME 04101

Telephone: (207) 800-3400

Fax: (207) 800-3401

Lead Counsel for Petitioner

*LTI Flexible Products, Inc. d/b/a Boyd
Corporation*

Case IPR2021-01189
U.S. Patent No. 10,309,728

CERTIFICATE OF FILING

The undersigned certifies that on March 13, 2023, a copy of this Notice of Appeal was filed with the Patent Trial and Appeal Board via P-TACTS.

The undersigned also certifies that on March 13, 2023, a copy of this Notice of Appeal was deposited with USPS Priority Mail Express for filing with the Director of the United States Patent and Trademark Office at the following address:

Office of the Solicitor
United States Patent and Trademark Office
Mail Stop 8
Post Office Box 1450
Alexandria, VA 22313-1450

The undersigned further certifies that on March 13, 2023, a copy of this Notice of Appeal was filed electronically with the United States Court of Appeal for the Federal Circuit via its CM/ECF system.

Dated: March 13, 2023

Respectfully submitted,

/kkm/

Kevin K. McNish (Reg. No. 65,047)

kkm-ptab@mcnishpllc.com

McNISH PLLC

254 Commercial Street, Suite 245

Portland, ME 04101

Telephone: (207) 800-3400

Fax: (207) 800-3401

Lead Counsel for Petitioner

*LTI Flexible Products, Inc. d/b/a Boyd
Corporation*

Case IPR2021-01189
U.S. Patent No. 10,309,728

CERTIFICATE OF SERVICE

Under 37 C.F.R. § 42.6(e), the undersigned certifies that on March 13, 2023, a complete copy of the foregoing and any accompanying papers and exhibits were served on counsel of record for UC by filing them through P-TACTS and emailing them to the following addresses:

Donald R. McPhail (Reg. No. 35,811)
cpdocketmcphail@oblon.com
Oblon, McClelland, Maier & Neustadt,
LLP
1940 Duke Street
Alexandria, Virginia 22314
Telephone: (703) 412-1432

Daniel J. Pereira (Reg. No. 45,518)
dpereira@oblon.com
Oblon, McClelland, Maier & Neustadt,
LLP
1940 Duke Street
Alexandria, Virginia 22314
Telephone: (703) 412-3527

Dated: March 13, 2023

Respectfully submitted,

/kkm/
Kevin K. McNish (Reg. No. 65,047)
kkm-ptab@mcnishpllc.com
McNISH PLLC
254 Commercial Street, Suite 245
Portland, ME 04101
Telephone: (207) 800-3400
Fax: (207) 800-3401

*Lead Counsel for Petitioner
LTI Flexible Products, Inc. d/b/a Boyd
Corporation*

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LTI FLEXIBLE PRODUCTS, INC. d/b/a BOYD CORPORATION,
Petitioner,

v.

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA,
Patent Owner.

IPR2021-01189
Patent 10,309,728 B2

Before HYUN J. JUNG, MICHAEL L. WOODS, and
ALYSSA A. FINAMORE, *Administrative Patent Judges*.

JUNG, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining No Challenged Claim Unpatentable
Dismissing Patent Owner's Motion to Amend
35 U.S.C. § 318(a)

I. INTRODUCTION

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons that follow, we determine that LTI Flexible Products, Inc. d/b/a Boyd Corporation (“Petitioner”) has not shown by a preponderance of the evidence that claims 1–13 of U.S. Patent No. 10,309,728 B2 (Ex. 1001, “the ’728 patent”) are unpatentable. We also dismiss as moot the Revised Contingent Motion to Amend filed by The Regents of the University of California (“Patent Owner”).

A. *Background and Summary*

Petitioner filed a Petition (Paper 2, “Pet.”) requesting institution of an *inter partes* review of claims 1–13 of the ’728 patent. Patent Owner filed a Preliminary Response (Paper 7, “Prelim. Resp.”). With our authorization (Paper 9), the parties filed additional briefs directed solely to the issues of our discretion to deny institution under 35 U.S.C. § 325(d) and the written description standard for determining the effective filing date. Papers 10, 12. Pursuant to 35 U.S.C. § 314, we instituted an *inter partes* review of the ’728 patent. Paper 13 (“Inst. Dec.”). In particular, we instituted review of claims 1–13 on all presented challenges. Inst. Dec. 20, 22.

After institution, Patent Owner filed a Response (Paper 20, “PO Resp.”), to which Petitioner filed a Reply (Paper 24, “Pet. Reply”), and Patent Owner thereafter filed a Sur-reply (Paper 30, “PO Sur-reply”).

Patent Owner also filed a Contingent Motion to Amend (Paper 18), and Petitioner filed an Opposition to the Motion to Amend (Paper 25). After receiving Preliminary Guidance for the Contingent Motion to Amend (Paper 26), Patent Owner filed a Revised Contingent Motion to Amend

(Paper 31), to which Petitioner filed an Opposition (Paper 35). Subsequently, Patent Owner filed a Reply (Paper 38), and Petitioner filed a Sur-reply (Paper 39).

An oral hearing in this proceeding was held on November 8, 2022; a transcript of the hearing is included in the record. Paper 43 (“Tr.”).

B. Real Parties in Interest

Petitioner identifies Boyd Corporation; Lifetime Industries, Inc.; LTI Holdings, Inc.; PiMEMS, Inc.; AAVID Corporation; AAVID Laboratories, Inc.; and AAVID Thermalloy, LLC as real parties in interest. Pet. 5. Petitioner also notes that “Boyd is a wholly-owned subsidiary of Basilisk Holdings, LLC,” but that “Basilisk Holdings, LLC is not a real party-in-interest to this proceeding.” *Id.* n.5.

Patent Owner identifies the Regents of the University of California and TiMEMS, Inc. as real parties in interest. Paper 4, 2.

C. Related Matters

The parties indicate that the ’728 patent has been asserted in *Regents of Univ. of Cal. v. LTI Flexible Prods., Inc.*, No. 3:20-cv-08686-WHO (N.D. Cal.). Pet. 5; Paper 4; *see also* Paper 6, 1 (indicating that resolution of the infringement claim has been deferred pending determination of ownership).

D. The ’728 Patent (Ex. 1001)

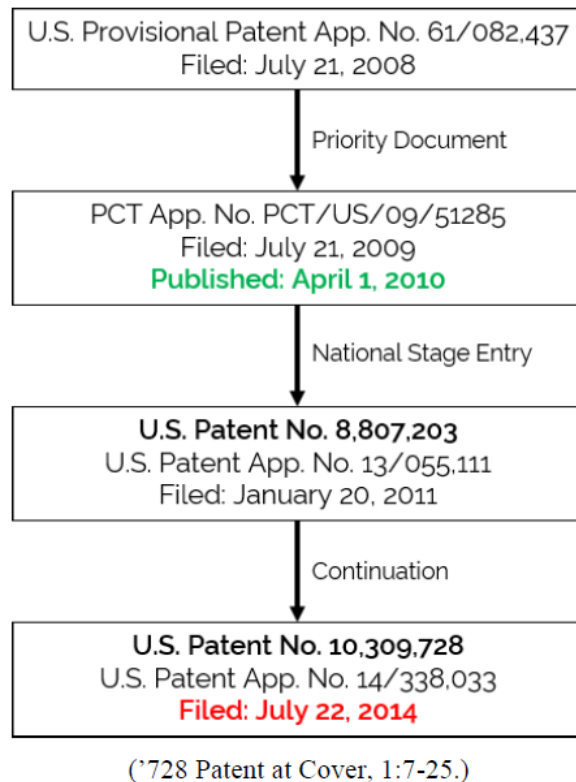
1. Priority Chain of the ’728 Patent

The ’728 patent issued on June 4, 2019, from an application filed on July 22, 2014, that is a continuation of application no. 13/055,111 (“the ’111 application”) filed on January 20, 2011, which was filed as a PCT international application (“the PCT application”) on July 21, 2009. Ex. 1001, codes (22), (45), (63), 1:7–17. The ’728 patent also claims

priority to provisional application no. 61/082,437 (“the provisional application”) filed on July 21, 2008. *Id.* at code (60), 1:18–23; Ex. 1002.

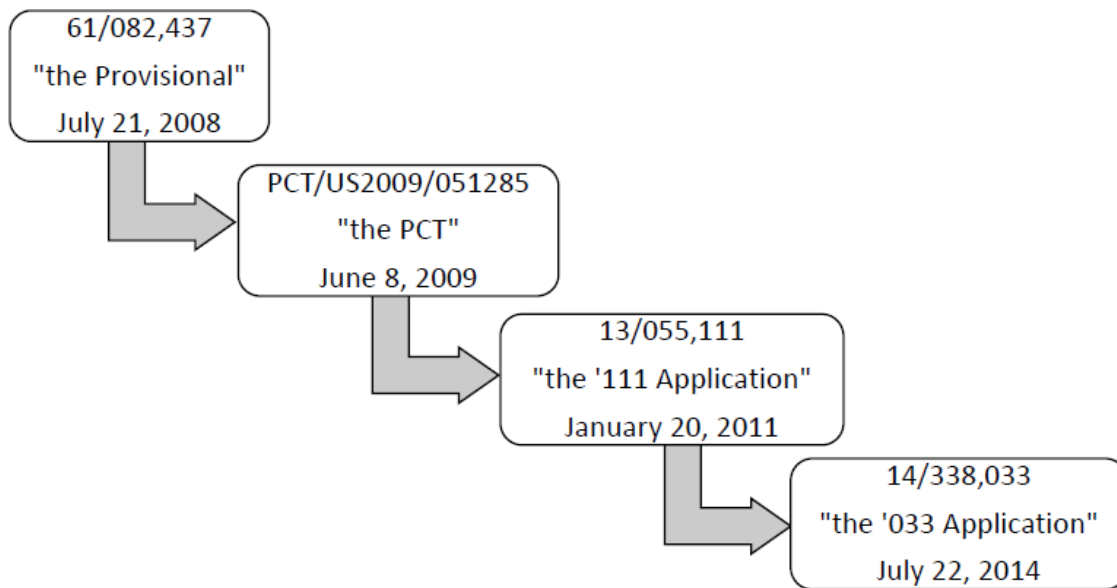
The ’111 application issued as U.S. Patent No. 8,807,203 B2 and claims priority to the same provisional application. Ex. 1005, codes (21), (60), (86), 1:17–20. The PCT application was published on April 1, 2010. Ex. 1007, code (43).

Petitioner provides a flowchart, reproduced below, diagramming the relationship between applications.



Petitioner’s flowchart shows the relevant dates and relationships between the provisional application, the PCT application, the ’111 application, and the application that issued as the ’728 patent. Pet. 11.

Patent Owner also provides a flowchart, reproduced below, that shows the same provisional application, PCT application, ’111 application, and application that issued as the ’728 patent.



PO Resp. 11. Patent Owner’s flowchart also includes the filing dates and relationships between the applications. *Id.* The filing date for the PCT application, however, should be July 21, 2009, not June 8, 2009. Ex. 1007, code (22).

As exemplified above by the parties’ flowcharts, the full record shows that the parties do not dispute the priority chain of the ’728 patent. Pet. 11; PO Resp. 11. The parties instead dispute whether the challenged claims of the ’728 patent are entitled to the benefit of priority to the earliest-filed non-provisional application (i.e., the PCT application filed July 21, 2009) or only to the July 14, 2014 filing date of the application that issued as the ’728 patent, based on whether the earliest-filed application provides written description support for the subject matter claimed in the ’728 patent. Pet. 16–26; PO Resp. 11–38; Pet. Reply 1–22; PO Sur-reply 1–11; *see also* PO Resp. 5 (arguing that “Petitioner’s challenge here is actually an attack on the adequacy of the written description of the specific limitations in claims 1 and 9” regarding “the pitch of the microfabricated structures in a range

between 5–500 micrometers” and “a pitch ranging from 5–500 microns”);
Ex. 1012 ¶ 90 (testifying that a micrometer and a micron are equivalent).

