

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

RJ TECHNOLOGY LLC,
Patent Owner.

IPR2023-01350
Patent 7,749,641 B2

Before JON B. TORNQUIST, CHRISTOPHER M. KAISER, and
BRIAN D. RANGE, *Administrative Patent Judges*.

TORNQUIST, *Administrative Patent Judge*.

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

I. INTRODUCTION

Apple Inc. (“Petitioner”) filed a Petition requesting *inter partes* review of claims 5–14 of U.S. Patent No. 7,749,641 B2 (Ex. 1001, “the ’641 patent”). Paper 2 (“Pet.”). RJ Technology LLC (“Patent Owner”)¹ filed a Preliminary Response to the Petition (Paper 7), to which Petitioner filed a reply (Paper 8) and Patent Owner filed a sur-reply (Paper 9). We instituted review with respect to all grounds and claims set forth in the Petition. Paper 10. After institution, Patent Owner filed a Response (Paper 20, “PO Resp.”), to which Petitioner filed a Reply (Paper 24, “Pet. Reply”), and Patent Owner filed a Sur-reply (Paper 28, “Sur-reply”).

Petitioner relies, *inter alia*, upon two declarations from Mr. Louis Hruska (Ex. 1003 (original declaration); Ex. 1035 (reply declaration)), and Patent Owner relies upon a declaration from Yan Yao, Ph.D. (Ex. 2007).

An oral hearing was held on December 4, 2024, and a transcript of the hearing is included in the record (Paper 36, “Tr.”).

For the reasons that follow, we conclude that Petitioner demonstrates by a preponderance of the evidence that claims 5–10 of the ’641 patent are unpatentable. Petitioner has not, however, demonstrated by a preponderance of the evidence that claims 11–14 are unpatentable.

II. BACKGROUND

A. Related Matters

The parties indicate that the ’641 patent is at issue in *RJ Technology LLC v. Apple Inc.*, 8:22-cv-01874 (C.D. Cal.) and *RJ Technology LLC v.*

¹ The Notice of Filing Date Accorded identifies Xiaoping Ren as the owner of the ’641 patent. Paper 3. Patent Owner’s Mandatory Notices indicate that the ’641 patent has been assigned to RJ Technology LLC. Paper 4, 1.

Samsung Electronics Co., Ltd., 22-cv-00401 (E.D. Tex.). Pet. 73; Paper 4, 1. The parties further note that the '641 patent is at issue in IPR2023-01183. Pet. 73; Paper 4, 1.

B. Real Parties in Interest

The parties identify themselves as the real parties-in-interest. Pet. 73; Paper 4, 1.

C. The '641 patent

The '641 patent discloses “a new method for improving capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery.” Ex. 1001, code (57).

The '641 patent notes that the positive and negative electrode materials used in current secondary lithium ion batteries have high theoretical capacities, but a “lower actual utilization rate of said capacity.” Ex. 1001, 1:36–40. According to the '641 patent, the lower utilization rate is “mainly caused by the limitation of charge cut-off voltage commonly used in the art,” which is “no more than 4.2 V.” *Id.* at 1:44–47. The '641 patent asserts that the technical requirement that the charge cut-off voltage not exceed 4.2 V is “well accepted” in the industry and “all lithium ion batteries in the markets around the world are manufactured under this technical requirement.” *Id.* at 1:46–51.

Although it was known in the art that capacity could be improved by increasing the charge cut-off voltage, the '641 patent reports that the “opinions in the prior art research results and documents” were that “the positive electrode materials and negative electrode materials will undergo structure change, the electrolyte may decompose, and the recycle property of

the cell will be adversely affected when the charge cut-off voltage is greater than 4.2 V.” Ex. 1001, 1:56–63.

The ’641 patent reports that, after conducting “a large number of experiments and studies,” it was determined that “the efficacy of electrode active materials is greatly increased by increasing the charge cut-off voltage and proper[ly] adjusting the ratio of positive electrode material to negative electrode material of [a] single lithium ion cell.” Ex. 1001, 3:3–12. The ’641 patent further reports that “[w]ithin a certain range of charge cut-off voltage,” it was determined that “the decomposition of little electrolyte solution brings about negligible effect on the recycle property of [the] cell.” *Id.* at 5:19–21

D. Illustrative Claim

Claim 5 is the only challenged independent claim of the ’641 patent and is reproduced below.

5. A secondary lithium ion cell or battery, characterized in that the secondary lithium ion cell or battery has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V, and a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5, as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2 V.

Ex. 1001, 17:5–11.

E. Asserted Grounds of Unpatentability

Petitioner asserts that claims 5–14 are unpatentable based on the following challenges (Pet. 5):²

Claims Challenged	35 U.S.C. §	Reference(s)/Basis
5–8, 11–14	103(a)	Yamaki ³ , Sakamoto ⁴
9, 10	103(a)	Yamaki, Sakamoto, Abraham ⁵
5–14	103(a)	Yasunami ⁶ , Koyama ⁷
9, 10	103(a)	Yasunami, Koyama, Richardson ⁸

III. ANALYSIS

A. Legal Standard

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and “the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said

² The relevant sections of the Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112–29, took effect on March 16, 2013. The ’641 patent issued July 6, 2010. Ex. 1001, code (45). Thus, we apply the pre-AIA version of §103.

³ JP Publ. No. 2001-167763A, published June 22, 2001. Ex. 1004 (“Yamaki”).

⁴ JP Publ. No. H09-293536, published November 11, 1997. Ex. 1005 (“Sakamoto”).

⁵ US 5,858,573, issued January 12, 1999. Ex. 1009 (“Abraham”).

⁶ JP Publ. No. H07-122298, published May 12, 1995. Ex. 1006 (“Yasunami”).

⁷ JP Publ. No. 2000-260472A, published September 22, 2000. Ex. 1007 (“Koyama”).

⁸ WO 01/29920 A1, published April 26, 2001. Ex. 1008 (“Richardson”).

subject matter pertains.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) when in evidence, objective evidence of nonobviousness.⁹ *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. Level of Ordinary Skill in the Art

In order to determine whether an invention would have been obvious at the time it was made, we consider the level of ordinary skill in the pertinent art. *Graham*, 383 U.S. at 17. In assessing the level of ordinary skill in the art, various factors may be considered, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field.” *In re GPAC, Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (quoting *Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc.*, 807 F.2d 955, 962 (Fed. Cir. 1986)).

Petitioner contends a person of ordinary skill in the art “would have held a Bachelor’s degree in chemistry or chemical engineering, with at least 4 years of experience in cell design, electrochemical techniques, and battery materials development.” Pet. 4. Petitioner further contends that a “Master’s Degree can substitute[] for some of the relevant experience,” and “[e]quivalent training with battery specific experience can accommodate other degreed fields.” *Id.*

⁹ The parties here do not address objective evidence of nonobviousness.

Patent Owner does not dispute Petitioner’s definition of the ordinarily skilled artisan. PO Resp. 20.

We adopt Petitioner’s unopposed definition of the person of ordinary skill in the art as it is consistent with the ’641 patent, the prior art of record, and the parties’ arguments.

C. Claim Construction

In this proceeding, the claims of the ’641 patent are construed “using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. [§] 282(b).” 37 C.F.R. § 42.100(b). Under that standard, the words of a claim are generally given their “ordinary and customary meaning,” which is the meaning the term would have had to a person of ordinary skill at the time of the invention, in the context of the entire patent including the specification. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc).

The parties agree that the term “charge cut-off voltage” is “the maximum voltage to which the battery is configured to be charged.” PO Resp 21–22; Pet. Reply 1. The parties dispute, however, whether the “charge cut-off voltage” is a “battery property” or “the voltage applied to the battery during charging.” PO Resp. 21–24; Pet. Reply 1–6. We need not resolve the precise meaning of “charge cut-off voltage” because there is no dispute that Yamaki discloses this limitation under either party’s interpretation of the claim term.

