

SAMSUNG ELECTRONICS CO., LTD. AND APPLE INC.,
PETITIONER,

V.

RJ TECHNOLOGY LLC,
PATENT OWNER.

IPR2023-01183
U.S. Patent No. 7,749,641

Petitioner's Oral Hearing Demonstratives – October 22, 2024

Overview

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Overview of the '641 Patent and Prior Art

'641 Patent: Problem and Solution

Problem

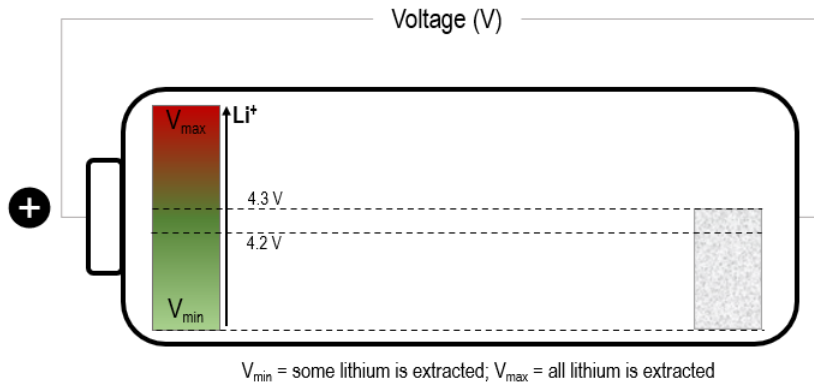
- The prior art did not utilize the full capacity of battery materials because charge cut-off voltage was limited to 4.2V
- Increasing charge cut-off voltage was known to increase capacity but it reduced cycle life, e.g., by causing “deposition of excessive lithium ions on the surface of negative electrode as metallic lithium”

SUMMARY OF INVENTION

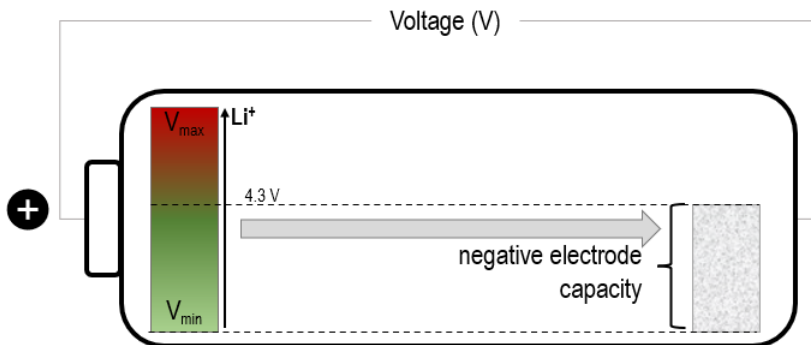
As to the common opinion in the art that increasing the charge cut-off voltage above 4.2 V may greatly shorten the recycle life, the inventor of the present invention conducted a large number of experiments and studies to elevate the charge cut-off voltage and the capacity of cell. Contrary to this opinion, the inventor unexpectedly found that the efficacy of electrode active materials is greatly increased by increasing the charge cut-off voltage and properly adjusting the ratio of positive electrode material to negative electrode material of single lithium ion cell. Consequently, the specific energy, capacity and average operating voltage of secondary lithium ion cell or battery are improved, while the performance of cell is substantially not changed. The present invention is fulfilled based on the aforesaid discovery.

Petition, 1-2; Ex. 1001, 1:36-63, 3:3-16, 4:57-64.

'641 Patent: Problem and Solution



As voltage increases, more lithium is extracted from the positive electrode.



The extracted lithium will be incorporated into the negative electrode material.

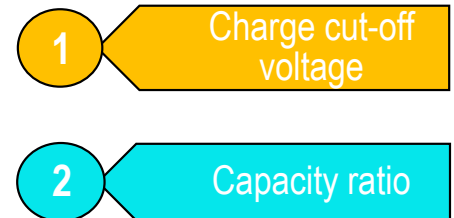
The capacity of the negative electrode determines how much lithium can be incorporated.

Petition, 13; Ex. 1002, ¶¶22.

Independent Claims of the '641 Patent

1. A method for improving the capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery, characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V; and a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5 as calculated by a specific capacity with a charge voltage limited to 4.2 V.

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



Ex. 1001, 16:54-61, 17:5-11.

Uemura Solves the Same Problem as the '641 Patent

(54) RECHARGEABLE LITHIUM BATTERY

Properly adjust capacity ratio

[0033] Furthermore, a capacity balance ratio B/A of the total capacity B of the negative electrode material to the total capacity A of the positive electrode material is preferably fixed at a range of 1 to 1.5. If the capacity balance ratio B/A is below 1, lithium ion holding sites on the negative electrode material become insufficient. As the result, branch-shaped or needle-shaped crystal (dendrite crystal) tends to occur during the charge to cause a short circuit phenomenon between the positive electrode and the negative electrode. If the capacity balance ratio B/A exceeds 1.5, negative electrode sites that do not contribute to the charge-discharge are increased, leading to the wasteful use of materials.

