

Apple Inc. (Petitioner)
v.
RJ Technology LLC (Patent Owner)
Petitioner's Demonstratives

Case No. IPR2023-01350
U.S. Patent No. 7,749,641
Before Jon B. Tornquist, Christopher M. Kaiser, and Brian D. Range
Administrative Patent Judges



DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

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'641 Patent and Petition Overview

The '641 Patent

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

Asserted Grounds

Ground	Claims	Basis for Rejection
1A	5-8, 11-14	§103: Yamaki, Sakamoto
1B	9-10	§103: Yamaki, Sakamoto, Abraham
2A	5-14	§103: Yasunami, Koyama
2B	9-10	§103: Yasunami, Koyama, Richardson

Claims 5-8 Are Unpatentable over Yamaki-Sakamoto

Yamaki-Sakamoto Combination

- Overview of the Yamaki-Sakamoto combination
- Issue 1.1: The Yamaki-Sakamoto combination satisfies the claimed charge cut-off voltage range
- Issue 1.2: A POSITA would have been motivated to combine Yamaki and Sakamoto
- Issue 1.3: A POSITA would have expected success in combining Yamaki and Sakamoto

The Yamaki-Sakamoto Combination

Yamaki's battery has high CCV and good cycle life

[0012]

It is an object of the present invention to solve this problem by providing a lithium secondary battery with high energy density and excellent cycle characteristics by specifying a Co-based oxide to be used as the positive electrode active material and a conductive material to be used in the positive electrode.

[0014]

When such a battery configuration is used, the maximum potential of the positive electrode during charging can be from 4.4 V to 4.8 V in terms of metallic Li while also suppressing deterioration in the reversibility of charging and discharging as more charging and discharging cycles are performed.

APPLE-1004, [0012], [0014]; Petition, 6-7

Sakamoto describes a range of capacity balance values

[0007]

[Means for Solving the Problem]

In order to solve the problems described above, in the present invention, the reversible capacity balance of the positive electrode and the negative electrode is set to the range of $1.05 < \text{negative electrode/positive electrode} \leq 1.30$, and the reversible capacity of the negative electrode is set so to be greater than the reversible capacity of the positive electrode. Therefore, lithium ions can be sufficiently occluded in the negative electrode during charging or overcharging, and deposition of lithium is less likely to occur. As a result, a high-performance battery can be obtained that experiences less deterioration after repeated charging and discharging, and that is safer.

APPLE-1005, [0007]; Petition, 8-9

The Yamaki-Sakamoto combination

In Yamaki-Sakamoto, a lithium secondary cell based on Yamaki includes positive and negative electrode active materials in amounts that satisfy a reversible capacity balance based on Sakamoto. APPLE-1003, ¶¶29-35.

As taught by Yamaki, the combination battery operates with “a maximum potential of the positive electrode during charging...from 4.4 V to 4.8 V.”

APPLE-1004, [0014]; APPLE-1003, ¶34. The presence of the additional elements

...

The amounts of positive and negative electrode active material in the combination battery are set based on Sakamoto such that “[t]he reversible capacities of the positive electrode and the negative electrode” are in “the range of $1.05 < \text{negative electrode/positive electrode} \leq 1.30$.” APPLE-1005, Abstract;

The Yamaki-Sakamoto combination

Petition

First, a POSITA would have expected success because Yamaki suggests increasing the relative amount of negative electrode active material in its battery, and indeed, does so specifically in the context of a “maximum potential” of 4.4-4.8V. APPLE-1004, [0014]-[0015]; APPLE-1003, ¶48.

Yamaki

[0014]

When such a battery configuration is used, the maximum potential of the positive electrode during charging can be from 4.4 V to 4.8 V in terms of metallic Li while also suppressing deterioration in the reversibility of charging and discharging as more charging and discharging cycles are performed.

[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 4.4 V 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.

ISSUE 1.1

The Yamaki-Sakamoto Battery Satisfies the Claimed Charge Cut-off Voltage Range

[5a] the secondary lithium ion cell or battery has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V

Yamaki's charge cut-off voltage falls within the claimed range

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

[0014]

When such a battery configuration is used, the maximum potential of the positive electrode during charging can be from 4.4 V to 4.8 V in terms of metallic Li while also suppressing deterioration in the reversibility of charging and discharging as more charging and discharging cycles are performed.

APPLE-1004, [0014]; Petition, 15

Expert testimony confirms that Yamaki describes viable batteries

Patent Owner's Sur-reply

As an initial matter, Yamaki's data is limited to 10 charge-discharge cycles (APPLE-1003, ¶28); thus, Yamaki does not provide a POSITA with sufficient information from which to draw conclusions as to the performance of a battery using Yamaki's CCV, alone or in combination with a different battery such as Sakamoto's. POR, 27-33; Ex2007, ¶¶126-145. Rather, a POSITA would lack a reasonable expectation as to how such a combination might operate regardless of its starting point (i.e., Yamaki or Sakamoto). This is reflected in Mr. Hruska's testimony that

APPLE-1035, ¶7-8; Pet. Reply, 7-8; PO Sur-reply, 2-3

Second Hruska Declaration

7. I acknowledge that Yamaki gives experimental results for only 10 cycles of testing. *See, e.g.*, APPLE-1004 (Yamaki), Table 1. However, given the entire context of Yamaki, it is my opinion that a POSITA would have understood Yamaki to be teaching a viable battery. Specifically, Yamaki describes its own battery as a "lithium secondary battery with high energy density and *excellent cycle characteristics*." APPLE-1004 (Yamaki), Abstract. And, importantly, Yamaki describes the physical mechanism that enables this excellent cycle life behavior to be achieved: the composition of Yamaki's electrodes "suppress[es] deterioration in the reversibility of charging and discharging as more charging and discharging cycles are performed." APPLE-1004 (Yamaki), [0014]. This occurs because the presence of "at least one element selected from Mg, Al, Mn, Ti and Sr" helps to avoid the "phase transition" that would otherwise occur and lead to deterioration. *Id.*, [0018]. Indeed, Yamaki gives a credible and detailed explanation for why the presence of this element helps to avoid this undesirable phase transition: "the added element is believed to replace Co or Li or form a solid

Yamaki describes viable batteries

[0012]

It is an object of the present invention to solve this problem by providing a lithium secondary battery with high energy density and excellent cycle characteristics by specifying a Co-based oxide to be used as the positive electrode active material and a conductive material to be used in the positive electrode.

Deposition of Patent Owner's expert

14 Q. Okay. And if I could point you to
15 paragraph 12 of Yamaki, Dr. Yao.

16 A. Yes.

17 Q. There it says that an object of Yamaki
18 is, one, high energy density; and, two, excellent
19 cycle characteristics.

20 Do you see that?

21 A. Yes.

22 Q. What would a POSITA understand the

1 phrase "excellent cycle characteristics" to mean?

2 For instance, would that mean long cycle life?

3 MR. ZHOU: Object to form.

4 THE WITNESS: I think that excellent
5 cycle characteristics, yeah, meaning, you know,
6 many long cycle life, according to the standard
7 testing standards that typically more than a few
8 hundred cycles is considered excellent cycle
9 characteristics.