Upon review of the prior art and the parties’ arguments, we determine that no terms of the ’641 patent require express construction. *See Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in controversy, and only

to the extent necessary to resolve the controversy.” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)); Pet. Reply 1 (asserting that the challenged claims are unpatentable under either parties’ construction of “charge cut-off voltage”).

D. Asserted Obviousness of Claims 5–8 and 11–14 over Yamaki and Sakamoto

Petitioner asserts that the subject matter of claims 5–8 and 11–14 would have been obvious over the combined disclosures of Yamaki and Sakamoto. Pet. 6–30.

1. Yamaki

Yamaki discloses “a lithium secondary battery with high energy density and excellent cycle characteristics.” Ex. 1004 ¶ 1. The battery of Yamaki includes a positive electrode containing a Co-based oxide that includes “at least one element selected from Mg, Al, Mn, Ti, and Sr,” and “a conductive material whose main component is carbon,” wherein at least a surface layer of the conductive material has an amorphous carbonaceous material. *Id.* ¶ 13. The negative electrode may be a carbon material or another material that is capable of intercalating Li. *Id.* ¶ 30. Yamaki explains that “[w]hen such a battery configuration is used, the maximum potential of the positive electrode during charging can be from 4.4 V to 4.8 V in terms of metallic Li” and the “deterioration in the reversibility of charging and discharging as more charging and discharging cycles are performed” is suppressed. *Id.* ¶ 14. Yamaki reports that setting the maximum potential of the positive electrode during charging to 4.4 V or more improves “the discharge capacity of the positive electrode active material” and, “[a]s a result, the amount of positive electrode active material

in the battery can be reduced, and the amount of negative electrode active material can be increased.” *Id.* ¶ 15. “Therefore, a lithium secondary battery with a higher energy density can be obtained in a limited battery volume.” *Id.*

Yamaki reports testing results for 10 example batteries and 2 comparative example batteries. Ex. 1004 ¶¶ 36–57, Table 1. Yamaki reports that after 10 charge/discharge cycles using charge cut-off voltages of 4.4 V (Example 9), 4.5 V (Examples 1–8), or 4.6 V (Example 10), the inventive batteries retained up to 98% of capacity. *Id.* ¶¶ 52–54, 57, Table 1 (charging the positive electrode material in Example 3 to a potential of 4.5 V in terms of metallic Li and achieving 98% capacity after 10 cycles). In contrast, the comparative example batteries using a LiCoO_2 positive electrode material achieved only 75% capacity after 10 charge/discharge cycles when using a charge cut-off voltage of 4.5 V in terms of metallic Li. *Id.* ¶¶ 52, 57, Table 1.

2. Sakamoto

Sakamoto discloses a non-aqueous electrolyte secondary battery with “a highly reliable positive and negative electrode configuration with excellent charge-discharge cycle performance.” Ex. 1005 ¶ 1. Sakamoto notes that “if the reversible capacities of the positive and negative electrodes are approximately equal, deposit of lithium occurs on the negative electrode during overcharge,” which “increases the amount of passive lithium, and leads to a decrease in battery capacity and to deterioration in cycle characteristics.” *Id.* ¶ 6. In order to solve these problems, Sakamoto sets “the reversible capacity balance of the positive electrode and the negative electrode” in the “range of $1.05 < \text{negative electrode/positive electrode}$

≤ 1.30 .” *Id.* ¶ 7. Sakamoto explains that “[i]f the reversible capacity balance is 1.05 or less, the reversible capacity balance may reach 1 or less locally in the electrode due to variations in electrode manufacturing, etc,” and “[i]f the reversible capacity balance is greater than 1.30, too much of the compound does not participate in charging and discharging.” *Id.* ¶ 8.

Sakamoto tests the capacity retention of batteries having various negative electrode/positive electrode capacity balances at “a charge upper limit voltage of 4.2 V.” Ex. 1005 ¶ 16. Batteries with capacity balances of 0.94 and 1.01 demonstrated “significant cycle deterioration,” whereas Battery D, with a capacity ratio of 1.18, “remained above 70%” capacity after 300 cycles. *Id.* ¶ 16, Fig. 1 (reporting that Battery D retained roughly 75% capacity after 300 cycles).

3. Analysis—Claim 5

Petitioner contends Yamaki and Sakamoto in combination disclose every limitation of independent claim 5. Pet. 9–11, 15–21. In particular, Petitioner contends that Yamaki discloses the preamble of claim 5 (a secondary lithium ion cell or battery) and also discloses selecting a charge cut-off voltage in the range of 4.4 V to 4.8 V, and Sakamoto discloses a ratio of positive electrode material to negative electrode material that is greater than 1.05 and less than or equal to 1.30. *Id.* at 15–21 (citing Ex. 1004 ¶¶ 1, 14; Ex. 1005 ¶ 7; Ex. 1003 ¶¶ 60–68, 71). Petitioner further contends that calculation of reversible capacity using theoretic capacity “was conventional in battery design” and, because Sakamoto describes reversible capacity balances for batteries that have “a charge upper limit voltage” of 4.2 V, one of ordinary skill in the art would have understood that Sakamoto’s reversible

capacities were calculated using a theoretic capacity at a charge cut-off voltage of 4.2 V. *Id.* at 20 (citing Ex. 1005 ¶ 16; Ex. 1003 ¶¶ 81–83).

Petitioner contends one of ordinary skill in the art would have used Sakamoto’s ratio of negative to positive electrode material of 1.05 to 1.30 in Yamaki’s battery because this combination would improve the cycle performance of Yamaki’s battery, create a “safer” battery that is resistant to overcharging, and provide “implementation details” that are missing from Yamaki. Pet. 11–13. Petitioner further contends that the proposed combination represents “merely the application of known techniques,” “by a known system,” to “yield predictable results.” *Id.* at 13 (citing *KSR*, 550 U.S. at 417; Ex. 1003 ¶ 46).

Petitioner contends one of ordinary skill in the art would have had a reasonable expectation of success in combining Yamaki and Sakamoto because (1) Yamaki expressly suggests increasing the relative amount of negative electrode active material in its battery in the context of a maximum potential of 4.4–4.8 V; (2) Sakamoto promotes Yamaki’s objective of improving cycle life; (3) Yamaki and Sakamoto both describe secondary lithium ion batteries with similar materials and systems; and (4) secondary batteries with either charge cut-off values greater than 4.2 V or utilizing more negative than positive electrode capacity were known in the art. Pet. 13–14 (citing Ex. 1004 ¶¶ 1, 12–18, 20–23, 30, 33, 59–60; Ex. 1005 ¶¶ 6–8, 12, 13, 15, 17; Ex. 1003 ¶¶ 48–55; Ex. 1007 ¶ 6; Ex. 1012, 1; Ex. 1020, 5; Ex. 1021 ¶ 11; Ex. 1023, 1:25–35; Ex. 1024, 40:3–14; Ex. 1025, 2:63–3:3).

Patent Owner contends Petitioner’s arguments with respect to Yamaki and Sakamoto are not persuasive because (a) Petitioner’s proposed

combination is driven by hindsight bias, (b) Yamaki's battery is fundamentally different than Sakamoto's battery, and (c) there is no suggestion in the art that adjusting the capacity ratio of a battery would allow the charge cut-off voltage to be raised above 4.2 V. PO Resp. 25–36. We address these arguments in turn.

a. Hindsight Bias

Patent Owner contends that Petitioner's proposed combination ignores the conventional teachings in the art that the charge cut-off voltage could not safely exceed 4.2 V. PO Resp. 27. And, although Yamaki expressly discloses a charge cut-off voltage of 4.4 V to 4.8 V, Patent Owner contends Yamaki's cathode is so "preliminary and untested" that one of ordinary skill in the art "would not understand Yamaki to teach that it is safe or efficacious to exceed the conventional 4.2V charge cutoff voltage limit." *Id.* (citing Ex. 2007 ¶¶ 126–127). Patent Owner reasons that Yamaki only discloses testing data for 10 charge-recharge cycles, which Patent Owner contends does not allow for meaningful conclusions regarding the rechargeability, performance, or safety of Yamaki's battery in normal operating conditions over its life cycle. *Id.*; Tr. 44:7–21 (Patent Owner's counsel asserting that the 4.4 to 4.8 V range disclosed in Yamaki is not the voltage to which the battery is configured to be charged).