2. The Specification of the '728 Patent

The '728 patent “relates to semiconductor devices, and, more particularly, to thermal ground planes used with semiconductor devices.”

Ex. 1001, 1:38–40. Figure 1 of the '728 patent is reproduced below.

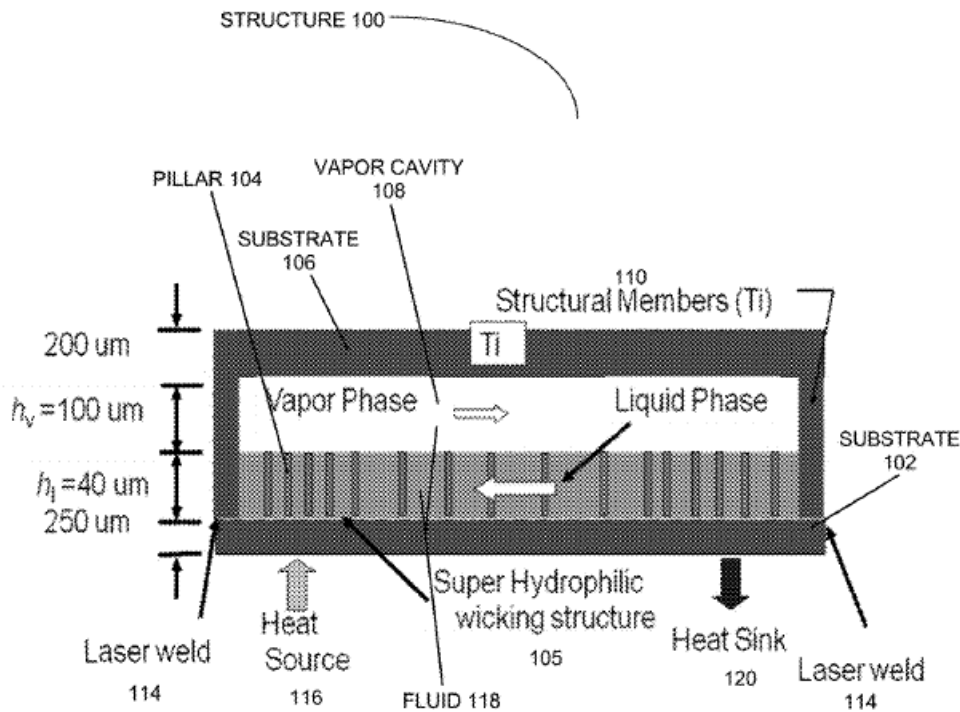


FIG. 1

Figure 1 is a schematic of a titanium-based thermal ground plane. Ex. 1001, 3:31–33, 4:44–46. Thermal ground plane (“TGP”) 100 has substrate 102 that includes pillars 104, and pillars 104 form wicking structure 105. *Id.* at 4:47–49. Heat source 116 generates heat, and first substrate 102 and

wicking structure 105 transfer the generated heat to fluid 118, which can be water, in wicking structure 105. *Id.* at 5:52–54. The heat causes fluid 118 to transform to its vapor phase, and the vapor condenses back to its liquid state near heat sink 120. *Id.* at 5:55–57, 5:66–6:2. The evaporation creates a region void of fluid 118 in wicking structure 105, and that void causes a capillary force through surface tension that draws fluid 118 through wicking structure 105. *Id.* at 5:60–64. The condensed fluid 118 thereby moves from the cooler region near heat sink 120 towards the hotter region near heat source 116. *Id.* at 6:2–6.

Pillars 104 can be made from titanium and can be formed by many methods, including etching. Ex. 1001, 4:57, 6:36–37. The '728 patent states that pillars 104 are “typically nominally 5–200 microns in height, and nominally 5–500 microns in diameter.” *Id.* at 4:65–67; *see also id.* at 5:30–31 (describing pillars 104 that are “5 μ m in diameter and 40 μ m in height”). “The spacing between the pillars 104 (i.e. the gap) can be nominally 1–500 microns.” *Id.* at 4:67–5:1.

According to the '728 patent, “[t]hese dimensions of the pillars, e.g., height, diameter, and spacing (or gap), are controlled and optionally varied within the plurality of pillars within the TGP 100 in order to maximize TGP performance.” Ex. 1001, 5:1–5; *see also id.* at 8:24–30 (describing that “diameter 304, gap 306, and height 308 of the pillars 104, individually, locally, or collectively can be controlled and/or optionally varied within the structure 100 plurality of pillars to optimize the performance of the TGP 100”), Fig. 4B (showing diameter “d,” spacing or gap “g,” and height “h”).

The '728 patent also states that “the dimensions can be designed such that viscous losses are minimized and capillary forces are maximized in

order to improve TGP performance;” “the dimensions, or characteristics, of the pillars 104 can vary throughout the TGP 100;” and “the characteristics can vary locally within the TGP 100 or can vary from one pillar 104 to another pillar 104, as desired for a given application or use of TGP 100.” Ex. 1001, 5:5–12; *see also id.* at 6:62–64 (describing that “large height and large spacing of the pillars 104 will reduce viscous losses” and “smaller spacing of the pillars 104 will increase capillary forces”).

E. Illustrative Claim

The ’728 patent includes claims 1–13, all of which Petitioner challenges. Claims 1 and 9 are independent, and reproduced below is claim 1.

1. A thermal ground plane, comprising:
 - a wicking structure on a titanium substrate, the wicking structure comprising a plurality of microfabricated structures etched into the titanium substrate, *wherein a pitch of the microfabricated structures is a distance from a center of one microfabricated structure to a center of a next neighboring microfabricated structure*, and the microfabricated structures comprise titanium;
 - a vapor cavity in communication with the wicking structure;
 - a fluid contained within the wicking structure and the vapor cavity for transporting thermal energy between a hotter region of the thermal ground plane and a colder region of the thermal ground plane, wherein the hotter region is hotter than the colder region, the fluid is driven by capillary forces within the wicking structure, and the fluid comprises a liquid phase and a vapor phase; and
 - the pitch of the microfabricated structures in a range between 5–500 micrometers*, wherein the microfabricated structures include an etched roughness in a range of 1–1000 nanometers that enhances wetting performance of the wicking structure.

Ex. 1001, 14:42–64 (emphases added). Independent claim 9 also recites a “thermal ground plane” that comprises first and second titanium substrates, wicking structure, vapor cavity, and fluid, “wherein the wicking structure has . . . a pitch ranging from 5–500 microns.” *Id.* at 15:20–16:12.

F. Asserted Prior Art and Proffered Testimonial Evidence

Petitioner identifies the following references as prior art in the asserted grounds of unpatentability:

Name	Reference	Exhibit
MacDonald	WO 2010/036442 A1, published Apr. 1, 2010	1007
Ding	Ding et al., <i>A Titanium Based Flat Heat Pipe</i> , 13 PROC. ASME 2008 INT’L MECH. ENG’G CONG & EXPOSITION 1045 (2008)	1008

MacDonald is the publication of the PCT application that is a parent to the application that issued as the ’728 patent. Pet. 16; PO Resp. 1; Ex. 1001, code (63). Petitioner contends that MacDonald is prior art under 35 U.S.C. § 102(a)(1) because MacDonald was published a year before the filing date of the application that issued as the ’728 patent. Pet. 7.

Petitioner provides a Declaration of John P. Abraham, Ph.D. (Ex. 1012) and Second and Third Declarations by Prof. Abraham (Exs. 1030, 1043). Patent Owner proffers a Declaration of Steven Wereley, Ph.D. (Ex. 2001) and Supplemental and Second Supplemental Declarations by Prof. Wereley (Exs. 2003, 2007). A deposition transcript for Prof. Wereley was filed. Ex. 1031.

G. Asserted Grounds

Petitioner asserts that claims 1–13 are unpatentable on the following grounds:

Claims Challenged	35 U.S.C. §	Reference(s)/Basis
1–13	102 ¹	MacDonald
2, 3, 7	103	MacDonald, Ding

II. ANALYSIS

A. Legal Standards

In *inter partes* reviews, the petitioner bears the burden of proving unpatentability of the challenged claims, and the burden of persuasion never shifts to the patent owner. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). To prevail in an *inter partes* review, the petitioner must support its challenges by a preponderance of the evidence. 35 U.S.C. § 316(e) (2018); 37 C.F.R. § 42.1(d) (2021).

Petitioner contends that the challenged claims of the ’728 patent are unpatentable under §§ 102(b) and 103(a).² Pet. 9. A claim is anticipated under § 102(b) “only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art

¹ The relevant sections of the Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112–29, 125 Stat. 284 (Sept. 16, 2011), took effect on March 16, 2013. Because the ’728 patent claims priority to an application filed before that date, our citations to 35 U.S.C. §§ 102 and 103 are to their pre-AIA versions. Petitioner, however, argues that the earliest effective filing date of the ’728 patent subjects it to AIA law. Pet. 4–5, 11–14, 16–26. The applicable version of the statute does not affect this Decision.

² Petitioner applies the AIA version of the statute and asserts the claims are unpatentable under §§ 102(a)(1) and 103. We reference the corresponding pre-AIA versions in this Decision.

reference.” *Verdegaal Bros., Inc. v. Union Oil Co. of Cal.*, 814 F.2d 628, 631 (Fed. Cir. 1987).

A claim is unpatentable under § 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 the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *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 skill in the art; and (4) where in evidence, so-called secondary considerations. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). When evaluating a combination of teachings, we must also “determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue.” *KSR*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)). Whether a combination of elements produces a predictable result weighs in the ultimate determination of obviousness. *Id.* at 416–417.

B. Level of Ordinary Skill in the Art

Petitioner asserts that one of ordinary skill in the art “would have had (1) a bachelor’s degree in mechanical engineering or a similar field that includes thermal sciences; and (2) at least two years of industrial experience on the design and evaluation of thermal management of electronic systems and heat pipes/TGPs.” Pet. 14–15 (citing Ex. 1012 ¶ 71). Petitioner also argues that “[a]dditional education could have compensated for less industrial experience.” *Id.* at 15 (citing Ex. 1012 ¶ 71).

Patent Owner responds that the relevant date for determining level of ordinary skill in the art is July 21, 2008, the filing date of the provisional application to which priority is claimed. PO Resp. 2. Patent Owner proposes that a person of ordinary skill in the field of the '728 patent “would have had at least a bachelor of science or engineering degree in mechanical engineering or a related field, and either an advanced degree (such as a masters) or an equivalent amount of work experience, i.e., 2–4 years, in an area relating to fluid mechanics, particularly as it applies to thermal transfer.” *Id.* at 3. Patent Owner also notes that the relevant education and work experience would be the same, even if the relevant date is July 21, 2009, the filing date of the earliest non-provisional application to which priority is claimed. *Id.* at 2 n.1.

Patent Owner further notes that we preliminarily adopted Petitioner’s proposed level of skill. PO Resp. 3. Patent Owner, however, contends that “irrespective of which definition of a [person of ordinary skill in the art] is applied in this case, for the reasons set forth in detail below, a [person of ordinary skill in the art] would recognize that the '728 Patent and its parent applications all provide an adequate written description of the claimed invention.” *Id.* at 3–4 (citing Ex. 2003 ¶ 35). No reply arguments are presented regarding the level of ordinary skill in the art. *See generally* Pet. Reply; PO Sur-reply.

In determining the level of ordinary skill in the art, various factors may be considered, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active

workers in the field.” *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (citation and internal quotation marks omitted).

