

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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APPLE INC.,  
Petitioner,

v.

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

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Case IPR2019-00377  
Patent 6,176,947 B1

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Before CHRISTOPHER L. CRUMBLEY, JO-ANNE M. KOKOSKI, and  
CHRISTOPHER C. KENNEDY, *Administrative Patent Judges*.

KENNEDY, *Administrative Patent Judge*.

DECISION  
Institution of *Inter Partes* Review  
35 U.S.C. § 314

## I. INTRODUCTION

Petitioner Apple Inc. filed a Petition for *inter partes* review of claim 10 of U.S. Patent No. 6,176,947 B1 (Ex. 1001, “the ’947 patent”). Paper 2 (“Pet.”). Patent Owner Singapore Asahi Chemical & Solder Industries PTE LTD. filed a Preliminary Response. Paper 5 (“Prelim. Resp.”).

Pursuant to 35 U.S.C. § 314 and 37 C.F.R. § 42.4(a), the Board has authority to determine whether to institute *inter partes* review. *Inter partes* review may not be instituted unless “there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” 35 U.S.C. § 314(a). Upon consideration of the Petition and the Preliminary Response, and for the reasons set forth below, we institute *inter partes* review of claim 10.

### A. 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; Prelim. Resp. 22–23. Patent Owner states 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.” Prelim. Resp. 22–23.

### B. THE ’947 PATENT

The ’947 patent relates to lead-free solders. *E.g.*, Ex. 1001 at [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). *Id.* at 2:35–38.

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,” a “moderate melting temperature range,” 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.

C. CHALLENGED CLAIM

Claim 10, the only claim challenged in the Petition, is reproduced below.

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.

D. 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	<i>Getting Ready for Lead-free Solders</i> , 9 Soldering & Surface Mount Tech. 65	1997	1007

Matsumoto	JPH08132277A	May 28, 1996	1010, 1011 (English translation)
Yamaguchi '923	WO97/28923	Aug. 14, 1997	1023, 1024 (English translation)

E. ASSERTED GROUNDS OF UNPATENTABILITY

Petitioner contends that claim 10 is anticipated under 35 U.S.C. § 102(b)<sup>1</sup> by Yamaguchi '874 or Lee, or obvious under 35 U.S.C. § 103(a) over Lee, over Matsumoto, or over Yamaguchi '923<sup>2</sup>.

II. DISCUSSION

A. LEVEL OF ORDINARY SKILL IN THE ART

Petitioner contends that a person of ordinary skill in the art at the time of the invention would have had “an advanced degree, or equivalent (*i.e.*, a

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<sup>1</sup> 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.

<sup>2</sup> 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 “WO '923/EP '265,” and Petitioner’s analysis includes parallel citations to both Yamaguchi '923 and EP '265. *See id.* at 54–56. In the Preliminary Response, Patent Owner treats Yamaguchi '923 and EP '265 as a single reference and refers to them “collectively” as “Yamaguchi 2.” *See* Prelim. Resp. 4 n.5. For simplicity and clarity, and because neither party identifies any material difference between Yamaguchi '923 and EP '265, we cite only the certified translation of Yamaguchi '923 (Ex. 1024) in this Decision.

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.” Pet. 5. Petitioner further states that a person of ordinary skill would have had “knowledge of metallurgy, how alloy processing impacts the behavior of solder joints, and the skill to modify the relative quantities and processing of the components in a solder alloy to create or select the most suitable alloy for use in specific applications” such as “integrated circuit packaging technologies.” *Id.* at 5–6.

Patent Owner does not dispute the level of education and/or experience described by Petitioner. Prelim. Resp. 23–24. Patent Owner, however, takes issue with Petitioner's failure to “specify or clarify ‘the behavior of solder joints,’ what ‘the most suitable alloy’ would be for which ‘specific applications,’ [and] how one would identify ‘the most suitable alloy.’” *Id.* at 23. Patent Owner asserts that “a PHOSITA would have the ability to prepare solder alloys with different components,” “would have the ability to test the properties of the solder alloys,” and “would have a working understanding of the quality of solder alloys, including, for example, whether impurities were present.” *Id.* at 23–24. Patent Owner does not assert, however, that a person with the education and experience of Petitioner's stated level of skill in the art would lack any of those qualifications. *See id.*

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.” *See* Pet. 5. As noted above, at least at this stage of the proceeding, this level of education and experience is uncontested, and we find that it is also supported by the prior art of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001); *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995); *In re Oelrich*, 579 F.2d 86, 91 (CCPA 1978).

