

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

POSCO FUTURE M CO., LTD.,
Petitioner,

v.

CAMX POWER LLC,
Patent Owner.

IPR2024-01229
Patent 9,391,317 B2

Before JEFFREY W. ABRAHAM, JULIA HEANEY, and
JANE E. INGLESE, *Administrative Patent Judges*.

INGLESE, *Administrative Patent Judge*.

DECISION

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

I. INTRODUCTION

A. Overview

POSCO Future M Co., Ltd. (“Petitioner”) filed a Petition (Paper 2, “Pet.”) for *inter partes* review of claims 1–17 (the “challenged claims”) of U.S. Patent No. 9,391,317 B2 (Ex. 1001, “the ’317 patent”). CAMX POWER LLC (“Patent Owner”) filed a Preliminary Response. Paper 6 (“Prelim. Resp.”). With Board pre-authorization, Petitioner filed a Reply (Paper 7, “Reply”), and Patent Owner filed a Sur-reply (Paper 8, “Sur-reply”), limited to addressing “Patent Owner’s reliance on Exhibits 2001–2004.” Ex. 1029, 1–2 (e-mail correspondence with the Board).

We have authority to determine whether to institute *inter partes* review. *See* 35 U.S.C. § 314 (2018); 37 C.F.R. § 42.4(a) (“The Board institutes the trial on behalf of the Director.”). *Inter partes* review may not be instituted “unless . . . the information presented in the petition . . . shows that 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).

After considering the information presented in the Petition, Preliminary Response, Reply, and Sur-reply, we determine that Petitioner does not make a sufficient showing to demonstrate a reasonable likelihood of prevailing with respect to at least one of the challenged claims. We therefore deny institution of *inter partes* review.

B. Real Parties-in-Interest

Petitioner identifies itself, POSCO Future M Co., Ltd., as the real party-in-interest. Pet. 78.

Patent Owner identifies itself, CAMX Power LLC, as the real party-in-interest. Paper 4, 1.

C. Related Matters

The parties do not identify any related matters. Pet. 78; Paper 4, 1.

II. BACKGROUND

A. The '317 patent (Ex. 1001)

According to the '317 patent, “[l]ithium nickel oxide (LiNiO₂) materials having a layered structure are desirable as lithium battery cathode materials because they generally provide lower cost, higher capacity, and higher rate capability than lithium cobalt oxide,” but “pure LiNiO₂ materials exhibit poor electrochemical stability and cycling performance.” Ex. 1001, 1:21–26. “[S]ome of the capacity and cost benefits of LiNiO₂ can be obtained with improved electrochemical cycling stability” by substituting varying amounts of other metals, such as cobalt (Co), for some of the nickel (Ni) in LiNiO₂. *Id.* at 1:26–30. Although incorporation of cobalt into LiNiO₂ enhances electrochemical cycling stability, it “generally results in some diminution of the high capacity and rate capability provided by LiNiO₂,” and cobalt is also more costly than nickel. *Id.* at 1:33–40.

The '317 patent discloses that lithium nickel oxides in the form of secondary particles “comprising a plurality of crystallites (i.e., primary particles)” in which grain boundaries between adjacent crystallites are enriched with cobalt, “are surprisingly stabilized.” *Id.* at 3:10–16. Because “cobalt is preferentially provided in the grain boundaries, where it is understood to be most effective at stabilizing the lithium nickel oxide, less cobalt is required to provide a lithium nickel oxide” material that exhibits

improved cycling stability and capacity than if cobalt were present uniformly in the particles, resulting in a “lower cost material . . . that provides more of the desirable properties of LiNiO_2 with less cobalt.” *Id.* at 3:21–28.

The disclosed secondary particles of the '317 patent are formed of a plurality of crystallites comprising a first composition having a layered α - NaFeO_2 -type structure and including lithium, nickel, cobalt, and oxygen; and grain boundaries “between adjacent crystallites” that comprise a second composition having a layered α - NaFeO_2 -type structure, a cubic structure, or a combination thereof, where a concentration of cobalt in the grain boundary is greater than a concentration of cobalt in the adjacent crystallites. *Id.* at 1:49–62.

Figure 1 of the '317 patent, reproduced below, illustrates an exemplary secondary particle:

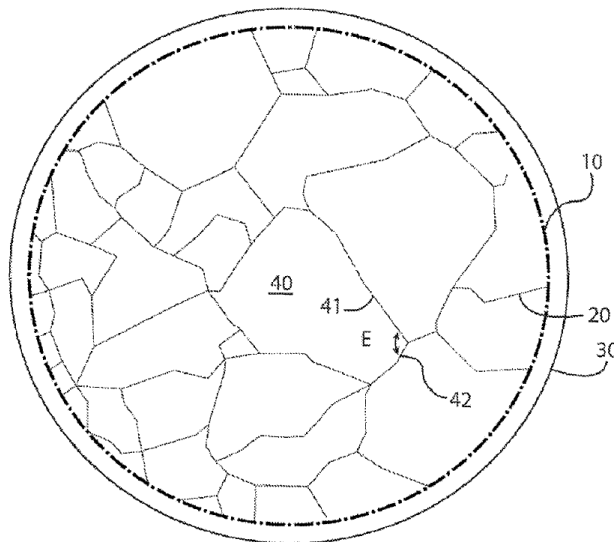


FIG. 1

Figure 1 provides a schematic perspective view of a cross-section of a

secondary particle. *Id.* at 2:44–45. The secondary particle of Figure 1 is formed of a plurality of crystallites and includes crystallite 10 comprising a first composition, grain boundary 20 comprising a second composition, and layer 30 disposed on an outer surface of the secondary particle. *Id.* at 4:44–52. The first composition of crystallite 10 has a layered α -NaFeO₂-type structure, and the second composition of grain boundary 20 has a cobalt concentration greater than that of the first composition of crystallite 10. *Id.* at 4:44–48, 4:53–54. First grain boundary 41 and second grain boundary 42 are disposed on adjacent faces of crystallite 40 and intersect to form angle E. *Id.* at 6:47–52.

The '317 patent describes a method of manufacturing the disclosed secondary particles that involves combining a lithium compound, a cobalt compound, and a nickel compound to form a mixture; heat treating the mixture at about 30 to about 200 °C to form a dried mixture; heat treating the dried mixture at about 200 to about 500 °C for about 0.1 to about 5 hours; and heat treating the resulting product at 600 to about 900 °C for about 0.1 to about 10 hours, to yield the secondary particles. *Id.* at 13:63–14:18.

The '317 patent explains that the “grain boundary of the secondary particle disclosed herein is distinguished from a ‘shell’ of a ‘core/shell’ material or a ‘coating’ of a coated particle in which a lithium nickel oxide secondary particle is coated with a Co-containing material, such as LiCoO₂, to provide a LiCoO₂ coated LiNi_(1-x)Co_xO₂ core/shell or coated material, for example.” *Id.* at 11:63–12:1.

B. Challenged Claims

Petitioner challenges claims 1–17 of the '317 patent. Pet. 17.

Independent claim 1 reads as follows:

1. A particle, comprising:
a plurality of crystallites comprising a first composition
having a layered α -NaFeO₂-type structure and comprising:
lithium, nickel, and oxygen;
a grain boundary between adjacent crystallites of the plurality
of crystallites and comprising a second composition having
the layered α -NaFeO₂-type structure, a cubic structure, or a
combination thereof,
wherein a concentration of cobalt in the grain boundary is greater than
a concentration of cobalt in the crystallites.

Ex. 1001, 17:26–36.

C. Asserted Grounds of Unpatentability

Petitioner asserts that the challenged claims are unpatentable on the following grounds (Pet. 17):

Ground	Challenged Claim(s)	35 U.S.C. §	Reference(s)
1	1–17	102	Lampe-Onnerud ¹
2	1–17	103	Park, ² Lampe-Onnerud
3	1–9, 11, 14–17	102	Takagi ³
4	10, 12, 13	103	Takagi

The Petition is supported by the Declaration of Doron Aurbach, Ph.D. (Ex. 1002) and the Declaration of Hyunkuk Noh, Ph.D. (Ex. 1003).

¹ US 6,921,609 B2, issued July 26, 2005 (Ex. 1007, “Lampe-Onnerud”).

² US 2011/0143209 A1, published June 16, 2011 (Ex. 1008, “Park”).

³ Japanese Unexamined Patent App. Pub. No. JP2003-59489A, published February 28, 2003 (Ex. 1010 (certified English translation), “Takagi”; Ex. 1009 (original document)).

III. ANALYSIS

A. Principles of Law

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)); *see also* 37 C.F.R. § 42.104(b) (requiring a petition for *inter partes* review to identify how the challenged claim is to be construed and where each element of the claim is found in the prior art patents or printed publications relied upon).

B. Level of Ordinary Skill in the Art

The level of ordinary skill in the art at the time of the invention is a factual determination that provides a primary guarantee of objectivity in an obviousness analysis. *Al-Site Corp. v. VSI Int’l Inc.*, 174 F.3d 1308, 1324 (Fed. Cir. 1999) (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966); *Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714, 718 (Fed. Cir. 1991)).

Petitioner asserts that a person of ordinary skill in the art (“POSITA”) “would have at least a master’s degree in chemistry, chemical engineering, or materials science, or related field of study, and at least three years’ experience in academia or industry researching, designing, or developing lithium-ion battery materials, which would include performing experiments to synthesize and characterize polycrystalline materials.” Pet. 12 (citing Ex. 1002 ¶ 78). Patent Owner neither adopts nor disputes Petitioner’s proposed level of ordinary skill in the art. *See generally* Prelim. Resp.