Patent Owner further contends that Petitioner's declarant, Mr. Hruska, agreed that establishing an appropriate charge cutoff voltage involved testing and ascertaining "a host of factors," such as the stability of the electrolyte, the metals, and electrodes for use in the battery, and the industry arrived at the conventional 4.2 V charge cutoff limit "only after balancing issues such as 'safety, capacity, [and] lifetime performance.'" PO Resp. 28 (citing

Ex. 2008, 72:3–7, 89:22–90:8); Ex. 2007 ¶¶ 126–127. According to Patent Owner, one of ordinary skill in the art “would not have jettisoned the rigor that was customary in the art and raised the charge cutoff voltage to levels known to be unsafe in light of Yamaki’s indisputably preliminary and inconclusive disclosures.” *Id.*

Patent Owner’s arguments do not persuasively undermine Petitioner’s position. First, the claims do not require an effective battery, a particularly safe battery, or a battery that is suitable for commercial use. Second, Yamaki’s battery is expressly *designed and configured* to be charged to a maximum potential of between 4.4 and 4.8 V in terms of metallic Li. Ex. 1004 ¶ 14. Specifically, Yamaki notes that prior art batteries suffered from cycle deterioration and decomposition of organic solvent and lithium salt when charged above 4.3 V (in terms of metallic Li), and Yamaki expressly states that it solved these issues and obtained a battery that is configured to be charged from 4.4 V to 4.8 V in terms of metallic Li. *Id.* ¶¶ 7 (noting that prior art batteries were limited to about 4.3 V in terms of metallic Li during charging), 8–9, 12, 13, 14 (explaining that “charging can be from 4.4 V to 4.8 V in terms of metallic Li” in the battery of Yamaki), 15 (noting that the resulting battery has “a higher energy density” and improved discharge capacity).

Consistent with the finding that Yamaki’s battery is configured to use a charge cut-off voltage between 4.4 and 4.8V, during prosecution of Yamaki the inventors asserted that the inventive battery of Yamaki was specifically designed to operate within “a suitable voltage range” of 4.4 to greater than 4.6 V. Ex. 2019, 5–6 (contrasting a battery that was overcharged to 5 V with the claimed battery that had a “suitable voltage

range” of 4.4 to 4.6 V).¹⁰ This clearly suggests that the 4.4 to greater than 4.6 V charge cut-off range is the voltage to which the battery of Yamaki was designed and configured to be charged.

Patent Owner argues that even if one of ordinary skill in the art would have attempted to raise the charge cut-off voltage of Yamaki’s battery above 4.2 V, they would not have sought to use Sakamoto’s disclosed ratio of positive to negative electrode active materials. PO Resp. 28–29. According to Patent Owner, Sakamoto teaches away from elevated voltages that would increase lithium in circulation and, instead, teaches prioritizing safety and against increasing the amount of lithium in circulation during charging/discharging, as increasing the lithium circulating in the battery may lead to undesirable lithium plating. *Id.* at 29 (citing Ex. 1005 ¶¶ 5, 15). Patent Owner also argues that there was no definitive guidance in the art for setting appropriate ranges for the capacity ratio of a secondary lithium battery, and some references used more positive electrode active material than negative electrode active material to compensate for lithium losses during the first charge/discharge cycles. *Id.* at 29–30 (citing Ex. 2016, 3650; Ex. 2015, 4; Ex. 2007 ¶ 51).

Patent Owner’s arguments do not persuasively undermine Petitioner’s position. Sakamoto expressly discloses setting the ratio of negative to positive electrode active material in the range of 1.05 to 1.30. Ex. 1005 ¶ 8. Sakamoto also explains why this range is preferable, i.e., if the ratio is roughly equal “the charge-discharge cycle performance is insufficient due to significant deterioration from charging and discharging,” and if the ratio is

¹⁰ Citations to the prosecution history of Yamaki are to the page numbers added to the lower right corner of the document.

too high “too much of the compound does not participate in charging and discharging.” *Id.* ¶¶ 6, 8. These disclosures are sufficient to explain why one of ordinary skill in the art would have found it obvious to select the ratios disclosed in Sakamoto in Yamaki. *Id.* ¶ 8 (providing a secondary battery with a capacity ratio between 1.05 and 1.30 and noting that by setting the ratio within this range the resulting secondary lithium battery is “safe due to low risk of heat being generated and an explosion occurring”).

We also disagree that Sakamoto teaches away from elevated voltages or from increasing the amount of lithium in circulation. *See* PO Resp. 29. Contrary to Patent Owner’s arguments, Sakamoto provides no general teaching against using a charge cut-off voltage above 4.2 V, or against increasing the level of lithium in circulation. Nor does Sakamoto “criticize, discredit, or otherwise discourage” the claimed invention. *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004). Rather, Sakamoto warns against setting the reversible capacities of the positive and negative electrode substantially equal as this may result in excess lithium plating on the surface of the electrode. Ex. 1005 ¶¶ 6, 8. We agree with Petitioner that this disclosure would lead one of ordinary skill in the art to design a battery with a higher capacity in the negative electrode active material than the positive electrode active material. Pet. 11–12.

Patent Owner argues that Yasunami teaches that the ratio of positive to negative active electrode material may be set arbitrarily, indicating to one of ordinary skill in the art that “they had great flexibility in setting the capacity ratio for secondary lithium-ion batteries.” PO Resp. 30–31 (citing Ex. 2030 ¶ 32; Ex. 1006 ¶ 19). Patent Owner further argues that, “setting aside Yasunami’s teaching that the ratio can be set arbitrarily,” there is no

evidence of record that a person of ordinary skill in the art would consider the capacity ratio relevant to increasing the charge cut-off voltage. *Id.* at 31. According to Patent Owner, “Petitioner provides no reason why [a person of ordinary skill in the art] would have ignored the various references describing batteries with capacity ratios outside of the claimed range . . . and attempted to exceed the conventional 4.2 V limit on the charge cutoff voltage.” *Id.*

Patent Owner’s argument does not persuasively undermine Petitioner’s position. First, Petitioner need not demonstrate that one of ordinary skill in the art would have understood that increasing the ratio of negative to positive electrode material would be relevant to, or would allow, increasing the charge cutoff voltage above 4.2 V in Yamaki because Yamaki already successfully uses a charge cut-off voltage of 4.4 to greater than 4.6 V. Ex. 1004 ¶¶ 13–14. Second, the fact that one of ordinary skill in the art would have understood there to be “great flexibility” in setting the capacity range of a battery only strengthens Petitioner’s argument that one of ordinary skill in the art, seeking to achieve the benefits expressly set forth in Sakamoto, would have sought to use a capacity ratio between 1.05 and 1.30 with a reasonable expectation of success. PO Resp. 30–31 (citing Ex. 1006 ¶ 19 (“[E]ither the positive electrode active material or the negative electrode active material is preferably increased.”)).

