

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD. and
APPLE INC.,¹
Petitioner,

v.

RJ TECHNOLOGY LLC,
Patent Owner.

IPR2023-01183
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)

¹ Apple Inc. was joined as a petitioner in this proceeding based on a petition and motion for joinder filed in IPR2024-00597, which was granted. IPR2024-00597, Paper 8.

I. INTRODUCTION

Samsung Electronics Co., Ltd. (“Samsung”) filed a Petition requesting *inter partes* review of claims 1–18 of U.S. Patent No. 7,749,641 B2 (Ex. 1001, “the ’641 patent”). Paper 1 (“Pet.”).² RJ Technology LLC (“Patent Owner”) filed a Preliminary Response. Paper 7.

Upon review of the parties’ arguments and supporting evidence, we instituted review with respect to all grounds and claims set forth in the Petition. Paper 8. After institution, Patent Owner filed a Response (Paper 17, “PO Resp.”), to which Petitioner filed a Reply (Paper 29, “Pet. Reply”), and Patent Owner filed a Sur-reply (Paper 33, “Sur-reply”).

In IPR2024-00597, Apple Inc. filed a petition (substantially identical to Samsung’s Petition) and a motion for joinder seeking to join the present proceeding, which were granted. IPR2024-00597, Papers 2, 4, 8. Thus, Samsung Electronics Co., Ltd. and Apple Inc. now comprise the Petitioner in this proceeding.

Petitioner relies, *inter alia*, upon two declarations from Marc Juzkow (Ex. 1002 (original declaration); Ex. 1044 (reply declaration)), and Patent Owner relies upon a declaration from Yan Yao, Ph.D. (Ex. 2006).

An oral hearing was held on October 22, 2024, and a transcript of the hearing is included in the record (Paper 38, “Tr.”).

For the reasons that follow, we conclude that Petitioner demonstrates by a preponderance of the evidence that claims 2–4 and 6–18 are

² The Petition was filed under seal due to the identification of various parties Petitioner contends might be considered real parties in interest. Pet. 62; Paper 3. We do not identify those parties in this decision, and no other portion of the Petition or the Papers of record are alleged to contain confidential information.

unpatentable. Petitioner has not demonstrated by a preponderance of the evidence, however, that claims 1 and 5 are unpatentable on any asserted grounds set forth in the Petition.

II. BACKGROUND

A. Related Matters

The parties indicate that the '641 patent is the subject of *RJ Technology LLC v. Apple Inc.*, 8:22-cv-01874 (C.D. Cal.) and *RJ Technology LLC v. Samsung Electronics Co., Ltd.*, 22-cv-00401 (E.D. Tex.). Pet. 62; Paper 6, 1.

B. Real Parties in Interest

Petitioner identifies Samsung Electronics, Co., Ltd., Samsung Electronics America, Inc., and Apple Inc., as the real parties in interest. Pet. 62; IPR2024-00597, Paper 2, 62.

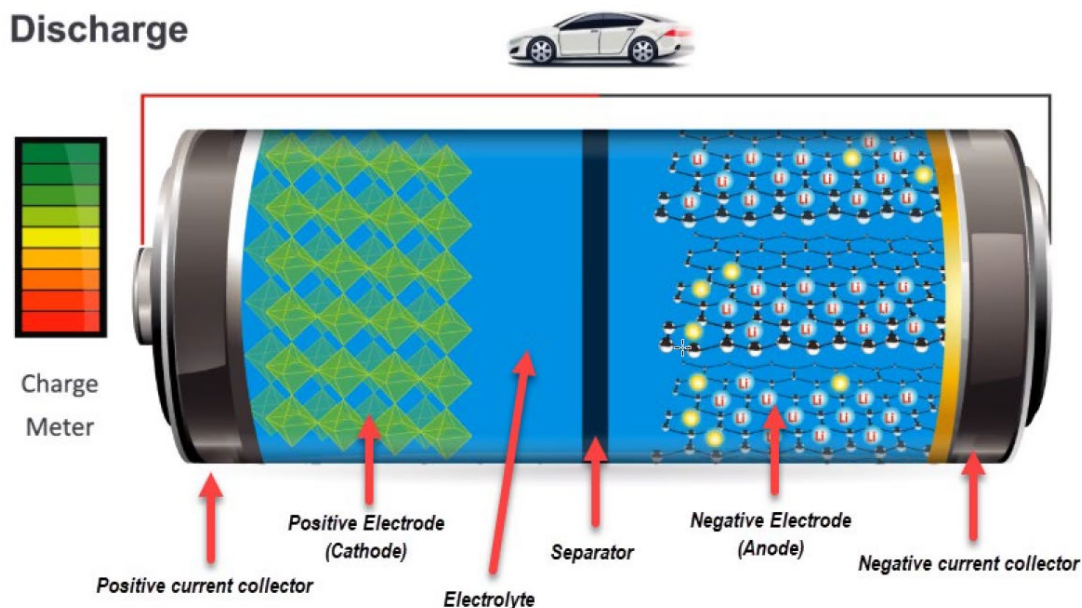
Patent Owner identifies itself as the real party in interest. Paper 23, 1.

C. Overview of Lithium-Ion Secondary Battery Technology

The '641 patent is directed to secondary lithium-ion cells or batteries. Ex. 1001, code (57). A lithium battery is typically “made up of a positive electrode (often called a cathode) consisting of an active material coated onto a current collector, a negative electrode (often called an anode) consisting of an active material coated onto a current collector, an electrolyte, a separator, and a container or cell case.” Ex. 1002 ¶ 14.³

³ The general background of lithium-ion batteries is taken from Dr. Juzkow's declaration. Ex. 1002. This overview is supported by, among other things, a description provided by the United States Department of Energy in “How Lithium-ion Batteries Work.” See <https://www.energy.gov/energysaver/articles/how-lithium-ion-batteries->

A depiction of the elements of a secondary lithium-ion battery is reproduced below:



The above depiction, annotated by Petitioner’s declarant Mr. Juzkow, is based on a depiction provided in “How Lithium-ion Batteries Work,” and shows a battery having a positive current collector, a positive electrode, an electrolyte, a separator, a negative electrode, and a negative current collector. Ex. 1002 ¶ 14. Mr. Juzkow explains that the positive electrode stores lithium atoms and releases the lithium as ions when the battery is being charged. *Id.* ¶ 15. The negative electrode stores lithium atoms and releases the lithium as ions when the battery is being discharged. *Id.* ¶¶ 15–16. The separator, which is filled with electrolyte (which includes mobile lithium ions), allows the lithium ions to flow from the negative electrode to the positive electrode and vice versa. *Id.* ¶ 15. “The process by which lithium is inserted into the structure of the positive and negative electrode materials is called ‘intercalation.’” *Id.* ¶ 17.

work.

D. 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 discloses 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.

E. Illustrative Claim

Claims 1 and 5 are the only independent claims of the ’641 patent, with challenged claims 2–4 and 15–18 depending from claim 1, and challenged claims 6–14 depending directly or indirectly from independent claim 5. Claims 1 and 5 are illustrative of the challenged claims and are reproduced below.

1. A method for improving the capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery, characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is 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 specific capacity with a charge voltage limited to 4.2 V.

Ex. 1001, 16:54–61.

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.

Id. at 17:5–11.

F. Asserted Grounds of Unpatentability

Petitioner asserts the following grounds of unpatentability (Pet. 7):

Claim(s) Challenged	35 U.S.C. §⁴	Reference(s)/Basis
1–8	102(e)	Uemura ⁵
1–8, 11–18	103(a)	Uemura
11–18	103(a)	Uemura, Guyomard ⁶
1–8	102(b)	Abe ⁷
1–8	103(a)	Abe
2–4, 6–8, 11–18	103(a)	Abe, Guyomard
9	103(a)	Uemura, Iwaizono ⁸
9, 10	103(a)	Uemura, Iwaizono, Guyomard
9, 10	103(a)	Abe, Guyomard, Iwaizono

III. ANALYSIS

A. Legal Standard

A claim may be unpatentable as anticipated if “each and every limitation is found either expressly or inherently in a single prior art reference.” *Sanofi-Synthelabo v. Apotex, Inc.*, 470 F.3d 1368, 1375 (Fed. Cir. 2006) (internal quotation marks omitted). Anticipation under § 102 may be established by showing, as a matter of fact, that all elements arranged as

⁴ 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 versions of §§ 102 and 103.

⁵ US 2002/0012830 A1, published January 31, 2002. Ex. 1009 (“Uemura”).

⁶ WO 93/21665, published October 28, 1993, with a stated priority date of April 21, 1992. Ex. 1008 (“Guyomard”).

