

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner

v.

RJ TECHNOLOGY LLC,
Patent Owner.

Case IPR2023-01350

Patent No. 7,749,641

PATENT OWNER RESPONSE PURSUANT TO 37 C.F.R. § 42.120

Table of Contents

	<u>Page</u>
I. INTRODUCTION	1
II. BACKGROUND	2
A. Procedural History	2
B. Technology Background	3
1. Li-ion battery basics	3
2. The 4.2V charge cut-off voltage limit.....	7
3. The electrode capacity ratio	10
4. The '641 Patent's combined approach to the charge cut-off voltage and capacity ratio	11
C. Petitioner's Cited References	12
1. Yamaki (APPLE-1004).....	13
2. Sakamoto (APPLE-1005)	17
3. Yasunami (Ex2030).....	18
4. Koyama (APPLE-1007).....	19
5. Richardson (APPLE-1008).....	20
6. Abraham (APPLE-1009).....	20
D. Level of Ordinary Skill	20
III. CLAIM CONSTRUCTION.....	21
A. “charge cut-off voltage”	21
IV. GROUND 1A: A POSITA WOULD NOT HAVE HAD REASON TO COMBINE YAMAKI WITH SAKAMOTO WITH A REASONABLE EXPECTATION OF SUCCESS.....	25

A.	Ground 1 fails because it is driven by hindsight bias.	26
B.	Ground 1 fails because a POSITA would not combine Yamaki's battery with the fundamentally different Sakamoto battery.	32
C.	Ground 1 fails because there is no suggestion that adjusting the capacity ratio would allow a POSITA to raise the charge cutoff voltage above 4.2V.....	33
V.	GROUND 1A: YAMAKI-SAKAMOTO COMBINATION DOES NOT DISCLOSE THE LIMITATION OF CLAIMS 11-14	36
A.	The cycle life limitations of claims 11-14 are not necessarily present in the structure of claim 5.....	37
B.	A POSITA would not practice the cycle life limitations of claims 11-14 through routine experimentation with the structure of claim 5.....	39
VI.	GROUND 1B: CLAIMS 9 AND 10 ARE NOT RENDERED OBVIOUS BY YAMAKI, SAKAMOTO, AND ABRAHAM	49
VII.	GROUND 2A/2B: YASUNAMI DOES NOT RENDER THE CLAIMED CHARGE CUTOFF VOLTAGE RANGE OBVIOUS.....	49
A.	Yasunami discloses an applied voltage rather than a charge cutoff voltage.....	50
B.	The prior art taught away from the claimed charge cutoff voltage range and reported unexpected results.....	56
VIII.	Ground 2A: A POSITA WOULD NOT HAVE HAD A REASON TO COMBINE YASUNAMI WITH KOYAMA OR A REASONABLE EXPECTATION OF SUCCESS IN DOING SO	59
IX.	GROUND 2A: YASUNAMI-KOYAMA COMBINATION DOES NOT RENDER CLAIMS 11-14 OBVIOUS.....	62
X.	GROUND 2B: CLAIMS 9 AND 10 ARE NOT RENDERED OBVIOUS BY YASUNAMI, KOYAMA, AND RICHARDSON	66
XI.	CONCLUSION	66

TABLE OF AUTHORITIES

	Page(s)
Cases	
<i>Allergan, Inc. v. Sandoz Inc.</i> , 796 F.3d 1293 (Fed. Cir. 2015)	57
<i>Cheese Sys., Inc. v. Tetra Pak Cheese and Powder Sys., Inc.</i> , 725 F.3d 1341 (Fed. Cir. 2013)	27
<i>Endo Pharm. Inc. v. Teva Pharm. USA, Inc.</i> , 731 Fed. Appx. 962 (Fed. Cir. 2018)	37
<i>Hill-Rom Servs., Inc. v. Stryker Corp.</i> , 755 F.3d 1367 (Fed. Cir. 2014)	37
<i>K-2 Corp. v. Salomon S.A.</i> , 191 F.3d 1356 (Fed. Cir. 1999)	37
<i>PAR Pharm., Inc. v. TWI Pharm., Inc.</i> , 773 F.3d 1186 (Fed. Cir. 2014)	38
<i>Ruckus Wireless, Inc. v. Innovative Wireless Sols., LLC</i> , 824 F.3d 999 (Fed. Cir. 2016)	25
<i>Ruiz v. A.B. Chance Co.</i> , 357 F.3d 1270 (Fed. Cir. 2004)	26

EXHIBIT LIST	
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2002	Declaration of George Stamatopoulos in support of Patent Owner’s Motion for Pro Hac Vice Admission
2003	Declaration of Daniel Zaheer in support of Patent Owner’s Motion for Proo Hac Vice Admission
2004	Declaration of Robert Zhou in support of Patent Owner’s Motion for Pro Hac Vice Admission
2005	Declaration of Michael Ng in support of Patent Owner’s Motion for Pro Hac Vice Admission
2006	CV of Dr. Yan Yao
2007	Declaration of Dr. Yan Yao
2008	Deposition Transcript of Louis Hruska dated June 4, 2024
2009	Bradely Johnson & Ralph White, Characterization of commercially available lithium-ion batteries, Journal of Power Sources 70 (1998) 48-54 (“Johnson 1998”)
2010	Jaephil Cho et al., Electrochemical properties and thermal stability of $\text{LiNi}_{1-x}\text{Co}_x\text{O}_2$ cathode materials, 147 Journal of the Electrochemical Society (1) 15-20 (2000) (“Cho 2000”)
2011	Ramadass Premanand et al., Studies on Capacity Fade of Spinel-Based Li-ion Batteries, J. Electrochem. Soc 149 A54 (2002)
2012	U.S. Patent No. 5,721,067 (“Jacobs”)
2013	U.S. Patent No. 5,871,863 (“Miyasaka”)
2014	Kazunori Ozawa, Lithium-ion rechargeable batteries with LiCoO_2 and carbon electrodes: the LiCoO_2/C system, 69 Solid State Ionics 212 (1994) (“Ozawa 1994”)
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2016	Pankaj Arora et al., Capacity fade mechanisms and side reactions in lithium-ion batteries, J. Electrochemical Soc. 145, Issue 10, 3647 (1998) (“Arora 1998”)
2017	National Standard of the People’s Republic of China General specification of lithium-ion battery for cellular phone (GB/T 18287-2000).

2018	Lithium ion batteries: individual data sheet CGR18650 (January 2000)
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2021	M. Broussely et al., Main aging mechanisms in Li ion batteries, J. Power Source 146 (2005) 90-96 (“Broussely 2005”)
2022	Deposition of Marc Juzkow dated May 3, 2024
2023	Nina Laszcynski et al., Understanding electrode decomposition of graphite/NCM811 cells at elevated operating voltage, J. Electrochemical Soc. 166 (10) A1853-A1859 (2019) (“Laszcynski 2019”)
2024	Declaration of Dr. Yan Yao in Samsung Electronics Co., Ltd. v. RJ Technology LLC, IPR2023-01183 dated May 15, 2024
2025	SAFT, Charging your lithium-ion batteries: 5 expert tips for a longer lifespan
2026	B. Pattipati et al., Open circuit voltage characterization of lithium-ion batteries, 269 J. Power Sources 317 (2014) (“Pattipati 2014”)
2027	Plaintiff RJ Technology LLC’s and Defendants Samsung Electronics Co., Ltd.’s and Samsung Electronic America, Inc.’s P.R. 4-5(d) Joint Claim Construction Chart, RJ Technology LLC v. Samsung Electronics Co., Ltd., No. 2:22-v-00401-JRG-RSP, Dkt. 105 (January 25, 2024)
2028	Cheon-Soo Kim et al., Effects of capacity ratios between anode and cathode on electrochemical properties for lithium polymer batteries, Electrochimica Acta 155 (2015) 431 (Kim 2015”)
2029	P. Ramadass et al., Capacity fade of Sony 18650 cells cycled at elevated temperatures Part 1, Cycling performance, J. Power Sources 112 (2002) 606-613 (“Papov 2002”)
2030	Japanese Unexamined Patent Application Publication No. H7-122298 (“Yasunami”) (with certified translation dated June 13, 2024)

I. INTRODUCTION

Patent Owner respectfully requests that the Board reject Petitioner's Grounds and find the challenged claims of U.S. Pat. No. 7,749,641 (the "'641 Patent") patentable.

The independent claims of the '641 Patent are directed to "secondary lithium ion" batteries with a "charge cut-off voltage greater than 4.2V" (the claimed "charge cut-off voltage") and a negative to positive electrode ratio of materials, as calculated by "a theoretic capacity with a charge cut-off voltage set at 4.2V" in a range from 1-2.5 (the claimed "capacity ratio"). The independent claim thus recites the first battery in which the electrode capacity ratio allows raising the charge cut-off voltage above 4.2V, *i.e.*, what was known as of the priority date as the maximum safe charge cutoff voltage limit. The dependent claims, among other elements (e.g., narrower charge cut-off voltage and capacity ratio ranges, mechanisms against overcharging) recite batteries that retain certain capacity levels after 400 charging and discharging cycles.

Petitioner's obviousness grounds assert that different references supply voltages higher than 4.2V and the claimed capacity ratio ranges. None of Petitioner's references discloses both the claimed charge cutoff voltage and capacity ratio ranges. Critically, there are no teachings in the prior art that a POSITA would: (i) try to practice the claimed charge cutoff voltage by adjusting the capacity ratio

by making Petitioner's asserted prior art combinations, (ii) expect that Petitioner's combinations would allow successfully practicing the independent claims, or (iii) expect that Petitioner's combination would successfully meet the capacity retention levels in the dependent claims. Petitioner's grounds are driven by hindsight bias as to a POSITA's understanding of battery design as of the priority date and incorrect assertions about the performance of its combinations.

Accordingly, Patent Owner respectfully submits that the reasons set forth in this response, many of which were not previously presented to the Board, compel a Final Written Decision finding all challenged claims patentable.

II. BACKGROUND

A. Procedural History

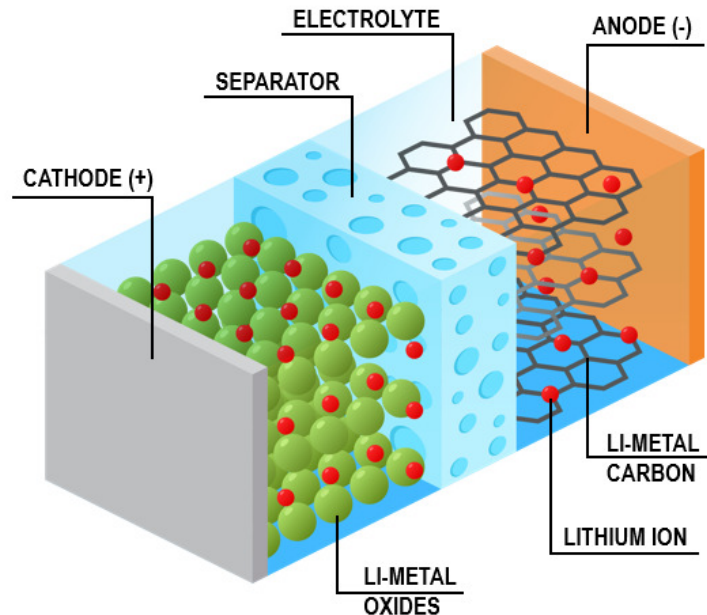
Patent Owner ("PO") asserted the '641 Patent against Petitioner in *RJ Technology LLC v. Apple Inc.*, No. 8:22-cv-1874-JVS-JDE (C.D. Cal) and against Samsung in *RJ Technology LLC v. Samsung Electronics Co. Ltd.*, No. 2:22-v-00401-JRG-RSP (E.D. Tex.). Samsung filed an IPR against PO in *Samsung Electronics Co., Ltd. v. RJ Technology LLC*, IPR2023-01183, which Petitioner also sought to join.

B. Technology Background

1. Li-ion battery basics

Lithium-ion batteries used today are typically rechargeable (“secondary”) and can be recharged repeatedly without heavy capacity losses, *i.e.*, the amount of electricity the battery can store on a charge. Ex2007 (Yao Decl.), ¶¶29-30.