In view of the foregoing, we are not persuaded that Petitioner uses impermissible hindsight to arrive at the combination of Yamaki and Sakamoto. Rather, as Petitioner argues, a preponderance of the evidence, including the express teachings of these references and evidence regarding knowledge of one of ordinary skill in the art, establishes why one of

ordinary skill in the art would have combined Yamaki and Sakamoto to arrive at the claimed invention with a reasonable expectation of success.

b. Alleged Fundamental Differences Between Yamaki and Sakamoto

Patent Owner contends that during prosecution the inventors of Yamaki stated that Yamaki's battery system is "fundamentally different" from conventional 4.2 V battery systems and that it is "extremely difficult" to predict the performance of Yamaki's battery at a voltage above 4.2 V based on performance at lower voltages. PO Resp. 32 (citing Ex. 2019). Patent Owner contends that determining the safety and efficacy of Yamaki's battery at a particular charge cut-off voltage would involve the assessment of numerous factors and would require "substantial and rigorous testing over hundreds of cycles." *Id.* at 32–33 (citing Ex. 2007¹¹ ¶¶ 134–136). Patent Owner further contends there is no reason to believe that the combination of Yamaki and Sakamoto would operate safely and efficaciously, "especially in light of Yamaki's statement that it is materially different from batteries configured for a 4.2V charge cutoff voltage (like Sakamoto's)." *Id.* at 33 (citing Ex. 2007 ¶¶ 134–136).

Patent Owner's arguments do not persuasively undermine Petitioner's position. First, Patent Owner overstates the Yamaki inventors' prosecution arguments. During prosecution, the pending claims were rejected over, among other references, Reference 4 (JP H10-223229) and Reference 2 (JP

¹¹ Patent Owner erroneously cites to Exhibit 2006, which is the CV, not the Declaration, of Dr. Yao.

H11-007958). Ex. 2019, 2, 5–6.¹² The applicants characterized Reference 4 as disclosing a secondary lithium-ion battery that was charged to an overcharge state of 5.0 V in order to evaluate the overcharge characteristics of the battery, and characterized Yamaki as disclosing a “suitable voltage range” of 4.4 to greater than 4.6 V. *Id.* at 5–6 (“In contrast, as described above, the invention of the present application specifies a suitable voltage range that can provide a higher performance lithium secondary battery at a voltage of less than or equal to the theoretical voltage (about 4.8 V).”). The applicants characterized Reference 2 as merely disclosing a charging voltage of 4.2 V, and asserted that it is “extremely difficult to predict” the performance of a battery charged at 4.4 V or more based on performance when charging is 4.3 V or less. *Id.* at 6–7. The applicants therefore concluded that “[i]n other words, we believe that it is difficult to derive the invention of the present application even if References 2 and 4 are combined.” *Id.* at 7.

We discern no indication from these disclosures that it is difficult to predict the performance of a battery that is already successfully charged to a “suitable voltage” of 4.4 to greater than 4.6 V, such as that of Yamaki. Nor are we directed to any suggestion in the Yamaki prosecution history that increasing the ratio of negative to positive electrode material would be unpredictable. As such, Patent Owner’s arguments based on the Yamaki applicants’ statements during prosecution are not persuasive.

Second, Patent Owner identifies no persuasive scientific principle to suggest that increasing the ratio of negative to positive electrode active

¹² We cite to the page numbers inserted at the lower right corner of the document.

material would be unpredictable or would adversely impact the cycle performance or safety of Yamaki's battery. Indeed, Sakamoto suggests that the tradeoffs for increasing cycle performance and safety by increasing the relative amount of negative electrode active material are decreased energy density and costs, due to the increase in anode active material as compared to the cathode active material. Ex. 1005 ¶ 8. Petitioner persuasively explains, however, why one of ordinary skill in the art would have sought to achieve a longer cycle life and improved safety in Yamaki by increasing the ratio of negative to positive active electrode material as disclosed in Sakamoto, even if this resulted in a slightly lower energy density and increased costs. Pet. 11–13; Pet. Reply 6, 10.

c. No Suggestion that Adjusting the Capacity Ratio Would Allow a Charge Cutoff Voltage Above 4.2 V

Patent Owner contends that “[t]he absence of a motivation to combine Yamaki and Sakamoto to raise the charge cutoff voltage above 4.2V and set the capacity ratio in the claimed range is underscored by the fact that none of the references Petitioner cites describe a battery with those features.”

PO Resp. 33. Patent Owner contends that “every battery in the record designed with greater anode than cathode capacity was also configured to a maximum charge cut-off voltage of 4.2V or lower,” and the consistency with which the prior art discloses a maximum 4.2 V charge cutoff voltage “evidences that [persons of ordinary skill in the art] did not have reason to expect that adjusting the capacity ratio allowed raising the charge cutoff voltage.” *Id.* at 34.

Patent Owner's argument does not persuasively undermine Petitioner's position. Petitioner need not show that one of ordinary skill in

the art would have sought to increase the charge cut-off voltage in Yamaki, or that such a skilled artisan would have had reason to believe that increased levels of negative electrode active materials would allow charge cut-off voltages of greater than 4.2 V, because Yamaki already discloses successfully using a charge cut-off voltage of 4.4 to 4.6 V. Pet. Reply 10, 12–13; Ex. 1004 ¶ 14. And, although Petitioner identifies no reference that discloses both the claimed charge cut-off voltage range and capacity ratio range recited in independent claim 5, Petitioner provides several persuasive reasons, supported by a preponderance of the evidence, why one of ordinary skill in the art would have sought to combine Yamaki and Sakamoto to arrive at the claimed invention with a reasonable expectation of success. Pet. 9–14 (explaining that the proposed combination would improve the cycle performance of Yamaki’s battery, create a “safer” battery that is resistant to overcharging, and provide “implementation details” that are missing from Yamaki).

d. Conclusion – Claim 5 over Yamaki and Sakamoto

Petitioner persuasively demonstrates that Yamaki and Sakamoto disclose every limitation of independent claim 5. Pet. 15–21. Petitioner also persuasively explains why one of ordinary skill in the art would have sought to combine these references to arrive at the claimed invention with a reasonable expectation of success. *Id.* at 9–14. Thus, Petitioner demonstrates by a preponderance of the evidence that claim 5 would have been obvious over Yamaki and Sakamoto.

4. Claims 6–8

Petitioner persuasively identifies where Yamaki and Sakamoto disclose the limitations of dependent claims 6–8. Pet. 21–22. In particular,

Petitioner demonstrates that the charge cut-off voltage of Yamaki (4.4–4.8 V) falls entirely within the claimed ranges of 4.3–5.2 V (claim 6) and 4.3–4.8 V (claim 7). Pet. 21–22. Petitioner also persuasively demonstrates that the ratios of positive to negative electrode material specifically disclosed in Sakamoto (i.e., ratios of 1:1.18, 1:1.30, 1:1.41, 1:1.5) fall within the claimed range of 1:1.15–1:2.5 when calculated at a charge cut-off voltage of 4.2 V, and that the range of 1:1.05 to 1:1.30 disclosed in Sakamoto overlaps with the recited range of 1:1.15 to 1:2.5 (claim 8). *Id.*; see *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003) (“In cases involving overlapping ranges, we and our predecessor court have consistently held that even a slight overlap in range establishes a *prima facie* case of obviousness.”).

Patent Owner does not contest Petitioner’s arguments with respect to claims 6–8, apart from its arguments regarding independent claim 5.

Upon review of the arguments and evidence of record, we determine that Petitioner demonstrates by a preponderance of the evidence that claims 6–8 would have been obvious over the combined disclosures of Yamaki and Sakamoto.

5. Claims 11–14

Claims 11–14 depend from claim 5 and further require “wherein the secondary lithium ion cell or battery maintains at least” 75%¹³ (claim 11), 75.83% (claim 12), 80% (claim 13), and 80.72% (claim 14) capacity after

¹³ Claim 11 recites “at least 7500 of capacity after 400 cycles.” Ex. 1001, 18:4–6. The parties agreed in co-pending litigation, and appear to agree here, that “7500” should be interpreted as “75%.” Pet. 24 n.4 (citing Ex. 1001, Tables 2–3; Ex. 1031, 7; Ex. 1003 ¶ 92).