The full record makes clear that the parties do not dispute the portion of Petitioner’s proposed level of ordinary skill regarding education and years of experience. *Compare* Pet. 14–15, *with* PO Resp. 3. Patent Owner acknowledges that the analysis does not depend on whether Petitioner’s proposed level of ordinary skill or Patent Owner’s proposal is adopted. *See* PO Resp. 3–4; Ex. 2003 ¶ 34 (testifying that Patent Owner’s declarant has an understanding of the capabilities of one of ordinary skill in the art irrespective of which proposed skill level is adopted), ¶ 35. The parties’ proposals are consistent with the factors of *GPAC*, the disclosure of the ’728 patent, and the prior art of record. Ex. 1012 ¶ 71 (testifying that Petitioner’s proposed level of ordinary skill is based on considering the factors of *GPAC*); Ex. 2003 ¶ 32 (testifying that Patent Owner’s proposed level of ordinary skill is based on the ’728 patent); *GPAC*, 57 F.3d at 1579.

In view of the above, we see no reason to disturb our preliminary determination regarding the level of ordinary skill in the art. Thus, we maintain and reaffirm that one of ordinary skill in the art would have had “(1) a bachelor’s degree in mechanical engineering or a similar field that includes thermal sciences; and (2) at least two years of industrial experience on the design and evaluation of thermal management of electronic systems and heat pipes/TGPs.” Pet. 14–15; Ex. 1012 ¶ 71; Ex. 2003 ¶ 35. We agree with Patent Owner that the analysis would not be affected by adopting Patent Owner’s proposed level of ordinary skill in the art. PO Resp. 3–4; Ex. 2003 ¶ 35.

C. Claim Construction

In an *inter partes* review based on a petition filed on or after November 13, 2018, the claims are construed

using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. [§] 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.

37 C.F.R. § 42.100(b) (2019); *see Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc).

Petitioner contends that “the ordinary and customary meaning of the term ‘pitch’ in [c]laim 9 encompasses the definition of ‘pitch’ given in [c]laim 1—‘a distance from a center of one microfabricated structure to a center of a next neighboring microfabricated structure.’” Pet. 15. No claim term was interpreted expressly for our Institution Decision. Inst. Dec. 10.

Patent Owner does not propose expressly any interpretation for any claim term. *See generally* PO Resp. Patent Owner, however, states that “claim 1 of the ’728 Patent expressly defines the claimed ‘pitch’ of the microfabricated structures as being ‘a distance from a center of one microfabricated structure to a center of a next neighboring microstructure.’” *Id.* at 12 (citing Ex. 1001, 14:45–48). Patent Owner notes that “[c]laim 9 does not include this particular definition, but the Board apparently applied the definition of the ‘pitch’ limitation in claim 1 to claim 9, as did Petitioner.” *Id.* “Patent Owner does not dispute or disagree with this.” *Id.*

Based on the full record and because the parties do not dispute it, we apply the definition of pitch in claim 1 to the recited pitch of claim 9. Also, based on the full record, we determine that no other claim term requires

express interpretation. *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms that . . . are in controversy, and only to the extent necessary to resolve the controversy.’” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

D. Effective Filing Date

1. The Specification of the Parent Applications

According to Petitioner, the PCT and ’111 applications (collectively, “the parent applications” or the “non-provisional parent applications”) have substantially the same specifications and figures as the application that issued as the ’728 patent. *See* Pet. 16, 26; Ex. 1012 ¶¶ 63, 76. Petitioner contends that the Specification of the ’728 patent “describes selecting or varying characteristics of the plurality of pillars 104 that form wicking structure 105 to optimize the TGP’s performance,” and that those characteristics include pillar diameter and spacing. Pet. 2 (citing Ex. 1001, 2:20–23, 3:40–46, 4:65–5:5, 5:30–35, 8:24–30, Fig. 4B).

Petitioner argues that the ’728 patent’s “non-provisional parent applications describe that the pillars’ diameters can range from 5–500 microns and that the pillars’ spacings can range from 1–500 microns” and “at best, from those ranges’ endpoints, an ordinarily skilled artisan might have derived a pitch range of 6–1000 microns.” Pet. 3.

Petitioner also argues that the “derived pitch range of 6–1000 microns does not describe the claimed pitch range of 5–500 microns,” “excludes pitches inside the claimed range, such as 5 microns,” and “includes pitches outside the claimed range, such as 501 to 1000 microns.” Pet. 4. Petitioner, thus, argues that the earliest possible effective filing date for the claims of

the '728 patent is July 22, 2014, the filing date of the application that issued as the '728 patent. *Id.*; Ex. 1001, code (22).

Patent Owner responds that the '728 patent incorporates by reference both the '111 and PCT applications in their entireties. PO Resp. 7 (citing Ex. 1001, 1:7–25). Patent Owner contends that the '728 patent's Specification “describes the characteristics of TGPs that the inventors determined should be varied or adjusted to change the cooling performance of the TGP” and “ranges of suitable values for certain dimensions of the pillars.” *Id.* at 6–7 (quoting Ex. 1001, 4:65–5:5, 8:31–34, 10:67–11:4), 7–8 (quoting Ex. 1001, 8:24–30, 8:49–57). Patent Owner also contends that the PCT and '111 applications include original claim 2 that recited “wherein a pillar in the plurality of pillars comprises dimensions between one micron and one millimeter.” *Id.* at 7 (citing Ex. 1003, 37; Ex. 1004, 206, 249).

We agree with Petitioner that the specifications and figures of the PCT and '111 applications and the application that issued as the '728 patent are substantially the same. Pet. 16, 26; Ex. 1012 ¶¶ 63, 76. The full record also shows that the parties do not dispute that the specification common to the PCT and '111 applications and the application that issued as the '728 patent “describes selecting or varying characteristics of the plurality of pillars 104 that form wicking structure 105 to optimize the TGP's performance,” and that those characteristics include pillar diameter and spacing. Pet. 2 (citing Ex. 1001, 2:20–23, 3:40–46, 4:65–5:5, 5:30–35, 8:24–30, Fig. 4B); *see also* PO Resp. 6–7 (arguing characteristics can be varied or adjusted to change TGP performance) (citing Ex. 1001, 4:65–5:5, 8:31–34, 10:67–11:4), 7–8 (quoting Ex. 1001, 8:24–30, 8:49–57).

2. *Prosecution History*

In summarizing the prosecution history of the '728 patent, Petitioner contends that the application that issued as the '728 patent “should have been examined under AIA law.” Pet. 12 (citing Ex. 1006, 77, 114, 165, 194, 233, 278). Because originally-filed claim 5 recited “smaller spacings equal to zero” and “no parent application describes ‘spacings equal to zero,’” Petitioner asserts that original claim 5 “could not have obtained the benefit of any earlier filing date.” *Id.* (citing Ex. 1003, 19–20; Ex. 1004, 23; Ex. 1005, 4:47–50, 5:10–15; Ex. 1006, 50–51; Ex. 1012 ¶¶ 61–63). Petitioner also asserts that the effective filing date of original claim 5 is July 22, 2014, and thus, original claim 5 is a post-March 16, 2013, claim. *Id.* Petitioner, therefore, asserts that the '728 patent should have been subjected to AIA law. *Id.*; *see also id.* at 25–26 (arguing similarly). Petitioner notes that the Examiner objected to original claim 5 for lack of antecedent basis in the Specification and lack of support in the drawings, and that claim 5 was thereafter canceled. *Id.* at 12 (citing Ex. 1006, 77–78, 100–101, 104).

Patent Owner responds that “the Examiner included a statement that ‘[t]he present application is being examined under the pre-AIA first to invent provisions.’” PO Resp. 10 (citing Ex. 1006, 262, 357). Patent Owner also argues that the claims were amended to include the pitch limitations and the Examiner did not reject the amended claims based on new matter or lacking written description support and did not reject any claim over MacDonald. *Id.* at 9 (citing Ex. 1006, 152–162, 357–367).

Patent Owner further argues that the Examiner must have necessarily determined that the Specification of the '728 patent provided adequate written description for the pitch limitations. *Id.* at 36–38 (citing Ex. 1006,

152–162, 176–179, 357–367). According to Patent Owner, “there is no evidence that the Examiner failed to evaluate the claims for compliance with 35 U.S.C. § 112,” and “[t]he Examiner’s alleged error during prosecution has nothing to do with the challenge raised in the Petition or the issues now before the Board.” PO Resp. 10.

Patent Owner, thus, argues that prosecution history provides “very strong evidence that the Examiner determined the pitch limitations to be fully supported by the common specification of the PCT and the ’111 Application” and the ’728 patent. PO Resp. 9–10; *see also id.* at 36 (arguing that because, the Specification of the ’728 patent adequately describes the pitch limitations, those limitations are described in the PCT and ’111 applications by sharing common specifications), 38 (arguing the same) (citing Ex. 1006, 152–162, 357–367).

3. *Written Description Support and Priority*

Petitioner contends that the parent applications provide no “blaze marks directing an ordinarily skilled artisan to the claimed pitch range of 5–500 microns.” Pet. 18; *see also id.* at 16–17 (citing case law). In Petitioner’s view, the “non-provisional parent applications do not expressly describe any distance for pitch” and “[a]t most, they expressly describe (1) a range of pillar spacings from 1–500 microns and (2) a range of pillar diameters from 5–500 microns, plus a specific example of 5-micron diameter.” *Id.* at 18 (citing Ex. 1003, 19–20; Ex. 1004, 23–24; Ex. 1005, 4:47–50, 5:10–11; Ex. 1012 ¶¶ 93–96). Petitioner also contends that “an ordinarily skilled artisan could have derived various pitches,” but the derived pitches do not support a pitch range of 5–500 microns. *Id.* (citing Ex. 1012 ¶ 97).

Petitioner summarizes its declarant testimony regarding how pitch is measured and how the disclosed spacings and diameters result in a pitch range of 6–1000 microns. Pet. 18–20 (citing Ex. 1012 ¶¶ 98–112). Petitioner asserts that the derived range would not allow the ordinarily skilled artisan to immediately discern the claimed range, because the “derived and claimed ranges differ both numerically and functionally” and even a 1-micron change would alter several properties. *Id.* at 20 (citing Ex. 1012 ¶¶ 113–119); *see also id.* at 21–22 (arguing that the derived pitch from originally-filed claim 2’s recitation that “the plurality of pillars comprises dimensions between one micron and one millimeter” does not support the claimed pitch range of 5–500 microns) (citing Ex. 1003, 37; Ex. 1004, 41, 179; Ex. 1005, claim 2; Ex. 1012 ¶¶ 123–129).

Petitioner also asserts that any derived subrange would not align with the claimed pitch range. Pet. 21 (citing Ex. 1012 ¶ 120), 23 (citing Ex. 1012 ¶ 130). Petitioner further asserts that the parent applications provide no “blaze marks to guide an ordinarily skilled artisan to any particular subrange” and “only describe the pillars’ pitch as a characteristic to vary.” *Id.* at 21 (citing Ex. 1003, 14–16, 27, 34–35; Ex. 1004, 18–20, 31, 38–39; Ex. 1005, 2:7–10, 2:38–43, 2:65–3:4, 8:66–9:5, 13:9–16; Ex. 1012 ¶ 121); *see also id.* at 23 (making a similar argument for the recitation of originally-filed claim 2) (citing Ex. 1012 ¶¶ 131–133).

Petitioner further asserts that the provisional application “does not cure the non-provisional parent applications’ deficiencies.” Pet. 23. According to Petitioner, “the provisional application describes only a 3-micron pillar diameter, a 4-micron pitch, and an implied 1-micron spacing” and those dimensions either do not support the claimed pitch range or

“yield[] more unblaze-marked, mismatched subranges and more individual pitches outside the claimed pitch range of 5–500 microns.” *Id.* at 24 (citing Ex. 1012 ¶¶ 134–139).