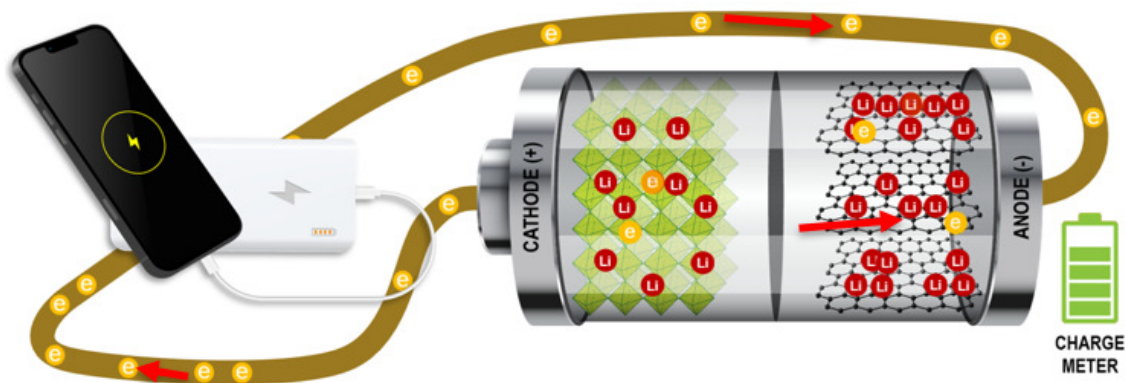
The basic construction of lithium-ion batteries includes a positive electrode (cathode), negative electrode (anode), electrolyte, and separator (*Id.*, ¶33):



The cathode is typically made of a lithium metal oxide compound (e.g., lithium cobalt oxide, or LiCoO_2). The anode is commonly made of carbon material (e.g., graphite). The electrolyte is typically a liquid medium that facilitates movement of lithium ions between the cathode and anode. The separator physically separates the

cathode from the anode, as contact between the two can cause short circuits. *Id.*, ¶¶33-34.

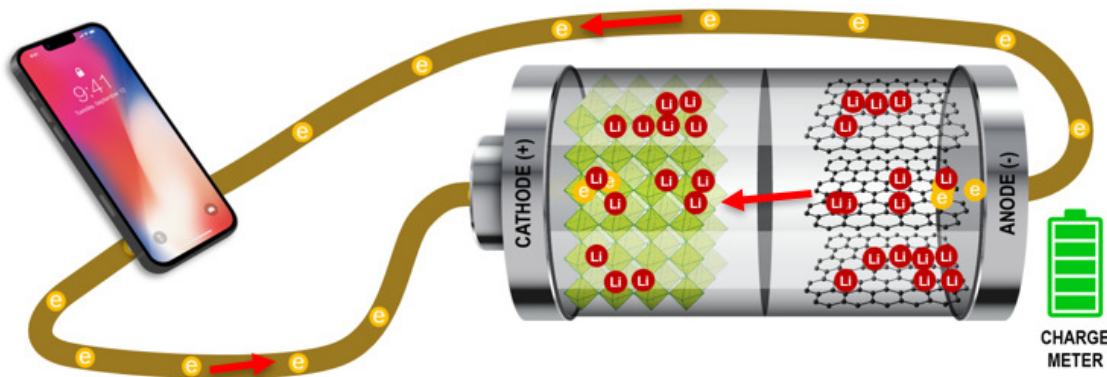
The basic operation of a lithium-ion battery is storing and releasing electricity, accomplished by the movement of positively charged lithium ions (Li^+) and negatively charged electrons (e^-) between the cathode and anode:



During charging (i.e., when electricity is applied to the battery, shown above), the cathode releases lithium ions and electrons. The lithium ions travel from the cathode to the anode through the separator in a process called intercalation; and electrons travel from the cathode, through the charging circuit, to the anode, where they combine with the lithium ions (Li^+) to form lithium atoms (Li), which are stored in the anode. *Id.*, ¶¶35-36.

During discharge (e.g., to power a device, shown below), the process reverses. Electrons separate from the anode, through the external circuit and powered device,

to the cathode; and the lithium ions travel from the anode, through the separator, and back to the cathode, in a process called deintercalation:

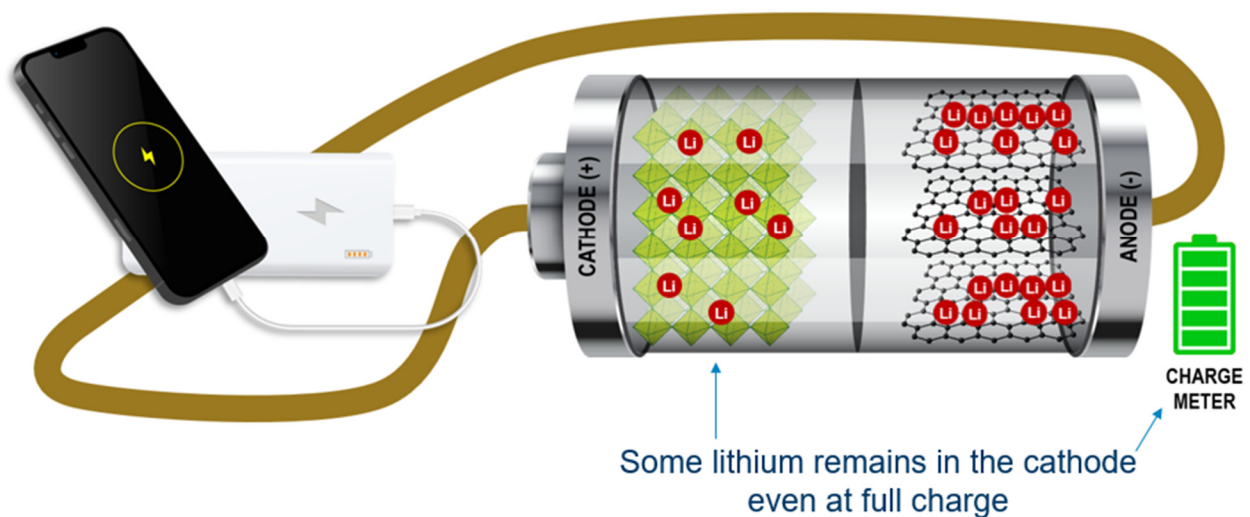


Id., ¶37.

Relevant characteristics of lithium-ion batteries can be measured in current, voltage, and capacity. Analogizing these characteristics to water flow, electrical current is analogous to the flow of water; voltage is analogous to pressure; and capacity is analogous to the size of a reservoir. Current describes the flow of electricity (or the number of electrons flowing per second) and is measured in amperes (A); voltage measures the strength of electrical potential (or voltage) difference between two points and is measured in volts (V). Differences in potential cause current—just as pressure differences cause waterflow. Battery capacity measures how much electricity a battery can store and is measured in ampere-hours (Ah) or milliampere hours (mAh), reflecting the amount of electrical current the

battery can deliver in one hour. For example, a battery with 1 mAh capacity could deliver 1 mA of current for an hour. *Id.*, ¶¶38-39.

Even when a battery is fully charged, some lithium typically remains in the cathode and is not moved to the anode:



Elevating the battery voltage can increase its capacity, as more lithium ions are extracted from the cathode. When the battery is fully charged to a higher voltage, the anode stores more lithium and electricity. It thus has greater capacity even at the same battery size. However, it is possible to overcharge a battery by charging it to a voltage greater than its chemical structure can handle, which can cause fires and explosions, or degrade the battery causing it to lose capacity after successive charges and recharges. Battery engineers have thus historically avoided charging batteries to voltages that could damage the battery or shorten its useful life. *Id.*, ¶¶40-42.

2. The 4.2V charge cut-off voltage limit

The charge cut-off voltage¹ of lithium-ion batteries is critical for battery performance and safety. As of the priority date, it was well-known in the art that the charge cut-off voltage could not exceed 4.2V, regardless of materials used. APPLE-1001, 1:46-51.

For example, it was widely believed that charging LiCoO₂ (a widely used cathode material) to voltages above 4.2V would lead to the cathode releasing oxygen thus increasing the risk of a “thermal runaway” phenomenon that could cause fires or explosions. *Id.*, 1:55-63. Higher voltages were also known to degrade the LiCoO₂ crystal structure, thus rapidly shortening battery life. Ex2007, ¶¶44-45.

Charging batteries with spinel lithium manganese oxide (“LiMn₂O₄” – another common cathode material made with manganese) to voltages above 4.2V was likewise known to degrade battery performance over time. Ex2007, ¶46. As of the priority date, POSITAs also knew to limit the charge cut-off voltage of LiMn₂O₄ to less than 4.2V. *See* APPLE-1008 at 8; Ex2012, 8:65-9:3; Ex2013, 1:59-60; Ex2014, Fig.1.

¹ As explained in section III.A, the “charge cut-off voltage” is the “maximum voltage to which the battery is configured to be charged,” *i.e.*, equal to the maximum full-cell voltage between the electrodes for which a battery is configured.

Numerous references cited by Petitioner show that the conventional wisdom as of the priority date was to limit the charge cutoff voltage to 4.2V. For example, Linden's Handbook of Batteries states that "[i]t is necessary to control the charging voltage for the LiCoO₂ cell to about 4.2V per cell." APPLE-1015, 36.45; *see also* APPLE-1008 at 8 ("lithium manganese oxide cells containing these additives can be charged to their full normal capacity at 4.2V"); APPLE-1015 at 23.11 (describing the "open circuit" voltage of LiCoO₂ cell as 4.2V); APPLE-1017 at 5:13-15 (charging the battery at a maximum of 4.2V); APPLE-1020 at 3546 (considering voltages of 4.25, 4.35, 4.45V all as "overcharged"); APPLE-1027 at ¶78; APPLE-1029, 15:34-38; *see also* Ex2007, ¶47.

Petitioner's expert testified that as of the priority date, 4.2V was a conventional charge cutoff voltage that a POSITA would have also used to measure electrode capacity. APPLE-1003, ¶81; *see also* Ex2008 (Hruska Dep. Tr.), 66:16-22. Mr. Hruska testified further that 4.2V was "widely adopted" by "commercial developers of lithium-ion batteries" as there was industry consensus that 4.2V attained a "combination of safety, capacity, lifetime performance." *Id.*, 72:3-7; 80:3-7 ("Q. what was it about 4.2 volts that was significant enough that that value had become common? A. It was the point where the cell manufacturers clearly found the combination of characteristics that they felt were the best for their system"); 78:6-9; 81:6-21; 84:8-20.

In Samsung's co-pending IPR, Samsung's expert likewise testified that 4.2V was known to be the maximum charge cutoff voltage for secondary lithium-ion batteries as of the priority date:

Q. And was 4.2 volts the threshold at which a person of ordinary skill in the art would understand a charge might lead to extracting excess lithium from a cathode?

A. We started with 4.1V and then we moved to 4.2V. But we did not go beyond 4.2V, as we would lessen the cycle life of the cell.

...

Q. So did I understand correctly that one of the reasons you didn't go beyond 4.2V was out of concern that doing so would extract an excess amount of lithium that might lead to thermal runaway phenomena?

A. That was one of the reasons, yes.

Q. And that was considered dangerous?

A. Yes.

See Ex2022 (Juzkow Dep. Tr.) at 75:8-15; 77:9-15.

Efforts, if any, to raise the maximum charge cutoff voltage as of the priority date focused on improving battery materials, not adjusting the battery electrode capacity ratio. Ex2007, ¶48.

3. The electrode capacity ratio

As of the priority date, there was no specific cut-off for the electrode capacity ratio (*i.e.*, the ratio of the anode to cathode capacity), guidance as to ratio's appropriate ranges, or teaching that the ratio could allow raising the charge cutoff voltage. Technical literature and industry guidelines were silent, and POSITAs had different approaches to setting the capacity ratio, depending on various design needs unrelated to increasing the charge cutoff voltage (which was capped at 4.2V). Ex2007, ¶¶49-50.