Charge cut-off voltage of 4.3 V

[0081] The charge-discharge was repeatedly performed at a constant current of 0.5 mA/cm^2 and a voltage ranging from 4.3 V to 2.0 V at an atmospheric temperature of 60° C . by the use of the made sealed type non-aqueous solvent battery cell. The number of cycles taken to a point where the discharge capacity becomes less than 90% of the initial discharge capacity was obtained. Thus, the resistance was evaluated. A result thereof is shown in Table 1 together with the other values.

Petition, 2; Ex. 1002, ¶90; Ex. 1009, ¶¶[0033], [0081].

Abe Solves the Same Problem as the '641 Patent

(54) [Title of Invention] **NON-AQUEOUS ELECTROLYTE-BASED SECONDARY BATTERY**

Problem

[Problems to be Solved by the Invention] In recent years, non-aqueous electrolyte-based secondary batteries with high energy density and excellent cycle characteristics have attracted attention as large-scale batteries, such as batteries for electric vehicles and household power storage systems.

[0009] Incidentally, in general, in the case of overcharging lithium-ion secondary batteries or when the charging current is increased, etc., needle-like lithium may be precipitated on the surface of the negative electrode, interposed between the positive electrode and the negative electrode, making it easier to break through the separator and short out. As a result, lithium-ion secondary batteries may also explode and ignite.

Petition, 2; Ex. 1002, ¶94; Ex. 1005, ¶¶[0008], [0009].

Abe Solves the Same Problem as the '641 Patent

Properly adjust capacity ratio

(4) A negative electrode formed by a graphitized vapor-phase-grown carbon fiber having a specific surface area of $5 \text{ m}^2/\text{g}$ and an average aspect ratio of 2 to 30, a cathode having a lithium-containing composite oxide, and an electrolyte solution obtained by dissolving a lithium salt in a mixed solvent of cyclic carbonate and chain carbonate, wherein the design capacity of the negative electrode is a non-aqueous electrolyte-based secondary battery having a design capacity greater than that of the positive electrode, (5) a non-aqueous electrolyte-based secondary battery according to (4) having a design capacity of more than 1 and less than or equal to 1.6 for the design capacity of the positive electrode described in (4), (6) a lithium-

Charge cut-off voltage of 4.3 V

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

Petition, 2; Ex. 1002, ¶¶156-157; Ex. 1005, ¶¶[0018], [0078].

Guyomard Solves One of the Problems of the '641 Patent

(54) Title: HIGH-VOLTAGE STABLE ELECTROLYTES FOR $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$ /CARBON SECONDARY BATTERIES

Problem

Presently-used intercalation electrolytes, e.g., a 1M solution of LiClO_4 in a 50:50 mixture of ethylene carbonate (EC) and diethoxyethane (DEE) such as described in U.S. Pat. No. 5,110,696, when employed in a $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$ / C cell, will begin to oxidize at about 4.5 V at room temperature and as low as about 4.3 V at temperatures in the range of 55° C. Thus, to operate such a cell in the higher temperature ambient, one must reduce the charging cut-off voltage to a level below about 4.3 V in order to avoid electrolyte oxidation. Because of this lower cut-off voltage, the available capacity of the cell at about 55° C is only 75% of that at room temperature.

Petition, 28-30; Ex. 1002, ¶¶97-98, 186; Ex. 1008, 2:34-3:7.

Guyomard Solves One of the Problems of the '641 Patent

(54) Title: HIGH-VOLTAGE STABLE ELECTROLYTES FOR $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$ /CARBON SECONDARY BATTERIES

Optimize electrolyte

The present invention provides a class of electrolyte compositions that is exceptionally useful for minimizing electrolyte decomposition in secondary batteries comprising strongly oxidizing positive electrode materials. These electrolytes are thereby uniquely capable of enhancing the cycle life and improving the temperature performance of practical "rocking chair" cells. In our search for such an

Increase charge cut-off voltage

oxidation tendency was additionally reduced. A set of such test cells with the separator element comprising an electrolyte of 1 M LiPF_6 in 95 DMC:5 EC and a carbon (graphite or petroleum coke) negative electrode were repeatedly charged and discharge over two hours cycles at about 25° C and 55° C and at charging cut-off voltages of 4.9 V and 4.5 V, respectively. Even at this cycling rate and high charging voltage, the voltage polarization was unusually small, confirming the high ionic conductivity of the electrolyte, and there was no significant loss of cell capacity, verifying the high voltage stability of the electrolyte. The ability of the electrolyte to extend the cycle life of the batteries was amply demonstrated by the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.

Petition, 28-30; Ex. 1002, ¶186; Ex. 1008, 3:34-4:3, 8:32-9:8.

Claim Construction

There Are Two Main Issues For Claim Construction

1. Does a POSITA have to measure the capacity of a battery to determine its actual voltage, or can a POSITA review the battery design to determine its charge cut-off voltage?

1. A method for improving the capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery, characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V; and a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5 as calculated by a specific capacity with a charge voltage limited to 4.2 V.