400 cycles. Ex. 1001, 18:4–15. Petitioner contends claims 11–14 would have been obvious in view of Yamaki and Sakamoto because (a) the capacity retention limitations of claims 11–14 do not carry patentable weight, (b) one of ordinary skill in the art would have found it obvious that the battery of Yamaki and Sakamoto achieves the recited capacity retention after 400 cycles, and (c) one of ordinary skill in the art could have used routine experimentation to arrive at the limitations of claims 11–14 in the battery of Yamaki and Sakamoto. Pet. 23–30. For the reasons set forth below, we do not find Petitioner’s arguments persuasive.

a. Patentable Weight

Petitioner contends that claims 11–14 do not recite structural features that further limit the secondary lithium-ion cell or battery and, therefore, these claims “are rendered obvious by Yamaki-Sakamoto at least as discussed *supra* for claim 5.” Pet. 23; *see Hewlett-Packard Co. v. Bausch & Lomb Inc.*, 909 F.2d 1464, 1468 (Fed. Cir. 1990) (“[A]pparatus claims cover what a device *is*, not what a device *does*.”); *Catalina Marketing Int’l, Inc. v. Coolsavings.com, Inc.*, 289 F.3d 801, 809 (Fed. Cir. 2002) (“[T]he patentability of apparatus or composition claims depends on the claimed structure, not on the use or purpose of that structure.”).

An apparatus claim may include functional language that informs us of the structural requirements of the claim. PO Resp. 37 (citing *Alere, Inc. v. Rembrandt Diagnostics, LP*, 791 Fed. Appx. 173, 177 (Fed. Cir. 2019) (non-precedential); *K-2 Corp. v. Salomon S.A.*, 191 F.3d 1356, 1363 (Fed. Cir. 1999)). Claim 5, an apparatus claim from which the disputed claims 11–14 depend, requires selecting particular charge cut-off voltages and capacity ratios for the positive and negative electrode active materials. Patent Owner

persuasively demonstrates that selection from within the claimed ranges and ratios will affect the capacity of the battery or cell after 400 cycles, with an increased charge cut-off voltage and lower capacity ratio leading generally to lower capacity retention levels. Ex. 1001, Table 2; PO Resp. 41–42.

Dr. Yao also persuasively demonstrates that one primary cause of capacity fade is structural and chemical changes within the battery, especially the positive electrode material. Ex. 2007 ¶ 150 (“One primary factor is the degradation of the reversibility of active materials, especially the positive electrode material.”). Thus, we agree with Patent Owner that the recited capacity levels at 400 cycles inform us of the structural requirements of the claim. *See Alere*, 791 Fed. Appx. at 177; *K-2*, 191 F.3d at 1363.

b. Obvious to Achieve the Claimed Cycle Retention Levels

To the extent the capacity retention limitations of claims 11–14 are found to have patentable weight, Petitioner contends a person of ordinary skill in the art would have understood, or at least found it obvious, that the Yamaki-Sakamoto battery maintains at least 75% to 80.72 % capacity after 400 cycles, as recited in the claims. Pet. 23–24 (citing Ex. 1003 ¶¶ 93–103). Petitioner reasons that the ’641 patent indicates that it was the combination of a higher charge cut-off voltage and an increased capacity ratio that resulted in the improved cycle capacity performance, and the proposed combination of Yamaki and Sakamoto has this same combination of features. *Id.* at 24–25. Petitioner also argues that, although Yamaki reports capacity after only 10 cycles, one of ordinary skill in the art would have reasonably predicted the performance of the Yamaki-Sakamoto battery when charged/discharged 400 times in view of Yamaki’s 10-cycle testing in conjunction with the performance of similar batteries after 400 cycles. *Id.* at

26. Notably, according to Petitioner, “many such batteries that exhibit high capacity retention after a small number of cycles (*e.g.*, consistent with the Yamaki-Sakamoto battery) exhibit significant capacity retention even after more (*e.g.*, hundreds) cycles.” *Id.* (citing Ex. 1003 ¶ 102; Ex. 1015, 23.10; Ex. 1018, Fig. 3; Ex. 1016, 5:32–36; Ex. 1017, 5:10–17).

Mr. Hruska testifies that Yamaki discloses that its example batteries retained up to 98% capacity after 10 cycles when charged to a charge cutoff voltage of 4.5 V, and asserts that one of ordinary skill in the art would have understood that use of Sakamoto’s reversible capacity balance would result in a battery with cycle characteristics “at least as good as . . . if not better,” than Yamaki’s. Ex. 1003 ¶¶ 97–98. And, although Yamaki “[u]nfortunately” does not describe testing of more than 10 cycles, Mr. Hruska contends one of ordinary skill in the art “would have found it reasonable to predict” the longer life performance of the Yamaki-Sakamoto battery “based on the performance of other, similar batteries.” *Id.* ¶ 101.

In support of this argument, Mr. Hruska identifies several example lithium-ion batteries that achieved high capacity retention levels after 400 or 500 cycles, and testifies that the Handbook of Batteries indicates “a typical cycle life of 500-1000 cycles for lithium ion batteries.” Ex. 1003 ¶ 102 (citing Ex. 1015, 23.10; Ex. 1016, 5:32–36; Ex. 1017, 5:10–17; Ex. 1018 ¶ 81, Fig. 3). According to Mr. Hruska, “[g]iven that batteries that behave similarly to the Yamaki-Sakamoto combination battery after a small number of cycles retain a significant percentage of their capacity even after hundreds of cycles,” one of ordinary skill in the art “would have good reason to expect the Yamaki-Sakamoto battery to show similar behavior during longer-term cycle life testing.” *Id.* ¶ 103.

Upon review of Petitioner's arguments and evidence, as well as Mr. Hruska's and Dr. Yao's testimony (discussed below), we credit the testimony of Dr. Yao that there is insufficient evidence of record to allow one of ordinary skill in the art to reasonably predict that the battery of Yamaki and Sakamoto would retain the claimed capacity levels after 400 cycles for two reasons. Ex. 2007 ¶¶ 149–161. First, although the '641 patent indicates that an increased charge cut-off voltage in combination with an increased ratio of anode to cathode active material resulted in batteries with capacities above 75% after 400 cycles, we discern no teaching in the '641 patent that all batteries with charge cut-off values above 4.2 V and a greater than 1:1.0 ratio of positive to negative active material will achieve the claimed capacity retention rates after 400 cycles. Ex. 2007 ¶ 148; Ex. 2008, 120:20–121:13; PO Resp. 38–39. Indeed, the battery of Sakamoto, which used increased negative electrode capacity to improve cycle performance and was charged to a cutoff voltage of 4.2 V, only retained approximately 75% of its capacity after 300 cycles. Ex. 2007 ¶ 162 (citing Ex. 1005, Fig. 1). As noted by Dr. Yao, one of ordinary skill in the art would not expect this cycle performance to improve when the battery of Yamaki and Sakamoto is charged to a higher charge cutoff value. *Id.*

Second, Dr. Yao persuasively testifies that capacity fade of batteries is “not a linear process,” but rather a complex process involving multiple interrelated factors. Ex. 2007 ¶¶ 150–153; PO Resp. 40–41. Dr. Yao explains that a battery that loses capacity at a relatively stable rate after a certain number of initial cycles may reach a “knee” point at which the rate of capacity loss accelerates. Ex. 2007 ¶ 153. In support of this argument, Dr. Yao identifies prior art disclosures demonstrating that, although capacity

loss may be gradual during the initial cycles, after additional cycles the battery could rapidly lose capacity or otherwise fail to achieve 75% capacity after 400 cycles. *Id.* ¶¶ 153–160. Dr. Yao also persuasively testifies that the cathode is one of the primary drivers of capacity fade, and none of the references identified by Petitioner and Mr. Hruska uses Yamaki’s specific cathode material with its amorphous carbonaceous surface layer and crystal structure. Ex. 1004 ¶ 13; Ex. 2007 ¶¶ 150, 163–164.

