

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.

Case IPR2024-01229

Patent No. 9,391,317 B2

PATENT OWNER'S PRELIMINARY RESPONSE

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EXHIBIT LIST

EXHIBIT NO.	DESCRIPTION
2001	Lüther et al., <i>Systematic “Apple-to-Apple” Comparison of Single-Crystal and Polycrystalline Ni-Rich Cathode Active Materials: From Comparable Synthesis to Comparable Electrochemical Conditions</i> , SMALL STRUCTURES 5 (2024)
2002	Zhang et al., <i>Surface Regulation Enables High Stability of Single-Crystal Lithium-Ion Cathodes at High Voltage</i> , NATURE COMMUNICATIONS 11 (2020)
2003	Song et al., <i>Synthesis of Cathode Materials $\text{LiNi}_{1-y}\text{Co}_y\text{O}_2$ From Various Starting Materials and Their Electrochemical Properties</i> , JOURNAL OF THE KOREAN CERAMIC SOCIETY 40 (2003)
2004	Li et. al, <i>Effect of Grain Size of Single Crystalline Cathode Material of $\text{LiNi}_{0.65}\text{Co}_{0.07}\text{Mn}_{0.28}\text{O}_2$ on Its Electrochemical Performance</i> , ELECTROCHIMICA ACTA 435 (2022)
2005	SAMSUNG SDI Obtains a License From CAMX for Its GEMX™ Advanced Battery Cathode Material Platform, https://www.prnewswire.com/in/news-releases/samsung-sdi-obtains-a-license-from-camx-for-its-gemx-tm-advanced-battery-cathode-material-platform-872817512.html (last visited November 14, 2024)
2006	LG Energy Solution Obtains License From CAMX Power for Its GEMX® Advanced Cathode Material Platform for Lithium-Ion Batteries, https://www.prnewswire.com/news-releases/lg-energy-solution-obtains-license-from-camx-power-for-its-gemx-advanced-cathode-material-platform-for-lithium-ion-batteries-301496092.html (last visited November 14, 2024)
2007	L&F of Korea Obtains License From CAMX Power for Its GEMX® Advanced Cathode Material Platform for Lithium-Ion Batteries, https://www.prnewswire.com/news-releases/lf-of-korea-obtains-license-from-camx-power-for-its-gemx-advanced-cathode-material-platform-for-lithium-ion-batteries-301813533.html (last visited November 14, 2024)
2008	CAMX and Umicore Sign Non-Exclusive IP Licensing Agreement on NMC Battery Technology, https://www.unicore.com/en/newsroom/camx-and-unicore-

EXHIBIT NO.	DESCRIPTION
	sign-non-exclusive-ip-licensing-agreement-on-nmc-battery-technology/ (last visited November 14, 2024)
2009	<i>ECOPRO BM Has Taken a License From CAMX POWER to the Latest GEMX® Platform of Cathode Active Material for Lithium-Ion Batteries</i> , https://www.prnewswire.com/news-releases/ecopro-bm-has-taken-a-license-from-camx-power-to-the-latest-gemx-platform-of-cathode-active-material-for-lithium-ion-batteries-302130626.html (last visited November 14, 2024)
2010	<i>Panasonic Energy Has Taken a License From CAMX Power to the Latest GEMX® Platform of Cathode Active Material for Lithium-Ion Batteries</i> , https://www.prnewswire.com/news-releases/panasonic-energy-has-taken-a-license-from-camx-power-to-the-latest-gemx-platform-of-cathode-active-material-for-lithium-ion-batteries-302226700.html (last visited November 14, 2024)

I. INTRODUCTION

Patent Owner CAMX Power LLC (“CAMX” or “Patent Owner”) achieved a significant breakthrough in the development of cathode (positive electrode) materials for lithium-ion batteries. CAMX discovered that when the cathode is composed of a polycrystalline lithium-nickel-oxide material, its electromechanical stability can be substantially improved by selectively “enriching” certain regions of the polycrystalline particles—namely, their “grain boundaries”—with cobalt. By targeting these specific regions of the polycrystalline particles for enrichment with cobalt, CAMX’s invention uses only as much cobalt as is necessary to stabilize the material—a crucial advantage, because cobalt is a very expensive metal, and because replacing too much of the nickel with cobalt can cause the material to lose many of the benefits traditionally associated with high-nickel cathode materials. CAMX’s fundamental invention has received patent protection in numerous jurisdictions, including the U.S., Europe, China, Japan, and Korea, and its patent portfolio—including the challenged ’317 Patent—has been licensed by nearly all of the leading battery manufacturers and battery materials producers in the world. The Petition filed by POSCO Future M Co., Ltd. (“Petitioner”) fails to demonstrate a reasonable likelihood that any claim of the ’317 Patent is unpatentable.

In **Ground 1**, Petitioner asserts that Lampe-Onnerud anticipates all of the challenged claims. However, Lampe-Onnerud does not even teach a *polycrystalline*

(i.e., grain-boundary-containing) cathode material. In fact, Petitioner concedes that Lampe-Onnerud nowhere as much as mentions grain boundaries. By definition, because Lampe-Onnerud does not teach a material with grain boundaries, it cannot teach *cobalt-enriched* grain boundaries. Petitioner nonetheless relies on its “replication” of Lampe-Onnerud’s Example 1 to prove that this example *inherently* teaches the enrichment of grain boundaries with cobalt. But Petitioner’s experiment fails to prove inherency because it is not a faithful reproduction of the Lampe-Onnerud example. For one, Petitioner opts to start with a polycrystalline material in its “replication” of the example *even though*, as just noted, a polycrystalline material is not taught in that example or anywhere else in Lampe-Onnerud. Then, having started with the wrong material, Petitioner proceeds to make matters worse by materially deviating (with no explanation whatsoever) from the actual processing conditions set forth in Lampe-Onnerud’s example, in an apparent attempt to reverse-engineer cobalt-enriched grain boundaries. At least for these reasons, Ground 1 fails to raise a reasonable likelihood that the challenged claims are anticipated.

In **Ground 2**, Petitioner asserts that all of the challenged claims are rendered obvious by a combination of Park and Lampe-Onnerud. Petitioner, however, concedes that Park does not teach cobalt-enriched grain boundaries, either explicitly or inherently. In fact, Park does not teach enriching grain boundaries with any kind of transition-metal compound or structured material; it only teaches enriching with

an amorphous lithium salt. Thus, combining Park with Lampe-Onnerud cannot cure the deficiencies in Ground 1. Indeed, Petitioner does not adequately explain *why* a person of ordinary skill in the art (“POSITA”) would combine these references or *how* he or she would combine them, let alone combine them in a way that could result in a material with cobalt-enriched grain boundaries. Therefore, Ground 2 does not establish a reasonable likelihood that the challenged claims are obvious.

Finally, in **Grounds 3 and 4**, Petitioner asserts that some of the challenged claims are anticipated by Takagi and the rest are rendered obvious by it. Again, Petitioner is wrong. First, Takagi does not teach a cathode material with grain boundaries. Indeed, to the extent that Takagi’s precursor material has grain boundaries (and Takagi does not say that it does), Takagi’s disclosure makes it clear that any grain boundaries are necessarily eliminated in the final product via subsequent processing steps. Second, even if Takagi’s cathode material actually had grain boundaries, Takagi would still lack any disclosure of *cobalt-enriched* grain boundaries. At most, Takagi teaches that the concentration of cobalt varies *within* the individual “primary” particles that make up its cathode material. However, there is no suggestion in Takagi that the concentration of cobalt may be higher in the grain boundaries that surround these primary particles (to the extent grain boundaries even exist in Takagi’s material, which they do not). Grounds 3 and 4 fail for at least these reasons.

II. THE TECHNOLOGY OF THE '317 PATENT

Cathode (positive electrode) materials in lithium-ion batteries are typically made from lithium metal oxides, including, for example, lithium nickel oxides (LiNiO_2) and lithium cobalt oxides (LiCoO_2). (Ex. 1007 at 1:11-33.) Lithium-metal-oxide materials generally take one of two forms when used in a lithium battery cathode: polycrystalline or single-crystal. (Ex. 2001 at 1; Ex. 2002 at 1.) In a polycrystalline material, each polycrystalline particle (sometimes referred to as a “secondary particle”) consists of an arrangement of densely packed, smaller “primary particles” (“crystallites” or “grains”) of varying sizes and orientations. These smaller particles are separated by “grain boundaries.” (Ex. 2001 at 1-2.) The drawing below, taken from the '317 Patent, is a schematic illustration of a cross-section of a polycrystalline particle comprising many crystallites (including **40**) and grain boundaries between adjacent crystallites (including **41** and **42**).