#### 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 on institution. *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”

The parties agree that the commonly accepted meaning of the transitional phrase “consisting essentially of” applies in this case. *See* Pet. 6;

Prelim. Resp. 27–28. 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; Prelim. Resp. 27–28. *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.” *PPG Indus.*, 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 to include only (1) “listed ingredients,” and (2) “unlisted ingredients that do not materially affect the basic and novel properties” of the composition. *See id.*

2. “lead-free solder alloy”

Petitioner does not expressly propose a construction for the term “lead-free solder alloy.” Patent Owner asserts that the term should be construed as follows:

a composition of two or more metallic elements for use and/or used in soldering and solder interconnections that is lead-free, *has a solidus melting temperature and a liquidus melting temperature suitable for SMT manufacturing, and an improved thermal fatigue resistance.*

Prelim. Resp. 26 (emphasis added). Patent Owner argues that “the Applicants of the ’947 patent clearly and unmistakably claimed solder alloys that have a melting temperature range suitable for SMT manufacturing as well as solder alloys that have an improved thermal fatigue resistance when compared with traditional tin-lead eutectic solder alloys.” *See id.*

On this record, we disagree. Contrary to Patent Owner’s assertion that the applicants “clearly and unmistakably *claimed* solder alloys that

have” certain properties, *id.* (emphasis added), claim 10 says nothing about solidus or liquidus melting temperatures, SMT (surface mount technology) manufacturing, or thermal fatigue resistance. The fact that the Specification of the ’947 patent provides background information concerning those things does not indicate that the term “lead-free solder alloy” should be limited in the way that Patent Owner proposes. *Cf. Phillips v. AWH Corp.*, 415 F.3d 1303, 1323 (Fed. Cir. 2005) (en banc) (warning against “importing limitations from the specification into the claims”); *cf. also Openwave Sys., Inc. v. Apple Inc.*, 808 F.3d 590, 513 (Fed. Cir. 2015) (“disavowal of claim scope” must be “clear” and “unmistakable”).

At least at this stage of the proceeding, we are not persuaded that the term “lead-free solder alloy” should be limited in the way that Patent Owner proposes. Beyond that determination, we need not expressly construe this term to reach a decision on institution. *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”).

### C. PRINCIPLES OF LAW

Anticipation under 35 U.S.C. § 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 omitted); *see also Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1369 (Fed. Cir. 2008). “[W]hen, as by a recitation of ranges or otherwise, a claim covers several compositions, the claim is ‘anticipated’ if *one* of them is in the prior art.” *Titanium Metals*

*Corp. of Am. v. Banner*, 778 F.2d 775, 782 (Fed. Cir. 1985) (emphasis in original).

“Section 103(a) forbids issuance of a patent when the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007) (internal quotation marks omitted). Obviousness under § 103 is resolved based on underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

“Where a claimed range overlaps with a range disclosed in the prior art, there is a presumption of obviousness.” *Ormco Corp. v. Align Tech., Inc.*, 463 F.3d 1299, 1311 (Fed. Cir. 2006); *see also E.I. DuPont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1006 (Fed. Cir. 2018) (“[A] prima facie case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the art.” (quoting *In re Peterson*, 315 F.3d 1325 (Fed. Cir. 2003))). “The presumption can be rebutted if it can be shown that the prior art teaches away from the claimed range, or the claimed range produces new and unexpected results.” *Id.* “[I]t is to be expected that a change . . . in concentration . . . would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and

not merely in degree from the results of the prior art.” *In re Aller*, 220 F.2d 454, 456 (CCPA 1955).

D. 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 a reasonable likelihood that Petitioner will prevail with respect to this proposed ground of unpatentability.

1. *Yamaguchi '874 (Ex. 1006)*

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 at [57] (Abstract).

