UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,

Petitioner,

v.

SINGAPORE ASAHI CHEMICAL & SOLDER INDUSTRIES PTE LTD.,

Patent Owner.

Case No.: IPR2019-00377
Patent 6,176,947 B1

PATENT OWNER'S NOTICE OF APPEAL

Via PTAB E2E
Patent Trial and Appeal Board
U.S. Patent & Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Via Federal Express
Office of the General Counsel
U.S. Patent & Trademark Office
Madison Building East, 10B20
600 Dulany Street
Alexandria, VA 22313-1450

Via CM/ECF
United States Court of Appeals for the Federal Circuit

Pursuant to 35 U.S.C. § 141 and 37 C.F.R. § 90.2, Patent Owner Singapore Asahi Chemical & Solder Industries PTE Ltd. ("Asahi" or "Patent Owner") hereby provides notice that it appeals to the United States Court of Appeals for the Federal Circuit from the Final Written Decision entered by the Patent Trial and Appeal Board ("the Board") on May 27, 2020 (Paper 40) and from all underlying orders, decisions, rulings, and opinions adverse to them regarding U.S. Patent No. 6,176,947 ("the '947 patent") at issue in *Inter Partes* Review IPR2019-00377. A copy of the Final Written Decision is attached as Exhibit A.

In accordance with and for the purpose of providing the Director with the information requested pursuant to 37 C.F.R. § 90.2(a)(3)(ii), Patent Owner anticipates that the issues on appeal may include, but are not limited to, the

following, as well as any underlying findings, determinations, rulings, decisions, opinions, or other related issues:

1) Whether the Board erred in determining that Petitioner has shown by a preponderance of the evidence that claim 10 is unpatentable over Yamaguchi '874 under 35 U.S.C. § 102(b);

2) Whether the Board erred in determining that Petitioner has shown by a preponderance of the evidence that claim 10 is unpatentable over Lee under 35 U.S.C. § 102(b);

3) Whether the Board erred in determining that Petitioner has shown by a preponderance of the evidence that claim 10 is unpatentable over Yamaguchi '923 under 35 U.S.C. § 103(a);

4) Whether the Board erred in giving weight to non-expert attorney argument presented in Petitioner's Reply (Paper 28);

5) Whether the Board erred in denying Patent Owner's Motion to Exclude (Paper 33); and

6) Any and all explicit or implicit Board findings, determinations, judgments, or orders supporting or related to the above-identified issues or the Final Written Decision and decided adversely to Patent Owner in any order, decision, ruling, or opinion issued by the Board, including, without limitation, the Board's construction and application of the claim language, the Board's interpretation of the prior art and the '947 patent, and the Board's interpretation of expert evidence.

In accordance with 35 U.S.C. § 142, 37 C.F.R. § 90.2(a)(1), and 37 C.F.R. § 104.2, this Notice is being filed with the Director of the United States Patent and Trademark Office, and a copy of this Notice is being concurrently filed with the Patent Trial and Appeal Board. In addition, this Notice along with the required

fees are being filed with the Clerk's Office for the United States Court of Appeals for the Federal Circuit via CM/ECF.

Dated: July 23, 2020

Respectfully submitted,

/s/ Jude A. Fry

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6(e), the undersigned certifies that on July 23, 2020, a true and complete copy of the foregoing ***Patent Owner's Notice of Appeal*** was served via electronic mail (by consent) upon the following counsel for the Petitioner:

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The undersigned also certifies that in addition to being filed electronically with the Board through PTAB E2E, a true and complete copy of the foregoing ***Patent Owner's Notice of Appeal*** was served, pursuant to 37 C.F.R. § 104.2, by Federal Express on July 23, 2020 to the United States Patent and Trademark Office at the

following address: Office of the General Counsel, 10B20, Madison Building East, 600 Dulany Street, Alexandria, Virginia.

The undersigned further certifies that a true and complete copy of the foregoing ***Patent Owner's Notice of Appeal*** and the required fees are being filed via CM/ECF on July 23, 2020 with the United States Court of Appeals for the Federal Circuit.

Dated: July 23, 2020

/s/ Brendan J. Goodwine

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EXHIBIT A

Trials@uspto.gov
571.272.7822

Paper 40
Entered: May 27, 2020

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
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v.

SINGAPORE ASAHI CHEMICAL & SOLDER INDUSTRIES PTE LTD.,
Patent Owner.

IPR2019-00377
Patent 6,176,947 B1

Before CHRISTOPHER L. CRUMBLEY, J. JOHN LEE, and CHRISTOPHER C. KENNEDY, *Administrative Patent Judges*.

KENNEDY, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

ORDER
Denying Patent Owner's Motion to Exclude
37 C.F.R. § 42.64

I. INTRODUCTION

Petitioner Apple Inc. challenges the patentability of claim 10 of U.S. Patent No. 6,176,947 B1 (Ex. 1001, "the '947 patent"). We have jurisdiction under 35 U.S.C. § 6, and we issue this Final Written Decision under 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons below, we determine that Petitioner has proven by a preponderance of the evidence that claim 10 of the '947 patent is unpatentable.

A. PROCEDURAL HISTORY

Petitioner filed a Petition seeking *inter partes* review of claim 10 of the '947 patent. Paper 2 ("Pet."). Patent Owner filed a Preliminary Response. Paper 5. We instituted trial. Paper 10 ("DI" or "Institution Decision").

During trial, Patent Owner filed a Response (Paper 14, "PO Resp."), Petitioner filed a Reply (Paper 28), and Patent Owner filed a Sur-reply (Paper 32). Additionally, Petitioner filed a Motion for Additional Discovery (Paper 16), which Patent Owner opposed (Paper 21). We granted the motion (Paper 22). Patent Owner filed a Motion to Exclude Evidence (Paper 33), which Petitioner opposed (Paper 34).

Petitioner relies on the declaration testimony of John W. Morris, Jr., Sc.D. *See* Ex. 1004. Patent Owner relies on the declaration testimony of Ephraim Suhir, Ph.D. (Ex. 2012), and Jennie S. Hwang, Ph.D. (Ex. 2013).

Oral argument was held on February 28, 2020. The transcript of that argument was entered into the record. Paper 39 ("Hearing Tr.").

B. RELATED MATTERS

The parties identify the following related case: *Singapore Asahi Chem. & Solder Indus. v. Apple Inc.*, No. 1:18-cv-01662-DCN (N.D. Ohio). Pet. 3; Paper 4 (PO's Mandatory Notices), 1. In the Preliminary Response, Patent Owner stated that the case has been dismissed without prejudice, and that the district court "gave Patent Owner leave to re-open the action within 30 days of the conclusion of the *inter partes* review process." Paper 5, 22–23.

C. THE '947 PATENT

The '947 patent relates to lead-free solders. *E.g.*, Ex. 1001, code (54) (title), claim 10. The '947 patent discloses that, "due to lead toxicity and the control or prohibition of the use of lead on a global landscape[,] . . . many initiatives on a world-wide basis have been taken to find suitable lead-free alternatives" to commonly used Pb-Sn (lead-tin) solder alloys. *Id.* at 1:12–17. The '947 patent recognizes that "[a] number of lead-free solders have been proposed in the art," and the '947 patent describes several known lead-free solders, including, e.g., a particular solder alloy disclosed by U.S. Patent No. 5,520,752 (issued May 28, 1996) that comprises 86 to 97% Sn (tin), 0.3 to 4.5% Ag (silver), 0 to 9.3% Bi (bismuth), and 0 to 5% Cu (copper). *Compare id.* at 2:35–38 (known solder alloy), *with id.* at 8:18–20 (claim 10).

After describing certain prior art solder alloys, the '947 patent goes on to identify several "advantages of this invention," including "high-strength," "high fatigue resistance,"[1] a "moderate melting temperature range,"

[1] The parties agree that the terms "fatigue resistance" and "fatigue life" are interchangeable. *See* Hearing Tr. 7:22–8:4, 54:13–17.

desirable wettability characteristics, and "adapt[ability] to the established electronic manufacturing process and infrastructure." *Id.* at 2:58–3:10. The '947 patent then describes the effects of modifying the concentrations of various metals on the properties of the solder alloy. *Id.* at cols. 3–6. For example, the '947 patent discloses that "Cu and Ag combined in proper dosages not only increase the fatigue resistance but also lower the melting temperature." *Id.* at 3:62–64.

Of particular relevance to the alloy of claim 10 (the only claim challenged in the Petition), the '947 patent includes the following disclosures:

> The content of 2.5–3.5% Ag is critical for solder alloys in Sn/Cu/Ag/Bi system in contrast to 2.5–4.5% Ag for any other systems containing In. A content of Ag beyond 3.5 in Sn/Cu/Ag/Bi system induces alloy brittleness. For example, the fatigue life and plasticity of an alloy (93.3 Sn/0.5 Cu/3.1 Ag/3.1 Bi) at 3.1% Ag are about 152% and 138% higher than an alloy (90.5 Sn/1.7 Cu/4.7 Ag/3.1 Bi) at 4.7% Ag. The content of 2.5% Ag is a minimum to provide a superior fatigue resistance. Below 2.5%, the fatigue resistance is lowered. For example, the fatigue lives of alloys 93.3 Sn/0.5 Cu/3.1 Ag/3.1 Bi, and 92.2 Sn/1.5 Cu/3.2Ag/3.1 Bi and 91.5 Sn/2 Cu/3.4 Ag/3.1 Bi are about 538%, 366% and 281% higher than that of an alloy (93 Sn/2 Cu/2 Ag/3 Bi) at 2% Ag.
>
> * * *
>
> In another preferred embodiment of the invention, there is provided a solder alloy containing about 92% Sn, 2% Cu, 3% Ag and 3% Bi. The alloy has melting temperatures from about 209° C. to 212° C. The tensile strength and fatigue life of the alloy are 89 MPa and 8135 cycles, respectively. The fatigue life of this invention is 223% higher than that of 63 Sn 37 Pb, and the tensile strength is 189% higher than that of 63 Sn/37 Pb.

Id. at 5:22–34, 6:28–35.

The ’947 patent does not say anything about impurities that might be present in its alloys. *See generally* Ex. 1001. In describing preferred embodiments, the ’947 patent identifies the elements and weight percentages of the elements included in the alloy, but it does not describe impurities. *See, e.g.*, *id.* at 5:62–6:43.

D. CHALLENGED CLAIM

Claim 10, the only claim challenged in the Petition, is reproduced below (paragraph breaks added).

10. A lead-free solder alloy consisting essentially of
76% to 96% Sn,
0.2% to 2.5% Cu,
2.5% to 3.5% Ag, and
0.5% to 5.0% Bi.

E. PRIOR ART RELIED UPON

Petitioner relies on the following references, as well as the Declaration of John W. Morris, Jr., Sc.D. (Ex. 1004).

Reference	Title or Patent/Pub. No.	Date	Exhibit
Yamaguchi ’874	JPH08206874A	Aug. 13, 1996	1005, 1006 (English translation)
Lee	*Getting Ready for Lead-free Solders*, 9 Soldering & Surface Mount Tech. 65	1997	1007
Matsumoto	JPH08132277A	May 28, 1996	1010, 1011 (English translation)

Reference	Title or Patent/Pub. No.	Date	Exhibit
Yamaguchi '923	WO97/28923	Aug. 14, 1997	1023, 1024 (English translation)

F. INSTITUTED GROUNDS OF UNPATENTABILITY

We instituted *inter partes* review based on the following grounds of unpatentability asserted by Petitioner:

Claims Challenged	35 U.S.C. §[2]	References
10	102(b)	Yamaguchi '874
10	102(b)	Lee
10	103(a)	Lee
10	103(a)	Matsumoto
10	103(a)	Yamaguchi '923[3]

[2] The relevant section of the Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112–29, took effect on March 16, 2013. Because the application from which the '947 patent issued was filed before that date, the pre-AIA statutory framework applies.