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.

Pet. Reply, 3-7; Ex. 1001, 16:54-61, 17:5-11.

There Are Two Main Issues For Claim Construction

2. Does “theoretic capacity” mean something different than what Patent Owner told the Court?

1. A method for improving the capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery, characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V; and a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5 as calculated by a specific capacity with a charge voltage limited to 4.2 V.

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.

Pet. Reply, 7-9; Ex. 1001, 16:54-61, 17:5-11.

RJ Tech Seeks to Avoid Invalidity By Reinterpreting Claim Constructions it Successfully Advanced in the Trial Court

- The position in the Petition is what RJ Tech argued for and won in the District Court
- RJ Tech persuaded the *Apple* Court that a “charge cut-off voltage” is a “charging voltage”
- RJ Tech persuaded the *Apple* Court that the patent specification expressly defined “theoretic capacity” to mean “capacity”

UNITED STATES DISTRICT COURT
CENTRAL DISTRICT OF CALIFORNIA

For the foregoing reasons, the Court construes the disputed claim terms as follows:

No.	Term	Court's Construction
1.	“charge cut-off voltage”	“the maximum voltage to which the battery is configured to be charged.”
2.	“ratio of positive electrode material to negative electrode material as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2 V”	“the ratio calculated as the product of the capacity of the cathode active material per mass unit and the amount of the cathode active material in the same mass unit divided by the product of the capacity of the anode active material per mass unit and the amount of the anode active material in the same mass unit, when the charge cutoff voltage is 4.2 V.”

Petition, 8-11; Pet. Reply, 3-9; Ex. 2010, 31.

Charge Cut-Off Voltage: RJ Tech Told the Court that the Charge Cut-Off Voltage is a “Charging Voltage” based on Intrinsic and Extrinsic Evidence

What RJ Tech Told the Court

4 RJ Technology’s construction is supported by intrinsic evidence. The term
5 is used throughout the specification, and in each case, it refers to the charging
6 voltage maximum:

14 The Examiner understood the term the same way, using charge cutoff without
15 reference to a particular charging algorithm and, in many cases, synonymously with
16 charging voltage. For example, the Examiner distinguished one prior art reference

22 Still further, the patent specification repeatedly refers to 4.2V as the then-
23 universal industry standard for charge cutoff voltage, e.g., ’641 Patent at 2:38-41
24 (“In 1990, Sony Corporation issued the lithium ion cell using coke as negative
25 electrode, which has a charge cut-off voltage of not more than 4.20V, and it is
26 accepted as a common technical requirement of lithium ion cells thereafter.”), and
27 the extrinsic sources confirm that the 4.2V limit was a maximum charging voltage
28 and not a particular algorithm for implementing that voltage. E.g., Ex. 3 (Amatucci

RJ Tech’s Position Here

17 Q. Sure. Your opinions for claim
18 construction, your opinions that you provide to
19 the board on claim construction for charge cut-off
20 voltage are in paragraphs 83 to 97 of your IPR
21 declaration; correct?

22 A. Yes.

1 Q. Okay. You don’t cite to any intrinsic
2 evidence to support your opinions in paragraphs 82
3 to 96; correct?

4 MR. STAMATOPOULOS: Object to
5 form.

6 A. This term is used in the industry
7 broadly. You are right; I didn’t cite any
8 intrinsic – intrinsic evidence.



Dr. Yan Yao*

Pet. Reply 5; Ex. 1032, 12, 13; Ex. 1043, 67:17-68:8.

*<https://www.eurekalert.org/multimedia/714911>

Charge Cut-Off Voltage: RJ Tech Distinguished Between “Fully Charged” and the Designed “Charge Cut-Off Voltage”

What RJ Tech Told the Court

17 The algorithms regulate the amount of voltage and current that are fed to the
18 battery, usually to maximize the amount of electricity the battery can store, while
19 minimizing damage to the battery. Some commonly used charging algorithms are:

- 20 • **Constant Voltage (CV):** The battery is charged at a constant voltage until
21 fully charged.
- 22 • **Constant Current (CC):** The battery is charged at constant current until
23 it reaches the charge cut-off voltage.
- 24 • **Constant Current/Constant Voltage (CC/CV):** The battery is first
25 charged at constant current up to a specific voltage (typically in the prior
26 art 4.2V) and then charged at constant voltage until the battery is fully
27 charged.
- 1 • **Pulse Charging:** The battery is charged by intermittent pulses of charging
2 current rather than a continuous stream.

3 In each case, there is a maximum voltage to which the battery is configured to be
4 charged. This is called the charge cutoff voltage. Yao Decl., ¶ 33. It can also be
5 referred to as the cutoff voltage, the potential limit, the upper voltage limit or the
6 upper charge limit, but in each case, it refers to the designed maximum charging
7 limit of the battery. *Id.*, ¶ 26.



RJ Tech's Position Here

8 Q. (BY MR. COLIN) Well, it's your opinion
9 that charge cut-off voltage is a measured value;
10 you actually have to measure the battery voltage
11 to see it. Correct?
12 A. Yes.