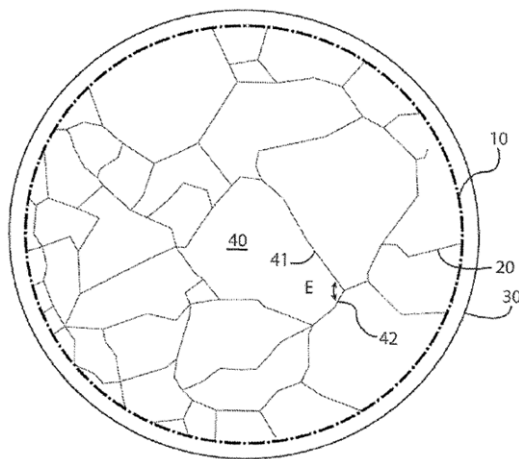
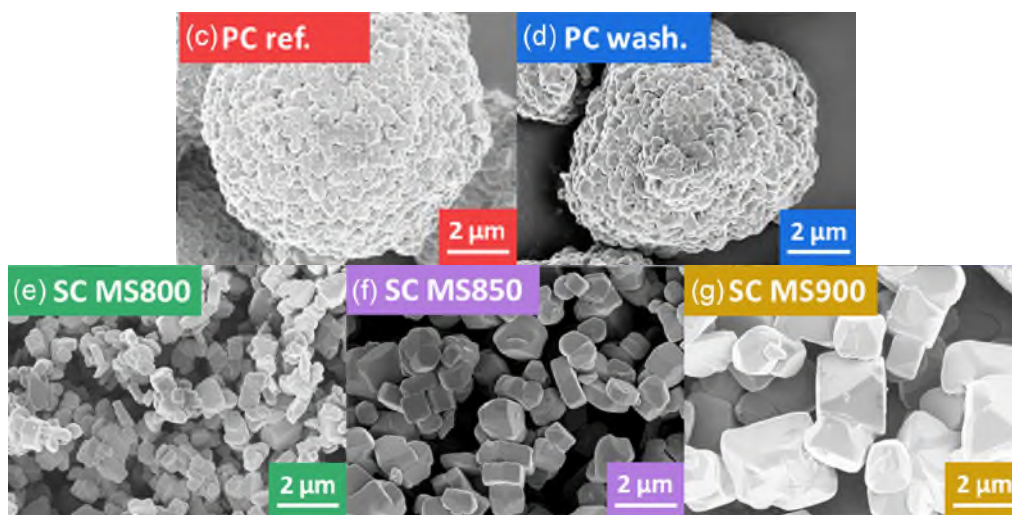


FIG. 1

(Ex. 1001 at Fig. 1.)

By contrast, in a single-crystal material, each particle consists of a single grain of uniform crystal arrangement throughout and therefore has no grain boundaries. (Ex. 2002 at 2.) The following microscopic images illustrate the characteristic morphologies of polycrystalline (top row) and single-crystal (bottom row) lithium-metal-oxide materials:



(Ex. 2001 at 3.)

The '317 Patent, entitled “Polycrystalline Metal Oxide, Methods of Manufacture Thereof, and Articles Comprising the Same,” addresses problems unique to *polycrystalline* cathode materials. The specification explains that polycrystalline LiNiO_2 -based cathode materials suffer from poor cycling stability (reflected in the number of times a battery can be charged and discharged before its capacity is reduced to a certain amount of its nominal capacity) because the cycling causes cracking to occur in the grain boundaries between adjacent primary particles. (Ex. 1001 at 11:29-36.) The inventors surprisingly discovered that this problem can

be solved by selectively “enriching” the grain boundaries of a polycrystalline LiNiO₂-based material with cobalt. (*Id.* at 3:10-16, 11:46-49.) The focused enrichment of the grain boundaries with cobalt stabilizes those targeted regions against damage caused by cycling. (*Id.* at 3:18-28, 11:49-62.) At the same time, because the cobalt is preferentially provided in the grain boundaries where it was discovered to be most effective at stabilizing the lithium nickel oxide, its total amount in the material is kept to a minimum (which is important, because cobalt is expensive), and the material retains many of the superior characteristics associated with LiNiO₂ cathode materials, including higher capacity (the amount of energy a battery can store and release) and rate capability (the ability to generate a large amount of power while maintaining a certain voltage limit). (*Id.* at 3:18-28, 11:49-62.)

The specification describes in detail the process by which a polycrystalline LiNiO₂-based material with cobalt-enriched grain boundaries may be prepared. First, a precursor polycrystalline lithium-nickel-oxide material may be formed by mixing lithium hydroxide and lithium nitrate with one or more metal hydroxides and gradually sintering this mixture in a staged heating process. (Ex. 1001 at 9:22-28, 14:25-46, 16:30-39). The grain boundaries of the precursor polycrystalline material are then selectively enriched with cobalt by mixing the material with a solution of a lithium compound (*e.g.*, a lithium nitrate) and a cobalt compound (*e.g.*, a cobalt

nitrate); drying the resulting slurry via spray-drying to produce a powder; and then subjecting the powdered material to gradual calcination, again according to a specific, staged heating process, which causes the cobalt to preferentially enter the grain boundaries of the material. (*Id.* at 14:48-66.)

Patent Owner has commercialized its groundbreaking discovery under the trade name GEMX[®]. Patent Owner's GEMX[®] patent portfolio, including the '317 Patent, has been licensed by most leading lithium-ion materials and battery manufacturers in the world, including Samsung SDI, LG Energy Solution, L&F, Umicore, EcoPro, and Panasonic Energy. (*See* Exs. 2005-10.)

The '317 Patent has two independent claims. Claim 1 is a composition claim:

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 at 17:26-36.) Thus, claim 1 specifically describes a polycrystalline particle—one comprising “a plurality of crystallites” and “a grain boundary between adjacent crystallites”—and specifically requires “a concentration of cobalt in the grain boundary [to be] greater than a concentration of cobalt in the crystallites.”

Claim 17, the other independent claim, is directed to a method of manufacture:

17. A method of manufacturing the particle of claim 1, the method comprising:

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; then

heat treating at 600 to about 900° C. for about 0.1 to about 10 hours to manufacture the particle, wherein the particle comprises a plurality of crystallites comprising a first composition having a layered α -NaFeO₂-type structure and comprising Li, Ni, Co, and O; and

a grain boundary between adjacent crystallites of the plurality of crystallites and comprising a second composition having a 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 at 18:60-19:11.) In addition to describing a series of specific preparation and processing steps, claim 17 (like claim 1) requires the final product to be a polycrystalline particle with “a concentration of cobalt in the grain boundary . . . greater than a concentration of cobalt in the crystallites.”

III. ASSERTED PRIOR ART

A. Lampe-Onnerud

Lampe-Onnerud describes a cathode material made of particles comprising a lithium-metal-oxide particle “core” and a cobalt-rich coating located “on the core.”

(Ex. 1007 at 3:41-44.) The coating “on the core” of the particle is a “gradient” coating, meaning the concentration of cobalt relative to nickel in this coating gradually “increases as a gradient from the core to an outer surface of the coating.” (*Id.* at 4:14-16.) Lampe-Onnerud does not suggest that the cobalt in this gradient coating “on” the surface of the particle “core” penetrates that surface and enters the “core.” Lampe-Onnerud certainly does not indicate that the cobalt penetrates the surface of the “core” in a way that causes its concentration to be higher in the grain boundaries than in the bulk of the material. Petitioner admits that Lampe-Onnerud *does not even mention grain boundaries*. (Pet. at 19.) Indeed, Lampe-Onnerud nowhere as much as suggests that its particle “core” is *polycrystalline* in nature.

B. Park

Park describes a polycrystalline lithium-metal-oxide cathode material, in which a lithium salt or another amorphous material may be present along the grain boundaries between adjacent primary particles. (Ex. 1008 at ¶¶ 21-24.) However, Petitioner concedes that Park does not teach enriching the grain boundaries of the material with cobalt. (Pet. at 50.)

C. Takagi

Takagi describes a method of forming a cathode material that involves several basic steps. (Ex. 1010 at ¶ 13.) First, Takagi mixes all of the element-containing compounds (*e.g.*, lithium, nickel, and cobalt hydroxides) together at the very

beginning in order to form a precursor material. (*Id.* at ¶ 26.) Second, Takagi subjects this precursor material to two calcination (or “firing”) steps. (*Id.* at ¶ 27.) Third, Takagi subjects this intermediate “fired” product to a granulation step, which “disaggregate[s]” the product to “about the level of the primary particles.” (*Id.* at ¶ 28.) Finally, Takagi subjects the resulting “primary particles” to a third “firing step” to obtain the final product, which it calls the “positive electrode active material.” (*Id.* at ¶¶ 29, 46.)

Takagi thus differs fundamentally from the ’317 Patent, both in terms of its preparation method and the final product. To start, in Takagi, all of the cobalt is incorporated at the very first step of forming a precursor material, *prior to* the possible formation of any grain boundaries. This is in contrast to the ’317 Patent, where cobalt-enriched grain boundaries are achieved by first preparing a precursor polycrystalline lithium-metal-oxide material, and *only then* enriching the grain boundaries of this precursor material with cobalt via additional mixing, drying, and calcination steps. (*See supra* at 6-7.) Furthermore, to the extent that Takagi’s precursor material even has any grain boundaries to begin with (and Takagi nowhere claims that it does), Takagi necessarily *eliminates them* in the granulation step. As noted above, Takagi explicitly teaches that its granulation step “disaggregate[s]” the material down to “about the level of the primary particles.” So, even if, *prior to* the granulation step, Takagi’s material consists of polycrystalline particles (*i.e.*,

arrangements of densely packed primary particles separated by grain boundaries), the purpose and effect of the granulation step is to disassemble these polycrystalline particles into a *single*-crystal material.

Thus, although Takagi defines its final “positive electrode active material” as a “secondary particle” having a “plurality of primary particles” (Ex. 1010 at ¶ 15), it is clearly not using the term “secondary particle” in the same way as the ’317 Patent, to refer to a polycrystalline (densely packed, grain-boundary-containing) particle. Rather, Takagi is using the term to refer to a loose arrangement of single crystals (“primary particles”) that have been “disaggregated,” and thus have no grain boundaries between them. As discussed *infra* at 42, Petitioner’s own *reproduction* of Takagi’s Example 5 confirms that Takagi’s final product has a single-crystal structure, without any grain boundaries.