⁷ JP Patent Application Publication No. H10[1998]-189052, published July 21, 1998. Ex. 1005 (“Abe”).

⁸ US 6,577,105 B1, issued June 10, 2003. Ex. 1007 (“Iwaizono”).

specified in a claim are disclosed within the four corners of a reference, either expressly or inherently, in a manner enabling one skilled in the art to practice an embodiment of the claimed invention without undue experimentation. *See ClearValue, Inc. v. Pearl River Polymers, Inc.*, 668 F.3d 1340, 1344 (Fed. Cir. 2012).

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 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. *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 the invention was made, we consider the level of ordinary skill in the pertinent art. *Graham*, 383 U.S. at 17. The resolution of this question is important because it allows us to “maintain[] objectivity in the obviousness inquiry.” *Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714, 718 (Fed. Cir. 1991).

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) (quotation omitted).

Petitioner contends that a person of ordinary skill in the art “would have had a Master’s degree in material science, chemical engineering, chemistry, or similar field with four years of experience designing testing, and building secondary lithium batteries.” Pet. 11 (citing Ex. 1002 ¶ 51). Petitioner further contends that a person of ordinary skill in the art would have been aware of “(1) positive electrode materials, (2) negative electrode materials, (3) separators, (4) electrolytes, (5) charge-discharge parameters, and (6) protection circuits, as well as ‘battery failure modes’ such as plating and the formation of dendrites.” *Id.* (citing Ex. 1002 ¶¶ 50–51).

Patent Owner “does not dispute Petitioner’s level of ordinary skill.” PO Resp. 17.

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

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 dispute or discuss the proper construction of the terms “charge cut-off voltage,” “theoretic capacity,” and “specific capacity.” PO Resp. 18–26; Pet. Reply 3–9. We address these terms below.

Charge Cut-off Voltage

Independent claims 1 and 5 both require that “the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V.” Ex. 1001, 16:56–58, 17:5–7. The parties agree that the term “charge cut-off voltage” means “the maximum voltage to which the battery is configured to be charged.” PO Resp. 18; Ex. 2008, 217:6–11. The parties’ dispute, however, what this construction requires or permits.

Patent Owner contends the “charge cut-off voltage” is “different than the voltage applied to the battery during charging,” because to drive lithium ions from the cathode to the anode during charging the voltage must be higher than the “open circuit voltage” of the battery.⁹ PO Resp. 18–19. Patent Owner further contends that an applied voltage may be higher than the charge cut-off voltage during charging; “however, this external condition would not change the charge cut-off voltage (e.g., raise it to a higher level), as this would require altering what is a battery design property.” *Id.* at 21 (citing 2006 ¶¶ 92). According to Patent Owner, construing the term as the applied voltage “would improperly render a claimed structural property of the claimed secondary battery dependent upon external factors (e.g., the

⁹ The “open circuit voltage” is the voltage measured between the electrodes of a battery when disconnected from the power source. PO Resp. 19 (citing Ex. 2006 ¶¶ 86–91; Ex. 2008, 56:3–9).

charging conditions controlled by the charger) and introduce uncertainties.”
Id.

Petitioner contends Patent Owner is improperly attempting to “engraft an implied limitation” “that would limit [the charge cut-off voltage] to an internal property of the battery as opposed to the voltage to which the battery is designed to be charged as applied to the battery.” Pet. Reply 6. Petitioner asserts that such a construction is contrary to the intrinsic evidence of record, which indicates that a charging device controls the charge cut-off voltage of the battery or cell:

Similarly, the charging device for the secondary lithium ion cell or battery of the present invention can be a charging device having any type and structure with the proviso that said charging device controls the charge cut-off voltage of the single lithium ion cell within a range from 4.3 V to 5.8 V, preferably from 4.3 V to 5.2 V, more preferably from 4.3 V to 4.8 V.

Ex. 1001, 9:49–55; Pet. Reply 3–4. Petitioner also asserts that, consistent with its understanding, the ’641 patent repeatedly discloses that different examples were tested “using a charge cut-off voltage” of 4.45 V, 4.60 V, and 4.80 V. Pet. Reply 4 (citing Ex. 1001, 10:57–61, 11:13–16, 11:23–26, 11:44–49, 11:56–61). According to Petitioner, under Patent Owner’s understanding of the claim term “a charging device would be unable to control the charge cut-off voltage” and the “charge cut-off voltage” is something that could not be “used,” which conflicts with the express disclosures of the ’641 patent. Pet. Reply 4. Petitioner also notes that Examples 14 and 15 of the ’641 patent test identical batteries at charge cut-off voltages of 4.20 V and 4.30 V, which Petitioner contends demonstrates that “charge cut-off voltage” is not a physical property of the cell. *Id.* at 4–5 (citing Ex. 1001, 12:58–13:59, Table 2).

Patent Owner argues in its Sur-reply that the “charge cut-off voltage” is clearly a “battery property.” Sur-reply 2. Patent Owner notes that the battery’s voltage when fully charged, i.e., when it reaches its “charge cut-off voltage,” “is not necessarily equal to the maximum applied voltage” because, for example, “the battery voltage is lower than the applied voltage in fast charging conditions.” *Id.* (citing Ex. 2006 ¶¶ 89–90; Ex. 2008, 58:18–20; PO Resp. 19–21). Patent Owner contends the claim language is consistent with its position, as claim 5 recites a “secondary lithium-ion cell or battery [that] has a charge cut-off voltage.” *Id.* (quoting Ex. 1001, claim 5). According to Patent Owner, because the specification describes the charge cut-off voltage as a voltage “of” the battery or something that the battery “has,” this indicates that charge cut-off voltage is “a battery property.” *Id.*

With respect to examples 14 and 15, Patent Owner contends that these batteries were not identical because each battery had a different formation period and testing voltage, which resulted in a battery with different properties “even if they have identical pre-formation compositions.” Sur-reply 3 (citing Ex. 1041, 7:12–16).

For the reasons that follow, we agree with portions of both parties’ constructions. First, we agree with Petitioner that the ’641 patent indicates that the charge cut-off voltage selected for a particular battery need not be a fixed property of the battery or something that is set by the design and chemistry of the battery. Consistent with this conclusion, the ’641 patent discloses that a “charging device controls the charge cut-off voltage of the single lithium-ion cell within a range from 4.3 V to 5.8 V.” Ex. 1001, 9:50–55. This strongly suggests that the charge cut-off voltage is controlled by the charger and is not necessarily an inherent property of the battery. Patent

Owner contends that this is merely an unclaimed embodiment, but the relevant disclosure states that the charging device for the “present invention” may be any type of device “with the proviso that said charging device controls the charge cut-off voltage.” *Id.* at 9:50–53.

Consistent with this conclusion, the ’641 patent discloses experiments in which batteries of identical composition are charged to different charge cut-off voltages of 4.20 and 4.30 V. Ex. 1001, 12:60–13:58, Table 2. This also suggests that a charge cut-off voltage is not necessarily inherent to a particular battery, but rather is controlled by the charging system. *Id.*; *see also* Ex. 2020, A55 (charging identical batteries to “various cutoff potentials” (cutoff voltages)). Patent Owner contends there is no conflict in these disclosures because each battery is subject to a formation period using different charge cut-off voltages, which configures each battery to that particular charge cut-off voltage. Sur-reply 3. In support, Patent Owner looks to the ’641 patent’s disclosure that in order to reach the optimum working state, the same charge cut-off voltage should be applied during both formation and examination of the cell. Ex. 1001, 4:43–53. Patent Owner’s arguments regarding the formation differences between the two batteries affecting the charge cut-off voltage, however, is attorney argument that is, in turn, based on attorney argument before the district court. Ex. 1041, 7:12–20; Tr. 14:4–15. In addition, the attorney argument before the district court did not expressly assert that the use of different charge cut-off voltages during the formation period would change the charge cut-off voltage of the battery during use. Thus, Patent Owner’s attempts to explain away the express disclosures in the ’641 patent are not persuasive.

Extrinsic evidence also supports the conclusion that the charge cut-off voltage of a battery is not necessarily set by the design and chemistry of the

battery. For example, Premanand, et. al., published experimental results in which all the reported studies were conducted with a “Cell-Batt Li-ion cell (obtained from International Battery Technologies) with an initial capacity of 1050 mAh at room temperature.” Ex. 2020, A54. These cells were “charged to various cutoff potentials,” for example, 4.00, 4.05, 4.10, 4.17, and 4.30 V. *Id.* at A55, Table II. That identical batteries may be charged to different charge cut-off voltages again suggests that an individual battery does not have one, structurally and chemically dictated, charge cut-off voltage. *Id.* Rather, the charge cut-off voltage selected for a particular battery represents a trade-off between, among other things, increased capacity on the one hand and reduction in cycle life and safety on the other. *See id.* at A55, Figure 1 (noting experiments showing increased discharge capacity at higher cut-off voltages, but selecting a charge cut-off voltage below 4.2 V to avoid cathode dissolution); Ex. 1008, 3 (selecting a charge cut-off voltage that does not result in electrolyte dissolution, which could cause reduced capacity, cycle life, and safety in the battery cell).

