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Paper 38
Entered: March 28, 2023

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AMPEREX TECHNOLOGY LIMITED,
Petitioner,

v.

MAXELL, LTD.,
Patent Owner.

IPR2021-01442
Patent 9,166,251 B2

Before KRISTINA M. KALAN, WESLEY B. DERRICK, and ELIZABETH M. ROESEL, *Administrative Patent Judges.*

KALAN, *Administrative Patent Judge*.

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

I. INTRODUCTION

Amperex Technology Limited ("Petitioner") filed a Petition (Paper 2, "Pet.") requesting *inter partes* review of claims 1–37 of U.S. Patent No. 9,166,251 B2 (Ex. 1001, "the '251 patent"). Maxell, Ltd. ("Patent Owner") filed a Preliminary Response (Paper 9). Pursuant to Board authorization, Petitioner filed a Reply (Paper 10) and Patent Owner filed a Sur-Reply (Paper 13).

We instituted *inter partes* review of claims 1–37 of the '251 patent on the grounds of unpatentability alleged in the Petition. Paper 16 ("Dec."). After institution of trial, Patent Owner filed a Patent Owner Response. Paper 23 ("PO Resp."). Petitioner filed a Reply. Paper 26 ("Reply"). Patent Owner filed a Sur-Reply. Paper 31 ("Sur-Reply"). We held an oral hearing on January 10, 2023, and a transcript of the hearing is included in the record. Paper 37 ("Tr.").

This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a). For the reasons that follow, we determine that Petitioner has shown by a preponderance of the evidence that claims 1–37 of the '251 patent are unpatentable.

A. Related Proceedings

The parties identify the following district court litigation as a related matter: *Maxell, Ltd. v. Amperex Tech. Ltd.*, No. 6:21-cv-00347-ADA (W.D. Tex.). Pet. 69; Paper 8, 2 (Patent Owner's updated mandatory notices).

B. Real Parties-in-Interest

Petitioner identifies itself as the real party-in-interest. Pet. 69. Patent Owner identifies itself as the real party-in-interest, but clarifies: "On October 1, 2021, following a corporate restructuring, Maxell Holdings, Ltd.

changed its name to Maxell, Ltd. Maxell, Ltd. is working to update assignment records to reflect Patent Owner's new name." Paper 4, 2.

C. The '251 Patent

The '251 patent is titled "Battery Separator and Nonaqueous Electrolyte Battery," and is directed to a battery including "a positive electrode having a positive active material capable of intercalating and deintercalating a lithium ion, a negative electrode having a negative active material capable of intercalating and deintercalating a lithium ion, a separator interposed between the positive electrode and the negative electrode, and a nonaqueous electrolyte." Ex. 1001, codes (54), (57). The "heat generation starting temperature of the positive electrode is 180° C. or higher," and the separator "includes heat-resistant fine particles and a thermoplastic resin" where the "proportion of particles with a particle size of 0.2 μm or less in the heat-resistant fine particles is10 vol% or less and the proportion of particles with a particle size of 2 μm or more in the heat-resistant fine particles is 10 vol% or less," and the "separator effects a shutdown in the range of 100° C. to 150° C." *Id.* at code (57). Figure 1B of the '251 patent is reproduced below.

FIG. 1B

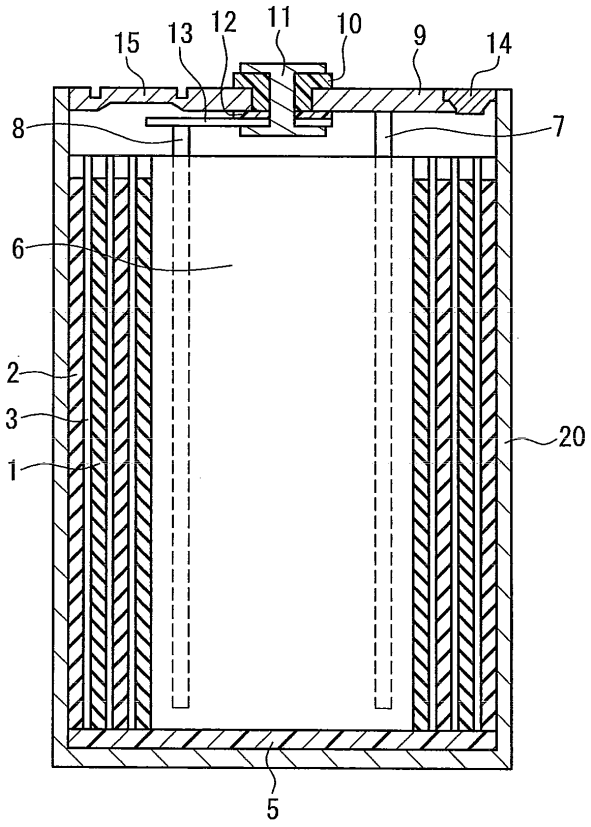


Figure 1B of the ’251 patent is a schematic cross-sectional view of a nonaqueous electrolyte battery, having negative electrode 1 and positive electrode 2 wound via separator 3 in a spiral fashion, and then pressed into a flat shape, thereby providing wound electrode body 6, housed in rectangular cylindrical outer can 20. *Id.* at 2:63–65, 13:34–40. The ’251 patent provides examples illustrating production of a separator (*see, e.g.*, *id*. at 14:56–15:10, 16:35–42) and the results of the measurement of thermal shrinkage ratio and the measurement of shutdown temperature using these separators (*id*. at 17:39–18:42; Table 1).

D. Illustrative Claims

Claims 1 and 10 are representative of the challenged claims, and are reproduced below:

1[Pre]. A battery separator comprising:
[1.A] heat-resistant fine particles; and
[1.B] a thermoplastic resin,
[1.C] wherein the heat-resistant fine particles along with a binder constitute a heat-resistant layer,
[1.D] the thermoplastic resin constitutes a shutdown layer formed of a heat-shrinkable microporous film,
[1.E] the heat-resistant layer and the shutdown layer are integrated into a multilayer structure,
[1.F] the shutdown layer has a thickness A (μm) of 5 to 30, the heat-resistant layer has a thickness B (μm) of 1 to 10, a sum of A and B is 6 to 23, and a ratio A/B is 1/2 to 4,
[1.G] a content of the heat-resistant fine particles in the heat-resistant layer is 50 vol % or more of a total volume of components in the heat-resistant layer,
[1.H] a proportion of particles with a particle size of 0.2 μm or less in the heat-resistant fine particles is 10 vol% or less and a proportion of particles with a particle size of 2 μm or more in the heat-resistant fine particles is 10 vol% or less, and
[1.I] a shutdown is effected in a range of 135° C. to 150° C.

Ex. 1001, 19:51–20:4 (bracketed designations added).

10. A nonaqueous electrolyte batter[y] comprising:
a positive electrode having a positive active material capable of intercalating and deintercalating a lithium ion;
a negative electrode having a negative active material capable of intercalating and deintercalating a lithium ion;
a separator interposed between the positive electrode and the negative electrode; and
a nonaqueous electrolyte,
wherein a heat generation starting temperature of the positive electrode is 180° C. or higher, and
wherein the separator is the battery separator according to claim 1.

Id. at 20:27–40.

E. Instituted Grounds of Unpatentability

We instituted *inter partes* review of claims 1–37 of the '251 patent on the following grounds:

Ground	References/Basis	35 U.S.C. §[1]	Claims Challenged
1A	Kasamatsu,[2] Katayama[3]	§ 103	1, 3–10, 13–30, 32–37
1B	Kasamatsu, Katayama, Miyatake[4]	§ 103	2, 11, 12
2A	Yoshida,[5] Nagayama,[6] Takezawa,[7] Amagi[8]	§ 103	1, 4–10, 13, 15–23, 26–27, 30–35
2B	Yoshida, Nagayama, Takezawa, Amagi, Miyatake	§ 103	2, 11, 12

[1] The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) ("AIA"), included revisions to 35 U.S.C. § 103 that became effective on March 16, 2013. Because the '251 patent has an effective filing date prior to the effective date of the applicable AIA amendments, we refer to the pre-AIA version of § 103.