Yamaguchi '874 provides a table of “working example[s]” “according to the present invention,” reproduced below and annotated to include a dashed box surrounding Example 7.

[Table 1]

		Percent composition (wt%)							Melting point (°C)	Tensile strength (Kgf/mm <sup>2</sup> )	Wettability	
		Sn	Ag	Sb	Bi	In	Zn	Cu				Pb
Working example	1	Rest	3.5		3					214	7.43	Δ
	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	Δ
	8	Rest			5	10				212	6.18	Δ
	9	Rest			5		10			214	5.36	
Comparative example	1	Rest	3.5							221	6.26	□
	2	Rest		5						240	6.27	Δ
	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

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. 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 under 35 U.S.C. § 102(b).” Pet. 38 (alterations in original).

Because each element of Example 7 of Yamaguchi ’874 falls within the recited ranges of claim 1, Petitioner’s showing is persuasive.

Patent Owner argues that Example 7 of Yamaguchi '874 does not meet the “consisting essentially of” limitation of claim 10 because Yamaguchi '874 “does not contemplate or teach thermal fatigue resistance” and “makes no teaching as to the purity of its raw materials or the conditions under which its working examples were produced.” Prelim. Resp. 44–48. Patent Owner argues that “certain levels of impurities are inherent to solder raw materials and solder alloys due to manufacturing and processing conditions,” and that “one cannot conclude, based on the teachings of Yamaguchi ['874], that the working examples listed by Yamaguchi ['874] necessarily include only elements that do not materially affect the novel and basic characteristics of the solder alloys recited by claim 10 of the '947 patent (e.g. thermal fatigue resistance).” *Id.* at 46–47 (citing, *e.g.*, Ex. 2006 (Hwang Decl.) ¶¶ 33–34).

Those arguments do not persuade us that the Petition’s analysis fails to meet the threshold for institution of trial. As set forth above, Example 7 of Yamaguchi '874 expressly discloses only the elements recited by claim 10, and it discloses them in weight percentages that fall squarely within the scope of the ranges recited by claim 10. Ex. 1006 ¶ 27. Relying on Example 7, and consistent with the express disclosure of Yamaguchi '874, Dr. Morris asserts 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.” Ex. 1004 ¶ 123.

We recognize that Patent Owner includes a Declaration from a named inventor on the '947 patent, Jennie S. Hwang, Ph.D. (Ex. 2006), and that Dr. Hwang asserts that certain examples of Yamaguchi '874 “may” have poor fatigue resistance. *See* Ex. 2006 ¶¶ 35–36. Even assuming, however,

that fatigue resistance is a basic and novel property required by claim 10, and that Examples 2 and 5 of Yamaguchi '874 have poor fatigue resistance due to their high tensile strength, that does not indicate that Example 7 (which has a lower tensile strength) would also have poor fatigue resistance. As set forth above, and in contrast to Examples 2 and 5, the weight percentages of the elements of Example 7 of Yamaguchi '874 fall squarely within the claimed ranges, and Patent Owner does not provide a persuasive explanation as to why Example 7 of Yamaguchi '874 would lack desired fatigue resistance but the composition of claim 10 would not. *Cf. In re Papesch*, 315 F.2d 381, 391 (CCPA 1963) (chemical compound and its properties are “inseparable”).

During the prosecution of the parent application of the application that led to the '947 patent (“the '323 application”), the applicant criticized the Examiner’s finding that impurities may be present in the compositions of Yamaguchi '874, and the applicant repeatedly asserted that Yamaguchi '874 “does not include a statement that impurities could be present.” *E.g.*, Ex. 1002 at 80–81. It is noteworthy that Patent Owner now appears to take the opposite position. *See* Prelim. Resp. 46–47. We agree with the applicant’s statements during related prosecution that Yamaguchi '874 gives no indication that any impurities are present in its compositions. *See generally* Ex. 1006. Thus, even assuming that, in practice, trace amounts of impurities would be present in a composition that is physically reduced to practice, the composition that is described in Table 1 of Yamaguchi '874 includes no impurities and appears to anticipate claim 10 of the '947 patent.