That said, the '641 patent and the prior art of record support Patent Owner's argument that the design and chemistry of a particular battery will set an upper limit for the charge cut-off voltage. Ex. 1001, 1:51–63; *In re Cortright*, 165 F.3d 1353, 1358 (Fed. Cir. 1999) (“Prior art references may be ‘indicative of what all those skilled in the art generally believe a certain term means.’”). For example, the '641 patent expressly states that the charge cut-off voltage should be below the point where the positive and negative electrode materials undergo significant structural changes. *Id.* at 1:55–63. Likewise, Guyomard discloses that previously-available electrolytes used in batteries are often oxidized at voltages “even slightly greater than 4.3 V,” which reduces the capacity, cycle life, and safety of the

battery cell. Ex. 1008, 3:9–28; *see id* at 8:23–9:8 (noting that changing the electrolyte allowed for charge cut-off voltages up to 4.9 V without causing oxidation or significant loss of cell capacity). These intrinsic and extrinsic disclosures suggest that the chemistry and design of a secondary lithium-ion battery will dictate an upper limit on the charge cut-off voltage. Ex. 1001, 1:44–66.

We also agree with Patent Owner that the charge cut-off voltage is not necessarily the applied voltage during charging. PO Resp. 20. Rather, depending on the charging protocol used and when in the charging cycle the voltage is applied, the applied voltage could be higher than the battery voltage. Ex. 2013; Ex. 2006 ¶ 91. For example, as discussed in more detail below with respect to the Uemura grounds, when fast charging using constant current is used and the charging rate is not slow, the applied voltage will be higher than the battery voltage when the constant current charging phase is stopped. Ex. 2006 ¶ 91; Ex. 2013. Likewise, during constant current/constant voltage charging, the applied voltage approximates the battery voltage only when the battery is nearly completely charged. Ex. 2013; Ex. 2006 ¶ 91. Thus, the applied voltage may be, but is not necessarily, the charge cut-off voltage.

In view of the foregoing, we construe “charge cut-off voltage” in claims 1 and 5 as “the maximum value to which the battery is configured to be charged.” PO Resp. 18; Ex. 2008, 217:6–11; Pet. Reply 5. Contrary to Patent Owner’s arguments, however, we do not understand the phrase “configured to be charged” to necessarily represent a single voltage for the battery that is determined based on the structure and chemistry of the battery. Pet. Reply 4–5. Rather, the charge cut-off voltage is a selected potential, or voltage, *of the battery or cell* at the end of charging that is

controlled by a circuit or device, such as a charger or control circuit within the battery. Ex. 1001, 9:50–55; Ex. 1048, 2, 7–8; Ex. 1008, 3:9–13. And, for the reasons discussed herein, the charge cut-off voltage may be, but is not necessarily, the same as the applied voltage during charging.

PO Resp. 20.

Theoretic Capacity and Specific Capacity

Independent claim 1 requires calculating the ratio of positive electrode active material to negative electrode active material using a “specific capacity.” Ex. 1001, 16:57–61. Independent claim 5 requires calculating the same ratio using a “theoretic capacity.” *Id.* at 17:7–11. Although different terms are used, the parties agree that there is no difference between a ratio calculated using a “specific capacity” and one calculated using a “theoretic capacity.” Tr. 75:1–6, 75:24–76:3 (Patent Owner’s counsel agreeing that the two terms are used “interchangeably”); Pet. Reply 26.

Full-Cell or Half-Cell Voltage

Claims 1 and 5 require a “secondary lithium ion cell or battery” with a charge cut-off voltage “greater than 4.2 V but less than 5.8 V” and calculating a specific or theoretic capacity “with a charge cut-off voltage limited to 4.2” (claim 1) or “with a charge cut-off voltage set at 4.2 V” (claim 5). Ex. 1001, 16:56–61, 17:6–11. Although the parties dispute the precise scope of these claim terms, the parties agree that the first use of “charge cut-off voltage” in claims 1 and 5 refers to the potential of the battery as a whole (between the cathode and the anode), and not a half-cell voltage using lithium metal as a counter electrode.¹⁰ Tr. 17:1–3 (agreeing

¹⁰ With respect to the phrase “as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2 V,” the parties in fact appear to be in

that the first use of “charge cut-off voltage” in claim 5 refers to a full-cell voltage); Sur-reply 5; PO Resp. 22. We need not further construe the claims to resolve the disputes between the parties. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.”)).

D. Anticipation by Uemura

Petitioner asserts that claims 1–8 are anticipated by Uemura under 35 U.S.C. § 102(e). Pet. 16–27.

1. *Uemura*

Uemura discloses a “non-aqueous electrolytic rechargeable lithium battery” and, more particularly, “a negative electrode material and a positive electrode material for improving cyclic resistance.” Ex. 1009 ¶ 2.

The positive electrode of Uemura “is not particularly limited,” but is preferably a “Li deficient type lithium manganese complex oxide of a layer structure, which is represented by a general formula $\text{Li}_{1-x}\text{MnO}_2$, $\text{Li}_{1-x}\text{Mn}_{1-y}\text{M}_y\text{O}_2$, or $\text{Li}_{1-x}\text{Mn}_{1-y}\text{M}_y\text{O}_{2-\delta}$.” Ex. 1009 ¶ 35. The negative electrode is preferably “a carbon material for use in a typical non-aqueous electrolytic secondary battery,” and the irreversible capacity of the carbon material can be selected by controlling the carbon content in the material. Ex. 1009 ¶ 53.

agreement that the charge cut-off voltage may be that of a half-cell using lithium metal as a counter electrode. Tr. 17:4–9; Sur-reply 5–6; Ex. 1001, 1:64–2:30; Ex. 1043, 79:21–81:2, 94:14–95:17 (Dr. Yao testifying that “theoretic capacity with a charge cut-off voltage at 4.2 volt . . . relates with the – with the halfcell, was the reference, lithium metal”), 96:2–9; Ex. 1039, 4; Ex. 2006 ¶ 95.

Uemura discloses that the capacity balance ratio B/A of the total capacity B of the negative electrode material to the total capacity A of the positive electrode material is preferably “fixed at a range of 1 to 1.5.”

Ex. 1009 ¶ 33. Uemura explains that “[i]f the capacity balance ratio B/A is below 1, lithium ion holding sites on the negative electrode material become insufficient,” and dendrite crystals may form, potentially causing a short circuit within the battery. *Id.* In contrast, “[i]f the capacity balance ratio B/A exceed 1.5, negative electrode sites that do not contribute to the charge-discharge are increased, leading to the wasteful use of materials.” *Id.*

Uemura discloses 17 exemplary batteries that utilize its positive and negative electrode materials. Ex. 1009 ¶ 69. Charge-discharge of these batteries was “repeatedly performed at a constant current of 0.5 mA/cm² and a voltage ranging from 4.3 V to 2.0 V at an atmospheric temperature of 60° C.” *Id.* ¶ 81.

2. Analysis—Independent Claims 1 and 5

Petitioner contends that Uemura anticipates independent claims 1 and 5. In particular, to the extent the preambles of claim 1 and 5 are limiting, Petitioner contends that Uemura expressly discloses a secondary lithium ion cell or battery (claim 5), as well as negative and positive electrode materials that improve capacity (and therefore provide a higher specific energy) and allow for improved average operating voltages (claim 1). Pet. 16–17 (citing Ex. 1009 ¶¶ 2, 21, 81). Petitioner further contends that Uemura discloses a charge cut-off voltage of 4.3 V, which is “greater than 4.2 V but less than 5.8 V,” as recited in claims 1 and 5. *Id.* at 17 (citing Ex. 1002 ¶ 113; Ex. 1009 ¶ 81). Petitioner further contends that the ratio of positive to negative electrode material in Uemura is “preferably fixed at a

range of 1 to 1.5, which falls within the claimed range of 1:1.0 to 1:2.5” of claims 1 and 5. *Id.* at 17–23 (also disclosing specific examples with ratios of 1:1.3 and 1:1.5).

Petitioner contends that, although Uemura’s ratios would have been calculated using a charge cut-off voltage of 4.3 V, i.e., the charge cut-off voltage used in the battery, a person of ordinary skill in the art would have understood that Uemura’s ratio of positive to negative capacity “would remain within the range of the ’641 patent when determined at a charge cutoff voltage of 4.2 V instead of 4.3 V.” Pet. 20 (citing Ex. 1002 ¶¶ 121–123).