Yamaki is an enabling reference

Pet Reply

To the extent that PO is implicitly denigrating Yamaki as non-enabling (which Petitioner does not concede), PO's position is legally flawed. Prior art is presumed to be enabling absent a compelling reason otherwise, which PO has not provided.³ See *In re Sasse*, 629 F.2d 675, 681 (C.C.P.A. 1980). Moreover, in an obviousness ground, "a reference need not be enabled; it qualifies as a prior art, regardless, for whatever is disclosed therein." *Amgen Inc. v. Hoechst Marion Roussel, Inc.*, 314 F.3d 1313, 1357 (Fed. Cir. 2003); *Canon Inc. et al. v. HS Asset and Technology, LLC*, IPR2018-00499, Paper 19 at 27-28 (July 23, 2019) (citing *Symbol Techs., Inc. v. Opticon, Inc.*, 935 F.2d 1569, 1578 (Fed. Cir. 1991) ("obviousness references do not need to be enabling")). In the Yamaki-Sakamoto context, then, PO's attempt to belittle the sufficiency of Yamaki's disclosure (POR, 27-28) should be rejected: Yamaki can be relied upon properly for its undisputed disclosure of a battery having CCV above 4.2V. APPLE-1004, [0014]; Petition, 15-17.

Pet. Reply, 8-9

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ISSUE 1.2

A POSITA Would Have Been Motivated to
Combine Yamaki and Sakamoto

*[5b] 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*

The Yamaki-Sakamoto combination

Patent Owner's Response

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-

Petitioner's Reply

PO's argument that Sakamoto "teaches against raising the charge cutoff voltage" betrays a continued misunderstanding of the Yamaki-Sakamoto combination. POR, 28. As was previously established, the question raised in the Petition is the obviousness of modifying Yamaki's battery—which already has a CCV above 4.2V—to implement a capacity ratio per Sakamoto. Petition, 10; Petitioner's Reply to Patent Owner's Preliminary Response, 3-4; Institution Decision, 29. In this context, there is no question of a motivation to "rais[e] the charge cutoff voltage," as PO asserts, or indeed of a teaching away from so doing, because the starting point for the combination—Yamaki—already has such a CCV. POR, 28. See *Schwendimann v. Neenah, Inc.*, 82 F.4th 1371, 1384 (Fed. Cir. 2023) ("In the context of an obviousness challenge ..., describing one of the references as 'primary' means that it is the reference to be modified by the 'secondary' or other references.").

POR, 28; Pet. Reply, 9-10

The Yamaki-Sakamoto combination

Petition

The value of the ratio in the combination

The **ratio of positive electrode material to negative electrode material** in the combination battery (the reciprocal of Sakamoto's reversible capacity balance) is, e.g., **1:1.05-1:1.30** (Sakamoto's "1.05 < negative electrode/positive electrode <= 1.30") or **1:1.10-1:1.20** (Sakamoto's "1.10 or more and 1.20 or less"). APPLE-1005, [0007]-[0008]; see [0012], [0015]-[0016], claim 1; APPLE-1003, ¶¶84-85. These ratios and ranges of ratios fall within the range of ratios recited in claim 5 (**1:1.0-1:2.5**). APPLE-1003, ¶86. In the combination, Sakamoto's disclosure of these ratios thus informs the obviousness of the recited range of ratios: Yamaki-Sakamoto renders obvious a battery having positive and negative electrode material in **a ratio of from 1:1.0 to 1:1.25**. APPLE-1003, ¶87. See *Ineos*, 783 F.3d at 869, *Titanium Metals*, 778 F.2d at 782.

Patent Owner's Response

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.

Petitioner's Reply

PO's argument that "a body of literature evidenc[es] that batteries were routinely designed with excess cathode capacity" (POR, 29) **ignores that the advanced ground is based on the specific Yamaki-Sakamoto combination, not a generic combination of Yamaki and some arbitrary teachings in the art**. That other batteries may have had more positive than negative capacity is not at issue here; the question is specifically the combination of Yamaki and Sakamoto. POR, 29; Petition, 14; APPLE-1003, ¶55.

Petition, 20-21; POR, 29; Pet. Reply, 11

The Petition motivated the Yamaki-Sakamoto combination

Patent Owner's Response

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.

Petitioner's Reply

PO argues that "there was no definitive guidance ... as to the appropriate ranges for setting the capacity ratio." POR, 30. This is just not true. The Petition identified *five distinct reasons* providing such guidance. Petition, 11-13. PO does not even attempt to rebut any of these reasons.

Instead, PO cites to Yasunami's disclosure that the ratio can be set "arbitrarily" as evidence that "POSITAs understood that they had great flexibility in setting the capacity ratio." POR, 30, citing EX2030, [0032].⁴ But PO's reliance on this statement is misplaced: PO appears to take Yasunami's statement as a proxy for *all* knowledge of a POSITA, ignoring that other teachings in the art do counsel toward having more negative than positive capacity, and indeed would have been attractive to a POSITA specifically because of Yasunami's indicated "flexibility" in this regard. Petition, 11-13.

POR, 30-31; Pet. Reply, 12

The Petition presented five motivations for the combination

First, a POSITA would have been motivated to pursue improved “cycle performance” offered by batteries having the materials ratio described by Sakamoto, particularly given Yamaki’s indication that such a ratio is appropriate. APPLE-1005, [0017]; *see* APPLE-1004, [0015]; APPLE-1003, ¶¶37-40.

Second, a POSITA would have been motivated to pursue this implementation because batteries having a capacity balance such as Sakamoto’s are “safer,” *e.g.*, “due to low risk of heat being generated and an explosion occurring,” again encouraged by Yamaki’s teaching that such a ratio is appropriate. APPLE-1005, [0007], [0008]; *see* [0017]; APPLE-1004, [0015]; APPLE-1020, 5; APPLE-1022, [000], [0017]; APPLE-1018, [0033]; APPLE-1003, ¶¶41-42.

Third, a POSITA would have been motivated to obtain a battery having “[r]esistance to overcharging,” which is achievable with batteries satisfying Sakamoto’s capacity balance. APPLE-1005, [0017]; *see* APPLE-1004, [0015];

Fourth, an increase in the amount of negative electrode active material is suitable for Yamaki’s battery: in a battery implementing a “maximum potential” of 4.4-4.8V, Yamaki explains that “the amount of positive electrode active material in the battery can be reduced, and *the amount of negative electrode active material can be increased.*” APPLE-1004, [0014]-[0015]; APPLE-1003, ¶45. Absent specifics from Yamaki regarding the magnitude of this increase, a POSITA would have looked to Sakamoto—which describes a battery composition consistent with that of Yamaki’s battery—for implementation details. APPLE-1003, ¶45. For

Fifth, a POSITA would have been prompted to pursue this implementation because doing so is merely the application of known techniques (*e.g.*, a secondary lithium battery having more negative electrode capacity than positive electrode capacity) by a known system (*e.g.*, Yamaki’s battery, which does not promote an alternative ratio) to yield predictable results (*e.g.*, a secondary lithium ion battery having positive/negative electrode active material in amounts to provide a specific, and known, capacity balance). APPLE-1003, ¶46; *see KSR Int’l Co. v. Teleflex*