Though Mr. Hruska incorrectly asserted that POSITAs designed batteries with greater anode than cathode capacity (Ex2008, 139:15-19; 148:16-149:1), there was ample guidance that cathode capacity should exceed anode capacity, including to compensate for potential lithium ion losses during repeated charging/discharging cycles. *See, e.g.*, Ex2016, 3650; Ex2015, 4; Ex2007, ¶51. As of the priority date, POSITAs knew that lithium-ion batteries undergo irreversible capacity loss (*i.e.*, loss of lithium ions) during charging/recharging, attributable to lithium-ion attachment in the anode and similar phenomena in the cathode. Ex2007, ¶¶51, 132-133; Ex2012, 1:64-2:4, 2:20-26. POSITAs knew that these losses were “compensated by adding an excess amount of lithium containing transition metal compound to the battery,” *i.e.*, additional cathode material. *Id.*, 2:50-53. The art belies Mr. Hruska's assertion that there was no reason for cathode capacity to exceed anode capacity.

Moreover, there was no teaching that it was possible to safely raise the cutoff voltage by adjusting the capacity ratio. The conventional wisdom was that batteries could not be safely charged to voltages exceeding 4.2V, irrespective of the capacity ratio, and a POSITA as of the priority date would not have attempted to exceed 4.2V by adjusting the capacity ratio. Ex2007, ¶¶43-48, 53.

Decades after the priority date, the literature confirms that “research[] of electrode-design parameters ha[s] focused on individual electrodes such as cathode or anode,” but research around “the capacity ratio of [the] negative to positive electrode” has been “limited.” Ex2015 at 431; Ex2007, ¶¶49-50.

4. The '641 Patent's combined approach to the charge cut-off voltage and capacity ratio

The '641 Patent tackles the charge cut-off voltage and the capacity ratio in tandem, for the first time in the art, to raise the charge cut-off voltage and improve battery energy density while maintaining superior cycle life. At a time when researchers focused on developing new materials to improve capacity, the inventors improved utilization of existing cathode materials by adjusting the anode to cathode capacity ratio to a range such that allowed raising the charge cut-off voltage safely above 4.2V without substantial performance loss. Ex2007, ¶53.

The '641 Patent is titled “Secondary lithium ion cell or battery, and protecting circuit, electronic device, and charging device of the same” and claims priority to a

Chinese patent application dated September 28, 2001, which is assumed to be its priority date for purposes of this IPR. Petitioner challenges claims 5-14 of the patent.

The only independent claim at issue in this IPR is claim 5:

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 4.2V but less than 5.8V, 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 4.2V.

Claim 5 includes (1) a charge cut-off voltage ranging between 4.2V and less than 5.8V, and (2) a capacity ratio ranging between 1:1.0 to 1:2.5, as calculated by a theoretic capacity with a charge cut-off voltage of 4.2V.

Claims 6-7 depend from claim 5 and narrow the charge cut-off voltage range to 4.3-5.2V and 4.3-4.8V, respectively; and Claim 8 depends from claim 5 and narrows the capacity ratio range to 1:1.15 and 1:2.5.

Claims 9 and 10 depend from claim 5 and recite limitations relating to the battery's protection mechanisms.

Claims 11-14 depend from claim 1 or 5 and require that the battery maintain certain capacity levels after 400 cycles.

C. Petitioner's Cited References

Petitioner asserts the following grounds:

Ground	Claims	Basis
1A	5-8, 11-14	Obvious over Yamaki and Sakamoto
1B	9-10	Obvious over Yamaki, Sakamoto, and Abraham
2A	5-14	Obvious over Yasunami and Koyama
2B	9-10	Obvious over Yasunami, Koyama, and Richardson

1. Yamaki (APPLE-1004)

Yamaki is titled “Lithium Secondary Battery” and describes a new battery cathode. Yamaki discloses an experimental battery in which the “capacity retention rate is 80% or more when charging and discharging are repeated 10 times” (or “cycles”). APPLE-1004, Claim 4. Yamaki does not disclose capacity retention (or any other cycle life data) for more than 10 cycles, (e.g., 400 cycles as in claims 11-14) or teach that its battery retains appreciable capacity levels after hundreds of charge/discharge cycles. Ex2007, ¶¶57, 64-65.

Contrary to the '641 Patent, which increases the charge cutoff voltage by adjusting the ratio of existing materials, Yamaki describes using a new cathode material, untested in normal operating conditions, and hypothesizes that it may be stable at voltages higher than 4.2V. APPLE-1004, ¶14.

Yamaki identifies two issues in the cathode that adversely affect battery performance when the charge cutoff voltage exceeds 4.2V: *first*, the crystal structure of the LiCoO₂ cathode changes, impairing the ability of lithium ions to travel

between the anode and cathode (a function essential to a rechargeable battery), and *second*, the conductive material of the cathode reacts with the electrolyte, an undesirable reaction that also impairs the rechargeability of the battery. APPLE-1004, ¶¶8-9; Ex2007, ¶¶58-61.

Yamaki proposes a nascent, two-fold potential solution: *first*, a new cathode active material with a Co-based oxide “containing at least one element selected from Mg, Al, Mn, Ti and Sr,” and *second*, using an amorphous carbonaceous material for the surface layer of the cathode’s conductive material. APPLE-1004, ¶13. Yamaki hypothesizes on the basis of its 10-cycle testing that its new cathode material may improve aspects of the cathode.

Yamaki’s purported solution is highly preliminary; and there is no evidence that its battery retains substantial capacity levels after 400 cycles (e.g., as claimed in claims 11-14). A POSITA would know that determining battery cycle life requires rigorous testing over hundreds or even thousands of cycles, including to reliably ascertain degradation and longevity under normal operating conditions. *Id.* Yamaki only reports testing for 10 cycles for its experimental battery and does not thus disclose testing (or data that could substitute for testing) that would allow a POSITA to glean, let alone reliably, the Yamaki battery’s long-term cycle life. *Id.* Nor does Yamaki provide capacity retention data points that would allow a POSITA to

extrapolate capacity retention beyond the 10 cycles for which Yamaki discloses capacity data. Ex2007, ¶¶62-66.

A POSITA would also know that battery testing must be conducted in normal charging conditions to assess cycle life. Yamaki discloses very slow charging, from which a POSITA could not determine the Yamaki battery cycle life in normal operating conditions. *Id.* A POSITA would understand that slow charging like that described in Yamaki is only used in controlled experimental settings to preliminarily assess the cathode active material. *Id.* In short, Yamaki does not disclose a battery that retains substantial capacity over more than 10 cycles or other data that would allow a POSITA to glean battery capacity over 400 cycles. *Id.*

Moreover, Yamaki made statements during prosecution that would lead a POSITA to conclude that Yamaki's system differs materially from existing systems and that Yamaki's battery would likely lose substantial capacity if charged to a charge cutoff voltage greater than the conventionally accepted maximum of 4.2V.

In particular, the Japanese Patent Office rejected Yamaki's application based on a reference disclosing the same cathode material as Yamaki charged up to the conventional limit of 4.2V. Ex2019 (in "Reference 2," "the initial capacity was measured after charging for 2.5 hours under the condition of a charging voltage of 4.2V"). To overcome the rejection, Yamaki disclosed testing of its cathode material above 4.2V (for 10 cycles) but explained that its battery system operated in a

materially different way than traditional systems in which the charge cutoff voltage was limited to 4.2V. *Id.* Critically, according to Yamaki, battery operation “is completely different” at higher voltages (e.g., “4.4V or more”) than at lower voltages (e.g., “4.3V or less”) such that it would be “extremely difficult to predict” that it would be possible to apply a charging voltage equal to “4.4V based on the performance of lithium ion batteries” at lower charging voltages, even charging voltages that were “about 4.3V or less.” Ex2019; Ex2007, ¶¶67-68.²

Yamaki thus acknowledges that (i) battery performance changes dramatically even in response to small (i.e., in the order of 0.1V) changes to the charge cutoff voltage, (ii) its results do not allow conclusions about long-term cycle, and (iii) cycle life results for lower charge cutoff voltages cannot be used to determine cycle life for greater voltages. *Id.*, ¶¶62-68.

² As Dr. Yao explains, a voltage of the cathode of 4.3V relative to lithium metal is the half-cell voltage, and a POSITA would understand that such a half-cell voltage translates to a charge cutoff voltage up to approximately 4.2V. Ex2007, ¶¶48, 117-123. Thus, Yamaki’s 4.3V disclosure actually translates to the well-known 4.2V charge cutoff limit.

2. Sakamoto (APPLE-1005)

Sakamoto (titled “Non-aqueous electrolyte secondary battery”) is directed to a method that purports to improve cycle life. APPLE-1005, ¶6.

According to Sakamoto, battery designers trying to increase the energy density of lithium-ion batteries set the reversible capacity of the cathode and anode to “almost equal” values. *Id.*, ¶5. Sakamoto teaches that doing so resulted in “deposit of lithium ... on the negative electrode during overcharge,” which in turn “increases the amount of passive lithium, and leads to a decrease in battery capacity and to deterioration in cycle characteristics.” *Id.*, ¶6. Sakamoto teaches addressing this problem by setting the ratio of reversible capacity of the negative electrode to the reversible capacity of the positive electrode to be within the range of 1.05 and 1.30. *Id.*, ¶7.

Sakamoto describes a few examples with different reversible capacity ratios, where LiCoO_2 is used as the cathode active material and silicon monoxide was used as the anode active material. *Id.*, ¶15. Sakamoto cautions against raising cathode capacity and thus does not teach raising the charge cutoff voltage; instead, its examples are all charged to the traditional limit of 4.2V. *Id.*

Further, Sakamoto sets a conservative target for cycle life, *i.e.*, maintaining “70% of the initial capacity after 300 cycles.” APPLE-1005, ¶6. Sakamoto teaches that when the reversible capacity ratio of the anode active material to the cathode

active material was 0.94 (Battery A in Sakamoto), capacity “fell below 70% after 300 cycles.” ¶16. Sakamoto reports that its best-performing example (Battery D) had a reversible capacity ratio of 1.18 and retained approximately 75% of its capacity after 300 cycles. APPLE-1005, Fig. 1; Ex2007, ¶73.

3. Yasunami (Ex2030)

Yasunami is a Japanese patent application (titled “Method for charging and discharging a non-aqueous secondary battery”) directed to anode material improvements.

Yasunami criticizes prior art efforts to avoid lithium plating during overcharging (occurring when carbonaceous anode materials were used) by reconfiguring chargers or reducing the amount of positive electrode active material, reporting that they reduced the amount of active material thus “plac[ing] limits on the discharge capacity.” Ex2030, ¶2.

Yasunami teaches a new specific form transition metal oxide anode material. A POSITA would understand that lithium transition metal oxides have higher potential than carbonaceous materials, which reduces the risk of lithium plating. Ex2007, ¶80. Yasunami similarly explains that its anode is “fundamentally different” from carbonaceous materials” because transition metal oxides change their valence during charging and discharging. Ex2030, ¶44.

Though Yasunami hypothesizes about a broad range of “end-of-charge voltages,” none of its examples has a charge cutoff voltage above 4.2V. The highest voltage described in Yasunami’s examples was an externally applied 4.3V voltage with a constant current. As discussed below, a POSITA would understand that this applied voltage would result in a charge cutoff voltage below 4.2V.

Yasunami teaches that there is a significant degree of flexibility in terms of the electrode capacity ratio, which can thus be set “arbitrarily”:

The ratio of the positive electrode active material to the negative electrode active material used in the non-aqueous secondary battery of the present invention can be set *arbitrarily* according to the type of active materials to be combined.

Ex2030, ¶32 (emphasis added); Ex2007, ¶¶89-90.³

4. Koyama (APPLE-1007)

Koyama is titled “Non-aqueous electrolyte secondary battery” and discloses a battery with an anode to cathode reversible capacity ratio greater than 1.3 and equal

³ Petitioner’s translation of Yasunami conveniently omits the word “arbitrarily.” APPLE-1006, ¶32. PO provides a certified translation to correct this mistake. Ex2030.

to or less than 2.5. APPLE-1007, claim 1. Koyama does not disclose any cycle life data or a charge cutoff voltage higher than 4.2V.

5. Richardson (APPLE-1008)

Richardson is titled “Shutdown and redox shuttle additives for batteries” and describes “a group of shutdown additives” that could be added to the electrolyte of a secondary lithium-ion battery. APPLE-1008, Abstract. Richardson’s “redox shuttle additives” have a potential slightly above the maximum safe operating voltage of a lithium-ion battery. When the charging voltage exceeds that onset potential, the additives go through a process that consumes the excess electrical energy, thereby limiting the voltage of the battery to the onset potential of these molecules. Ex2007, ¶¶99-102.