By definition, because its final product does not even have any grain boundaries, Takagi does not (and cannot) teach cobalt-enriched grain boundaries. Takagi suggests that its material has a relatively higher concentration of cobalt only in two places, neither of which is relevant to grain-boundary enrichment. First, Takagi says that its process results in the concentration of cobalt being higher “near the surface[s]” of the larger, secondary particles that make up the “positive electrode active material” than in the interior of these secondary particles. (Ex. 1010 at ¶ 10.) As discussed above, the “secondary particles” that form Takagi’s “positive electrode

active material” do not even have grain boundaries—but even if they did, a disclosure that these secondary particles have more cobalt near their outer surfaces would not amount to a disclosure that they have more cobalt *in the grain boundaries*. Second, Takagi says that the concentration of cobalt is higher “near the surface[s]” of the smaller, primary particles that make up the secondary particles than in the interior of these primary particles. (*Id.*) However, even on its face, a suggestion that a concentration of cobalt varies *within* a primary particle (with more cobalt near its surface than in the interior) says nothing about how the concentration of cobalt in the primary particles compares to the concentration of cobalt in any surrounding grain boundaries—which, in any event, do not even exist in Takagi’s material.

IV. CLAIM CONSTRUCTION

Petitioner urges the Board to construe only one term: “grain boundary.” (Pet. at 12-16.) It argues that this term refers to “a region located generally at the edges/surfaces of and between adjacent crystallites where they interface with each other.” (*Id.* at 12-13.) By asserting that a grain boundary is “located generally at the edges/surfaces of . . . adjacent crystallites,” Petitioner apparently means that the grain boundary “*includes* the edges/surfaces of adjacent crystallites.” (*Id.* at 13 (emphasis added).) However, to the extent Petitioner’s position is that a grain boundary “includes” portions of the *crystallites themselves*, this interpretation contradicts the plain and ordinary meaning of the claims, the patent’s specification,

and how the term “grain boundary” is generally understood by those skilled in the art. Therefore, the Board should reject Petitioner’s proposed construction and instead construe “grain boundary” as “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.”⁸

A. The Intrinsic Record of the ’317 Patent Is Clear That a “Grain Boundary” Does Not Include Any Portions of the Adjacent Crystallites.

Starting with the words of independent claims 1 and 17, both describe a “grain boundary” as being “between” adjacent crystallites. (Ex. 1001 at 17:31-32, 19:6-7.) The plain and ordinary meaning of “between” is “in or into the space that *separates* two places, people, or objects.” *Between*, MERRIAM-WEBSTER, <https://dictionary.cambridge.org/us/dictionary/english/between> (last visited October 9, 2024) (emphasis added). Thus, when Object A is “between” Objects B and C, this plainly does not mean that Object A forms any part of Objects B and C; it means only that Object A is positioned somewhere in the space that separates Object B from Object C. For example, a mortar compound might be placed “between” two bricks in a brick wall to keep them together. But, though the mortar compound is in direct contact with the surface of each brick, it remains a separate and distinct

⁸ As discussed *infra* at 44, the proper construction of the term “grain boundary” is directly relevant to—indeed, is dispositive of—Petitioner’s anticipation and obviousness arguments based on Takagi (Grounds 3 and 4, respectively).

material. Likewise, insofar as a grain boundary is “between” adjacent crystallites, it merely occupies the space that separates the crystallites from one another, but it *does not* form any part of the crystallites.

The specification of the ’317 Patent confirms that a grain boundary does not include any part of the adjoining crystallites. It explains that a grain boundary is “between adjacent crystallites,” “on a surface of the crystallite,” and “disposed on adjacent faces of a crystallite.” (Ex. 1001 at 6:20-22, 6:48-50.) It is clear from these descriptions that a grain boundary is in contact with an exterior surface of an adjacent crystallite without extending *into* the crystallite, in much the same way that an object placed “on” a table sits on top of the table without penetrating its surface.

Similarly, the specification explains that “[t]he shape of the grain boundary is defined by the shape of the crystallite adjacent the grain boundary.” (Ex. 1001 at 6:28-29.) This further confirms that a grain boundary and an adjacent crystallite are separate, distinct objects, each with its own clearly defined “shape.” The shape of the grain boundary is naturally influenced by the shape of the crystallite, but they are different objects—one does not bleed into the other.

Petitioner points out that the specification describes grain boundaries as being at the “edges of the crystallites.” (Pet. at 13 (quoting Ex. 1001 at 11:30-35).) From this, Petitioner seems to infer that a grain boundary *is*, or *includes*, the “edge” of a crystallite. (*See id.*) This is incorrect. The passage cited by Petitioner discusses the

behavior of transition metal atoms “at the grain boundaries (e.g., edges of the crystallites).” (Ex. 1001 at 11:30-35.) The quoted phrase plainly does not say that a grain boundary *is* the “edge” of a crystallite; it says only that grain boundaries are located *at* the “edges” of the crystallites. To use the same analogy as before, an object placed on an end of a table might be said to be sitting “at the edge” of the table, but it would not form any part of the table.

Petitioner also points to Figure 7 (reproduced and annotated below on the left), which is a graph that shows the varying concentration of cobalt in an exemplary secondary particle of the invention. (Ex. 1001 at 15:24-29.) Each of the 25 data points in Figure 7 corresponds to a different spot (each identified with an “s” in Figure 5 on the right) on a first crystallite **201**, an adjacent second crystallite **202**, and the grain boundary **203** in between. (*Id.* at 15:8-16.)

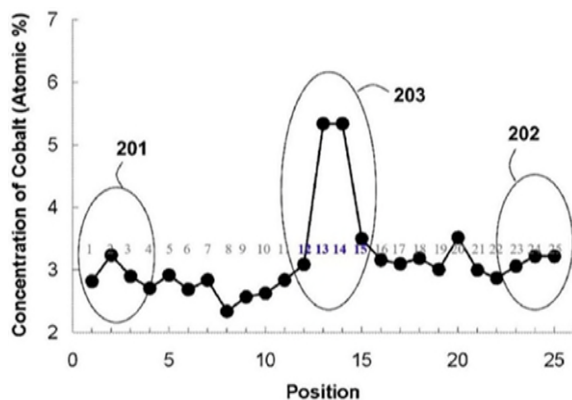


FIG. 7

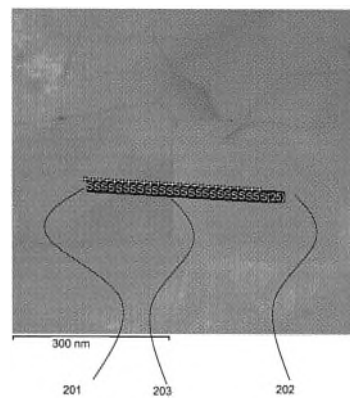


FIG. 5

Petitioner suggests that the oval in the center of Figure 7 serves to define the thickness of the grain boundary, and that, because this oval includes spots within the

edges of the crystallites, a “grain boundary” is properly understood as extending into the crystallites. (Pet. at 14.) Petitioner’s interpretation of Figure 7 is incorrect.

There is no indication in the specification that the oval in the center of Figure 7 is meant to precisely define the thickness of the grain boundary. Rather, the purpose of this oval is simply to highlight how the cobalt concentration is higher in the grain boundary (which corresponds to spots 13 and 14) than in the edges of the adjacent crystallites (which include, for example, spots 12 and 15). Petitioner seems to assume that all of the points within the center oval are part of the grain boundary because the center oval is annotated with number **203**, which the specification uses to refer to the grain boundary. (Ex. 1001 at 15:13-28.) However, Petitioner reads entirely too much into how number **203** is used in Figure 7. Indeed, the other two ovals in Figure 7 are annotated with numbers **201** and **202**, which in the specification refer to the first and second crystallites in Figure 5, respectively. (*Id.*) However, those other two ovals in Figure 7 are obviously not meant to define the width of the first and second crystallites; they only include a few spots (1, 2, 3, 4, 23, 24, and 25) from each one. This confirms that the ovals in Figure 7 are simply not intended to define where the crystallites **201** and **202** end and the grain boundary **203** begins.

Petitioner’s reliance on Figures 10 and 13 is also misplaced. Figure 10 is a STEM (scanning transmission electron micrograph) image of a thin cross-section of a secondary particle prepared in Example 6. (Ex. 1001 at 2:64-67.) Figure 13 is a

cobalt EDS (energy dispersive X-ray) map of the same cross-section and shows that cobalt (indicated by the white shading) is “concentrated at the grain boundaries.”

(*Id.* at 3:5, 17:4-5.)

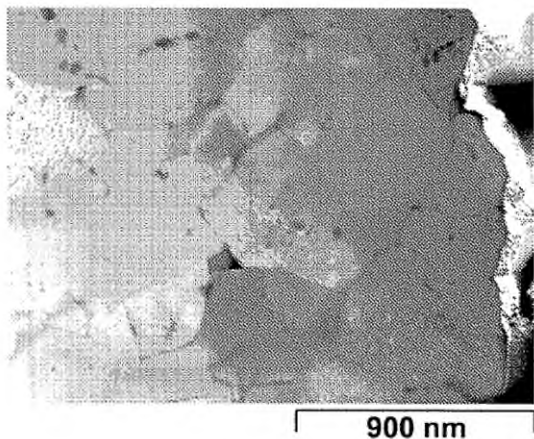


FIG. 10

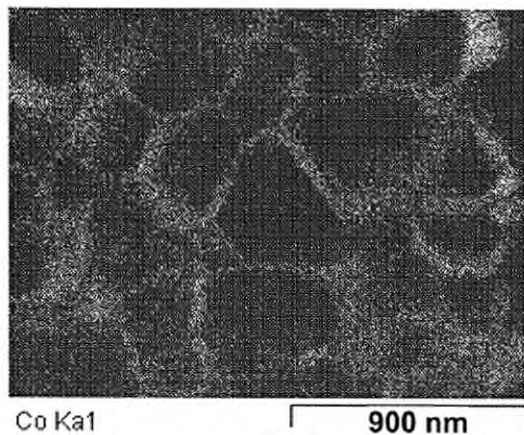


FIG. 13

Petitioner incorrectly assumes that, because the cobalt-containing white-shaded areas in Figure 13 extend beyond the grain boundaries visible in Figure 10 and into the outer edges of the crystallites, this means that those portions of the crystallites are *part of* the grain boundaries. (Pet. at 13-14.) In effect, Petitioner equates “grain boundaries” with “any portion of a secondary particle that contains cobalt.” However, there is no support in the specification for this interpretation of the term “grain boundary.” On the contrary, the specification expressly teaches that cobalt may be present in the “first composition,” which is the composition of *the crystallites*. (Ex. 1001 at 5:1-55 (describing multiple embodiments in which the “first composition” contains at least some amount of cobalt).) Said differently, the invention does not require the concentration of cobalt within the crystallites to be

zero; it simply requires “a concentration of cobalt in the grain boundary [to be] greater than a concentration of cobalt in the crystallites.” (*See supra* at 7-8.)