[2] WO 2006/061936 A1, published on June 15, 2006 (Ex. 1005). Exhibit 1005 includes a copy of the original document and a certified translation. Pet. 5 n.1.

[3] WO 2007/066768 A1, published on June 14, 2007 (Ex. 1006). Exhibit 1006 includes a copy of the original document and a certified translation. Pet. 5 n.1.

[4] JP 2007-335294, published on December 27, 2007 (Ex. 1007). Exhibit 1007 includes a copy of the original document and a certified translation. Pet. 5 n.1.

[5] EP 1115166 A1, published on July 11, 2001 (Ex. 1008).

[6] WO 2006/134833 A1, published on December 21, 2006 (Ex. 1009). Exhibit 1009 includes a copy of the original document and a certified translation. Pet. 5 n.1.

[7] US 2007/0015058 A1, published on January 18, 2007 (Ex. 1010).

[8] JP 2003-306594, published October 31, 2003 (Ex. 1022). Exhibit 1022 includes a copy of the original document and a certified translation. Pet. 5 n.1.

Ground	References/Basis	35 U.S.C. §[1]	Claims Challenged
2C	Yoshida, Nagayama, Takezawa, Amagi, Katayama	§ 103	3, 14, 24–25, 28–29, 36–37

In support of its unpatentability arguments, Petitioner relies on the declaration of Dr. Walter van Schalkwijk. Ex. 1003. Patent Owner relies on the declarations of Dr. Brett Lucht to support its opposition. Ex. 2008; Ex. 2015.

II. ANALYSIS

A. Legal Standards

A claim is unpatentable under 35 U.S.C. § 103(a) if 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 to a person of ordinary skill in the art at the time the invention was made. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). Obviousness is resolved based on underlying factual determinations, including: (1) the scope and content of the prior art; (2) differences between the prior art and the claims at issue; (3) the level of ordinary skill in the art; and (4) when in evidence, objective evidence of nonobviousness, i.e., secondary considerations.[9] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). Subsumed within the *Graham* factors are the requirements that all claim limitations be found in the prior art references and that the skilled artisan would have had a reasonable expectation of success in combining the prior art references to achieve the

[9] Neither Patent Owner nor Petitioner appear to present any evidence directed to objective indicia. *See generally* Pet., PO Resp., Reply, Sur-Reply.

claimed invention. *Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1361 (Fed. Cir. 2007). A decision on the ground of obviousness must include "articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006). The obviousness analysis "should be made explicit" and it "can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does." *KSR*, 550 U.S. at 418.

Petitioner bears the burden of proving unpatentability of the challenged claims, and the burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). Petitioner must demonstrate unpatentability by a preponderance of the evidence. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d); *see also Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")).

B. Level of Ordinary Skill in the Art

In our Institution Decision, we adopted Petitioner's undisputed contention that a person of ordinary skill in the art "would have had at least a bachelor's degree in chemistry, chemical engineering, or materials science and five or more years of experience in the field of batteries and battery materials" (Pet. 7 (citing Ex. 1003 ¶ 11)), with the caveat that the phrases "at least" and "or more" should not be construed as requiring a significantly greater level of education or experience than is explicitly set forth in Petitioner's definition. Dec. 7–8.

Patent Owner argues that one of ordinary skill in the art "in the field of the '251 Patent would have a bachelor's degree in chemistry, chemical engineering, or materials science or equivalent skill from professional experience, and about three years of experience in the field of batteries and battery materials." PO Resp. 10 (citing Ex. 2015 ¶ 24). During the hearing, Patent Owner stated that "we're fine with what the Board has expressed in its Institution Decision" as the definition of a person of ordinary skill in the art. Tr. 17:11–12.

In its Reply, Petitioner argues that "Patent Owner readily admits that its definition is substantially similar to the definition proposed by Petitioner and the one adopted in the Institution," and even "Patent Owner's expert agrees that his analysis would be the same under either construction." Reply 2 (citing Ex. 2008 ¶ 16).

Neither party argues that the outcome of this case would differ based on our adoption of any particular definition of one of ordinary skill in the art. We retain the definition set forth in the Institution Decision, because it is consistent with the cited prior art. We further note that the prior art itself demonstrates the level of skill in the art at the time of the invention. *Cf. Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (explaining that "specific findings on the level of skill in the art . . . [are not required] 'where the prior art itself reflects an appropriate level and a need for testimony is not shown'" (quoting *Litton Indus. Prods., Inc. v. Solid State Sys. Corp.*, 755 F.2d 158, 163 (Fed. Cir. 1985))).

C. Claim Construction

We apply the claim construction standard articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc); 37 C.F.R.

§ 42.100(b). Under *Phillips*, claim terms are afforded "their ordinary and customary meaning." *Phillips*, 415 F.3d at 1312. The "ordinary and customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention." *Id.* at 1313. Only terms that are in controversy need to be construed, and only to the extent necessary to resolve the controversy. *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

Petitioner states that "each of the challenged claims includes terms that POSITA would understand according to their plain and ordinary meaning." Pet. 5. Patent Owner does not appear to propose any express claim constructions. *See generally* PO Resp.; Sur-Reply. On this record, we determine that no claim terms require express construction.

D. Asserted Obviousness – Grounds 2A, 2B, and 2C

Petitioner argues that Yoshida, Nagayama, Takezawa, and Amagi would have rendered obvious claims 1, 4–10, 13, 15–23, 26–27, and 30–35. Pet. 38–58 (Ground 2A). Petitioner also argues that Yoshida, Nagayama, Takezawa, Amagi, and Miyatake would have rendered obvious claims 2, 11, and 12 (*id.* at 59–60 (Ground 2B)) and that Yoshida, Nagayama, Takezawa, Amagi, and Katayama would have rendered obvious claims 3, 14, 24–25, 28–29, and 36–37 (*id.* at 60–62 (Ground 2C)).

1. Yoshida

Yoshida is a patent application titled "Separator for Cell, Cell, and Method for Producing Separator" and is directed to a separator comprising a first porous layer mainly containing thermoplastic resin and a second porous layer formed over the first porous layer and having a heat resistance higher than that of the first porous layer. Ex. 1008, codes (54) (57).

2. Nagayama

Nagayama is a patent application publication titled "Non-Aqueous Electrolyte Secondary Battery," and is directed to a "non-aqueous electrolyte secondary battery comprising a positive electrode, a negative electrode, and a non-aqueous electrolyte" wherein the "porous heat-resistant layer is arranged between the positive electrode and the negative electrode." Ex. 1009, codes (54), (57).

3. Takezawa

Takezawa is a patent application publication titled "Positive Electrode for Lithium Secondary Battery, and Lithium Secondary Battery Using the Same," and is directed in part to a positive electrode film containing, "as a positive electrode active material, two or more kinds of lithium-containing compounds having exothermic initiation temperatures different from each other," wherein at least "one kind of the two or more kinds of lithium-containing compounds has the exothermic initiation temperature of 300° C. or higher." Ex. 1010, codes (54), (57).

4. Amagi

Amagi is a Japanese unexamined patent application publication titled "Epoxy Resin Composition and Rotating Machine Using the Same," and is directed to an epoxy resin composition having an inorganic filler. Ex. 1022, codes (54), (57). Amagi discloses using inorganic filler in various particle sizes and distributions. *Id.* ¶ 6.

5. Miyatake

Miyatake is a Japanese unexamined patent application publication titled "Laminated Battery." Ex. 1007, codes (12), (54). Miyatake is directed to a laminated rechargeable lithium ion battery having excellent durability

and heat resistance, due to its ability to "sufficiently suppress heat generation and temperature increases due to short circuits and the like." *Id.* at code (57).