[3] In addition to the certified translation of Yamaguchi '923, Petitioner includes EP 0 878 265 A1, published Aug. 14, 1997 (Ex. 1017), which Petitioner identifies as "the EP national phase application with an English translation of [Yamaguchi '923]." Pet. 54. Petitioner styles its challenge to claim 10 as being over "[Yamaguchi] '923/EP '265," and Petitioner's analysis includes parallel citations to Yamaguchi '923 and EP '265. *See id.* at 54–56. In the Institution Decision, we observed that "neither party identifies any material difference between Yamaguchi '923 and EP '265," and "we cite[d] only the certified translation of Yamaguchi '923 (Ex. 1024)" in the Institution Decision. DI at 5 n.2. Because neither party has objected to that, we do the same in this Decision.

II. DISCUSSION

A. LEVEL OF ORDINARY SKILL IN THE ART

The level of ordinary skill in the art is "a prism or lens" through which we view the prior art and the claimed invention. *Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). In the Institution Decision, we adopted Petitioner's formulation of the level of ordinary skill in the art:

> For purposes of institution, we find that a person of ordinary skill in the art would have had "an advanced degree, or equivalent (i.e., a Bachelor's degree and a number of years of experience), in the field of materials science, metallurgy, or a related technical subject," and "two to five years of experience in the development, analysis and/or advanced application of solder alloys."

DI 6–7 (quoting Pet. 5). We also observed that Petitioner's proposal is "supported by the prior art of record." *Id.* at 7.

Following institution, Patent Owner "agree[d] with the Board's determination," but, in addressing the level of ordinary skill in the art, Patent Owner argued that a person of ordinary skill would not have been able "to create or select the most suitable alloy for use in specific applications." *See* PO Resp. 13 (citing Pet. 5–6). We view Patent Owner's argument as directed to the merits of the proposed obviousness grounds, rather than as being directly relevant to defining the level of ordinary skill in the art. We address Patent Owner's contentions concerning the merits of the proposed grounds below. Given that there is not a material dispute concerning the level of ordinary skill adopted in the Institution Decision, and the evidence of record continues to support that definition after trial, we maintain that level of ordinary skill for purposes of this Final Written Decision.

B. CLAIM CONSTRUCTION

"In an *inter partes* review proceeding, a claim of a patent . . . shall be 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)." 37 C.F.R. § 42.100(b) (2018). That standard "includ[es] 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." *Id.*; *see also Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005).

We discuss two terms below. No other claim term needs to be expressly construed to reach a decision in this case. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (claim terms need only be construed "to the extent necessary to resolve the controversy"); *see also Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (applying *Vivid Techs.* in the context of an *inter partes* review).

1. "consisting essentially of"

Claim 10 recites, "[a] lead-free solder alloy *consisting essentially of*" certain ingredients. Ex. 1001, 8:18–20 (claim 10) (emphasis added). The parties agree that the commonly accepted meaning of the transitional phrase "consisting essentially of" applies in this case. *See* Pet. 6; PO Resp. 15. Both parties cite *PPG Industries v. Guardian Industries Corp.*, 156 F.3d 1351, 1354 (Fed. Cir. 1998), as providing the accepted meaning of the phrase. *See* Pet. 6; PO Resp. 15. *PPG Industries* states: "By using the term 'consisting essentially of,' the drafter signals that the invention necessarily includes the listed ingredients and is open to unlisted ingredients that do not

materially affect the basic and novel properties of the invention." 156 F.3d at 1354. Consistent with *PPG Industries* and the position of the parties, we interpret the transitional phrase "consisting essentially of" to permit a composition within the scope of claim 10 to include only (1) "listed ingredients," and (2) "unlisted ingredients that do not materially affect the basic and novel properties of the invention."[4]

Patent Owner also argues that "the 'novel and basic properties' of the claim 10 invention includes at least fatigue resistance," and, therefore, that the phrase "consisting essentially of" in claim 10 "would be understood by one of ordinary skill in the art . . . to include only the listed elements and unlisted elements that do not materially affect at least the composition's fatigue resistance." PO Resp. 16. To the extent necessary, we address that argument below in our discussion of the proposed grounds of unpatentability. Our findings and conclusions in this case would be the same regardless of whether we expressly identify fatigue resistance as a basic and novel property of the invention as part of our construction of the term "consisting essentially of."

2. "lead-free solder alloy"

In the Petition, Petitioner does not expressly propose a construction for the term "lead-free solder alloy." In Patent Owner's Response, Patent Owner asserts that a lead-free solder alloy is a metal alloy (1) "with a melting temperature that is below 427 °C (800.6 °F) that wets and bonds to

[4] This construction is consistent with our approach to this term in the Institution Decision. *See* DI 7–8.

other metals," and (2) that "does not contain intentionally added lead element." PO Resp. 14.

In the Reply Brief, Petitioner does not dispute that a lead-free solder alloy "does not contain intentionally added lead element." Reply Br. 2. Petitioner argues, however, that claim 10 "lacks any temperature limitation," and that "importing one into the meaning of the alloy term would be inappropriate," particularly given that other claims of the '947 patent expressly specify melting temperature requirements. *See id.*

In the Sur-reply, Patent Owner responds that a person of ordinary skill would have understood a solder alloy to be "solderable, i.e., having a melting temperature of less than 427°C," because "[t]his was the ordinary and customary meaning of the term 'solder alloy' at the time." Sur-reply 3.

We agree with Petitioner that claim 10 does not require a melting temperature below 427°C. The intrinsic record, including the claims themselves, supports Petitioner's position. *See Phillips v. AWH Corp.*, 415 F.3d 1303, 1314, 1317 (Fed. Cir. 2005) (explaining that "the claims themselves provide substantial guidance as to the meaning of particular claim terms" and that the Federal Circuit has "emphasized the importance of intrinsic evidence in claim construction"). Patent Owner does not identify any disclosure of a temperature of 427°C in the '947 patent, *see* PO Resp. 14, and, based on our review, the '947 patent does not mention a temperature of 427°C in any context, much less does it indicate that the term "solder alloy" is limited to compositions having a melting point below that temperature, *see generally* Ex. 1001.

Moreover, as Petitioner points out, *see* Reply 2, certain claims of the '947 patent are similar to claim 10 except that they expressly recite a

required melting temperature for the composition, while claim 10 says nothing about melting temperature. *See* Ex. 1001, 7:11–15 (claim 1), 8:10–13 (claim 8). That indicates that claim 10 should not be interpreted as including a melting temperature requirement. *Cf. Phillips*, 415 F.3d at 1314 ("Differences among claims can also be a useful guide in understanding the meaning of particular claim terms.").

Patent Owner cites only extrinsic evidence—Exhibit 2014—in support of its position concerning melting temperature. *See* PO Resp. 14. Extrinsic evidence is "less significant" than the intrinsic record. *See Phillips*, 415 F.3d at 1317. Exhibit 2014 is a 22-page document, and Patent Owner's citation does not include a page number or any other specific identification of the allegedly relevant portion of the document. *See* PO Resp. 14. We observe that Exhibit 2014 defines a "solder" as "[a] metal alloy having a liquidus melting point below 500°C (932°F)," Ex. 2014, 8,[5] but we do not immediately discern a relevant discussion of 427°C. We also observe that, according to its title, Exhibit 2014 concerns "electronic grade solder alloys and fluxed and non-fluxed solid solders for electronic solder applications." *See* Ex. 2014. Patent Owner does not argue that claim 10 is limited to electronic-grade alloys. *See* PO Resp. 14. Claim 10 broadly recites "[a] lead-free solder alloy" and says nothing about any particular application. Ex. 1001, 8:18–20. Even were Exhibit 2014 to support Patent Owner's contention that some solder alloys preferably have a melting

[5] Unless otherwise apparent (e.g., citations to columns and line numbers), pinpoint citations to exhibits are to the stamp added to the lower right corner of each page by the parties.

temperature below 427°C, Patent Owner does not explain why claim 10 is so limited.

On the record before us, we discern no persuasive reason to limit the claim in the way that Patent Owner proposes. We determine that claim 10 is not limited to compositions "with a melting temperature that is below 427° C." *See* PO Resp. 14. Beyond that determination, we need not expressly construe the term "lead-free solder alloy" to reach a decision in this case.

C. ANTICIPATION OF CLAIM 10 BY YAMAGUCHI '874

Petitioner asserts that claim 10 is anticipated by Yamaguchi '874. Pet. 34–38. For reasons set forth below, we determine that Petitioner's arguments and evidence establish by a preponderance of the evidence that Yamaguchi '874 anticipates claim 10.

1. Yamaguchi '874 (Ex. 1006)

Similar to the '947 patent, *see* Ex. 1001, 1:12–15, Yamaguchi '874 discloses that, due to environmental and toxicity concerns, "there has been a need to develop a solder material that does not contain lead (i.e., leadless solder) but can still be used as a substitute for a solder containing lead." Ex. 1006 ¶ 3. Consistent with that disclosure, a purpose of Yamaguchi '874 is "[t]o provide a lead-free solder material that offers superior mechanical strength and wettability while allowing the melting point of the solder to be

lowered to the extent that allows the assembly of electronic components." Ex. 1006, code (57) (Abstract).

Yamaguchi '874 provides a table of "working example[s]" "according to the present invention," which is reproduced below and annotated by the Board to include a dashed box around Example 7.

[Table 1]

		Percent composition (wt%)								Melting point (°C)	Tensile strength (Kgf/mm²)	Wett-ability
		Sn	Ag	Sb	Bi	In	Zn	Cu	Pb			
Working example	1	Rest	3.5		3					214	7.43	△
	2	Rest	3.5		20					187	9.02	○
	3	Rest	3.5			3				214	6.00	□
	4	Rest	3.5			10				200	5.90	□
	5	Rest	6		10	7				198	9.03	□
	6	Rest	3.5		3		1	0.7		210	11.8	□
	7	Rest	3		3			0.5		211	8.40	△
	8	Rest		5	10					212	6.18	△
	9	Rest		5		10				214	5.36	
Comparative example	1	Rest	3.5							221	6.26	□
	2	Rest		5						240	6.27	△
	3	Rest							37	183	5.41	○

Yamaguchi ¶ 27 (Table 1). Annotated Table 1 shows several working examples of lead-free solder alloys. *Id.* In particular, Example 7 consists of 3% Ag, 3% Bi, 0.5% Cu, and "rest" Sn. *Id.*

2. Analysis

Anticipation under § 102 requires "the presence in a single prior art disclosure of all elements of a claimed invention arranged as in the claim." *Therasense, Inc. v. Becton, Dickinson & Co.*, 593 F.3d 1325, 1332 (Fed. Cir. 2010) (internal quotation marks and citation omitted). "As long as the reference discloses all of the claim limitations and enables the subject matter that falls within the scope of the claims at issue, the reference anticipates—no actual creation or reduction to practice is required." *In re Gleave*, 560 F.3d 1331, 1334 (Fed. Cir. 2009) (internal quotation marks omitted). To be

anticipating, "a prior art reference must . . . describe the claimed invention sufficiently to have placed it in possession of a person of ordinary skill in the field of the invention." *Helifix Ltd. v. Blok-Lok, Ltd.*, 208 F.3d 1339, 1346 (Fed. Cir. 2000) (internal quotations and alterations omitted).

In evaluating whether a prior art reference anticipates under § 102, the reference "must be considered together with the knowledge of one of ordinary skill in the pertinent art." *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994) (internal quotation marks omitted). A prior art patent document is presumed to be enabling. *See, e.g.*, *In re Antor Media Corp.*, 689 F.3d 1282, 1287–88 (Fed. Cir. 2012).

Petitioner provides the following table showing the correspondence of Example 7 to claim 10 (Petitioner's table refers to Yamaguchi '874 as "JP '874").