Said yet another way, Petitioner’s argument conflates structure with material. A grain boundary is a *structural* region of a polycrystalline particle and exists independent of *content*. A grain boundary may contain a material like cobalt, or not, but neither its existence nor dimensions depend on that. To be sure, in the ’317 Patent, a grain boundary is required to have cobalt, and specifically more cobalt than the adjoining primary particles, but this does not mean that any region of the polycrystalline particle that has some amount cobalt is now part of the grain boundary. As noted above, the ’317 Patent explicitly contemplates that cobalt may be present *outside* of the grain boundary, in the adjoining primary particles. Therefore, the distribution of cobalt in Figures 10 and 13 of the patent does not suggest that grain boundaries extend into the outer edges of the adjacent crystallites.

To summarize, the term “grain boundary” is clearly defined in the ’317 Patent as the region *between* two adjacent crystallites, which does not include any portions of the crystallites themselves.

B. The External References Cited by Petitioner Support Patent Owner’s Proposed Construction of “Grain Boundary” and Refute Petitioner’s.

Petitioner cites two external references (Kagei and Zheng) as support for its position that a “grain boundary” includes portions of the adjacent crystallites. (Pet.

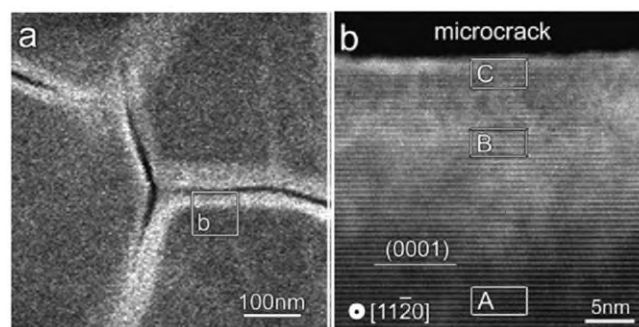
at 15-16.) However, even if these references supported Petitioner’s understanding of the term “grain boundary,” they would not displace the understanding of “grain boundary” explicitly articulated in the ’317 Patent. *Martek Biosciences Corp. v. Nutrinova, Inc.*, 579 F.3d 1363, 1380 (Fed. Cir. 2009). Regardless, both references are fully consistent with Patent Owner’s position that a “grain boundary” excludes any portions of the adjoining crystallites, as well as the general concept that grain boundaries are structural regions and are not defined by their content, which can be cobalt or some other element.

Paragraph 30 of the Kagei patent refers to “particles in which a plurality of primary particles aggregate so as to share part of respective peripheries (grain boundaries) thereof.” (Ex. 1024 at 3.) Petitioner seems to interpret this statement to mean that, in Kagei, the grain boundaries include portions of the primary particles.⁹ (Pet. at 15.) However, all that the statement says is that, in a secondary particle, the adjacent primary particles “share” grain boundaries. This is no different

⁹ The English translation of Kagei submitted by Petitioner is incomplete. It includes only the patent’s publication date, filing date, paragraph 30, and abstract. (See Ex. 1024.) Of note, the declaration that Petitioner obtained from the translator reads as if the translator had translated the entire patent. (*Id.* at 1 (“The attached translation is, to the best of my knowledge, a true, full and accurate translation of the attached Japanese document.”).) Thus, it would appear that Petitioner had the entire document translated but chose to submit only select portions of the translation—presumably because the *unsubmitted* portions provided additional context that further refuted Petitioner’s cramped reading of the reference.

from saying that Indiana and Pennsylvania share Ohio as a neighboring state. That may be, but, of course, Ohio is *not part of* either Indiana or Pennsylvania. In the same way, though two adjacent crystallites may share a common grain boundary, the grain boundary is not part of either crystallite (or vice versa). In fact, earlier in paragraph 30, Kagei explicitly refers to grain boundaries as “surround[ing]” a primary particle. (Ex. 1024 at 3.) This confirms that Kagei is using the term “grain boundary” consistently with the ’317 Patent—to refer to a region separate and distinct from the crystallites which it “surrounds.”

As to Zheng, this reference also supports Patent Owner’s construction of “grain boundary,” because it *explicitly differentiates* between the surface of a grain (*i.e.*, crystallite) and a grain boundary. (Ex. 1011 at A357 (discussing “grain surfaces” and “grain boundaries” separately).) Figures 7(a) and 7(b) of Zheng, cited by Petitioner, are not to the contrary. These figures show microscopic images of a secondary cathode particle (the image on the right is a blow-up of the framed section in the image on the left):



(*Id.* at A360.) Contrary to Petitioner’s suggestion (Pet. at 15-16), the white-shaded areas in these figures do not define the grain boundaries. Zheng states that the white-shaded regions correspond to “grain boundary *layers*,” which are specifically defined in Zheng as “layer[s] *along . . . grain boundar[ies]*,” meaning *separate from* the “grain boundaries.” (Ex. 1011 at A359 (emphasis added).) Zheng, then, uses the term “grain boundary layer” simply as shorthand to refer to the portion of a crystallite that *directly abuts* a grain boundary surrounding the crystallite. But Zheng does not suggest that a grain boundary *includes* this or any other portion of the crystallite.

The Board should adopt Patent Owner’s proposed construction of “grain boundary” and construe this term to exclude any portion of the adjacent crystallites. By contrast to Petitioner’s construction, Patent Owner’s construction fully aligns with the claims, the patent’s specification, and the extrinsic evidence of record.

V. GROUND 1: PETITIONER HAS NOT SHOWN A REASONABLE LIKELIHOOD THAT CLAIMS 1-17 ARE ANTICIPATED BY LAMPE-ONNERUD.

Ground 1 does not raise a reasonable likelihood that Lampe-Onnerud anticipates the challenged claims for at least two reasons. First, Lampe-Onnerud does not teach a material with grain boundaries. Second, Petitioner has not shown

that the process of Lampe-Onnerud inherently yields cobalt-enriched grain boundaries *even when* applied to a grain-boundary-containing material.

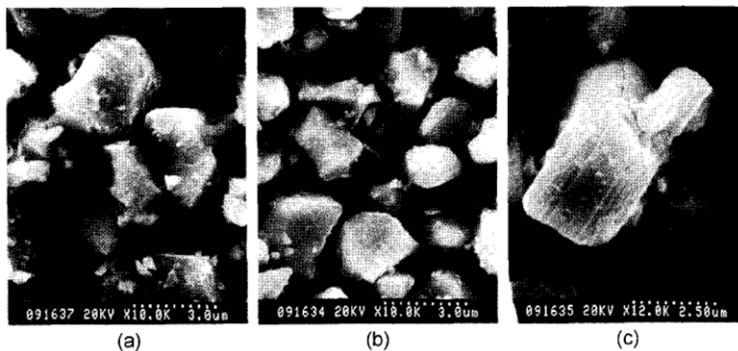
A. Lampe-Onnerud Does Not Teach a Cathode Material With Grain Boundaries.

The '317 Patent describes a cathode material formed from *polycrystalline* lithium-metal-oxide particles. The polycrystalline (secondary) particle engineered by the inventors is made of *a plurality of crystallites* (primary particles) and cobalt-enriched *grain boundaries between* adjoining crystallites. (*See supra* at 7-8.) Claims 1 and 17 thus specifically describe a particle comprising “a plurality of crystallites” and “a grain boundary between adjacent crystallites”—in short, a polycrystalline particle. By contrast, Lampe-Onnerud simply does not teach polycrystalline (*i.e.*, grain-boundary-containing) cathode particles.

In Lampe-Onnerud, the cathode material is made of particles comprising a lithium-metal-oxide particle “core” and a cobalt-rich coating located “on the core.” (*See supra* at 8-9.) Petitioner assumes that this particle “core” is polycrystalline, and thus satisfies the elements of independent claims 1 and 17 requiring a particle to comprise a plurality of crystallites and grain boundaries between adjoining crystallites. (Pet. at 21-27.) However, there is nothing in Lampe-Onnerud to indicate that its particle “core” is polycrystalline. It never refers to the material of the “core” as “polycrystalline.” Nor does its discussion of the “core” contain any

other indicia of polycrystallinity, such as any references to the “core” being comprised of many crystallites of varying sizes and orientations or the “core” having any “grain boundaries” between adjacent crystallites. (*See supra* at 4.) ***Indeed, Petitioner concedes (as it has to) that Lampe-Onnerud does not contain a single reference to grain boundaries.*** (Pet. at 19.) Simply put, a POSITA would see nothing in Lampe-Onnerud that would signal to him or her that the particle “core” in this reference is made of polycrystalline material.