6. Katayama

Katayama is a patent application publication titled "Separator for Electrochemical Device and Method for Producing the Same, and Electrochemical Device and Method for Producing the Same," and is directed to an "electrochemical device having excellent safety at a high temperature" because it uses "a separator for an electrochemical device, which is made of a porous film including a first separator layer and a second separator layer." Ex. 1006, codes (54), (57).

7. Petitioner's Arguments

Petitioner asserts that every element of claim 1 is found in the combination of Yoshida, Nagayama, Takezawa, and Amagi, as follows:

[1.Pre] *A battery separator comprising*: (Pet. 44 (relying on Ex. 1008 ¶ 1; Ex. 1009 ¶¶ 7–8, 44; Ex. 1010 ¶ 139; Ex. 1003 ¶¶ 358–360));[10]

[1.A] *heat-resistant fine particles*; (Pet. 44–45 (relying on Ex. 1008 ¶¶ 11, 25–26; Ex. 1009 ¶¶ 21, 9, 28, 4; Ex. 1022, Fig. 1; Ex. 1003 ¶¶ 361–366));

[1.B] *and a thermoplastic resin,* (Pet. 45 (relying on 1008 ¶ 22; Ex. 1009 ¶ 44; Ex. 1010 ¶ 58; Ex. 1003 ¶¶ 368–372));

[1.C] *wherein the heat-resistant fine particles along with a binder constitute a heat-resistant layer,* (Pet. 45 (relying on Ex. 1008 ¶ 25; Ex. 1009 ¶¶ 21, 9; Ex. 1003 ¶¶ 373–374));

[10] We express no opinion on whether the preamble is limiting.

[1.D] *the thermoplastic resin constitutes a shutdown layer formed of a heat-shrinkable microporous film,* (Pet. 46 (relying on Ex. 1008 ¶¶ 36, 22; Ex. 1009 ¶ 44; Ex. 1010 ¶ 58; Ex. 1003 ¶¶ 376–380));

[1.E] *the heat-resistant layer and the shutdown layer are integrated into a multilayer structure,* (Pet. 46–47 (relying on Ex. 1008 ¶ 21, Fig. 1; Ex. 1003 ¶ 382));

[1.F] *the shutdown layer has a thickness A (μm) of 5 to 30, the heat-resistant layer has a thickness B (μm) of 1 to 10, a sum of A and B is 6 to 23, and a ratio A/B is 1/2 to 4,* (Pet. 47 (relying on Ex. 1009 ¶¶ 44, 25; Ex. 1003 ¶¶ 385–387));

[1.G] *a content of the heat-resistant fine particles in the heat-resistant layer is 50 vol % or more of a total volume of components in the heat-resistant layer,* (Pet. 47–48 (relying on Ex. 1008 ¶¶ 31, 42; Ex. 1003 ¶¶ 391–394));

[1.H] *a proportion of particles with a particle size of 0.2 μm or less in the heat-resistant fine particles is 10 vol % or less and a proportion of particles with a particle size of 2 μm or more in the heat-resistant fine particles is 10 vol % or less, and* (Pet. 48–49 (relying on Ex. 1008 ¶ 26; Ex. 1022, Fig. 1; Ex. 1003 ¶¶ 395–402));

[1.I] *a shutdown is effected in a range of 135° C. to 150° C.* Pet. 49 (relying on Ex. 1008 ¶ 22; Ex. 1003 ¶ 404).

Addressing the limitations of claim 1 and its dependents, Petitioner argues that "each of the references are directed to non-aqueous secondary batteries and/or heat-resistant materials for use in non-aqueous secondary batteries." Pet. 39 (citing Ex. 1003 ¶ 337). Petitioner also argues that to the

extent Yoshida does not teach or suggest the claimed particle size distribution, one of ordinary skill in the art "would have looked to identify a particular particle that satisfies its specified particle size distribution," such as the alumina particles (AA-03) disclosed in Amagi, which "met the requirements of Yoshida and would have further improved the Yoshida system." *Id.* at 40 (citing Ex. 1022 ¶¶ 23, 48, 11, Fig. 1; Ex. 1003 ¶ 342). Petitioner further argues that, although Yoshida "does not provide specific implementation details for its separator," one of ordinary skill in the art "would have been motivated to turn to" Nagayama's specific separator properties, with a reasonable expectation of success, because using Nagayama's separator thickness instead of Yoshida's "is just a simple substitution." *Id.* at 41–42 (citing Ex. 1009 ¶¶ 44, 25; Ex. 1003 ¶¶ 345–346).

Addressing the limitations of claim 10 and its dependents, Petitioner contends that, although Yoshida does not specifically recite electrode materials, one of ordinary skill in the art would have looked to Nagayama's disclosed examples of positive electrode materials having heat generation starting temperatures of 180ºC or higher, and used those materials with a reasonable expectation of success as a matter of simple substitution. *Id.* at 42–43 (citing Ex. 1009 ¶¶ 2, 5, 11–12, 34–35, Table 4; Ex. 1003 ¶¶ 347–349, 444–449). Finally, Petitioner argues that one of ordinary skill in the art would have used the cathode materials of Takezawa, which discloses "high-capacity positive electrode active materials having heat generation temperatures ranging from 202 to over 400ºC," in the combination with a reasonable expectation of success as a matter of simple substitution. *Id.* at 43–44 (citing Ex. 1010 ¶¶ 21, 44, 87; Ex. 1003 ¶¶ 350–352).

The remaining challenged claims in Ground 2A all depend, directly or indirectly, from claim 1 or claim 10, and Petitioner presents arguments that the combination of Yoshida, Nagayama, Takezawa, and Amagi discloses all the limitations of those challenged claims. Pet. 50–58 (citing Ex. 1003 ¶¶ 407–487).

For Ground 2B (additionally relying on Miyatake to challenge claims 2, 11, and 12), Petitioner argues that the proposed combinations disclose all of the challenged dependent claim limitations. Pet. 59–60. Petitioner argues that one of ordinary skill in the art "would have turned to a reference that disclosed the specific thermal shrinkage ratio," such as Miyatake, which discloses "that the shrinkage rate of a separator is within 0 to 30% in all regions in the temperature range of 100–200ºC." *Id.* at 59 (citing Ex. 1007 ¶ 47; Ex. 1003 ¶¶ 491–494). Petitioner also argues that one of ordinary skill in the art would have had a "reasonable expectation of success" because Yoshida "discloses that thermal shrinkage of the separator is 'controlled' when a heat-resistant layer containing inorganic filler (such as alumina) is used" and "Miyatake discloses such an inorganic filler." *Id.* (citing Ex. 1008 ¶¶ 20, 25; Ex. 1007 ¶ 50; Ex. 1003 ¶¶ 495–496).

For Ground 2C (additionally relying on Katayama to challenge claims 3, 14, 24–25, 28–29, and 36–37), Petitioner argues that the proposed combination discloses all of the challenged dependent claim limitations. Pet. 60–62. Petitioner argues that Nagayama "does not explicitly disclose a vol. % of heat-resistant particles," but one of ordinary skill in the art "would have been motivated to optimize the concentration of heat-resistant fine particles according to the disclosure of Katayama," which discloses "a preference for at least 80 vol. % of heat-resistant particles in the heat-

resistant layer." *Id.* at 60–61 (citing Ex. 1006 ¶¶ 51, 59, 156; Ex. 1003 ¶¶ 510–512). Petitioner also argues that one of ordinary skill in the art would have had a "reasonable expectation of success," because "Nagayama already taught the need for a high concentration of heat resistant particles and that a concentration of heat-resistant particles greater than 90 weight-percent would work." *Id.* at 61 (citing Ex. 1009 ¶ 24; Ex. 1003 ¶¶ 40, 513). Petitioner also argues that "the claimed binders are all commonly used binders," and "it would have been a simple substitution to use the binders of Katayama in the separator of Yoshida/Nagayama." *Id.* Similarly, Petitioner argues, the three claimed methods of forming a microporous layer "were common ways to manufacture those microporous layers" and "it would have been a simple substitution to use the microporous film of Katayama in place of the microporous film of Yoshida/Nagayama/Takezawa." *Id.* at 61–62.