	Sn	Cu	Ag	Bi
US '947, Claim 10	76 – 96	0.2 – 2.5	2.5 – 3.5	0.5 – 5.0
JP '874, Example 7	93.5	0.5	3	3

Pet. 38. The table above shows the correspondence of Example 7 to claim 10. Petitioner asserts that "[a] POSITA would understand, based on the disclosure in Table 1, that Example 7 is a lead-free alloy including only the elements listed in the table and elements that do not materially affect the properties of the composition." *Id.* at 37 (citing Ex. 1004 (Morris Decl.) ¶ 123). Petitioner states that "[w]hile Table 1 discloses 'Rest' for Sn, a POSITA would understand that the Sn in Example 7 would be the percent by weight remaining from 100% after subtracting the 0.5, 3, and 3 weight

percent take by the other three elements." *Id.* at 38 (citing Ex. 1004 ¶ 118). According to Petitioner, "each element in example 7 of [Yamaguchi '874] falls squarely within the claimed ranges, 'disclosing a point within [those] claimed range[s]' and therefore anticipat[es] claim 10." Pet. 38 (alterations in original).

Consistent with Petitioner's arguments and evidence, it is clear from the tables reproduced above that Example 7 includes each of the four elements required by claim 10—Sn, Cu, Ag, and Bi. *Compare* Ex. 1006, 7 (Table 1), *with* Ex. 1001, 8:18–20 (claim 10). It is also clear that Example 7 includes those ingredients in amounts that fall squarely within the scope of the ranges recited by claim 10,[6] and that Yamaguchi '874 provides no indication that any other ingredients are present in any amount, much less present in an amount that would materially affect any property of the alloy. *Compare* Ex. 1006, 7 (Table 1), *with* Ex. 1001, 8:18–20 (claim 10). Moreover, Yamaguchi '874 describes the compositions of the examples of Table 1, including Example 7, as "solder material," and it discloses that the melting point of Example 7 is 211°C, which Patent Owner concedes is a temperature suitable for soldering. Ex. 1006 ¶¶ 26, 27 (Table 1); PO Resp. 14. Yamaguchi '874 states that its "purpose" is "[t]o provide a lead-free solder material that offers superior mechanical strength and wettability

[6] Other than arguments discussed below concerning impurities that "could" be present in Example 7, Hearing Tr. 43:15–18, Patent Owner does not dispute Petitioner's assertion that "[w]hile Table 1 [of Yamaguchi '874] discloses 'Rest' for Sn, a POSITA would understand that the Sn in Example 7 would be the percent by weight remaining from 100% after subtracting the 0.5, 3, and 3 weight percent take by the other three elements," i.e., 93.5 wt%. *Id.* at 38 (citing Ex. 1004 ¶ 118).

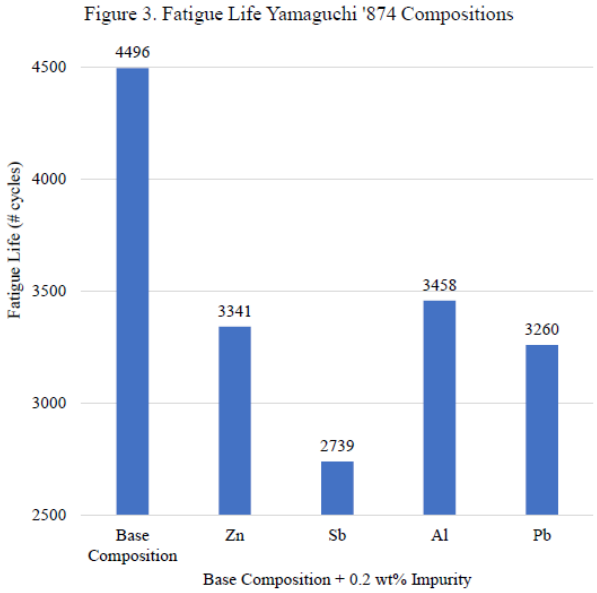
while allowing the melting point of the solder to be lowered to the extent that allows the assembly of electronic components." *Id.* at code (57) (abstract). Patent Owner does not contend that the composition of Example 7 falls beyond the scope of the term "lead-free solder alloy" as recited by claim 10. *See generally* PO Resp.

Patent Owner acknowledges that, during prosecution of the parent application of the application that led to the '947 patent, the applicant recognized that "what was literally disclosed by Yamaguchi '874" does not include any "statement that impurities could be present." *See* PO Resp. 21–22. Nevertheless, Patent Owner asserts that a person of ordinary skill in the art would have believed that the composition of Example 7 "could" (Hearing Tr. 43:15–18) have such a significant quantity and quality of impurities so as to cause Example 7's fatigue resistance to be materially different from that of the composition of claim 10. PO Resp. 17–26. According to Patent Owner, that is so because Yamaguchi '874 is concerned with tensile strength and melting point, but "does not contemplate fatigue resistance as a property of its solder alloys." PO Resp. 18, 19, 23; *see also* Hearing Tr. 36:16–20 (Counsel for PO: "I don't think you can make the conclusion [that Yamaguchi '874 does not include impurities that materially affect its properties], and the reason I say that is because Yamaguchi 874 says nothing about fatigue resistance.").

For reasons explained in detail below, Patent Owner's arguments are not persuasive, and we determine that a preponderance of the evidence establishes that Example 7 anticipates claim 10. Although the parties agree that a person of ordinary skill would have known that at least some trace impurities necessarily would be present in every solder alloy, *see* Reply 5

("some impurities were unavoidable"); PO Resp. 19 ("impurities are inherent in solder alloys"), the evidence of record does not support Patent Owner's contentions regarding the amount of impurities that would have been present; nor does it support Patent Owner's contention that the fatigue life of Example 7 is materially different from that of compositions falling within the scope of claim 10, even if we assume that Example 7 includes the amount of impurities asserted by Patent Owner.

To support its position concerning impurities, Patent Owner relies on a "Joint Industry Standard" document showing the following maximum allowable impurities in certain solder alloys: Zn 0.003, Al 0.005, Pb 0.2. PO Resp. 20 (citing Ex. 2014, 8). Patent Owner alleges that, because "Yamaguchi '874 itself does not contemplate fatigue resistance as a property of its solder alloys," "Petitioner cannot read into Yamaguchi '874 a teaching to exclude impurities that would have affected this unrecognized property." *Id.* at 23. In view of that, Patent Owner assumes that Example 7 "could" include 0.2 wt% of impurities such as Sb, Zn, Al, or Pb, and Patent Owner provides test data showing the effect of affirmatively adding those impurities on the fatigue life of Example 7. *Id.* at 23–24; Hearing Tr. 43:15–18. Patent Owner's data is reproduced below.



PO Resp. 24. Patent Owner's data shows the fatigue lives of five compositions tested by Patent Owner: (1) a "Base Composition" that "Singapore Asahi employees made . . . according to example 7 of Yamaguchi ['874]," Ex. 1051 (Hwang Tr.), 106:17–21, and (2) four compositions corresponding to Example 7 but with 0.2 wt% of Zn, Sb, Al, and Pb purposefully added, *id.* at 99:23–100:2. Patent Owner asserts that the fatigue lives of the impurity-containing compositions (which are 25–39% lower than the "base composition") are materially different from the "base composition" such that the impurity-containing compositions do not "consist essentially of" the four ingredients recited by claim 10. PO Resp. 24–26.

We agree with Petitioner that it is not reasonable to assume that Example 7 inherently would include any impurity in an amount that would materially affect any of Example 7's properties. *See* Reply 6–7; Hearing Tr. 43:5–8. As noted above, Yamaguchi '874 does not indicate the presence of any amount of any impurity in Example 7. Ex. 1006 ¶ 27 (Table 1). Because of that, Dr. Morris asserts that a person of ordinary skill in the art would have understood that Example 7 includes "only the elements listed in

[the example] and elements that do not materially affect the properties of the composition." Ex. 1004 ¶ 123. We credit Dr. Morris's testimony because we find the record as a whole to be more consistent with Petitioner's position than with Patent Owner's position, for reasons explained in detail below.

First, Patent Owner's premise for adding 0.2 wt% of certain impurities to Example 7 for purposes of obtaining the experimental results described above is that "Yamaguchi '874 itself does not contemplate fatigue resistance as a property of its solder alloys." PO Resp. 23; *see also, e.g.*, Hearing Tr. 36:16–20 (Counsel for PO: "I don't think you can make the conclusion [that Yamaguchi '874 does not include impurities that materially affect its properties], and the reason I say that is because Yamaguchi 874 says nothing about fatigue resistance."). Patent Owner acknowledged at oral argument that, if Yamaguchi '874 *did* discuss fatigue resistance, Patent Owner's arguments concerning impurities would be less persuasive. Hearing Tr. 52:6–9 (The Board: "If Yamaguchi did say something about fatigue, would that change the outcome of this ground?" Counsel for PO: "I think it would. I think it might . . . .").

Petitioner persuasively argues that, before the filing date of Yamaguchi '874, fatigue resistance was a known "material property" of lead-free solder alloys used in electronics applications. Reply 6. Petitioner cites the foreword to a volume of the Journal of Electronics Materials, which states that "[s]oldering technology is indispensable for the interconnection and packaging of essentially all electronics devices." Ex. 1028. The foreword goes on to state that "the required material properties" of a tin-based lead-free solder alloy are "melting temperature, solder wetting,

mechanical ductility, *fatigue*, and creep behavior, etc." *Id.* (emphasis added). Other evidence of record is consistent with that. *See, e.g.*, Ex. 1007, 4 (recognizing fatigue resistance as property that is "considered essential" in lead-free solders for electronic assembly use); Ex. 1020, 3 ("Critical to the reliability of electronic circuits is thermal fatigue resistance."); Ex. 1024, 5 (identifying "resistance to thermal fatigue" as a desirable property in lead-free solder alloys); *see also* Ex. 1004 (Morris Decl.) ¶ 73 ("It was understood that any replacement lead-free solder alloy would have to match the reliability and manufacturability of lead-based solders, addressing issues such as thermal fatigue resistance and wettability.").

We find that fatigue resistance was a known desirable property of lead-free solder alloys at the time of Yamaguchi '874 (and at the time of the invention), and, therefore, that a reference's failure to expressly mention fatigue resistance does not indicate that compositions of the reference would have included impurities that materially affect fatigue life. *See* Ex. 1004 ¶ 73; Ex. 1028; Ex. 1007, 4; Ex. 1020, 3; Ex. 1024, 5; *see also Paulsen*, 30 F.3d at 1480 (anticipatory reference "must be considered together with the knowledge of one of ordinary skill in the pertinent art"). Accordingly, we reject Patent Owner's premise for assuming that a person of ordinary skill would have understood that Example 7 implicitly includes impurities that materially affect fatigue resistance.

Second, we consider the specific impurities and quantities that Patent Owner adds to Example 7 to produce the fatigue life data reproduced above. As to Zn, Patent Owner's own submission shows a maximum allowable amount of 0.003 wt%, which is significantly less than the 0.2 wt% used in Patent Owner's tests. *See* PO Resp. 20. Similarly, Patent Owner's own

submission shows a maximum allowable amount of Al of 0.005 wt%—again, significantly less than the 0.2 wt% used by Patent Owner. *See id.* It is unclear why Patent Owner used 0.2 wt% in its tests of those impurities. *See, e.g.*, Reply 7.

As to Sb, Patent Owner cites a portion of Exhibit 2014 indicating allowable levels of up to 0.5 wt% in certain types of alloys ("A" alloys[7]), *id.* at 21 (citing Ex. 2014, 8 (§ 3.2.1)), but Petitioner cites a different portion of the same document indicating allowable levels of only 0.05 wt% for a different type of alloy ("C" alloys"), Reply 7 (citing Ex. 2014, 8 (§ 3.2.3)). As to lead, Patent Owner relies on a disclosure in Exhibit 2014 indicating an allowable amount of up to 0.2 wt% for some types of alloys, PO Resp. 20 (citing Ex. 2014, 8), while Petitioner relies on a different disclosure in the same document of allowable amounts of only 0.1 wt% in other types of alloys ("E" alloys), Reply 7 (citing Ex. 2014, 8 (§ 3.2.5)).