Petitioner argues that “[e]ven if the claimed pitch range would have been obvious over the parent applications, the written description requirement would remain unsatisfied.” Pet. 24. Petitioner also argues that, because “every challenged claim includes that unsupported pitch range, no claim can[] obtain any effective filing date earlier than the ’728 Patent’s filing date: July 22, 2014.” *Id.* at 25.

a) Patent Owner’s Response

Patent Owner responds that Petitioner incorrectly argues that neither the PCT nor the ’111 application provides written description support for limitations in claims 1 and 9 regarding “the pitch of the microfabricated structures in a range between 5–500 micrometers” and “a pitch ranging from 5–500 microns” (“the pitch limitations”). PO Resp. 11–12 (citing Pet. 16–25). Patent Owner argues that claim 1 “expressly defines the claimed ‘pitch’ of the microfabricated structures” and does not dispute that the same definition applies to the “pitch” of independent claim 9. *Id.* at 12 (citing Ex. 1001, 14:45–48). Patent Owner also argues that one of ordinary skill in the art would have understood that the definition, “for generally circular pillars,” can be calculated as:

$$pitch = spacing + \frac{1}{2}(diameter_1) + \frac{1}{2}(diameter_2)$$

Id. at 13 (citing Ex. 2003 ¶ 37).

Patent Owner states that “[t]he pitch limitations themselves are not explicitly mentioned in the common specification of the PCT and the ’111 Application and no values or ranges of values for the claimed pitch are

disclosed,” but the common specification does explicitly provide diameters of the pillars and the spacing between adjacent pillars. PO Resp. 13 (citing Ex. 2003 ¶ 38).

Patent Owner also argues that the PCT and ’111 applications both had an original claim 2 that recited at least one pillar having dimensions between 1 micron and 1000 microns, and that both applications “expressly identify pillar diameter and spacing (gap) as being ‘dimensions’ of the pillars.” PO Resp. 13 (citing Ex. 1003, 19, 37; Ex. 1004, 188, 206, 249; Ex. 2003 n.2). Patent Owner further argues that both applications disclose that pillars are typically 5–500 microns in diameter and the spacing between pillars can be nominally 1–500 microns. *Id.* at 13–14 (citing Ex. 1003, 19; Ex. 1004, 206, 249). Patent Owner contends that these “are the only numerical ranges disclosed for the spacing between the pillars and for the diameter of the pillars.” *Id.* at 14 (citing Ex. 2003 ¶ 38). Patent Owner, thus, contends that one of ordinary skill in the art would have looked to these numerical ranges when determining the values of pitch as defined by claim 1. *Id.* (citing Ex. 2003 ¶ 39).

By using the numbers from original claim 2, Patent Owner argues that the broadest range for pitch according to claim 1’s definition would be 2–2000 microns. PO Resp. 14 (citing Ex. 2003 ¶ 40). By using the ranges disclosed in the PCT and ’111 applications, Patent Owner argues that narrower ranges can be derived for the claimed pitch, such as 6–505 microns and 501–1000 microns as calculated by Petitioner’s declarant. *Id.* at 14–15 (citing Ex. 1012 ¶ 120; Ex. 2003 ¶¶ 41, 42). Patent Owner also argues that the disclosed ranges can also be used to derive pitch in ranges of 6–501 microns and 505–1000 microns. *Id.* at 15 (citing Ex. 2003 ¶ 43). Patent

Owner further points to the exact value of 5 microns for pillar diameter disclosed by the PCT and '111 applications, which results in a pitch between 6–505 microns. *Id.* at 15–16 (citing Ex. 1003, 20, 69; Ex. 1004, 189, 249; Ex. 2003 ¶ 45).

Based on the pitch ranges described above, Patent Owner contends that one of ordinary skill in the art “would conclude that the inventors were in possession of the invention claimed in the '728 Patent as of the filing dates of the PCT and the '111 Application, including the requirement that the microfabricated structures (pillars) have a pitch in the range of 5–500 microns.” PO Resp. 16 (citing Ex. 2003 ¶ 46). Patent Owner points to the PCT and '111 applications’ disclosure that pillar diameter, spacing, and pitch are “characteristic[s] of the plurality of pillars [that] can be controlled and optionally varied within the plurality of pillars to adjust a thermal transport of the thermal ground plane” to argue that one of ordinary skill in the art would recognize their values are “important features” and considered to be part of the invention of the PCT and '111 applications. *Id.* (citing Ex. 1003, 23; Ex. 1004, 240, 249; Ex. 2003 ¶ 48).

Patent Owner also points out that the broadest range that can be derived from the values disclosed by the PCT and '111 applications fully encompasses the claimed 5–500 microns range without any part of the range falling outside. PO Resp. 16–17 (citing Ex. 2003 ¶ 47). Patent Owner further points out that no other values are disclosed by the PCT and '111 applications that can be used to derive pitch as defined by claim 1 other than the ones described above. *Id.* at 17 (citing Ex. 2003 ¶ 47). Patent Owner argues that they are “the only possible ranges for the claimed pitch that could be derived from the numerical values in the specification.” *Id.*

Patent Owner also argues that “the claimed range of 5–500 microns is more than 99% identical to the derived ranges of 6–501 microns and 6–505 microns” with the upper endpoints “differing by less than 1%” and the lower endpoints within the margin of error used by the inventors. PO Resp. 17 (citing Ex. 2001 n.3; Ex. 2003 ¶ 50). Patent Owner, thus, argues that the PCT and ’111 applications provide sufficient support for the claimed pitch range because the only differences appear at the ends of the range, and “those differences would not be considered significant in the context of the ’728 Patent . . . nor would they result in functionally different devices.” *Id.* at 17–18 (citing Ex. 2003 ¶ 50).

Patent Owner contends that facts in this proceeding are similar those of *In re Wertheim*, 541 F.2d 257 (CCPA 1976). PO Resp. 18. According to Patent Owner, like *Wertheim*, “there is no dispute that the claimed pitch range of 5–500 microns does not read on any embodiments outside the 2–2000 micron range that can be derived from the dimensions recited in original claim 2” and that there is no difference in operability between pitch of 5 microns and 6 microns or between a pitch of 500 microns and a pitch of 501 or 505 microns. *Id.* at 18–19.

Patent Owner contends that the differences in the endpoints are not significant because they either differ by less than 1% or are within the margin of error. PO Resp. 19 (citing Ex. 2003 ¶¶ 50, 51). Patent Owner also contends that “changes in the pillar pitch, even across the full scope of the claimed range, do not result in changes in how those TGP’s operate or in the overall results that can be obtained with them.” *Id.* (citing Ex. 2003 ¶ 51). Patent Owner further contends that Petitioner’s declarant incorrectly

opines that that pitches that differ by 1 micron would not be functionally equivalent. *Id.* (citing Ex. 1012, 46; Ex. 2003 ¶ 51).

According to Patent Owner, changes in the pitch affect capillary pressure and viscous losses but would not change how the claimed TGP functions. PO Resp. 19. Patent Owner argues that, because the TGP relies on continuum fluid mechanics, heat transfer, and phase change, “no threshold for sudden functional changes will be found when reducing the spacing from 500 microns to 1 micron” and no difference in operation from reducing pitch from 6 microns to 5 microns. *Id.* at 19–20 (citing Ex. 2003 ¶ 52; Ex. 2004).

Patent Owner applies “Washburn dynamics, which describes the interaction between surface tension and viscous forces during the wetting of a circular capillary” to argue a theoretical “difference in capillary pressure of around 20%” from decreasing spacing between pillars from 6 to 5 microns, “a change in the capillary pressure of around 10,000%” for a decrease in spacing from 500 microns to 5 microns, and “a change of over 16,000% in capillary pressure” for a decrease in spacing from 500 microns to 1 micron. PO Resp. 20–21 (citing Ex. 2003 ¶¶ 53–55; Ex. 2005). Patent Owner argues that the disclosed range in spacing between neighboring pillars “encompasses devices which can exhibit capillary pressures that differ by orders of magnitude but which nevertheless still operate in substantially the same way with the same general results.” *Id.* at 22 (citing Ex. 1003, 19; Ex. 1004, 188, 249; Ex. 2003 ¶ 57). Patent Owner, thus, argues that one of ordinary skill in the art “would not regard a 20% difference in capillary pressure as evidence that two devices are ‘functionally different’ from each other.” *Id.* (citing Ex. 2003 ¶ 57).

Patent Owner also argues that Petitioner’s declarant “focused exclusively on the difference in capillary pressure that would result from changing the pitch between the pillars by reducing the spacing from 6 microns to 5 microns” but “did not address what happens when the pitch between the pillars is changed by increasing/decreasing the diameter of the pillars themselves.” PO Resp. 22 (citing Ex. 1012 ¶ 116; Ex. 2003 ¶ 58).

According to Patent Owner, one of ordinary skill in the art “would know, changes in capillary pressure will only be observed when the change in the pitch of the pillars is due to a change in the spacing between neighboring pillars,” and “there will be no change in capillary pressure when a change in the pitch of the pillars is due solely to a change in the diameter of the pillars alone[], regardless of whether that change in diameter is an increase/decrease of 1 micron or 10 microns or even 100 microns.” PO Resp. 22–23 (citing Ex. 2003 ¶ 59). Patent Owner contends that, when spacing between pillars is not changed, one of ordinary skill in the art “would know that the capillary pressure would be essentially constant over the entire pitch range” of the derived 6–501 microns and 505–1001 microns, and that “there would be no change in capillary pressure even as the pitch changes from 6 microns to 501 microns or from 505 microns to 1001 microns.” *Id.* at 23 (citing Ex. 2003 ¶ 60). Patent Owner also contends that the ordinarily skilled artisan would know that “if the change in the pitch of the pillars was due to a change in both the spacing between neighboring pillars and in the diameter of the pillars, then the effective change in capillary pressure would be due only to the change in the spacing between neighboring pillars.” *Id.* (citing Ex. 2003 ¶ 61).

According to Patent Owner, a hypothetical reduction in pitch from 6 microns to 5 microns due to a 0.9 micron reduction in diameter and 0.1 micron reduction in spacing would result in a capillary pressure change of only about 2%. PO Resp. 23–24 (citing Ex. 2003 ¶ 61). Patent Owner also provides graphs of capillary pressure versus pillar spacing to illustrate a “smooth, uninterrupted curve” over pillar spacings of 1–10 microns and 100–1000 microns. *Id.* at 24–25 (citing Ex. 2003 ¶¶ 63, 64). Patent Owner argues that “there is no threshold for sudden functional changes nor is there any change in how the TGP’s operate.” *Id.* at 25 (citing Ex. 2003 ¶ 64). Patent Owner also argues that the graphs show a “trivial” change in capillary pressure for a change in spacing from 6 microns to 5 microns. *Id.*

According to Patent Owner, one of ordinary skill in the art “would know that viscous losses can be addressed by applying Darcy’s Law, which simply states that the flow in a particular direction is related to the pressure gradient in that direction and depends directly on the porosity of the medium” and would know how to determine porosity of the medium. PO Resp. 25–26 (citing Ex. 2003 ¶ 65). Patent Owner argues that viscous losses therefore “depend on both the diameter of the pillars and the spacing (gap) between neighboring pillars,” and a change in either would result in observable viscous losses. *Id.* at 26 (citing Ex. 2003 ¶ 65). Patent Owner also argues that decreasing the pitch from 6 microns to 5 microns, either through reducing the diameter or the spacing, would result in viscous losses of around 44%. *Id.* (citing Ex. 2003 ¶ 65). Patent Owner further argues that “the potential changes in viscous losses that could occur over the full scope of the pitch range are several orders of magnitude greater than the 44% change” but “do not change how the claimed TGP’s operate.” *Id.* (citing

Ex. 2003 ¶ 67). In Patent Owner’s view, one of ordinary skill in the art would not consider a 44% difference between two TGPs to be a functional difference. *Id.* (citing Ex. 2003 ¶ 72).