Pet. Reply, 12; Ex. 1032, 9-10; Ex. 1043, 49:8-12

Charge Cut-Off Voltage: The Specification Indicates Charge Cut-Off Voltage is a Charging Voltage As RJ Tech Told the Court

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.

For investigating the reasons of poor recycle property when the charge cut-off voltage is 4.45 V or high, the inventor adjusted the ratio of positive electrode material to negative electrode material, i.e., said ratio was adjusted within the range from 1:1.3 to 1:2.5 calculated according to the theoretical capacity under the charge cut-off voltage of 4.2 V, and then the single lithium ion cell having the adjusted ratios were tested by charging at an charge cut-off voltage of 4.45 V, 4.6 V, 4.8 V, 5.0 V, 5.2 V, 5.4 V, 5.6 V and 5.8 V, preferably said charging tests were conducted during the formation and test of the cells. Experimental results show that the specific

Pet. Reply 4; Ex. 1001, 4:27-37, 9:49-55.

Charge Cut-Off Voltage: The Specification Indicates Charge Cut-Off Voltage is a Charging Voltage As RJ Tech Told the Court

Example	Charge cut-off voltage (V)	Processing change	Recycle property	Capacity (mAh)
14	4.20	—	Maintaining 84.23% after 400 recycles	375
15	4.30	—	Maintaining 85.12% after 400 recycles	405
16	4.60	The ratio of positive electrode material to negative electrode material is 1:1.6.	Maintaining 83.45% after 400 recycles	575
17	5.80	The ratio of positive electrode material to negative electrode material is 1:2.5, and substance A is added into the electrolyte solution.	Maintaining 82.83% after 400 recycles	567
18	5.90	The ratio of positive electrode material to negative electrode material is 1:2.7, and substance A is added into the electrolyte solution.	Maintaining 54.23% after 30 cycles	312

Examples 14-18 show that when using lithium manganese oxide as positive electrode active material, the cells obtain the results similar to that of examples 1-13. Namely, when the charge voltage is elevated above 4.2 V, the capacity, operating voltage and weight specific energy increase with the elevation of the charge voltage; and when the charge voltage is elevated above 4.45 V, the capacity, operating voltage and weight specific energy continuously increase with the elevation of the charge voltage and of the ratio of positive electrode material to negative electrode material; but when the charge voltage is greater than 5.8 V, the properties of cell decrease.

Pet. Reply 4-5; Ex. 1001, 13:1-59.

Charge Cut-Off Voltage : RJ Tech's Expert Used "Charging Voltage" Interchangeably with "Charge Cut-Off Voltage"



What Dr. Yao Told the Court

9 18. As the '641 Patent describes, increasing the charging voltage applied
10 to a battery can increase its capacity—at least in the short term—by pulling more
11 lithium from the cathode and pulling it to the anode. But increasing the charging
12 voltage can damage the battery, ultimately leading to capacity loss, rendering the
13 battery inoperable, and/or making the battery unsafe. For example, when the
14 voltage is higher, the lithium ions traverse the electrolyte and intercalate into the
15 anode with greater force, increasing the risk both components will be damaged.
16 Similarly, the energy can be dissipated into the system as heat, which can denature
17 the electrolyte and other components.

EX2022, ¶18 (highlighting added)

What Dr. Yao Told the Board

49. As the '641 Patent describes, increasing the charge cutoff voltage of a
battery can increase its capacity—at least in the short term—by pulling more lithium
from the cathode and pushing it to the anode. But doing so can damage the battery,
ultimately leading to capacity loss, rendering the battery inoperable, and/or making
the battery unsafe. For example, when the voltage is higher, the lithium ions traverse
the electrolyte and intercalate into the anode with greater force, increasing the risk
that both components will be damaged. Similarly, the energy can be dissipated into
the system as heat, which can decompose the electrolyte and other components.

EX2006, ¶49 (highlighting added)

Ex. 1037.

Charge Cut-Off Voltage: RJ Tech Asserted “Charge Cut-Off Voltage” is a “Charging Voltage” in the Samsung Litigation

2. A method according to claim 1, characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is within a range from 4.3 V to 5.2 V.

The Accused Device is designed and operates in such manner that Defendants, Defendants’ customers, and/or other product end users infringe claim 1, as set forth above, and also claim 2, as the charge cut-off voltage of the secondary lithium ion cell or battery is within a range from 4.3V to 5.2V.

Upon information and belief, the charging of the secondary lithium ion cell or battery of the Accused Device is regulated by a combination of (a) circuitry within the device (including one or more of the battery management system, circuitry external to the battery, and/or circuitry within housing of the battery component of the Accused Device) (which is connected to a power supply), in combination with (b) software (including one or more of the operating system, battery management software and relevant firmware, some of which may be implemented in hardware), such that the charge cut-off voltage recited in the claim is within the claimed range.

For example, the batteries in the Accused Device are used in such manner as to have a charging voltage of 4.47V.



Ex. 1048, 5.