Patent Owner's use of 0.2 wt% for each of the impurities tested is unreasonable because it assumes, based on a premise that is inconsistent with the record (i.e., that a person of ordinary skill in the art reviewing Yamaguchi '874 would not have been aware of the importance of fatigue resistance), that Example 7 of Yamaguchi '874 would have had impurity levels approaching or exceeding the maximum amounts listed by the Joint Industry Standard, notwithstanding the facts that (1) Yamaguchi '874 does not indicate the presence of any amount of any impurity, and (2) the Joint

[7] The letter-based alloy designations such as "A" are for "convenience" in facilitating ordering from a supplier. Ex. 1051 (Hwang Tr.), 95:9–97:7; *see also* Ex. 2014, 6 ("Each alloy is identified by an alloy name . . . ending with an arbitrarily assigned alloy variation letter (A, B, C, D, E).").

Industry Standard indicates that alloys with far smaller quantities of impurities were available. *E.g.*, Ex. 2014, 9 (§ 3.2.4) (describing "ultra-pure alloys" with a "combined total percentage by mass of all impurity elements" that "shall not exceed 0.05"). We discern no persuasive support for Patent Owner's assumption. Given that Table 1 of Yamaguchi '874 shows no elements other than Sn, Cu, Ag, and Bi for Example 7, the most reasonable interpretation is that a person of ordinary skill in the art reviewing Yamaguchi '874 would have envisaged an alloy that does not include impurities that materially affect properties known to be important to its function, such as fatigue life; not an alloy that includes impurity levels that approach or exceed the maximum amount permitted by the Joint Industry Standard. *See* Ex. 1004 (Morris Decl.) ¶ 123. That understanding is consistent with the applicant's argument during prosecution that Yamaguchi '874 "does not include a statement that impurities could be present." Ex. 1002, 80–81. Moreover, Yamaguchi '874 repeatedly identifies ingredients present in as small an amount as 0.1 wt%. *See, e.g.*, Ex. 1006, code (57) (abstract), 3 (claims), 5, 6, 7. It is unlikely that Yamaguchi '874 would affirmatively identify ingredients present at 0.1 wt% but not acknowledge the impurities relied on by Patent Owner allegedly present at 0.2 wt%. *Cf.* Ex. 1004 (Morris Decl.) ¶ 123.

Additionally, the record supports Petitioner's contention that "the state of the art in 1998 allowed for fairly reliable control of the presence of impurities in solder." Reply 5. A reference titled "SMT Soldering Handbook" discusses "solder impurities" and states, "[p]rovided the vendor is experienced and reliable . . . *the purity of the solder can be taken as granted*, given the present state of the art." Ex. 1052 ("Handbook"), 49

(emphasis added). The Handbook expressly references the Joint Industry Standard relied on by Patent Owner and states that "the purity of the solder supplied by the experienced and reliable vendors mentioned above does indeed keep well within these strict limits." *Id.* The Handbook goes on to provide a table setting forth some of the limits set forth by the Joint Industry Standard, and a second table showing that "[i]mpurity limits according to actual practice" are lower than the permissible maximums. *Id.* at 50.

Patent Owner argues that the Handbook's "tolerance levels relate specifically to wavesoldering, of which Yamaguchi '874 makes no mention." Sur-reply 6–7. The relevant portion of the Handbook, however, also contemplates "general soldering practice," and Patent Owner does not persuasively argue that results for wavesoldering would have been materially different from those of "general soldering practice" in any relevant respect. *See* Ex. 1052, 49 ("general soldering practice, but particularly wavesoldering practice, shows that with some of these impurities . . . limits tolerable in practical production are lower than those allowed in some standards . . . .").

Patent Owner also correctly points out that the tables in the Handbook do not list lead (Pb) (Sur-reply 7), but the trend suggested by the Handbook is that the impurities "according to actual practice" are lower than the limits of the Joint Industry Standard. *See id.* Moreover, we observe that, like the '947 patent, Yamaguchi '874 is explicitly concerned with "provid[ing] a *lead-free* solder material," Ex. 1006, code (57) (emphasis added), and we discern no persuasive evidence of record that the compositions of Yamaguchi '874 would have included the maximum permissible amount of an element (lead) that Yamaguchi '874 seeks to exclude, particularly given

that, as noted above, Yamaguchi '874 repeatedly identifies ingredients present in as small an amount as 0.1 wt% but says nothing about lead being present in that amount (or any amount) in Example 7. *See* Ex. 1006 ¶ 27 (Table 1).

Third, we observe that Yamaguchi '874's discussion of allowable impurities is the same as that of the '947 patent—neither says anything about impurities. *See generally* Ex. 1001; Ex. 1006; *see also* Reply 4 ("Like the '947 patent, Yamaguchi '874 does not mention impurities."); *cf. In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994) ("[T]he Board's observation that appellant did not provide the type of detail in his specification that he now argues is necessary in prior art references supports the Board's finding that one skilled in the art would have known how to implement the features of the references and would have concluded that the reference disclosures would have been enabling."). Although Yamaguchi '874 does not specifically mention fatigue life, it was a known desirable property in lead-free solders, *see, e.g.*, Ex. 1028; Ex. 1007, 4; Ex. 1024, 5; Ex. 1004 ¶ 73, and Yamaguchi '874 expressly discloses other properties (strength, wettability, desirable melting temperature, Ex. 1006, code (57)) and purposes (electronic components, *id.* ¶ 2) substantially the same as those disclosed by the '947 patent, *see* Ex. 1001, code (57) ("high strength" and "high wetting" with desirable melting temperature), 1:5–11 (disclosing "microelectronics and electronics applications"); *see also* Ex. 1004 (Morris Decl.) ¶¶ 89–90 (observing that the alloy of Yamaguchi '874 is for use in the electronics industry and is described as having superior mechanical strength, desirable melting points, and appropriate wettability).

Given the similarity of the disclosures in material respects, the most reasonable understanding of the evidence of record is that Example 7 of Yamaguchi '874 would have had an impurity profile similar to that which would have been expected to be present in the compositions of the '947 patent, and, thus, that the compositions of Yamaguchi '874 would not have had materially different properties—including fatigue resistance—due to alleged impurities. *Cf.* Ex. 1004 (Morris Decl.) ¶ 123.

Fourth, Patent Owner's test data and Dr. Hwang's deposition testimony support a determination that a person of ordinary skill in the art would not have understood Example 7 to include such a significant level of impurities so as to materially affect its properties. *See* Reply 3–7. During her deposition, Dr. Hwang repeatedly described the "Base Composition" of Patent Owner's Figure 3, *see* PO Resp. 24, as the composition of Example 7 of Yamaguchi '874. *See* Ex. 1051 at 103:18–20, 104:19–20, 106:17–21. When asked whether the "base composition" in Patent Owner's data was "made . . . according to example 7 of Yamaguchi," Dr. Hwang replied, "Correct." *Id.* at 106:17–21. Dr. Hwang did not identify particular steps taken to remove impurities from the "base composition" and acknowledges that it possessed the typical impurities of "a starting material." *Id.* at 104:24–105:2. Nor did Dr. Hwang indicate that unique "starting materials" were used, *see generally id.* at 103–107, or that the "starting materials" used in the tests were of higher purity than what would have been used in electronics soldering applications at the time of the invention, *see generally id.*; *see also* Ex. 1052 at 49 ("Provided the vendor is experienced and reliable . . . the purity of the solder can be taken as granted, given the present state of the art."). Only by affirmatively and purposefully adding impurities

to what appear to be routine starting materials did Patent Owner obtain test results showing decreased fatigue life. *See* PO Resp. 24; Ex. 1051 at 99:23–100:2.[8]

Considering the record as a whole, we are not persuaded that impurities allegedly present in Example 7 of Yamaguchi '874 would cause that composition to fall beyond the scope of claim 10. Patent Owner does not contend that Yamaguchi '874 fails to enable making and using high purity alloys in which impurities do not materially affect any property of the alloy. *Cf.* Ex. 2014 at 9 (§ 3.2.4) (describing "ultra-pure alloys" that have a "combined total percentage by mass of all impurity elements" of 0.05 or less); *cf. also Antor Media*, 689 F.3d at 1287–88 (prior art patent documents presumed to be enabling). We find that Petitioner's arguments and evidence establish that Yamaguchi '874's Example 7 anticipates claim 10. *See Helifix*, 208 F.3d at 1346.

[8] Patent Owner also argues, without citation, that because a comparative example in Table 1 of Yamaguchi '874 includes lead, Yamaguchi '874 was not using a lead-free environment, and "it is very likely that the 'lead-free' solder alloys tested in Yamaguchi '874 included trace amounts of lead that would have materially affected the fatigue resistance of the compositions." PO Resp. 26. We discern no persuasive reason to believe that the inclusion of a comparative example that includes lead indicates that Example 7 would have included 0.2 wt% lead, particularly given Yamaguchi '874's expressly stated goal of "provid[ing] a *lead-free* solder material." Ex. 1006, code (57) (abstract) (emphasis added). Example 7 includes a column for lead (Pb), and it is blank. *See* Ex. 1006 ¶ 27 (Table 1). That disclosure is adequate to "place[] in possession of a person of ordinary skill" an alloy that does not include lead impurities that would materially affect its properties. *See Helifix*, 208 F.3d at 1346; Ex. 1004 ¶ 123.

Even if we were to (1) accept Patent Owner's arguments concerning impurities in Yamaguchi '874 and assume that Example 7 includes 0.2 wt% of the impurities alleged by Patent Owner, (2) accept the fatigue life test results reproduced above as accurate,[9] and (3) assume that fatigue life is a basic and novel property of the composition of claim 10, we would nevertheless find that that Example 7 falls within the scope of claim 10. As set forth above, and as the parties agree, the "consisting essentially of" transition of claim 10 permits a composition to include "unlisted ingredients," such as the alleged impurities of Yamaguchi '874, so long as they "do not *materially affect* the basic and novel properties of the invention." *See PPG Indus.*, 156 F.3d at 1354 (emphasis added).

[9] We observe that Patent Owner provides no meaningful statistical analysis of the relied-upon data. *See* PO Resp. 24–25. For example, Patent Owner does not identify information concerning how many samples were prepared, how many times each sample was tested, what the standard deviations of the tests were, or any other relevant information that might assist in meaningfully evaluating the data. *See id.*; *see also* Ex. 1050, 29:6–11 (Suhir Tr.) (describing standard deviation as "an indication of how accurate . . . particular results are"). We also observe that the tests were run at the direction of an interested party, i.e., named inventor Jennie Hwang, *see* Ex. 2013 ¶ 15; Ex. 1001, code (75), and that there is evidence that the tests were conducted by Patent Owner itself rather than by a third party, *see* Ex. 1051, 20:8–23 (Hwang Tr.); Ex. 1048, 4 ("These fatigue data will be analysed and feedbacked to Asahi Solder to carry out elemental recompositions . . . ." / "Machines/equipment will be made available to Asahi Solder . . . ." / "The operation of some characterization equipment will be *supported by* SIMTech staff."). *Cf. In re Bulina*, 362 F.2d 555, 559 (CCPA 1966) ("[A]n affidavit by an applicant or co-applicant as to the advantages of his invention is less persuasive than one made by a disinterested person.").