For purposes of this Decision, we apply Petitioner’s definition of a POSITA, which is undisputed on this record, and is consistent with the level of ordinary skill in the art at the time of the invention as reflected in the asserted prior art.

C. Claim Interpretation

We interpret claims “using the same claim construction standard that would be used to construe the claims in a civil action held under 35 U.S.C. 282(b).” 37 C.F.R. § 42.100(b). According to that standard, claim terms generally are given their plain and ordinary meaning as would have been understood by the ordinarily skilled artisan at the time of the invention when read in the context of the specification and prosecution history. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005) (en banc). We construe terms in controversy only to the extent necessary to resolve the controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

Claim 1 recites, in part, a particle comprising a plurality of crystallites and a grain boundary between adjacent crystallites.

Petitioner and Patent Owner both present proposed constructions of a “grain boundary.” In particular, Petitioner asserts that a “grain boundary” is “a region located generally at the edges/surfaces of and between adjacent crystallites where they interface with each other.” Pet. 12–13 (emphasis omitted). Patent Owner contends that a “grain boundary” is “a region of a polycrystalline particle that exists between adjacent crystallites and that abuts the surfaces of the adjacent crystallites, but that does not include any portions of the crystallites themselves.” Prelim. Resp. 13.

For reasons that follow, we agree with Patent Owner's proposed construction.

We begin our analysis with the claim language. *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996) ("First, we look to the words of the claims themselves . . . to define the scope of the patented invention."). Claim 1 recites a particle that comprises (1) a plurality of crystallites comprising (a) a first composition (i) having a layered α -NaFeO₂-type structure and (ii) comprising lithium, nickel, and oxygen; and (2) a grain boundary between adjacent crystallites of the plurality of crystallites and comprising (a) a second composition (i) having the layered α -NaFeO₂-type structure, a cubic structure, or a combination thereof, and (ii) a concentration of cobalt in the grain boundary greater than a concentration of cobalt in the crystallites.

The plain language of claim 1 thus indicates that the grain boundary has a composition (i.e., a "second composition") distinct from that of the adjacent crystallites (i.e., a "first composition"), and that the grain boundary may have the same structure (i.e., a layered α -NaFeO₂-type structure) or a different structure (i.e., a cubic structure, or a combination of a cubic structure and a layered α -NaFeO₂-type structure) than the adjacent crystallites. The plain language of claim 1 thus structurally distinguishes the grain boundary from the adjacent crystallites by specifying that the grain boundary has a concentration of cobalt greater than that of the concentration of cobalt in the crystallites.

We turn next to the Specification of the '317 patent. *Vitronics*, 90 F.3d at 1582 ("[T]he specification 'is always highly relevant to the claim

construction analysis. Usually, it is dispositive; it is the single best guide to the meaning of a disputed term.”). The Specification describes “a secondary particle comprising a plurality of crystallites (i.e., primary particles)” in which “cobalt enriched grain boundaries are between adjacent crystallites.” Ex. 1001, 3:13–16; *see also id.* at 4:44–50. The crystallites comprise a first composition, and “[t]he grain boundary is between adjacent crystallites, is on a surface of the crystallite, and comprises [a] second composition.” *Id.* at 4:44–54, 6:20–22. The grain boundaries “are parallel to the surface of the adjacent crystallite,” and “[t]he shape of the grain boundary is defined by the shape of the crystallite adjacent the grain boundary.” *Id.* at 6:28–29, 7:3–5.

Figure 1 (reproduced in Section II.A above) illustrates a secondary particle comprising a plurality of crystallites, and shows that “disposed on adjacent faces of a crystallite 40 is a first grain boundary 41 and second grain boundary 42,” which “intersect at an angle E . . . defined by the shape of the crystallite on which the first grain boundary 41 and the second grain boundary 42 are disposed.” *Id.* at 4:44–50, 6:47–54.

As discussed above, Petitioner construes a “grain boundary” as “a region located generally at the edges/surfaces of and between adjacent crystallites where they interface with each other.” Pet. 11–12 (citing Ex. 1001, 6:20–26, 1:33–34, Figs. 5, 7, 9, 10, 13; Ex. 1002 ¶ 82). Petitioner’s declarant, Dr. Aurbach, echoes Petitioner’s proposed construction, opining that “a person of ordinary skill in the art would have understood that a grain boundary is a region located generally at the edges/surfaces of and between adjacent crystallites where they interface with each other.” Ex. 1002 ¶¶ 82. Dr. Aurbach, however, does not provide any objective evidence to

corroborate this understanding in the art. *Id.*

Petitioner further asserts that the Specification indicates that a “grain boundary includes the edges/surfaces of adjacent crystallites.” Pet. 13 (citing Ex. 1001, 6:20–25, 11:30–35; Ex. 1002 ¶¶ 90–92). The disclosures of the Specification as a whole do not support Petitioner’s construction, however. In particular, as discussed above, the Specification repeatedly and consistently indicates that grain boundaries are structurally distinct from the adjacent crystallites. Although the Specification does include a single reference to “edges” of crystallites in connection with grain boundaries (“the layers of the transition metal atoms at the grain boundaries (e.g., edges of the crystallites)),” when this disclosure is considered in the context of the discussion in which it occurs, it is apparent that grain boundaries are described as having a structure distinct from that of the adjacent crystallites, rather than constituting the edges of the crystallites. Ex. 1001, 11:32–33. In particular, the relevant discussion states:

While not wanting to be bound by theory, it is understood that the disclosed secondary particle is a dense polycrystalline agglomerate of submicron-sized primary crystallites. It has been shown that in polycrystalline materials having the layered α -NaFeO₂-type structure, electrochemical cycling induces the layers of the transition metal atoms at the grain boundaries (e.g., edges of the crystallites) to reorganize into a NiO-type rock salt structure and/or to be reduced in oxidation state. These transformations are also associated with the appearance of *cracks between adjacent crystallites*. While not wanting to be bound by theory, it is understood that the resulting NiO-type phase and *cracks in the grain boundaries between crystallites* significantly degrade the electrochemical performance of these materials. It is also understood that whereas Ni atoms at the grain boundaries undergo reduction in oxidation state as part of

these transformations, Co atoms in the grain boundaries do not, suggesting that it is primarily the Ni atoms that are mobile and drive the undesirable structural rearrangements in the grain boundaries.

The above observations indicate that Co substitution in lithium nickel oxides having the layered α -NaFeO₂-type structure enhances electrochemical performance by stabilizing the grain boundaries of the secondary particle. Therefore *Co-substituted lithium nickel oxides with **Co preferentially disposed at the grain boundaries (and relatively less Co in the crystallites)** can provide improved cycling stability with less overall cobalt content than a lithium nickel oxide with uniformly distributed Co, or Co disposed in a location other than in the grain boundaries.* Materials with Co-enriched grain boundaries can thus provide improved stability, such as improved capacity, cycle life, coulombic efficiency, rate capability, and safety, while minimizing the detrimental impacts of Co substitution on capacity, rate capability, and cost *by providing Co where it is most effective, e.g., in the grain boundaries, and avoiding use of Co where it is less effective, e.g., in the crystallites.*

Id. at 11:27–62 (all emphasis added).

This portion of the Specification thus discusses advantages of preferentially disposing cobalt in grain boundaries of the secondary particles, and avoiding deposition of cobalt in the crystallites. In describing the advantages of this cobalt distribution, the discussion makes a clear structural distinction between the grain boundaries and the crystallites of the particles, contrary to Petitioner's position that grain boundaries are part of the adjacent crystallites themselves, *i.e.*, Petitioner's position that grain boundaries constitute the edges of the crystallites.

Dr. Aurbach also opines that the Specification supports his

construction of a “grain boundary.” In particular, relying on the disclosure in the Specification that “[t]he grain boundary is between adjacent crystallites, **is on a surface of the crystallite**, and comprises the second composition,” Dr. Aurbach opines that “[i]n this sentence, the ’317 patent confirms that grain boundaries begin at the surfaces, or edges, of adjacent primary particles. It is part of and includes the surface.” Ex. 1002 ¶ 86 (citing Ex. 1001, 6:20–21 (emphasis added)). Contrary to Dr. Aurbach’s opinion, however, the Specification’s disclosure that the grain boundary is **on** a surface of the crystallite does not indicate that the grain boundary **includes** the surface of the crystallite. Rather, the disclosure refers to the location or disposition of the grain boundary—**on** the surface of the crystallite—rather than indicating that the grain boundary constitutes the surface of the crystallite itself, i.e., **is** the surface of the crystallite.

Although Petitioner and Dr. Aurbach also rely on Figures 5, 7, 10, 13 of the ’317 patent to support their construction of a “grain boundary,” none of these Figures, nor their accompanying descriptions in the Specification, indicates that grain boundaries are a part of the adjacent crystallites themselves (i.e., their edges), rather than constituting a separate structure distinct from the crystallites. Pet. 13–15; Ex. 1002 ¶¶ 87–91. Petitioner’s and Dr. Aurbach’s assertions related to the Figures amount to their subjective interpretations of the Figures, and do not identify any actual disclosure in the Figures or accompanying descriptions in the Specification indicating that grain boundaries include the edges of adjacent crystallites. Pet. 13–15; *see, e.g., id.* at 14 (“Oval 203 [shown in Figure 7], which corresponds to the ‘grain boundary’ and is cross-referenced with FIG. 5, spans across locations at the edges of the adjacent primary crystals and does

not have clearly defined limits.”); *id.* at 15 (“According to the scale for the image [Fig. 13], this means that the grain boundaries extend into white shaded areas in FIG. 13, which overlay with surfaces/edges of the primary particles.”); Ex. 1002 ¶¶ 87–91.