Petitioner contends Dr. Yao testified on cross-examination that batteries with “excellent” cycle characteristics would typically achieve more than “a few hundred cycles.” Pet. Reply 7–8; Ex. 1034, 38:14–39:9. Dr. Yao did not testify, however, that all batteries that report a “long” or “excellent” cycle life will achieve at least 75 % capacity after 400 cycles. Indeed, Sakamoto reports that its battery achieved “excellent charge-discharge cycle performance,” but only achieved roughly 75% capacity after 300 cycles. Ex. 1005 ¶¶ 1, 16, Fig. 1. Thus, we are not persuaded that Yamaki’s disclosure of a battery with “excellent cycle characteristics” would indicate to one of ordinary skill in the art that its battery would be expected to achieve greater than 75% capacity after 400 cycles.

Upon review of the arguments and evidence of record, we credit the testimony of Dr. Yao that without further investigation and/or testing, one of ordinary skill in the art would not have had a reasonable expectation of success in achieving the capacity retention rates recited in claims 11–14 after 400 cycles in the battery of Yamaki and Sakamoto. Ex. 2007 ¶¶ 147–153. Thus, the preponderance of the evidence supports Patent Owner’s position in this regard.

c. Routine Experimentation

Petitioner contends that one of ordinary skill in the art “would have been aware of the myriad factors that influence cycle life” of a battery, including the charge cut-off voltage, the ratio of positive to negative electrode active material, charge/discharge rates, ambient temperature, and electrolyte purity and strength. Pet. 27–29 (citing Ex. 1003 ¶¶ 108–114). Driven by the objective of improving cycle life, Petitioner contends one of ordinary skill in the art, using only routine experimentation, would have adjusted one or more of the relevant variables to achieve the claimed capacity retention levels after 400 cycles. *Id.* at 27–30.

Patent Owner argues that Yamaki discloses a “new cathode material” that was subjected to only 10-cycle testing, which Patent Owner contends would not allow one of ordinary skill in the art to reasonably predict capacity levels after hundreds of cycles. PO Resp. 40–41 (citing Ex. 2007 ¶¶ 149–161). Patent Owner reasons that high voltage cycling, as in Yamaki, would cause increased capacity loss as compared to batteries charged at a charge cut-off voltage of 4.2 V, and at least one prior art study showed that similar batteries charged to 4.2 V and 4.6 V had the same capacity retention after 10 charge/discharge cycles, but the cell cycled at 4.6 V exhibited substantial capacity loss after 100 cycles. *Id.* at 41–42, 47; Ex. 2007 ¶¶ 158–160.

Patent Owner presents evidence that Yamaki discloses a new type of cathode material that utilizes an amorphous carbon material on its surface. Ex. 1004, Fig. 1; PO Resp. 40. Petitioner identifies no battery that utilizes this type of cathode and achieves the claimed capacity rates after 400 cycles. Moreover, to have a reasonable expectation of success, one of ordinary skill

in the art must be motivated to do more than “vary all parameters or try each of numerous possible choices until one possibly arrived at a successful result.” *See Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006). Here, although many variables were known to potentially increase or decrease cycle life of a battery, Petitioner provides insufficient evidence and reasoning to support its argument that the specific battery of Yamaki and Sakamoto could be manipulated by adjusting the known variables to successfully achieve capacity rates of 75% or higher after 400 cycles. Pet. 29.

Petitioner contends that, because all of the factors necessary for improving cycle life of a secondary lithium-ion battery were known in the art, “there is no inventiveness to merely determining the optimal parameters to achieve that goal.” Pet. Reply 29 (citing *In re Aller*, 220 F.2d 454, 456 (CCPA 1955)). We disagree. Petitioner identifies no set of ranges for the numerous identified variables that were understood, individually or in combination, to routinely result in a battery with greater than 75% capacity after 400 cycles. Nor are we directed to evidence of specific variables and values that were known to achieve greater than 75% capacity after 400 cycles in a battery using the unique cathode material of Yamaki.

In view of the foregoing, we credit the testimony of Dr. Yao that one of ordinary skill in the art would not have been able to reasonably predict the capacity retention of Yamaki’s battery after 400 cycles, or to reasonably predict that adjusting the known, relevant variables would allow for capacity retention greater than 75% after 400 cycles in the battery of Yamaki and Sakamoto. Ex. 2007 ¶¶ 150–160, 174–176.

d. Conclusion – Claims 11–14

For the reasons set forth above, we determine that Petitioner does not demonstrate that the combination of Yamaki and Sakamoto teaches or suggests a lithium ion cell or battery that would maintain the capacities recited in claims 11–14 after 400 cycles. Nor does Petitioner persuasively demonstrate that one of ordinary skill in the art, using routine experimentation, would have adjusted the many relevant parameters to achieve the claimed capacities after 400 cycles in the battery of Yamaki and Sakamoto. As such, Petitioner does not demonstrate by a preponderance of the evidence that claims 11–14 would have been obvious over Yamaki and Sakamoto.

E. Claims 9 and 10 over Yamaki, Sakamoto, and Abraham

Claim 9 depends from claim 5 and further requires that the cell or battery “has a first overcharging protection voltage of greater than 4.35 V, and an overcharging protection release voltage of greater than 4.15 V.” Ex. 1001, 17:24–28. Claim 10 depends from claim 9 and further requires that the “battery has a first overcharging protection voltage of greater than 4.45 V, and an overcharge protection release voltage of greater than 4.25 V.” *Id.* at 17:29–18:3.

Petitioner contends the subject matter of claims 9 and 10 would have been obvious over the combined disclosures of Yamaki, Sakamoto, and Abraham. Pet. 31–38.

1. Abraham

Abraham discloses “the use of redox reagents, dissolved in non-aqueous electrolytes, to provide overcharge protection for cells having

lithium metal or lithium-ion negative electrodes (anodes).” Ex. 1009, code (57). Abraham explains its invention as follows:

A redox shuttle offers the best approach to cell overcharge protection. In this scheme, a material with an appropriate oxidation potential is dissolved in the electrolyte where it remains unreactive until the cell is charged fully. At a potential slightly above the cell charge limit (upper cutoff voltage), the redox shuttle is activated by its electrochemical conversion. The cell potential during overcharge is fixed at the oxidation potential of the redox shuttle. This process is supported by diffusion of the oxidized products to the anode where they recombine to form the starting material. Once the reformed material diffuses back to the cathode, it is oxidized and the cathode potential is maintained indefinitely at the oxidation potential of the redox reagent, until the time that charging is terminated.

Id. at 2:20–33.

Abraham notes that in the preferred embodiment thianthrenes are used to protect lithium and lithium-ion secondary cells from the effects of overcharge. Ex. 1009, 3:20–22. Abraham further notes that “[j]udicious selection of the particular thianthrene will allow the overcharge protection agent to be tailored to the appropriate cell voltage.” *Id.* at 3:52–54.

2. Analysis

Petitioner contends one of ordinary skill in the art would have sought to include the overcharging protection of Abraham in the battery of Yamaki and Sakamoto in order to “avoid degradation of battery performance,” “to mitigate safety risks associated with overcharging,” and to avoid the need for “electronic overcharge controllers,” which lower energy density and increase costs. Pet. 33–34. Petitioner further contends that one of ordinary

skill in the art considering the disclosures of Abraham would have selected an overcharging protection voltage for the battery of Yamaki and Sakamoto that is “slightly higher than” the charge cut-off voltage of the battery, i.e., 4.4 and 4.8 V. *Id.* at 37 (asserting that the overcharge protection voltage would be greater than the 4.35 V and 4.45 V limits recited in claims 9 and 10, respectively). Petitioner further contends that, because the oxidation potential of the redox shuttle is greater than 4.35 V, Abraham teaches or suggests the overcharge release voltage levels recited in claims 9 (greater than 4.15 V) and 10 (greater than 4.25 V). *Id.* at 38.