Nor would a POSITA have any reason to *assume* that the particle “core” of Lampe-Onnerud is polycrystalline. *Single*-crystal lithium-metal-oxide materials (meaning materials without any grain boundaries) are commonly used in lithium-ion battery cathodes. (*See, e.g.*, Ex. 2002.) Their use in lithium-ion battery development easily dates back to the time period around Lampe-Onnerud’s 2002 effective filing date. For example, the Song reference, which is roughly contemporaneous with Lampe-Onnerud, shows the authors synthesizing a variety of “mixed-phase” LiNiCoO_2 compositions in order to minimize the drawbacks of using pure LiNiO_2 or LiCoO_2 as the cathode material. (Ex. 2003 at 1; *see also supra* at 4.) It is clear from the images provided in the reference that the authors were working with *single*-crystal lithium-metal-oxide materials:



(Ex. 2003 at 5.)¹⁰ Song thus confirms that a POSITA familiar with the state of the art around the time of Lampe-Onnerud’s invention would not have assumed that a polycrystalline “core” was “necessarily present” in that reference. *See Trintec Indus., Inc. v. Top-U.S.A. Corp.*, 295 F.3d 1292, 1295 (Fed. Cir. 2002) (“Inherent anticipation requires that the missing descriptive material is ‘necessarily present,’ not merely probably or possibly present, in the prior art.”).

In fact, given the nature of its asserted invention, there would have been no reason for Lampe-Onnerud to employ a polycrystalline material as the particle “core.” In Lampe-Onnerud, the objective is to stabilize the cathode material by generating a “gradient coated” particle. (Ex. 1007 at 4:4-16, 9:29-32.) The gradient coating is located “on the core” of the particle. (*Id.* at 1:56-57, 2:13-14, 3:43-44 (emphasis added).) The concentration of cobalt relative to nickel in this surface

¹⁰ These images are uniquely characteristic of a single-crystal material, because each particle is shown to have a continuous crystalline structure. That is to say, the particles do *not* consist of dense, tightly packed clusters of smaller crystals (“primary particles”) of varying sizes and orientations and grain boundaries between adjoining primary particles. (*See supra* at 4-5.)

coating gradually “increases as a gradient from the core to an outer surface of the coating.” (*Id.* at 4:4-16.) But there is no discussion in Lampe-Onnerud of cobalt percolating from this surface gradient coating *into* the “core,” much less of cobalt percolating into the “core” in a way that causes its concentration to be higher in grain boundaries than in the bulk of the material. Therefore, the mechanism by which the cathode particle is stabilized in Lampe-Onnerud is simply not dependent in any way on the existence of grain boundaries within the particle “core.” It is not, in other words, dependent on the “core” being made of polycrystalline material.

In this way, Lampe-Onnerud differs fundamentally from the ’317 Patent, which addresses a challenge unique to polycrystalline (*i.e.*, grain-boundary-containing) lithium-metal-oxide cathode materials. As explained in the ’317 Patent, these materials tend to degrade due to the cracking in the grain boundaries between adjacent primary particles caused by repeated charging and discharging (or “cycling”) of the battery. (Ex. 1001 at 11:27-45.) The inventors of the ’317 Patent discovered that selectively enriching the grain boundaries of a polycrystalline lithium-metal-oxide material with cobalt can stabilize the structure of the grain boundaries and thus improve the overall characteristics of the material. (Ex. 1001 at 3:10-28.) The inventors *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 11:63-12:6.)

Although Petitioner concedes (Pet. at 19) that Lampe-Onnerud never actually describes its particle “core” as having grain boundaries, it suggests that the composition of the “core” *must* be polycrystalline because Lampe-Onnerud teaches that “[t]he particle size distribution ranges between 1-50 μm ” after the “core” material is coated with cobalt and the resulting gradient-coated product is ground to break up any lumps in the product. (Pet. at 21 (citing Ex. 1007 at 9:55-56).) However, apart from the brief and purely conclusory statement of its expert (Ex. 1002 at ¶ 124), Petitioner offers no support for its suggestion that a particle size range of 1-50 μm is only consistent with a polycrystalline material. In fact, it is well-known that polycrystalline *and* single-crystal cathode materials *both* generally have particle sizes in the 1-10 μm range. (Ex. 2001 at 1 (explaining that lithium-metal-oxide cathode materials generally exhibit two types of morphologies: “polycrystalline particles ($\approx 10\mu\text{m}$)” and “single-crystal particles ($<5\mu\text{m}$)”); Ex. 2004 at 1 (describing a “single crystalline” lithium-metal-oxide cathode material with particle size ranging between 3 μm and 9 μm); Ex. 1001 at 15:5-7 (describing an exemplary polycrystalline particle with a diameter of “about 7 μm ”).) Therefore, Lampe-Onnerud’s reference to a particle size range of 1-50 μm does not establish that its “core” material is necessarily polycrystalline.

Petitioner also claims that its “replication” of Lampe-Onnerud’s Example 1 “confirm[s]” that Lampe-Onnerud’s particle “core” is polycrystalline. (Pet. at 22-23, 25.) However, Petitioner’s so-called “replication” of this example proves nothing. As discussed *infra* at 31, Example 1 of Lampe-Onnerud describes a process by which particles of the “core” material are coated with a cobalt-containing gradient coating. The “core” (or “base”) material coated in this Example 1 is a commercially available lithium-metal-oxide material called “N-82” and manufactured by Nippon Chemical. (Ex. 1007 at 9:32-36, 9:64-66, 12:25-26.) Nothing in Lampe-Onnerud suggests that N-82 is a polycrystalline material, and Petitioner submits no evidence whatsoever (*e.g.*, a Material Safety Data Sheet) to suggest that this material is, in fact, polycrystalline. And, crucially, Petitioner did not even use N-82 in its “replication” of Example 1; instead, it replaced N-82 with another, apparently polycrystalline lithium-metal-oxide material (which, incidentally, it manufactured itself). (Ex. 1003 at ¶¶ 8, 10 (Step 2).) So, the fact that Petitioner’s STEM imaging of this material shows a polycrystalline structure (*see* Pet. at 23, 25) confirms only one thing: that *Petitioner* chose to use a polycrystalline material in its “replication” of Example 1. It does not and cannot prove that *Lampe-Onnerud itself* teaches a polycrystalline material.¹¹

¹¹ In a footnote, Petitioner also cites paragraphs 110-13 of its expert’s declaration to support its assumption that the “core” material used in Lampe-Onnerud’s Example

Because Petitioner fails to present any evidence that Lampe-Onnerud discloses a cathode particle comprising “a plurality of crystallites” and “a grain boundary between adjacent crystallites,” Lampe-Onnerud cannot anticipate any of the challenged claims.

B. Lampe-Onnerud Does Not Teach, Either Explicitly or Inherently, Cobalt-Enriched Grain Boundaries.

In addition to describing a polycrystalline (*i.e.*, grain-boundary-containing) particle, independent claims 1 and 17 of the '317 Patent specifically require “a concentration of cobalt in the grain boundary [to be] greater than a concentration of cobalt in the crystallites.” (*See supra* at 7-8.) Because Lampe-Onnerud does not teach a material with grain boundaries, it cannot possibly teach *cobalt-enriched* grain boundaries either. Accordingly, Lampe-Onnerud cannot anticipate the challenged claims for this reason, too.

1 is polycrystalline. (Pet. at 21.) However, Petitioner does not explain how the expert’s declaration supports its position. *See Cisco Sys., Inc. v. C-Cation Techs., LLC*, IPR2014-00454, Paper 12 at 9-10 (PTAB Aug. 29, 2014) (informative) (explaining that citations to an expert declaration to “support conclusory statements for which the Petition does not otherwise provide an argument or explanation” amount to improper incorporation by reference and will not be considered). In any event, it does not. Petitioner’s expert asserts, in reference to the “core” material of Lampe-Onnerud’s Example 1, that “[s]uch base material is known to be comprised of secondary particles having agglomerated primary particles and grain boundaries.” (Ex. 1002 at ¶ 110.) But the only support he cites for this assertion is Zheng. (*Id.* at ¶ 111.) However, while Zheng describes a polycrystalline material, this does not prove that all commercially available lithium-metal-oxide materials—let alone N-82 specifically—are polycrystalline. In fact, as discussed *supra* at 4-5, single-crystal materials are commonly used in lithium-ion battery cathodes.

Because Petitioner acknowledges that Lampe-Onnerud makes no mention of grain boundaries, it has to acknowledge that the reference does not explicitly teach the enrichment of grain boundaries with cobalt. (See Pet. at 19.) Even so, it claims that Lampe-Onnerud *inherently* teaches cobalt-enriched grain boundaries, citing its “replication” of the gradient-coating process of Lampe-Onnerud’s Example 1. (Pet. at 20, 27-31.) However, this inherency argument fails for at least two reasons.

First, Petitioner’s experiment rests on a fundamentally flawed premise. By definition, to establish that Example 1 *necessarily yields cobalt-enriched grain boundaries*, Petitioner would first have to establish that the “core” material subjected to Lampe-Onnerud’s gradient-coating process in Example 1 *necessarily has grain boundaries to begin with*. And, as discussed *supra* at 22-23, there is absolutely no indication in Lampe-Onnerud that this is the case. In effect, what Petitioner has done is take a grain-boundary-containing “core” material that is *not actually taught in Example 1* (or anywhere else in Lampe-Onnerud, for that matter), subject this material to the coating process of Example 1, and then argue that its experiment somehow proves that Example 1 inherently teaches cobalt-enriched grain boundaries. But this experiment cannot prove inherency, because inherency requires the limitation at issue to be “necessarily present” or be “the natural result of the combination of *elements explicitly disclosed* by the prior art.” *PAR Pharm., Inc. v. TWI Pharms., Inc.*, 773 F.3d 1186, 1194-95 (Fed. Cir. 2014) (emphasis added)

(internal citation omitted). And, here, the type of grain-boundary-containing “core” material that Petitioner uses as the starting point for its “replication” of Lampe-Onnerud’s Example 1 is simply not disclosed, either explicitly or implicitly, in that example.