Petitioner’s further assertion (and Dr. Aurbach’s testimony) that “[c]ontemporaneous literature described and showed it was known that grain boundaries are transition regions at the edges/surfaces of the primary particles where they interface” is not substantiated by the relied-upon references. Pet. 15; Ex. 100 ¶¶ 92–98. In particular, we are unable to find the specific disclosure in Kagei quoted by Petitioner and Dr. Aurbach. Pet. 15 (citing Ex. 1024); Ex. 1002 ¶ 93. Regardless, as Patent Owner points out, Kagei refers to crystallites “surrounded” by grain boundaries, which appears to support a construction of “grain boundaries” as being separate and distinct from crystallites. Prelim. Resp. 20. At the very least, this disclosure in Kagei does not support Petitioner’s construction of a “grain boundary” as including the edges of adjacent crystallites.

As for Zheng, despite Petitioner’s assertion that the reference “discloses that in conventional lithium-ion battery cathode materials, grain boundaries are the transition regions between interiors of primary particles and their edges,” the reference as a whole does not support this assertion. Pet. 15–16 (citing Ex. 1011, Figs 7(a), 7(b)). In particular, Zheng uses the term “grain boundary layers” to refer to portions of primary particles that are *near* “grain boundaries,” and, therefore, Zheng draws a structural distinction between “grain boundaries” and “grain boundary layers.” *See, e.g.*, Ex. 1011, A359 (discussing “grain boundary layers” that are “adjacent to the boundary” and “near these grain boundaries”).

Finally, Petitioner refers to Park’s definition of “grain boundary” as “the interface between two adjacent primary particles” to support its proposed construction of the term. Pet. 16 (quoting Ex 1008 ¶ 22).

Although Park’s definition indicates that adjacent primary particles share a common grain boundary, this falls short of indicating that grain boundaries are known in the art to be part of the adjacent primary particles themselves.

Petitioner, therefore, does not provide sufficient information to establish that “contemporaneous literature” shows that it was known in the art that grain boundaries are transition regions at the edges/surfaces of primary particles where they interface.

After considering the information on the record before us, we interpret a “grain boundary” as this term occurs in the context of claim 1 to refer to a region of the recited particle that exists between adjacent crystallites and abuts the surfaces of the adjacent crystallites, which is consistent with how the Specification of the ’317 patent uses the term. As a consequence, we agree with Patent Owner that grain boundaries do not include any portion of the adjacent crystallites, contrary to the Petitioner’s proposed construction. *Compare* Prelim. Resp. 13–14, *with* Pet. 12–13.

No other claim terms require express construction for purposes of deciding whether to institute review.

D. The Patentability Challenges

1. Ground 1: Asserted Anticipation by Lampe-Onnerud

Petitioner asserts that claims 1–17 are anticipated by Lampe-Onnerud. Pet. 18–45. Patent Owner disagrees. Prelim. Resp. 21–34. We focus our analysis on the disputed limitations of claim 1, and begin with an overview of Lampe-Onnerud.

a. Lampe-Onnerud (Ex. 1007)

Lampe-Onnerud discloses that “[t]raditionally, the lithium battery industry has employed LiCoO_2 -type materials as the active component of lithium battery cathodes,” but “ LiCoO_2 lithium battery cathodes typically are very expensive and exhibit relatively low capacity.” Ex. 1007, 1:13–17. According to Lampe-Onnerud, LiNiO_2 -based materials are a less expensive alternative to LiCoO_2 -based cathode materials, and exhibit higher capacities. *Id.* at 1:19–22. Lampe-Onnerud indicates, however, that LiNiO_2 -based materials “generally are less safe (i.e. exhibit more gassing),” and are less efficient, than LiCoO_2 -based materials. *Id.* at 1:25–30.

Lampe-Onnerud’s invention is directed to a composition suitable for use as the active material in cathodes for rechargeable lithium-ion or lithium polymer-type batteries. *Id.* at 3:45–52. The composition has a core and a “coating on the core,” and the coating has a greater ratio of cobalt to nickel than the core. *Id.* at 3:41–44. “Generally, the ratio of cobalt to nickel of the composition . . . increases as a gradient from the core to an outer surface of the coating.” *Id.* at 4:14–16. In a particular embodiment, the core material includes $\text{LiNi}_{0.8}\text{Co}_{0.2}\text{O}_2$. *Id.* at 4:29–30. “The crystal structure of the core, and optionally of the coating, is of an ‘ α - NaFeO_2 -type’” *Id.* at 3:46–49. According to Lampe-Onnerud, its composition “generally will exhibit improved capacity, cyclability and safety over LiCoO_2 and LiNiO_2 counterparts” and typically is “less expensive to manufacture than LiCoO_2 -based materials.” *Id.* at 2:16–20.

Lampe-Onnerud describes a method of manufacturing its composition that involves immersing a core material in a solution of LiNO_3 and

$\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, evaporating water from the solution to form a precursor coating on the core material, and calcining the precursor coating. *Id.* at 4:61–5:2. In one embodiment, the calcining process involves heating the precursor coating to a temperature of between about 500 °C and about 900 °C for about 0.2 to about 12 hours. *Id.* at 5:12–18. In a preferred embodiment, calcining involves heating the precursor coating and core material at a rate of between about 5 °C and about 100 °C per minute to a temperature of between about 300 °C and about 500 °C, maintaining this temperature for about 0.2 to about 4 hours, heating the precursor coating and core material at a rate of between about 5 °C and about 50 °C per minute to a temperature of between about 600 °C and about 900 °C, and maintaining this temperature for about 0.2 hours to about 12 hours. *Id.* at 5:19–30.

b. Disputed Limitations of Claim 1

Claim 1 requires the recited particle to include a plurality of crystallites and a grain boundary between adjacent crystallites (under Patent Owner’s construction, which we have adopted), and requires a concentration of cobalt in the grain boundary to be greater than a concentration of cobalt in the adjacent crystallites. The parties dispute whether Lampe-Onnerud discloses a polycrystalline material having grain boundaries between adjacent crystallites, and whether Lampe-Onnerud discloses a higher concentration of cobalt in a grain boundary than the adjacent crystallites, *i.e.*, cobalt-enriched grain boundaries. *Compare* Pet. 24–31 *with* Prelim. Resp. 21–34.

In particular, Petitioner asserts that Lampe-Onnerud discloses “using the *same* compounds as in the ’317 patent, in the *same* wide ranges of amounts, pursuant to the *same* process,” which necessarily results in

production of the same material claimed in the '317 patent having cobalt-enriched grain boundaries. Pet. 1–2.

Patent Owner counters that Lampe-Onnerud does not disclose that its polycrystalline cathode material has grain boundaries, and “because Lampe-Onnerud does not teach a material with grain boundaries, it cannot teach *cobalt-enriched* grain boundaries.” Prelim. Resp. 1–2. Patent Owner contends that the inventors of the '317 patent “*expressly distinguished* their grain-boundary-enriched material from a ‘core/shell’ material (a ‘coated particle’), in which the ‘core’ of a lithium-metal-oxide particle is coated with a cobalt-rich material to provide cobalt ‘on the outer surface’ of the particle—*i.e.*, from exactly the type of material taught in Lampe-Onnerud.” *Id.* at 25–26 (citing Ex. 1001, 11:63–12:6)

For the reasons that follow, we determine that Petitioner does not provide sufficient information to establish that Lampe-Onnerud’s material necessarily includes a grain boundary between adjacent crystallites in which a concentration of cobalt in the grain boundary is greater than a concentration of cobalt in the adjacent crystallites, as required by claim 1 of the '317 patent. We address the numerous bases Petitioner advances in turn.

First, Petitioner asserts that because Lampe-Onnerud’s core and coating “have the same empirical formula” as the '317 patent’s first and second composition, respectively, Lampe-Onnerud’s core and coating are the same as the '317 patent’s first and second compositions. Pet. 19.

Petitioner, however, does not provide any evidence to establish that any such identity of empirical formulas means that Lampe-Onnerud’s cathode material necessarily has the same microstructure as the particle of claim 1. In particular, even if the empirical formula of Lampe-Onnerud’s

core material is the same as that of the '317 patent's first composition, Petitioner does not provide evidence establishing that it necessarily follows that Lampe-Onnerud's core is a polycrystalline material having a plurality of crystallites separated by grain boundaries between adjacent crystallites. Nor does Petitioner provide evidence establishing that it necessarily follows from any identity between the empirical formula of Lampe-Onnerud's coating material and the '317 patent's second composition that Lampe-Onnerud's coating material necessarily is present in grain boundaries at a higher concentration than in crystallites, assuming that Lampe-Onnerud's material is comprised of a plurality of crystallites having grain boundaries between adjacent crystallites.