Petition, 11-12

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The Petition motivated the Yamaki-Sakamoto combination

Patent Owner's Sur-reply

Mr. Hruska cherry-picked prior art with greater anode capacity to misleadingly bolster the opinions he was hired to supply, *i.e.*, that a POSITA would have known to design a battery with Yamaki's CCV and Sakamoto's capacity ratio.¹ In doing so, Mr. Hruska has improperly used the '641 Patent's disclosure about the interplay between the battery's CCV and capacity ratio as a roadmap for the Yamaki-Sakamoto combination, willfully ignoring the prior art in its context (including "the background knowledge possessed by a [POSITA]"), and engaging in textbook hindsight bias. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 401 (2007); see *WBIP*,

PO Sur-reply, 7

ISSUE 1.3

A POSITA Would Have Expected Success
in Combining Yamaki and Sakamoto

The Petition demonstrated that a POSITA would have expected success

Petition

First, a POSITA would have expected success because Yamaki suggests increasing the relative amount of negative electrode active material in its battery, and indeed, does so specifically in the context of a “maximum potential” of 4.4-4.8V. APPLE-1004, [0014]-[0015]; APPLE-1003, ¶48.

Yamaki

[0014]

When such a battery configuration is used, the maximum potential of the positive electrode during charging can be from 4.4 V to 4.8 V in terms of metallic Li while also suppressing deterioration in the reversibility of charging and discharging as more charging and discharging cycles are performed.

[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 4.4 V 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.

APPLE-1004, [0014]-[0015]; Petition, 13

25

The Petition demonstrated that a POSITA would have expected success

Patent Owner's Response

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.

POR, 33; Pet. Reply, 11-12, 14

Petition

Second, a POSITA would have been motivated to pursue this implementation because batteries having a capacity balance such as Sakamoto's are "safer," e.g., "due to low risk of heat being generated and an explosion occurring," again encouraged by Yamaki's teaching that such a ratio is appropriate.

Third, a POSITA would have expected success because both Yamaki and Sakamoto describe secondary lithium ion batteries with similar materials systems, as detailed by Hruska. APPLE-1003, ¶¶50-54; *see* APPLE-1004, Abstract, [0016], [0013], [0018], [0020]-[0023], [0030], [0033]; APPLE-1005, [0012]-[0013], [0015]. And as noted *supra*, neither Yamaki nor Sakamoto provides any indication that the features of their respective batteries would not be suitable for integration by the other. APPLE-1003, ¶54. Indeed, Yamaki even indicates the suitability of providing more negative electrode material capacity than positive, consistent with Sakamoto's implementation. *See* APPLE-1004, [0014]; APPLE-1005, [0012];

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The Petition demonstrated that a POSITA would have expected success

Sakamoto

[0008]

[Embodiment of the Invention]

The present invention increases the negative electrode/positive reversible capacity balance to within the range of $1.05 < \text{negative electrode/positive electrode} \leq 1.30$. If the reversible capacity balance is 1.05 or less, the reversible capacity balance may reach 1 or less locally due to variations in electrode manufacturing, etc. If the reversible capacity balance is more than 1.30, too much of the compound does not participate in charging and the amount of the compound that can be charged and discharged is locally reduced when a battery with a constant volume is inserted. Also, if the negative electrode active material changes due to the amount of compound and an excessive amount of negative electrode compound is present, the potential does not decrease during charging, leading substantially to overcharging of the positive electrode active material. Thus, as mentioned above, the optimum reversible capacity balance is in the range of $1.05 < \text{negative electrode/positive electrode} \leq 1.30$. However, the range is preferably 1.10 or more and 1.20 or less. By setting the reversible capacity balance of the negative electrode and the positive electrode to the range in the present invention, lithium is not deposited even when overcharged. This means a secondary battery can be provided that is safe due to low risk of heat being generated and an explosion occurring, and that has good cycle characteristics after repeated charging and discharging.

Petition

Second, a POSITA would have been motivated to pursue this implementation because batteries having a capacity balance such as Sakamoto's are "safer," e.g., "due to low risk of heat being generated and an explosion occurring," again encouraged by Yamaki's teaching that such a ratio is appropriate.

APPLE-1005, [0008]; Pet. Reply, 11-12

Claims 5-8 Are Unpatentable over Yasunami-Koyama

Yasunami-Koyama Combination

- Overview of the Yasunami-Koyama combination
- Issue 1.4: “Charge cut-off voltage”
- Issue 1.5: The combination satisfies the claimed charge cut-off voltage range
- Issue 1.6: A POSITA would have been motivated to combine Yasunami and Koyama

The Yasunami-Koyama Combination

Yasunami's battery has a high end-of-charge voltage

Yasunami

[0006]

[Problem to be Solved by the Invention]

It is an object of the present invention to provide a non-aqueous secondary battery having a high battery voltage, high discharge capacity (high energy density), and long charge/discharge cycle life, and to provide a charge/discharge method for this non-aqueous secondary battery.

[0034]

The end-of-charge voltage is preferably in the range from 3.5 to 4.7 V, more preferably from 3.7 to 4.5 V, and even more preferably from 3.8 to 4.4 V to realize a 3-V class battery voltage. If it is lower than 3.5 V, the battery voltage will be low, and if it is higher than 4.7 V, the positive electrode active material and the electrolyte may decompose.

APPLE-1006, [0006], [0034]; Petition, 39

Koyama describes a range of capacity balance values

Koyama

[0005]

It is an object of the present invention to solve this problem by providing a nonaqueous electrolyte secondary battery with better charging characteristics than the prior art.

[0006]

[Means for Solving the Problem]

The invention according to claim 1 is a secondary battery comprising a positive electrode, a negative electrode, and a nonaqueous electrolyte, wherein the capacity ratio (B/A) between the electrode capacity A of the positive electrode and the electrode capacity B of the negative electrode is $1.3 < (B/A) \leq 2.5$.

APPLE-1007, [0005]-[0006]; Petition, 40

The Yasunami-Koyama combination

Petition

In Yasunami-Koyama, a lithium secondary cell based on Yasunami includes positive and negative electrode active materials in amounts that satisfy a capacity ratio based on Koyama. APPLE-1003, ¶163.