Consistent with the conventional wisdom at that time, Richardson teaches that 4.2V is the voltage to which lithium manganese oxide cells will be charged to full normal capacity. APPLE-1008 at 8.

6. Abraham (APPLE-1009)

Abraham is titled “chemical overcharge protection of lithium and lithium-ion secondary batteries” and describes another group of redox agents to provide overcharge protection. APPLE-1009, Abstract.

D. Level of Ordinary Skill

For purposes of this Patent Owner Response, Patent Owner does not dispute Petitioner’s level of ordinary skill.

III. CLAIM CONSTRUCTION

Petitioner purports to base its challenges on the plain and ordinary meaning of the claim terms and contends that its references meet all the limitations under the constructions that PO proposed (and the district court adopted) or the constructions Petitioner proposed in the Apple litigation. Pet., 4-5. However, Petitioner has failed to apply the construction of “charge cut-off voltage.”

Accordingly, PO proposes the construction set forth below, consistent with the intrinsic record (including the claims where those terms appear), a POSITA’s understanding, and the testimony of the experts (including Petitioner’s expert and Samsung’s expert from the co-pending Samsung IPR).

A. “charge cut-off voltage”

In the Apple litigation, PO proposed, and the district court agreed, to construe “charge cut-off voltage” as “the maximum voltage to which the battery is configured to be charged.” APPLE-1031 at 7-11. Samsung also agreed in the Samsung litigation. Ex2027. In the Samsung IPR, Samsung’s expert Mr. Juzkow agrees that this construction is the plain and ordinary meaning of the term. Ex2022. at 217:6-11 (“Q. It also says that if this term needs construction, it should be afforded its plain and ordinary meaning, which is the maximum voltage to which the battery is configured to be charged, right? A. Right. That’s the plain and ordinary meaning that I agree with”).

Consistent with the Apple litigation, PO proposes that “charge cut-off voltage” should be construed as “the maximum voltage *to* which the battery is *configured to be charged*.”

As Dr. Yao explains, a POSITA would know that the battery voltage (including “the maximum voltage to which a battery is configured to be charged”) is different than the voltage applied to the battery during charging (including the maximum externally applied voltage). Ex2007, ¶107; Ex2008, 157:1-2 (“If you want to charge it, you got to apply a voltage that’s higher than [the open circuit voltage].”); *id.*, 91:19-22; Ex2022, 57:1-5 (“So in order to move ions from the cathode to anode, one would have to apply a voltage external to the battery that is greater than the open circuit voltage. Correct? A. Yes.”).

A POSITA would know that the battery voltage to which a battery is charged is equal to the voltage between the cathode and the anode.⁴ When no current is flowing between the electrodes, and the battery is in equilibrium, the battery voltage is known as the “equilibrium potential.” When the battery is disconnected from a power source, e.g., at the end of charging, the measured voltage between the

⁴ Or the difference between the voltage of the cathode versus lithium metal and that of the anode versus lithium metal.

electrodes is known as the “open circuit voltage.” Ex2007, ¶109; Ex2008, 91:23-92:1; Ex2022, 56:3-9.

A POSITA would also know that (i) the battery is charged at an externally applied voltage (applied, e.g., with a charger) that causes electrons and lithium ions to flow from the cathode to the anode (Ex2007, ¶¶109-112); and (ii) the applied voltage at which the battery is charged is always greater than the battery voltage because an external voltage greater than the battery voltage (i.e., the voltage difference between the cathode and anode) is needed to drive lithium ions from the cathode to the anode. *Id.*; Ex2022, 56:14-57:5.

The difference between the battery voltage and the applied voltage (also referred to in the art as the “overpotential”) depends on various factors, including the charging current and the duration of the charging, which are principal drivers of measured differences between applied voltage and battery voltage. Ex2007, ¶¶112-114. For example, when the current increases and the charging time decreases, *e.g.*, in fast charging conditions, the overpotential increases. *Id.*; Ex2008, 161:21-25; *id.*, 162:5-9; Ex2022, 58:18-20. In contrast, lower charging current (and slower charging) decreases the overpotential. Ex2007, ¶113.

Likewise, the use of a constant current for charging (i.e., a method whereby the current is kept constant until reaching a certain applied voltage) will lead to a greater overpotential than the more commonly applied constant current/constant

voltage charging method (i.e., a method in which a constant current is followed by a constant voltage at varying current, such that the battery charge is topped off). Ex2007, ¶114; Ex2022, 58:18-20.

A POSITA would also know that the applied voltage depends upon factors external to the battery, such as the charger's settings. In contrast, "the maximum voltage *to* which the battery is *configured to be charged*" (i.e., the charge cut-off voltage) is dictated by the battery's structure (i.e., the chemistry and design), and exceeding it can cause battery degradation or hazardous operating conditions. Ex2007, ¶115. Petitioner's expert Mr. Hruska agrees. *See* Ex2008, 155:11-14 ("the open circuit is determined by the chemistry of the components").

Because the claims of the '641 Patent are directed to the secondary lithium-ion battery itself, and "charge cut-off voltage" is a property of the battery, it is clear that "charge cut-off voltage" refers to the maximum voltage to which a battery is configured to be charged (i.e., a battery voltage) and not the externally applied voltage at which a battery is charged. Ex2007, ¶115.

A POSITA would also understand that the applied voltage may (even if temporarily) exceed the charge cut-off voltage during charging (technically, the applied voltage can be set to any level by external equipment); however, this external condition would not change the charge cut-off voltage (e.g., increase it), as this would require altering what is a battery property. *Id.*

Moreover, construing “charge cut-off voltage” as the applied voltage would improperly render a claimed structural property of the claimed secondary battery dependent upon external factors (e.g., charging conditions controlled by the charger) and introduce uncertainties when the meaning of the term as proposed by PO in the Apple case would be clear to a POSITA. *See Ruckus Wireless, Inc. v. Innovative Wireless Sols., LLC*, 824 F.3d 999, 1004 (Fed. Cir. 2016) (construction that creates ambiguity should be rejected).

PO’s construction is also consistent with the literature as of the priority date. As discussed above, at that time, the charge cutoff voltage of secondary lithium-ion battery was limited to 4.2V. Linden’s Handbook of Batteries expressly states that this limit of 4.2V refers to the “open circuit” voltage, i.e., the battery voltage. *See* APPLE-1015, 23.11; Ex2007, ¶116.

Accordingly, the Board should construe “charge cut-off voltage” as “the maximum voltage *to* which the battery is *configured to be charged*,” distinguished from an externally applied voltage.

IV. GROUND 1A: A POSITA WOULD NOT HAVE HAD REASON TO COMBINE YAMAKI WITH SAKAMOTO WITH A REASONABLE EXPECTATION OF SUCCESS

In Ground 1A, Petitioner asserts that a POSITA would combine Yamaki and Sakamoto to practice a battery with the cathode and anode active materials described

in Yamaki, the charge cutoff voltage described in Yamaki, and the capacity ratio described in Sakamoto.

As discussed in detail below, Ground 1A fails because: (1) Petitioner's alleged combination is driven by hindsight bias, including because the prior art, including Sakamoto (which Petitioner asserts supplies the claimed capacity ratio range), taught away from charge cutoff voltages above 4.2V, and there was no teaching or guidance that would have led a POSITA to consider the capacity ratio (an overlooked design parameter as of the priority date) as relevant to the charge cutoff voltage (*Ruiz v. A.B. Chance Co.*, 357 F.3d 1270, 1275 (Fed. Cir. 2004)); (2) Yamaki's battery system is "fundamentally different" from the Sakamoto system such that a POSITA would have had no reason to combine them or a reasonable expectation of success in doing so; and (3) even assuming a POSITA were to raise the charge cutoff voltage above 4.2V, there is no suggestion to also set the capacity ratio within the levels Petitioner alleges are disclosed in Sakamoto.

A. Ground 1 fails because it is driven by hindsight bias.

Petitioner asserts that a POSITA would be motivated to combine Yamaki with Sakamoto to achieve a battery with better cycle life, improved safety, and resistance to overcharging. Pet., 11-12. Petitioner's assertion is incorrect and driven by improper hindsight bias because it ignores the teachings of the prior art and instead uses the '641 Patent itself as a roadmap to find the claimed elements in different

prior art references. *See, e.g., Cheese Sys., Inc. v. Tetra Pak Cheese and Powder Sys., Inc.*, 725 F.3d 1341, 1352 (Fed. Cir. 2013) (“Among the difficult challenges of applying the doctrine of obviousness is avoidance of even a hint of hindsight. Obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention.”).

As a threshold matter, Petitioner ignores the teachings in the art that the charge cutoff voltage could not safely exceed 4.2V, which were conventional wisdom as of the '641 Patent's priority date. *See* section II.B.2. Petitioner asserts that Yamaki goes against this conventional wisdom and teaches a battery that can be safely charged to levels above 4.2V. Not so. As discussed *supra*, a POSITA would understand that Yamaki's alleged invention was still at a highly preliminary stage. Ex2007, ¶¶126-127; *see supra* section II.C.1. Further, Yamaki only provides testing data for 10 cycles, which do not allow meaningful conclusions as to the Yamaki or Yamaki-Sakamoto battery's rechargeability, performance, and safety in normal operating conditions over its life cycle. *See* APPLE-1004, claim 4; *see supra* section II.C.1. Critically, Yamaki's data is so limited—and the cathode it discloses so preliminary and untested—that a POSITA would not understand Yamaki to teach that it is safe or efficacious to exceed the conventional 4.2V charge cutoff voltage limit. Ex2007, ¶¶126-127.

Petitioner’s expert confirms the preliminary nature of the Yamaki battery with his testimony that establishing an appropriate charge cutoff voltage involved testing and ascertaining “a host of factors,” including the “electrolytes, the salts, the electrodes, the metals, the positive electrode, the carbons used in the negative” (Ex2008, 89:22-90:8); and that the industry arrived at the conventional 4.2V only after balancing issues such as “safety, capacity, lifetime performance.” *Id.*, 72:3-7; *see also* Ex2007, ¶¶126-127.

Contrary to Petitioner’s assertions—which improperly ignore the conventional wisdom of limiting the charge cutoff voltage to 4.2V (arrived at through years of rigorous research)—a POSITA 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.*

But even if a POSITA attempted to raise the charge cutoff voltage above 4.2V in light of Yamaki, Petitioner engages in hindsight bias by contending that a POSITA would combine Yamaki with Sakamoto. For example, Petitioner ignores that Sakamoto teaches against increasing positive electrode capacity, i.e., the principal effect of raising the charge cutoff voltage to the levels Petitioner asserts are disclosed in Yamaki, and thus teaches against raising the charge cutoff voltage. Ex2007, ¶¶128-129.

In particular, Sakamoto teaches prioritizing safety and against increasing the lithium in circulation during charging/discharging. APPLE-1005, ¶5. Sakamoto explains that increasing the lithium circulating in the battery leads to undesirable lithium plating (*id.*); and, consistent with its teachings about safety, Sakamoto limits the charge cutoff voltage to 4.2V. *Id.*, ¶15. A POSITA would understand that Yamaki's higher voltages would increase the lithium in circulation during charging/recharging, *i.e.*, precisely what Sakamoto expressly teaches away from. Accordingly, a POSITA would understand that Sakamoto teaches away from the elevated voltage levels that Petitioner asserts are disclosed in Yamaki. Ex2007, ¶129.

Further, Petitioner ignores a body of literature evidencing that batteries were routinely designed with excess cathode capacity and POSITA did not understand that adjusting the anode to cathode capacity (e.g., to the claimed ranges) would allow raising the charge cutoff voltage. Ex2007, ¶¶130-133.

In particular, Petitioner's expert incorrectly and misleadingly asserts that battery manufacturers always designed lithium-ion batteries with more anode capacity than cathode capacity. Ex2008, 139:15-19, 148:16-149:1. But the record is replete with references—which Petitioner and its expert have improperly overlooked—disclosing batteries that as of the priority date were designed with more cathode than anode capacity. *See* section II.B.3. The record thus belies Petitioner's expert, who testified that he could not think of any reason for using more cathode

capacity or recall any battery manufacturers that did so. Ex2008, 139:15-19, 148:16-149:1. For instance, battery manufacturers designed batteries with more cathode than anode capacity to compensate for lithium loss known to occur during charging and discharging. *See, e.g.*, Ex2016, 3650 (“the common procedure is to assemble cells having a greater than theoretical amount of positive-electrode mass, thus allowing for losses of cyclable lithium during operation by initially providing extra lithium”); Ex2015, 4 (study by US Army Research Laboratory reporting greater cathode than anode active material capacity); Ex2007, ¶51. The Board should disregard Petitioner’s cherry-picked (and inaccurate) portrayal of the state of the art.