The Patent Claims and Specification Show “Charge Cut-Off Voltage” is Context Dependent

The claims indicate where a charge cut-off voltage is for a secondary lithium-ion cell or battery, making RJ Tech’s proposed “full cell” limitation redundant

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.

The specification discusses “charge cut-off voltage” in the context of a “half cell” using metallic lithium

of the theoretical capacity, although many documents indicate that the charge cut-off voltage can be over 4.2 V for a test cell using metallic lithium as counter electrode. In fact,

erty of cell. The results of experiments showed that as to a test button cell having metallic lithium as negative electrode, the capacity of lithium cobalt oxides reaches 159 mAh/g when the charge cut-off voltage is 4.35 V, but it drops to 135 mAh/g after several cycles; and the capacity attenuates quickly when the charge cut-off voltage is 4.25 V. This document takes the

Pet. Reply, 6-7; Ex. 1001, 2:1-3, 2:25, 17:5-11,

RJ Tech's Expert Admits "Charge Cut-Off Voltage" is Context Dependent



2 Q. Okay. And so for the capacity ratio
3 limitation, when you're talking about electrode
4 capacity, it's your opinion that that's referring
5 to a half cell capacity relative to a reference
6 electrode; correct?

7 MR. STAMATOPOULOS: Object to
8 form.

9 A. Yes.

6 Q. The inventors during prosecution history
7 of the Chinese patent that's related to the '641
8 patent indicated that the ratio of positive to
9 negative electrode is calculated with a charging
10 potential relative to lithium metal at 4.2 volts;
11 correct?

12 A. Yes.

13 Q. Okay. And in your claim construction
14 declaration to the court, referring to this
15 document, you state in paragraph 8 in the Chinese
16 patent prosecution history, "The inventors
17 explained to the examiner in China that to
18 calculate the claimed ratio, the capacity at a
19 charge cut-off voltage at 4.2 volts should be
20 used"; correct? That's in your declaration?

21 A. Yes.

22 Q. Okay. And you told the court that "the 39
1 statement by -- made during the Chinese patent
2 prosecution is consistent with my reading of the
3 claims in the '641 patent"; correct?

4 MR. STAMATOPOULOS: Object to --
5 object to form. You can answer.

6 A. Yes.

Pet. Reply, 7; Ex. 1043; 88:6-21, 96:2-9.

Capacity Ratio Limitation: The Petition Applied RJ Tech's Construction

and claim 5. EX1031, pp.8-10. As Patent Owner's litigation positions reveal, Patent Owner contends both claims 1 and 5 require a ratio of "capacity" (as opposed to "specific" or "theoretic" capacity) because capacity is calculated "with a charge cut-off voltage set at 4.2V." EX1016, p.4; EX1031, pp.8-10.

For purposes of this proceeding the Petition construes this limitation of claim 1 the same way that Patent Owner has construed the ratio limitation of claim 5—by using the term "capacity" and providing for the calculation discussed above because that is how Patent owner has contended it should be construed. *Supra* §II.C.2.

Petition, 10-11; Ex. 1016, 4; Ex. 1031, 8-10.

Capacity Ratio Limitation: The Construction RJ Tech Argued For and Won Does Not Include “Theoretic”

RJ Tech Told the Court the Specification Defined “Theoretic Capacity” as “Capacity”

20 reaches 159 mAh/g when the charge cut-off voltage is 4.35V...”). And, lest there
21 be any doubt, the patent specification expressly defines theoretical capacity to mean
22 the capacity at 4.2V:
23 ‘theoretical capacities of the positive and negative electrode’ means
24 the capacities of the positive electrode and the negative electrode
calculated with a charge cut-off voltage set at 4.2 V.
25 ‘641 patent at 4:5-9. This rules out Apple’s construction and is dispositive. See
26 *Jack Guttman, Inc. v. Kopykake Enterprises, Inc.*, 302 F.3d 1352, 1360–61 (Fed.
27 Cir. 2002) (“Where, as here, the patentee has clearly defined a claim term, that
1 definition usually is dispositive; it is the single best guide to the meaning of a
2 disputed term”) (internal quotation omitted).

The Court Agreed with RJ Tech that the Patent Defined “Theoretic Capacity” as “Capacity”

As an initial matter, the ‘641 Patent defines “theoretical capacities” of the anode and cathode as “the capacities of the positive electrode and the negative electrode calculated with a[] charge cut-off voltage set at 4.2 V.” (‘641 Patent at 4:5–9.) “Where, as here, the patentee has clearly defined a claim term, that definition usually is dispositive; it is the single best guide to the meaning of a disputed term.” *Jack Guttman, Inc. v. Kopykake Enterprises, Inc.*, 302 F.3d 1352, 1360-61 (Fed. Cir. 2002). This

Accordingly, the Court construes this term as follows: “the ratio calculated as the product of the capacity of the cathode active material per mass unit and the amount of the cathode active material in the same mass unit divided by the product of the capacity of the anode active material per mass unit and the amount of the anode active material in the same mass unit, when the charge cutoff voltage is 4.2 V.” The Court additionally

Pet. Reply, 7-9; Ex. 1032, 18-19; Ex. 2010, 14, 16.