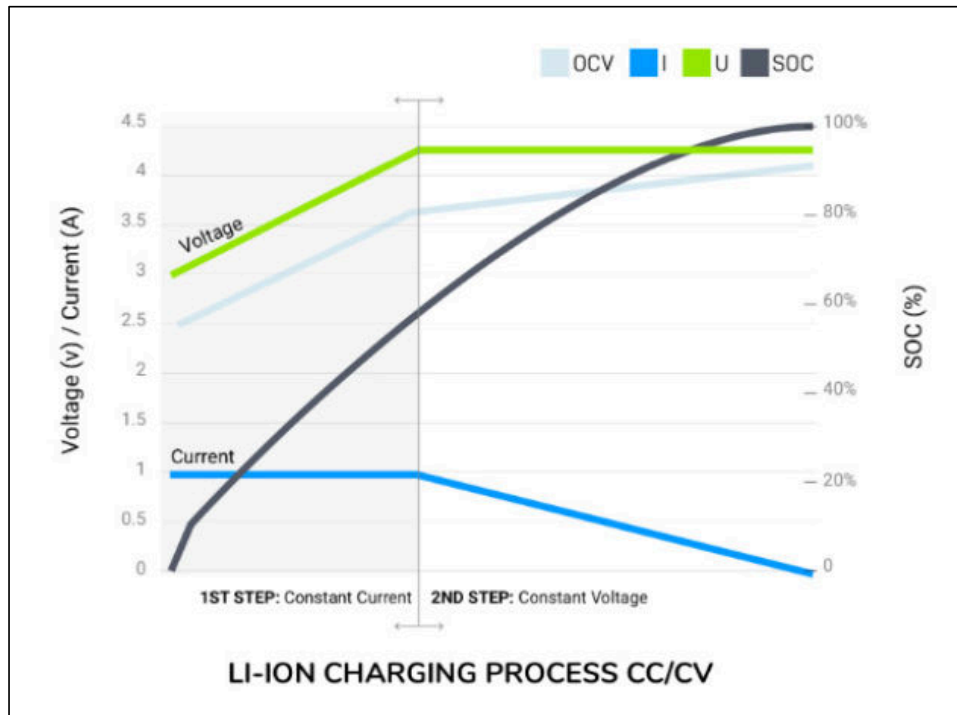
The combination battery includes positive and negative electrode active material in amounts such that the capacity ratio (B/A) between the capacity of the positive electrode active material and the capacity of the negative electrode active material is in the range of “ $1.3 < (B/A) \leq 2.5$,” based on Koyama. APPLE-1007, [0006]; APPLE-1003, ¶167.

In operation, the end-of-charge voltage of the combination battery is 3.5V-4.7V, as taught by Yasunami. See APPLE-1006, [0034]; APPLE-1003, ¶168. Importantly, the combination battery does not risk decomposition of the positive electrode active material or the electrolyte (see APPLE-1006, [0034]) because the composition of the positive electrode active material and electrolyte are consistent with those described by Yasunami and thus compatible with this range of voltages.

ISSUE 1.4

“Charge Cut-off Voltage”

Battery charging



Patent Owner's Response

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,

Second Hruska Declaration

battery continues to charge. See my First Declaration, ¶62. During this second, constant voltage phase of the charging process, the battery voltage continues to increase and the current decreases. Specifically, the battery voltage asymptotically approaches the applied voltage as charging progresses toward equilibrium. When charging is complete (and importantly, even after a reasonable amount of charging time), the battery voltage has become nearly equal to the applied voltage. For

PO's construction of "charge cut-off voltage"

Patent Owner's Response

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.

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.

Petitioner's Reply

PO's proposed construction for "charge cut-off voltage" as "the maximum voltage to which the battery is configured to be charged" is consistent on its face with its construction in district court. APPLE-1031, 11. But PO's arguments here—that "charge cut-off voltage" is "a battery property" rather than "the voltage applied to the battery during charging" (POR, 21-24)—improperly attempt to reconstrue this term in a way contradicted by the '641 Patent itself and PO's own litigation positions, and should be rejected. Nevertheless, regardless of whether or not PO's unjustified construction is adopted, the advanced grounds render obvious the Challenged Claims.

POR, 24-25; Pet. Reply, 1

The '641 Patent contradicts PO's construction

'641 Patent

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

Petitioner's Reply

First, the '641 Patent contradicts PO's position that the charge cut-off voltage ("CCV") is "not the externally applied voltage at which a battery is charged." POR, 24. The '641 Patent describes that a "charging device *controls the charge cut-off voltage*" of the cell.¹ APPLE-1001, 9:49-55; see 3:45-50, 4:26-37. PO's remarks responsive to a similar argument in the co-pending Samsung IPR (IPR2023-01183)—that a charger could "ensure a battery's voltage does not exceed" its intrinsic battery voltage (what PO equates to CCV)—are misleading. APPLE-1033, 3. A charging device cannot "control" (APPLE-1001, 9:52) a battery property, as PO contended there; it can only control applied voltage. And PO's attempt in the Samsung IPR to discount this relevant disclosure as merely an "unclaimed embodiment" (APPLE-1033, 2-3) runs directly counter to Federal Circuit precedent requiring consideration of the entire specification in construing claims. See *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005).

CCV – Statements by PO's expert

Petitioner's Reply

Third, statements by PO's own expert, Dr. Yao, confirm that CCV is a voltage applied to a battery, not an intrinsic battery voltage. Dr. Yao explains here that "[t]he applied voltage ... is always greater than the battery voltage" (EX2007, ¶111), and in district court, Dr. Yao cautions that "during normal use of a battery, the charging voltage *should not exceed* the charge cutoff voltage." APPLE-1042, 41. The only way to reconcile these statements is to recognize CCV as applied voltage, not battery voltage.

Pet. Reply, 4

ISSUE 1.5

The Yasunami-Koyama Battery Satisfies
the Claimed Charge Cut-off Voltage Range

[5a] the secondary lithium ion cell or battery has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V

Yasunami's end-of-charge voltage is a charge cut-off voltage

Petition

A POSITA would have understood, or at least found obvious, that Yasunami's "end-of-charge voltage" is a **charge cut-off voltage** at least because it is the maximum voltage to which the combination battery is configured to be charged, *e.g.*, the voltage at which charging of the battery is stopped. APPLE-1006, [0034]; *see* [0066]-[0067] ("Charging/discharging cycle testing was performed on the prepared batteries at a *final charge voltage* of 3.9 to 4.3 V," shown as "*End-of-Charge Voltage*" in Table 1), [0068]-[0069]; APPLE-1003,

POR

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

Yasunami's end-of-charge voltages fall within / overlap with the claimed range

5. A secondary lithium ion cell or battery, characterized in that the secondary lithium ion cell or battery has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V, and a

[0067]

[Table 1]

Table 1				
No.		Negative Electrode Active Material	End-of-Charge Voltage	End-of-Discharge Voltage Prior to Charging
1	Invention	a	4.3 V	1.0 V
2	"	a	4.2	1.0
3	"	a	4.1	0.8
5	"	a	4.0	0.6

In the combination, at least one of the charge cut-off voltages disclosed by Yasunami (4.3V; see APPLE-1006, [0067] (line 1 of Table 1), [0069] (line 1 of Table 2), [0071] (No. 4 in Table 3)) falls within the range of charge cut-off voltages recited in claim 5, thus informing the obviousness of the recited charge cut-off voltage range. APPLE-1003, ¶193. See *Ineos USA LLC v. Berry Plastics*

[0034]

The end-of-charge voltage is preferably in the range from 3.5 to 4.7 V, more preferably from 3.7 to 4.5 V, and even more preferably from 3.8 to 4.4 V to realize a 3-V class battery voltage. If it is lower than 3.5 V, the battery voltage will be low, and if it is higher than 4.7 V, the positive electrode active material and the electrolyte may decompose.