In addition, as of the priority date, there was no definitive guidance in the art of battery design as to the appropriate ranges for setting the capacity ratio. *See* section II.B.3. Petitioner’s own primary reference Yasunami suggests that the ratio can be set “arbitrarily,” thus suggesting that POSITAs understood they had great flexibility in setting the capacity ratio for secondary lithium-ion batteries. Ex2030, ¶32. Indeed, Yasunami teaches that “[t]here are no particular restrictions on the use ratio for the positive electrode active material and the negative electrode active

material” and that it does not matter whether the capacity of one electrode is greater, less, or equal than the capacity of the other.⁵ APPLE-1006, ¶19; Ex2007, ¶¶88-90.

In any event, even setting aside Yasunami’s teaching that the ratio can be set arbitrarily, there is no evidence that a POSITA would consider the capacity ratio relevant to increasing the charge cutoff voltage. Literature published almost two decades after the priority date demonstrates that the impact of the capacity ratio on battery performance was little known and under-researched as of the priority date. *See* Ex2028; Ex2007, ¶130. Thus, a POSITA would not understand that it would be possible to practice the claimed charge cutoff voltage range by practicing the claimed capacity ratio, as taught in the ’641 Patent and required by claim 5.

Critically, Petitioner provides no reason why a POSITA would have ignored the various references describing batteries with capacity ratios outside of the claimed range (i.e., with greater cathode than anode capacity) and attempted to exceed the conventional 4.2V limit on the charge cutoff voltage by adjusting the capacity ratio. Ex2007, ¶¶126-133. Rather than provide a reason why a POSITA would make such

⁵ Patent Owner disagrees that paragraph 19 of Yasunami describes the ratio of a secondary lithium-ion battery. Instead, as Dr. Yao explains, paragraph 19 describes the ratio of a precursor battery used to prepare the anode active material in Yasunami. Ex2007, ¶¶83-87.

an adjustment, Petitioner and its expert use the '641 Patent as a roadmap to combine elements from Sakamoto and Yamaki to meet the claims, notwithstanding that Sakamoto teaches away from Yamaki's voltage levels. The Board should reject Petitioner's assertion that a POSITA would combine Yamaki and Sakamoto because it is marred by hindsight bias.

B. Ground 1 fails because a POSITA would not combine Yamaki's battery with the fundamentally different Sakamoto battery.

Petitioner contends that secondary lithium-ion batteries were known to “operate with a charge cut-off voltage of greater than 4.2V and were known to have more negative than positive electrode capacity” (Pet., 14), and that a POSITA would have been motivated to combine Yamaki and Sakamoto with a reasonable expectation of success on the basis of alleged similarities between the two references. *Id.*, 13-14. Not so.

As discussed *supra* (II.C.1.), Yamaki stated during prosecution that Yamaki's battery system is “fundamentally different” from conventional 4.2V battery systems, such that it is “extremely difficult” to predict the Yamaki battery's performance voltages above 4.2V based on performance at lower voltages. Ex2019. This is consistent with the conventional wisdom as of the priority date that it was not safe or efficacious to use a charge cutoff voltage over 4.2V, as well as Sakamoto's teachings to limit the amount of lithium ions in circulation and its disclosure of batteries that did not exceed 4.2V. Ex2007, ¶¶129, 135. Further, as discussed *supra*,

the safety and efficacy of a particular charge cutoff voltage involved the assessment of numerous factors. *See* Ex2008, 89:22-90:8;72:3-7; *see also* Ex2007, ¶¶126-127. In short, a POSITA would understand that (i) the efficacy and safety of the Yamaki-Sakamoto combination would require substantial and rigorous testing over hundreds of cycles and assessing numerous factors bearing upon the combination battery's structure and performance, and (ii) there was no reason to expect that the Yamaki-Sakamoto combination would operate safely and efficaciously (e.g., based on the data disclosed in Yamaki, Sakamoto and in the art more generally), 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). Ex2006, ¶¶134-136.

In sum, a POSITA would not be motivated to combine Yamaki and Sakamoto; but even if a POSITA did, such a POSITA would not have a reasonable expectation that the Yamaki-Sakamoto combination would successfully meet the claimed charge cutoff voltage and capacity ratio limitations without undue experimentation. *Id.*

C. Ground 1 fails because there is no suggestion that adjusting the capacity ratio would allow a POSITA to raise the charge cutoff voltage above 4.2V.

The 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.

Indeed, 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, as disclosed in Sakamoto. *See, e.g.*, APPLE-1007 (Koyama) (charging at 4.2V); APPLE-1019, 5:39-53 (disclosing an “upper limit voltage” of 4.1V); APPLE-1021 (Satoshi) (charging at 3.5V); *see also* Ex2007, ¶138. The consistency with which the prior art discloses a maximum 4.2V charge cutoff voltage in batteries with more anode than cathode capacity evidences that POSITAs did not have reason to expect that adjusting the capacity ratio allowed raising the charge cutoff voltage. Indeed, the ’641 Patent is the first to link these two battery design parameters.

Further, every battery that Petitioner asserts discloses charge cutoff voltages higher than 4.2V either contains no disclosures about the capacity ratio (*see* APPLE-1023, APPLE-1025, APPLE-1012) or discloses a capacity ratio outside the claimed range (i.e., has greater cathode than anode capacity). *See* APPLE-1024, 34:1-5; Ex2007, ¶139.

Petitioner also incorrectly asserts that Yamaki (at paragraph 15) provides a reason to adjust the capacity ratio in connection with raising the charge cutoff voltage above 4.2V. Not so. Paragraph 15 of Yamaki merely describes the benefit of Yamaki’s alleged invention: using a cathode with greater discharge capacity requires using less cathode material overall by increasing energy density. It does

teach it is in any way desirable to practice the claimed capacity ratio. Ex2007, ¶¶140-144.

In particular, Paragraph 15 of Yamaki states:

[0015] In other words, the discharge capacity of the positive electrode active material can be improved by setting the maximum potential of the positive electrode during charging to 4.4V or more in terms of metallic Li. As 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. Therefore, a lithium secondary battery with a higher energy density can be obtained in a limited battery volume.

According to Yamaki, increasing the voltage also increases cathode discharge capacity. Thus, less cathode active material is required for the same energy output, given a certain a battery volume, and more space is available within the battery for anode material (and because carbon anode is lighter than the cathode active material, the overall weight of the battery decreases). Accordingly, the amount of energy stored per unit of mass increases for a given overall energy output. In any event, there is no teaching to increase the relative capacity of the anode. Ex2007, ¶¶140-144. Even Petitioner's expert acknowledges that Yamaki does not disclose adjusting the capacity ratio. Ex2008, 104:21-22 ("Yamaki doesn't describe, of course, one of

the key features, so it's missing that aspect"). Paragraph 15 merely describes one effect of increasing the voltage applied to a lithium-ion battery; but it does not teach a POSITA to modify the capacity ratio in any way, let alone to provide more anode than cathode capacity. Ex2007, ¶¶142-144.

Accordingly, Petitioner fails to meet its burden of showing that a POSITA would have been motivated to combine Yamaki with Sakamoto to arrive at the invention of the '641 Patent with a reasonable expectation of success.

V. GROUND 1A: YAMAKI-SAKAMOTO COMBINATION DOES NOT DISCLOSE THE LIMITATION OF CLAIMS 11-14

Claims 11-14 require the secondary lithium-ion battery to maintain at least 75%, 75.83%, 80%, or 80.72% of capacity after 400 cycles, respectively (the "cycle life limitation"). Petitioner claims that these claims are obvious over Yamaki and Sakamoto. Petitioner is wrong as a matter of law.

There is simply no evidence that the Yamaki-Sakamoto combination battery would maintain (or that a POSITA would expect it to maintain) the requisite level of capacity after 400 cycles (i.e., the claimed cycle life). Moreover, the evidence shows that a POSITA would expect that the Yamaki-Sakamoto combination battery would not retain the claimed cycle life.

A. The cycle life limitations of claims 11-14 are not necessarily present in the structure of claim 5.

Petitioner's first assertion is that claims 11-14 "do not recite structural features that further limit the secondary lithium ion cell or battery of claim 5, and thus are rendered obvious by Yamaki-Sakamoto at least as discussed *supra* for claim 5." Pet., 23. Petitioner is wrong as a matter of law.

It is well-settled that an apparatus claim may recite a claim limitation that describes a structural component of the invention in terms of a function that the structure must be able to perform. *See K-2 Corp. v. Salomon S.A.*, 191 F.3d 1356, 1363 (Fed. Cir. 1999) (finding it entirely appropriate that the claim includes functional language as "the functional language tells us something about the structural requirements" of the claimed device); *see also Alere, Inc. v. Rembrandt Diagnostics, LP*, 791 Fed. Appx. 173, 177 (Fed. Cir. 2019) ("This clause includes functional language that informs us of the structural requirements of the claim"); *Hill-Rom Servs., Inc. v. Stryker Corp.*, 755 F.3d 1367, 1374–75 (Fed. Cir. 2014) ("[D]efining a particular claim term by its function is not improper..."). Accordingly, the cycle life limitations of dependent claims 11-14—which require that the secondary lithium ion batteries of retain certain capacity levels after 400 cycles—properly narrow the structure recited in claim 5. *See, e.g., Endo Pharm. Inc. v. Teva Pharm. USA, Inc.*, 731 Fed. Appx. 962, 971 (Fed. Cir. 2018) (finding that patent owner did not claim "any controlled release configuration of oxymorphone

dosage, rather only those which have been specifically calibrated to produce the pharmacokinetic properties recited in the claims—excluding those that do not exhibit such properties.”).

It is also well-settled that for the prior art to meet dependent claims that narrow the structure of an independent claim with functional limitations, those limitations must be “necessarily ... present” in the prior art or “the natural result of the combination elements explicitly disclosed in the prior art.” *PAR Pharm., Inc. v. TWI Pharm., Inc.*, 773 F.3d 1186, 1195–96 (Fed. Cir. 2014).

Here, claims 11-14 narrow the scope of claim 5 to a secondary lithium-ion battery that maintains certain claimed capacity levels after 400 cycles; thus, claims 11-14 are not directed to **any** secondary lithium-ion battery that meets claim 5 but only those secondary lithium-ion batteries that meet both claim 5 **and** the cycle life limitations of claims 11-14. Accordingly, to prove by a preponderance of the evidence that the Yamaki-Sakamoto combination renders claims 11-14 obvious, Petitioner must demonstrate that the claimed cycle life limitations (i.e., minimum capacity retention levels recited in those claims) are either “necessarily present” or the “natural result of” the structure recited in claim 5. *Id.*

Petitioner cannot meet this burden. Petitioner’s expert testified that the limitations of claims 11-14 are **not** necessarily present in the battery recited in claim 5:

Q. Would every single battery that has all of those other aspects and a charge cutoff voltage above 4.2 volts but below 5.8 volts necessarily meet claims 11 through 14 so long as its capacity ratio fell within the claimed range?

A. No, I don't think so... You can't say these two features would guarantee that you would reach that cycle life in all cases, no.

Ex2008, 120:20-121:13; *see also* Ex2007, ¶148. Petitioner cannot thus contend that the cycle life limitation is necessarily present in or the natural result of the Yamaki-Sakamoto battery. Accordingly, Petitioner's first assertion (i.e., that the Yamaki-Sakamoto battery renders obvious claims 11-14 insofar as it renders obvious claim 5) fails.

B. A POSITA would not practice the cycle life limitations of claims 11-14 through routine experimentation with the structure of claim 5.

Petitioner's second assertion is that the Yamaki-Sakamoto retains claims 11-14 obvious on the basis that a POSITA could achieve the claimed capacity levels after 400 cycles through routine experimentation, *i.e.*, by adjusting the capacity ratio of the battery recited in claim 5. Pet., 23-30. This assertion likewise fails because (i) the Yamaki battery in Petitioner's combination only discloses capacity retention data for 10 cycles; and (ii) other batteries upon which Petitioner relies are operate in a materially different manner that would not lead a POSITA to expect that the

Yamaki-Sakamoto combination would retain the claimed capacity levels after 400 cycles.