Patent Owner contends Uemura fails to anticipate independent claims 1 and 5 because: (1) Uemura discloses an applied voltage of 4.3 V, as opposed to a battery voltage; (2) Uemura does not disclose the claimed capacity ratio limitation; (3) Uemura is not enabled; and (4) one of ordinary skill in the art would disregard Uemura’s disclosures because they contain serious and obvious errors. PO Resp. 27–52. For the reasons set forth below, we agree with Patent Owner that Petitioner has not demonstrated by a preponderance of the evidence that Uemura discloses a charge cut-off voltage of greater than 4.2 V.

Charge Cut-Off Voltage

Both parties agree that Uemura discloses charging its batteries at a constant current of 0.5 mA/cm² and an applied voltage up to 4.3 V, and that charging would stop when the externally applied voltage reached 4.3 V. Ex. 1009 ¶ 81; PO Resp. 28; Sur-reply 8–9; Ex. 2008, 113:5–12. This was unambiguously confirmed by Mr. Juzkow during cross-examination:

Q. And according to Uemurua's description, the charging would stop once the externally applied voltage would reach 4.3 volts. Correct?

A. The way it's written in paragraph 81, yes.

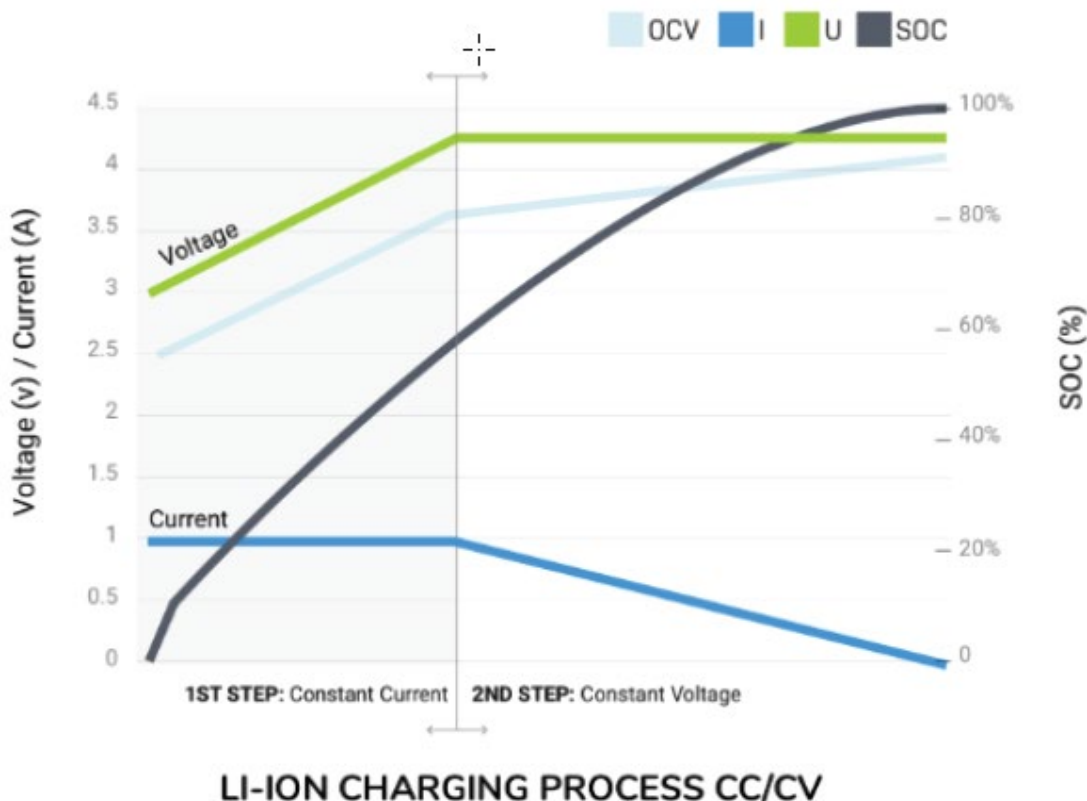
Q. Is there any other way to understand what's written in paragraph 81?

...

A. No, unless they left out the constant voltage component, if they left that out....

Ex. 2008, 113:5–13.

Patent Owner provides the following graph depicting the Li-ion charging process using constant current/constant voltage (CC/CV) charging. Ex. 2006 ¶ 91; Ex. 2013.



The chart above depicts the open cell voltage (light blue, OCV), current (dark blue, I), applied voltage (green, U), and the state of charge (black,

SOC) of a battery during constant current/constant voltage charging.¹¹ Ex. 2013; Ex. 2006 ¶¶ 91–92. As shown in this chart, a constant current is applied to charge the battery until the applied voltage reaches the end-of-charge voltage level. Ex. 2006 ¶ 91. At this point, constant voltage charging begins and the current decreases. *Id.* Of particular note, at the point where the applied voltage reaches the end-of-charge voltage level, the battery voltage, or open cell voltage, is below the applied voltage level. For example, in the chart above, when the applied voltage is 4.2 V the open cell voltage is approximately 3.6 V.

Patent Owner concedes that if only constant current charging is used (as asserted by Mr. Juzkow) and the constant current rate of charging is slow, then the applied voltage could approximate the charge cut-off voltage. Sur-reply 9–10; Ex. 2008, 113:5–16 (“[I]f you charge it at a slow enough rate, you don’t need that constant voltage component.”). Dr. Yao testifies, however, that the constant current charging rate used in Uemura is “a relatively medium charging current,” not a slow one. Ex. 2006 ¶ 119 n.64. Mr. Juzkow testified similarly that Uemura appears to use a charging rate that is “in the middle” between slow and fast, and that Uemura does not provide sufficient information to conclude that a slow rate was used. Ex. 2008, 117:16–118:22.

Given Mr. Juzkow’s unambiguous testimony that Uemura uses constant current charging that would stop when the applied voltage reached

¹¹ The chart is reproduced from SAFT, *Charging your lithium-ion batteries: 5 expert tips for a longer lifespan*, (<https://www.saft.com/energizing-iot/charging-your-lithium-ion-batteries-5-expert-tips-longerlifespan#:~:text=When%20the%20battery%20provides%20current,This%20restores%20the%20battery's%20capacity>).

4.3 V, as well as Dr. Yao's persuasive testimony that Uemura's constant charging rate is not slow, we credit the testimony of Dr. Yao that one of ordinary skill in the art would have understood that the internal voltage to which the battery of Uemura was charged is less than 4.3 V. Ex. 2006 ¶ 119. In particular, Dr. Yao persuasively testifies that one of ordinary skill in the art would have believed that the charge cut-off voltage was no more than 4.2 V, and most likely equal to "about 4 V." *Id.* ¶¶ 119–122.

Petitioner argues that because the battery of Uemura is charged "to" a maximum voltage of 4.3 V, Uemura discloses the claimed charge cut-off voltage under either Petitioner's or Patent Owner's construction of the term. Pet. Reply 11–12 (citing Ex. 1009 ¶ 81; Ex. 1044 ¶¶ 56–59). This argument is not persuasive because Mr. Juzkow unambiguously testified that charging in Uemura stopped when the applied voltage reached 4.3 V, and Uemura discloses that the battery was charged "at" a voltage ranging from 4.3 V to 2.0 V, not "to" such a voltage. Ex. 1009 ¶ 81; Ex. 2008, 113:2–13; Ex. 2006 ¶ 119 n.64; Sur-reply 9.

In view of the foregoing, we determine that Petitioner has not demonstrated by a preponderance of the evidence that Uemura anticipates independent claims 1 and 5 of the '641 patent.

3. Analysis—Dependent Claims 2–4 and 6–8

Claims 2, 3, 6, and 7 require a charge cut-off voltage of at least 4.3 V. Ex. 1001, 16:62–67, 17:12–19. Claims 4 and 8 require a ratio of positive electrode material to negative electrode material from 1:1.15 to 1:2.5. *Id.* at 17:1–4, 17:20–23. Petitioner's arguments with respect to these claims do not resolve the issues noted above with respect to Uemura's charge cut-off voltage. Pet. 27. Accordingly, Petitioner does not demonstrate by a

preponderance of the evidence that claims 2–4 and 6–8 are anticipated by Uemura.

E. Obviousness of Claims 1–8 and 11–18 Over Uemura

Petitioner contends that the subject matter of claims 1–8 and 11–18 would have been obvious in view of the disclosures of Uemura. Pet. 16–34. Petitioner’s arguments with respect to this ground, however, still rely on Uemura as disclosing a charge cut-off voltage of 4.3 V. *Id.* at 17 (“Uemura’s secondary lithium-ion battery has a charge cut-off voltage greater than 4.2V but less than 5.8V—and specifically 4.3V.”). Thus, for the reasons set forth above with respect to anticipation by Uemura, Petitioner has not demonstrated by a preponderance of the evidence that claims 1–8 and 11–18 would have been obvious over Uemura.