Alternatively or additionally, the charge cut-off voltage range recited in

claim 5 overlaps with the noted range of charge cut-off voltages of the combination

battery (e.g., between 3.5V-4.7V, as disclosed by Yasunami). APPLE-1003, ¶194.

In the absence of any indication of criticality or unexpected results, as discussed *infra*, the overlapping range of charge cut-off voltages described by Yasunami presents a *prima facie* case and renders obvious the recited range.⁸ See *In re Peterson*, 315 F.3d at 1329; *In re Geisler*, 116 F.3d at 1469–70.

APPLE-1006, [0034], [0067]; Petition, 49-50

The Yasunami's end-of-charge voltage is substantially equivalent to the battery voltage

Petition

But even under PO's proposed (and unjustified; *see* §I, *supra*) construction of CCV as a battery voltage, a POSITA would have understood or found obvious that Yasunami's end-of-charge voltage is substantially equivalent to the battery voltage, given the expected implementation of the end-of-charge voltage as the applied voltage in a CC/CV charging process. APPLE-1003, ¶¶187-191; APPLE-1035, ¶¶9-19.

Pet. Reply

Importantly, Yasunami's end-of-charge voltage range of 3.5-4.7V has such extensive overlap with the claimed CCV range as to render it obvious even if PO's construction is adopted. There is negligible difference between Yasunami's end-of-charge voltage and the battery voltage (CCV, according to PO) when CC/CV charging concludes. APPLE-1003, ¶¶190-191; APPLE-1035, ¶¶13-16; APPLE-

Second Hruska Declaration

14. That the battery voltage becomes essentially equal to the applied voltage in a CC/CV charging process is well known. For instance, Shen, in a review of lithium-ion battery charging algorithms, states that in CC/CV charging, "a constant current is applied to charge the battery until the battery voltage rises to a preset maximum charging voltage ($V_{pre-set}$), then the charging voltage is held constant at $V_{pre-set}$ and corresponding the charging current is reduced exponentially." APPLE-1038 (Shen), 2; *see id.* ("when the battery voltage charges to $V_{pre-set}$ (e.g. 4.2V), the charging process switches to the CV mode, the battery is charged at the constant voltage of 4.2V and the charging current is reduced correspondingly"). *See also* APPLE-1039 (Halme), 5:32-36 ("The measured

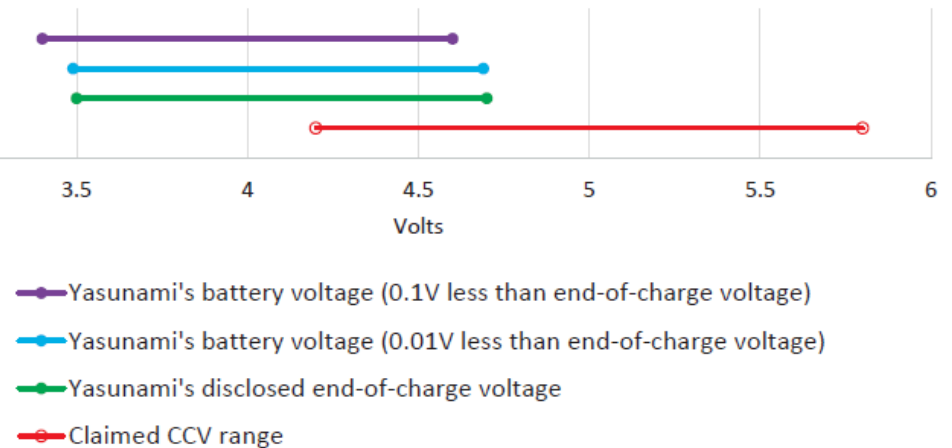
APPLE-1035, ¶14; Pet. Reply, 15-16, 19

The CCV range is obvious even under PO's construction

18. I have illustrated this overlap graphically below. The red line depicts the claimed charge cut-off voltage range (greater than 4.2 V but less than 5.8 V). Yasunami's end-of-charge voltage range (3.5-4.7 V), shown in green, overlaps significantly with the claimed charge cut-off range. As I noted above, it is my opinion that a POSITA would have known with reasonable certainty that, at the end of a constant current-constant voltage charging process, Yasunami's battery voltage is only about 0.01 V less than the applied end-of-charge voltage, which means that the battery voltage range (shown in blue) would be 3.49-4.69. Clearly, there is still a significant overlap with the claimed charge cut-off voltage range. In fact, even if the difference between the battery voltage and the end-of-charge voltage were a full order of magnitude greater—i.e., a 0.1 V difference rather than a 0.01 V difference—there *still* would be a significant overlap between Yasunami's battery voltage range (3.4-4.6 V) and the claimed charge cut-off voltage range, as shown in purple.

Second Hruska Declaration

Significant overlap between the claimed CCV and both Yasunami's end-of-charge voltages and battery voltages



APPLE-1035, ¶18-19; Pet. Reply, 19-20

Overlapping ranges

Petition

ratios. APPLE-1003, ¶¶91-92. See *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003) (“A *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art”); *In re Geisler*, 116 F.3d 1465, 1469–70 (Fed. Cir. 1997) (“When an applicant seeks to overcome a *prima facie* case of obviousness by showing improved performance in a range that is within or overlaps with a range disclosed in the prior art, the applicant must “show that the [claimed] range is *critical*, generally by showing that the claimed range achieves unexpected results relative to the *1470 prior art range,” quoting *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990)).

Petition, 2

The 4.2 V lower limit of the claimed range

Petition

The '641 Patent fails even to present results for experiments conducted at charge cut-off voltages below 4.2V, instead presenting data with charge cut-off voltages starting at a minimum of 4.2V. See APPLE-1001, 10:29-12:55 (Examples 1-28); APPLE-1003, ¶197. Without a demonstration of the behavior of cells charged to a charge cut-off voltage *below* 4.2 V, there is no way to conclude that 4.2 V is a threshold for onset of unexpected results or criticality. APPLE-1003,

Second Hruska Declaration

experiments—particularly experiments testing the effect of multiple variables—need to be designed in such a way as to produce meaningful results. That is not the case in the '641 experiments. The design of experiments in the '641 Patent changed many variables concurrently, including not only charge cut-off voltage and capacity ratio (for instance, see Examples 1-7) but also electrolyte composition (see Example 8), electrode composition (see Examples 9-12), making it such that the individual effect of any one variable, or even any particular combination of variables, cannot be determined.

22. Based on these results, it is impossible to tease out what aspects (if any) of the observed changes in capacity and capacity retention are attributable to changes in charge cut-off voltage and which are attributable to changes in capacity ratio. That is, a POSITA would not have been able to conclude from these data that there is any impact whatsoever of charge cut-off voltage on the observed results, and certainly would not have been able to conclude that there is a threshold change in the results at charge cut-off voltages greater than 4.2 V.