In particular, Yamaki discloses a new cathode material used in experimental batteries that were subjected to 10-cycle testing. APPLE-1004, Fig.1. The testing in Yamaki is insufficient for a POSITA to glean a battery's long-term performance over hundreds of cycles, let alone to expect that the battery would retain the claimed capacity levels after 400 cycles. This is especially true in the case of Yamaki because Yamaki discloses an altogether *new* cathode material, as to the behavior, performance, and cycle life of which a POSITA would have had limited knowledge. Ex2007, ¶¶149-152, 161.

As Dr. Yao testifies, citing numerous examples, capacity retention after only a few initial cycles (e.g., 10 cycles) does not allow reasonably reliable conclusions concerning a battery's capacity retention over hundreds of cycles. A POSITA would know that batteries often retain substantial capacity during the first several charging/discharging cycles only to exhibit substantial capacity loss after hundreds of cycles. This is especially true for batteries that are subjected to voltages as high as those that Petitioner proposes for the Yamaki-Sakamoto combination. Moreover, a POSITA would know that capacity retention is an unpredictable battery property that may vary for different batteries, even when those batteries exhibit similar

capacity retention over the first several charging/discharging cycles to which they are subjected (e.g., 10 cycles). Ex2007, ¶¶153-161.

For example, Dr. Yao discusses a study where two cells with the same cathode active material ($\text{LiNi}_{0.8}\text{Co}_{0.1}\text{Mn}_{0.1}\text{O}_2$) and anode active material were cycled at 4.2V and 4.6V, respectively. Though the two cells exhibited similar capacity retention after 10 cycles, their retention differed after 100 cycles, where the cell cycled at 4.6V exhibited significant capacity loss, and the cell cycled at 4.2V exhibited substantially no capacity loss. *Id.*, ¶¶158-160.

As Dr. Yao further explains, the cycle life of a lithium-ion battery is primarily affected by the degradation of the electrode active material, especially the cathode. After successive charge/discharge cycles, the cathode undergoes more pronounced changes than the anode. For example, its crystal structure becomes unstable, and its resistance increases significantly, while the anode's resistance stays relatively the same. The literature explains that these structural changes of the cathode are “especially significant” at higher voltages. *Id.*, ¶¶153-161. Thus, a POSITA would not expect the Yamaki-Sakamoto battery to meet the cycle life limitations in light of the high voltages at which it is intended to operate and the fact that Yamaki does not provide data about cathode or battery cycle life for more than 10 cycles.

In addition, the data disclosed in Sakamoto would not create a reasonable expectation of success, as it does not suggest that the cathode of the Yamaki-

Sakamoto battery could withstand 400 charge-discharge cycles, as claimed at the high voltages disclosed in Yamaki. The battery with the greatest capacity retention in Sakamoto only maintains approximately 75% of capacity after 300 cycles tested at a charge cutoff voltage of 4.2V. A POSITA would not expect that raising the charge cutoff voltage above 4.2V limit would improve capacity retention; rather, a POSITA would expect that raising the charge cutoff voltage above 4.2V would dramatically decrease capacity retention, especially after 400 cycles, as required by claims 11-14, versus the 300 cycles disclosed in Sakamoto. *See* Ex2007, ¶162. Petitioner's expert testimony confirms this understanding. *See* APPLE-1003, ¶108 ("while batteries charged to higher cutoff voltages will have higher discharge capacity, they will generally also show more rapid loss in capacity upon extended cycling").

Petitioner concedes that Yamaki "does not provide a complete picture of the cyclability of the battery," but asserts (incorrectly) that a POSITA "would have found it reasonable to predict performance of the combination battery across more cycles based on Yamaki's 10-cycle testing in conjunction with knowledge of performance of other, similar batteries." Pet., 26. This is belied by Petitioner's expert, however, who testified that a POSITA cannot reliably predict the capacity retention of a battery based on its performance at a single test point (e.g., at the 10th cycle):

Q. I'm asking whether you could reliably predict the capacity retention of a battery after, say, 200 or 300 cycles without testing.

A. Well, *you can't reliably predict the capacity of a system from one data point no matter what the point is.*

It's a much more complex surface of the failure modes and capacity loss over time and cycles and conditions.

So you're asking if you could reliably predict. *I would say that you can't [reliably] predict from a single test point no matter where the point is.*

Ex2008, 46:12-23 (emphasis added). Mr. Hruska testified that testing is necessary (e.g., "the only way" and "always important") to obtain information about capacity retention after a number of cycles. *Id.*, 54:19-55:18; *see also* Ex2007, ¶¶160-161, 173.

In addition, Yamaki discloses testing conditions that are materially different from those in which the cycle life limitation of claims 11-14 were determined and defined. The '641 Patent discloses capacity retention levels after 400 cycles determined in what a POSITA would consider normal operating conditions of a secondary lithium-ion battery. In particular, the '641 Patent is directed to "improvement of [the] capacity of [a] commercialized secondary lithium ion battery." APPLE-1001, 1:19-28. It repeatedly explains that its invention achieves "substantial improvement of the specific energy of commercial lithium ion cells." *Id.*, 4:43-53;

1:64-67, 7:1-8, 9:45-49, 16:45-51. The '641 Patent specifies many conditions for its cycle life testing, including the assembly of a battery incorporating essential components, the charge cutoff voltage, the capacity ratio, and the average operating voltage. *See, e.g., id.*, 9:56-10:25; 10:33-36. The '641 Patent further states that “[e]xcept voltage, all process parameters for charge and discharge are commonly used in the art.” *Id.*, 9:22-23. Reading the claimed language in this context, “a POSITA [would] understand that normal testing conditions for commercial batteries are to be utilized” for the cycle life testing in claims 11-14, just as the district court in the Apple litigation concluded. *See* APPLE-1031 at 30. For instance, a POSITA would avoid employing elevated or low temperatures that could sharply diminish the battery’s cycle life. Rather, they would opt for room temperature testing. Similarly, a POSITA would avoid using low or high charging current; instead, they would use a typical charging current, such as 0.5C or 1C as noted in industry standards and product specifications. *See* Ex2017; Ex2018; *see also* Ex2007, ¶¶167-172.

In contrast to the '641 Patent, Yamaki discloses an extremely low charging and discharging current: it would take at least 8 hours for the battery to be fully charged, and another 8 hours for the battery to be fully discharged. This is not the typical charging and discharging current used to assess the normal cycle life of a

battery.⁶ A POSITA would understand that a low current is used usually as part of the initial assessment of a battery's performance, but it does not reflect how the battery will be used in practical settings, and it is not within the scope of claims 11-14. Ex2007, ¶173.

In short, Yamaki discloses testing in experimental conditions, i.e., using a low current in a highly controlled experimental setting, designed for a preliminary assessment of the battery cathode's performance. A POSITA would know that the low current (and slow charging) disclosed in Yamaki extends a battery's cycle life. Thus, even setting aside Yamaki's lack of experimental data for more than 10 cycles, a POSITA would know that Yamaki's capacity retention data does not allow the conclusion (or create the expectation) that the Yamaki or the Yamaki-Sakamoto battery would retain the capacity levels required by claims 11-14 after 400 cycles. Ex2007, ¶¶167-173; *see Endo Pharm.*, 731 Fed. Appx. at 970 (affirming the district

⁶ Petitioner also asserts that the '641 Patent does not provide a description of "how to achieve the recited capacity retention beyond specifying the charge cut-off voltage and ratio." Pet., 24. However, the '641 Patent provides 28 examples, several of which meet the required capacity retention in claims 11-14 after 400 cycles. APPLE-1001, 9:56-15:54. In contrast, Petitioner provides no such data with respect to the Yamaki-Sakamoto combination battery.

court's finding of non-obviousness because the prior art references measured the limitations in a different manner).

Because Yamaki and Sakamoto do not disclose testing data—or other information—that would allow a POSITA to ascertain the Yamaki-Sakamoto battery's cycle life or capacity retention after 400 cycles, Petitioner has cannot establish by a preponderance of the evidence that the Yamaki-Sakamoto battery render claims 11-14 obvious.

Petitioner attempts to supply the missing data that precludes Yamaki-Sakamoto from rendering claims 11-14 obvious as a matter of law with other references containing cycle life and capacity retention data. Pet., 26. As explained below, none of these would allow a POSITA to draw conclusions about the Yamaki-Sakamoto hypothetical battery's capacity retention.

As an initial matter, all of the references cited by Petitioner are drawn to fundamentally different battery systems than the alleged Yamaki-Sakamoto combination, and therefore do not lend themselves to conclusions about the cycle life of the combination battery. For example, Petitioner relies upon the cycle life relating to batteries using spinel lithium manganese oxide (LiMn_2O_4) as the cathode active material. Pet., 26. However, as Dr. Yao explains, LiMn_2O_4 has a different crystal structure from the cathode active material used in Yamaki and a different degradation mechanism. Accordingly, a POSITA would not have relied upon the

cycle life performance of LiMn_2O_4 to predict the cycle life of the batteries in Yamaki. Ex2007, ¶164.

Further, Petitioner relies upon references that disclose cycle life data for batteries that were charged to the conventional charge cutoff voltage of 4.2V or less. *See* APPLE-1015, 23.11 (charging up to 4.2V); APPLE-1017, 5:11-17 (cycling between 4.2V and 2.5V). These references are insufficient to glean the cycle life and capacity retention of the Yamaki-Sakamoto battery because, as discussed above, increasing the charge cutoff voltage (as Petitioner proposes with respect to the Yamaki-Sakamoto combination) decreases cycle life and capacity retention. A POSITA would thus expect the Yamaki-Sakamoto battery system charged to voltages above 4.2V to retain dramatically less capacity than systems configured to be charged to 4.2V. Ex2007, ¶165. Accordingly, Petitioner cannot demonstrate by a preponderance that the Yamaki-Sakamoto battery would retain the capacity levels required by claims 11-14 based upon evidence of satisfactory capacity retention in dramatically different systems, designed for lower voltage levels. *Id.*, ¶166.

Lastly, Petitioner's assertion that a POSITA would have found it obvious to implement through routine experimentation a Yamaki-Sakamoto battery that has the claimed capacity retention (Pet., 27-30) misses the point. The point is not only that a POSITA could not adjust the Yamaki-Sakamoto battery design (e.g., the proportion of the cathode to the anode) to affect battery performance (e.g., cycle life

or capacity retention) with routine experimentation, but also that the proposed combination would not meet claims 11-14 even after routine experimentation.

As a threshold matter, there is no evidence that a POSITA could configure Petitioner's Yamaki-Sakamoto combination to meet the claimed capacity levels after 400 cycles. But Petitioner's contentions suffer also from a much greater problem. In particular, it is unlikely (or at the very least entirely uncertain) that the cathode material in the Yamaki-Sakamoto combination (i.e., the cathode of Yamaki) would be suitable for retaining the capacity levels required by claims 11-14 when it is used in a battery charged to the claimed charge cutoff voltage range. A POSITA would understand that if the reason a cathode active material cannot be durably cycled at a voltage greater than 4.2V is due to its structural characteristics, then there is no way for a POSITA to adjust other design parameters (e.g., electrolyte, separator) to retain the required capacity after 400 cycles. As discussed above, Yamaki provides no data showing that its new and unknown cathode material retained the claimed capacity levels after 400 cycles in the claimed charge cut-off voltage range, as required by claims 11-14. Yamaki's disclosure is limited to batteries that maintain more than 80% of capacity after only 10 cycles. APPLE-1004, claim 4. It is impossible to—and a POSITA would not—conclude from this data that Yamaki (or Yamaki-Sakamoto) would perform as required in claims 11-14. None of the other references relied upon by Petitioner suggest otherwise either. Contrary to Petitioner's assertion,

a POSITA would not have found it obvious to combine Yamaki-Sakamoto through routine experimentation and reasonably expect to practice claims 11-14. Ex2007, ¶¶174-175.

Accordingly, Petitioner fails to meet its burden that Yamaki in view of Sakamoto renders claims 11-14 obvious.