Moreover, on this record, Patent Owner does not provide a persuasive reason to believe that any impurities that may be in the composition of

Example 7 of Yamaguchi '874 would have been of a quality or quantity sufficient to prevent Example 7 from having the same basic and novel properties as the alloy of claim 10. Yamaguchi '874 discloses properties (strength, wettability, desirable melting temperature, Ex. 1006 at [57]) and purposes (electronic components, *id.* ¶ 2) substantially the same as those disclosed by the Specification of the '947 patent, *see* Ex. 1001 at [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 electronic industry and is described as having superior mechanical strength, desirable melting points, and appropriate wettability). Dr. Morris relies on those properties and purposes in comparing the alloy of Yamaguchi '874 to the alloy of claim 10. *See* Ex. 1004 ¶¶ 114–116. The fact that neither Yamaguchi '874 nor the Specification of the '947 patent discusses impurities suggests that a person of ordinary skill in the art would not have expected typical quantities and types of impurities to meaningfully affect the properties of the solder alloy. At least at this stage of the proceeding, the fact that Yamaguchi '874 may not expressly describe the fatigue resistance properties of its alloys does not persuade us that Petitioner has failed to establish a reasonable likelihood of prevailing. Based on the current record, we determine that Petitioner has established a reasonable likelihood that it will prevail with respect to claim 10 on this ground.

E. 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 a reasonable likelihood that Petitioner will prevail with respect to this proposed ground of unpatentability.

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 at 4.<sup>3</sup> 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 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 labeled “Lead-free Solder Alloys Investigated Recently,” reproduced below as annotated by Petitioner.

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 at 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 at 6.

<sup>3</sup> Pincites to Lee refer to the page number added to the bottom right corner of the reference by Petitioner.

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. 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.<sup>4</sup> 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 remainder of Table 4 likewise to refer to weight percentages. Pet. 42–43 (citing several references). Therefore, Petitioner asserts that the Senju example of Lee anticipates claim 10. Pet. 41–44.

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<sup>4</sup> The parties agree that the “%” symbol in claim 10 refers to weight percentage. *See* Pet. 7; Prelim. Resp. 28–29; *see also* Ex. 1001 at 3:60–61 (“Unless otherwise identified in the description and claims, all parts and percentages are by weight.”).

Patent Owner argues only that Lee does not anticipate claim 10 because Lee “does not disclose whether the listed values are weight percentages, as required by claim 10, or are some other unit of measurement.” Prelim. Resp. 49–50. Patent Owner asserts that “such compositions may be also defined by atomic percentage (at%).” *Id.*

That argument does not persuade us that the Petition’s analysis fails to meet the threshold for institution. In particular, we note that Patent Owner does not persuasively address or otherwise refute Petitioner’s explanation as to why a person of ordinary skill in the art would have understood Table 4 to refer to weight percentages. At least at this stage of the proceeding, we find Petitioner’s explanation to be persuasive and consistent with the record.

Additionally, we observe that the current record indicates only two possibilities for the disclosed numbers: weight percentage or atomic percentage. *See, e.g.*, Pet. 44–45 (describing “only two options (weight or atomic percent)”); Ex. 1004 ¶ 147; Prelim. Resp. 50 (identifying only “atomic percentage” as a potential alternative to weight percentage). Given only two options, it appears that a person of ordinary skill in the art would have “at once envisage[d]” both options even if there were some ambiguity as to which option were intended. *See Kennametal, Inc. v. Ingersoll Cutting Tool Co.*, 780 F.3d 1376, 1381 (Fed. Cir. 2015) (“[A] reference can anticipate a claim even if it does not expressly spell out all the limitations arranged or combined as in the claim, if a person of skill in the art, reading the reference, would ‘at once envisage’ the claimed arrangement or combination.” (some internal quotation marks and citation omitted)). Thus, even if Lee’s numbers are ambiguous in the way asserted by Patent Owner,

Petitioner's showing would still be sufficient to establish a reasonable likelihood of prevailing as to this proposed ground of unpatentability.

Petitioner has established a reasonable likelihood that it will prevail with respect to claim 10 on this ground.