According to Patent Owner's test results, Example 7 of Yamaguchi '874 has a fatigue life ranging from 2739 to 3458 when an impurity is present at 0.2 wt%. *See* PO Resp. 24. The average fatigue life of the impurity-containing samples is 3199.5. *See id.* As Petitioner points out in the Reply, Patent Owner's own experimental data indicates that those fatigue life figures are consistent with the fatigue lives of compositions that fall within the scope of claim 10. *See* Reply 7. Specifically, Petitioner cites Exhibit 1045, which is a collection of pages produced by Patent Owner pursuant to our discovery order. *See* Paper 22. Page 3 of Exhibit 1045 includes data with a "Sample ID." prefix of "L0." Ex. 1045, 3. The "Sample Alloy" associated with "L0" is 92.5 wt% Sn, 3.5 wt% Ag, 1.0 wt% Cu, and 3.0 wt% Bi. *Id.* Petitioner asserts in the Reply, and Patent Owner does not dispute in the Sur-reply, that the "L0" alloy falls within the scope of claim 10. Reply 7. Patent Owner's data shows a fatigue life range for the L0 samples of 2590 to 4024, and a fatigue life average for the L0 samples of 3054.4. Ex. 1045, 3. In addition to the "L0" data identified by Petitioner, Patent Owner itself identifies several alloy samples that Patent Owner describes as "within the scope of claim 10" that have fatigue lives around 3000. *See* PO Resp. 55–56.[10]

[10] We recognize that the '947 patent includes the following statement: "The present inventive solder alloy demonstrates . . . a low-cycle fatigue life at 0.2% strain of at least about 5,000 cycles." Ex. 1001, 5:55–57. Patent Owner does not argue that statement is limiting of the claimed subject matter or otherwise indicative of a minimum required fatigue life for alloys within the scope of claim 10. On the contrary, and as set forth above, Patent Owner indicates that alloys having fatigue lives at least as low as 2960 fall within the scope of claim 10. *See* PO Resp. 55–56.

Thus, according to Patent Owner, alloys may have fatigue lives at least as low as approximately 3000 and still fall within the scope of claim 10. *Id.* As noted above, the average fatigue life of the impurity-containing samples of Example 7 of Yamaguchi '874 that were prepared by Patent Owner is nearly 3200. That figure is higher than the fatigue lives of at least some alloy samples that Patent Owner describes as falling within the scope of claim 10. *See* PO Resp. 55–56.

Petitioner argues that such data proves that "Figure 3 [i.e., Patent Owner's fatigue data for impurity-containing samples, PO Resp. 24] shows no 'material effect' on fatigue life." Reply 7. Patent Owner fails to acknowledge that argument in the Sur-reply.[11] *See generally* Sur-reply.

Petitioner's argument is supported by at least Exhibit 1045 and Figure 10 of Patent Owner's Response, *see* PO Resp. 55–56, which, as set forth above, disclose samples prepared and tested by Patent Owner that fall within the scope of claim 10, but that have similar or slightly lower fatigue life than the impurity-containing samples prepared by Patent Owner. Given that samples that admittedly fall within the scope of claim 10 have fatigue lives comparable to and lower than the impurity-containing samples based

[11] We recognize that Patent Owner's declarants state that the data represented in Figure 3 of Patent Owner's Response, *see* PO Resp. 24, demonstrates a "material[] [e]ffect" on the properties of a solder alloy due to 0.2 wt% impurities. *E.g.*, Ex. 2012 ¶ 74; Ex. 2013 ¶ 85. The declarants, however, do not identify what is meant by "material," and Patent Owner does not identify any assertion, for example, that the fatigue lives of the Yamaguchi '874 Example 7 impurity-containing compositions render those compositions unsuitable for use in electronics soldering applications, or that the fatigue lives of the impurity-containing compositions are lower than the fatigue lives of all compositions that fall within the scope of claim 10.

on Example 7 of Yamaguchi '874, the record does not support Patent Owner's contention that Example 7 of Yamaguchi '874 has a "materially" different fatigue life than compositions falling within the scope of claim 10, even assuming that Example 7 includes the impurities asserted by Patent Owner.

On the contrary, a preponderance of the evidence supports Petitioner's contention that, even assuming Example 7 includes 0.2 wt% of the impurities alleged by Patent Owner, resulting in the fatigue lives identified by Patent Owner, *see* PO Resp. 24, Example 7 demonstrates a fatigue life that is substantially similar to that of compositions that fall within the scope of claim 10, as evidenced by Patent Owner's own data. Accordingly, the alleged impurities "do not materially affect the basic and novel properties of the invention," *see PPG Indus.*, 156 F.3d at 1354 (emphasis added), and Example 7 of Yamaguchi '874 falls within the scope of claim 10, even if it includes the impurities asserted by Patent Owner.

For all of the reasons set forth above, we find that a preponderance of the evidence supports Petitioner's contention that Example 7 of Yamaguchi '874 anticipates claim 10.

D. ANTICIPATION OF CLAIM 10 BY LEE

Petitioner asserts that claim 10 is anticipated by Lee. Pet. 38–44. For reasons set forth below, we determine that Petitioner's arguments and evidence establish by a preponderance of the evidence that Lee anticipates claim 10.

1. Lee (Ex. 1007)

Lee discloses that concerns "about the toxicity of lead ha[ve] led to an

increase in controls and legislation on the use of lead." Ex. 1007, 4. Lee explains that, "[a]lthough the use of lead in solders for electronics assembly has not yet been banned, the strong trend of moving towards a green world is driving the industry to develop lead-free solder alternatives with immense enthusiasm." *Id.* Lee teaches that, "[t]o become a viable lead-free solder alternative for electronic assembly use, it is considered *essential* for the candidate solder to meet" certain "criteria," one of which is "good fatigue resistance." *Id.* Lee goes on to "review[]" and "discuss[]" "the status of lead-free developmental works." *Id.*

As part of its review and discussion, Lee includes a Table 4 labeled "Lead-free Solder Alloys Investigated Recently," reproduced below as cropped and annotated by Petitioner.

Table 4

Lead-free Solder Alloys Investigated Recently

Alloy Category	*Composition*	*Solidus (°C)*	*Liquidus (°C)*	*Note*	*Density*	*Manufacturer or Investigator*
Sn-Ag-Zn-Cu	95Sn-3.5Ag-1.0Zn-0.5Cu					AT&T
Sn-Bi-Ag	91.8Sn-4.8Bi-3.4Ag		211			Sandia
Sn-Bi-Ag-Cu	91.0Sn-4.5Bi-3.5Ag-1.0Cu		210			Senju
Sn-Bi-Cu-Ag	48Sn-46Bi-4Cu-2Ag					IBM
Sn-Bi-Cu-Ag-P	Bi0.08-20%, Cu 0.02-1.5, Ag 0.01-1.5, P 0-0.20, rare earth mixture 0-0.20, balance Sn					Cookson

Pet. 40; Ex. 1007, 6. Annotated Table 4 describes an example (the "Senju" example) with a composition of "91.0Sn–4.5Bi–3.5Ag–1.0Cu." Pet. 40; Ex. 1007, 6.

Lee also includes a table (Table 5) titled "Pros and Cons of Lead-free Solders Investigated Recently," which appears to include most or all of the compositions from Table 4, including the Senju example. *See* Ex. 1007, 8. Table 5 includes columns listing "advantages" and "disadvantages" for each composition. *Id.* For some compositions, poor fatigue is expressly listed as a disadvantage. *See id.* (identifying fatigue in the "disadvantages" column

for the compositions 52In-48Sn and 96.5Sn-3.5Ag). No disadvantage is listed for the Senju example. *Id.*

2. Analysis

Petitioner provides the following table showing the correspondence of the Senju example of Lee to claim 10.

	Sn	Cu	Ag	Bi
US '947, Claim 10	76 – 96	0.2 – 2.5	2.5 – 3.5	0.5 – 5.0
Lee, Senju example	91	1	3.5	4.5

Pet. 41. The table above shows the correspondence of the Senju example of Lee to claim 10. Petitioner acknowledges that Lee does not expressly state that its disclosure of "91.0Sn–4.5Bi–3.5Ag–1.0Cu" refers to the "weight percent" of each listed element.[12] Pet. 41–42. Petitioner asserts, however, that because Tables 1 and 2 of Lee—which list elements often added to lead-free solder compositions—describe the elements in terms of "[p]ossible wt [a]ddition (%)," a person of ordinary skill in the art would have understood Table 4 likewise to be using weight percent numbers. Pet. 42 (citing Ex. 1004 (Morris Decl.) ¶ 132). Petitioner also asserts that, because Table 4 discloses "63Sn–37Pb" as a "(Control)" composition, and 63Sn–37Pb is a well-known solder alloy that consists of 63 weight percent Sn and 37 weight percent Pb, a person of ordinary skill in the art would have understood the

[12] The parties agree that the "%" symbol in claim 10 refers to weight percentage. *See* Pet. 7; PO Resp. 14–15; *see also* Ex. 1001, 3:60–61 ("Unless otherwise identified in the description and claims, all parts and percentages are by weight.").

remainder of Table 4 likewise to refer to weight percentages. Pet. 42–43 (citing several references). Petitioner asserts that the Senju example of Lee includes "only the listed ingredients . . . and elements that do not materially affect the properties of the composition," and that it anticipates claim 10. Pet. 41–44 (citing Ex. 1004 (Morris Decl.)).

Consistent with Petitioner's arguments and evidence, it is clear from the tables reproduced above that the Senju example includes each of the four elements required by claim 10—Sn, Cu, Ag, and Bi. *Compare* Ex. 1007, 6, *with* Ex. 1001, 8:18–20 (claim 10). As explained in more detail below in our discussion of Patent Owner's arguments, we also find that the Senju example includes those ingredients in amounts that fall within the scope of the ranges recited by claim 10, and that Lee provides no indication that any other ingredients are present. *Compare* Ex. 1007, 6, *with* Ex. 1001, 8:18–20 (claim 10). Moreover, Lee describes the alloys of Table 4, including the Senju example, as "Lead-free Solder Alloys," and it discloses that the melting point of the Senju example is 210°C, which Patent Owner concedes is a temperature suitable for soldering. Ex. 1007, 6; PO Resp. 14. Patent Owner does not contend that the composition of the Senju example falls beyond the scope of the term "lead-free solder alloy" as recited by claim 10. *See generally* PO Resp.

Patent Owner argues that Lee does not anticipate claim 10 because "Lee does not expressly or inherently disclose whether the listed values are weight percentages." PO Resp. 27. Patent Owner argues that, even if the "63Sn-37Pb" composition would have been understood to represent weight percentages, it does not necessarily and inherently mean that the other compositions of Table 4 are likewise represented by weight percentage,

because they "may also be defined in atomic percentages." *Id.* at 27–29. Patent Owner also argues that, the mere fact that "Tables 1 and 2 of Lee mention weight percent" "gives no indication that Table 4 imports the weight percentages of Tables 1 and 2." *Id.* at 29. Patent Owner argues that it is "uncontroverted fact" that solder alloys may be defined in terms of weight % or atomic %. *Id.* at 30 (citing Exs. 2017–2020, 2027).

Consistent with Petitioner's arguments, in two tables that precede Table 4, Lee refers to "wt Addition (%)" of elements to an alloy. *See* Ex. 1007, 4. Dr. Morris cites those disclosures and explains that, after using weight % in Tables 1 and 2, "[i]t would be impractical to recite a composition that was made in terms of atomic percent." Ex. 1004 ¶¶ 132, 133. Dr. Morris also states that, if an author changes from weight % to atomic % "in the course of a paper," "the change is always clearly noted and explained." *Id.* ¶ 135.

Dr. Morris also explains that the "control" alloy of Table 4, 63Sn-37Pb, is "known in the art to consist of 63 wt% Sn and 37 wt% Pb." *Id.* ¶ 134 (citing Ex. 1001, 3:60–61, 5:45–46; Ex. 1012, 1:23–25; Ex. 1017, 2:21–22; Ex. 1020, 56; Ex. 1022, 1). Patent Owner admits that 63Sn-37Pb "usually contains 63 wt% Sn with the remainder comprising Pb," and Patent Owner fails to identify a single example in the record to the contrary. PO Resp. 28; Hearing Tr. 57:12–15 (The Board: "Is there any reference in the record that uses the 63 Sn/37 Pb as atomic percent?" Counsel for PO: "I'm not aware of one."). Dr. Morris states: "In my 50 years of experience in metallurgy, which includes review of thousands of technical papers that include alloy compositions and tables of compositions, I have never encountered a case where an author mixed compositions in weight % and

atomic % in a single table." Ex. 1004 ¶ 135. One of Patent Owner's declarants, Dr. Suhir, agreed with Dr. Morris, stating that "usually authors are consistent." Ex. 1050, 64:2–9; *see also* Hearing Tr. 57:16–20 (counsel for PO acknowledging that no evidence of record mixes atomic % and weight % in a single table). Dr. Morris also asserts that, "when a person skilled in the art in this field discloses a solder alloy composition in terms of percent, absent some express statement to the contrary, that percent is understood to be weight percent." *Id.* ¶ 136; *accord* Ex. 2014 (Joint Industry Standard) at 6 (§ 1.2.1) ("Each alloy is identified by an alloy name, which is composed of a series of alphanumeric characters that identify the component elements in the alloy by chemical symbol and nominal percentage by mass.").