VI. GROUND 1B: CLAIMS 9 AND 10 ARE NOT RENDERED OBVIOUS BY YAMAKI, SAKAMOTO, AND ABRAHAM

Petitioner asserts that claims 9-10 of the '641 Patent are obvious over Yamaki in view of both Sakamoto and Abraham. Pet., 31. Ground 1B only adds to Yamaki and Sakamoto the Abraham reference to attempt to show that dependent claims 9-10 are obvious. However, because claims 9-10 depend from claim 5, Petitioner has failed to show that claims 9-10 are also rendered obvious by the three references.

VII. GROUND 2A/2B: YASUNAMI DOES NOT RENDER THE CLAIMED CHARGE CUTOFF VOLTAGE RANGE OBVIOUS

Petitioner argues that a POSITA would have been motivated to combine Yasunami with Koyama with a reasonable expectation of success. Petitioner relies exclusively on Yasunami for the charge cutoff voltage limitation and on Koyama for the ratio limitation. According to Petitioner, the Yasunami-Koyama combination battery would have the cathode active material and anode active material as described in Yasunami, and such a battery would have the charge cutoff voltage described in Yasunami and the capacity ratio described in Koyama. Pet., 41-43.

Claim 5 recites a secondary lithium-ion battery with a charge cut-off voltage “greater than 4.2V but less than 5.8V.” APPLE-1001, 17:6-7. Petitioner argues that Yasunami discloses the charge cutoff voltage range based on Yasunami’s disclosures of (1) a range of “end-of-charge voltage” of 3.5-4.7V; and (2) three examples of “end-of-charge voltage” of 4.3V (battery no. 1 in Table 1; battery no. 1 in Table 2; and battery no. 4 in Table 3). Pet., 48-51.

As explained in detail below, Grounds 2A&2B fail because Yasunami discloses an applied voltage of 4.3V, not a charge cutoff voltage. In addition, the numerical overlap between the claimed charge cutoff voltage range (greater than 4.2V and lower than 5.8V) and the “end-of-charge voltage” range described in Yasunami (3.5V to 4.7V) does not render the claimed range obvious because a POSITA would have understood that the prior art taught away from the claimed range, and the range of 3.5-4.2V works in a materially different manner from the claimed range of 4.2-4.7V.

A. Yasunami discloses an applied voltage rather than a charge cutoff voltage.

The claimed charge cut-off voltage is the “the maximum voltage to which the battery is configured to be charged,” *i.e.*, a battery voltage. *Supra*, III.A. In contrast, Yasunami discloses an *applied voltage* of 4.3V, which is *not a battery voltage*, let alone a charge cut-off voltage above 4.2V. Ex2030, ¶66. As conceded by

Petitioner's own expert, an applied voltage is not a battery voltage. Ex2008, 157:1-2.

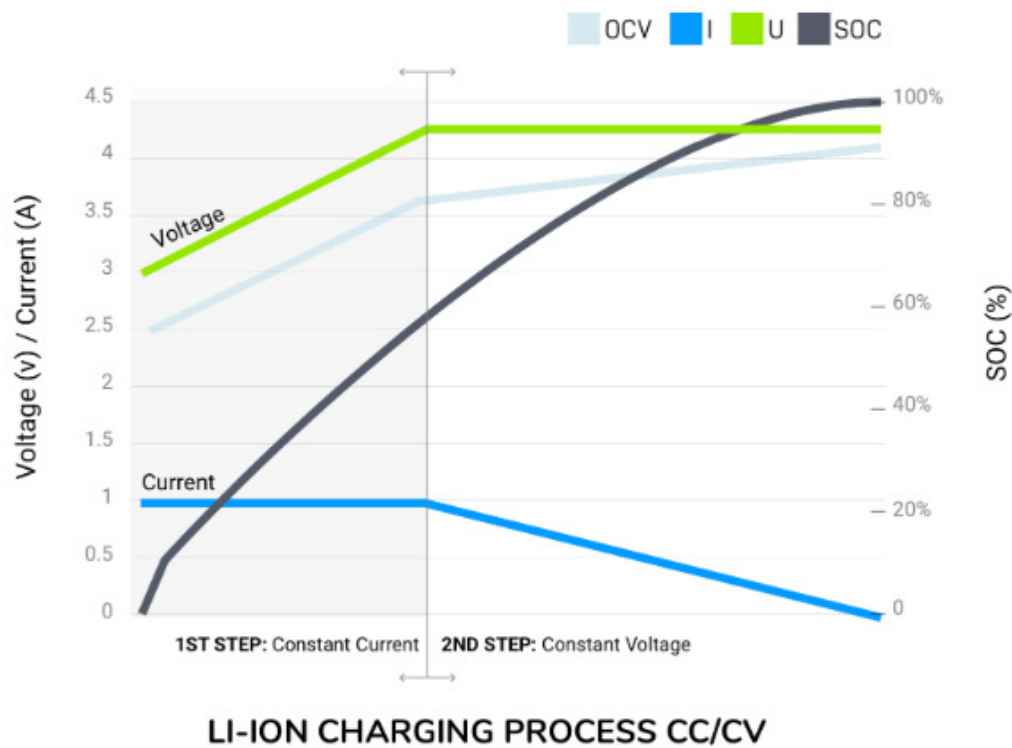
Further, Yasunami's disclosure of an applied voltage equal to 4.3V does not translate to a disclosure of a battery voltage above 4.2V. First, as all experts agree, the applied voltage is always higher than the battery voltage. Ex2007, ¶111; Ex2008, 157:1-2; 91:19-22; Ex2022, 57:1-5. Dr. Yao further explains that it is not possible to determine the battery voltage (i.e., open circuit voltage) in Yasunami from Yasunami's disclosure of an applied voltage. Indeed, Yasunami's battery voltage is likely lower than 4.2V. Ex2007, ¶187.

In particular, Yasunami discloses charging batteries with a constant current at 2 mA/cm² at a maximum *applied* voltage equal to 4.3V. Ex2030, ¶66. A POSITA would understand that in Yasunami's constant current charging, the charging stops once the applied voltage reaches 4.3V. A POSITA would also understand that charging a battery *to* the maximum voltage for which it was configured (i.e., the charge cut-off voltage) requires applying an external voltage (equal to or higher than the charge cut-off voltage) in a constant voltage charging phase that follows the

constant current phase described.⁷ Ex2007, ¶¶188-189. Using a constant voltage charging phase after the constant current charging phase was known in the art to be the typical way to obtain a battery voltage that approximates the applied voltage (e.g., 4.2V).

Below is a figure showing the process of CC/CV charging.

⁷ Though it is possible to fully charge a battery using only a constant current, the current must be lower and the charging slower than what is disclosed in Yasunami. Yasunami does not disclose whether the current used, i.e., 2 mA/cm², constitutes slow or fast charging. Accordingly, Petitioner cannot meet its burden to show that the batteries in Yasunami would have been fully charged to a charge cut-off voltage above 4.2V.



Ex2025. As shown, in CC/CV charging (i) the battery is charged with a constant current until the applied voltage reaches a specified voltage (e.g., the maximum battery voltage), (ii) as the current gradually decreases, the applied voltage is kept constant for enough time to allow the battery voltage (light blue line) to increase and gradually approximate the applied voltage (green line), and (iii) when the current approximates zero, and the battery voltage is practically equal to the applied voltage, the charging stops. At this point, the battery is considered fully charged. Ex2007, ¶114.

A POSITA would thus understand that obtaining with reasonable certainty a battery voltage above 4.2V would require applying a constant voltage above 4.2V for sufficient time to allow the battery voltage to approximate the applied voltage.

Critically, a POSITA would expect that the difference between Yasunami's applied voltage and the battery voltage in Yasunami's examples is greater than 0.1V, such that the battery voltage in Yasunami is less than 4.2V. Ex2007, ¶¶188-192. For example, the literature reports for a battery with a LiCoO_2 cathode that when the applied voltage reaches 4.2V for the first time under the constant current charging phase, its capacity was only approximately 60% of its full capacity, for a charge current equal to 1A. Ex2014. Such a state of charge could correspond to an open circuit voltage of less than 4V. Ex2007, ¶¶188-192.

Moreover, even if a POSITA expected the difference between Yasunami's applied voltage and its charge cutoff voltage to be less than 0.1V (a POSITA would not), Yasunami's disclosures of its applied voltage do not disclose the charge cutoff voltage ranges in claims 6 and 7 because those claims require a charge cut-off voltage of at least 4.3V. Because it is undisputed that the applied voltage must be less than the battery voltage, claims 6 and 7 are indisputably patentable over Yasunami and Koyama.

In any event, Yasunami does not disclose information sufficient to determine the difference between the applied voltage and the corresponding battery voltage for

its examples. This difference depends on many factors, including the charging current and the battery's resistance. Without such information, a POSITA would not be able to determine the battery voltage in Yasunami's examples because Yasunami does not provide the information needed to do so. Ex2007, ¶¶186-192.

Petitioner's expert Mr. Hruska admits that the "end-of-charge voltage" described in Yasunami is "in the context of constant current charging." APPLE-1003, ¶189. Mr. Hruska asserts that a POSITA would have found it obvious to further charge the battery at a constant voltage phase to "gain additional capacity." *Id.*, ¶190. Not so. Charging the battery at a constant voltage would increase the charge cutoff voltage of those example batteries to be above the traditional limit of 4.2V. Ex2007, ¶192. As discussed above, at the priority date, a POSITA would not have done so because exceeding this limit would cause of undesirable consequences and degrade battery performance. *See* section II.B.2. There is no suggestion that a POSITA would disregard this conventional wisdom with respect to the Yasunami battery, let alone with a reasonable expectation of success.

In summary, Yasunami discloses constant current charging with an applied voltage rather than a battery voltage; and a POSITA would understand that the corresponding battery voltage for Yasunami's batteries could not exceed 4.2V, because (i) the applied voltage always exceeds the battery voltage, (ii) the applied

constant current was not followed by a constant voltage that would charge the battery to such a voltage level.

B. The prior art taught away from the claimed charge cutoff voltage range and reported unexpected results.

Petitioner additionally asserts that because Yasunami discloses an “end-of-charge voltage” range of 3.5-4.7V, which allegedly overlaps with the “charge cutoff voltage” range of 4.2-5.8V of claim 5, Yasunami renders the claimed charge cutoff voltage range *prima facie* obvious. Not so.

First, because Yasunami’s “end-of-charge voltage” is the externally applied voltage and a POSITA cannot determine with a reasonable certainty what the corresponding battery voltage is from Yasunami’s disclosure of such an applied voltage, Petitioner fails to show that there is an overlap between the voltage range disclosed in Yasunami and the claimed charge cutoff voltage of the ’641 Patent. Ex2007, ¶194.

Second, the prior art’s teaching away from the claimed range and the ’641 Patent’s new and unexpected results within the claimed range (i.e., when the charge cutoff voltage is above 4.2V) rebut Petitioner’s contention about *prima facie* obviousness on the basis of Yasunami’s disclosures of applied voltages within the same numerical (but not battery voltage) range.

A presumption of obviousness applies where a claimed range overlaps with a range disclosed in the prior art. The presumption is overcome if the patentee can

come forward with evidence that “(1) the prior art taught away from the claimed invention; (2) there were new and unexpected results relative to the prior art; or (3) there are other pertinent secondary considerations.” *Allergan, Inc. v. Sandoz Inc.*, 796 F.3d 1293, 1305 (Fed. Cir. 2015).

Because Petitioner fails to prove with reasonable certainty there is an overlap between Yasunami’s “end-of-charge voltage” range and the claimed charge cutoff voltage range of the ’641 Patent, Petitioner fails to establish a case of *prima facie* obviousness. Even if there were an overlap, as discussed above, the prior art teaches away from the claimed range, as it was conventional wisdom that the charge cutoff voltage of a secondary lithium-ion battery was limited to 4.2V as of the priority date. *See supra* section II.B.2. As the ’641 Patent explains, consistent with a large body of literature in the field, when the charge cutoff voltage exceeds 4.2V, electrolyte decomposes, the crystal structure of the cathode becomes unstable, and battery performance deteriorates. *See, e.g.*, APPLE-1001, 1:51-63. It was thus well-known in the art that the range between 3.5V and 4.2V works in a materially different way from the range of 4.2-4.7V. As discussed *supra*, this is also reflected in the statements by Yamaki before the Japanese Patent Office. Ex2019.