F. OBVIOUSNESS OF CLAIM 10 IN VIEW OF LEE

Petitioner asserts that, if not anticipated by Lee, claim 10 would have been obvious in view of Lee. Pet. 44–45. Petitioner argues: “A POSITA, having the disclosure of the Senju SAC-B alloy in Lee, would have known that only two options for the disclosed element amounts existed, weight percent or atomic percent. Thus, even if ambiguous (which it is not), with only two options (weight or atomic percent), the disclosure renders claim 10 of the '947 patent obvious.” Pet. 44–45.

Patent Owner argues that Lee discloses a wide variety of compositions and provides no particular reason to look specifically at the Senju example. Prelim. Resp. 51–53.

We offer the following observations as to this proposed ground. The Petition does not extensively discuss the fact that Lee discloses alloys other than the Senju example. However, the number of disclosed compositions appears to be less than 50, *see* Lee at 6 (Table 4), and, even if doubled to reflect Patent Owner's argument that the numbers could be weight percent or atomic percent, the total number of compositions remains less than 100. “That the [prior art] patent discloses a multitude of effective combinations does not render any particular formulation less obvious.” *Merck & Co. v. Biocraft Labs., Inc.*, 874 F.2d 804, 807 (Fed. Cir. 1989).

We also observe that, in a case involving a single reference obviousness analysis as an alternative to an anticipation analysis that we

have found reasonably likely to prevail, the principle that “anticipation is the epitome of obviousness” would appear to be relevant. *See Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1372–74 (Fed. Cir. 2019).

G. OBVIOUSNESS OF CLAIM 10 IN VIEW OF MATSUMOTO

Petitioner asserts that claim 10 would have been obvious in view of Matsumoto. Pet. 45–53. For reasons set forth below, we determine that Petitioner’s arguments and evidence establish a reasonable likelihood that Petitioner will prevail with respect to this proposed ground of unpatentability.

1. *Matsumoto (Ex. 1011)*

Matsumoto identifies environmental and toxicity concerns with lead-containing solders, and Matsumoto states that “there has been an urgent need to develop a lead-free solder without the use of lead, doing so while maintaining characteristics equivalent to those of lead-containing solders.” Ex. 1011 ¶ 2. Consistent with that need, Matsumoto “pertains to a lead-free solder primarily used to accurately mount small chip components and semiconductor components on a circuit board of an electronic device or electrical equipment.” *Id.* ¶ 1. A “purpose” of Matsumoto is identified as follows: “To provide a lead-free solder that allows the melting point to be lower and thus provides good wettability and mechanical properties.” *Id.* at [57] (abstract).

Matsumoto discusses “operational advantages” to its invention and discusses the effect of various metals on the properties of the solder. *Id.* ¶¶ 8–12. For example, Matsumoto teaches that the addition of Ag to primary component Sn “is effective in lowering the melting point and

improving the mechanical properties,” and explains that “such effects are insufficient when the additive amount of Ag is 1.0 wt% or less, whereas the addition of 3.0 wt% or more will be minimally effective without notable enhancements and is therefore unfavorable because it will only lead to high cost and a higher liquidus temperature.” *Id.* ¶ 9. Matsumoto includes similar discussions concerning Cu and Bi. *Id.* ¶¶ 10–11.

Matsumoto identifies the following solder alloy as “resolv[ing]” its objectives: “Ag 1.0 to 3.0 wt%; Cu 0.5 to 2.0 wt%; Bi 1.0 to 10.0 wt%; and Sn constituting all or the majority of the remaining portion.” *Id.* ¶ 7.

## 2. Analysis

Petitioner provides the following table showing the overlap of Matsumoto’s composition with claim 10 (Petitioner refers to Matsumoto as JP ’277).

	Sn	Cu	Ag	Bi
US ’947, Claim 10	76 – 96	0.2 – 2.5	2.5 – 3.5	0.5 – 5.0
JP ’277	<b>85-97.5</b>	<b>0.5-2.0</b>	<b>1.0-3.0</b>	<b>1.0-10</b>

Pet. 46. 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 47–53. Petitioner also argues that the ranges of claim 10 are not critical and do not produce unexpected results. *Id.* Petitioner argues that, because the weight percent range of each element of Matsumoto’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 47 (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.”)).