Patent Owner does not address Petitioner’s arguments with respect to Abraham, apart from its arguments with respect to the combination of Yamaki and Sakamoto. PO Resp. 49.

Upon review of Petitioner’s arguments and supporting evidence, we determine that Petitioner persuasively demonstrates that one of ordinary skill in the art would have combined Yamaki, Sakamoto, and Abraham to arrive at the subject matter of claims 9 and 10 with a reasonable expectation of success. Thus, Petitioner demonstrates by a preponderance of the evidence that claims 9 and 10 would have been obvious over the combined disclosures of Yamaki, Sakamoto, and Abraham.

F. Claims 5–14 over Yasunami and Koyama

Petitioner contends the subject matter of claims 5–14 would have been obvious over the combined disclosures of Yasunami and Koyama. Pet. 39–63.

1. Yasunami

Yasunami is directed to “a charging and discharging method for a non-aqueous secondary battery that has improved charge/discharge cycle

characteristics.” Ex. 1006 ¶ 1. The negative electrode of Yasunami’s battery may be a lithium containing transition metal oxide represented by Li_xMO_j , where M is at least one transition metal selected from the group of Ti, V, Mn, Co, Fe, Ni, Nb, and Mo, x is in the range from 0.17 to 11.25, and j is in the range from 1.6 to 4.1. *Id.* ¶ 7. The positive electrode active material is “a lithium-containing transition metal oxide represented by Li_yNO_z (where N represents at least one transition metal selected from Co, Mn, Ni, V, and Fe, y is in the range from 0.2 to 1.2, and z is in the range from 1.4 to 3).” *Id.* The “end-of-charge voltage” of the battery “is from 3.5 to 4.7 V.” *Id.*

Yasunami explains that “[t]here are no particular restrictions on the use ratio for the positive electrode active material and the negative electrode active material, but the ratio is preferably set so that the effective equivalents of each are equal (an effective equivalent is the equivalent that can substantially maintain cycle performance).” Ex. 1006 ¶ 19. Yasunami notes, however, that “either the positive electrode active material or the negative electrode active material” may be increased. *Id.*

With respect to the end-of-charge voltage, Yasunami explains that the voltage is preferably in the range of 3.5 to 4.7 V, and even more preferably from 3.8 to 4.4 V. Ex. 1006 ¶ 34. According to Yasunami, if the end-of-charge voltage “is lower than 3.5 V, the battery voltage will be low, and if it is higher than 4.7 V, the positive electrode active material and the electrolyte may decompose.” *Id.*

2. Koyama

Koyama discloses a secondary lithium ion battery with a positive electrode active material that may contain “Li-containing transition metal

oxides such as Li_xMO_y (where M includes at least one transition metal such as Co, Mn, Ni, V, and Fe),” and the negative electrode active materials may include metal oxides such as Li_xMO_y , where M includes at least one transition metal such as Ti, V, Mn, Co, and Fe. Ex. 1007 ¶¶ 8–9. Koyama also discloses that “the capacity ratio (B/A) between the electrode capacity A of the positive electrode and the electrode capacity B of the negative electrode is $1.3 < (B/A) \leq 2.5$.” Ex. 1007 ¶ 6. According to Koyama, by using the disclosed capacity ratio range “the nonaqueous electrolyte secondary battery can obtain excellent charging characteristics.” *Id.* ¶ 10.

3. Claims 5–10

Petitioner contends that the subject matter of claims 5–10 would have been obvious over the combined disclosures of Yasunami and Koyama. Pet. 39–58. We do not address these claims, however, because we determined above that claims 5–8 would have been obvious in view of Yamaki and Sakamoto and that claims 9 and 10 would have been obvious in view of Yamaki, Sakamoto, and Abraham. *See SAS Inst. Inc. v. Iancu*, 138 S. Ct. 1348, 1359 (2018) (holding that a petitioner “is entitled to a final written decision addressing all of the claims it has challenged”).

4. Analysis—Claims 11–14

Petitioner contends one of ordinary skill in the art would have understood, or at least found obvious, that the battery of Yasunami and Koyama maintains at least 75%, 75.83%, 80%, or 80.72% of capacity after 400 cycles, as recited in claims 11–14, respectively. Pet. 59 (citing Ex. 1003 ¶¶ 219–223). Petitioner further contends that one of ordinary skill in the art would have arrived at the claimed capacities after 400 cycles using routine experimentation. *Id.* at 61–63. Claims 11–14 depend from independent

claim 5; although we do not separately analyze the patentability of claim 5 as discussed *supra* (see *SAS*), we evaluate the limitations of claim 5 insofar as they are incorporated into the analyzed dependent claims 11–14

a. *Capacity Retention of the Yasunami-Koyama Battery*

Petitioner contends that one of ordinary skill in the art would have understood that the battery of Yasunami and Koyama achieves the capacity retention levels recited in claims 11–14 after 400 cycles for several reasons. First, Petitioner contends that the '641 patent provides no description of how to achieve the recited capacity retention beyond the specified charge cut-off voltage and electrode material ratios and, because the disclosures of Yasunami and Koyama align with these structural and charge characteristics, Yasunami and Koyama render the recited capacities obvious. Pet. 59–60.

Second, Petitioner contends one of ordinary skill in the art would have found it obvious that the battery of Yasunami and Koyama achieves the recited capacities at 400 cycles in view of (1) the cycle life performance demonstrated for Yasunami's battery, (2) "the effect of the material ratio provided by the combination with Koyama," and (3) in view of "the well-known cycle life behavior of secondary lithium batteries." Pet. 60 (citing Ex. 1003 ¶¶ 221–222). In support of this theory, Petitioner contends that lithium-containing transition metal oxides were known to achieve "good charge/discharge cycle characteristics," and Yasunami's battery achieves over 200 cycles before discharge capacity reaches 60% of the initial value. *Id.* at 60–61 (citing Ex. 1006 ¶¶ 1, 6, 7, 20, 21, Abstract; Ex. 1005 ¶¶ 7, 8, 12, 17; Ex. 1021 ¶ 11; Ex. 1019, 3:24–28; Ex. 1018 ¶ 33; Ex. 1003 ¶¶ 222–223).

Yasunami discloses a battery with “long charge/discharge cycle life.” Ex. 1006 ¶ 6. This battery, however, retained only 60% of its initial discharge capacity after 220 cycles. *Id.* ¶ 66, Table 1. Koyama suggests that its disclosed ratios of negative and positive electrode materials would improve the cycle characteristics of a secondary lithium-ion battery, but neither Yasunami nor Koyama teach or suggest that the ratios set forth in Koyama would allow the battery of Yasunami and Koyama to achieve at least 75% capacity after 400 cycles. That is, there is no persuasive evidence that Koyama’s ratios would allow Yasunami’s battery to achieve an increase in discharge capacity above 60% (to at least 75% up to 80.72% as required by the challenged claims) after nearly doubling the number of charge/discharge cycles for the battery (220 as disclosed in Yasunami up to 400 as required by the challenged claims).

In contrast, Dr. Yao persuasively testifies that the capacity of Yasunami’s battery at 400 cycles cannot be reasonably predicted, especially given Koyama’s retention of only 60% capacity after 220 cycles. Dr. Yao testifies that Koyama does not provide any cycle life data, and Sakamoto’s best battery (which is relied upon by Petitioner to support its arguments with respect to the combination of Yasunami and Koyama) having an increased ratio of negative to positive electrode active material retained only about 75% capacity after 300 cycles. Ex. 2007 ¶¶ 210–211. And, although other batteries in the art had been shown to achieve the claimed levels of capacity after 400 cycles, Dr. Yao persuasively testifies that those batteries did not use the same anode active material as Yasunami and Koyama (lithium transition oxides vs. carbon) and therefore would not reasonably

demonstrate the capacity of the Yasunami/Koyama battery after 400 cycles.
Id. ¶ 213.