In view of the foregoing, although we agree with Patent Owner that, in some references, solder alloys are defined by atomic %, *see* PO Resp. 30 (citing Exs. 2017–2020, 2027), we credit the testimony of Dr. Morris because it is consistent with the evidence of record, discussed above, and we find that a preponderance of the evidence of record supports Petitioner's contention that the 63Sn-37Pb "control" alloy of Lee's Table 4 is 63 wt% Sn, 37 wt% Pb. *See* Ex. 1004 ¶ 134; Ex. 1001, 3:60–61, 5:45–46; Ex. 1012, 1:23–25; Ex. 1017, 2:21–22; Ex. 1020, 56; Ex. 1022, 3. We find that a preponderance of the evidence also supports Petitioner's contention that a person of ordinary skill would have understood that the remainder of Table 4, including the Senju example, is likewise expressed in terms of weight percentage. *See* Ex. 1004 ¶ 132–135; Ex. 1050, 64:2–9; Ex. 1050, 64:2–9; Ex. 1007, 4 (Tables 1 & 2).

Those findings do not fully resolve the issue of whether the Senju example anticipates claim 10, however, because Patent Owner also argues that "Lee does not anticipate for the same reason that Yamaguchi '874 does not anticipate claim 10," i.e., "a person of ordinary skill in the art would have understood the Senju composition to include the presence of impurities, such as Pb, Sb, Zn, and Al." PO Resp. 33. Patent Owner argues that "these impurities would have a material effect on the basic and novel properties of claim 10—namely, its fatigue resistance." *Id.* In the Sur-reply, Patent Owner observes that "Lee contains no discussion of whether the Senju composition has a good fatigue resistance and even states that all of the compositions 'exhibit some shortcomings.'" Sur-reply 10 (citing Ex. 1007, 7–8).

Those arguments are unpersuasive for the reasons set forth above in our discussion of the ground based on Yamaguchi '874. As with the ground based on Yamaguchi '874, we credit Dr. Morris's testimony that a person of ordinary skill in the art would have understood the Senju example to include "only the listed elements . . . and elements that do not materially affect the properties of the composition," Ex. 1004 ¶ 144, because his testimony and Petitioner's position are more consistent with the record as a whole than is Patent Owner's position.

Like Example 7 of Yamaguchi '874, the Senju example of Lee lists only the ingredients recited by claim 10, and it lists them in amounts that fall within the scope of claim 10. Ex. 1007, 6 (Table 4). Lee provides no indication that any other ingredients are present, *id.*, and Patent Owner does not dispute the enablement of high purity alloys that do not include impurities that materially affect the properties of the alloy. Lee's disclosures

are adequate "to have placed [the claimed invention] in possession of a person of ordinary skill in the field of the invention." *See Helifix*, 208 F.3d at 1346.

Patent Owner's arguments concerning impurities are less persuasive with respect to Lee than they were as to Yamaguchi '874 for at least three reasons. First, Lee repeatedly discusses fatigue resistance and describes it as an "essential" property of lead-free solder alternatives. *See* Ex. 1007, 4; *see also* Ex. 1050 (Suhir Tr.), 66:7–19 (agreeing that "Lee considered a good fatigue resistance to be an essential criteria for a lead-free alloy"); Reply Br. 10. As noted above, Yamaguchi '874's failure to expressly discuss fatigue resistance is the premise of Patent Owner's addition of 0.2 wt% impurities to Example 7 of Yamaguchi '874. *See, e.g.*, PO Resp. 22–23. It is unclear what basis Patent Owner has for asserting that the Senju composition of Lee includes significant amounts of impurities that would affect fatigue resistance.

Second, as Petitioner observes (Reply 10), at least in one instance, Lee discusses an impurity present at only 0.002% when it had an impact on the properties of the alloy. Lee discloses that, "[a]lthough the wetting of 58Bi-42Sn seems to be acceptable, the allowed concentration of *foreign elements* is an order of magnitude lower for eutectic 58Bi-42Sn than for eutectic Sn-Pb solder. Therefore, the presence of 0.002% phosphorous would cause wetting to degrade." Ex. 1007, 5 (emphasis added). Lee says nothing about foreign elements or impurities in the Senju example. *See generally id.* In the Sur-reply, Patent Owner does not address Petitioner's discussion of "foreign elements" in Lee. *See* Sur-reply 9–10.

Third, and as noted above, Table 5 of Lee describes certain compositions as having poor fatigue resistance but does not indicate that as a disadvantage for the Senju composition. Patent Owner's apparent assumption that the Senju example would have had poor fatigue resistance due to impurities is inconsistent with Lee because Lee identifies no impurities in the Senju example and because Lee says nothing about poor fatigue resistance for the Senju example. *Cf.* Ex. 1004 ¶ 144. Of itself, Lee's statement that all compositions listed in Table 4 "exhibit some shortcomings," *see* PO Resp. 10 (citing Ex. 1007 at 7–8), does not persuasively suggest that the Senju example includes impurities that materially affect its fatigue resistance at least because fatigue resistance is not listed as a disadvantage of the Senju composition in Table 5, and because Lee identifies "good fatigue resistance" as an "essential" criteria for lead-free solder alloys. *See* Ex. 1007, 4, 8. Indeed, Lee does not identify any specific shortcoming for the Senju composition. *Id*. As noted above, Patent Owner does not argue that Lee is not enabling or that high purity starting materials were unavailable. *Cf.* Ex. 2014 at 9 (§ 3.2.4) (describing "D" alloys as "ultra-pure alloys . . . the combined total percentage by mass of all impurity elements shall not exceed 0.05 . . . .").

On the complete trial record, we discern no persuasive basis to believe that the Senju example of Lee would have included such significant quantities and/or types of impurities as to have materially different properties from the composition of claim 10. On the contrary, and as set forth above, we find by a preponderance of the evidence that a person of ordinary skill would have understood the Senju example did not include impurities that materially affect its properties.

We find that Petitioner has adequately established that the Senju example of Lee anticipates claim 10.

E. OBVIOUSNESS OF CLAIM 10 IN VIEW OF YAMAGUCHI '923

Petitioner asserts that claim 10 would have been obvious in view of Yamaguchi '923. Pet. 54–57. For reasons set forth below, we determine that Petitioner's arguments and evidence establish by a preponderance of the evidence that claim 10 would have been obvious over Yamaguchi '923.

1. Yamaguchi '923 (Ex. 1024)

Yamaguchi '923 discloses that various factors, including advances in electronic circuitry and "global advancement in the regulation of lead (which is a toxic substance contained in solder materials, i.e., Sn-Pb alloys)," have created a need for new solder alloys. Ex. 1024, 3–4. Yamaguchi '923 describes the effect of a number of different metals, including Ag, Bi, and Cu, on the properties of lead-free solder alloys. *Id.* at 5. For example, Yamaguchi '923 discloses the following about the effect of silver:

> The addition of Ag makes it possible to obtain a solder alloy that has a fine metallographic structure and can therefore provide superior ***thermal resistance, such as resistance to thermal fatigue***. If the content of Ag is less than 2.0 wt%, a sufficient effect cannot be obtained in terms of the improvement of the thermal resistance. But, if the content of Ag exceeds 3.5 wt%, the melting point of the alloy rapidly increases. Accordingly, the maximum content of Ag is 3.5 wt% in order to ensure that the melting point of the alloy stays in the temperature range that is preferable for an alloy used in solder creams, i.e., 220°C or less. Thus, the appropriate content of Ag is 2.0 to 3.5 wt%.

Id. (emphasis added). Yamaguchi '923 provides similar descriptions of bismuth and copper. *Id.* (explaining that "Bi makes it possible to lower the melting point of the solder alloy and thereby improve wettability" and that

"Cu makes it possible to restrict the growth of intermetallic compounds at the solder/copper-land joint interface and thereby improve the strength at the joint interface"). Yamaguchi '923 explains that including too much or too little of each metal may result in a composition with undesirable properties. *Id.*

Yamaguchi '923 identifies the following composition as a desirable solder alloy: (1) "Ag in the amount of 2.0 to 3.5 wt%," (2) "Bi in the amount of 5 to 18 wt%," (3) "at least one type of element selected from the group consisting of In in the amount of 0.1 to 1.5 wt%, Cu in the amount of 0.1 to 0.7 wt% and Zn in the amount of 0.1 to 10 wt%," and (4) Sn constituting the remaining portion. *Id.* at 4.

2. Analysis

Petitioner provides the following table showing the overlap of the relied-upon composition of Yamaguchi '923 with claim 10 when Cu is selected as the additional element of Yamaguchi '923 (Petitioner refers to Yamaguchi '923 as "EP '265/WO '923").

	Sn	Cu	Ag	Bi
US '947, Claim 10	76 – 96	0.2 – 2.5	2.5 – 3.5	0.5 – 5.0
EP '265/ WO '923	**77.8 - 92.9**	0.1 - **0.7**	2.0 - **3.5**	**5** - 8

Pet. 56.[13] The table above shows the overlap of the relied-upon composition of Yamaguchi '923 with claim 10 when Cu is selected as the additional

[13] Petitioner's identification of "5 – 8" as the range of Bi disclosed by Yamaguchi '923 includes a typographical error and should read "5 – 18."

element of Yamaguchi '923. Petitioner argues that the weight percentages of Sn, Cu, Ag, and Bi were known result-effective variables, and that routine optimization would have led to the composition of claim 10. *Id.* at 56–57; *see also id.* at 47–53. Petitioner also argues that the ranges of claim 10 are not critical and do not produce unexpected results. *Id.* at 56–57. Petitioner argues that, because the weight percentage range of each element of Yamaguchi '923's composition overlaps the claimed ranges, the composition of claim 10 would have been obvious to a person of ordinary skill in the art. *Id.* at 56 (citing *Ormco Corp. v. Align Tech., Inc.*, 463 F.3d 1299, 1311 (Fed. Cir. 2006) ("Where a claimed range overlaps with a range disclosed in the prior art, there is a presumption of obviousness.")).

Consistent with Petitioner's arguments and evidence, Yamaguchi '923 teaches or suggests alloys including only Sn, Cu, Ag, and Bi, and it teaches or suggests weight percentages of Sn, Cu, Ag, and Bi that overlap with the claimed ranges. *E.g.*, Ex. 1024, 2 (abstract), 4. Yamaguchi '923 also discloses that the weight percentages of the alloy ingredients affect various properties of the alloy, and it discloses suggested minimum and maximum weight percentages of Ag, Bi, and Cu to achieve desired alloy characteristics. *Id.* at 5. "A recognition in the prior art that a property is affected by the variable is sufficient to find the variable result-effective." *In re Applied Materials, Inc.*, 692 F.3d 1289, 1297 (Fed. Cir. 2012).

Because Yamaguchi '923 teaches or suggests a solder alloy that includes only the four elements required by claim 10 in weight percentage

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See Ex. 1024, 4 ("Bi in the amount of 5 to 18 wt%"); *see also* Ex. 1004 (Morris Decl.) ¶¶ 191–196 (repeatedly identifying "18" as the upper end of the Bi range disclosed by Yamaguchi '923).

ranges that overlap those of claim 10, Petitioner's showing weighs in favor of determining that claim 10 would have been obvious over Yamaguchi '923. That is so even though the overlap of Bi is only at an end point, i.e., 5 wt%, of the ranges. *See Genentech, Inc. v. Hospira, Inc.*, 946 F.3d 1333, 1341 (Fed. Cir. 2020) ("[W]e and our predecessor court have consistently held that even a slight overlap in range establishes a prima facie case of obviousness." (internal quotation marks omitted)).