Petition, 50; APPLE-1035, ¶21-22; Pet. Reply, 19

45

It was obvious for Yasunami to implement CC-CV charging

Yasunami

[0006]

[Problem to be Solved by the Invention]

It is an object of the present invention to provide a non-aqueous secondary battery having a high battery voltage, high discharge capacity (high energy density), and long charge/discharge cycle life, and to provide a charge/discharge method for this non-aqueous secondary battery.

Hruska Declaration

190. Moreover, as I discussed above for the Yamaki-Sakamoto ground, in constant current charging, once the charge cut-off voltage is reached, either charging is stopped, or charging changes to constant voltage charging for further charging of the battery. The latter approach is advantageous in that it provides additional capacity to the battery, e.g., as compared to the former approach. Consistent with Yasunami's objective of providing a battery with "high discharge capacity," a POSITA would have understood, or otherwise at least found obvious, that Yasunami employs this second charging method, e.g., to obtain these further capacity gains. APPLE-1006 (Yasunami), [0006].

APPLE-1003, ¶190; APPLE-1006, [0006]; Petition, 49

ISSUE 1.6

A POSITA Would Have Been Motivated to Combine Yasunami and Koyama

[5a] the secondary lithium ion cell or battery has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V

The Petition presented four motivations for the combination

First, a POSITA would have been motivated to pursue **improvements in charging performance (e.g., charge rate)** that are enabled by providing electrode materials that satisfy Koyama's range of capacity ratios, particularly given Yasunami's teaching that such a ratio may be appropriate. *See* APPLE-1007,

Second, a POSITA would have recognized the well-known **safety advantages** of a battery in which there is more capacity in the negative electrode than in the positive—e.g., as described by Koyama—and would have been motivated to improve safety of the combination battery, again encouraged by Yasunami's teaching that such a ratio may be appropriate. *See* APPLE-1005,

Third, a POSITA would have understood that batteries having more capacity in the negative electrode than in the positive—e.g., a battery satisfying the capacity ratio described by Koyama and consistent with ratios indicated as suitable by Yasunami—have **good cycle life characteristics**, and would therefore have been motivated to obtain a battery with good capacity retention over a long cycle life.

Fourth, a POSITA would have been prompted to pursue this implementation because doing so is merely **the application of known techniques** (e.g., a secondary lithium ion battery having more negative electrode capacity than positive electrode capacity, per Koyama) **by a known system** (e.g., Yasunami's battery) to **yield predictable results** (e.g., a secondary lithium ion battery having negative electrode active material and positive electrode active material in amounts to satisfy a specific known capacity ratio, and having a charge cut-off voltage range). APPLE-

Petition, 43-45

48

Koyama's capacity ratio is compatible with Yasunami's battery

Patent Owner's Response

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.

Petitioner's Reply

USPQ 237, 244 (CCPA 1969)). That is, far from being "redundant and indeed counterproductive" (POR, 61) to incorporate a capacity ratio based on Koyama into Yasunami's battery, a POSITA in fact would have recognized the potential for a reduction in energy density as one among a variety of factors to be considered, and would have weighed the numerous *unrebutted* benefits of implementing such a capacity ratio (Petition, 43-45) against any potential reduction in energy density. APPLE-1035, ¶¶26-27. See *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006) (holding that "[a] given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine."); *Winner Int'l Royalty Corp. v. Wang*, 202 F.3d 1340, 1349 n.8 (Fed. Cir. 2000) ("The fact that the motivating benefit comes at the expense of another benefit...should not nullify its use as a basis to modify the disclosure of one reference with the teachings of another."); *In re Urbanski*, 809 F.3d 1237, 1244

Koyama's capacity ratio is compatible with Yasunami's battery

Patent Owner's Response

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.

Petitioner's Reply

PO attempts to seize upon Yasunami's statement that "reducing the amount of positive electrode active material ... places limits on the discharge capacity" of batteries having carbonaceous electrode materials (APPLE-1006, [0002]), arguing that given the (purported) already reduced energy density of batteries with Yasunami's lithium transition metal oxides as compared to those with these typical carbonaceous materials, "[a] POSITA thus would be careful not to adopt an approach—such as the one disclosed in Koyama—that would further reduce energy density." POR, 60. But PO fails to recognize that Koyama explicitly teaches the applicability of advantages of its capacity ratio not only for carbonaceous electrodes, but also for those composed of lithium transition metal oxides—the very composition of Yasunami's electrodes. APPLE-1007, [0008]-

Pet. Reply, 21; POR, 59-60

Koyama's capacity ratio is compatible with Yasunami's battery

Yasunami

[0002]

[Prior Art]

Lithium metal and lithium alloys are typically used as negative electrode active materials in non-aqueous secondary batteries. When they are used, lithium metal grows in dendrite form during charging and discharging, causing internal short circuits, and because the activity of dendritic metal is high, there is an increased risk of ignition. Meanwhile, fired carbonaceous materials capable of occluding and releasing lithium have recently come into use. These excellent carbonaceous materials have a relatively low risk of ignition and high charge/discharge capacities. However, because carbonaceous materials are conductive, lithium metal may be deposited on carbonaceous materials during overcharge or rapid charging, resulting in the deposition of dendritic metal. In order to avoid this problem, methods have been adopted to prevent overcharging by reconfiguring chargers and reducing the amount of positive electrode active material. The latter method reduces the amount of active material, and so places limits on the discharge capacity. Also, because carbonaceous materials have a relatively low density, the discharge capacity per volume is low. As a result, the discharge capacity is constrained by both the restrictions placed on the amount of active material used and the low capacity per volume.

[0007]

[Means for Solving the Problem]

This object is achieved when a non-aqueous secondary battery whose negative electrode active material is a lithium-containing transition metal oxide represented by Li_xMO_j (where M represents at least one transition metal selected from Ti, V, Mn, Co, Fe, Ni, Nb, and Mo, x is in the range from 0.17 to 11.25, and j is in the range from 1.6 to 4.1), whose positive

Pet. 46; POR, 59; APPLE-1006, [0002], [0007]

Koyama's capacity ratio is compatible with Yasunami's battery

Koyama

[0009]

Examples of negative electrode active materials that can constitute the negative electrode include metals, carbonaceous materials, metal chalcogenides, metal oxides, and conductive polymers. Specific examples include metal Li, alloys of Li with other metals such as Al, Zn, and Sn, carbonaceous materials such as graphite and amorphous carbon, metal oxides such as Li_xMO_y (where M includes at least one transition metal such as Ti, V, Mn, Co, and Fe), Nb_2O_5 , and WO_3 , metal chalcogenides such as TiS_2 , MoS_2 , and NbSe_3 , and conductive polymers such as polyacene and polyacetylene doped with Li ions, etc.

Second Hruska Declaration

metal oxides. However, this is not correct. While it is true that Koyama carbonaceous material compositions for negative electrodes, it also describes the use of lithium transition metal oxides—a composition that aligns with the composition of Yasunami's electrodes. See APPLE-1007 (Koyama), [0009].

29. Thus, it is clear that the several benefits that I previously described related to incorporating Koyama's capacity ratio into Yasunami's battery are applicable to the electrode compositions described by Yasunami. See my First Declaration, ¶¶171-175. Even if a reduction in energy density might occur when making this modification, it is my opinion that a POSITA would have been capable of weighing this one potential disadvantage against these many advantages—specifically, improvements in charging performance, better safety, and good cycle life.