8. Analysis

i. Ground 2A - Analogous Art

Patent Owner argues that Petitioner's motivation for combining Yoshida, Nagayama, Takezawa, and Amagi is flawed because Amagi is non-analogous art. PO Resp. 28–31. First, Patent Owner argues that Amagi is in a different field of endeavor. *Id.* at 29. Second, Patent Owner argues that Amagi is not reasonably pertinent to any problem addressed by the '251 patent. *Id.* at 29–30. Additionally, Patent Owner argues, Petitioner's reliance on Shinohara (Pet. 41 n.9) should be ignored, because Shinohara is not relied upon in this ground of rejection. PO Resp. 31.

Petitioner replies that a "prior art reference qualifies as reasonably pertinent as long as it addresses 'at least one problem faced by the inventors.'" Reply 17 (quoting *Ethicon LLC v. Intuitive Surgical, Inc.*,

No. 2021-1601, slip op. at 8 (Fed. Cir. May 19, 2022), ECF No. 57). According to Petitioner, the '251 patent "relies on resins and heat resistant particles" to address the "need for improved heat resistance in the separator," and Patent Owner admits that "Amagi discloses 'an epoxy *resin* [with] excellent heat resistance." *Id.* at 17–18 (citing Ex. 1001, 1:36–38, 5:31–44; PO Resp. 30; Ex. 1022 ¶ 10). Thus, argues Petitioner, both the '251 patent and Amagi are part of the field of heat resistant particles and heat resistant resins. *Id.* Petitioner also argues that the '251 patent is concerned with a particular particle size (as is Yoshida), and "Amagi provides specific details regarding a particle that meets each of these requirements and solves at least one problem in those references." *Id.* at 18 (citing Ex. 1003 ¶¶ 337, 341–343, 397–398; Ex. 2016, 75:21–76:22). Moreover, argues Petitioner, "both the '251 patent and Yoshida are concerned with heat resistant materials and insulating materials." *Id.* at 18. Petitioner relies on Dr. van Schalkwijk's testimony and corroborating evidence that "the Amagi heat resistant particles were in fact used in other battery separators." *Id.* (citing Ex. 1025, 23:17–20 (discussed at Ex. 1003 ¶ 343); Ex. 1019 ¶ 118). In sum, Petitioner argues, Amagi is reasonably pertinent because one of ordinary skill in the art "would have understood that the properties of the inorganic filler used to solve heat-related issues in a rotating machine are the same when used to solve the similar heat-related issues in non-aqueous electrolyte batteries." *Id.* at 19 (citing Ex. 1003 ¶ 337 n.30.)

Patent Owner responds, first, that Amagi is not in the same field of endeavor because "Amagi is in the field of 'rotating machinery,'" whereas the '251 patent is in the field of nonaqueous electrolyte batteries. Sur-

Reply 16–18. Second, Patent Owner responds that "Amagi is not pertinent to any problem addressed by the '251 patent," and Petitioner's references to Yoshida are inapposite: "All the evidence presented by Petitioner to allegedly show that Amagi is pertinent prior art is with reference to Yoshida, not the '251 patent." *Id.* at 18–19.

The Federal Circuit has set forth "two separate tests" to determine whether a reference is analogous art to the claimed invention, i.e., whether one of ordinary skill in the art would even look to the teachings of that reference. *In re Bigio*, 381 F.3d 1320, 1325 (Fed. Cir. 2004). They are (1) whether the art is from the same field of endeavor, regardless of the problem addressed and, (2) if the reference is not within the field of the inventor's endeavor, whether the reference is still reasonably pertinent to the particular problem with which the inventor is involved. *Id.*; *Circuit Check Inc. v. QXQ Inc.*, 795 F.3d 1331, 1335 (Fed. Cir. 2015). In order for a reference to be "reasonably pertinent" to the problem, it must "logically . . . have commended itself to an inventor's attention in considering his problem." *In re ICON Health & Fitness, Inc.*, 496 F.3d 1374, 1379–80 (Fed. Cir. 2007); *see also KSR*, 550 U.S. at 417 ("When a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one."). The "reasonable-pertinence analysis must be carried out through the lens of a [person having ordinary skill in the art]." *Donner Tech., LLC v. Pro Stage Gear, LLC*, 979 F.3d 1353, 1360 (Fed. Cir. 2020). The scope of analogous art is to be construed broadly. *Wyers v. Master Lock Co.*, 616 F.3d 1231, 1238 (Fed. Cir. 2010).

We focus here on the "reasonably pertinent" test for analogous art.[11] Based on our review of the disclosures of the '251 patent, we determine that the '251 patent is broadly concerned with a battery separator with improved heat resistance. Ex. 1001, 2:14–19 ("it is an object of the present invention to provide a battery separator that can constitute a nonaqueous electrolyte battery having excellent safety in a high-temperature environment"); *see also* Reply 17 (citing Ex. 1001, 1:36–38). The '251 patent uses resins and heat resistant particles. Ex. 1001, 5:31–44; *see also* Reply 17. Amagi teaches an epoxy resin with excellent heat resistance. Ex. 1022 ¶ 10. We agree with Petitioner that Amagi "is reasonably pertinent to the particular problem with which the inventor is involved," because it addresses one of the same problems, namely, how to make a resin with sufficient heat resistance. *In re Bigio*, 381 F.3d at 1325; *Donner,* 979 F.3d at 1360 ("[I]f the two references have 'pertinent similarities' such that Mullen is reasonably pertinent *to one or more* of the problems to which the '023 patent pertains, then Mullen is analogous art."); *see also In re Clay*, 966 F.2d 656, 659–60 (Fed. Cir. 1992) (noting that similarities in structure and function between the claimed invention and the reference "carry far greater weight [in determining analogy]" (quoting *In re Ellis*, 476 F.2d 1370, 1372 (CCPA 1973))). We also agree with Petitioner that Amagi is "reasonably pertinent to the particular problem with which the inventor is involved" because it addresses another issue pertinent to the heat resistant resin layer in a lithium-ion battery, namely, the particular particle size of the filler in the heat

[11] Because we find that Amagi meets the "reasonably pertinent" test for analogous art, we do not address the question of whether Amagi is in the same field of endeavor as the '251 patent.

resistant resin. Reply 18 (citing Ex. 1003 ¶¶ 337, 341–343, 397–398; Ex. 2016, 75:21–76:22); Ex. 1022 ¶¶ 10–12, 23, Fig. 1.

Patent Owner argues that Amagi is not reasonably pertinent because the "problem to be solved by Amagi is to produce an electric insulator having 'good heat dissipation propert[ies],' 'high thermal conductivity' and 'low viscosity when electrically insulating a rotating machine.'" PO Resp. 29–30 (quoting Ex. 2015 ¶ 47). We disagree. Limiting the reasonably pertinent art to only the battery described in the '251 patent "effectively collapses the field-of-endeavor and reasonable-pertinence inquiries and ignores that the reasonable-pertinence analysis must be carried out through the lens of a [person having ordinary skill in the art] who is considering turning to art outside her field of endeavor." *Donner*, 979 F.3d at 1360. We find credible Dr. van Schalkwijk's testimony that a person of ordinary skill in the art "would have understood that the properties of the inorganic filler used to solve heat-related issues in a rotating machine are the same when used to solve the similar heat-related issues in non-aqueous electrolyte batteries." Ex. 1003 ¶ 337 n.30. We also credit Dr. van Schalkwijk's testimony that "a POSITA would have understood that AA-03 had been used in separators," i.e., that Amagi's particles were, in fact, used in batteries. *Id.* ¶ 343, ¶ 343 n.31 (relying on Shinohara, U.S. 6,447,958, which "explicitly discloses the use of AA03 in a battery").