Second, even if Lampe-Onnerud had actually taught the use of a polycrystalline “core” material in Example 1, Petitioner’s “replication” of that example still would not establish that it inherently yields cobalt-enriched grain boundaries. An experiment reproducing an example in a prior art reference can prove that the example inherently teaches the claimed subject matter only if “the reproduction is consistent with the teaching of the example, any deviations in the reproduced experiment are immaterial, and the reasons for any deviations are adequately explained.” *Daikin Industries Ltd. v. Chemours Co. FC, LLC*, IPR2016-00452, Paper 42 at 17 (PTAB July 5, 2017) (citing *Purdue Pharma L.P. v. Epic Pharma, LLC*, 811 F.3d 1345, 1357 (Fed. Cir. 2016); *Glaxo Inc. v. Novopharm Ltd*, 52 F.3d 1043, 1047 n.4 (Fed. Cir. 1995)). Here, not only did Petitioner improperly select a polycrystalline “core” material as the starting point for its “replication” of Example 1 (despite the absence of any teaching in Lampe-Onnerud to that effect), but the process to which it then subjected this material did not even accurately reproduce the process conditions of the example.

In Lampe-Onnerud's Example 1, the "core" lithium-metal-oxide material (N-82, having the empirical formula $\text{LiNi}_{0.8}\text{Co}_{0.2}\text{O}_2$)¹² is mixed with an aqueous solution of lithium nitrate (LiNO_3) and cobalt nitrate ($\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$). (Ex. 1007 at 9:36-38, 9:64-66.) Once the "core" material, which is in the form of a powder, is immersed in this solution, the water is evaporated from the solution, causing a precursor coating to form on the surfaces of the particles of the "core" material. (*Id.* at 9:38-40, 9:66-67.) This "dried cake" is ground for 5 minutes to break up any lumps and then sintered under a very specific heating profile to give the coating the desired "concentration gradient structure." (*Id.* at 9:40-45, 9:66-10:4.) The specified heating profile requires first ramping up the temperature at a rate of 5° C per minute until it reaches 450° C; then holding the temperature at 450° C for one hour; then ramping up the temperature at a rate of 2° C per minute until it reaches 750° C; and, finally, holding that temperature for one hour. (*Id.*)

Petitioner's "replication" of Example 1 nominally follows the same heating profile. (Ex. 1003 at ¶ 10 (Step 5).) ***The problem, however, is that Petitioner's declarant, Dr. Noh, admits to using significantly different amounts of the starting ingredients.*** This is how Dr. Noh's amounts compare to the amounts actually used in Example 1:

¹² As Petitioner points out (Ex. 1003 at 3 n. 1), though Lampe-Onnerud states that the atomic ratio of Ni in this material is 0.6, this is a typographical error.

Starting Ingredient	Amount in Example 1	Amount in Petitioner's Experiment
LiNi _{0.6} Co _{0.2} O ₂	100 g	30 g
Distilled H ₂ O	150 ml	45 ml
LiNO ₃	7.06 g	2.12 g
Co(NO ₃) ₂ ·6H ₂ O	29.69 g	8.91 g

(Ex. 1007 at 9:64-66; Ex. 1003 at ¶ 10 (Steps 1 and 2).) The Noh declaration acknowledges that “the weight of the precursors used in [Petitioner’s] testing method corresponds to **30%** of the weight of the precursors used in Example 1 of the Lampe-Onnerud patent.” (*Id.* at ¶ 8 (emphasis added).) In effect, Petitioner’s “replication” of Example 1 involved taking a much smaller sample than is specified in the example and then subjecting this much smaller sample to the exact same heating profile, without making any adjustments to the heating profile to account for the much-reduced sample size. It was akin to taking a recipe for a whole oven-roasted chicken and then using this recipe to cook a chicken nugget.

Dr. Noh made no effort to explain why the amounts of the starting materials in Petitioner’s experiment deviated so significantly from those specified in Lampe-Onnerud’s Example 1, or why no adjustments were made to the heating profile to account for this acknowledged difference. (*See* Ex. 1003 at ¶¶ 7-25.) Nor did Dr. Noh opine that the difference would not be expected to have a material effect on the end result of the experiment, let alone explain why. (*See id.*) Therefore, this is not a situation where “the reproduction [of a prior art example] is consistent with the

teaching of the example, any deviations in the reproduced experiment are immaterial, and the reasons for any deviations are adequately explained.” *Daikin*, IPR2016-00452, Paper 42 at 17. Petitioner’s experiment satisfies none of these conditions. *See id.* at 18-23 (finding no inherency where, in reproducing a prior art example, the petitioner used a longer reactor with additional heated zones without establishing that this was a non-material deviation or explaining why it made the deviation); *Daicel Corp. v. Celanese Int’l Corp.*, IPR2015-00170, Paper No. 19 at 15-16 (PTAB Apr. 2015) (finding no inherency based on the petitioner’s reproduction of a prior art example where the petitioner used different concentrations of reactants without explaining why the reactor contents did not “more closely approximate” those in the example or why “it was not feasible to run the equipment in exactly the same way as was used in the [example]”).

Indeed, the only plausible inference is that Petitioner changed the size of the sample in its “replication” of Example 1 in an attempt to reverse-engineer the desired result (*i.e.*, to obtain cobalt-enriched grain boundaries). Nor is it surprising that Petitioner had to resort to reverse-engineering in order to obtain that result. As discussed *supra* at 24-25, Lampe-Onnerud’s gradient-coated process is simply not geared to grain-boundary enrichment (a concept not as much as hinted at in that reference). Lampe-Onnerud’s goal is to create a cobalt gradient coating “on the core” of the cathode particle, and the process steps described in the reference—

including the heating profile—are selected specifically to achieve that effect. (See Ex. 1007 at 9:40-45.) They are not designed to cause the cobalt to penetrate the surface of the “core” and preferentially enter any grain boundaries that might exist in its interior.

Lampe-Onnerud does not teach, either explicitly or inherently, cobalt-enriched grain boundaries. Therefore, Ground 1 of the Petition fails for this reason, too.

VI. GROUND 2: PETITIONER HAS NOT SHOWN A REASONABLE LIKELIHOOD THAT CLAIMS 1-17 ARE OBVIOUS OVER PARK IN VIEW OF LAMPE-ONNERUD.

In Ground 2, Petitioner asserts that the challenged claims would have been obvious over Park in combination with Lampe-Onnerud. This ground also fails. Petitioner admits that Park does not teach the enrichment of grain boundaries with cobalt. (Pet. at 50.) Therefore, this reference cannot fill the gaps in Lampe-Onnerud’s teachings. In fact, Petitioner has not adequately established (1) *why* a POSITA would even want to combine Park and Lampe-Onnerud; (2) *how* a POSITA would combine these references; or that (3), however combined, these two references together would lead those skilled in the art to a polycrystalline particle with cobalt-enriched grain boundaries as required by independent claims 1 and 17.

First, Petitioner does not articulate an adequate motivation to combine Park and Lampe-Onnerud. In an obviousness analysis, a sufficient reason must be shown

as to why a POSITA would have thought of combining or modifying the prior art to achieve the patented invention. *Innogenetics, N.V. v. Abbott Labs.*, 512 F.3d 1363, 1374 (Fed. Cir. 2008). Here, Park describes a polycrystalline lithium-metal-oxide material for use in battery cathodes, in which a lithium salt or another amorphous material is present along the grain boundaries between adjacent primary particles. (*See supra* at 9; *see also* Pet. at 47.) Park dopes the grain boundaries of the cathode material with a lithium salt in order to improve the battery’s “capacity, recovery capacity, and thermal stability.” (Ex. 1008 at ¶ 8.) However, as noted above, ***Petitioner admits that Park does not teach enriching the grain boundaries of the material with cobalt.*** (Pet. at 50.) Even so, Petitioner suggests that, based on Lampe-Onnerud’s disclosures, 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.” (*Id.* at 48.) This asserted motivation fails on its face.

As discussed *supra* at 24-25, Lampe-Onnerud does *not* teach “enriching the grain boundaries with [a] cobalt salt-based coating.” Lampe-Onnerud does not even teach a polycrystalline (*i.e.*, grain-boundary-containing) material. Rather, Lampe-Onnerud teaches a process by a cobalt “gradient” coating is placed “*on the core*” of a cathode particle. (*See supra* at 22-23.) Contrary to Petitioner’s assertion in Ground 2 (Pet. at 51), there is no discussion in Lampe-Onnerud of the cobalt penetrating the

surface of the particle “core” and entering any grain boundaries. (*See supra* at 24-25.)

To summarize, Park mentions grain boundaries but says nothing about enriching them with cobalt; Lampe-Onnerud mentions using cobalt but only in a gradient coating located “on the core” of a cathode particle, and never mentions grain boundaries. At most, a POSITA reading these two references together might have envisioned a material in which the grain boundaries of the secondary particles are doped with a lithium salt (per Park’s teaching), and the exterior surfaces of the secondary particles are coated with a cobalt-rich gradient coating (per Lampe Onnerud’s teaching). But neither Park nor Lampe-Onnerud could have supplied any motivation to enrich the grain boundaries of Park’s cathode material with cobalt.