Pet. Reply, 21; APPLE-1007, [0009]; APPLE-1035, ¶¶28-29

ISSUE 2

Claims 11-14 Are Obvious over
Yamaki-Sakamoto or Yasunami-Koyama

Claims 11-14 recite percent capacity retention values

11. A secondary lithium ion cell or battery according to claim 5, wherein the secondary lithium ion cell or battery maintains at least 7500 of capacity after 400 cycles.

12. A secondary lithium ion cell or battery according to claim 5, wherein the secondary lithium ion cell or battery maintains at least 75.83% of capacity after 400 cycles.

13. A secondary lithium ion cell or battery according to claim 5, wherein the secondary lithium ion cell or battery maintains at least 80% of capacity after 400 cycles.

14. A secondary lithium ion cell or battery according to claim 5, wherein the secondary lithium ion cell or battery maintains at least 80.72% of capacity after 400 cycles.

Apple-1001, Claims 11-14; Petition, 23

The '641 Patent does not describe how to achieve the capacity retention features

First, the '641 Patent provides no description of how to achieve the recited capacity retention beyond specifying the charge cut-off voltage and ratio. See APPLE-1001, Examples 1-28; APPLE-1003, ¶94. And as demonstrated *supra* in [5a]-[5b], the combination battery satisfies these charge cut-off voltage and ratio limitations that purportedly yield the recited capacity results. APPLE-1003, ¶94. It is inappropriate to hold the prior art to a stricter standard of disclosure than what is disclosed in the specification of the patent itself. See *In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994) (“the Board's observation that appellant did not provide the type of detail in his specification that he now argues is necessary in prior art references supports the Board's finding that one skilled in the art would have known how to implement the features of the references and would have concluded that the reference disclosures would have been enabling”). Because the disclosures of Yamaki-Sakamoto align with the elements that the '641 Patent indicates as providing the recited capacity retention, Yamaki-Sakamoto renders these claims obvious.

Indeed, this conclusion is logical: it is inappropriate for PO to be entitled to a claim to a result that requires more to achieve than what is taught, and by extension, PO cannot demand more of the art than what is described by the '641 Patent with respect to the recited capacity retention features. See *In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994).

Petition, 24-25; Pet. Reply, 28

The '641 Patent does not describe how to achieve the capacity retention features

Deposition of Patent Owner's expert

2 **Q. Besides adjusting the capacity ratio and**
3 **exceeding the voltage of 4.2 volts, does the**
4 **'641 patent mention anything else that it does to**
5 **obtain improved battery performance?**

6 MR. ZHOU: Object to form.

7 THE WITNESS: I believe that's -- those
8 two major -- two things are what they emphasize in
9 the claims.

10 BY MR. IN:

11 **Q. What about in the specification, are any**
12 **other factors mentioned in the specification as**
13 **contributing to improved performance?**

14 A. As far as I understand, no.

Pet. Reply, 27; APPLE-1034, 32:2-14

The '641 Patent does not describe how to achieve the capacity retention features

The '641 Patent attributes its purported performance improvements solely to two features: CCV and capacity ratio—both of which are satisfied by the Yamaki-Sakamoto and Yasunami-Koyama combinations. APPLE-1001, 3:3-15; POR, 11

The only aspect of claims 11-14 that is not explicitly described by either combination is the cycle life result itself—a result that PO (and the '641 Patent itself) has linked exclusively to those elements that *are satisfied* by the combinations. Thus, a POSITA, recognizing satisfaction by Yamaki-Sakamoto and Yasunami-Koyama of the CCV and capacity ratio characteristics to which the '641 Patent attributes the recited cycle life features, would have found it obvious that the cycle life features themselves are likewise satisfied. *See Alcon Rsch., Ltd. v. Apotex Inc.*, 687 F.3d 1362, 1369 (Fed. Cir. 2012) (A claimed property “is not an additional requirement imposed by the claims” where patent discloses that it is “a property necessarily present” where other claim limitations are present (quoting

Pet. Reply, 26-27

The recited capacity retention capabilities were achievable by routine experimentation

Yamaki and Sakamoto share a common objective: improving cycle life. *See* APPLE-1004, [0014]; APPLE-1005, [0012]; APPLE-1003, ¶105. Furthermore, a generally accepted objective for a commercially viable battery is the ability to retain a significant capacity over a many cycles. APPLE-1003, ¶105, citing APPLE-1015, 23.10-23.11; APPLE-1016, 5:32-36; APPLE-1017, 5:10-17. A POSITA implementing the Yamaki-Sakamoto battery would thus have had cycle life in mind as a design criterion. APPLE-1003, ¶105.

As also discussed *supra* for [11]-[14] in Ground 1A, a POSITA implementing the Yasunami-Koyama battery with cycle life in mind as a design criterion would have been aware of factors influencing cycle life, including charge cut-off voltage, electrode material ratio, electrolyte purity/strength, charge/discharge rate, and ambient temperature. *See* APPLE-1004, [0057]; APPLE-1006, [0067]-[0071]; APPLE-1005, [0015]-[0016]; APPLE-1015, 36.46; APPLE-1014, 1; APPLE-1016, 5:5-9; APPLE-1003, ¶226. Guided by the objective of improving cycle life, it would have been a matter of routine experimentation for a POSITA to adjust these factors (none of which is specified in the claims), within the scope of Yasunami-Koyama (*e.g.*, consistent with charge cut-off voltage and ratio ranges of the combination; *see* [5a]-[5b]), to optimize capacity retention—*e.g.*, to obtain a Yasunami-Koyama battery that **maintains at least 75%, 75.83%, 80%, or 80.72% of capacity after 400 cycles**. APPLE-

Routine experimentation

Petitioner's Reply

1003, ¶106; APPLE-1034, 39:4-9. And PO's own corroborating references confirm that the routine adjustment of parameters to achieve better cycle life was conventional. See EX2007, ¶155 (characterizing EX2021 as teaching that "to avoid such sudden decay [in capacity], one should make a proper *choice of carbon and electrolyte*"). Given these parameters, and the objective of improving cycle

EX2021 (Broussely)

4. Conclusions

Although each Li ion chemistry may behave differently, there are few basic mechanisms, which may account for general aging phenomena in Li ion batteries. The most obvious is linked to the high reactivity of lithium from lithiated carbon, and stability of the passivating layer (SEI) is the key of the overall cell stability (electrolyte composition and purity, additives, . . .). Proper choice of carbon and electrolyte makes the negative electrode very stable, either on rest and cycling. This condition being fulfilled, the nature of positive

Pet. Reply, 29; EX2021, 7

Yamaki-Sakamoto – Cycle life

Hruska Declaration

98. In the combination, a battery such as that described by Yamaki is implemented to have positive and negative electrode active material in amounts satisfying the “reversible capacity balance” described by Sakamoto. Sakamoto describes that batteries satisfying this “reversible capacity balance” “experience[] less deterioration after repeated charging and discharging.” APPLE-1005 (Sakamoto), [0007]; see [0001], [0012], [0016]. That is, Sakamoto indicates that batteries implementing its reversible capacity ratio have improved capacity retention and cycle life. In light of the improved cycle life enabled by Sakamoto’s reversible capacity balance, a POSITA would have expected a battery based on the Yamaki-Sakamoto combination to have cycle characteristics at least as good as those of Yamaki’s battery, if not even better—that is, a POSITA would have

APPLE-1003, ¶98; Petition, 25

60

Yamaki – Cycle life

Yamaki [0012]

It is an object of the present invention to solve this problem by providing a lithium secondary battery with high energy density and excellent cycle characteristics by specifying a Co-based oxide to be used as the positive electrode active material and a conductive material to be used in the positive electrode.