Despite Patent Owner's urging, we do not discount Petitioner's reliance on Shinohara. Pet. 40–41 (citing Ex. 1003 ¶ 343), 41 n.9. As made clear by Petitioner, "Shinohara does not form part of the combination/ modification" (*id.* at 41 n.9), but rather provides a basis for Dr. van Schalkwijk's testimony. Ex. 1003 ¶ 343. In considering Shinohara as a

basis for Dr. van Schalkwijk's testimony, we heed the instruction of our reviewing court that, when applying the "reasonably pertinent" test, "a reasonable factfinder should consider record evidence cited by the parties to demonstrate the knowledge and perspective of a person of ordinary skill in the art at the time of the invention." *Airbus S.A.S. v. Firepass Corp.*, 941 F.3d 1374, 1383 (Fed. Cir. 2019) (instructing the Board to consider whether an asserted reference is analogous art in view of other prior art references cited). Dr. van Schalkwijk's testimony about Shinohara leads us to conclude that an ordinarily skilled artisan in the field of lithium-ion batteries would have looked to Amagi for its disclosure of a heat resistant epoxy resin, even if Amagi is considered outside the '251 patent's field of endeavor. Ex. 1003 ¶ 343, ¶ 343 n.31.

We also find inaccurate, on this complete record, Patent Owner's characterization that "[a]ll the evidence presented by Petitioner to allegedly show that Amagi is pertinent prior art is with reference to Yoshida, not the '251 patent." Sur-Reply 18–19. Petitioner and Dr. van Schalkwijk provide ample discussion of the reasonable pertinence of Amagi to the '251 patent. Reply 17–19; Pet. 39–41, 41 n.9; Ex. 1003 ¶¶ 333–335, 337, 337 n.30. For example, Petitioner presents the uncontroverted testimony of Dr. van Schalkwijk that a person of ordinary skill in the art "would have understood that the properties of the inorganic filler used to solve heat-related issues in a rotating machine are the same when used to solve the similar heat-related issues in nonaqueous electrolyte batteries." Ex. 1003 ¶¶ 337, 337 n.30. Petitioner's additional discussion of Amagi's relevance to Yoshida does not undermine Petitioner's argument.

We determine reasonable pertinence by determining the problem faced by the inventor of the '251 patent and asking whether the applied reference is pertinent to that problem. Accordingly, we determine that the evidence in the record supports Petitioner's assertion that a person having ordinary skill in the art would have understood the '251 patent's concern with "heat resistant materials and insulating materials" (Reply 18) and looked to Amagi's "epoxy resin composition containing the AA-03 particles" as "an electrically insulating material." *Id*.

We also determine that the evidence in the record supports Petitioner's assertion that a person having ordinary skill in the art "would have understood the importance of the size distribution of the heat-resistant particles." Pet. 48 (citing Ex. 1003 ¶ 395 ("size distribution of the heat resistant particles is important because particles that are too small might become dislodged from the separator and pass through the anode or cathode" and "particles that are too large may deform the shape of the heat-resistant layer and by extension the shape of the overall separator"); Ex. 1008 ¶ 26)); *see also* Reply 18. The evidence also supports Petitioner's assertion that "Amagi discloses an example of [] heat-resistant fine particles (alumina, referred to by the manufacturer as 'Sumicorundum AA-03' or 'AA-03')." Pet. 48–49 (citing Ex. 1022, Fig. 1; Ex. 1003 ¶ 398). Because Amagi is reasonably pertinent to the '251 patent's concern with heat resistant materials and insulating materials, we find that a person of ordinary skill in the art would reasonably have been expected to consult Amagi to address such materials, including the particle size distribution of the filler. As a result, we determine that Amagi is analogous art.

ii. Ground 2A - Combination of Teachings

Patent Owner argues that a "POSA would not be motivated to combine the disparate teachings of Yoshida, Nagayama, Takezawa, and Amagi." PO Resp. 31–35. More particularly, Patent Owner argues that "Petitioner's four-way combination is merely a hindsight-driven approach to piecing together disparate teachings to arrive at the claimed invention." *Id.* at 32. First, according to Patent Owner, "Yoshida does not, in fact, disclose a particle size distribution" and, thus, "under Petitioner's own reasoning," one of ordinary skill would not be motivated to combine Yoshida with Amagi. *Id.* at 33. Second, Patent Owner criticizes Petitioner's reliance on Nagayama, because Yoshida "discloses batteries for portable devices such as laptops and toothbrushes" while Nagayama describes "vibration-resistant batteries for power tools and hybrid electric vehicles." *Id*. Finally, Patent Owner criticizes Petitioner's reliance on Takezawa, because Nagayama "provides no further motivation to combine to achieve the high power output battery that it already describes." *Id.* at 34.

Petitioner replies that the Petition does not suffer from hindsight bias, and Patent Owner's approach "haphazardly walks through each reference and strains to find shortcomings with the references." Reply 19. First, according to Petitioner, "Yoshida specifies a maximum average particle size of at most 0.5 μm and specific consequences related to ion conductivity with regard to the particular particle size and the disclosed end points (e.g., below 0.2 μm and above 2.0 μm)" and, thus, "Yoshida alone renders the claims unpatentable and, if not, provides the POSITA with a strong motivation of exactly what particles to look for—the alumina particles in Amagi." *Id.* at 20. Second, regarding Nagayama and Takezawa, Petitioner argues that

the Petition states that Nagayama would be combined for at least the reason that it provides an optimal thickness, and Petitioner reiterates reasons to combine the references, i.e., incorporating cathode materials having high heat generation starting temperatures, maximizing battery capacity, and minimizing thermal runaway. *Id*. Third, Petitioner argues that "motivation may come from the references themselves or it may come from an outside source." *Id.* at 21 (citing *KSR*, 550 U.S. at 418). The motivation here, Petitioner argues, comes from the references themselves and, also, "thermal runaway is a motivation that would drive a POSITA to improve upon the prior art batteries." *Id.* (citing Ex. 1038, 43:10–18, 56:8–12). Fourth, Petitioner argues that accepting Patent Owner's argument that Nagayama is a complete invention "would be tantamount to a holding that combining two inventions is never permitted because POSITAs never try to improve on existing 'complete' inventions, which is plainly wrong." *Id.* at 21–22. Petitioner reiterates that one of ordinary skill in the art would have looked to Takezawa to disclose the heat generation temperatures that Nagayama was unable to achieve on its own, and use of Takezawa's materials would be a "simple substitution" with reasonable expectation of success. *Id.* at 22 (citing Pet. 43–44).

Patent Owner argues that "Petitioner's expert has made clear that different applications require different sets of criteria—including heat resistance," so that there is not "one battery that is optimal for all applications." Sur-Reply 19 (citing Ex. 2016, 13:24–18:12). First, Patent Owner reiterates that Yoshida provides no particle size distribution, and Amagi is non-analogous art. *Id.* at 20. Second, Patent Owner argues that Petitioner "provides no motivating factor to combine Nagayama and

Takezawa other than generalized 'optimizing' arguments" which is "merely using the claims as a blueprint." *Id.* at 20–21. Third, Patent Owner argues that "Petitioner has identified no application for the Yoshida/Amagi/Nagayama battery that would lead a POSA to look to yet another reference directed to batteries for power tools and cars to further modify the invention." *Id.* at 21. Fourth, Patent Owner argues that Petitioner provides no answer to the question of "why is a very high heat generation starting temperature needed" to make the combination of Nagayama with the remaining references. *Id.* at 22.