Furthermore, although Petitioner's declarant, Dr. Aurbach, indicates that Lampe-Onnerud's process "begins with a conventional lithium nickel oxide-base material . . . known to be comprised of secondary articles having agglomerated primary particles and grain boundaries," Dr. Aurbach does not provide any objective evidence to substantiate this asserted knowledge in the art. Ex. 1002 ¶ 110. We, therefore, accord little weight to Dr. Aurbach's opinion on this issue. 37 C.F.R. § 42.65(a) (opinion testimony that does not disclose underlying facts or data "is entitled to little or no weight"); *Velandier v. Garner*, 348 F.3d 1359, 1371 (Fed. Cir. 2003) ("[W]hat the Board consistently did was accord little weight to broad conclusory statements that it determined were unsupported by corroborating references. It is within the discretion of the trier of fact to give each item of evidence such weight as it feels appropriate."); *In re Am. Acad. of Sci. Tech Ctr.*, 367 F.3d 1359, 1368 (Fed. Cir. 2004) ("[T]he Board is entitled to weigh the declarations and conclude that the lack of factual corroboration warrants

discounting the opinions expressed in the declarations.”).

Although Petitioner further asserts that “Lampe-Onnerud describes that particle sizes can be 50 μm , which confirms to a POSITA that it is referring to a secondary particle,” neither Petitioner nor Dr. Aurbach provides any objective evidence to substantiate this asserted understanding of an ordinarily skilled artisan. Pet. 21 (citing Ex 1007, 9:55–56; Ex. 1002 ¶ 124). The disclosure of Lampe-Onnerud Petitioner relies on describes an exemplary process for preparing a cobalt gradient-coated lithium nickel cobalt oxide material, which Lampe-Onnerud indicates has a particle size distribution of 1–50 μm . Ex. 1007, 9:29–56. Nothing in this disclosure indicates that, due to the particle size distribution, the material is *necessarily* a secondary particle.

To the contrary, Patent Owner provides objective evidence showing that both single crystal and polycrystalline lithium nickel cobalt manganese oxide materials can have particle sizes within Lampe-Onnerud’s range. Prelim Resp. 26; Ex. 2001, 1–2; Ex. 2004, 1. Although Petitioner criticizes Patent Owner’s evidence because the references were published nearly 20 years after Lampe-Onnerud’s effective date (Reply 1–3), Patent Owner’s evidence nonetheless shows that particle size does not necessarily dictate the microstructure of lithium metal oxide materials, and evidence establishing (or disproving) inherency need not be contemporaneous with evidence asserted to provide an inherent disclosure. *Monsanto Tech. LLC v. E.I. DuPont de Nemours & Co.*, 878 F.3d 1336, 1345 (Fed. Cir. 2018) (allowing non-prior art extrinsic evidence to be used in an analysis of what is necessarily present (inherent) in a prior art teaching); *Schering Corp. v. Geneva Pharm., Inc.*, 339 F.3d 1373, 1377 (Fed. Cir. 2003) (explaining that

extrinsic evidence relied on in an inherency analysis need not antedate the critical date of the patent at issue).

Petitioner further relies on an asserted identity between the processes disclosed in Lampe-Onnerud and the '317 patent to support its position that Lampe-Onnerud's process necessarily yields a material that includes cobalt-enriched grain boundaries. Pet. 18–19, 29–30. In particular, Petitioner asserts that “because Lampe-Onnerud teaches the same process disclosed in the '317 patent and essentially the same temperatures and heating times as in the examples of the '317 patent, the resulting secondary particle disclosed by Lampe-Onnerud necessarily has higher concentrations of cobalt in grain boundaries located near the surface of the secondary particle relative to its inner core of the crystallites.” Pet. 18–19 (citing Ex. 1002 ¶¶ 108–122, 140; Ex. 1001, 13:64–14:18; Ex. 1007, 9:62–10:12); *see also id.* at 29–30 (citing Ex. 1007, 9:61–10:17; Ex. 1002 ¶¶ 64, 107–122, 139; Ex. 1001, 13:63–14:3).

Petitioner and Dr. Aurbach, however, do not address the various differences between the processes disclosed in Lampe-Onnerud and the '317 patent, or provide objective evidence establishing that, despite such differences, the two processes would yield products having no material microstructural differences, including no material differences in crystal structure and cobalt distribution. *Compare* Ex. 1007, 4:61–5:2, 5:12–30, *with* Ex. 1001, 13:63–14:18; *see also* Pet. 18–19, 29–30; Ex. 1002 ¶¶ 64, 107–122, 139, 140. Instead, Petitioner and Dr. Aurbach merely state that both processes yield polycrystalline materials having cobalt-enriched grain boundaries because the processes are “the same.” Pet. 18–19, 29–30; Ex. 1002 ¶¶ 107, 109, 139. Petitioner's assertion of identity between Lampe-

Onnerud's process and that of the '317 patent, therefore, is insufficient to establish that Lampe-Onnerud's process necessarily yields a material that includes cobalt-enriched grain boundaries.

Petitioner and Dr. Aurbach further assert that Lampe-Onnerud's process results in the coating "percolating" into grain boundaries in the core of Lampe-Onnerud's material. Pet. 27 (citing Ex. 1014, 2182; Ex. 1002 ¶ 134). Even if grain boundaries exist in Lampe-Onnerud's material, neither Petitioner nor Dr. Aurbach provides sufficient evidence to establish that such percolation into the grain boundaries occurs. In particular, Dr. Aurbach indicates that Lampe-Onnerud's coating solution "wets the surface of the secondary particle and through percolation, the solution enters into grain boundaries at the surface and near the surface of the secondary particle." Ex 1002 ¶ 115, *see also id.* at ¶¶ 116–118. According to Dr. Aurbach, "[t]his process of having the solution seep into the secondary particle can be referred to as percolation." *Id.* at ¶ 116 (citing Ex. 1014). The reference Petitioner and Dr. Aurbach cite to support the asserted percolation (Volvich), however, explicitly indicates that grain boundary wetting (liquid penetration into grain boundaries, i.e., percolation) is specific to certain systems, and "sometimes it is not observed at all." Ex. 1014, 2182. Volvich further indicates that the entirety of a grain boundary network in a polycrystal is "never wetted completely," and "the fraction of wetted boundaries depends on many factors." *Id.* Volvich indicates that the "role of these factors, as well as the molecular mechanism of GB [grain boundary] wetting are still not enough clear." *Id.*

Volvich, therefore, evidences that percolation of Lampe-Onnerud's coating into grain boundaries, to the extent that grain boundaries exist in

Lampe-Onnerud's material, would not *necessarily* occur, undermining Dr. Aurbach's opinion. Dr. Aurbach's opinion, therefore, fails to support Petitioner's assertion that Lampe-Onnerud's coating percolates into grain boundaries.

Petitioner also asserts that its employee, Dr. Noh, reproduced Example 1 of Lampe-Onnerud, resulting in production of a polycrystalline material having cobalt concentrated "at grain boundaries near the secondary particle's surface." Pet. 25–29 (citing Ex. 1003 ¶¶ 16, 20, 25, Figs. A(2), C(1), C(2), D(1), E, F; Ex. 1002 ¶¶ 81–98, 102–122, 130–141).

According to Petitioner, Dr. Noh's experiments demonstrate that Lampe-Onnerud's process "necessarily" results in a polycrystalline material having "at least an area . . . where there is a higher concentration of cobalt in grain boundaries." Pet. 27 (citing Ex. 1003 ¶ 20; Ex. 1002 ¶¶ 137–141).

Patent Owner, however, points out differences between Dr. Noh's experiments and Lampe-Onnerud's Example 1, which neither Petitioner nor Dr. Noh address. Prelim. Resp. 27, 31–32. In particular, Dr. Noh used a core starting material in his experiments manufactured by Petitioner, but Lampe-Onnerud's core starting material was commercially available⁴ and was manufactured by Nippon Chemical (referred to as "N-82"). *Compare* Ex 1003 ¶ 8, *with* Ex. 1007, 9:61–66, 10:20–21. Neither Dr. Noh nor Petitioner explains why Dr. Noh did not use N-82 as the starting material in his experiments. Nor does Dr. Noh or Petitioner provide any type of

⁴ Dr. Noh and Patent Owner both acknowledge that Example 1 of Lampe-Onnerud has a typographical error in the atomic ratio of Ni in the starting material. Ex. 1003, 3 n.1; Prelim. Resp. 31 n.12.

comparison between N-82 and Dr. Noh's starting material, such as indicating whether any differences exist between them.

In addition, the weight of the precursor materials Dr. Noh used in his experiments "corresponds to 30% of the weight of the precursors used in Example 1 of the Lampe-Onnerud patent." Ex. 1003 ¶ 19. Neither Dr. Noh nor Petitioner addresses this difference and explains why Dr. Noh's experiments were conducted on a significantly smaller scale than Lampe-Onnerud's Example 1. As Patent Owner points out, despite the smaller scale, Dr. Noh's experiments used the same heating profile as Lampe-Onnerud's Example 1. Neither Dr. Noh nor Petitioner provides any explanation indicating that adjustments to the heating profile were not necessary, despite the significantly different amounts of materials used.

Petitioner, therefore, does not provide any persuasive evidence establishing that the differences between Dr. Noh's experiments and Lampe-Onnerud's Example 1 would not have had any material effect on the end result of Dr. Noh's experiments. In particular, neither Dr. Noh nor Petitioner provides a technical explanation supported by objective evidence to show how and why the deviations in Dr. Noh's experiments from Lampe-Onnerud's Example 1 are immaterial. Dr. Noh's alleged reproduction of Lampe-Onnerud's Example 1, therefore, is insufficient to show that Lampe-Onnerud's process necessarily results in a polycrystalline material having at least an area with a higher concentration of cobalt in grain boundaries.

As discussed above, Lampe-Onnerud discloses a composition having a core, and a coating *on* the core having a greater ratio of cobalt to nickel than the core, such that the ratio of cobalt to nickel in the material generally increases as a gradient from the core to an outer surface of the coating.