Patent Owner's expert

- 1 phrase "excellent cycle characteristics" to mean?
- 2 For instance, would that mean long cycle life?
- 3 MR. ZHOU: Object to form.
- 4 THE WITNESS: I think that excellent
- 5 cycle characteristics, yeah, meaning, you know,
- 6 many long cycle life, according to the standard
- 7 testing standards that typically more than a few
- 8 hundred cycles is considered excellent cycle
- 9 characteristics.

Table 1

Positive Electrode Active Material	Conductive Material	Charged Positive Electrode Potential (V: Metal Li Reference)	Initial Battery Capacity (mAh)	Initial Discharge Capacity of Positive Electrode Material (mAh/g)	Capacity Retention After 10 Cycles (%)
0.97Al _{0.03} O ₂	(A)	4.5	3.99	182	95
0.99Al _{0.01} O ₂	(A)	4.5	4.12	188	94
0.99Mg _{0.01} O ₂	(A)	4.5	4.17	190	98

Pet. Reply, 7-8; Petition, 25; APPLE-1004, [0012], [0057]

Sakamoto – Cycle life

Sakamoto

[0007]

[Means for Solving the Problem]

In order to solve the problems described above, in the present invention, the reversible capacity balance of the positive electrode and the negative electrode is set to the range of $1.05 < \text{negative electrode/positive electrode} \leq 1.30$, and the reversible capacity of the negative electrode is set so to be greater than the reversible capacity of the positive electrode. Therefore, lithium ions can be sufficiently occluded in the negative electrode during charging or overcharging, and deposition of lithium is less likely to occur. As a result, a high-performance battery can be obtained that experiences less deterioration after repeated charging and discharging, and that is safer.

Petition, 25; APPLE-1005, [0007]

Yasunami-Koyama – Cycle life

Hruska Declaration

223. Moreover, the positive and negative electrode active materials in the combination battery are provided in a ratio based on the teachings of Koyama, such that there is more negative electrode capacity than positive electrode capacity. As I discussed previously in Paragraphs [37]-[39] of this Declaration, it was well-known that having more negative electrode capacity than positive electrode capacity was beneficial for cycle life of a secondary lithium battery. Thus, with this understanding in hand, a POSITA would have been confident that incorporating teachings based on Koyama into Yasunami's battery—and thus providing more negative electrode capacity than positive electrode capacity—would result in a battery having cycle life at least consistent with (but probably better than) that demonstrated for Yasunami's battery. For instance, a POSITA

Yasunami – Cycle life

Yasunami

[0006]

[Problem to be Solved by the Invention]

It is an object of the present invention to provide a non-aqueous secondary battery having a high battery voltage, high discharge capacity (high energy density), and long charge/discharge cycle life, and to provide a charge/discharge method for this non-aqueous secondary battery.

[0066]

Charging/discharging cycle testing was performed on the prepared batteries at a final charge voltage of 3.9 to 4.3 V, a final discharge voltage of 1.8 V, and a current density of 2 mA/cm². The number of cycles before the discharge capacity reached 60% of the initial value was used as the charge/discharge cycle life. In the batteries of the present invention

Table 1

No.		Negative Electrode Active Material	End-of-Charge Voltage	End-of-Discharge Voltage Prior to Charging	Energy Density After Discharge to 1.8 V	Cycles (No.)
1	Invention	a	4.3 V	1.0 V	2450 mWH	220
2	"	a	4.2	1.0	2310	255

APPLE-1006, [0006], [0066]; Petition, 60

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Koyama – Cycle life

Koyama

The invention according to claim 1 is a secondary battery comprising a positive electrode, a negative electrode, and a nonaqueous electrolyte, wherein the capacity ratio (B/A) between the electrode capacity A of the positive electrode and the electrode capacity B of the negative electrode is $1.3 < (B/A) \leq 2.5$.

Petition

Third, a POSITA would have understood that batteries having more capacity in the negative electrode than in the positive—e.g., a battery satisfying the capacity ratio described by Koyama and consistent with ratios indicated as suitable by Yasunami—have good cycle life characteristics, and would therefore have been motivated to obtain a battery with good capacity retention over a long cycle life. See APPLE-1005, [0006]-[0008], [0012], [0017]; APPLE-1006, [0019]; APPLE-1018, [0033]; APPLE-1021, [0011]; APPLE-1019, 3:24-28; APPLE-1004, Abstract; APPLE-1003, ¶174. For instance, a POSITA implementing Yasunami's

APPLE-1019

Accordingly, it is necessary to set the $-/+$ ratio in the range of at least 1.3 and at most 1.8. According to the present invention, since the deterioration of the positive and negative electrodes can be suppressed, the charging/discharging cycle life and preservation life can be improved.

Cycle life testing

Hruska Declaration

101. Unfortunately, Yamaki does not describe results of testing for more than 10 cycles. However, this 10 cycle capacity measurement does not provide a complete picture of the capacity retention capability of the battery. Testing the cycle life of a battery is a time-intensive and expensive process, and often battery designers perform initial testing of only a small number of cycles to gauge battery performance. In the absence of specific testing data regarding the longer term capacity retention of the Yamaki-Sakamoto battery, a POSITA would have found it reasonable to predict its longer life performance—that is, to predict the results of capacity testing after more than 10 cycles—based on the performance of other, similar batteries. This is often what is done at early stages of battery testing.

APPLE-1003, ¶101; Petition, 26

Claims 11-14 do not recite structural features

Petition

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. See *Hewlett-Packard Co. v. Bausch & Lomb Inc.*, 909 F.2d 1464, 1469 (Fed. Cir. 1990) (“[A]pparatus claims cover what a device *is*, not what a device *does*” (emphasis in original)); *Catalina Marketing Int’l v. Coolsavings.Com.*, 289 F.3d 801, 809 (Fed. Cir. 2002) (“[T]he patentability of apparatus or composition claims depends on the claimed structure, not on the use or purpose of that structure”); *In re Gardiner*, 171 F.2d 313, 315–316 (CCPA 1948) (“[T]he patentability of apparatus claims must be shown in the structure claimed and not merely upon a use, function, or result thereof.”). Nevertheless, to the extent claims 11-14 are afforded patentable weight, they are obvious over Yamaki-Sakamoto as discussed in the following paragraphs.

Petition, 23