Patent Owner contends that one of ordinary skill in the art would have known that “viscous losses are very predictable based on the geometry of the vapor chamber” and, if pillars do not completely touch, “the porosity changes continuously irrespective of whether that change is due to a change in the diameter of the pillars or the spacing between the pillars (or even both).” PO Resp. 27 (citing Ex. 2003 ¶ 68). Patent Owner also contends that “[t]here are no sudden increases or decreases in viscous resistance as the spacing/porosity changes.” *Id.* Patent Owner provides a graph of porosity versus pitch. *Id.*

Patent Owner also provides graphs of viscous pressure drop versus pillar spacing. PO Resp. 28 (citing Ex. 2003 ¶ 69). Patent Owner argues that “changes in viscous losses follow a smooth, uninterrupted curve over the entirety of the 1–500 micron spacing range disclosed in the specification and the 1–1000 micron range of original claim 2.” *Id.* at 29 (citing Ex. 2003 ¶ 70). Patent Owner also argues that performance characteristics, such as thermal transport, dryout temperature, and heat carrying capacity, depend on TGP properties including capillary pressure, viscous losses, and others. *Id.* (citing Ex. 2003 ¶ 71), 30–32 (citing Ex. 2003 ¶¶ 74–77). Patent Owner further argues that capillary pressure is an essential property for proper functioning of a TGP and has an effect on its performance characteristics. *Id.* at 29 (citing Ex. 2003 ¶ 72).

According to Patent Owner, changes in capillary pressure do not give rise to a functionally different TGP. PO Resp. 29–30 (citing Ex. 2003 ¶ 72).

Patent Owner contends that changes in capillary pressure from changes in pillar spacing do not change how a TGP functions or operates and do not produce “results of a different type or kind, only of degree.” *Id.* at 30 (citing Ex. 2003 ¶ 72). Patent Owner also contends that changes in viscous losses due to changes in pitch do not result in a functionally different TGP and do not produce “results of a different type or kind, only of degree.” *Id.* (citing Ex. 2003 ¶ 73). In Patent Owner’s view, “the operation and function of those TGPs remain basically the same [with] the same fundamental results,” and “[t]he variations in performance that may appear from changing the spacing between the pillars and/or the diameter of the pillars are not differences in type or kind, only differences in degree.” *Id.* at 32 (citing Ex. 2003 ¶ 78).

Patent Owner also responds that a “specification does not have to provide exact or verbatim textual support for the claimed subject matter.” PO Resp. 32. Regarding “blaze marks,” Patent Owner responds that “the ‘blaze marks’ test should not be universally invoked in every case where the adequacy of written description is at issue, but, rather, is best applied to cases where the specification includes a ‘laundry list’ disclosure” with support from case law. *Id.* at 32–34 (citing Pet. 18).

Patent Owner contends that “there is no laundry list of possible pitch ranges disclosed in the specification or even derivable from the pillar diameter and spacing ranges that are disclosed, nor is Patent Owner arbitrarily selecting an undisclosed narrower range from a disclosed broad range.” PO Resp. 34. Patent Owner, thus, contends that “blaze marks” are not required for the pitch limitations. *Id.*

Patent Owner also argues that, even if “blaze marks” were necessary for the pitch limitations to have adequate written description support, one of ordinary skill in the art would have easily recognized such “blaze marks” in the common specification of the PCT and ’111 applications. PO Resp. 34 (citing Ex. 2003 ¶ 80). Patent Owner contends that one of ordinary skill in the art must look to pillar diameter and spacing values to find values for the claimed pitch, and, thus, claim 1’s express language is a clear example of “blaze marks.” *Id.* at 34–35 (citing Ex. 1001, 14:45–48; Ex. 2003 ¶¶ 81, 82). Patent Owner also contends that the common specification of the PCT and ’111 applications discloses ranges for pillar diameters and spacings, and those ranges are the only ranges expressly stated in the common specification. *Id.* at 35 (citing Ex. 1003, 19; Ex. 1004, 188, 249; Ex. 2003 ¶ 81). Patent Owner, thus, contends that one of ordinary skill in the art would have necessarily used those ranges. *Id.* (citing Ex. 2003 ¶ 81).

Patent Owner further responds that a range is not being created from discrete examples and that a specific value is not being claimed from a broadly disclosed range. PO Resp. 35–36. Patent Owner argues that it “is using the end points of the only expressly disclosed ranges (pillar diameter and spacing) to derive the end points of a range (pitch) that the claim specifically instructs should be calculated from the expressly disclosed ranges.” *Id.* at 36.

b) Petitioner’s Reply

Petitioner replies that, as conceded by Patent Owner, the parent applications do not describe expressly any pitch range. Pet. Reply 1–2 (citing Pet. 18; PO Resp. 13; Ex. 1012 ¶¶ 93–94; Ex. 2003 ¶ 38). Petitioner also argues that the parent applications do not describe implicitly the

claimed pitch range because an ordinarily skilled artisan is not even invited to hunt for the claimed pitch range. *Id.* at 2–3 (citing PO Resp. 13; Ex. 1012 ¶¶ 121, 131). Petitioner further asserts that the parent applications list characteristics to control but are silent as to any pitch range. *Id.* at 3 (citing PO Resp. 13, 16, 34–35; Ex. 2003 ¶ 38).

Petitioner contends that claim 1’s now recited definition of pitch cannot be used to show that the ’728 patent’s parent applications conveyed possession of any pitch range. Pet. Reply 3–4 (citing PO Resp. 13–16, 34–35). Petitioner also contends that none of the parent applications could have reasonably conveyed claim 1’s pitch definition because they do not disclose that definition and instead use the term pitch to describe an angle of the pillars. *Id.* at 4–5 (citing PO Resp. 13; Ex. 1002, 9; Ex. 1003, 27; Ex. 1004, 31; Ex. 1005, 8:66–9:1; Ex. 1006, 50; Ex. 1012 ¶¶ 64–68, 93, 135).

Petitioner also replies that it is not possible to derive the claimed pitch range from the parent applications’ disclosures, as conceded by Patent Owner’s declarant Prof. Wereley. Pet. Reply 6 (citing Ex. 1031, 43:14–20). According to Petitioner, there is no guidance to the two derived pitch ranges of 6–501 microns and 6–505 microns relied upon by Patent Owner. *Id.* (citing PO Resp. 14–19). Petitioner argues that both of the parties’ asserted broadest possible pitch ranges are larger than the claimed pitch range with no guidance toward any particular pitch range. *Id.* at 6–7 (citing Pet. 20–23; Prelim. Resp. 17; PO Resp. 14–19; Ex. 1012 ¶¶ 108–112, 121, 126–129, 131).

Petitioner also argues that using the disclosed pillar diameters and spacings would yield at least 72 unique pitch ranges, not just five as argued by Patent Owner. Pet. Reply 8 (citing Pet. 21, 23; PO Resp. 14–19;

Ex. 1003, 20; Ex. 1004, 20; Ex. 1005, 5:10–11; Ex. 1012 ¶¶ 120–121, 130–131; Ex. 1030 ¶¶ 73–75). Petitioner further contends that Patent Owner assumes that an ordinarily skilled artisan would have used the child application claims to find written description support in the parent applications, and that Patent Owner ignores a broader spacing range of original claim 2 of the parent applications with no guidance to select Patent Owner’s narrower spacing range. *Id.* at 8–9 (citing Pet. 21, 23; PO Resp. 14, 25; Ex. 1012 ¶¶ 121, 131; Ex. 1030 ¶¶ 69–72, 76).

In Petitioner’s view, blaze marks would be required in view of the large number of possible pitch ranges. Pet. Reply 9–10 (citing Pet. 20–23; Prelim. Resp. 17; PO Resp. 13–14, 32–34; Ex. 2003 ¶ 47; Ex. 1012 ¶¶ 108–133; Ex. 1030 ¶¶ 73–75). Petitioner asserts the selection of a narrower range must have been arbitrary. *Id.* at 9–10 (citing PO Resp. 13, 34; Ex. 1012 ¶¶ 121, 131). Petitioner also asserts that blaze marks are also necessary because the parent applications do not disclose expressly any pitch range or the claimed definition of pitch. *Id.* at 10 (citing PO Resp. 13, 33; Ex. 1012 ¶¶ 64–68, 121, 131). Petitioner further asserts that the parent applications do not guide the ordinarily skilled artisan to any pitch range and lack any discrete examples, any end point to the pitch range, and any broadly disclosed pitch range. *Id.* at 10–11 (citing PO Resp. 13, 34–36; Ex. 1030 ¶¶ 64–68). Petitioner additionally asserts that the parent applications do not offer any guidance for 5 or 500 microns. *Id.* at 11–12 (citing Pet. 20, 21; PO Resp. 17; Ex. 1012 ¶¶ 116, 121–122; Ex. 1030 ¶¶ 77–80; Ex. 2003 ¶¶ 55, 66).

According to Petitioner, Patent Owner applies a 1-micron margin of error to its derived ranges, but that 1-micron margin of error should also be

applied to all the inputs of the pitch calculation. Pet. Reply 12 (citing PO Resp. 17; Ex. 1030 ¶¶ 78–79). Petitioner argues that applying the 1-micron margin of error to all inputs yields a broader spread around the derived endpoints, with no guidance to the claimed pitch range. *Id.* at 12–13 (citing Ex. 1030 ¶¶ 79, 80). Petitioner also argues that the margin of error argument does not show that one of ordinary skill in the art would have been guided to the claimed pitch range. *Id.* at 13 (citing PO Resp. 17, 19; Ex. 1012 ¶¶ 121, 131; Ex. 1030 ¶ 80). Petitioner further argues that Patent Owner is contending that the claimed pitch range would have been obvious, but obviousness does not show that the written description requirement was met. *Id.* at 14 (citing PO Resp. 17).

Petitioner again argues that there are functional differences between the derived and claimed pitch ranges, such as differences in capillary pressure, viscous losses, and other performance characteristics. Pet. Reply 14–16 (citing Pet. 20–22, 26, 29; PO Resp. 21–22, 26, 29–30; Ex. 1012 ¶¶ 114–119; Ex. 1030 ¶¶ 81–95; Ex. 2003 ¶ 66). Because of these changes, Petitioner argues that the derived pitch ranges of 6–501 and 6–505 microns cannot reasonably convey the claimed pitch range. *Id.* at 16–17 (citing PO Resp. 26, 29–30; Ex. 1012 ¶¶ 114, 120–121, 130–131; Ex. 1030 ¶¶ 94–95). Petitioner also argues that Patent Owner’s asserted differences only of degree, not of type or kind, and continuous changes in performance as spacing and diameter changes are concessions that the derived pitch ranges do not reasonably convey the claimed pitch range. *Id.* at 17 (citing PO Resp. 20, 22, 24–30, 32; Ex. 1012 ¶ 114).

Petitioner further argues that there are threshold changes as pillar diameter and spacings are changed, particularly the threshold at which

dryout occurs, as described in the '728 patent. Pet. Reply 17 (citing Ex. 1001, 10:67–11:4; Ex. 1012 ¶ 118; Ex. 1030 ¶¶ 83–85, 92–93; Ex. 1037, 6; Ex. 1038, 3). Petitioner additionally argues that Patent Owner's arguments about variations in capillary pressure and viscous losses do not address the claimed pitch range and threshold changes. *Id.* at 18 (citing PO Resp. 21–29). In Petitioner's view, a broadly disclosed range with varied functionality within the range does not support a claim for a different range. *Id.* at 18. Petitioner also addresses the functional variations and contends that derived and claimed pitch ranges are not functionally equivalent. *Id.* at 18–19 (citing Ex. 1012 ¶¶ 114–119; Ex. 1030 ¶¶ 85–91, 94–95).