Ex. 1007, 3:41–44, 4:14–16. Lampe-Onnerud does not disclose that the composition includes grain boundaries enriched with cobalt, or even includes grain boundaries at all. Petitioner does not provide a sufficient showing to establish that Lampe-Onnerud’s composition necessarily is a polycrystalline material having a cobalt-enriched grain boundary between adjacent crystallites, as required by claim 1 of the ’317 patent.

We, therefore, determine that Petitioner does not provide sufficient information to establish that Lampe-Onnerud anticipates independent claim 1, and claims 2–17, which depend from claim 1. Petitioner’s assertions, therefore, are not sufficient to support institution on ground 1, because Petitioner does not demonstrate a reasonable likelihood of prevailing in its challenge to the patentability of at least one claim of the ’317 patent.

2. Ground 2: Asserted Obviousness over Park and Lampe-Onnerud

Petitioner asserts that claims 1–17 would have been obvious over Park and Lampe-Onnerud. Pet. 45–63. Patent Owner disagrees. Prelim. Resp. 34–39. We focus our analysis on the disputed limitations of claim 1, and begin with an overview of Park.

a. Park (Ex. 1008)

Park discloses that although “LiCoO₂ is widely used as a positive electrode active material for lithium secondary batteries,” it “is expensive and its supply is unreliable.” Ex. 1008 ¶ 7. Park further indicates that because “the residual capacity, recovery capacity, and thermal stability of conventional positive electrode active materials are unsatisfactory,” “alternatives (such as composites including nickel or manganese) are being developed for use as a positive electrode active material.” *Id.* ¶¶ 7–8.

Park discloses a positive electrode active material for lithium batteries formed of secondary particles including an agglomeration of primary particles comprised of a lithium composite oxide and an amorphous material. *Id.* ¶¶ 11, 21. The amorphous material “may be a lithium salt, but is not limited thereto,” and may be present along a grain boundary of adjacent primary particles, and/or as an amorphous material layer. *Id.* ¶¶ 22, 24. Park defines a “grain boundary” as “the interface between two adjacent primary particles.” *Id.* ¶ 22.

Figure 1 of Park illustrates an exemplary secondary particle:

FIG. 1

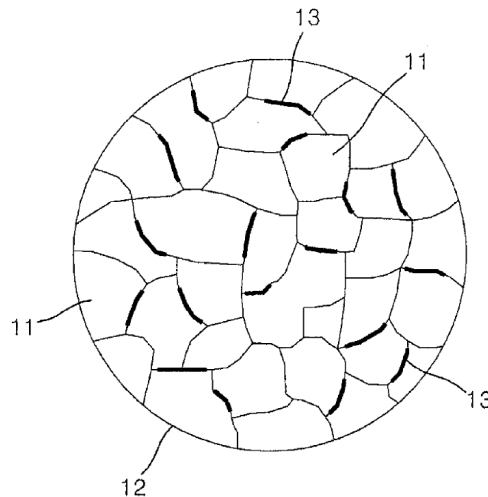


Figure 1 is a cross-sectional schematic view of secondary particle 12 included in a positive electrode active material for lithium batteries. *Id.* ¶ 29. Secondary particle 12 is formed of agglomerated primary particles 11 and amorphous material 13 along a grain boundary of primary particles 11 at the surface of secondary particle 12. *Id.* ¶ 29.

Park describes manufacturing its positive electrode active material by mixing and stirring a lithium composite oxide and a lithium salt, and heat

treating the resulting mixture at a temperature of between about 700° C and about 950° C. *Id.* ¶¶ 12, 30, 33. Park’s Preparation Examples 1 and 2 describe preparing a positive electrode active material by adding $\text{LiNi}_{0.6}\text{CO}_{0.2}\text{Mn}_{0.2}\text{O}_2$ (lithium composite oxide) to Li_2SO_4 (lithium sulfate), stirring, and heating the mixture at either 800 °C (Example 1) or 900 °C (Example 2). *Id.* ¶¶ 63–65. Park indicates that the materials produced according to these processes included “an amorphous layer formed of lithium sulfate between adjacent primary particles.” *Id.* ¶ 74.

b. Disputed Limitations of Claim 1

Our analysis for ground 2, like ground 1, focuses on claim 1’s requirement that the recited particle include a plurality of crystallites and a grain boundary between adjacent crystallites, where a concentration of cobalt in the grain boundary is greater than a concentration of cobalt in the adjacent crystallites.

Petitioner asserts that it would have been obvious to a POSITA to modify Park “by further enriching the grain boundaries with Lampe-Onnerud’s cobalt salt-based coating—in addition to Park’s amorphous lithium salt—to further improve the ‘capacity, cyclability, and safety’ of the cathode material ‘throughout the life of the battery.’” Pet. 48 (citing Ex. 1007, 2:16–28, 6:53–7:30, Example 1; Ex. 1002, ¶ 191). According to Petitioner, a “POSITA would have understood that additionally increasing cobalt concentration would provide even greater structural stability to the grain boundaries of the cathode material than by just forming a lithium-based amorphous material in that region.” *Id.* (citing Ex. 1007, 2:16–28, 6:53–7:30). Petitioner asserts that “[i]t would have been obvious to a POSITA to modify (or simply augment) Park to mix a cobalt salt in addition

to lithium salt when forming the coating for enriching the grain boundary. Using a cobalt salt, as disclosed in Lampe-Onnerud, would additionally enrich the grain boundary with cobalt.” *Id.* at 51 (citing Ex 1007, 2:16–28, 6:53–7:30, Example 1; Ex. 1002 ¶¶ 190–192, 200–204).

Patent Owner counters that “Petitioner does not articulate an adequate motivation to combine Park and Lampe-Onnerud” because “Lampe-Onnerud does not even teach a polycrystalline (*i.e.*, grain-boundary-containing) material,” much less teach “enriching the grain boundaries with [a] cobalt salt-based coating.” Prelim. Resp. 34–35. Patent Owner contends Lampe-Onnerud instead “teaches a process by a cobalt ‘gradient’ coating is placed ‘on the core’ of a cathode particle,” and “there is no discussion in Lampe-Onnerud of the cobalt penetrating the surface of the particle ‘core’ and entering any grain boundaries.” *Id.* at 35–36.

We agree with Patent Owner that Petitioner does not provide a sufficient rationale for combining the teachings of Park and Lampe-Onnerud in a manner that would have led a POSITA to a particle as recited in claim 1.

As discussed above, Lampe-Onnerud’s material has a core, and a coating *on* the core having a greater ratio of cobalt to nickel than the core, such that the ratio of cobalt to nickel in the material generally increases as a gradient from the core to an outer surface of the coating. Ex. 1007, 3:41–44, 4:14–16. Petitioner does not identify any disclosure in Lampe-Onnerud indicating that Lampe-Onnerud’s material includes grain boundaries enriched with cobalt, or even includes grain boundaries at all. Nor does Petitioner explain why Lampe-Onnerud’s disclosure of a material having a coating on a core with a greater ratio of cobalt to nickel than the core would have suggested a material having cobalt-enriched grain boundaries. Rather,

as discussed above for ground 1, Petitioner asserts that Lampe-Onnerud's material necessarily—or inherently—has such a microstructure. For reasons discussed above, however, Petitioner does not provide sufficient information to establish such necessity or inherency.

Now, in ground 2, Petitioner relies on this asserted inherent feature of Lampe-Onnerud's material as the basis for its proffered motivation to combine Park and Lampe-Onnerud. It is well-established, however, that unknown features of prior art articles cannot be relied upon to provide a motivation to combine prior art references. *Cytiva Bioprocess R&D AB v. JSR Corp*, 122 F.4th 876, 890 (Fed. Cir. 2024) (“When claims require prior knowledge of the inherent property—e.g., for motivation to combine—then a petitioner would still generally need to demonstrate a reasonable expectation of success. As explained decades ago . . . unknown properties cannot be used as the basis for such a motivation.”) (citing *In re Spormann*, 363 F.2d 444, 448 (C.C.P.A. 1966) (“[T]he inherency of an advantage and its obviousness are entirely different questions. That which may be inherent is not necessarily known. Obviousness cannot be predicated on what is unknown.”) (citing *In re Adams*, 356 F.2d 998, 1001 (C.C.P.A. 1966))); *see also Honeywell Int’l Inc. v. Mexichem Amanco Holding S.A. DE C.V.*, 865 F.3d 1348, 1354–55 (Fed. Cir. 2017) (“We have previously stated that the use of inherency in the context of obviousness must be carefully circumscribed because ‘[t]hat which may be inherent is not necessarily known’ and that which is unknown cannot be obvious.”).

In the present case, Petitioner does not provide sufficient evidence to establish that a POSITA reasonably would have been led from Lampe-Onnerud's disclosures to add a cobalt salt to the lithium salt used in Park's

process to “further enrich” the grain boundaries of Park’s secondary particles with cobalt, when Lampe-Onnerud lacks any disclosure of enriching grain boundaries with cobalt, and even lacks disclosure of grain boundaries. In view of the absence of any such disclosures in Lampe-Onnerud, along with the absence of disclosure of forming a cobalt-enriched coating *on* the core of Lampe-Onnerud’s material, Petitioner does not provide a sufficient showing to establish that a POSITA would have been led from Lampe-Onnerud’s disclosures to attempt to enrich the grain boundaries of Park’s secondary particles with cobalt. Although Dr. Aurbach opines that it would have been obvious to a POSITA to do so by adding a cobalt salt to Park’s lithium salt, we accord Dr. Aurbach’s unsupported opinion on this issue little weight, because it is not corroborated with any objective evidence. Ex. 1002 ¶¶ 191, 200–203.