Second, Petitioner does not articulate how a POSITA could carry out the proposed combination of Park and Lampe-Onnerud, much less with a reasonable expectation of successfully obtaining cobalt-enriched grain boundaries. Park and Lampe-Onnerud teach very different processes for manufacturing their respective cathode materials. In Park, the cathode material is prepared using a simple two-step process, in which a lithium-metal-oxide compound is first mixed with a lithium salt, and then the resulting mixture is “heat treated,” for an unspecified amount of time, at a temperature between 700° C and 950° C. (Ex. 1008 at ¶¶ 30-33, 63-69.) Meanwhile, in Lampe-Onnerud, the preparation process is far more involved. First,

a “core” lithium-metal-oxide material is immersed (or “wetted”) in an aqueous solution of lithium nitrate and cobalt nitrate; then, water is evaporated from the mixture, causing a precursor coating to form on the surfaces of the particles of the “core” material; then, this “dried cake” is ground to break up any lumps; and then, the product is gradually sintered using a very specific, staged heating profile to give the coating the desired “concentration gradient structure.” (*See supra* at 31; *see also* Ex. 1007 at 4:61-5:2, 5:12-30.)

Petitioner does not explain how these processes could (or would) be combined by those skilled in the art. At one point, it suggests that a POSITA would combine Park and Lampe-Onnerud by “modify[ing] (or simply augment[ing]) Park to mix a cobalt salt in addition to lithium salt” when preparing Park’s material. (Pet. at 51.) That is to say, it seems to suggest that a POSITA would expect to obtain a material with cobalt-enriched grain boundaries by simply adding some unspecified amount of a cobalt salt at the first step of Park’s process, when a lithium-metal-oxide compound is mixed with a lithium salt, and then heat-treating this mixture according to Park’s step two. (*See supra* at 36.)

However, elsewhere in the Petition, Petitioner seems to argue something else entirely when it asserts that a POSITA would combine Park and Lampe-Onnerud by applying a cobalt coating to Park’s material “using the wetting and subsequent evaporation/sintering technique in Lampe-Onnerud.” (Pet. at 52.) Petitioner does

not explain how a POSITA would incorporate Lampe-Onnerud's "wetting and subsequent evaporation/sintering technique" into Park's two-step process. For example, would a POSITA simply carry out these processes back to back, by first preparing the material of Park using Park's two-step process, and then subjecting this material to all of the steps of Lampe-Onnerud's process (immersing the material in a solution of lithium nitrate and cobalt nitrate, evaporating the water, grinding the resulting "dried cake," and gradually heating the ground product according to a staged calcination process)? Or would a POSITA merge some of the mixing or processing steps described in Park and Lampe-Onnerud? And, if so, which ones, and how?

The Petition does not explain. This is fatal to Ground 2, because, to prove obviousness, "[a] petitioner must articulate '[1] how specific references could be combined, [2] which combination(s) of elements in specific references would yield a predictable result, or [3] how any specific combination would operate or read on the asserted claims.'" *QIAGEN North American Holdings, Inc., V. HandyLab, Inc.*, IPR2019-00488, Paper 52 at 35-36 (PTAB July 14, 2020) (quoting *ActiveVideo Networks, Inc. v. Verizon Commc'ns, Inc.*, 694 F.3d 1312, 1327 (Fed. Cir. 2012)). Ground 2 fails to meet any of these prerequisites.

Third, Petitioner has not established that the combination of Park and Lampe-Onnerud (however they might be combined) would, in fact, produce a material with

cobalt-enriched grain boundaries, *i.e.*, with “a concentration of cobalt in the grain boundary [being] greater than a concentration of cobalt in the crystallites” as required by independent claims 1 and 17. As admitted by Petitioner, neither Park nor Lampe-Onnerud explicitly teaches cobalt-enriched grain boundaries. (Pet. at 19, 50.) Thus, to prove obviousness, Petitioner would have to establish that some combination of these two references *inherently* yields a material with cobalt-enriched grain boundaries. Petitioner has failed to do so. It has not presented the results of any experiment in which it attempted to combine the materials and processes of Park with those of Lampe-Onnerud. Instead, Petitioner relies on its “replication” of Lampe-Onnerud’s Example 1. (Pet. at 47 (citing Ex. 1002 at ¶ 20).) However, as discussed *supra* at 30-33, that experiment does not prove that Lampe-Onnerud inherently discloses cobalt-enriched grain boundaries, since it failed to faithfully reproduce Lampe-Onnerud’s example. Therefore, it cannot prove that some unspecified combination of Park and Lampe-Onnerud inherently teaches this claim limitation, either.

For at least these reasons, the Board should reject Ground 2.

VII. GROUND 3: PETITIONER HAS NOT SHOWN A REASONABLE LIKELIHOOD THAT CLAIMS 1-9, 11, AND 14-17 ARE ANTICIPATED BY TAKAGI.

Takagi does not disclose cobalt-enriched grain boundaries, or even grain boundaries, period. Therefore, Takagi cannot meet the limitation of independent

claims 1 and 17 (also necessarily present in dependent claims 2-8, 11, and 14-16) requiring “a grain boundary between adjacent crystallites” or the limitation requiring “a concentration of cobalt in the grain boundary . . . greater than a concentration of cobalt in the crystallites.” (*See supra* at 7-8.) Ground 3 fails for at least these two reasons.

A. Takagi Does Not Teach a Cathode Material With Grain Boundaries.

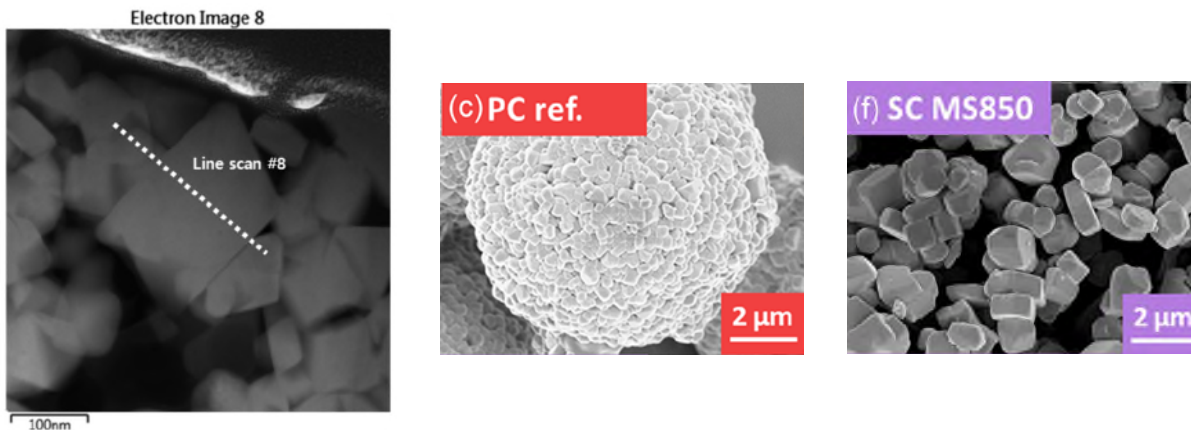
As explained *supra* at 9-10, Takagi prepares its cathode material by (1) mixing all of the element-containing compounds, including cobalt, at once to form a precursor material; (2) calcinating this precursor material in two “firing steps”; (3) granulating this intermediate “fired” product in order to “disaggregate[]” it to “about the level of the primary particles”; and (4) calcinating these primary particles in a third “firing step” to obtain the final “positive electrode active material.” This process differs fundamentally from the grain-boundary-enrichment process of the ’317 Patent. In the latter, cobalt-enriched grain boundaries are achieved by first preparing a precursor polycrystalline lithium-metal-oxide material that itself has grain boundaries, and *only then* enriching the grain boundaries with cobalt by mixing the precursor material with a lithium compound (*e.g.* lithium nitrate) and a cobalt compound (*e.g.*, a cobalt nitrate), drying the mixture, and subjecting it to calcination using a specific heating profile, which causes the cobalt to preferentially enter the

grain boundaries. (*See supra* at 6-7; Ex. 1001 at 9:22-28, 14:24-46 (Example 1 describing preparation of the precursor polycrystalline material), 14:48-66 (Example 2 describing the mixing and heating steps).) By contrast, in Takagi, all of the cobalt is added at the very first step, prior to the possible formation of any grain boundaries. No more cobalt is added later in the process to enrich any grain boundaries that might have formed as a result of the first step.

In fact, 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.¹⁴ Further, even assuming, for argument's sake, that Takagi's precursor material initially consists of polycrystalline particles (dense agglomerates of primary particles separated by grain boundaries), Takagi subsequently disassembles these particles into a single-crystal material—thus *eliminating any existing grain boundaries* in the process—at the granulation step. As stated above, Takagi expressly describes this step as having the effect of “disaggregat[ing]” the precursor material to “about the level of the primary particles.” (*See supra* at 40.)

¹⁴ Petitioner asserts that Takagi's term “bonding interface” is synonymous with a “grain boundary.” (Pet. at 64.) However, other than the conclusory statement of its expert (Ex. 1002 at ¶ 245), 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.”

Petitioner's own reproduction of Example 5 of Takagi proves that Takagi's final product has a single-crystal structure. A STEM image of the final product obtained by Petitioner as a result of its experiment is reproduced below on the left:



(Pet. at 68.) As seen in the image on the left, the crystals in Takagi's final product are not tightly packed in dense clusters of grain-boundary-containing polycrystalline particles (an example of which is shown above on the middle). (*See supra* at 5.) Rather, Takagi's final product consists of only loosely agglomerated individual crystals, with no grain boundaries between them. The final product thus plainly exhibits a morphology that is characteristic of a single-crystal material (shown above on the right). (*See supra* at 5.)

Contrary to Petitioner's suggestion (Pet. at 65), Takagi's reference to "secondary particles" comprising a "plurality of primary particles" (Ex. 1010 at ¶ 15) does not indicate that Takagi's final product has a polycrystalline structure. While the '317 Patent uses the term "secondary particle" to refer to a polycrystalline

particle (Ex. 1001 at 3:10-16), this term simply does not mean the same thing in Takagi that it does in the '317 Patent. As explained above, Takagi makes it clear that, at the granulation step, its precursor material is “disaggregated” into primary particles. Thus, 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.