We have reviewed Petitioner's rationale to combine and arguments regarding reasonable expectations of success, and are persuaded that Petitioner has met its burden by a preponderance of the evidence, without reliance on hindsight. *See, e.g.*, *In re McLaughlin*, 443 F.2d 1392, 1395 (CCPA 1971) ("Any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning," but "so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made and does not include knowledge gleaned only from applicant's disclosure, such a reconstruction is proper."). Petitioner clearly articulates its motivations to combine with a reasonable expectation of success (Pet. 39–44), supporting these arguments with testimony from its expert (Ex. 1003 ¶¶ 336–357). We credit Petitioner's argument that "each of the references are directed to non-aqueous secondary batteries and/or heat-resistant materials for use in non-aqueous secondary batteries." Pet. 39. Dr. van Schalkwijk explains why Yoshida, Nagayama, and Takezawa "are all directed to non-aqueous secondary batteries and/or heat-resistant materials for use in non-aqueous secondary batteries," and that

one of ordinary skill in the art "would have understood that the properties of the inorganic filler used to solve heat-related issues in a rotating machine [as in Amagi] are the same when used to solve the similar heat-related issues in non-aqueous electrolyte batteries," providing citations to each reference to support his assertions. Ex. 1003 ¶ 337 (citing Ex. 1008 ¶¶ 1, 6; Ex. 1009 ¶ 1; Ex. 1010 ¶ 2), ¶ 337 n.30.

Regarding the combination of Yoshida and Amagi, we credit Petitioner's argument that, to the extent Yoshida does not teach or suggest the claimed particle size distribution, one of ordinary skill in the art "would have looked to identify a particular particle that satisfies its specified particle size distribution," such as the alumina particles (AA-03) disclosed in Amagi, which "met the requirements of Yoshida and would have further improved the Yoshida system." Pet. 40 (citing Ex. 1022 ¶¶ 23, 48, 11, Fig. 1; Ex. 1003 ¶ 342). Dr. van Schalkwijk's testimony here is persuasive:

> In addition to the properties of AA-03 matching those disclosed by Yoshida, the POSITA would have been further motivated to combine the teachings of Amagi based on its disclosure that the disclosed size distribution of alumina is effective and its confirmation of the heat-resistant properties of alumina as an inorganic filler.

Ex. 1003 ¶ 342.

Regarding the combination with Nagayama, and Patent Owner's argument that Yoshida "discloses batteries for portable devices such as laptops and toothbrushes" while Nagayama describes "vibration-resistant batteries for power tools and hybrid electric vehicles" (PO Resp. 33), we agree with Petitioner's cited testimony that this argument "is simply wrong given the diverse applications of lithium ion batteries, the common goals and

methods of manufacturing such batteries, and the overlapping temperature ranges." Reply 21 (citing Ex. 2016, 35:22–37:14; 86:8–88:1; Ex. 1038, 32:16–34:11; Ex. 1003 ¶ 40). We are persuaded that there are many applications for lithium ion batteries, and that these two references are both "directed to non-aqueous secondary batteries and/or heat-resistant materials for use in non-aqueous secondary batteries." Ex. 1003 ¶ 337. Regarding Patent Owner's argument that one of ordinary skill in the art would not consider preventing displacement of the electrodes by swelling (PO Resp. 33), we also credit Petitioner's argument that the motivation to combine these references may come from an outside source but, nevertheless, "the motivation to avoid 'swelling' ***does*** come from the references themselves and therefore provides a sufficient motivation to combine" (Reply 21 (citing *KSR*, 550 U.S. at 418)). We further credit the Petition's argument that Nagayama's separator thicknesses are "optimal for maintaining the high energy density, ion conductivity, and discharge characteristics" (Pet. 40–41), and Dr. van Schalkwijk's testimony:

> Together, Nagayama confirms what Yoshida suggested, that a particular thickness of the heat-resistant layer is advantageous. In this way, the POSITA would have been motivated to include Nagayama's disclosure of its 3 and 7 μm heat resistant layer to minimize swell and to maintain discharge characteristics, and because Yoshida and Nagayama disclose similar separators, a POSITA would have had a reasonable expectation of success in making such a substitution.

Ex. 1003 ¶ 346.

Regarding the combination with Takezawa, we agree with Petitioner that one of ordinary skill in the art would have turned to the cathode materials of Takezawa, which discloses "high-capacity positive electrode

active materials having heat generation temperatures ranging from 202 to over 400ºC," in the combination with a reasonable expectation of success. Pet. 43–44 (citing Ex. 1010 ¶¶ 21, 44, 87; Ex. 1003 ¶¶ 350–352). Contrary to Patent Owner's argument, Petitioner need not "explain why the cathode materials of Nagayama are inadequate for any particular application," and we do not agree that "Nagayama provides no further motivation to combine to achieve the high power output battery that it already describes." PO Resp. 34. We credit Petitioner's position that Nagayama on its own was unable "to achieve heat generation temperatures that a POSITA would have required" and Takezawa's disclosure of a higher exothermic initiation temperature minimizes thermal runaway of the positive electrode. Reply 21 (citing Ex. 1003 ¶¶ 350–352; Ex. 1010 ¶ 21). We further credit the testimony of Dr. van Schalkwijk, who opines that "the importance of maximizing battery capacity and overall safety" would have led one of ordinary skill in the art to turn to the cathode materials of Takezawa. Ex. 1003 ¶ 350. "Indeed, recognizing that having a cathode active material with a high heat generation temperature is important to help minimize thermal runaway, Takezawa discloses many examples of cathode active materials having heat generation temperatures higher than 180 ºC," which could have been successfully used in batteries having the separators disclosed in Yoshida and Nagayama. *Id.* ¶¶ 351, 357.

Accordingly, we find that Petitioner has established by a preponderance of the evidence that one of ordinary skill in the art would have had a motivation to combine Yoshida, Nagayama, Takezawa, and Amagi, with a reasonable expectation of success.

iii. Ground 2A - Particle Sizes

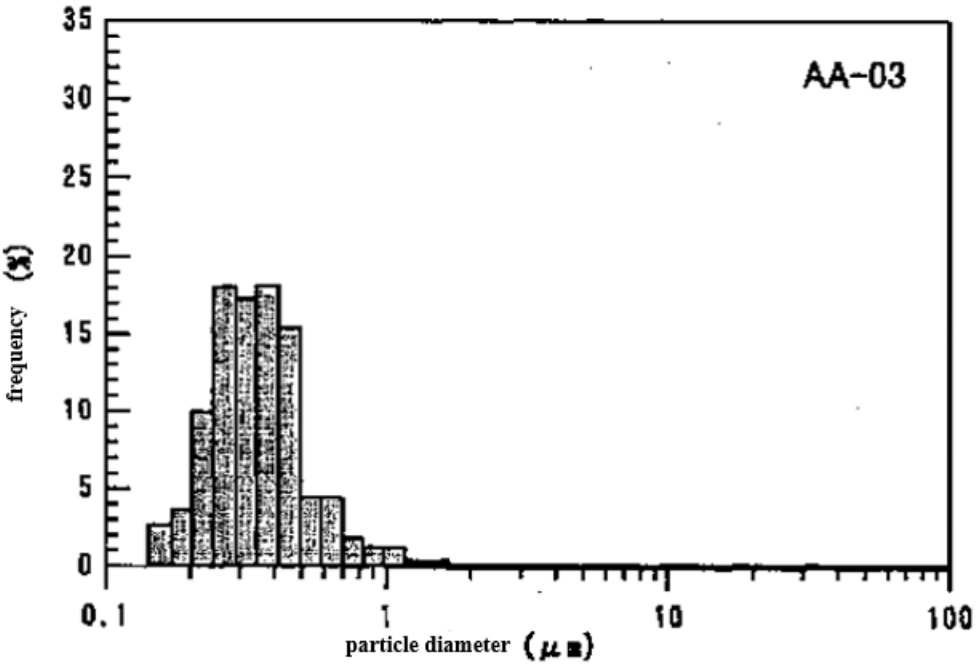
Patent Owner argues that Yoshida fails to disclose "a proportion of particles with a particle size of 0.2 μm or less in the heat-resistant fine particles is 10 vol % or less and a proportion of particles with a particle size of 2 μm or more in the heat-resistant fine particles is 10 vol % or less," as recited in claim 1 (limitation 1.H) and claim 10. PO Resp. 35. Petitioner's reliance on Yoshida's paragraph 26, argues Patent Owner, "discusses only that *average* particle sizes should be between 0.2 μm and 2.0 μm, but provides *no disclosure at all* of the distribution of particle sizes around those averages." *Id.* at 35–36. Because Amagi is "unconcerned with the heat resistance of particles," Patent Owner argues, Amagi fails to disclose the "heat-resistant fine particles" of the challenged claims. *Id.* at 36.