Patent Owner does not persuasively dispute Petitioner’s assertion that the weight percentages of the alloy elements were known result-effective variables. *See* Prelim. Resp. 53–58. For reasons set forth above and in the Petition, *see* Pet. 13–23, and for purposes of institution, Petitioner has adequately established that the weight percentages of the recited elements were known result-effective variables that a person of ordinary skill in the art would have been motivated to optimize to achieve desired solder alloy characteristics.

Patent Owner argues that the claimed amount of silver is critical and produces unexpected results. *See* Prelim. Resp. 56–58. Patent Owner cites portions of the declaration of Zhenfeng Guo filed during the prosecution of the ’323 application. *Id.* at 15–16; Ex. 1002 at 59–61 (Guo Declaration); *see also* Ex. 1003 at 80–82 (Guo Declaration).

The Federal Circuit has explained:

[E]ven though a modification results in great improvement and utility over the prior art, it may still not be patentable if the modification was within the capabilities of one skilled in the art, *unless the claimed ranges produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art.*

*Iron Grip Barbell Co. v. USA Sports, Inc.*, 392 F.3d 1317, 1322–23 (Fed. Cir. 2004) (emphasis added; internal quotation marks and alterations omitted). “A claimed range that demonstrates such unexpected results is referred to as a ‘critical’ range, and the patentee has the burden of proving criticality.” *Synvina*, 904 F.3d at 1006.

“[I]t is well settled that unexpected results must be established by factual evidence.” *In re Geisler*, 116 F.3d 1465, 1470 (Fed. Cir. 1997) (quoting *In re De Blauwe*, 736 F.2d 699, 705 (Fed. Cir. 1994)). “[A]ny superior property must be *unexpected* to be considered as evidence of non-obviousness.” *See Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1371 (Fed. Cir. 2007) (emphasis in original).

At this stage of the proceeding, there is a genuine dispute of material fact as to whether the claimed silver range is critical and/or yields unexpected results. Dr. Morris provides a detailed and persuasive explanation as to why the claimed silver range would not have been considered critical by a person of ordinary skill in the art. *See* Ex. 1004 ¶¶ 168–188. Although Patent Owner criticizes Dr. Morris’s analysis as a “conclusory” “pseudo-analysis,” *see* Prelim. Resp. 57, Patent Owner does not meaningfully address the points raised by Dr. Morris, which appear to be supported by the current record and by the data relied on by Dr. Morris. *See* Ex. 1004 ¶¶ 168–188. As to unexpected results, we recognize that the word “unexpected” (or a variant) appears in the Preliminary Response. *E.g.*, Prelim. Resp. 4, 16. However, we discern no persuasive explanation or evidence as to why any results would have been considered “unexpected” as opposed to merely being considered “superior.” *Cf. Pfizer*, 480 F.3d at 1371 (“Thus, in order to properly evaluate whether a superior property was unexpected, the court should have considered what properties were expected.”).

Additionally, we observe that the Guo Declaration discussed only five compositions, and only three of those compositions fall within the scope of claim 10. *See* Ex. 1004 ¶ 169 (listing compositions described in the Guo

Declaration). The range of Sn content in the five compositions is 90.5–93.3 wt%, whereas claim 10 recites a significantly broader Sn content range of 76% to 96%. *Compare* Ex. 1004 ¶ 169 *with* Ex. 1001 claim 10. Similarly, all five compositions discussed by the Guo Declaration have a Bi content of either 3.0 or 3.1 wt%, whereas claim 10 recites a significantly broader Bi content range of 0.5 to 5.0 wt%. *Compare* Ex. 1004 ¶ 169 *with* Ex. 1001 claim 10. At least at this stage of the proceeding, it is not sufficiently clear that the alleged unexpected results are commensurate in scope with claim 10 to support a conclusion of nonobviousness. *See 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)).

Whether criticality and unexpected results support Patent Owner’s assertion that the subject matter of claim 10 would not have been obvious is an issue best resolved after the development of a complete trial record. On the current record, Petitioner’s evidence and arguments are adequate to establish a reasonable likelihood that Petitioner will prevail in its challenge to claim 10 on this ground.

H. 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 a reasonable likelihood that Petitioner will prevail with respect to this proposed ground of unpatentability.