And even if Lampe-Onnerud’s disclosures would have suggested adding a cobalt salt to the lithium salt used in Park’s process, Petitioner does not provide sufficient information to establish that a POSITA reasonably would have expected that so modifying Park’s process would result in the grain boundaries of Park’s secondary particles being enriched with cobalt. The processes Park and Lampe-Onnerud use for forming their respective materials differ significantly. Neither Petitioner nor Dr. Aurbach addresses the differences between the two processes or explains why, despite the differences, a POSITA reasonably would have expected that simply adding a cobalt salt to Park’s lithium salt would result in grain boundaries in Park’s material becoming enriched with both lithium and cobalt. *Compare* Ex. 1007, 4:61–5:2, 5:12–30, *with* Ex. 1008 ¶¶ 12, 30, 33. Rather, Petitioner and Dr. Aurbach merely state, without providing any objective supporting

evidence, that this would be the case. Pet. 51, Ex. 1002 ¶¶ 203.

Nonetheless, Petitioner further asserts that “[i]t also would have been obvious to a POSITA from Lampe-Onnerud to improve upon Park’s concept by applying the coating using the wetting and subsequent evaporation/sintering technique in Lampe-Onnerud to ensure that the coating percolates into the surface of the secondary particle, to prevent cracking at areas where the electrolyte can seep into the material.” Pet. 52 (citing Ex. 1008 ¶ 29).

Lampe-Onnerud does not disclose that its coating percolates into the core of its material, however, much less disclose that cobalt in the coating percolates into grain boundaries in the core (to the extent that grain boundaries exist in the core material). As discussed above for ground 1, Petitioner does not provide sufficient information to establish that a POSITA would have understood such percolation to occur. Petitioner, therefore, does not provide sufficient information to establish that a POSITA reasonably would have expected that adding Park’s lithium salt to the cobalt salt used in Lampe-Onnerud’s process would result in formation of secondary particles having cobalt-enriched grain boundaries. Rather, Petitioner merely states, without providing any objective supporting evidence, that this would be the case. Pet. 52.

We, therefore, determine that Petitioner does not provide sufficient information to establish that Lampe-Onnerud and Park would have rendered obvious the subject matter of independent claim 1 and claims 2–17, which depend from claim 1. Petitioner’s assertions, therefore, are not sufficient to support institution on ground 2, because Petitioner does not demonstrate a reasonable likelihood of prevailing in its challenge to the patentability of at least one of the claims challenged in this ground.

3. Ground 3: Asserted Anticipation by Takagi

Petitioner asserts that claims 1–9, 11, and 14–17 are anticipated by Takagi. Pet. 63–76. Patent Owner disagrees. Prelim. Resp. 39–48. We focus our analysis on the disputed limitations of claim 1, and begin with an overview of Takagi.

a. Takagi (Ex. 1010)

Takagi discloses a lithium battery positive electrode active material or “positive electrode active material” in the form of “secondary particle[s] having a plurality of primary particles containing a layered rock salt structure lithium complex oxide containing at least lithium, nickel, and cobalt.” Ex. 1010 ¶ 15. The portion near the surface of at least one of the secondary particles and the “primary particles constituting the [secondary] particles” has a higher cobalt concentration “than the cobalt concentration inside” the particles. *Id.* ¶¶ 10, 11, 13. Takagi explains that “when the cobalt concentration in a region near the surface of the primary particle is set to be high, the cobalt concentration in the portion near the surface of the positive electrode active material formed from the primary particle is normally also high.” *Id.* ¶ 20. And “setting the cobalt concentration in the portion near the surface of the primary particles to be high enables suppression of occurrence of cracking at the bonding interface of the primary particles,” which stabilizes the crystal structure “in the portion near the surface,” “resulting in improved cycle characteristics.” *Id.* ¶¶ 10, 11, 13, 19.

Takagi discloses a process for manufacturing its positive electrode active material that involves subjecting a mixture of oxides and hydroxides of at least lithium, nickel, and cobalt (the “raw materials”) to a first firing

step by heating the mixture at a temperature within the range of 100 to 300 °C in an oxygen-containing environment for preferably one or more hours, subjecting the resulting material to a second firing step by heating the material at a temperature within the range of 400 to 700 °C in an oxygen-containing environment for preferably 3 or more hours, to yield “a fired product having a high cobalt concentration in the portion near the surface.” *Id.* ¶¶ 26–27. Takagi’s process further involves subjecting the second-fired material to a granulation step in which the material “is made into a powder or granular material” by first disaggregating the material “to about the level of the primary particles,” and then granulating the material to an extent that preferably yields a powder. *Id.* ¶ 28. The final step of Takagi’s process involves a third firing step in which “the powder and granular material obtained in the granulation step is fired at 600 to 900 °C in an atmosphere containing oxygen” preferably for two or more hours. *Id.* ¶ 29.

Takagi provides experimental examples describing the manufacture of five inventive and three comparative positive electrode active materials. *Id.* ¶¶ 44–52. The inventive materials were produced using process parameters within the general conditions described above, and the resulting products were examined using Auger electron spectroscopy to obtain a profile of cobalt concentration in each material from a depth of 250 nm outwards to the materials’ surfaces. *Id.* ¶¶ 44–47, 51. In each of the inventive materials, the cobalt concentration began increasing at a depth of about 50 nm and continued to increase until the concentration reached its highest level at a depth of zero, *i.e.*, at the material’s surface. *Id.* ¶ 52, Fig. 1.

In describing these results, Takagi implicitly defines a “portion near the surface” of the active material (*i.e.*, secondary particles) as a region

spanning a depth of about 50 nm to the material's surface. *Id.* ¶ 52 (“As evident from FIG. 1, for all of the positive electrode active materials of each of the Example and Comparative Examples 2 and 3, the cobalt concentrations increased as the surface was approached *within a range from the surface to near 50 nm (portion near the surface).*”) (emphasis added).

b. Disputed Limitations of Claim 1

The parties dispute whether Takagi discloses (1) a polycrystalline material having grain boundaries between adjacent crystallites, and (2) a higher concentration of cobalt in a grain boundary than in the adjacent crystallites, as required by claim 1. *Compare* Pet. 63–70 with Prelim. Resp. 39–48.

(1) A grain boundary between adjacent crystallites

Petitioner asserts that Takagi discloses a cathode material formed of secondary particles having a plurality of agglomerated primary particles “that form grain boundaries at their ‘bonding interface.’” Pet. 64–66 (citing Ex. 1010 ¶¶ 6, 9–10, 15, 19). According to Petitioner, Takagi refers to the “portion near the surface” of the primary particles as the “bonding interface” between the primary particles, and a “POSITA would have understood that a bonding interface is a grain boundary.” *Id.* at 64 (citing Ex. 1002 ¶ 245). Petitioner indicates that, “[a]s properly construed, a grain boundary is a region located generally at the edges/surfaces of and between adjacent crystallites where they interface with each other.” *Id.* at 66 (citing Ex. 1002 ¶ 245).

Patent Owner counters that “other than the conclusory statement of its expert . . . Petitioner offers no support for its assertion that the term ‘bonding interface’ would be understood by those skilled in the art to have the same

meaning as a ‘grain boundary.’” Prelim. Resp. 41 n.14 (citing Ex. 1002 ¶ 245). Patent Owner further contends that “[c]ontrary to Petitioner’s suggestion, Takagi’s reference to ‘secondary particles’ comprising a ‘plurality of primary particles’ does not indicate that Takagi’s final product has a polycrystalline structure.” *Id.* at 42 (citing Pet. 65; Ex. 1010 ¶ 15). Patent Owner explains that although the ’317 patent uses the term “secondary particle” to refer to a polycrystalline particle, “this term simply does not mean the same thing in Takagi that it does in the ’317 patent.” *Id.* at 42–43 (citing Ex. 1001, 3:10–16).

Patent Owner contends that Takagi’s process for producing its cathode material involves forming a precursor material, disaggregating the precursor material to about the level of the primary particles, and calcining the disaggregated primary particles. *Id.* at 40. According to Patent Owner, Takagi “nowhere states that any grain boundaries actually form in its precursor material, nor does it contain any other indication that the precursor material has a polycrystalline structure,” and even if the precursor material initially consisted of polycrystalline particles, Takagi’s disaggregation process eliminates any existing grain boundaries, as indicated by Takagi’s explicit disclosure that the precursor material is disaggregated to about the level of the primary particles. *Id.* at 41. Patent Owner contends that “to the extent Takagi uses the term ‘secondary particles’ to describe its final product, it is using this term to refer to a loose arrangement of single crystals (‘primary particles’) that have been ‘disaggregated,’ and thus have no grain boundaries between them.” *Id.* at 43.

For the reasons that follow, we determine that Petitioner does not provide sufficient information to establish that Takagi discloses a cathode

material formed of secondary particles having a plurality of agglomerated primary particles with grain boundaries between adjacent primary particles. We address the numerous bases Petitioner advances to support its position in turn.

First, although Petitioner asserts that a POSITA would have understood Takagi's disclosure of a "bonding interface" to refer to a grain boundary, Petitioner does not provide sufficient information to establish this understanding in the art. Takagi does not disclose that its active material includes grain boundaries between adjacent primary particles (crystallites), and in fact, Takagi makes no mention of grain boundaries. Although Takagi refers to the "bonding interface of the primary particles," the only evidence that Petitioner provides to support its assertion that a POSITA would have understood this disclosure of a "bonding interface" to refer a grain boundary is Dr. Aurbach's conclusory, unsupported opinion to that effect. Pet. 64 (citing Ex. 1002 ¶ 245). Dr. Aurbach's uncorroborated opinion does not constitute sufficient information to establish the asserted understanding of a POSITA.