Petitioner argues that other factors identified by Patent Owner that can affect performance do not change the outcome. Pet. Reply 19 (citing PO Resp. 26, 29–32; Ex. 1012 ¶ 114). Petitioner also argues that *In re Wertheim* does not apply because the parent applications do not disclose the pitch limitations or any value or range for pitch. *Id.* at 19–20 (citing PO Resp. 13, 18, 26, 29–30; Ex. 1012 ¶ 114; Ex. 1030 ¶¶ 94–95).

Petitioner further replies that Patent Owner's request to consider arguments in preliminary briefing should be disregarded. Pet. Reply 21 (citing PO Resp. 12, 41). Petitioner additionally argues that Patent Owner's arguments regarding prosecution history largely repeat arguments made in the Preliminary Response and are still not persuasive. *Id.* at 21–22 (citing Prelim. Resp. 9–14; PO Resp. 8–9, 36–38).

c) Patent Owner's Sur-reply

Patent Owner replies that, from the disclosed diameter and spacing ranges, one of ordinary skill in the art would have calculated pitch ranges of 6–501 and 6–505 microns from the endpoints of those disclosed ranges. PO

Sur-reply 1 (citing Ex. 1012 ¶¶ 95, 120; Ex. 2003 ¶¶ 38, 42–43). Patent Owner argues that Petitioner incorrectly asserts that the parent applications would not have guided an ordinarily skilled artisan to any pitch range because the endpoints of the disclosed ranges are “very obvious ‘blaze marks’” for determining pitch ranges. *Id.* at 1–2 (citing Pet. Reply 1; Ex. 2003 ¶¶ 79–82); *see also id.* at 9–10 (citing Pet. Reply 9–11; Ex. 2003 ¶¶ 81–82) (arguing the disclosed end points are blaze marks).

Patent Owner also argues that Petitioner’s 72 unique pitch ranges “can only be obtained through complex combinatorial gymnastics” of values from the parent applications. PO Sur-reply 2–3 (citing Pet. Reply 8; Ex. 1012 ¶ 137). According to Patent Owner, adequate written description support is not undermined by other calculated values for pitch range or by disclosed but unclaimed pitch ranges. *Id.* at 3. Patent Owner further argues that, even without the recited definition of pitch in claim 1, a person of ordinary skill in the art would understand that center-to-center distance between neighboring pillars is important because both pillar diameter and pillar spacing can have an effect on TPG performance. *Id.* at 3–4 (citing Pet. Reply 3; Ex. 2003 ¶¶ 19–20, 39).

Patent Owner also replies that pitch ranges of approximately 6–501 and 6–505 microns support the claimed range because the numerical differences are inconsequential, and there is no evidence that a 5-micron pitch TGP operates differently from a 6-micron pitch TGP. PO Sur-reply 4–6 (citing Pet. Reply 1; Ex. 2003 ¶¶ 51–78). Patent Owner argues, with support from case law, that verbatim support is not necessary for numerical ranges. *Id.* at 4–5, 7 (citing Pet. Reply 3). Patent Owner also argues that Petitioner’s asserted functional differences are irrelevant because varying

pillar diameter and spacing does not cause a TGP to operate differently or fail to move heat away from a heat source. *Id.* at 6–7 (citing Ex. 2003 ¶¶ 51–78), 10.

Patent Owner also argues that one of ordinary skill in the art would recognize the claimed pitch range uses the nearest round values, rather than the calculated values, consistent with how other dimensions are described and claimed. PO Sur-reply 7 (citing Ex. 1001, 15:9–10, 16:7–10; Ex. 2001 ¶ 58). Patent Owner further argues that the parent applications expressly disclose typical pillar diameter and spacing and identify pillar diameter and spacing as important variables. *Id.* at 7–8 (citing Ex. 1006, 353, 380). Patent Owner additionally argues that no “extrapolation, interpolation, and assumptions” are required. *Id.* at 8 (citing Pet. Reply 2; Ex. 1001, 15:7–10, 16:7–10).

Patent Owner further replies that requiring express disclosure of values, as opposed to deriving values, is inconsistent with case law. PO Sur-reply 8–9, 10. Patent Owner contends that Petitioner asserts that a broader range cannot support a narrower range by citing a case that does not support Petitioner’s argument. *Id.* at 9. In Patent Owner’s view, case law supports that a broad range can support a narrower range. *Id.*

d) Petitioner Fails to Meet its Burden for Showing Inadequate Written Description for the Pitch Limitations

For a claim in a later-filed application to be entitled to the filing date of an earlier application, the earlier application must provide written description support for the claimed subject matter. *Anascope, Ltd. v. Nintendo of Am. Inc.*, 601 F.3d 1333, 1337 (Fed. Cir. 2010). The written description inquiry is a question of fact, context-specific, and determined on

a case-by-case basis. *Ariad Pharm., Inc. v. Eli Lilly & Co.*, 598 F.3d 1336, 1351 (Fed. Cir. 2010) (en banc).

The test for sufficiency of support is whether the disclosure of the application relied upon “reasonably conveys to the artisan that the inventor had possession at that time of the later claimed subject matter.” *Vas-Cath Inc. v. Mahurkar*, 935 F.2d 1555, 1563 (Fed. Cir. 1991). “One shows that one is ‘in possession’ of *the invention* by describing *the invention*, with all its claimed limitations.” *Lockwood v. Am. Airlines, Inc.*, 107 F.3d 1565, 1572 (Fed. Cir. 1997). In some instances, a patentee can rely on information that is well known in the art to satisfy the written description requirement. *Ariad Pharm.*, 598 F.3d at 1351 (“[T]he level of detail required to satisfy the written description requirement varies depending on the nature and scope of the claims and on the complexity and predictability of the relevant technology.”). “[T]he test requires an objective inquiry into the four corners of the specification from the perspective of a person of ordinary skill in the art. Based on that inquiry, the specification must describe an invention understandable to that skilled artisan and show that the inventor actually invented the invention claimed.” *Ariad Pharms.*, 598 F.3d at 1351.

Starting with what the Specification expressly discloses, we find that one of ordinary skill in the art would understand that the Specification discloses explicitly that pillars 104 are “typically nominally 5–200 microns in height, and nominally 5–500 microns in diameter.” Ex. 1001, 4:65–67; Ex. 1012 ¶¶ 93–96, 109; Ex. 2003 ¶¶ 30, 38; *see also* Pet. 18 (noting ranges for pillar diameter and spacing); Ex. 1001, 5:30–31 (describing pillars 104 that are “5 μ m in diameter and 40 μ m in height”); Ex. 1012 ¶ 63 (noting that the Specification of the ’728 patent and the parent applications are

substantially the same). The Specification also discloses that the “spacing between the pillars 104 (i.e. the gap) can be nominally 1–500 microns.”

Ex. 1001, 4:67–5:1; Ex. 1012 ¶¶ 93–96, 109; Ex. 2003 ¶¶ 30, 38.

We also find that one of ordinary skill in the art would understand that the Specification discloses that “dimensions of the pillars, e.g., height, diameter, and spacing (or gap), are controlled and optionally varied within the plurality of pillars within the TGP 100 in order to maximize TGP performance.” Ex. 1001, 5:1–5; *see also* Pet. 2 (arguing that the ’728 patent describes varying pillar diameter and spacing); PO Resp. 6–7 (arguing that dimensions can be varied to change TGP performance); Ex. 1012 ¶¶ 191–194 (testifying that MacDonald describes varying pillar spacing and other dimensions), 231 (testifying that MacDonald describes varying pitch); Ex. 2003 ¶¶ 27–29, 42, 44 (discussing the characteristics of a titanium TGP that can be varied or adjusted in the ’728 patent). For one embodiment, the Specification describes that “diameter 304, gap 306, and height 308 of the pillars 104, individually, locally, or collectively can be controlled and/or optionally varied within the structure 100 plurality of pillars to optimize the performance of the TGP 100.” Ex. 1001, 8:24–30, Fig. 4B (showing diameter “d,” spacing or gap “g,” and height “h”); Ex. 1012 ¶¶ 191–194, 231; Ex. 2003 ¶¶ 29, 32.

We further find that one of ordinary skill in the art would understand that the Specification discloses that “the dimensions can be designed such that viscous losses are minimized and capillary forces are maximized in order to improve TGP performance.” Ex. 1001, 5:5–7; *see also* Pet. 2; PO Resp. 6–7; Ex. 2003 ¶¶ 42, 45. The Specification describes that “large height and large spacing of the pillars 104 will reduce viscous losses” and

“smaller spacing of the pillars 104 will increase capillary forces.” Ex. 1001, 6:62–64; Ex. 2003 ¶ 72 (Prof. Wereley testifying “it is clear that the inventors of the ’728 Patent contemplated a very wide range of capillary pressures being part of their invention”).

Based on our determinations above, we find that the Specification would have conveyed to one of ordinary skill in the art that the pillars have a diameter, there is a spacing between adjacent pillars, and at least the diameter and spacing can be varied to minimize viscous losses and maximize capillary forces to maximize TGP performance. Ex. 1001, 4:65–5:1, 5:5–7, 6:62–64, 8:24–30, Fig. 4B; Ex. 2003 ¶¶ 43, 72.

As for the level of detail required to satisfy the written description requirement, there is no dispute that the Specification describes with sufficient detail at least a preferred embodiment of TGP 100 with substrate 102, pillars 104, wicking structure 105, and structural member 110. Pet. 1–3 (citing Ex. 1001, 2:6–9, 2:20–23, 2:28–43, 3:40–46, 4:36–42, 4:47–49, 4:65–5:5, 5:14–23, 5:28–35, 5:46–48, 8:24–30, Figs. 1, 4B); PO Resp. 6–8 (citing Ex. 1001, 4:65–5:5, 8:24–30, 8:31–34, 8:49–57, 10:67–11:4,); Ex. 1001, 4:47–50, 4:57, 5:14–17, 6:36–37, 8:52–53, Fig. 1; Ex. 1012 ¶¶ 55–57. As determined above, the Specification also describes varying the diameters of and the spacing between pillars 104, and therefore describes the recited “distance from a center of one microfabricated structure to a center of a next neighboring microfabricated structure” and the distance having several values. Ex. 1001, 4:65–5:7; *see also* Pet. 2 (arguing that the ’728 patent describes varying pillar diameter and spacing); PO Resp. 6–7 (arguing that dimensions can be varied); Ex. 1030 ¶ 67 (stating that persons

of ordinary skill in the art “might have used the term ‘pitch’ to refer to a center-to-center distance in other contexts”); Ex. 2003 ¶¶ 27–29, 42–44, 72.

There is no dispute that changing pillar diameters and spacings would have been well within ordinary skill in the art, as indicated by the Specification (Ex. 1001, 5:5–7, 6:62–64). *See generally* Pet.; PO Resp. There is also no dispute that these dimensions can be varied while avoiding dryout because doing so would have been within ordinary skill in the art, as also indicated by the Specification. Ex. 1001, 10:67–11:4 (“By varying the design parameters of the TGP 100, including pillar 104 diameter 304, height 308, and spacing 306, the dryout temperature and overall heat carrying capacity of the TGP 100 can be optimized for various applications.”).