Patent Owner argues that "Yamaguchi '923 teaches away from the claimed bismuth range" because Yamaguchi '923 teaches that "[w]hen the content of Bi is below 5 wt%, it is impossible to . . . sufficiently" lower the melting point of the alloy. PO Resp. 54–55 (citing Ex. 1024, 5). Patent Owner also argues that "the claimed 5 wt% bismuth limit is critical when compared with Yamaguchi '923" because going even "slightly" above 5 wt% allegedly "results in a significantly decreased fatigue life." *Id.* at 55.

Those arguments are not persuasive because they do not account for the fact that Yamaguchi '923 teaches a Bi weight percentage range that includes 5% and therefore overlaps the range of claim 10. "A reference teaches away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken in the claim." *Meiresonne v. Google, Inc.*, 849 F.3d 1379, 1382 (Fed. Cir. 2017) (internal quotation marks omitted); *see also DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1327 (Fed. Cir. 2009) ("A reference does not teach away, however, if it merely expresses a general preference for an alternative invention but does not criticize, discredit, or otherwise discourage investigation into the invention claimed." (internal quotation

marks omitted)). Given that Yamaguchi '923 teaches a Bi weight percentage range that overlaps the range of claim 10, we are not persuaded that Yamaguchi '923 teaches away from the Bi range of claim 10.

Patent Owner also argues that "Yamaguchi '923 does not recognize the wt% of silver as a result-effective variable for fatigue resistance, and therefore it would not have been obvious or routine to optimize the silver content when attempting to provide a high-reliability quaternary solder alloy." PO Resp. 52.

That argument is not persuasive for at least three reasons. First, no particular optimization of Yamaguchi '923's silver is necessary given that the silver range disclosed as desirable by Yamaguchi '923 (2.0–3.5 wt%) substantially overlaps with the claimed range (2.5–3.5 wt%). *See Ormco*, 463 F.3d at 1311.

Second, to the extent that optimization of Yamaguchi '923's Ag range is required to achieve the claimed range, optimization of Yamaguchi '923's composition need not be performed for the same reason as by the inventors of the '947 patent, particularly in view of the fact that Yamaguchi '923's Ag range substantially overlaps the claimed range. *See, e.g.*, *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 419 (2007) ("In determining whether the subject matter of a patent claim is obvious, neither the particular motivation nor the avowed purpose of the patentee controls. What matters is the objective reach of the claim."). Optimization of Yamaguchi '923's Ag range reasonably would have led to values falling within the scope of claim 10 because the vast majority of values within Yamaguchi '923's disclosed range fall within the scope of claim 10.

Third, although Patent Owner asserts that "Yamaguchi '923 does not recognize the wt% of silver as a result-effective variable for fatigue resistance," PO Resp. 52, Yamaguchi '923 expressly teaches that "[t]he addition of Ag . . . can therefore provide superior thermal resistance, such as *resistance to thermal fatigue*," Ex. 1024, 5 (emphasis added). Yamaguchi '923 goes on to explain that Ag content of less than 2.0 wt% does not provide "a sufficient effect . . . in terms of the improvement of the thermal resistance," and that Ag content of greater than 3.5 wt% undesirably increases melting point, thereby leading to an optimal Ag content of "2.0 to 3.5 wt%." *Id.* Patent Owner does not address that disclosure in its assertion that "Yamaguchi '923 does not recognize the wt% of silver as a result-effective variable for fatigue resistance." *See* PO Resp. 52. On its face, that disclosure directly contradicts Patent Owner's assertion. At oral argument, Patent Owner acknowledged that its assertion was a "mistake." *See* Hearing Tr. 60:1–61:1.

We recognize that Petitioner did not cite the relevant portion of Yamaguchi '923 in the Petition. *See generally* Pet. However, Petitioner did cite the corresponding portion of EP '265 (a related European application that Petitioner alternatively relies on in this proposed ground of unpatentability, *see supra* p. 6 n.3), for the proposition that silver was known to provide heat resistance to alloys. *See id.* at 49 (citing Ex. 1017, 3). The page cited by Petitioner describes "heat resistance" as "resistance against thermal embrittleness." Ex. 1017, 3:7–8. The '947 patent associates "brittleness" and fatigue life. *See* Ex. 1001, 5:22–28.

In the Institution Decision, we noted that "neither party identifies any material difference between Yamaguchi '923 and EP '265," and we limited

our discussion to Yamaguchi '923. *See* DI 5 n.2. In our discussion of Yamaguchi '923 in the Institution Decision, we observed that "Yamaguchi '923 explains that Ag content influences thermal resistance." *Id.* at 25. The very same sentence of Yamaguchi '923 that first mentions thermal resistance also expressly mentions fatigue. *See* Ex. 1024, 5 ("The addition of Ag . . . can therefore provide superior thermal resistance, such as resistance to thermal *fatigue*." (emphasis added)).

Accordingly, although Petitioner did not cite Yamaguchi '923's disclosure concerning thermal resistance and fatigue, the Institution Decision did, and the significance of Yamaguchi '923's disclosures concerning thermal resistance, brittleness, and fatigue was reasonably discernible from both the Petition (including its citation of EP '265) and the Institution Decision. Patent Owner, thus, had sufficient notice and opportunity to address that teaching during trial.

Patent Owner's arguments fail to persuade us that Yamaguchi '923's disclosures concerning the Ag weight % range of its alloys are inadequate to lead to the claimed range. *See Ormco*, 463 F.3d at 1311. We find that Yamaguchi '923 discloses that the weight % of Ag affects fatigue resistance, and that Yamaguchi '923 discloses a weight % range of Ag that substantially overlaps with, and fully encompasses, the claimed range. *See* Ex. 1024, 5.

Patent Owner also argues that "unexpected fatigue resistance was achieved by limiting silver content to 2.5 to 3.5 wt%." PO Resp. 52. For support, Patent Owner cites only ¶¶ 123 and 124 of Dr. Hwang's Declaration. *See id.*

"For objective evidence of secondary considerations to be accorded substantial weight, its proponent must establish a nexus between the

evidence and the merits of the claimed invention." *In re Kao*, 639 F.3d 1057, 1068 (Fed. Cir. 2011) (quotation and emphasis omitted). "[T]he burden of showing unexpected results rests on he who asserts them." *In re Klosak*, 455 F.2d 1077, 1080 (CCPA 1972); *see also Wm. Wrigley Jr. Co. v. Cadbury Adams USA LLC*, 683 F.3d 1356, 1363 ("Therefore, to show that the [result] was unexpected, [Patent Owner] needed to demonstrate that the results were unexpected to a significant degree beyond what was already known . . . .").

At the outset, we note that Patent Owner does not appear to address whether any allegedly unexpected results involve a comparison to the closest prior art. *See In re Baxter Travenol Labs.*, 952 F.2d 388, 392 (Fed. Cir. 1991) ("[W]hen unexpected results are used as evidence of nonobviousness, the results must be shown to be unexpected *compared with the closest prior art*." (emphasis added)).

We also determine that Patent Owner does not adequately show that alleged unexpected results are reasonably commensurate with the scope of claim 10. *See ClassCo, Inc. v. Apple, Inc.*, 838 F.3d 1214, 1220 (Fed. Cir. 2016) ("[T]here is no nexus unless the evidence presented is reasonably commensurate with the scope of the claims." (internal quotation marks omitted)); *Allergan Inc. v. Apotex, Inc.*, 754 F.3d 952, 965 (Fed. Cir. 2014) ("It is the established rule that objective evidence of non-obviousness must be commensurate in scope with the claims which the evidence is offered to support." (internal quotation marks omitted)); *In re Greenfield*, 571 F.2d 1185, 1189 (CCPA 1978) ("Establishing that one (or a small number of) species gives unexpected results is inadequate proof, for it is the view of [the CCPA] that objective evidence of non-obviousness must be commensurate

in scope with the claims which the evidence is offered to support." (internal quotation marks omitted)).

In the context of a separate ground of unpatentability based on Matsumoto, Patent Owner argues that evidence of unexpected results need only be commensurate "with the portion of the claim giving rise to such results." PO Resp. 51. For support, Patent Owner cites *In re Clemens*, 622 F.2d 1029, 1036 (CCPA 1980), and argues that, so long as Patent Owner's evidence of unexpected results is commensurate with the claimed Ag range of 2.5 to 3.5 wt%, the evidence meets the "commensurate in scope" requirement, irrespective of any evidence concerning the weight percentages of the other three elements required by claim 10. PO Resp. 51; *see also id.* at 52 ("[T]he unexpected results are commensurate in scope with the claimed invention because claim 10 recites the critical 2.5 to 3.5 wt% silver range.").

As set forth above, the Federal Circuit (and its predecessor court) has repeatedly held that evidence of unexpected results must be commensurate with the scope of "the claims." *See ClassCo*, 838 F.3d at 1220; *see also Allergan*, 754 F.3d 965; *In re Greenfield*, 571 F.2d at 1189. *Clemens* itself, relied on by Patent Owner, is no different: "In order to establish unexpected results for a claimed invention, objective evidence of non-obviousness must be commensurate in scope with *the claims* which the evidence is offered to support." 622 F.2d at 1035 (emphasis added). In view of that case law, Patent Owner's assertion that unexpected results need only be commensurate "with the portion of the claim giving rise to such results," with an unexplained citation to *Clemens*, *see* PO Resp. 51, is not persuasive.

We agree with Petitioner that *Clemens* does not support Patent Owner's position. *See* Reply 23. In *Clemens*, the CCPA found that the scope of the claims at issue was broad, while the "appellants' evidence, on the other hand, is quite narrow," and the CCPA determined that "the evidence of unexpected results was not commensurate in scope *with the breadth of these claims*." 622 F.2d at 1036 (emphasis added). It is unclear what portion of *Clemens* Patent Owner believes supports its position that evidence need only be commensurate with "the portion of the claim giving rise to" unexpected results. *See* PO Resp. 52. We decline to adopt Patent Owner's proposed rule, and we apply the well established rule that evidence of unexpected results must be commensurate with the scope of "the claims." *See ClassCo*, 838 F.3d at 1220.

Applying that rule, Patent Owner has not established that its evidence is commensurate in scope with claim 10. Petitioner asserts (Reply 23 (citing PO Resp. 47 (Fig. 7)), 24), and Patent Owner does not dispute (Sur-reply 23), that the relevant evidence of allegedly unexpected results involves only five alloys, all with 0.5 wt% Cu and 3 wt% Bi, notwithstanding the fact that claim 10 covers 0.2–2.5 wt% Cu and 0.5–5 wt% Bi. Patent Owner does not persuasively assert that a person of ordinary skill in the art would have understood that limited evidence to be representative of the full scope of claim 10. *See* PO Resp. 51. One of Patent Owner's Declarants, Dr. Suhir, testified that he did not know whether compositions beyond the limited compositions tested would show an unexpected improvement in fatigue life. *See* Ex. 1050, 92:4–96:14 (Q: "So there are many alloys . . . that fall within the scope of Claim 10 for which you don't know whether silver has an unexpected improvement in fatigue life?" A: "Yeah, I don't know.").

That deficiency in Patent Owner's arguments and evidence, as well as Patent Owner's failure to address whether any allegedly unexpected results involve a comparison to the closest prior art, significantly reduces any persuasive value Patent Owner's arguments and evidence may otherwise have. *Cf. In re GPAC Inc.*, 57 F.3d 1573, 1580 (Fed. Cir. 1995) ("To the extent that the patentee demonstrates the required nexus, his objective evidence of nonobviousness will be accorded more or less weight.").