Second, Petitioner does not address Takagi's disclosure that during the process of manufacturing its active material, the second-fired material is disaggregated "to about the level of the primary particles" before subjecting the material to a third and final firing step. Ex. 1010 ¶ 28. Petitioner does not provide technical reasoning supported by objective evidence to show that despite this disaggregation step, a POSITA nonetheless would have understood that the final material resulting from Takagi's process would be a polycrystalline material having a plurality of crystallites with grain boundaries between adjacent crystallites.

Petitioner, therefore, does not provide sufficient information to establish that a POSITA would have understood Takagi's disclosure of a "bonding interface" to refer to a grain boundary.

Although Petitioner also relies on its construction of a "grain boundary" as "a region located generally at the edges/surfaces of and between adjacent crystallites where they interface with each other" to support its assertion that "the portion near the surface" of Takagi's primary particles is a grain boundary, we disagree with Petitioner's construction. Pet. 66. As discussed above, we do not interpret a "grain boundary" as including any portion of adjacent crystallites, and instead interpret the term to refer to a region that exists between adjacent crystallites and abuts the surfaces of the adjacent crystallites. Takagi's disclosure suggests that a portion near the surface of its primary particles is a portion of the particles themselves, and, therefore, is not a grain boundary under our interpretation of the term.

Petitioner also relies on Zheng (Ex. 1011) to support its assertion that Takagi's material includes agglomerated primary particles that form grain boundaries at their "bonding interface," based on Petitioner's construction of a "grain boundary." Pet. 66–67. In particular, Petitioner asserts that Zheng's "image of a secondary particle of a lithium nickel cobalt aluminum oxide cathode material, showing the grain boundaries therein [Figure 5]" illustrates that "a grain boundary is a region located generally at the edges/surfaces of and between adjacent crystallites where they interface with each other." Pet. 66–67 (citing Ex. 1002 ¶ 245). Although Petitioner does not elaborate on this assertion, Dr. Aurbach opines that Zheng's image is a secondary particle formed of a composition "that fits within Takagi's

empirical formula,” and the image shows grain boundaries annotated with white arrows. Ex. 1002 ¶ 246; *see also* Ex. 1010 ¶¶ 10, 18.

Petitioner, however, does not identify any disclosure in Zheng indicating that grain boundaries include the edges/surface of adjacent crystallites, and Petitioner does not explain how and why the relied-upon image of Zheng conveys such information. In fact, Zheng indicates that the arrows in the image (Zheng’s Figure 5) point to grain boundary *layers*, which Zheng explicitly differentiates from grain boundaries, referring to grain boundary layers as being “near” grain boundaries. Ex. 1011, A359 (Fig. 5 legend discussing the thickness of the grain boundary layers shown in white contrast indicated by arrows), A362 (“near these grain boundaries . . . the thickness of the corresponding grain boundary layers increases dramatically after cycling”).

Furthermore, neither Petitioner nor Dr. Aurbach provides any evidence to establish that any identity of empirical formulas between Takagi and Zheng’s materials means that the materials have the same microstructure. In particular, even if the empirical formula of the material used to form Takagi’s secondary particles is the same as that of the material used to form the sample shown in Zheng’s Figure 5, Petitioner does not provide any evidence establishing that it necessarily follows that Takagi’s secondary particles are a polycrystalline material having a plurality of crystallites separated by grain boundaries between adjacent crystallites.

Petitioner further asserts that Dr. Noh reproduced Example 5 of Takagi, which resulted in production of secondary particles having grain boundaries between crystals. Pet. 67 (citing Ex. 1003, Figure L(1); Ex. 1002 ¶ 247). The only evidence Petitioner provides to support this assertion is Dr.

Aurbach's opinion that Dr. Noh's experiments produced secondary particles with grain boundaries throughout (shown in Figure L(1) of the Declaration), which Dr. Aurbach opines are "analogous to" those depicted in Figure 10 of the '317 patent, and "very similar to the image of Zheng's agglomerated primary particles." Ex. 1002 ¶ 247. Dr. Aurbach's statements about the images are conclusory, however, and do not point to specific similarities. As such, Dr. Aurbach's opinion does not cure the deficiencies in Petitioner's analysis of Zhang, discussed above. Even more fundamentally, Dr. Aurbach's opinion is based on a construction of "grain boundary" that differs from our construction. *Id.* ¶ 245.

Petitioner, therefore, does not provide sufficient information to establish that Takagi discloses a polycrystalline material having grain boundaries between adjacent crystallites.

(2) A higher concentration of cobalt in grain boundaries than in crystallites

Even if Petitioner's showing were sufficient to establish that Takagi discloses a polycrystalline material having a grain boundary between adjacent crystallites according to our construction of a "grain boundary," Petitioner does not provide sufficient information to establish that the grain boundary has a higher concentration of cobalt than the crystallites. Our reasoning follows in the context of addressing the numerous bases Petitioner advances to support its position.

Petitioner first asserts that Takagi discloses a material having cobalt-enriched grain boundaries based on Petitioner's construction of a "grain boundary" as including the edges/surfaces of adjacent crystallites. Pet. 68. Petitioner also bases its assertion on an interpretation of Takagi's "bonding interface" as being a grain boundary, and interpretation of the "portion near

the surface” of Takagi’s primary particles as being the bonding interface (grain boundary) (discussed above). *Id.* at 68–69. More specifically, Petitioner asserts that “Takagi synthesizes primary particles such that the portion ‘near the surface,’ which the reference also refers to as the ‘bonding interface’ or grain boundary, has [a] higher concentration of cobalt relative to the primary particle’s ‘inside.’” *Id.* at 68 (citing Ex. 1010 ¶¶ 10, 11, 13, 14, 19). Petitioner asserts that this is shown in Takagi’s Figure 1, reproduced below, where the cobalt “concentration is highest at the outer surface of the primary particles (at 0 nm at the left) and decreases toward the inside.” *Id.* (citing Ex. 1002 ¶ 247).

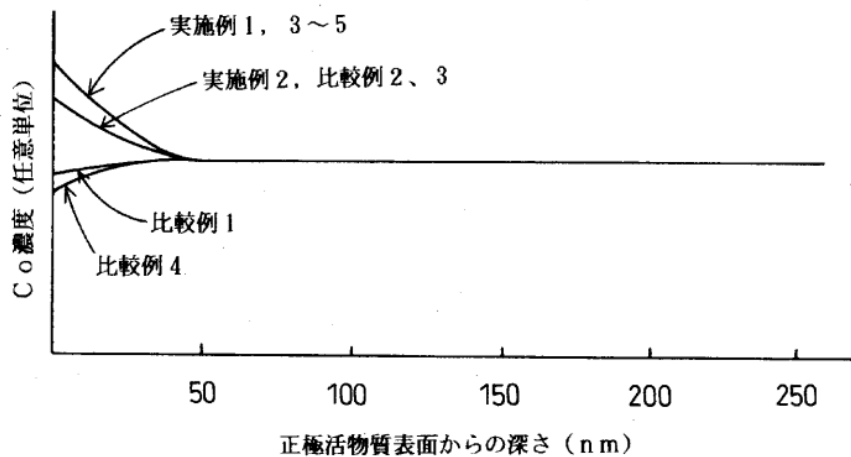


Figure 1 of Takagi is “a diagram illustrating a surface profile of a cobalt concentration of the positive electrode active material of each Example and Comparative Example.” Ex. 1010 ¶ 66.

Patent Owner counters that even if grain boundaries are present in Takagi’s cathode material, “there is still nothing in Takagi to indicate that the concentration of cobalt in these regions would be higher than in the adjoining primary particles.” Prelim. Resp. 43. We agree with Patent

Owner for the following reasons.

As discussed above, we do not interpret a “grain boundary” as including any portion of the adjacent crystallites, and instead interpret the term to refer to a region that exists between adjacent crystallites and abuts the surfaces of the adjacent crystallites. We, therefore, do not interpret a “grain boundary” to include the surfaces of the adjacent crystallites.

Takagi’s Figure 1 (reproduced above) shows the cobalt concentration in a region of numerous exemplary inventive and comparative positive electrode active materials—*i.e.*, secondary particles—rather than primary particles, as Petitioner asserts. Ex. 1010 ¶¶ 44–52. The figure shows that in each of the inventive materials tested, the cobalt concentration began increasing at a depth of about 50 nm, and continued to increase until the concentration reached its highest level at a depth of zero, *i.e.*, at the material’s surface. Figure 1 of Takagi thus shows that the exemplary inventive *secondary* particles had a cobalt concentration gradient that spanned a depth of 50 nm to the particles’ surfaces. Figure 1 of Takagi does not provide any information about the concentration of cobalt in the grain boundaries of the tested materials, however, to the extent that any such grain boundaries exist in the materials, based on our interpretation of a “grain boundary” as not including the surfaces of adjacent crystallites, *i.e.*, the *primary* particles. Rather, Takagi’s Figure 1 only shows a cobalt concentration gradient within secondary particles, not in a grain boundary between adjacent primary particles. Takagi’s Figure 1, therefore, does not support Petitioner’s assertion that Takagi discloses a higher concentration of cobalt in grain boundaries than in adjacent crystallites (primary particles).