Petitioner contends Patent Owner should not be entitled to a claim that requires more to achieve than what is taught in the '641 patent “and by extension, [Patent Owner] cannot demand more of the art than what is described by the '641 Patent with respect to the recited capacity retention features.” Pet. Reply 28. The '641 patent, however, provides specific experimental results, with specific anode and cathode materials, specific charge cut-off voltages, and specific material ratios that, in combination, achieve the claimed capacity levels at 400 cycles.¹⁴ Ex. 1001, 10:27–15:53, Tables 1–4. On this record, we have no persuasive evidence, experimental or otherwise, to suggest that the battery of Yasunami and Koyama, with its particular cathode and anode materials, would achieve at least 75% capacity after 400 cycles. Nor does Petitioner identify a sufficiently similar battery to that of Yasunami and Koyama such that one of ordinary skill in the art could reasonably predict the capacity of the Yasunami and Koyama battery after 400 cycles. Ex. 2007 ¶¶ 211–213 (Dr. Yao testifying that one of ordinary skill in the art could not reasonably predict that the battery of Yasunami and Koyama would achieve the capacity retention rates recited in claims 11–14 after 400 cycles). This is especially true given that Yasunami uses the same types of materials as Koyama (lithium-containing oxides), uses an end-of-charge voltage of 4.3 V, and achieves only 60% capacity after 220 cycles. Ex. 1006 ¶¶ 7, 66, Table 1; Ex. 1007 ¶¶ 9, 21–22; Ex. 2007 ¶¶ 209–210.

¹⁴ To the extent Petitioner contends the '641 patent does not enable the full scope of the claims, this is not a question that can be raised in this proceeding. 35 U.S.C. § 311(b).

b. Routine Experimentation

To the extent that Yasunami and Koyama do not teach or suggest a battery that retains at least 75% capacity after 400 cycles, Petitioner contends one of ordinary skill in the art, using only routine experimentation, “would have found it obvious to obtain a battery consistent with Yasunami-Koyama that maintains” the recited capacities after 400 cycles. Pet. 61. Petitioner reasons that Yasunami aims to improve cycle life of a secondary battery, which is a generally accepted objective for the design of a commercially viable battery. *Id.* (citing Ex. 1003 ¶ 225). Petitioner further reasons that one of skill in the art seeking to improve cycle life “would have been aware of factors influencing cycle life, including charge cut-off voltage, electrode material ratio, electrolyte purity/strength, charge/discharge rate, and ambient temperature.” *Id.* at 62 (citing Ex. 1004 ¶ 57; Ex. 1006 ¶¶ 67–71; Ex. 1005 ¶¶ 15–16; Ex. 1015, 36.46; Ex. 1014, 1; Ex. 1016, 5:5–9; Ex. 1003 ¶ 226). Petitioner contends it would have been a matter of routine experimentation for a person of ordinary skill in the art to adjust the known factors influencing battery capacity retention to achieve the claimed retention rates after 400 cycles, “particularly in view of the lack of detail in the ’641 Patent and the purportedly generic applicability of its teachings, and in view of the lack of criticality of the recited values.” *Id.*

We are not persuaded by Petitioner’s argument. As noted by Petitioner, Yasunami sought a battery with “long charge/discharge cycle life.” Ex. 1006 ¶ 6. The inventors of Yasunami presumably were also aware of the various factors influencing cycle life, “including charge cut-off voltage, electrode material ratio, electrolyte purity/strength, charge/discharge rate, and ambient temperature.” Pet. 62. Yet, the battery of Yasunami

achieved only 60% capacity after 220 cycles. Ex. 1006 ¶¶ 66–67 (Table 1). In addition, Koyama does not provide cycle capacity data to support the proposition that increasing the level of anode active material would allow for the necessary improvement in capacity after 400 cycles (increase of at least 15% capacity after an additional 180 cycles). Sakamoto discloses setting the negative electrode/positive electrode reversible capacity balance of a battery between 1.05 and 1.30, but reports roughly 75% capacity after 300 cycles. Ex. 1005, Fig. 1; Ex. 2007 ¶ 211. Thus, we credit the testimony of Dr. Yao that the evidence of record does not support a reasonable expectation of success in achieving greater than 75% capacity retention after 400 cycles in the battery of Yasunami and Koyama. Ex. 2007 ¶¶ 211–216.

As noted by Petitioner, the '641 patent does not explain which factors, beyond the capacity ratio and charge cut-off voltage, would be manipulated to achieve the claimed capacity after 400 cycles. Pet. 29–30, 61–63. But the '641 patent provides testing data, with specific battery structures, cathodes, anodes, and electrolytes, to show that the specific capacities could be achieved after 400 cycles.¹⁵ Ex. 1001, 9:59–15:54. This is in stark contrast to Petitioner's proposed quest to manipulate multiple variables, in unexplained ways, to try to achieve the claimed capacity retention values after 400 cycles in the battery of Yasunami and Koyama.

In view of the foregoing, we determine that Petitioner has not demonstrated by a preponderance of the evidence that claim 11–14 would have been obvious in view of Yasunami and Koyama.

¹⁵ To the extent Petitioner contends the '641 patent does not enable the full scope of its claims, that is an issue we may not address in this proceeding. 35 U.S.C. § 311(b).

G. Yasunami, Koyama, and Richardson

Petitioner contends that the subject matter of claims 9 and 10 would have been obvious in view of the combined disclosures of Yasunami, Koyama, and Richardson. Pet. 63–69. Because we determined that claims 9 and 10 would have been obvious in view of the combined disclosures of Yamaki, Sakamoto, and Abraham, we do not address whether these same claims would have been obvious over Yasunami, Koyama, and Richardson.

IV. CONCLUSION¹⁶

For the foregoing reasons, we determine that Petitioner demonstrates by a preponderance of the evidence that claims 5–10 are unpatentable. Petitioner fails to demonstrate by a preponderance of the evidence, however, that claims 11–14 are unpatentable. Our conclusions are summarized in the following table.

Claim(s)	35 U.S.C. §	Reference(s)/Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
5–8, 11–14	103(a)	Yamaki, Sakamoto	5–8	11–14
9, 10	103(a)	Yamaki, Sakamoto, Abraham	9–10	

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

Claim(s)	35 U.S.C. §	Reference(s)/Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
5–14	103(a)	Yasunami, Koyama ¹⁷		11–14
9, 10	103(a)	Yasunami, Koyama, Richardson ¹⁸		
Overall Outcome			5–10	11–14

V. ORDER

For the foregoing reasons, it is:

ORDERED that Petitioner demonstrates by a preponderance of the evidence that claims 5–10 of the '641 patent are unpatentable; and

FURTHER ORDERED that Petitioner does not demonstrate by a preponderance of the evidence that claims 11–14 are unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

¹⁷ For the reasons set forth above in section III.F.3, we do not address whether claims 5–10 are unpatentable in view of Yasunami and Koyama.

¹⁸ For the reasons set forth above in section III.G, we do not address whether claims 9 and 10 are unpatentable in view of Yasunami, Koyama, and Richardson.

IPR2023-01350
Patent 7,749,641 B2

For PETITIONER:

W. Karl Renner
Hyun Jin In
Gretchen DeVries
FISH & RICHARDSON P.C.
axf-ptab@fr.com
in@fr.com
devries@fr.com

For PATENT OWNER:

Minghui Yang
James T. Carmichael
Stephen McBride
CARMICHAEL IP, PLLC
jim@carmichaelip.com
stevemcbride@carmichaelip.com
mitch@carmichaelip.com