Regarding whether the disclosure reasonably allows one of ordinary skill in the art to recognize that the inventors of the ’728 patent invented what is claimed, based on the above determinations, we find that the disclosure would allow the ordinarily skilled artisan to recognize that the inventors of the ’728 patent invented a “thermal ground plane, comprising: a wicking structure on a titanium substrate, the wicking structure comprising a plurality of microfabricated structures etched into the titanium substrate . . . ; a vapor cavity in communication with the wicking structure;” and the recited fluid, “wherein the microfabricated structures include an etched roughness in a range of 1–1000 nanometers that enhances wetting performance of the wicking structure.” Ex. 1001, 14:42–64; *see also id.* at 4:47–50, 4:57, 5:14–17, 6:36–37, 8:52–53, Fig. 1; Ex. 1012 ¶¶ 55–57.

For the limitations “wherein a pitch of the microfabricated structures is a distance from a center of one microfabricated structure to a center of a next neighboring microfabricated structure” and “the pitch of the

microfabricated structures in a range between 5–500 micrometers,” based on the Specification disclosing varying the dimensions of the pillar, we find that the disclosure would allow one of ordinary skill in the art to recognize that the inventors of the ’728 patent invented a TGP in which pillar diameter and spacing are varied to minimize viscous losses and maximize capillary forces to maximize TGP performance. Ex. 1001, 4:65–5:1, 5:5–7, 6:62–64, 8:24–30, Fig. 4B; Ex. 2003 ¶¶ 27–29, 42–44, 72; *see also* Pet. 2; PO Resp. 6–7. We also find that the disclosure would allow one of ordinary skill in the art to recognize that the inventors invented a TGP with pillars 104 “typically . . . nominally 5–500 microns in diameter” and the “spacing between the pillars 104 (i.e. the gap) . . . nominally 1–500 microns.” Ex. 1001, 4:65–5:1. Because the pillar diameters and spacings between pillars have ranges of values, we further find that the disclosure would allow one of ordinary skill in the art to recognize that the claimed “distance from a center of one microfabricated structure to a center of a next neighboring microfabricated structure” has a range of values. *See id.*; *see also* Pet. 18 (arguing that one of ordinary skill in the art could derive various pitch ranges); Ex. 1012 ¶¶ 97, 103–107; Ex. 2003 ¶¶ 27–29, 42–44, 72.

Petitioner acknowledges that the parent applications included claim 2 that recited “wherein a pillar in the plurality of pillars comprises dimensions between one micron and one millimeter.” Pet. 21–22; Ex. 1003, 37; Ex. 1004, 41; Ex. 1005, 14:22–24; Ex. 1012 ¶ 123; Ex. 2003 ¶ 31. Petitioner argues that, if the recited “dimension” refers to pillar diameter, adjacent pillars of 1-micron diameter and 1 micron spacing would provide a pitch of 2 microns, and adjacent pillars of 1 millimeter or 1000 microns in diameter with spacing of 500 microns would provide a pitch of 1500 microns,

resulting in a pitch range of 2–1500 microns. Pet. 22 (citing Ex. 1012 ¶¶ 126–129); Ex. 1012 ¶ 123 (“A millimeter is equivalent to 1000 microns.”), ¶¶ 126–129 (calculating pitch based on diameter range of 1–1000 microns).

We credit Prof. Wereley’s testimony that the recited “dimension” of claim 2 refers to, at least, pillar diameter because it is supported by the cited portions of the parent applications and prosecution history. Ex. 2003 ¶ 40 (calculating pitch range to be 2–2000 microns “from combining the lowest possible values for the pillar diameter and spacing”), ¶¶ 45–57 (citing Ex. 1003, 7; Ex. 1004, 69, 188, 249); *see also id.* ¶ 47 n.3 (stating that “[t]o the extent that pitch itself is not considered a dimension of the pillars, in contrast to the height and diameter of the pillars and the spacing (gap) between them, then the range for the pitch of the pillars based on original claim 2 would be 2–2000 microns”). Prof. Abraham’s testimony points to a single argument from the prosecution history of a parent application that does not clearly exclude diameter from being the recited “dimension,” and Prof. Abraham does not directly address the disclosure of the parent applications like Prof. Wereley. Ex. 1012 ¶¶ 123–125 (citing Ex. 1004, 179). As Prof. Abraham testifies, during the prosecution of the ’111 application, claim 2 was distinguished from a reference that did not have a diameter between 1 micron and 1 millimeter, which shows that “dimension” recited in claim 2 was understood to be, at least, diameter. *Id.* ¶ 124 (citing Ex. 1004, 179).

Petitioner also argues that the parent applications disclose pillar diameters of 5–500 microns and spacing of 1–500 microns. Pet. 20. According to Petitioner, using the end points of those ranges would lead to a

pitch range of 6–1000 microns. *Id.* (citing Ex. 1012 ¶¶ 108–112). Petitioner contends that a pitch range of 6–1000 microns would not allow one of ordinary skill in the art to discern immediately the claimed pitch range of 5–500 microns because the ranges are numerically and functionally different. *Id.* (citing Ex. 1012 ¶¶ 113–114). The same numerical and functional difference argument is implicitly asserted for all of Petitioner’s other derived pitch ranges from the provisional and parent applications’ disclosures. *See* Pet. 21–23.

Petitioner appears to be seeking verbatim support, when, as argued by Patent Owner, the Specification does not need to provide exact or verbatim support to meet the written description requirement. *See* Pet. 20; PO Resp. 32. One of ordinary skill in the art would have immediately discerned that 5–500 microns is well within 2–1500 microns calculated by Petitioner using the parent applications’ claim 2. *See* Pet. 21–22; PO Resp. 16–17; Ex. 2003 ¶ 47.

The numerical differences between the derived and claimed ranges do not address sufficiently why one of ordinary skill in the art would not discern the claimed range. *See* Pet. 20. As determined above, the disclosure would allow one of ordinary skill in the art to recognize that the claimed “distance from a center of one microfabricated structure to a center of a next neighboring microfabricated structure” has a range of values, such as the 2–1500 microns calculated by Petitioner. *See id.* at 22. The numerical differences between the calculated ranges and the claimed ranges alone fail to show that the ordinarily skilled artisan would not have discerned the claimed range of 5–500 microns from the range of 2–1500 microns.

Turning to the asserted functional difference between the derived and claimed ranges, Petitioner argues that “even a 1-micron pitch difference—whether produced by a difference in the pillars’ spacings, diameters, or both—would have altered some or all of the TGP’s capillary pressure, viscous losses, thermal transport, dryout temperature, and overall heat carrying capacity.” Pet. 20 (citing Ex. 1012 ¶¶ 114–119); *see also* Tr. 50:14–52:24 (discussing Petitioner’s functional differences argument).

Patent Owner, however, shows that differences in the TGP’s capillary pressure, viscous losses, thermal transport, dryout temperature, and overall heat carrying capacity are only differences of degree, not of type or kind. PO Resp. 30 (citing Ex. 2003 ¶¶ 72, 73), 32 (citing Ex. 2003 ¶ 78). We agree with Patent Owner that changes in the pitch affect capillary pressure and viscous losses but would not change how the claimed TGP functions and that the disclosed range in spacing between neighboring pillars “encompasses devices which can exhibit capillary pressures that differ by orders of magnitude,” specifically “a change in the capillary pressure of around 10,000%” for a decrease in spacing from 500 microns to 5 microns “but which nevertheless still operate in substantially the same way with the same general results.” PO Resp. 19, 20–22 (citing Ex. 1003, 19; Ex. 1004, 188, 249; Ex. 2003 ¶ 57); Ex. 2003 ¶¶ 53–55, 57. We, thus, agree that one of ordinary skill in the art “would not regard a [smaller] difference in capillary pressure as evidence that two devices are ‘functionally different’ from each other.” PO Resp. 22 (citing Ex. 2003 ¶ 57).

We credit Prof. Wereley’s testimony that changes in TGP performance characteristics are of degree, not of kind, because the full record supports it. Ex. 2003 ¶¶ 51–78 (citing Ex. 2005; Ex. 2006); *see also*

Tr. 53:21–54:5 (confirming that Prof. Abraham does not dispute what Prof. Wereley shows in his graphs). As set forth above, the '728 patent describes ranges for pillar diameter and spacing, which provide ranges for pitch, and the '728 patent expressly describes that “dimensions of the pillars, e.g., height, diameter, and spacing (or gap), are controlled and optionally varied within the plurality of pillars within the TGP 100 in order to maximize TGP performance.” Ex. 1001, 4:65–5:5. Prof. Abraham does not explain why changes in pillar diameter, spacing, or both would lead to functional differences when the exemplary differences in capillary pressure of 20% and viscous losses of 44% would be within the differences one of ordinary skill in the art would expect based on the Specification. Ex. 1012 ¶¶ 114–119; Ex. 2003 ¶¶ 51–78.

Petitioner does not dispute Prof. Wereley’s testimony regarding the changes in TGP performance characteristics but argues that the changes show that derived pitch ranges would not reasonably convey the claimed pitch range because of functional differences near the endpoints. Pet. Reply 14–19. Patent Owner, however, shows that the claimed pitch range includes “functional differences” of larger magnitude. PO Resp. 20–21; Ex. 2003 ¶¶ 53–55. Petitioner’s arguments about the threshold at which dryout occurs (Pet. Reply 17) are also insufficient to show a functional difference because, as determined above, the Specification indicates that avoiding dryout would have been within ordinary skill in the art (Ex. 1001, 10:67–11:4).

Furthermore, Petitioner’s arguments do not sufficiently address what one of ordinary skill in the art would have understood from the Specification’s use of “typically” and “nominally” in describing the ranges of pillar diameter and spacing. Ex. 1001, 4:65–5:1. Petitioner’s arguments

indicate that one of ordinary skill in the art would have read the ranges as if the words “typically” and “nominally” were not there and treated their endpoints as exact values. *See* Pet. 18–21 (calculating pitch values using only the exact values of the endpoints).

The full record does not support treating the endpoints as exact values. The provisional application and the parent applications indicate that, at least, the lower endpoint of the pillar diameter range is not an exact value. The provisional application describes that “pillars in the array 104 are typically 3 μm in diameter” and “are etched into titanium with a 4 micron pitch,” and the parent applications include a claim that recites “dimensions between one micron and one millimeter.” Ex. 1002, 7; Ex. 1003, 25; Ex. 1004, 41; Ex. 1012 ¶ 93 (discussing the 4-micron pitch), ¶¶ 135–138 (calculating pitch ranges with a 3-micron diameter). While Petitioner does address the provisional application’s 3-micron diameter and 4-micron pitch and the parent applications’ claim 2, Petitioner does not address sufficiently how these disclosures would affect the ordinarily skilled artisan’s understanding of the diameter and spacing ranges described as “typically” or “nominally.” Pet. 21–25; Ex. 1001, 4:65–5:1.

Petitioner’s declarant, Prof. Abraham, does not address explicitly “typically” or “nominally,” but Patent Owner’s declarant, Prof. Wereley, does provide testimony. Ex. 2003 ¶¶ 58 n.3, 63–66, 68–69; *see also* Tr. 9:13–24 (discussing whether Prof. Abraham addressed “nominally” in his testimony). We credit Prof. Wereley’s testimony regarding “nominally” because the record supports it. Ex. 1001, Fig. 4A; Ex. 1003, 4, 7, 10; Ex. 1004, 144, 184, 249, 289; Ex. 2003 ¶¶ 58 n.3, 63–66, 68–69; Ex. 2002, 155. Because the ’728 patent incorporates the provisional and parent

applications in their entirety, one of ordinary skill in the art would understand the endpoint of the ranges to be approximate values and that pillar diameter could be 1 micron or 3 microns. Ex. 1001, 4:65–5:1; Ex. 1002, 7; Ex. 1003, 25; Ex. 1004, 41; Ex. 2001 ¶¶ 58 n.3, 63–66, 68–69; *see also* Tr. 9:1–2 (Petitioner’s counsel indicating that “nominally” would have been understood to mean “approximately”).