Capacity Ratio Limitation: The Construction RJ Tech Argued For and Won Does Not Include “Theoretic”

RJ Tech Told the Court That “Theoretic” Should Not Be in The Construction

5 So the fact that the patent defines it by dropping
6 the word "theoretical" tells you that the construction
7 shouldn't have that word reinserted, again, which doesn't
8 add clarity, doesn't -- I didn't hear any substantive
9 difference that was added there, so it's unnecessary.

10 Now, in the art, sometimes they call that
11 "theoretical capacity." Sometimes they call it "theoretical
12 specific capacity." Sometimes they call it "specific
13 capacity." But in the patent, we have defined it. We've
14 defined it at -- in this patent, when we say "theoretical
15 capacity," we mean capacity at that voltage.

RJ Tech Tells the Board the Opposite

Claim 5 of the '641 Patent recites a “ratio of positive electrode material to negative electrode material” between 1:1.0 and 1:2.5, “as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2V.” Ex1001, 17:7-11.⁶ Petitioner

⁶ Claim 1 contains a similar limitation with the same construction.

predetermined voltage is reached.” Ex1005, ¶78. This disclosure suggests that the design capacity is the practical specific capacity of the cathode, instead of its theoretical capacity at 4.2V. Petitioner provides no analysis as to how that “design capacity” compares with the theoretical capacity at 4.2V, as required by the claims of the '641 Patent. Ex2006, ¶203.

Pet. Reply, 7-9; Ex. 1041, 20:5-9, 23:10-15; POR, 34, 62.

Capacity Ratio Limitation: The Construction RJ Tech Argued For and Won in the C.D. Cal. Does Not Include “Theoretic”

RJ Tech Told the Court That Capacity is Measured

The parties’ constructions are, once again, similar. Both parties’ constructions propose the same formula to calculate the ratio, which can be shown as follows:

$$\text{Ratio} = \frac{C_p \times m_p}{C_n \times m_n}$$

where C_p is the capacity per mass unit of the cathode active material (typically measured in milliamperes per gram, or “mAh/g”), m_p is the weight of the cathode active material (here measured in grams), C_n is the capacity per mass unit of the anode active material, and m_n is the weight of the anode active material. Yao Decl., ¶ 38. In other words, each part of the ratio is a simple multiplication in which capacity per mass unit (mAh/g) is multiplied by weight (g) such that the grams mathematically cancel each other out, leaving a capacity ratio. *Id.*, ¶ 39. The final ratio is therefore stated as a ratio of cathode capacity (in mAh) to anode capacity (in mAh). *Id.*

manufactures an indefiniteness problem where there is none. Apple defines “theoretic capacity” in a way that ignores that the claim expressly provides that the capacity is measured “at 4.2V.” Then Apple claims the ratio term is indefinite

RJ Tech Tells the Board the Opposite

Further, a POSITA would understand that theoretical capacity at 4.2V is distinct from an experimentally determined specific capacity at 4.2V. The claim expressly refers to the “*theoretic*” capacity, and not an experimentally determined capacity; and it was conventional and efficient to use the theoretical capacity at different voltage levels instead of experimental capacities when calculating such ratios, including to avoid the need to perform experiments. Ex2006, ¶113.

14 Q. Practical specific capacity is a type of
15 capacity?

16 A. That's correct.

17 Q. But in your analysis, a practical
18 specific capacity does not meet the court's claim
19 construction; correct?

20 MR. STAMATOPOULOS: Object to
21 form.

22 A. You are correct.

Pet. Reply, 7-9; Ex. 1032, 13-14, 20-21; POR, 25; Ex. 1043, 134:11-22.

Claims 1-8: Anticipated and Rendered Obvious by Uemura

(Grounds 1-2)

There is No Dispute Uemura Discloses the Preambles

[1P] “A method for improving the capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery, characterized in that”;
[5P] “A secondary lithium ion cell or battery, characterized in that”

(57)

ABSTRACT

A rechargeable lithium battery includes a negative electrode material having a total irreversible capacity of 45% or less of a total capacity of a positive electrode material. By adjusting the irreversible capacity of the negative electrode material in a wide range, a crystalline structure of the positive electrode material during charge-discharge is stably maintained, and cyclic resistance of the rechargeable lithium battery is improved. Moreover, the rechargeable lithium battery having a large capacity and high cyclic resistance at high temperature can be provided by the use of Li deficient type lithium manganese oxide of a layer structure as a positive electrode material.

[0002] The present invention relates to a non-aqueous electrolytic rechargeable lithium battery, more particularly, to a negative electrode material and a positive electrode material for improving cyclic resistance.

[0021] In a rechargeable lithium battery, lithium ions partially escape from a positive electrode by initial charge, pass through an electrolyte, and are doped onto a negative electrode. During discharge, the lithium ions doped onto the

[0081] The charge-discharge was repeatedly performed at a constant current of 0.5 mA/cm² and a voltage ranging from 4.3 V to 2.0 V at an atmospheric temperature of 60° C. by the use of the made sealed type non-aqueous solvent battery cell. The number of cycles taken to a point where the discharge capacity becomes less than 90% of the initial discharge capacity was obtained. Thus, the resistance was evaluated. A result thereof is shown in Table 1 together with the other values.