F. Obviousness of Claims 11–18 over Uemura and Guyomard

Petitioner contends the subject matter of claims 11–18 would have been obvious over the combined disclosures of Uemura and Guyomard. Pet. 28–34. In this combination, Petitioner contends that one of ordinary skill in the art would have sought to use the electrolyte of Guyomard in Uemura. *Id.* at 31–34. In this combination, however, Petitioner does not propose modifying the charge cut-off voltage of Uemura in view of Guyomard’s teachings. *Id.* As such, Petitioner does not demonstrate by a preponderance of the evidence that claims 11–18 would have been obvious over the combined disclosures of Uemura and Guyomard.

G. Obviousness of Claim 9 over Uemura and Iwaizono

Petitioner contends the subject matter of claim 9 would have been obvious over the combined disclosures of Uemura and Iwaizono. Pet. 53–57. In this ground, Petitioner again relies on Uemura for the disclosure of a

charge cut-off voltage of 4.3 V. *Id.* Accordingly, Petitioner does not demonstrate by a preponderance of the evidence that claim 9 would have been obvious over Uemura and Iwaizono.

H. Anticipation of Claims 1–8 by Abe

Petitioner contends claims 1–8 are anticipated by Abe. Pet. 34–41.

1. Abe

Abe discloses “non-aqueous electrolyte-based secondary batteries” that have “no risk of rupture and ignition, excellent cycle characteristics, and good stability against higher loads.” Ex. 1005, code (57). Abe notes that “in the case of overcharging lithium-ion secondary batteries or when the charging current is increased, etc., needle-like lithium may be precipitated on the surface of the negative electrode,” which makes “it easier to break through the separator and short out.” *Id.* ¶ 9. To address this problem, in Abe’s batteries “the design capacity of the negative electrode is adjusted so that the design capacity of the negative electrode is greater than the design capacity of the cathode.” *Id.* ¶ 78.

In determining the design capacity of the anode and cathode materials, Abe discloses that:

The design capacity is determined, for example, from the initial charge capacity per unit weight of the active material in a predetermined charging voltage range and the amount of active material coated on the current collector. The charging capacity can be obtained, for example, by continuously recording a voltage that changes over time by applying a constant current using a three-electrode cell in which both the counter and the reference pole are made of metal lithium. The charge capacity is the amount of charge until a predetermined voltage is reached. In the triode cell, the starting voltage when using a vapor-phase-grown carbon fiber negative electrode as the working electrode is 3 V, and the charge (applying current from

the working electrode to the counter electrode) proceeds and decreases towards 0 V. When a positive electrode is used for the working electrode, the voltage at the start is the potential difference between the metal lithium and the positive electrode material, and the voltage rises with charging (applying current from the counter electrode to the working electrode). The predetermined voltage is 0 V at the vapor-phase-grown carbon fiber negative electrode, and at the positive electrode, the voltage is set to a range in which no electrolyte decomposition occurs, and no irreversible structural breakdown of the positive electrode active material occurs. For example, LiMn_2O_4 is 4.2–4.3 V, preferably 4.2 V, and LiCoO_2 and LiNiO_2 are 4.1–4.2 V, preferably 4.1 V.

Ex. 1005 ¶ 78.

Abe compares two disclosed embodiments to three comparative examples. Ex. 1005 ¶ 94. The negative electrode/cathode design capacity of Embodiment 1 was 1.2 and the design capacity of Embodiment 2 was 1.1. *Id.* Abe also generally discloses negative electrodes “having a design capacity of more than 1 and less than or equal to 1.6 for the design capacity of the positive electrode.” *Id.* ¶ 18.

Abe concludes that its disclosed non-aqueous electrolyte-based secondary batteries “have high electrical conductivity,” “excellent cycle characteristics,” “high capacity,” and “a long service life.” Ex. 1005 ¶ 121.

2. Analysis—Independent Claims 1 and 5

Petitioner contends that the preambles of claims 1 and 5 are disclosed in Abe because its secondary lithium ion batteries (claim 5) “exhibit high capacity” and have “high energy density and excellent cycle characteristics” (claim 1). Pet. 34–35 (citing Ex. 1005 ¶¶ 8, 11, 17, 78; Ex. 1002 ¶¶ 156–159). Petitioner further contends that a charge cut-off voltage of greater than 4.2 but less than 5.8 V is disclosed by Abe’s charge cut-off voltage range of

4.2–4.3 V. *Id.* at 36. Petitioner further contends that a ratio of positive to negative electrode material from 1:1.0 to 1:2.5, as calculated by a specific capacity or theoretic capacity at 4.2 V, is disclosed by Abe’s example battery with a ratio of 1.1, as well as Abe’s broader disclosed range of 1 to 1.6. *Id.* at 37, 40. According to Petitioner, although the ratio would have been calculated at a charge cut-off of 4.3 V, this ratio would only increase slightly above 1:1.0 and would still remain less than 1:2.5 when measured at 4.2 V. *Id.* at 39 (citing Ex. 1002 ¶¶ 120–123, 167).

Patent Owner contends Petitioner’s arguments with respect to Abe are not persuasive because (1) the 4.2–4.3 V charging range disclosed in Abe for LiMn_2O_4 is for a half-cell battery with a lithium anode; and (2) Abe does not disclose the claimed ratio of positive electrode material to negative electrode material of 1:1.0 to 1:2.5. PO Resp. 53–62.

Upon review of the parties’ arguments and supporting evidence, and for the reasons that follow, we determine that Petitioner persuasively demonstrates that Abe discloses every limitation of independent claims 1 and 5, except the claimed charge cut-off voltage.

a. Charge Cut-Off Voltage

Patent Owner contends the 4.2–4.3 V range disclosed in Abe would not be greater than 4.2 V when measured in a “secondary lithium-ion battery or cell” because the voltage of a carbon material anode, such as that disclosed in Abe, is typically 0.1 V. PO Resp. 54–57. And, because the total voltage of the battery is a combination of the voltage of the cathode and the anode, this would result in Abe’s full-cell battery having a charge cut-off

voltage of 4.0–4.2 V.¹² *Id.* at 56–57 (citing Ex. 2018, 15; Ex. 2008, 79:8–18, 110:20–24; Ex. 2006 ¶¶ 193–195).

Petitioner argues in reply that Abe expressly states that the predetermined voltage for the vapor-phase-grown carbon fiber negative electrode is 0 V and the voltage for the LiMn₂O₄ positive electrode is 4.2–4.3 V. Pet. Reply 22–23 (citing Ex. 1005 ¶ 78). Thus, Petitioner contends “Abe establishes the charge cut-off voltage is 4.2-4.3 V for LiMn₂O₄ relative to a carbon fiber negative electrode.” *Id.* at 23–24. Petitioner contends this is consistent with the knowledge of one of ordinary skill in the art who understood that lithium manganese oxide-based batteries could be charged to cut-off voltages greater than 4.2 V. *Id.* at 24 (citing Ex. 1008, 8:23-37; Ex. 1009 ¶ 81; Ex. 1040, A981; Ex. 1045, 14; Ex. 1046, 4078; Ex. 1047, 695; Ex. 2009, 501; Ex. 2017, 40; Ex. 2023, 3653, Table I; Ex. 2030 ¶ 33; Ex. 2039, Abstract).

Patent Owner argues in its Sur-reply that Abe discloses a 4.2–4.3 V voltage in a half-cell using lithium metal counter and reference electrodes and argues that Petitioner provides only attorney argument to suggest that the 4.2–4.3 V range reported in Abe would correspond to a full-cell voltage. Sur-reply 23–24.

The parties’ dispute centers around whether Abe’s disclosure of a carbon anode at 0 V and a cathode at 4.2–4.3V in a half-cell configuration

¹² Patent Owner also argues that one of skill in the art would not have adjusted Abe’s voltage range upwards because Abe teaches away from raising the charge cut-off voltage above 4.1 V. PO Resp. 57–58. We do not address that argument here, as teaching away is not relevant to an anticipation ground. *See Celeritas Techs., Ltd. v. Rockwell Int’l Corp.*, 150 F.3d 1354, 1361 (Fed. Cir. 1998) (“the question whether a reference ‘teaches away’ from the invention is inapplicable to an anticipation analysis”).

discloses a full-cell or battery with a charge cut-off voltage of 4.2–4.3 V. On this point, we credit the testimony of Dr. Yao that paragraph 78 of Abe is focused on determining the design capacity of the anode and cathode materials using a “three-electrode cell in which both the counter and the reference pole are made of metal lithium.” Ex. 2006 ¶ 192. And, although the capacity of the carbon anode was determined by charging from 3 to 0 V, Patent Owner and Dr. Yao persuasively demonstrate that when a carbon anode is used in a full-cell or battery the carbon anode will retain a residual potential after charging. Ex. 2006 ¶¶ 193–194; PO Resp. 56–57. Thus, a 4.3 V half-cell capacity for LiMn_2O_4 would correspond to a full-cell or battery voltage of no more than 4.2 V, due to the residual potential of the carbon anode after charging. Ex. 2006 ¶¶ 193–194.