Turning to Petitioner’s argument that guidance is required for subranges of pitch, as determined above, we find that the Specification itself in many places would convey to one of ordinary skill in the art to vary pillar diameter and spacing for optimum performance. Ex. 1001, 2:27–29, 7:19–22, 10:24–28, 10:67–11:4; Ex. 1012 ¶¶ 191–194; Ex. 2003 ¶¶ 27–29, 42–44, 72. We find that those disclosures would be sufficient guidance for any value of pitch in the claimed range.

To the extent that “blaze marks” are required for the recited pitch range of claims 1 and 9, we find that the expressly disclosed end points for the ranges for pillar diameter and spacing provide such “blaze marks.” Ex. 1001, 4:65–5:1; Ex. 1003, 37; Ex. 1004, 41; Ex. 1005, 14:22–24; Ex. 2003 ¶ 39. Because the values for pillar diameter and spacing are specifically identified to describe an acceptable range for the claimed TGP, we find that one of ordinary skill in the art would have started with those values, just as Petitioner did in making its arguments for both written description and anticipation. Pet. 18–25, 35–36. Both parties’ declarants (asserted to be ordinarily skilled artisans) also started with those endpoints. *See, e.g.*, Ex. 1012 ¶¶ 100, 111; Ex. 2001 ¶¶ 39–42. Both declarants also looked at claim 2 for a pitch range. Ex. 1012 ¶¶ 126–129; Ex. 2003 ¶¶ 38–40. The full record, thus, shows that one of ordinary skill in the art would

have used at least the endpoints for the ranges of pillar diameter and spacing as “blaze marks” to determine the claimed pitch.

For the reasons above and based on our factual findings from the Specification, Petitioner fails to show by a preponderance of the evidence that the pitch limitations lack written description support and that claims 1–13 of the ’728 patent are not entitled to the filing date of its earlier applications.

E. Asserted Anticipation by MacDonald

1. MacDonald (Ex. 1007)

MacDonald is the publication of the PCT application, and the ’728 patent issued from an application that is a continuation of the ’111 application that was filed as the PCT application. Ex. 1001, codes (22), (45), (63), 1:7–17; *see also* Pet. 16 (noting the same); PO Resp. 1 (noting the same).

Petitioner contends that MacDonald is prior art under § 102(a)(1) because MacDonald was published a year before the filing date of the application that issued as the ’728 patent. Pet. 7. If the ’728 patent is entitled to the benefit of the filing dates of the PCT and ’111 applications, then MacDonald would not qualify as prior art, as argued by Patent Owner. PO Resp. 2, 39.

2. Claims 1–13

Petitioner argues with citations to MacDonald and declarant testimony that, because MacDonald has the same figures and substantively same specification, MacDonald anticipates independent claims 1 and 9. Pet. 26–37, 53–58. In particular, for the claimed pitch range, Petitioner argues that, because MacDonald discloses pillar spacings between 1–500 microns and

pillar diameters between 5–500 microns, MacDonald discloses, at least, two pitches of 6 microns and 253.5 microns, both of which are in the claimed pitch range. *Id.* at 36 (citing Ex. 1012 ¶¶ 176–178). Petitioner determined a pitch of 6 microns based on adjacent pillars having diameters of 5 microns with a spacing of 1 micron between the pillars. *Id.* (citing Ex. 1012 ¶¶ 176–178). For the pitch of 253.5 microns, Petitioner used pillar diameters of 5 and 500 microns and spacing of 1 micron. *Id.* (citing Ex. 1012 ¶¶ 176–178). For dependent claims 2–8 and 10–13, Petitioner argues with citations to MacDonald and declarant testimony that MacDonald discloses all their limitations. *Id.* at 37–53, 58–62.

Based on the arguments summarized above, Patent Owner responds that MacDonald is not prior art under either pre-AIA § 102 or AIA § 102(a) to the '728 patent because the '728 patent is entitled to the benefit of the filing dates of both the PCT and the '111 applications. PO Resp. 39 (citing Pet. 4). Patent Owner, thus, argues that Petitioner fails to show that MacDonald anticipates the claims of the '728 patent. *Id.* at 40. No further arguments specifically for the anticipation challenge are presented in the replies. *See generally* Pet. Reply; PO Sur-reply.

For the reasons given above, we agree with Patent Owner that MacDonald is not prior art to the '728 patent. PO Resp. 39. Moreover, even if Petitioner could show that claims 1–13 lack written description support, Petitioner's arguments for its anticipation challenge would undermine its lack of written description arguments. *See* Pet. 35–36 (citing Ex. 1007, 2:24–26, 4:4–5, 6:11–13, 7:4–8, 7:17–19, 10:6–8; Ex. 1012 ¶¶ 173–178); *see also* Tr. 6:22–8:13, 16:10–18:14 (discussing the interaction of written description and anticipation arguments). Petitioner does not rely on express

disclosures to argue that MacDonald anticipates the claimed pitch range. *See* Pet. 35–36; *see also* Tr. 17:24–18:4 (Petitioner’s counsel confirming that an express disclosure of pitch in MacDonald is not relied on for the anticipation challenge).

Petitioner relies on one of ordinary skill in the art being able to calculate pitch from the end points of the pillar diameter range 5–500 microns and the low end of the spacing range 1–500 microns. Pet. 36 (citing Ex. 1007, 7:17–19; Ex. 1012 ¶¶ 176–178); *see also* Tr. 18:5–14 (Petitioner’s counsel confirming implicit disclosure is being used for the anticipation challenge). Petitioner argues, with respect to anticipation, that one of ordinary skill in the art would have applied the disclosed endpoints to the definition of pitch recited by claim 1. Pet. 35–36 (citing Ex. 1007, 2:24–26, 4:4–5, 6:11–13, 7:4–8, 7:17–19, 10:6–8; Ex. 1012 ¶¶ 173–178).

Petitioner’s analysis for implicit disclosure is substantially the same as Petitioner’s analysis for asserting insufficient written description support. *Compare* Pet. 17–23 (starting with end points of pillar diameter and spacing ranges to argue there is no exact overlap with the claimed pitch range), *with id.* at 35–36 (starting with end points of diameter and spacing ranges to calculate two values that would anticipate). Petitioner’s analysis for implicit disclosure supports that there is adequate written description support for the claimed pitch range because, according to Petitioner, one of ordinary skill in the art would have recognized “at least two pitches” by using the end points of the pillar diameter and spacing ranges. *Id.* at 36 (citing Ex. 1007, 7:17–19; Ex. 1012 ¶¶ 176–178).

There is no argument addressing what other values of pitch would be recognized. *See* Pet. 35–36. There is also no argument addressing why

recognizing at least two values of pitch is not sufficient for recognizing other values of pitch so that the claimed pitch range has written description support. *See id.* Petitioner’s analysis for implicit disclosure further indicates that the range end points are the guidance or blaze marks that Petitioner asserts are missing in its written description arguments. *See id.* at 16–26, 35–36.

Based on the above, Petitioner’s implicit disclosure argument undermines its lack of written description argument without an adequate explanation of why the disclosure of the parent applications fails to reasonably convey to one of ordinary skill in the art that the inventors had possession of the later claimed pitch range, even though, according to Petitioner, at least two values of pitch are implicitly disclosed in the same Specification. *See Pet.* 16–26, 35–36. Petitioner does not provide a cogent way to determine what implicit disclosure is sufficient for anticipation yet insufficient for written description. *See id.* Because Petitioner has the burden to prove unpatentability, this lack of a rational distinction between implicit disclosure sufficient for anticipation but insufficient for written description leads us to determine that Petitioner has not shown anticipation by a preponderance of the evidence.

Accordingly, based on the full record, Petitioner fails to show by a preponderance of the evidence that MacDonald anticipates claims 1–13.

F. Asserted Obviousness Over MacDonald and Ding

1. Ding (Ex. 1008)

Ding is an article regarding “innovative heat pipes based on Nano-Structured Titania (NST) with a potential for high heat carrying capacity and high thermal conductivity.” Ex. 1008, 1.

2. *Claims 2, 3, and 7*

Claims 2, 3, and 7 ultimately depend from claim 1. Ex. 1001, 14:65–15:5, 15:14–17. These claims require pitch in a hotter region to be smaller than the pitch in a colder region. *See id.*

Petitioner argues that “[i]f it is found that *MacDonald* does not teach smaller pillar spacings in the hotter region and larger spacings in the colder region, that feature would have been obvious over *MacDonald* in view of *Ding*.” Pet. 63 (citing Ex. 1008, 6; Ex. 1012 ¶¶ 305–309, 318, 319, 323–326, 329–331). Petitioner also provides arguments that one of ordinary skill in the art would have combined *MacDonald* and *Ding*. Pet. 63–64 (citing Ex. 1008, 6; Ex. 1012 ¶¶ 310, 311).

Patent Owner responds that “[b]ecause *MacDonald* does not qualify as prior art against the claims of the ‘728 Patent, Petitioner has failed to show that the challenged claims of the ‘728 Patent . . . would have been obvious over *MacDonald* in view of *Ding*.” PO Resp. 40. No reply arguments are presented specifically for the obviousness challenge. *See generally* Pet. Reply; PO Sur-reply.

For the reasons given above, we agree with Patent Owner that *MacDonald* is not prior art to the ‘728 patent. PO Resp. 39. Accordingly, based on the full record, Petitioner fails to show by a preponderance of the evidence that *MacDonald* and *Ding* would have rendered obvious claims 2, 3, and 7.

III. PATENT OWNER’S REVISED CONTINGENT MOTION TO AMEND

Patent Owner filed a Revised Contingent Motion to Amend. Paper
31. The motion states that

If . . . the Board determines that original claims 1–13 of the ’728 patent are unpatentable, Patent Owner respectfully requests the Board grant entry of substitute independent claim 27 for original independent claim 1, substitute independent claim 35 for original independent claim 9, substitute dependent claims 28–34 for original dependent claims 2–8, and substitute dependent claims 36–38 for original dependent claims 10–12.

Id. at 1.

For the reasons discussed above in Section II, we determine that Petitioner has not shown by a preponderance of the evidence that claims 1–13 are unpatentable. Therefore, we dismiss as moot the Revised Contingent Motion to Amend.

IV. CONCLUSION

In summary:

Claims	35 U.S.C. §	References/Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–13	102	MacDonald		1–13
2, 3, 7	103	MacDonald, Ding		2, 3, 7
Overall Outcome				1–13

Motion to Amend Outcome	Claims
Original Claims Cancelled by Amendment	
Substitute Claims Proposed in the Amendment	27–38
Substitute Claims: Motion to Amend Granted	
Substitute Claims: Motion to Amend Denied	
Substitute Claims: Not Reached	27–38

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1–13 of U.S. Patent No. 10,309,728 B2 have not been shown, by a preponderance of the evidence, to be unpatentable;

FURTHER ORDERED that we dismiss as moot Patent Owner’s Revised Contingent Motion to Amend; and

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

IPR2021-01189
Patent 10,309,728 B2

FOR PETITIONER:

Kevin K. McNish
McNISH PLLC
kkm-ptab@mcnishpllc.com

Kathryn Bi
DAVIS POLK & WARDWELL LLP
kathryn.bi@davispolk.com

FOR PATENT OWNER:

Donald R. McPhail
Christopher Ricciuti
OBLON, McCLELLAND, MAIER & NEUSTADT, LLP
cpdockemtmcphail@oblon.com
cpdocketricciuti@oblon.com

Stanislav Torgovitsky
DICKINSON WRIGHT PLLC
storgovitsky@dickinson-wright.com