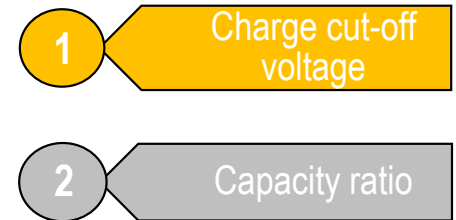
Petition, 16-17; Ex. 1009, Abstract, ¶¶[0002], [0021], [0081].

Uemura Discloses the Charge Cut-Off Voltage

[1A]: “the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V;”

[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”

[0081] The charge-discharge was repeatedly performed at a constant current of 0.5 mA/cm² and a voltage ranging from 4.3 V to 2.0 V at an atmospheric temperature of 60° C. by the use of the made sealed type non-aqueous solvent battery cell. The number of cycles taken to a point where the discharge capacity becomes less than 90% of the initial discharge capacity was obtained. Thus, the resistance was evaluated. A result thereof is shown in Table 1 together with the other values.



Petition, 17; Ex. 1009, ¶[0081].

Uemura Discloses the Charge Cut-Off Voltage

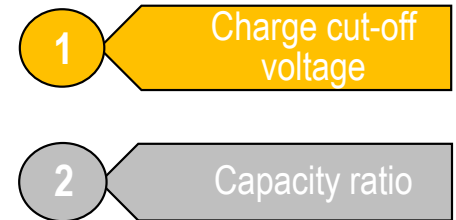
[1A]: “the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V;”

[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”



Marc Juzkow*

113. Uemura describes a cutoff voltage of the secondary lithium-ion cell or battery as being greater than 4.2V and less than 5.8V as required by these requirements of claims 1 and 5. Specifically, Uemura describes repeatedly charging and discharging a battery “between 4.3 V and 2.0 V.”¹⁰⁵ The 4.3V value is the charge cutoff voltage because it reflects the maximum voltage to which Uemura’s batteries are charged to.



Petition, 17; Ex. 1002, ¶113; Pet. Reply, 11-12.
*<https://www.lithiumion.expert/>

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[1A]: "the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V;"

[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"



2 Q. So Uemura's describing constant current

3 charging. Is that fair?

4 A. Yes.

15 Uemura here doesn't disclose that constant

16 voltage charging was performed in the experiment

17 described in paragraph 81. Correct?

18 A. Correct.

13 The way I read this, a POSITA would read it --

14 sorry. The way a POSITA would read this is saying that

15 if there's not using the constant voltage mode that they

16 are fully charging and fully discharging the cell at

17 that rate.

1

Charge cut-off
voltage

2

Capacity ratio

Ex. 2008, 113:2-4, 119:15-18, 120:13-17.

Uemura Discloses the Charge Cut-Off Voltage

[1A]: “the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V;”

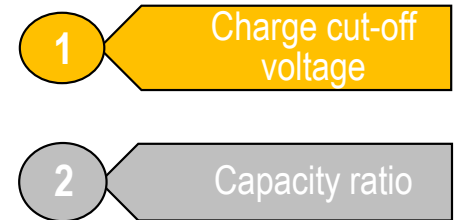
[5A] “the secondary lithium ion cell or battery has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V”



58. This understanding of Uemura is consistent with what Dr. Yao and Uemura previously told the Court regarding the use of constant current charging:

- “Constant Current (CC): The battery is charged at constant current *until it reaches the charge cut-off voltage.*” (EX1032, p.9 (emphasis added));
- “in many laboratory settings, batteries are charged at a *constant current* without a constant voltage stage. *Once the battery reaches a predetermined voltage (i.e., the charge cut-off voltage), the charging stops.*” (EX2022, ¶33 (emphasis added));
- “the voltage at which the charging switches to constant voltage in CC/CV is the charge cutoff voltage” (EX1050, ¶4).

59. As shown by RJ Tech’s own statements, a POSITA would understand that constant current charging involves the use of a constant current—not an applied voltage—until the battery reaches the charge cutoff voltage.

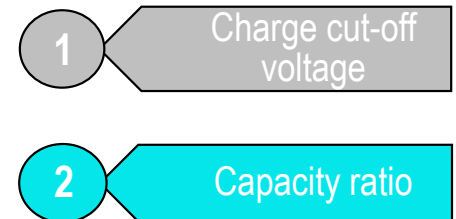


Pet. Reply, 12; Ex. 1044, ¶¶58-59.

Uemura Discloses the Capacity Ratio Limitation By Disclosing a Range

[1B]: “a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5 as calculated by a specific capacity with a charge voltage limited to 4.2 V”;
[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, as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2 V.”