Petitioner claims that PO fails to show any unexpected results because it does not present any data for charge cutoff voltage below 4.2V. Not so. As of the priority date of the ’641 Patent, a POSITA would understand that below 4.2V, the battery

would have lower capacity and longer cycle life; and exceeding 4.2V would lead to decreasing cycle life. In contrast, the '641 Patent presents surprising data showing that when the charge cutoff voltage was increased to greater than 4.2V and the capacity ratio was adjusted according to the teachings of the '641 Patent, even at voltages greater than 4.2V, the batteries were able to have increased capacity while still maintain excellent cycle life. APPLE-1001, 10:26-15:54. For example, the '641 Patent teaches the unexpected result that it is possible to raise the charge cutoff voltage (e.g., to 4.3V in Example 2) and also increase the capacity (from 1113 mAh to 1206 mAh) and improve cycle life (maintaining 86.31% of capacity after 400 cycles, compared to 85.72% of capacity at 4.2V after 400 cycles). APPLE-1001, 10:26-50. The '641 Patent further teaches that when the charge cutoff voltage was increased further to 4.4V in Example 4, the capacity was substantially higher at 1302 mAh, and the battery was still able to retain 83.93% of its initial capacity after 400 cycles. *Id.*, 10:65-11:6. The '641 Patent shows numerous similar examples in its specification. *See* APPLE-1001, 10:26-15:54; Ex2007, ¶¶195-197.

Accordingly, any presumption of obviousness is rebutted by the evidence of teaching away and unexpected results.

VIII. Ground 2A: A POSITA WOULD NOT HAVE HAD A REASON TO COMBINE YASUNAMI WITH KOYAMA OR A REASONABLE EXPECTATION OF SUCCESS IN DOING SO

Petitioner argues that a POSITA would have been motivated to combine Yasunami with Koyama with a reasonable expectation of success.

First, Petitioner argues that a POSITA would have been motivated to implement the capacity ratio described by Koyama to obtain a battery with better charging performance (i.e., faster charging), better safety, and good cycle life. Pet., 43-44. Not so. A POSITA would not adopt the approach described in Koyama to the battery system in Yasunami. Contrary to the prior art approach of using carbonaceous materials as the anode (Ex2030, ¶2), Yasunami teaches that a lithium-containing transition metal oxide should be used as the anode active material. *Id.*, ¶7. Yasunami discloses that its anode active material works in a “fundamentally different” way than carbonaceous anode materials. Ex2030, ¶44. Yasunami claims that by using its proposed anode active material, the “dendritic metal precipitation” problem identified can be addressed, and a secondary battery “having a higher battery voltage, a high discharge capacity (high energy density), and a long charge/discharge cycle lifespan” can be obtained. *Id.*, ¶6; Ex2007, ¶¶200-201.

As Dr. Yao explains and consistent with Yasunami, a POSITA would understand that lithium-containing transition metal oxide is fundamentally different from carbonaceous material as an anode active material. As discussed in section

II.C.3, because lithium transition metal oxides, such as LiCoVO_4 , operate at a higher potential than graphite, using lithium transition metal oxides reduces the risk of lithium plating on the anode during charging, which enhances safety. However, also because of the higher potential, the voltage difference between the cathode and the anode would be smaller, compared to when graphite is used as the anode material, which in turn reduces energy density. A POSITA thus would be careful not to adopt an approach—such as the one disclosed in Koyama—that would further reduce energy density. Ex2007, ¶¶201-204.

Given Yasunami's teaching, a POSITA would not have been motivated to modify Yasunami by adopting the capacity ratio described by Koyama. As an initial matter, Koyama's proposed approach is exactly the approach that Yasunami teaches against. Yasunami states that reducing the cathode active material is disfavored because it reduces discharge capacity. Koyama suggests reducing the cathode active material to have more anode capacity than cathode capacity in a battery. APPLE-1007, ¶¶3, 6-7. A POSITA would not have combined Yasunami with Koyama's approach, which Yasunami expressly teaches against. *See* Ex2030, ¶2 ("However, a problem with the latter method is that limiting the amount of active material, which in turn limiting the discharge capacity"); Ex2007, ¶¶201-203.

More importantly, a POSITA would understand that any benefit from Koyama's approach would be marginal at most. In particular, Yasunami addresses

the problem of lithium plating (i.e., the problem to which the Koyama approach is directed) by using lithium transition metal oxides as the anode active material; thus, it would be redundant and indeed counterproductive to combine Koyama, whose approach reduces energy density to undesirably low levels. Ex2007, ¶204. Accordingly, a POSITA would not combine Yasunami with Koyama because such a combination would reduce energy density without any appreciable benefit.

Second, a POSITA would not have had reason to implement the ratio described by Koyama because Yasunami teaches that the capacity ratio is a trivial design parameter that would not have a significant effect on battery performance. As discussed above, Yasunami states that for a combination of cathode and anode materials, the ratio between the two can be set “arbitrarily.” Ex2030, ¶44. Even the passage on which Petitioner relies states that virtually any ratio is acceptable, thus teaching a POSITA that the ratio is not relevant to the charge cutoff voltage of a lithium-ion battery. *Id.*, ¶19. As discussed above, Koyama’s approach reduces energy density by reducing the amount of positive electrode material in the battery. A POSITA would not have modified a battery to reduce its energy density by adjusting a design parameter (the ratio) that Yasunami expressly taught was unimportant.

Finally, Petitioner incorrectly asserts that a POSITA would have been motivated to combine Yasunami with Koyama with a reasonable expectation of

success because they describe “similar materials systems” and that “because secondary lithium ion batteries were known to operate with a charge cutoff voltage of greater than 4.2V and were known to have more negative than positive electrode capacity, and disclosures of each were commonly described, as in Yasunami and Koyama, without precluding the other.” Pet., 45-47. Petitioner is wrong.

To the extent that Yasunami discloses charge cutoff voltage higher than 4.2V (it does not, as discussed above), the battery system in Yasunami is fundamentally different from the one in Koyama. As discussed above, a battery with higher voltages is fundamentally different from a battery with the conventional 4.2V limit, and it is “extremely difficult” to predict the performance of a battery with a higher voltage based on its performance at lower voltages. *See supra* section IV. Petitioner also fails to point to any reference that discloses the two elements in tandem.

Accordingly, a POSITA would not have been motivated to combine Yasunami with Koyama with a reasonable expectation of success.

IX. GROUND 2A: YASUNAMI-KOYAMA COMBINATION DOES NOT RENDER CLAIMS 11-14 OBVIOUS

Like the Yamaki-Sakamoto combination, Petitioner argues that the Yasunami-Koyama combination also renders claims 11-14 of the '641 Patent obvious. For similar reasons as those discussed *supra* with respect to Yamaki-Sakamoto, Petitioner is wrong as a matter of law.

Petitioner provides no evidence showing that the Yasunami-Koyama combination battery would maintain the claimed level of capacity after 400 cycles. On the contrary, a POSITA would have reasonably expected the opposite.

Rather than adduce evidence that its proposed combination discloses the claimed cycle life limitations—or that a POSITA could reasonably expect to adjust the combination to meet them without undue experimentation—Petitioner contends that claims 11-14 “do not recite structural features that further limit the secondary lithium ion cell or battery of claim 5, and thus are rendered obvious by Yasunami-Koyama at least as discussed *supra* for claim 5.” Pet., 59. For the same reasons as explained above, Petitioner is wrong as a matter of law. *See supra* section V.

Petitioner then argues that a POSITA would have found obvious that the Yasunami-Koyama battery retains the claimed capacity levels. Pet., 59. Again, not so. As Petitioner admits, Yasunami achieves only 60% capacity retention after 200 cycles. Pet., 60; *see also* Ex2001, Table 1, Table 2, Table 3. Further, ***none*** of the example batteries in Yasunami meet the limitations of claims 11-14. The other reference in Petitioner’s combination, Koyama does not provide any cycle life data. Thus, the combination does not disclose the cycle life limitation. Ex2007, ¶¶209-211.

Because Koyama does not disclose any cycle life data, Petitioner instead refers to Sakamoto. Pet., 60. But there, the best example battery was only able to

retain approximately 75% of capacity after 300 cycles. APPLE-1005, Fig. 1; Ex2007, ¶211. As discussed above, additional charge/discharge cycles would result in further capacity loss. At 400 cycles, the best battery in Sakamoto would have a capacity lower than 75%, which does not meet the requirement of claim 11, let alone other claims which require even higher capacity retention. *Id.*

Moreover, to the extent that Yasunami discloses a charge cutoff voltage greater than higher than 4.2V (it does not), a POSITA would have expected the cycle life to worsen, not become better compared to a battery when cycled at the traditional limit of 4.2V. *See* section V. A POSITA thus would not have found it obvious that the Yasunami-Koyama battery would be able to maintain more than 75% of capacity after 400 cycles based on the data in Yasunami and Koyama.

In Ground 1A, Petitioner cites to a number of references that are not asserted in its grounds showing the cycle life behavior of secondary lithium-ion batteries. *See* Section V.A. As discussed above, those references are irrelevant to the purported Yamaki-Sakamoto combination battery because they concern cathode materials that are dissimilar from the Yamaki cathode active material. Here, for the Yasunami-Koyama combination, Petitioner relies upon the same references attempting to show that the purported Yasunami-Koyama combination battery would have the same cycle life as the batteries in those references. Pet., 60. However, Petitioner makes the same mistake: those references concern materially

different battery systems from the Yasunami-Koyama combination battery. In particular, the references Petitioner relies upon all employ carbon material as the anode. In contrast, the Yasunami-Koyama combination battery uses lithium transition metal oxides as the anode active material, and thus behave differently from carbon anode batteries. As discussed above, Yasunami teaches that its anode, i.e., lithium transition metal oxides, are “fundamentally different” from carbon anode. Ex2030, ¶44. Lithium transition metal oxides have a higher potential relative to carbon material, and they change valence during charging and discharging. *Id.*; Ex2007, ¶213. In addition, lithium transition metal oxides tend to suffer from structural instability during cycling, leading to capacity fading and reduced cycle life. A POSITA would not expect that the cycle life of the Yasunami-Koyama combination would meet the claimed cycle life limitations in claims 11-14 on the basis of the carbon anode battery systems cited by Petitioner, which were known to possess materially different cycling stability than lithium transition metal oxide systems like the Yasunami-Koyama combination. *Id.*

Petitioner finally argues that a POSITA would have found it obvious to implement through routine experimentation a Yasunami-Koyama battery that has the claimed capacity retention. Pet., 61. But just like the Yamaki-Sakamoto combination, Petitioner fails to demonstrate that the Yasunami-Koyama combination battery is suitable to maintain more than 75% of capacity after 400

cycles. If anything, the data in Yasunami demonstrates that such a battery cannot maintain the required capacity, as its capacity dropped below 60% after about 200 cycles. Ex2007, ¶¶214-215.

Accordingly, Petitioner fails to meet its burden of demonstrating that claims 11-14 are obvious over Yasunami and Koyama.

X. GROUND 2B: CLAIMS 9 AND 10 ARE NOT RENDERED OBVIOUS BY YASUNAMI, KOYAMA, AND RICHARDSON

Petitioner asserts that claims 9-10 of the '641 Patent are obvious over Yasunami in view of both Koyama and Richardson. Pet., 63. Ground 1B only adds to Yasunami and Koyama the Richardson reference to attempt to show that dependent claims 9-10 are obvious. However, because claims 9-10 depend from claim 5, Petitioner has failed to show that claims 9-10 are also rendered obvious by the three references.

XI. CONCLUSION

For the reasons set forth herein, PO respectfully requests that the Board find each of the challenged claims patentable.

Date: June 17, 2024

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CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMITS

This Patent Owner's Response ("POR") consists of 13,563 words, excluding table of contents, table of authorities, certificate of service, this certificate, or table of exhibits. The POR complies with the type-volume limitation of 14,000 words as mandated in 37 C.F.R. § 42.24. In preparing this certificate, counsel has relied on the word count of the word-processing system used to prepare the paper (Microsoft Word).

Dated: June 17, 2024

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that the following documents were served by electronic service, by agreement between the parties, on the date below:

**PATENT OWNER'S RESPONSE
EXHIBIT 2006-2030**

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