This conclusion is amply supported by the remaining evidence of record. For example, Petitioner’s declarant testified before the district court that the battery or cell voltage (V_{cell}) = $\phi_p - \phi_n$, and when graphite is used as the negative electrode, 4.3 V (Li/Li+) corresponds to a positive cathode potential of 4.2 V. Ex. 2019 ¶ 179. Consistent with this testimony, Cho et al.¹³ report that a potential of 4.3 V vs. Li metal “corresponds approximately to a 4.2 V charging voltage for a practical Li-ion cell, because the potential of an incompletely charged carbon anode in the cell at the end of charge is approximately 0.1 V vs. Li.” Ex. 2018, 15.

In view of the foregoing, we are not persuaded that Abe discloses a charge cut-off voltage of greater than 4.2 V, as recited in independent

¹³ Cho et al, *Electrochemical Properties and Thermal Stability of $\text{Li}_a\text{Ni}_{1-x}\text{Co}_x\text{O}_2$ Cathode Materials*, Journal of the Electrochemical Society, Vol. 147, 15–20 (2000). Ex. 2018.

claims 1 and 5. Thus, Petitioner does not demonstrate by a preponderance of the evidence that Abe anticipates claims 1 or 5 of the '641 patent.

b. *Capacity Ratio*

Petitioner contends that the “design capacity” in Abe for the LiMn_2O_4 cell is 1:1.1, and that this capacity was determined based on a charge cut-off voltage between 4.2 V and 4.3 V. Pet. 37. Patent Owner contends that, for the reasons set forth above, Abe does not disclose a charge cut-off voltage of 4.2–4.3 V. PO Resp. 59–60. Rather, Patent Owner contends the capacity ratio in Abe was calculated at a charge cut-off voltage of no more than 4.1 V. *Id.* at 60 (citing Ex. 2008, 215:2–6; Ex. 1005 ¶¶ 80, 104; Ex. 2006 ¶¶ 201–202).

Abe specifically discloses that the design capacity of the negative electrode is greater than the design capacity of the positive electrode, and *Patent Owner* expressly asserts that Abe contemplates a range of charge cut-off voltages for LiMn_2O_4 between 4.0–4.2 V. Ex. 1005 ¶ 78; PO Resp. 58 (asserting that Abe’s disclosed range corresponds to a full-cell secondary battery voltage range of 4.0–4.2 V). As Abe discloses the use of a 4.2 V charge cut-off voltage and the use of capacity ratios of 1 to 1:1.6, with specific examples at 1:1.1, we credit the testimony of Mr. Juzkow that Abe discloses the capacity ratios recited in claims 1 and 5.¹⁴ Ex. 1002 ¶ 166. Mr. Juzkow also persuasively explains why one of ordinary skill in the art

¹⁴ Independent claim 1 recites a “specific capacity” and independent claim 5 recites a “theoretic capacity.” As noted above, however, both parties agree that these terms “can be used interchangeably.” Tr. 75:14–76:3; Pet. Reply 26.

would have calculated the capacity ratio using the charge cut-off voltage used in the battery. Ex. 1002 ¶ 166 (citing Ex. 1005 ¶ 78).

c. Conclusion

Upon review of the parties' arguments and supporting evidence, we determine that Petitioner persuasively demonstrates that Abe discloses every limitation of independent claims 1 and 5, except a charge cut-off voltage of greater than 4.2 V. Because Petitioner has not demonstrated that Abe discloses every limitation of claims 1 and 5, however, Petitioner does not demonstrate by a preponderance of the evidence that Abe anticipates claims 1 or 5.

3. Analysis—Claims 2–4 and 6–8

Petitioner contends Abe anticipates claims 2–4 and 6–8. Pet. 40–41. Each of these claims depends from either independent claim 1 or 5, and Petitioner's arguments with respect to these claims do not remedy the deficiencies noted above with respect to independent claims 1 and 5. *Id.* Accordingly, Petitioner does not demonstrate by a preponderance of the evidence that claims 2–4 and 6–8 are anticipated by Abe.

I. Claims 1–8 as Obvious in View of Abe

Petitioner contends the subject matter of claims 1–8 would have been obvious in view of Abe. Pet. 34–41. In this ground, Petitioner contends that Abe's disclosure of an overlapping "range of charge cutoff voltages" renders the claims *prima facie* obvious. *Id.* at 34. Petitioner's arguments with respect to this ground, however, still rely on Abe's disclosure of a charge cut-off voltage for the battery or cell of 4.2–4.3 V. *Id.* at 34, 36. For the reasons set forth above, we are not persuaded that Abe discloses a charge cut-off voltage for a full-cell or battery that is greater than 4.2 V. As such,

Petitioner does not demonstrate by a preponderance of the evidence that claims 1–8 would have been obvious over Abe.

J. Obviousness of Claims 2–4, 6–8, and 11–18 over Abe and Guyomard

Petitioner contends the subject matter of claims 2–4, 6–8, and 11–18 would have been obvious over the combined disclosures of Abe and Guyomard. Pet. 41–51.

1. *Guyomard*

Guyomard is titled “High-Voltage-Stable Electrolytes for $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$ /Carbon Secondary Batteries” and published October 28, 1993. Ex. 1008, codes (43), (54). Guyomard explains that $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$ is a strongly oxidizing intercalation material that is preferably used as the positive electrode in a lithium-ion battery when the negative electrode is carbon. *Id.* at 2:5–18. Use of a strongly oxidizing intercalation material, however, introduces the risk of electrolyte decomposition from oxidation at higher operating voltages. *Id.* at 2:18–22. For example, Guyomard notes that presently-used intercalation electrolytes when employed in a $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$ /carbon cell, “will begin to oxidize at about 4.5 V at room temperature and as low as about 4.3 V at temperatures in the range of 55° C.” *Id.* at 2:34–3:2. “Thus, to operate such a cell in the higher temperature ambient, one must reduce the charging cut-off voltage to a level below about 4.3 V in order to avoid electrolyte oxidation.” *Id.* at 3:2–5.

After extensive investigations and experiments, Guyomard notes that the inventors discovered “an exceptional, wide temperature range, oxidation resistant electrolyte for a LiMn_2O_4 positive electrode intercalation battery cell, particularly one utilizing the preferred $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$ ($0 < x < 1$) electrode.”

Ex. 1008, 7:27–31. Guyomard further discloses that test cells having a $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$ positive electrode and carbon negative electrode

were repeatedly charged and discharged over two hours cycles at about 25° C and 55° C and at a charging cut-off voltages of 4.9 V and 4.5 V, respectively. Even at this cycling rate and high charging voltage, the voltage polarization was unusually small, confirming the high ionic conductivity of the electrolyte, and there was no significant loss of cell capacity, verifying the high voltage stability of the electrolyte. The ability of the electrolyte to extend the cycle life of the batteries was amply demonstrated by the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.

Id. at 8:32–9:8.

2. Analysis—Claims 2, 3, 6, and 7

Claims 2 and 6 depend from claims 1 and 5, respectively, and further require that the charge cut-off voltage “is within a range from 4.3 V to 5.2 V.” Ex. 1001, 16:62–64, 17:12–15. Claims 3 and 7 depend from claims 1 and 5, respectively, and further require that the charge cut-off voltage “is within a range from 4.3 V to 4.8 V.” *Id.* at 16:65–67, 17:16–19.

Petitioner contends that the subject matter of claims 2, 3, 6, and 7 is disclosed in Abe and Guyomard. Pet. 41–51. In particular, Petitioner contends that Abe discloses lithium-ion cells that use LiMn_2O_4 as a positive electrode and can be charged up to 4.2–4.3 V, and Guyomard discloses that the same type of positive electrode in combination with its disclosed electrolyte allows the use of a charge cut-off voltage of, for example, 4.5 V. Pet. 42–43. Petitioner further contends that one of ordinary skill in the art would have sought to set the charge cut-off voltage of Abe and Guyomard to, for example, 4.5 V because this would “result in (1) higher capacity and energy density in the battery, (2) good cyclability performance (e.g., less

than 10% decrease after the first 5 cycles through the 500th cycle), and (3) low oxidation of the electrolyte at higher voltages as taught by Guyomard.” *Id.* at 49–50 (citing Ex. 1002 ¶ 186).