Because Takagi does not teach a cathode material containing “a grain boundary between adjacent crystallites,” it cannot anticipate claims 1-8, 11, and 14-17.

B. Takagi Does Not Teach, Either Explicitly or Inherently, Cobalt-Enriched Grain Boundaries.

By definition, because Takagi’s preparation method necessarily eliminates any grain boundaries (to the extent they even exist in its precursor material), Takagi cannot teach the concept of *cobalt-enriched* grain boundaries. However, even assuming, for argument’s sake, that grain boundaries are somehow 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.

Petitioner suggests that Takagi teaches cobalt-enriched grain boundaries because the reference states that the final product contains more cobalt in “a portion near the surface” of the primary particles than “inside.” (Pet. at 64 (citing Ex. 1010 at ¶¶ 9, 10).) However, this statement is inapposite on its face. As discussed *supra* at 12-21, the term “grain boundary” is properly construed as a region *between* two adjacent primary particles in a polycrystalline particle, which region does *not* include any portions of *the primary particles themselves*. Therefore, insofar as Takagi purports to describe a material with more cobalt in “a portion near the surface” of the primary particles than the interior of the primary particles, this is *not* a disclosure that there is more cobalt in *the grain boundaries*.¹⁵ At no point does Takagi suggest that, as a result of its process, cobalt moves from the bulk of the primary particles

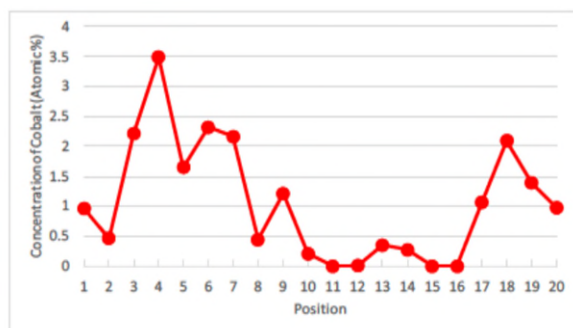
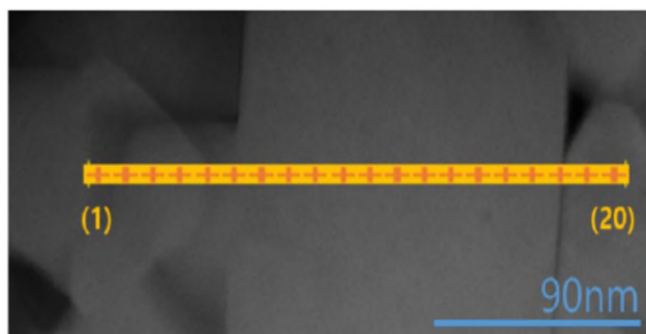
¹⁵ It is also worth noting that Takagi did not *show* that, in its material, the primary particles actually have more cobalt near their surfaces than inside. Instead, Takagi only tried to show that there is more cobalt near the surfaces of what he refers to as the “secondary particles” (a term he uses to describe non-polycrystalline, loose agglomerations of primary particles, as discussed *supra* at 42-43). Specifically, Figure 1 of Takagi indicates that cobalt concentration starts to increase at a depth of roughly 50 nm from the top surface of the “positive electrode active material,” which in Takagi is explicitly defined as “a secondary particle having a plurality of primary particles.” (Ex. 1010 at ¶¶ 15, 51, 52.) Thus, contrary to Petitioner’s suggestion (Pet. at 68-69), Figure 1 does not show that the *primary* particles that make up the secondary particles have a higher concentration of cobalt near their surfaces. Takagi did not even attempt to present any experimental data to that effect—not that it would have mattered here, since the presence of a relatively higher concentration of cobalt “near the surface” of the primary particles would not have established a relatively higher concentration of cobalt in *the “grain boundaries”* as that term is properly construed.

and into grain boundaries—which makes perfect sense, since the objective of Takagi’s granulation step is to *eliminate* any grain boundaries (to the extent grain boundaries even exist in Takagi’s precursor material *prior to* the granulation step) by “disaggregate[ing]” the material into individual primary particles.

Petitioner claims that its “replication” of Takagi’s Example 5 shows that Takagi inherently discloses cobalt-enriched grain boundaries. (Pet. at 69-70.) However, Petitioner’s reliance on this experiment is completely misplaced. First, as with its “replication” of Lampe-Onnerud’s Example 1, Petitioner’s experiment based on Takagi’s Example 5 is not even a faithful reproduction of that example. For example, Petitioner chose to mix 226.59 g of lithium hydroxide, 499.96 g of nickel hydroxide, and 25.2 g of cobalt hydroxide to prepare the precursor material at Takagi’s step one. (Ex. 1003 at ¶ 39; *see supra* at 40.) However, Takagi’s Example 5 does not specify the weights of these precursor compounds. (Ex. 1010 at ¶ 44.) Petitioner does not explain how it selected the weights for its experiment without any guidance on that point in Takagi. *See Bayer Ag v. Sony Elecs.*, 229 F. Supp. 2d 332, 352 (D. Del. 2002) (“[T]he Phillips Patent does not provide specific guidance regarding these conditions, and those who prepared the powders for Professor O’Grady’s analysis were required to ‘fill-in’ these gaps. As such, the Sony Defendants have not persuaded the Court that their reproduction was an accurate representative of the resulting powder from the prior art process described in

Phillips.”). As another example, Takagi specifies that, after the precursor material is formed and subjected to the two initial calcination steps, it is mixed with “ion-exchange water at a mass ratio of 30:70.” (Ex. 1010 at ¶ 45.) However, Petitioner’s declarant, Dr. Noh, **does not even say** that, in Petitioner’s experiment, the product was mixed with ion-exchange water, much less at the specific mass ratio required by Takagi. (Ex. 1003 at ¶ 39.)

More fundamentally, even apart from Petitioner’s failure to faithfully reproduce Takagi’s Example 5, the end result of Petitioner’s experiment actually *refutes* its argument that the example inherently yields cobalt-enriched grain boundaries. A STEM image of the final product obtained by Petitioner as a result of its Takagi experiment is reproduced *supra* at 42; below on the left is Petitioner’s blow-up of the area identified with the dashed white line in that STEM image, with the yellow line representing the twenty spots where Petitioner measured the concentration of cobalt in the sample. Meanwhile, the figure below on the right is Petitioner’s graph showing the results of that measurement.



(Ex. 1003 at ¶ 43; *see also* Pet. at 70.) Petitioner points to spots numbered 4 and 18 as the “grain boundaries” that have higher cobalt concentration than adjacent “primary particles.” (*Id.*) However, even setting aside the fact that the material shown in the image has no grain boundaries at all (since, as explained *supra* at 41-42, Takagi’s final product has a single-crystal, and not polycrystalline, structure), spots number 4 and 18 still do not prove Petitioner’s point.

Starting with spot number 4, though it has the highest concentration of cobalt in the measured part of the sample, it is located *well within the interior* of the left-most primary particle in the image. Thus, even if the sample had any grain boundaries, spot number 4 could not possibly be considered one of them, since the term “grain boundary,” as properly construed, refers to a region *between* adjacent crystallites and excludes any portion of them. As for spot number 18, the concentration of cobalt measured there is *not higher* than in the adjacent primary particles (the middle and right-most particles in the image); for example, spot number 7 clearly has a slightly higher concentration of cobalt than spot number 18. So, even if spot number 18 could be considered a “grain boundary,” Petitioner’s own data undermines its argument that the concentration of cobalt in this region is greater than in the adjacent primary particles, as the challenged claims require.

Because Takagi does not teach a grain-boundary-containing material with a higher concentration of cobalt in the grain boundaries than in the primary particles, as explicitly required by independent claims 1 and 17, Ground 3 fails.

VIII. GROUND 4: PETITIONER HAS NOT SHOWN A REASONABLE LIKELIHOOD THAT CLAIMS 10, 12, AND 13 ARE OBVIOUS OVER TAKAGI.

The claims challenged in this ground all depend from independent claim 1. As explained *supra* in Section VII, Takagi does not teach the limitation of claim 1 requiring “a grain boundary between adjacent crystallites” or the limitation requiring “a concentration of cobalt in the grain boundary [to be] greater than a concentration of cobalt in the crystallites.” Because these limitations are necessarily present in dependent claims 10, 12, and 13, Takagi cannot make these claims obvious. Therefore, Ground 4 also fails to raise a reasonable likelihood that any claim of the ’317 Patent is unpatentable.

IX. CONCLUSION

The Board should deny institution. Ground 1 fails because Lampe-Onnerud does not teach a grain-boundary-containing cathode material, and even if it did, Petitioner has not established that Lampe-Onnerud’s material has cobalt-enriched grain boundaries. Ground 2 fails because Park does not cure the deficiencies in Lampe-Onnerud, and Petitioner does not establish why a POSITA would combine these two references, how a POSITA would combine them, or that their combination

would yield a cathode material with cobalt-enriched grain boundaries. Finally, Grounds 3 and 4 fail because, like Lampe-Onnerud, Takagi lacks any disclosure of grain boundaries, and even if Takagi's cathode material had any grain boundaries, Petitioner has not shown that the grain boundaries are enriched with cobalt. If anything, Petitioner's own data (for example, its reproduction of Takagi's Example 5) actually serves to strengthen the validity of the '317 Patent.

Dated: November 14, 2024

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CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. 42.24(d), I hereby certify that based upon the word count of the word-processing system used to prepare this paper, the number of words in this PATENT OWNER'S PRELIMINARY RESPONSE is 11,029.

Dated: November 14, 2024

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CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing PATENT OWNER'S PRELIMINARY RESPONSE was served on November 14, 2024 by email on the following counsel of record for Petitioner:

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