Petitioner replies that Patent Owner overlooks Yoshida's "teachings of a preferred particle size and a preferred range of particles sizes and a teaching that aggregate particle sizes below 0.2 μm and above 2.0 μm do not provide 'sufficient ion conductivity.'" Reply 22 (citing Ex. 1008 ¶ 26). Therefore, argues Petitioner, "the importance of particle size distribution is confirmed by Yoshida, which states that the particles having larger size do not efficiently aggregate and sufficient ion conductivity improvement of the electrolytic gel cannot be expected when the aggregated particles are mixed." *Id.* at 23 (quoting Ex. 1003 ¶ 395; citing Ex. 1008 ¶ 26). Petitioner notes that it "also does not rely on Yoshida alone," and one of ordinary skill in the art would have "understood from Yoshida that particles (aggregated or not) below 0.2 μm and above 2.0 μm do not provide 'sufficient ion conductivity,'" and "would have turned to particles such as AA-03, which is disclosed in Amagi." *Id.* (citing Pet. 40–41; Ex. 1003 ¶ 341).

Patent Owner responds that one of ordinary skill in the art "would understand that Yoshida's disclosure of a preferred range of 'average particle size[s]' necessarily includes particles both below and above the described preferred range," and "Yoshida is silent on that issue." Sur-Reply 22–23.

We are persuaded that Petitioner's proposed combination of Yoshida and Amagi discloses the particle size distribution limitation. Yoshida's paragraph 26 discloses the "average particle size of the above particles is preferably at most 0.5 μm," and also that the "average particle size of the aggregate is preferably at least 0.2 μm to at most 2.0 μm," indicating that when the average particle size is smaller than 0.2 μm, "sufficient ion conductivity improvement . . . can not be expected" and when the average particle is larger than 2.0 μm , "film thickness becomes too large." Ex. 1008 ¶ 26; Pet. 48 (citing Ex. 1003 ¶¶ 395–397). Although Yoshida discusses average particle sizes of heat-resistant particles, Patent Owner states that "both parties agree, when selecting heat resistant particles, the actual particle sizes follow a 'bell-shaped distribution' around the average value." Sur-Reply 22 (citing Ex. 1003 ¶¶ 199–200, Ex. 2015 ¶ 43). To this point, Petitioner persuasively argues that one of ordinary skill in the art "would have been motivated to select particles with a particle size distribution between 0.2 μm and 2.0 μm to maximize ion conductivity" (Reply 23; Pet. 48; Ex. 1003 ¶ 395) and "would have turned to particles such as AA-03, which is disclosed in Amagi." Reply 22–23; Pet. 40–41, 48–49 (citing Ex. 1003 ¶¶ 395–402). Amagi's Figure 1, reproduced below, depicts the particle size distribution of AA-03.

[FIG. 1]



Ex. 1022, Fig. 1. In Amagi's Figure 1, "less than 6 weight % (6 vol. %) of the heat-resistant particles are 0.2 μm or less, and effectively 0 weight % (effectively 0 vol. %) of heat-resistant particles are larger than 2 μm." Pet. 49 (citing Ex. 1003 ¶¶ 398–402). Patent Owner's dispute with Petitioner's reliance on Yoshida's paragraph 26 as providing "*no disclosure at all* of the distribution of particle sizes around those averages" (PO Resp. 35–36) overlooks the totality of Petitioner's particle size distribution argument based on the *combination* of Yoshida and Amagi. Pet. 48–49. Arguing that Yoshida alone fails to disclose the distribution of particle sizes is not responsive to Petitioner's position as a whole. We also disagree with Patent Owner's assertion that Amagi is "unconcerned with the heat resistance of particles" (PO Resp. 36), because Amagi discloses alumina particles (AA-03) (Ex. 1022 ¶ 23, Fig. 1) that "necessarily, are heat

resistant." Reply 24 n.9 (citing Ex. 1038, 61:12–62:5, 68:17–69:2, 135:17–136:5). Accordingly, Petitioner has met its burden of demonstrating that one of ordinary skill in the art would have been motivated to combine Yoshida and Amagi, with a reasonable expectation of success, to meet the particle size distribution limitation of claims 1 and 10.

iv. Ground 2A - Claims 6 and 17

Claims 6 and 17 depend from claims 1 and 10, respectively, and require that the heat-resistant fine particles "include plate-like particles." Ex. 1001, 20:18–19, 21:15–17. Petitioner argues that "Yoshida discloses that the heat-resistant layer may be formed out of 'an organic or inorganic powder (fine particles), an organic or inorganic fiber, or an *organic or inorganic plate* whose softening temperature is at least 120°C.'" Pet. 50 (citing Ex. 1008 ¶ 24; Ex. 1003 ¶¶ 412–414).

Patent Owner responds that Yoshida does not disclose plate-like particles, as required by claims 6 and 17. PO Resp. 36–37 (citing Ex. 1008 ¶ 24). Patent Owner presents testimony that "Yoshida discloses three categories of materials for the second porous layer—fine particles, fibers, or plates," and "plates refer to monolithic materials, and not the claimed 'plate-like particles.'" *Id.* (citing Ex. 2015 ¶ 55).

Petitioner replies that one of ordinary skill in the art "would have understood that the heat-resistant fine particles could have various shapes. For instance, the particles could be flakes, which a POSITA would understand to be equivalent to 'plate-like.'" Reply 24 (quoting Ex. 1003 ¶ 412). Petitioner also replies that Patent Owner's expert admitted that

"particles can also be monolithic materials (and, of course, *vice-versa*)." *Id.* at 25 (citing Ex. 1038, 145:12–14).

Patent Owner responds that "a fiber is not a particle, and a plate is not a particle or a fiber," and, thus, Yoshida does not disclose "plate-like particles." Sur-Reply 23.

We are persuaded by Petitioner's reliance on Yoshida's paragraph 24 and Dr. van Schalkwijk's testimony that Yoshida meets the limitations of claims 6 and 17. As Dr. van Schalkwijk opines, one of ordinary skill in the art "would have understood that the heat-resistant fine particles could have various shapes," i.e., "the particles could be flakes." Ex. 1003 ¶ 412. Additionally, Dr. van Schalkwijk opines that one of ordinary skill in the art would have understood Yoshida's paragraph 24 "to mean that the particles used in the heat-resistant layer need not be spherical, but rather could be in the shape of a fiber or a plate." *Id*. ¶ 413; *see also* Ex. 1038, 145:12–14 (particles can be monolithic); Ex. 2016, 105:3–17 (opining that the particles are "so small, a POSITA would have understood that the particles need not be spherical or near spherical, and they could be in the shape of a fiber or a plate or a flake").