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 at 3–4.<sup>5</sup> 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 explains that Ag content influences thermal resistance and melting point, that Bi content influences melting point and wettability, and that Cu content influences the strength of solder joints. *Id.* 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

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<sup>5</sup> Pincites to Yamaguchi '923 refer to the page number added to the bottom right corner of the reference by Petitioner.

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 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	<b>77.8 - 92.9</b>	<b>0.1 - 0.7</b>	<b>2.0 - 3.5</b>	<b>5 - 8</b>

Pet. 56.<sup>6</sup> Similar to the proposed ground based on Matsumoto, discussed above, Petitioner argues that the subject matter of claim 10 would have been obvious because the elements were known result-effective variables and the ranges overlap, and because the claimed ranges are not critical and do not produce unexpected results. *Id.* at 56–57.

Patent Owner groups Yamaguchi '923 with Matsumoto and raises the same arguments discussed above. *See* Prelim. Resp. 53–57. For reasons set forth above in our discussion of the ground based on Matsumoto, Petitioner’s evidence and arguments are adequate to establish a reasonable

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<sup>6</sup> Petitioner’s identification of “5 – 8” as the range of Bi disclosed by Yamaguchi '923 appears to include a typographical error and should read “5 – 18.” *See* Ex. 1024 at 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).

likelihood that Petitioner will prevail in its challenge to claim 10 based on Yamaguchi '923.

I. OTHER ARGUMENTS RAISED BY PATENT OWNER

Patent Owner asks us to deny the Petition for additional reasons, which we address below.

1. 35 U.S.C. § 325(d)

Patent Owner argues that we should exercise our discretion to deny the Petition under 35 U.S.C. § 325(d) because (1) Yamaguchi '874 was considered during prosecution of the '947 patent or its parent application, (2) Lee is cumulative of Yamaguchi '947, (3) Matsumoto was considered during prosecution of the '947 patent or its parent application, and (4) Yamaguchi '923 is cumulative of Matsumoto. Prelim. Resp. 30–43.

Institution of *inter partes* review is discretionary. See 35 U.S.C. § 314(a); 37 C.F.R. § 42.108(a) (“the Board *may* authorize the review to proceed” (emphasis added)); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2140 (2016) (the AIA does not impose a “mandate to institute review”). Our discretion is guided by 35 U.S.C. § 325(d), which provides, in relevant part:

MULTIPLE PROCEEDINGS -- . . . In determining whether to institute or order a proceeding under this chapter, chapter 30, or chapter 31, the Director may take into account whether, and reject the petition or request because, the same or substantially the same prior art or arguments previously were presented to the Office.

We may consider multiple factors when determining whether to exercise our discretion not to institute under § 325(d), including:

(a) the similarities and material differences between the asserted art and the prior art involved during examination; (b) the cumulative nature of the asserted art and the prior art evaluated during examination; (c) the extent to which the asserted art was evaluated during examination, including whether the prior art was the basis for rejection; (d) the extent of the overlap between the arguments made during examination and the manner in which Petitioner relies on the prior art or Patent Owner distinguishes the prior art; (e) whether Petitioner has pointed out sufficiently how the Examiner erred in its evaluation of the asserted prior art; and (f) the extent to which additional evidence and facts presented in the Petition warrant reconsideration of the prior art or arguments.

*Becton, Dickinson & Co. v. B. Braun Melsungen AG*, Case IPR2017-01586, Paper 8 at 17–18 (PTAB Dec. 15, 2017) (informative).

In this case, we are not persuaded that we should exercise our discretion under § 325(d) to deny the Petition. Although Yamaguchi '874 was considered by the Examiner during examination of the parent '323 application, and thus *Becton* factors (a)–(c) may support Patent Owner's argument, it appears that the Examiner did not have an English translation of Yamaguchi '874 and/or that the Examiner did not consider Table 1 relied upon by Petitioner in this proceeding. *See* Ex. 1002 at 31–32. The Examiner expressly stated that “[t]he features relied upon described above can be found in the references *at their abstracts*,” *id.* (emphasis added), and Patent Owner identifies no portion of the prosecution history where the Examiner cited, discussed, or otherwise acknowledged Example 7 of Table 1, *see* Prelim. Resp. 30–43. Additionally, Patent Owner has not identified a translation of Yamaguchi '874 in the file history of either application. Thus, factors (d)–(f) weigh strongly against exercising our discretion to deny the Petition under § 325(d).