Petitioner, therefore, does not provide sufficient information to

establish that Takagi explicitly discloses a secondary particle including a plurality of crystallites with grain boundaries between adjacent crystallites in which the concentration of cobalt in a grain boundary is greater than in the adjacent crystallites, according to our construction of a “grain boundary.”

Petitioner further asserts that Dr. Noh replicated Example 5 of Takagi “confirmed that there is a higher concentration of cobalt in grain boundaries.” Pet. 69. Petitioner asserts that Figures L(2), M(1,) and M(2) of Dr. Noh’s Declaration (reproduced below) show that “[t]he regions where the grain boundary is crossed (positions 4 and 18) have higher cobalt concentration than interiors of adjacent primary particles, or crystallites (positions 2 and 11–16).” *Id.* at 70 (citing Ex. 1002 ¶ 253).

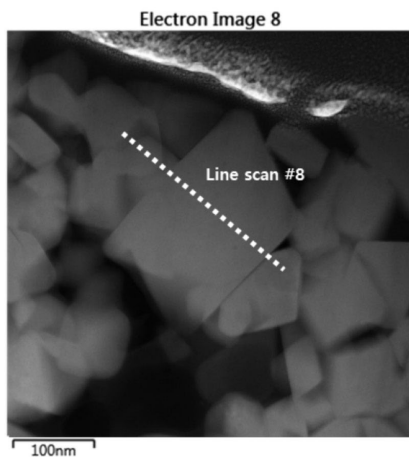


Figure L(2)

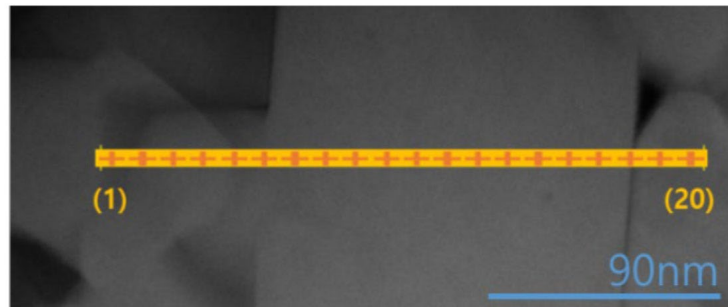


Figure M(1)

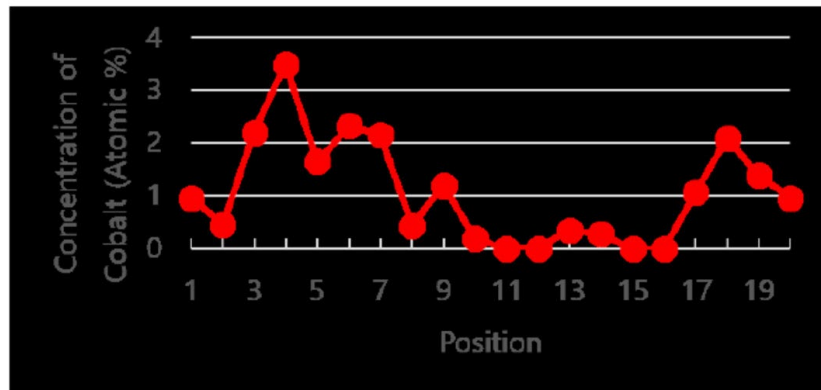


Figure M(2)

Figure L(2) of the Noh Declaration (left) is a scanning transmission electron micrograph (STEM) image of a portion of the final product prepared under Dr. Noh's supervision for replication of Example 5 of Takagi, and shows an area selected for a line scan for cobalt concentration. Figure M(1) of the Noh Declaration depicts a close up of 20 points where cobalt concentration was measured in the line scan #8 shown in Figure L(2), and Figure M(2) is a chart indicating the cobalt concentration by atomic percentage from STEM-EDS analysis performed at each position. Ex. 1003 ¶¶ 42, 43.

Patent Owner counters that Dr. Noh's experiment is not a "faithful reproduction" of Takagi's Example 5 because Example 5 of Takagi does not specify the weights of the precursor compounds used, and Dr. Noh does not explain how he selected the precursor compound weights for his experiment "without any guidance on that point in Takagi." Prelim. Resp. 45. Patent Owner also points out that in Example 5 of Takagi, after the precursor material was formed and subjected to two initial calcination steps, the product was mixed with ion-exchange water at a mass ratio of 30:70. *Id.* at 46 (citing Ex. 1010 ¶ 45). Dr. Noh, however, does not indicate that the corresponding product obtained in his experiment was mixed with ion-

exchange water, much less specify any mass ratio used. *Id.* at 46 (citing Ex. 1003 ¶ 39).

Patent Owner further contends that Dr. Noh's experiment actually refutes Petitioner's assertion that Takagi's Example 5 inherently yields cobalt-enriched grain boundaries. *Id.* at 46. Patent Owner points out that although spot number 4 (in the Figure M(2) image from the Noh Declaration shown above) "has the highest concentration of cobalt in the measured part of the sample, it is located *well within the interior* of the leftmost primary particle in the image," and, therefore, "even if the sample had any grain boundaries, spot number 4 could not possibly be considered one of them." *Id.* at 47. Patent Owner further contends that even if spot number 18 could be considered a grain boundary, the cobalt concentration measured at this spot is not higher than in the adjacent primary particles, because spot number 7 has a slightly higher cobalt concentration. *Id.*

We agree with Patent Owner's contentions. Our reasoning follows.

Similar to the situation discussed above for Dr. Noh's reproduction of Example 1 of Lampe-Onnerud, Petitioner does not provide any evidence establishing that the differences between Dr. Noh's experiments and Takagi's Example 5 (pointed out by Patent Owner above) would not have any material effect on the end results of the two processes. *Compare* Ex 1010 ¶¶ 44–47, *with* Ex. 1003 ¶ 39. In particular, neither Dr. Noh nor Petitioner provides a technical explanation supported by objective evidence to show how and why the deviations in Dr. Noh's experiments from Takagi's Example 5 are immaterial and would not meaningfully affect the result of Dr. Noh's process.

Furthermore, spot number 4 shown in Figure M(1) of the Noh

Declaration appears to be located well within the interior portion of a particle, yet the cobalt concentration measured at that point was higher than at any other spot assessed, including spot 5 which appears to be at the very edge of the particle, and spots 6 and 18, which appear to be at the very edges of the large, central particle shown in the figure. Nonetheless, Petitioner asserts that spot 4 is a “region[] where the grain boundary is crossed” (Pet. 70) without explanation, and Dr. Noh does not comment on the result obtained for spot 4.

In addition, the cobalt concentration at spot 18, which Petitioner also asserts is a “region[] where the grain boundary is crossed,” appears to be lower than at spot 7, which appears to be well inside the large, central particle, while spot 18 appears to be at the very edge of the particle. Although Dr. Noh refers to spot 7 as being in a grain boundary, our construction of “grain boundary” would not include this internal spot (discussed above). Ex. 1003 ¶ 44. And although Dr. Aurbach opines that “the regions [in Figure M(1) of the Noh Declaration] where the grain boundary is crossed have higher cobalt concentration than the interiors of the adjacent primary particles, or crystallites,” Dr. Aurbach does not provide any explanation or evidence to support his opinion. Ex. 1002 ¶¶ 252, 253.

Dr. Noh’s reproduction of Takagi’s Example 5, therefore, is insufficient to show that Takagi necessarily (or inherently) discloses a polycrystalline material having a higher concentration of cobalt in a grain boundary than in adjacent crystallites.

We, therefore, determine that Petitioner does not provide sufficient information to establish that Takagi anticipates independent claim 1, and claims 2–17, which depend from claim 1. As a consequence, Petitioner does

not demonstrate a reasonable likelihood of prevailing in its challenge to the patentability of at least one of the claims challenged in ground 3.

4. Ground 4: Asserted Obviousness over Takagi

Petitioner asserts that claims 10, 12, and 13, which each depend from claim 1, would have been obvious over Takagi. Pet. 76–77. Patent Owner disagrees. Prelim. Resp. 48.

As discussed above for ground 3, Petitioner does not provide sufficient information to establish that Takagi explicitly or inherently discloses a polycrystalline material having a higher concentration of cobalt in a grain boundary than in adjacent crystallites (a cobalt-enriched grain boundary). Petitioner’s assertions for ground 4 are directed to the nickel concentration of the first composition recited in the subject claims, and do not address claim 1’s requirement for a cobalt-enriched grain boundary. Pet. 76–77. Petitioner’s showing for ground 4, consequently, does not provide sufficient information to establish that Takagi would have suggested a polycrystalline material having a higher concentration of cobalt in a grain boundary than in adjacent crystallites, as required by claims 10, 12, and 13. We, therefore, determine that Petitioner does not provide sufficient information to establish that Takagi would have rendered obvious the subject matter of these claims. As a consequence, Petitioner’s showing is insufficient to support institution on ground 4, because Petitioner does not demonstrate a reasonable likelihood of prevailing in its challenge to the patentability of at least one of the claims challenged in this ground.

IV. CONCLUSION

For the reasons discussed above, Petitioner has not demonstrated a

reasonable likelihood of prevailing in its challenge to the patentability of at least one claim of the '317 patent. We, therefore, do not institute an *inter partes* review of the '317 patent. 35 U.S.C. § 314(a)(1).

V. ORDER

It is ORDERED that the Petition is *denied*, and no trial is instituted.

IPR2024-01229
Patent 9,391,317 B2

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