As noted by Petitioner, "evidence of the skilled artisan's knowledge, however, remains fundamental to the proper obviousness analysis." Tr. 32:8–14 (citing *Updated Guidance on the Treatment of Statements of the Applicant in the Challenged Patent in Inter Partes Reviews under § 311* at 3 (June 9, 2022), *available at* https://www.uspto.gov/sites/default/files/documents/2022060912updatedAAPAmemo.pdf; *KSR*, 550 U.S. at 401; *Randall Mfg. v. Rea*, 733 F.3d 1355, 1362–63 (Fed. Cir. 2013)). Patent Owner does not directly dispute Dr. van Schalkwijk's testimony regarding

the understanding of a person of ordinary skill in the art regarding particle shape. *See generally* PO Resp.; Sur-Reply. Accordingly, based on the totality of Petitioner's arguments, evidence, and testimony, we are persuaded that Petitioner has met its burden as to claims 6 and 17.

v. Ground 2B

Patent Owner relies on its Ground 2A arguments to argue that one of ordinary skill in the art would not have been motivated to combine Yoshida, Amagi, Nagayama, and Takezawa, and "thus would not be further motivated to modify that combination using the disclosure of Miyatake." PO Resp. 38. Patent Owner also argues that "Petitioner does not provide any deficiency in Yoshida-Nagayama-Takezawa-Amagi that Miyatake would solve, nor any rationale at all for making the combination." *Id.* at 39.

Petitioner argues that reducing thermal shrinkage is important to a POSITA, and Miyatake discloses a particular shrinkage rate of a separator. Reply 25. Petitioner argues that it "identified a need to suppress heat shrinkage at higher temperatures, a need that would have been understood by the POSITA," who would have turned to Miyatake and its disclosure of heat-resistant materials, including ceramic and alumina, and the shrinkage rate of a separator within 0 to 30% in all regions when heated between 100 to 200ºC. *Id*. Petitioner argues that "there is no dispute that reducing thermal shrinkage is important to a POSITA." *Id.* (citing Ex. 1003 ¶¶ 148, 298–302; Ex. 1038, 40:13–41:1; Ex. 1001, 1:59–64).

Patent Owner responds that Petitioner resorts again "to a generic 'better battery' argument without further rationale for modifying the combination." Sur-Reply 24.

We have reviewed Petitioner's Ground 2B arguments and determine that Petitioner has demonstrated, by a preponderance of the evidence, that claims 2, 11, and 12 would have been unpatentable over Yoshida, Nagayama, Takezawa, Amagi, and Miyatake. Petitioner presents motivation to combine the references (Pet. 59–60 (citing Ex. 1003 ¶¶ 497–507)) and identifies where each limitation is found in the combination (*id.* (citing Ex. 1003 ¶¶ 497–507)); *id.* at 34–38 (citing Ex. 1007 ¶¶ 1, 11, 46–47, 50–52). We credit the testimony of Dr. van Schalkwijk, who opines that, "[u]nderstanding the importance of suppressing heat shrinkage at higher temperatures," "a POSITA would have been motivated to optimize the properties of the Yoshida, Nagayama, Takezawa, and Amagi separators by following the thermal shrinkage disclosure in Miyatake" with a reasonable expectation of success, and that "Miyatake simply confirms the thermal shrinkage ratio at 200°C for the same type of materials disclosed in Yoshida (e.g. alumina)." Ex. 1003 ¶¶ 491, 494–496. Accordingly, based on the totality of Petitioner's arguments, evidence, and testimony, we are persuaded that Petitioner has met its burden as to claims 2, 11, and 12.

vi. Ground 2C

Patent Owner relies on its Grounds 1A and 2A arguments to argue that one of ordinary skill in the art would not have been motivated to combine Yoshida, Nagayama, Takezawa, and Amagi and "thus a POSA would not be further motivated to add to that combination the disclosure of Katayama." PO Resp. 40; *see also* Sur-Reply 24. Petitioner replies that because Ground 2A is proper, and because Patent Owner does not have an independent reason to challenge Ground 2C, the claims challenged under this ground should be found unpatentable. Reply 26.

We have reviewed Petitioner's Ground 2C arguments and determine that Petitioner has demonstrated, by a preponderance of the evidence, that claims 3, 14, 24–25, 28–29, and 36–37 would have been unpatentable over Yoshida, Nagayama, Takezawa, Amagi, and Katayama. Petitioner presents motivation to combine the references (Pet. 60–62 (citing Ex. 1003 ¶¶ 508–514)) and identifies where each limitation is found in the combination (*id.* at 62 (citing Ex. 1003 ¶¶ 515–522); *id.* at 20–21 (citing Ex. 1006 ¶¶ 53–54, 59, 156), 31–32 (citing Ex. 1006 ¶¶ 68–69, 82, 156), 34 (citing Ex. 1006 ¶¶ 91, 98–99)). We credit the testimony of Dr. van Schalkwijk, who opines that "a POSITA would have understood the importance of maximizing the concentration of heat-resistant particles, while still using an effective binder" and, thus, would have looked to Katayama, which "discloses the preferred volume concentration of heat-resistant particles as a function of volume-percent." Ex. 1003 ¶¶ 508, 510. "Given the importance of balancing a high concentration of heat-resistant fine particles against a lower concentration of binder, a POSITA would have been motivated to fine tune the concentrations based on Katayama to arrive at the claimed ranges" with a reasonable expectation of success. *Id.* ¶¶ 512–513. Accordingly, based on the totality of Petitioner's arguments, evidence, and testimony, we are persuaded that Petitioner has met its burden as to claims 3, 14, 24–25, 28–29, and 36–37.

E. Grounds 1A and 1B

Petitioner's Grounds 1A and 1B challenge claims 1–30 and 32–37. Petitioner presents arguments based on Kasamatsu as a primary reference as the basis for its challenge of claims 1–30 and 32–37 under Grounds 1A and 1B. Pet. 1, 8–38. For the purposes of this decision, we do not determine

the merits of Grounds 1A and 1B because, as explained above, every challenged claim 1–37 in this proceeding would have been obvious over the Yoshida-based challenges in Grounds 2A, 2B, and 2C. *See SAS Inst. Inc. v. Iancu*, 138 S. Ct. 1348, 1359 (2018) (holding a petitioner "is entitled to a final written decision addressing all of the claims it has challenged"); *Boston Sci. Scimed, Inc. v. Cook Grp. Inc.*, 809 F. App'x 984, 990 (Fed. Cir. 2020) (nonprecedential) ("We agree that the Board need not address [alternative grounds] that are not necessary to the resolution of the proceeding.").

III. CONCLUSION[12]

For the reasons discussed above, we determine Petitioner meets its burden of establishing, by a preponderance of the evidence, that the challenged claims are unpatentable, as summarized in the following table:

Claims	35 U.S.C. §[13]	References/ Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 3–10, 13–30, 32–37	§ 103	Kasamatsu, Katayama		

[12] 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*. *See* 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).

[13] As noted above, we need not reach the grounds relying on Kasamatsu and Katayama or Kasamatsu, Katayama, and Miyatake.

Claims	35 U.S.C. §[13]	References/ Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
2, 11, 12	§ 103	Kasamatsu, Katayama, Miyatake		
1, 4–10, 13, 15–23, 26–27, 30–35	§ 103	Yoshida, Nagayama, Takezawa, Amagi	1, 4–10, 13, 15–23, 26–27, 30–35	
2, 11, 12	§ 103	Yoshida, Nagayama, Takezawa, Amagi, Miyatake	2, 11, 12	
3, 14, 24–25, 28–29, 36–37	§ 103	Yoshida, Nagayama, Takezawa, Amagi, Katayama	3, 14, 24–25, 28–29, 36–37	
Overall Outcome			1–37	

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner establishes, by a preponderance of the evidence, that claims 1–37 of U.S. Patent No. Patent 9,166,251 B2 are unpatentable; and

FURTHER ORDERED that this is a Final Written Decision; therefore, 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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