According to Petitioner, the proposed combination would have entailed using

a known technique—applying Guyomard’s specific electrolyte composition in a battery that used carbon and LiMn_2O_4 as electrode active materials to allow higher voltages and reduce decomposition of the electrolytes . . . —to improve similar devices (i.e., Abe’s battery using a LiMn_2O_4 and carbon/graphite negative electrode) . . . in the same way (i.e., allowing higher charge cutoff voltages while maintaining excellent cyclability and low oxidation of the electrolyte).

Pet. 50 (citing Ex. 1005 ¶¶ 78, 87, 102; Ex. 1008, 7:27–8:9, 8:13–18, 8:32–9:9).

Patent Owner contends one of ordinary skill in the art would not have been motivated to increase Abe’s voltage because “Abe teaches enhancing safety and teaches away from the voltages in Guyomard.” PO Resp. 63. Patent Owner contends that, consistent with its arguments, Mr. Juzkow conceded that LiMn_2O_4 “will dissolve,” “poison the anode,” and breakdown at “high temperatures,” even at 4.2 V. *Id.* at 64 (citing Ex. 2008, 100:14–20, 123:15–24, 124:21–25). According to Patent Owner, this is consistent with the literature at the time, which acknowledges that $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$ is “extremely unstable and easily oxidized,” necessitating a charging voltage below 4.2 V. *Id.* (citing Ex. 1011, 1:59–60; Ex. 2020, A55). Patent Owner contends Guyomard does not address this issue, as it is focused exclusively on whether the electrolyte could maintain its stability at high voltages. *Id.*

Even if one of ordinary skill in the art were somehow motivated to combine Abe with Guyomard, Patent Owner contends “she would not have

had a reasonable expectation of success because Guyomard's electrolyte cannot enhance the stability of the cathode itself." PO Resp. 65 (citing Ex. 2006 ¶¶ 206–212). According to Patent Owner, this is consistent with references published years after Guyomard (1992) that consistently state that a lithium-ion battery with LiMn_2O_4 as the cathode should be charged to 4.2 V or lower. *Id.* (citing Ex. 1011 (published in 1996); Ex. 1013 (filed in 1996); Ex. 2020 (published in 2002); Ex. 2014 (published in 1994)).

Abe and Guyomard utilize the same type of battery, i.e., one utilizing a LiMn_2O_4 cathode and a carbon anode. Pet. 42–43; Ex. 1005 ¶¶ 6, 18–19, 78, 102; Ex. 1008, 7:27–31; Ex. 1002 ¶¶ 186–188. Both references also use a LiPF_6 -based electrolyte. Ex. 1008, 7:32–35; Ex. 1005 ¶ 72; Ex. 1002 ¶¶ 185–186, 188. Using its new electrolyte, Guyomard's lithium-ion batteries were repeatedly charged and discharged at charge cut-off voltages of 4.5 and 4.9 V, with no significant loss of cell capacity or noted safety concerns. Ex. 1008, 8:32–9:5. Indeed, "[t]he ability of the electrolyte to extend the cycle life of the batteries was amply demonstrated by the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles." *Id.* at 9:5–8. Given the successful results reported in Guyomard, we credit the testimony of Mr. Juzkow that one of ordinary skill in the art would have successfully designed the battery of Abe and Guyomard to have a charge cut-off voltage of 4.5, a value that falls squarely within the 4.3 V to 5.2 V and 4.3 V to 4.8 V ranges recited in dependent claims 2–3 and 6–7. Ex. 1002 ¶¶ 174, 182–190.

As noted by Patent Owner, Abe selects its charge cut-off voltages in a "range in which no electrolyte decomposition occurs, and no irreversible structural breakdown of the positive electrode active material occurs," which for the LiMn_2O_4 battery of Abe is up to 4.2 V. Ex. 1005 ¶ 78; PO Resp. 58.

But Guyomard reports successfully using a charge cut-off voltage of 4.5 V for LiMn_2O_4 cathodes and that the disclosed electrolyte had “high voltage stability” with no reported breakdown of the positive electrode active material. *Id.* As such, we are not persuaded that one of ordinary skill in the art would have avoided increasing the charge cut-off voltage in Abe and Guyomard to 4.5 V in view of Abe’s disclosures. Ex. 1002 ¶¶ 188–189.

With respect to a reasonable expectation of success, we find that the teachings of Guyomard demonstrate that Abe and Guyomard could be successfully combined to result in the claimed invention. For example, Guyomard specifically notes that LiMn_2O_4 is a strongly oxidizing intercalation material, but demonstrates with experimental results that a LiMn_2O_4 /carbon battery (like that of Abe) using its disclosed electrolyte could be successfully charged to 4.5 V and 4.9 V charge cut-off voltages and would achieve a long cycle life. Ex. 1008, 8:23–9:8; *see Amgen Inc. v. Hoechst Marion Roussel, Inc.*, 314 F.3d 1313, 1354 (Fed. Cir. 2003) (explaining that a prior art reference is presumed enabled); Ex. 1002 ¶¶ 188–189.

As argued by Patent Owner, Guyomard does not discuss LiMn_2O_4 dissolution or decomposition. Sur-reply 26–27. Guyomard clearly discloses, however, that its battery was successfully charged and discharged 500 times and that there was no significant loss of cell capacity. Ex. 1008, 8:37–9:8. We agree with Petitioner that this disclosure indicates that Guyomard’s LiMn_2O_4 cathode did not dissolve or render the battery otherwise unusable. Pet. Reply 28; Ex. 1002 ¶¶ 188–189.

As noted by Patent Owner, years after Guyomard was published (1993), certain publications set the charge cut-off voltage for LiMn_2O_4 anode-containing batteries to 4.2 V. Ex. 1011, 16:22–28 (filed in 1996);

Ex. 1013, Table 1 (filed in 1996); Ex. 2020, A55 (published in 2002); Ex. 2014, 219 (published in 1994). There is no suggestion, however, that these references used the electrolyte of Guyomard, nor any suggestion that Guyomard was unsuccessful in using a charge cut-off voltage of 4.5 V and 4.9 V for its batteries using its specific electrolyte, LiMn_2O_4 as the cathode, and carbon as the anode. Thus, we are not persuaded that one of ordinary skill in the art would have avoided the use of Guyomard's charge cut-off voltages in the battery of Abe and Guyomard.

In view of the foregoing, Petitioner persuasively demonstrates that Abe and Guyomard teach or suggest every limitation of claims 2, 3, 6, and 7, and that one of ordinary skill in the art would have combined these references to arrive at the claimed invention with a reasonable expectation of success. Accordingly, Petitioner demonstrates by a preponderance of the evidence that claims 2, 3, 6, and 7 are unpatentable as having been obvious in view of Abe and Guyomard.¹⁵

¹⁵ Petitioner did not rely on Guyomard in its obviousness ground based on Abe. The only limitation that was shown to be missing in Abe, however, was a charge cut-off voltage for the cell or battery that is above 4.2 V. Petitioner's arguments with respect to Abe and Guyomard demonstrate that one of ordinary skill in the art would have sought to use a charge cut-off voltage in the ranges of "4.3 V to 5.2 V" and "4.3 V to 4.8 V" in view of Guyomard. Despite this finding, we decline to determine that claims 1 and 5 would have been obvious in view of the combination of Abe and Guyomard, because Petitioner did not challenge claims 1 or 5 on this ground. Pet. 7, 41–51; Tr. 36:23–37:20; *SAS Inst. Inc. v. Iancu*, 584 U.S. 357, 367 (2018) ("the petitioner's contentions, not the Director's discretion, define the scope of the litigation all the way from institution through to conclusion"); *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1381 (Fed. Cir. 2016) ("the Board must base its decision on arguments that were advanced by a party, and to which the opposing party was given a chance to respond").

3. Analysis—Claims 4 and 8

Claims 4 and 8 depend from independent claims 1 and 5, respectively, and further require that the “ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.15 to 1:2.5.” Ex. 1001, 17:1–4, 17:20–23.

Abe discloses that “the design capacity of the negative electrode is greater than the design capacity of the cathode.” Ex. 1005 ¶ 78. Consistent with this disclosure, Petitioner contends that one of ordinary skill in the art seeking to apply the 4.5 V charge cut-off voltage in the battery of Abe and Guyomard would have increased the ratio of negative/positive electrode material in the battery when calculated at 4.2 V to “ensure there was more design capacity at the negative electrode” to avoid “plating and dendrite formation.” Pet. 44–45. In particular, Petitioner contends one of ordinary skill in the art would have exceeded a ratio of 1:1.15 to accommodate the increased charge cut-off voltage of Guyomard, but would not have exceeded 1:2.5 as this would provide “too much excess negative electrode material.” *Id.* at 46.