Turning to the substance of Patent Owner's argument concerning unexpected results, we observe that the argument is premised on the assertion that "neither Yamaguchi '923 nor the other references cited by Petitioner disclose the relationship between the wt% of silver and the fatigue resistance of the solder composition." PO Resp. 52; *see also* Ex. 2013 ¶¶ 123, 124. Patent Owner's argument is unpersuasive because it fails to address Yamaguchi '923's disclosures that "[t]he addition of Ag . . . can therefore provide superior thermal resistance, such as resistance to thermal fatigue," and that a desirable silver range is 2.0–3.5 wt%. *See* Ex. 1024, 5. As noted above, at oral argument, Patent Owner acknowledged that its assertion that Yamaguchi '923 does not disclose a relationship between weight % of Ag and fatigue resistance was a "mistake." *See* Hearing Tr. 60:1–61:1

Additionally, we observe that Patent Owner's own evidence casts doubt on whether a silver range of 2.5–3.5 wt% is critical to achieving unexpected fatigue resistance across the scope of claim 10. *See* Reply 24–25. Figure 8 of Patent Owner's Response (not relied on by Patent Owner to

show unexpected results[14]) shows that a composition of 93% Sn, 2% Cu, ***2% Ag***, and 3% Bi, has a fatigue life of 4141. *See* PO Resp. 50. That composition falls within the scope of claim 10 except that its Ag content of 2% is lower than the 2.5% minimum of claim 10 that is alleged by Patent Owner to be critical. That composition's fatigue life of 4141 is comparable to the fatigue lives of the samples comprising 2.5–3.5% Ag relied on by Patent Owner to show the alleged criticality of the claimed Ag range of 2.5–3.5%, *compare* PO Resp. 50, *with* PO Resp. 47, and it is significantly higher than the fatigue lives of certain alloys that Patent Owner admits fall within the scope of claim 10, *see id.* at 55–56.

Petitioner relies on that data in the Reply. *See* Pet. 24 ("Asahi's own data shows a fatigue life for a composition with 2% Ag . . . with 4141 cycles, well above the 3054 cycles of [certain compositions that Patent Owner admits fall within the scope of claim 10]."). Patent Owner did not respond to Petitioner's argument in the Sur-reply. *See* Sur-reply 21–23. At oral argument, Patent Owner responded by dismissing the alloy having 2% Ag and a fatigue life of 4141 as "one data point." Hearing Tr. 80:14–16. Given the limited number of examples relied on by Patent Owner in this case to show criticality, *see* PO Resp. 45–48, however, a single counterexample appears to be significant, and Patent Owner has not shown otherwise.

Based on that evidence and Patent Owner's arguments, we are not persuaded that Patent Owner has shown that an Ag range of 2.5–3.5 wt% is critical to achieving good fatigue resistance when Patent Owner's data

[14] Figure 8 appears in a section of Patent Owner's Response titled "Copper is Not the Dominant Influence on the Fatigue Life for Sn-Ag-Cu-Bi Solder Alloys." PO Resp. 48–50.

indicates that Ag content of 2% yields similar fatigue results in some alloys. On this record, Patent Owner has not established that a person of ordinary skill in the art would have regarded the claimed Ag range as critical or the improved fatigue resistance due to inclusion of 2.5–3.5 wt% as unexpected. We attribute only minimal weight to Patent Owner's evidence of unexpected results.

Patent Owner raises no other arguments as to this proposed ground of unpatentability. When considering all of the evidence of obviousness and nonobviousness together (*see In re Cyclobenzaprine Hydrochloride Extended-Release Capsule Patent Litig.*, 676 F.3d 1063, 1079 (Fed. Cir. 2012)), we conclude that Petitioner has shown by a preponderance of the evidence that the subject matter of claim 10 would have been obvious over Yamaguchi '923.

F. Obviousness of Claim 10 in View of Lee or Matsumoto

In the interest of efficiency and because, in our analysis above, we hold claim 10, the only challenged claim, unpatentable on three independent grounds covering both § 102 and § 103, we decline to reach decisions as to the obviousness ground based on Lee and the obviousness ground based on Matsumoto. *See SAS Inst. Inc. v. Iancu*, 138 S. Ct. 1348, 1359 (2018) (holding that a petitioner "is entitled to a final written decision addressing all of the claims it has challenged"); *see also Boston Sci. Scimed, Inc. v. Cook Grp. Inc.*, Nos. 2019-1594, -1604, -1605, 2020 WL 2071962, at *4 (Fed. Cir. Apr. 30, 2020) (nonprecedential) (recognizing that the "Board need not address issues that are not necessary to the resolution of the proceeding" and, thus, agreeing that the Board has "discretion to decline to decide

additional instituted grounds once the petitioner has prevailed on all its challenged claims").

G. PATENT OWNER'S MOTION TO EXCLUDE

Patent Owner moves to exclude certain exhibits (the "Challenged Exhibits") associated with "Grounds 4 and 5" (i.e., the obviousness ground based on Matsumoto and the obviousness ground based on Yamaguchi '923) under Federal Rules of Evidence ("FRE") 402 and 403. Paper 33. "The moving party has the burden of proof to establish that it is entitled to the requested relief." 37 C.F.R. § 42.20(c).

Patent Owner argues that Petitioner's proposed obviousness grounds are single-reference obviousness grounds, and that Petitioner's discussion of background art describing what was known about Sn, Ag, Cu, and Bi in the context of solder alloys, *see* Pet. 7–23, cannot be cited or relied on by Petitioner in Petitioner's substantive obviousness analysis because any attempt to do so is an improper attempt to shoehorn those references in as "secondary references . . . as one or more new grounds to challenge the validity of Claim 10." Paper 33, 7–9. Specifically, Patent Owner argues that none of the exhibits cited in the background discussion of the Petition should be allowed to support Petitioner's contention that the concentrations of Sn, Ag, Cu, and Bi were known result-effective variables. *Id.* Patent Owner also argues that we should exclude "exhibits attached to [the] Morris Declaration but never relied on." *Id.* at 13.

For reasons consistent with those argued by Petitioner in its opposition, *see* Paper 34, we deny Patent Owner's Motion to Exclude.

It is clear from the Motion that Patent Owner's arguments concern the substantive merit of Petitioner's proposed grounds. Patent Owner argues

that the Petitioner's proposed obviousness grounds "were not identified 'with particularity'" because the references used to supply information concerning the state of the art at the time of the invention are not listed in Petitioner's statement of the proposed grounds of unpatentability. Paper 33, 1–2, 8. Patent Owner argues that these background references are improperly being used as "secondary references" "to allegedly demonstrate that the amounts of tin, copper, silver and bismuth . . . are result-effective variables." *Id.* at 9. Patent Owner argues that Petitioner's "approach . . . bypasses the 'with particularity' notice requirements of 35 U.S.C. § 312 by leveling the Challenged Exhibits as secondary references without expressly identifying them as such. . . . In essence, [Petitioner] is sneaking additional, unasserted grounds into its Petition . . . ." *Id.* at 9–10.

In its argument, nowhere does Patent Owner mention FRE 402 or 403. Nor does Patent Owner attempt to explain how the Challenged Exhibits are irrelevant or unfairly prejudicial. Patent Owner itself describes the Challenged Exhibits as concerning whether Sn, Ag, Cu, and Bi were known result-effective variables. *Id.* at 7–9. That issue is plainly relevant to this proceeding, and, particularly in the absence of any meaningful argument from Patent Owner on point, we do not discern how any of the Challenged Exhibits is unfairly prejudicial or confusing.

Additionally, we observe that Patent Owner's request that we exclude certain exhibits appears to be made on a ground-by-ground basis. *See generally* Paper 33. In other words, Patent Owner does not appear to be asking us to exclude the Challenged Exhibits as to the entire proceeding, but only as to certain grounds. *See generally id.* Patent Owner cites no support for the apparent proposition that evidence may be excluded in that way.

Patent Owner's position supports our determination that Patent Owner's arguments concern the merits of the individual proposed grounds and the weight that should be given to the evidence, not the admissibility of the evidence.

Patent Owner's Motion is also procedurally defective. As Patent Owner acknowledges, a motion to exclude must "[a]ddress objections to exhibits in numerical order." Paper 33, 1 (quoting 37 C.F.R. 42.64(c) and Trial Practice Guide). Although Patent Owner provides a lengthy list of Challenged Exhibits, *see id.* at 2–5, in the argument section of Patent Owner's Motion, Patent Owner does not meaningfully discuss any of the listed exhibits, does not discuss exhibits in numerical order, and, as noted above, does not explain why any exhibit is irrelevant or prejudicial under the Federal Rules of Evidence, *see id.* at 8–12. We view arguments that Petitioner's proposed grounds are "inherently ambiguous," *id.* at 10, and that the Challenged Exhibits were not identified with sufficient "particularity," *e.g.*, *id.* at 7, to be directed to the merits of the Petition and the weight that should be given to the evidence, not to the admissibility of the evidence.

Additionally, as to Patent Owner's arguments concerning the use of certain exhibits with respect to the ground based on Matsumoto (what Patent Owner refers to as Ground 4), as set forth above, we decline to reach a decision as to that proposed ground. Accordingly, we have not relied on any of the exhibits at issue in the Motion to Exclude in any way that is relevant to Patent Owner's arguments. *See id.* at 8–11.

As to Patent Owner's arguments concerning the use of certain exhibits with respect to the ground based on Yamaguchi '923 (what Patent Owner refers to as Ground 5), we rely on Yamaguchi '923 itself as adequately

establishing that alloy components are result-effective variables. As with Patent Owner's argument concerning exhibits associated with the ground based on Matsumoto, we have not relied on any of the exhibits at issue in any way that is relevant to Patent Owner's arguments.

Finally, as to Patent Owner's arguments concerning exhibits cited by Dr. Morris but "never relied on by [Petitioner] in this proceeding," Patent Owner cites no legal support for its position that a reference is inadmissible under the Federal Rules of Evidence if it is cited only by a declarant. *See* Paper 33, 13. We again determine that Patent Owner's arguments go to the weight of the evidence, not its admissibility. We also observe that, as to three of the four exhibits identified by Patent Owner (Exs. 1031, 1032, 1033, *see* Paper 33, 13), we have not relied on them in reaching our decision. As to the only other exhibit identified by Patent Owner, Exhibit 1028, Petitioner expressly cites and relies on that exhibit in the Reply, which refutes Patent Owner's assertion that it was "never relied on by [Petitioner] in this proceeding." *See* Paper 33, 13; *see also* Reply 6 (citing Ex. 1028).

For those reasons, Patent Owner has not shown that any of the Challenged Exhibits is inadmissible under the Federal Rules of Evidence. We deny Patent Owner's Motion to Exclude.

III. CONCLUSION

After reviewing the record and weighing the evidence offered by both parties, we determine that Petitioner has demonstrated by a preponderance of the evidence that (1) Yamaguchi '874 anticipates claim 10, (2) Lee

anticipates claim 10, and (3) claim 10 would have been obvious over Yamaguchi '923.[15] We deny Patent Owner's Motion to Exclude.

In summary:

Claims	35 U.S.C. §	Reference(s)	Claims Shown Unpatentable	Claims Not Shown Unpatentable
10	102(b)	Yamaguchi '874	10	
10	102(b)	Lee	10	
10	103(a)	Lee		
10	103(a)	Matsumoto		
10	103(a)	Yamaguchi '923	10	
Overall Outcome			**10**	

[15] Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding, 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. §§ 42.8(a)(3), (b)(2).

IV. ORDER

It is hereby:

ORDERED that Petitioner has proven by a preponderance of the evidence that claim 10 is unpatentable;

FURTHER ORDERED that Patent Owner's Motion to Exclude (Paper 33) is denied;

FURTHER ORDERED that, pursuant to 35 U.S.C. § 318(b), upon expiration of the time for appeal of this decision, or the termination of any such appeal, a certificate shall issue canceling claim 10;

FURTHER ORDERED that, because this is a Final Written Decision, 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.

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