Particularly in view of the likelihood that the Examiner did not have an English translation of Yamaguchi '874 and/or that the Examiner did not consider Table 1 of Yamaguchi '874, we do not consider Lee to be “cumulative” of art considered by the Examiner in any respect that might warrant denial of the Petition under § 325(d). Patent Owner identifies no relationship between Lee and Yamaguchi '874, and Lee independently discloses separate and distinct solder alloys relevant to the patentability of the challenged claim.

We decline to deny the Petition under § 325(d) on basis of Patent Owner’s arguments concerning Yamaguchi '874 and Lee.

Because we have determined that denial under § 325(d) is not warranted as to at least three of Petitioner’s proposed grounds, and because a decision to institute is “a simple yes-or-no institution choice respecting a petition, embracing all challenges included in the petition,” *PGS Geophysical AS v. Iancu*, 891 F.3d 1354, 1360 & n.2 (Fed. Cir. 2018) (citing *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348, 1359–60 (2018) and corresponding USPTO Guidance, <https://www.uspto.gov/patents-application-process/patent-trial-and-appeal-board/trials/guidance-impact-sas-aia-trial> (Apr. 26, 2018)), we decline to address Patent Owner’s § 325(d) arguments concerning Matsumoto and Yamaguchi '923.

## 2. *Board Resources*

Patent Owner argues that we should exercise our discretion to deny the Petition under 35 U.S.C. § 314(a) because “the '947 patent is now expired, and an IPR would be a waste of the Board’s and parties’ resources.” Prelim. Resp. 58. Petitioner also argues that, “[d]espite knowing of the prior art that it now asserts in this Petition, Petitioner waited a significant period

of time before filing the Petition.” *Id.* at 58–59 (citing *General Plastic Indus. Co. v. Canon Kabushiki Kaisha*, IPR2016-01357, Paper 19 (PTAB Sept. 6, 2017) (precedential)).

We are not persuaded that we should exercise our discretion under § 314(a) to deny the Petition. This case will not consume a disproportionately or inappropriately significant amount of the Board’s resources. Patent Owner fails to persuasively explain how any of the *General Plastic* factors weigh in favor of denial in this case, *see* Prelim. Resp. 58–59, particularly in view of the fact that *General Plastic* was principally concerned with “follow-on petitions,” *see* Paper 19 at 8, and Patent Owner does not allege that a “follow-on petition” is at issue in this case. Patent Owner also does not allege that the Petition fails to comply with any statutory requirements for the timing of petitions, or that Petitioner’s timing somehow enabled Petitioner to gain an unfair advantage in this proceeding. We decline to deny the Petition under § 314(a).

### 3. *Translation Affidavits*

Patent Owner argues that we should deny the Petition because the translation “Certification[s]” attached to Yamaguchi ’874, Matsumoto, and Yamaguchi ’923, *see, e.g.*, Ex. 1006 at 1 (“Certification”), fail to comply with the Board’s rules for failure to “warn the translator that willful false statements and the like are punishable by fine or imprisonment, or both.” Prelim. Resp. 60 (internal quotation marks omitted).

We separately resolved this issue, and Petitioner filed updated exhibits. *See* Paper 9; Exs. 1037–1040. Accordingly, this argument does not provide a basis for denial of the Petition.

### III. CONCLUSION

We determine that Petitioner has demonstrated a reasonable likelihood of prevailing in showing the unpatentability of claim 10. At this preliminary stage of the proceeding, we have not made a final determination with respect to the resolution of any factual or legal issue.

### IV. ORDER

It is hereby:

ORDERED that, pursuant to 35 U.S.C. § 314(a), *inter partes* review of claim 10 of the '947 patent is instituted with respect to all grounds set forth in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4(b), *inter partes* review of claim 10 of the '947 patent shall commence on the entry date of this Order, and notice is hereby given of the institution of *inter partes* review.

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Patent 6,176,947 B1

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