Patent Owner does not address Petitioner’s argument with respect to the claimed ratio range. PO Resp. 62–65; Sur-reply 26–27.

Upon review of Petitioner’s arguments and supporting evidence, we find persuasive Petitioner’s argument that one of ordinary skill would have sought to utilize a ratio of positive to negative electrode material between 1:1.15 and 1:2.5, as determined at a charge cut-off voltage of 4.2 V, in the battery of Abe and Guyomard in view of the express teachings of Abe. Ex. 1005 ¶ 18 (explaining that the negative electrode has a “design capacity of more than 1 and less than or equal to 1.6 for the design capacity of the positive electrode.”). Accordingly, Petitioner demonstrates by a

preponderance of the evidence that claims 4 and 8 would have been obvious in view of the combined disclosures of Abe and Guyomard.

4. Analysis—Claims 11–18

Claims 11–18 require that the claimed secondary lithium-ion cell or battery of independent claims 1 (claims 15–18) and 5 (claims 11–14) maintain at least 75%, 75.83%, 80%, or 80.72% of capacity after 400 cycles. Ex. 1001, 18:4–27.

Petitioner concedes that Abe does not disclose the capacity retention of its batteries past 50 charge/discharge cycles, but contends Guyomard discloses that its battery had cell capacities after 500 cycles that were only about 10% less than after 5 cycles. Pet. 47–48 (citing Ex. 1008, 9:5–9). And, because 90% capacity is more than the highest capacity retention recited in dependent claims 11–18, i.e., 80.72%, Petitioner contends it would have been obvious to obtain the claimed capacity retention after 400 cycles in the battery of Abe and Guyomard. *Id.* at 48.

Patent Owner contends that Guyomard provides insufficient information to conclude that the capacity requirements recited in claims 11–18 are disclosed in Abe and Guyomard because the capacity loss between cycles 1 and 5 is not reported. PO Resp. 16; Sur-reply 27 (citing PO Resp. 16; Ex. 2006 ¶ 78; Ex. 1043, 107:3–108:12). We are not persuaded by this argument.

Claims 11–18 do not specify or limit which 400 cycles of the battery are used to measure capacity retention. Ex. 1001, 18:4–27. Nor are we directed to any intrinsic evidence that would support limiting the claims to the first 400 charge/discharge cycles of the battery. Thus, we decline to limit claims 11–18 to capacities achieved after cycles 1–400.

The evidence of record is generally consistent with this conclusion. For example, both the '641 patent and Dr. Yao note that batteries typically go through a formation period in which the battery is repeatedly charged and discharged before it is ready for use or testing. Ex. 1043, 107:3–108:22; Ex. 1001, 4:27–45 (noting that the elevated charge cut-off voltage is used “during the formation and examination of the cell”). And, although Dr. Yao did not believe that the formation process would include as many as five charge/discharge cycles, Dr. Yao’s testimony does suggest that capacity retention testing would not begin with the first cycle. Ex. 1043, 107:16–108:22. Thus, we are directed to no persuasive intrinsic or extrinsic evidence that would preclude Petitioner’s reliance on capacity retention rates for cycles other than cycles 1 to 400, e.g., between cycles 6 and 406 or cycles 6 and 506 in Guyomard.

In view of the foregoing, Petitioner persuasively identifies where Abe and Guyomard teach or suggest every limitation of claims 11–18, and persuasively explains why one of ordinary skill in the art would have combined these references to arrive at the claimed invention with a reasonable expectation of success. Thus, Petitioner demonstrates by a preponderance of the evidence that claims 11–18 would have been obvious over the combined disclosures of Abe and Guyomard.

K. Claims 9 and 10 over Abe, Guyomard, and Iwaizono

Claim 9 depends from independent claim 5 and further requires that the 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 first overcharging protection voltage is “greater than

4.45 V” and the overcharge protection release voltage is “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 in view of the combined disclosures of Abe, Guyomard, and Iwaizono. Pet. 60–61.

1. *Iwaizono*

Iwaizono is titled “Circuit and Device for Protecting Secondary Battery” and issued June 10, 2003. Ex. 1007, codes (45), (54).

Iwaizono discloses a circuit for protecting a rechargeable battery, such as a lithium-ion rechargeable battery, against overcharging. Ex. 1007, 1:6–9. Iwaizono notes that lithium-based rechargeable batteries are particularly susceptible to deterioration or damage when operated at a voltage exceeding a predetermined range and, therefore, “[i]t is therefore the normal practice to provide a battery protection device for protecting the battery from improper use.” *Id.* at 1:13–18.

In one embodiment, Iwaizono provides a transistor that is turned off to shut off charging current when the voltage across the positive and negative electrodes is over a predetermined first charge-prohibiting voltage, such as 4.30 V. Ex. 1007, 9:57–60. This transistor is kept off until a first charge-permitting voltage that is lower than the first charge-prohibiting voltage is detected. *Id.* at 10:1–3.

2. *Analysis*

Petitioner contends that one of ordinary skill in the art would have included the overcharge protection circuit of Iwaizono, including a suitable overcharging protection voltage (e.g., 4.65 V) and overcharging protection release voltage (e.g., 4.35 V or 4.45 V), in the battery of Abe and Guyomard

to prevent overcharging of the battery, as well as to resume charging when the voltage has sufficiently decreased. Pet. 60–61.

Patent Owner does not contest Petitioner’s arguments with respect to claims 9 and 10, apart from its arguments directed to independent claims 1 and 5. PO Resp. 66.

Upon review of Petitioner’s arguments and the disclosures of Iwaizono, we determine that Petitioner persuasively identifies where Abe, Guyomard, and Iwaizono teach or suggest every limitation of claims 9 and 10. Petitioner also provides a reasoned explanation as to why one of ordinary skill would have used Iwaizono’s protection circuit and voltages (overcharging and charge-permitting voltages), within the voltage ranges recited in claims 9 and 10, in the battery of Abe and Guyomard. Accordingly, Petitioner demonstrates by a preponderance of the evidence that claims 9 and 10 would have been obvious over Abe, Guyomard, and Iwaizono.

L. Claims 9 and 10 over Uemura, Iwaizono, and Guyomard

Petitioner contends the subject matter of claims 9 and 10 would have been obvious in view of the combined disclosures of Uemura, Iwaizono, and Guyomard. Pet. 51–59. Having determined that claims 9 and 10 would have been obvious over Abe, Guyomard, and Iwaizono, we do not address whether these same claims would have been obvious over Uemura, Iwaizono, and Guyomard. *SAS Inst.*, 138 S. Ct. at 1359 (holding that a petitioner “is entitled to a final written decision addressing all of the claims it has challenged”),

IV. CONCLUSION¹⁶

For the foregoing reasons, we determine that Petitioner demonstrates by a preponderance of the evidence that claims 2–4 and 6–18 are unpatentable. Petitioner does not demonstrate by a preponderance of the evidence, however, that claims 1 or 5 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
1–8	102	Uemura		1–8
1–8, 11–18	103	Uemura		1–8, 11–18
11–18	103	Uemura, Guyomard		11–18
1–8	102	Abe		1–8
1–8	103	Abe		1–8
2–4, 6–8, 11–18	103	Abe, Guyomard	2–4, 6–8, 11–18	
9, 10	103	Abe, Guyomard, Iwaizono	9, 10	
9	103	Uemura, Iwaizono		9

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
9, 10	103	Uemura, Iwaizono, Guyomard ¹⁷		
Overall Outcome			2–4, 6–18	1, 5

ORDER

For the foregoing reasons, it is:

ORDERED that Petitioner demonstrates by a preponderance of the evidence that claims 2–4 and 6–18 of the '641 patent are unpatentable; and

FURTHER ORDERED that Petitioner does not demonstrate by a preponderance of the evidence that independent claims 1 and 5 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 Because we find claims 9 and 10 would have been obvious over Abe, Guyomard, and Iwaizono, we do not address whether these same claims would have been obvious over Uemura, Iwaizono, and Guyomard.

IPR2023-01183
Patent 7,749,641 B2

PETITIONER:

Andrew Sommer
Stephen E. Pulley
Yejin Kuh
GREENBERG TRAURIG LLP
sommera@gtlaw.com
stephen.pulley@gtlaw.com
kuhj@gtlaw.com

W. Karl Renner
Hyun Jin In
Gretchen DeVries
axf-ptab@fr.com
in@fr.com
devries@fr.com

PATENT OWNER:

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