[0033] Furthermore, a capacity balance ratio B/A of the total capacity B of the negative electrode material to the total capacity A of the positive electrode material is preferably fixed at a range of 1 to 1.5. If the capacity balance ratio B/A is below 1, lithium ion holding sites on the negative electrode material become insufficient. As the result, branch-shaped or needle-shaped crystal (dendrite crystal) tends to occur during the charge to cause a short circuit phenomenon between the positive electrode and the negative electrode. If the capacity balance ratio B/A exceeds 1.5, negative electrode sites that do not contribute to the charge-discharge are increased, leading to the wasteful use of materials.

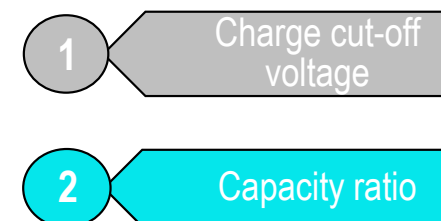


Petition 17-27; Ex. 1009, ¶[0033].

Uemura Discloses the Capacity Ratio Limitation By Disclosing Specific Embodiments

FIG.3

	Positive electrode material						Negative electrode material			Capacity balance Pc:Nc	Pc/Nc 100(%) of cycles	Number of cycles
	Used transition metal material	Composition of positive electrode material	X	Y	Weight (mg)	Total capacity : Pc (mAh)	Weight (mg)	Total capacity : Nc (mAh)	Total irreversible capacity : I			
Example 1	Cobalt(II) nitrate	$\text{Li}_{0.67}\text{Mn}_{0.5}\text{Co}_{0.5}\text{O}_{2-\delta}$	0.033	0.5	15	1.8	6.2	2.36	0.002	(1:1.3)	0.1	300
Example 2	Cobalt(II) nitrate	$\text{Li}_{0.83}\text{Mn}_{0.5}\text{Co}_{0.5}\text{O}_{2-\delta}$	0.17	0.5	15	2.24	6.2	3.41	0.44	(1:1.5)	20.0	330
Example 3	Cobalt(II) nitrate	$\text{Li}_{0.967}\text{Mn}_{0.5}\text{Co}_{0.5}\text{O}_{2-\delta}$	0.033	0.5	15	2.6	6.2	3.27	1.18	(1:1.3)	45.0	310
Example 4	Cobalt(II) nitrate	$\text{Li}_{0.967}\text{Mn}_{0.5}\text{Co}_{0.5}\text{O}_{2-\delta}$	0.033	0.5	15	2.6	4.9	2.6	0.94	(1:1)	36.0	350
Example 5	Cobalt(II) nitrate	$\text{Li}_{0.75}\text{Mn}_{0.75}\text{Co}_{0.25}\text{O}_{2-\delta}$	0.25	0.25	15	2	6.2	2.36	0.002	(1:1.3)	0.1	330
Example 6	Nickel(II) nitrate	$\text{Li}_{0.83}\text{Mn}_{0.75}\text{Ni}_{0.25}\text{O}_{2-\delta}$	0.17	0.25	15	2.24	6.2	2.36	0.002	(1:1.3)	0.1	325
Example 7	Iron(III) nitrate	$\text{Li}_{0.83}\text{Mn}_{0.67}\text{Fe}_{0.33}\text{O}_{2-\delta}$	0.17	0.33	15	2.24	6.2	2.36	0.002	(1:1.3)	0.1	245
Example 8	Aluminium(III) nitrate	$\text{Li}_{0.83}\text{Mn}_{0.75}\text{Al}_{0.25}\text{O}_{2-\delta}$	0.17	0.25	15	2.24	6.2	2.36	0.002	(1:1.3)	0.1	310
Example 9	Chromium(III) nitrate	$\text{Li}_{0.83}\text{Mn}_{0.75}\text{Cr}_{0.25}\text{O}_{2-\delta}$	0.17	0.25	15	2.24	6.2	2.36	0.002	(1:1.3)	0.1	350
Example 10	Gallium(III) nitrate	$\text{Li}_{0.83}\text{Mn}_{0.75}\text{Ga}_{0.25}\text{O}_{2-\delta}$	0.17	0.25	15	2.24	6.2	2.36	0.002	(1:1.3)	0.1	120
Example 11	Indium(III) hydroxide	$\text{Li}_{0.83}\text{Mn}_{0.75}\text{In}_{0.25}\text{O}_{2-\delta}$	0.17	0.25	15	2.24	6.2	2.36	0.002	(1:1.3)	0.1	110
Example 12	Zirconium(IV) hydroxide	$\text{Li}_{0.83}\text{Mn}_{0.75}\text{Zr}_{0.25}\text{O}_{2-\delta}$	0.17	0.25	15	2.24	6.2	2.36	0.002	(1:1.3)	0.1	95
Example 13	Vanadium(III) oxide	$\text{Li}_{0.83}\text{Mn}_{0.75}\text{V}_{0.25}\text{O}_{2-\delta}$	0.17	0.25	15	2.24	6.2	2.36	0.002	(1:1.3)	0.1	130
Example 14	Iron(III) oxide	$\text{Li}_{0.75}\text{Mn}_{0.875}\text{Fe}_{0.125}\text{O}_{2-\delta}$	0.25	0.125	15	2	6.2	2.36	0.002	(1:1.3)	0.1	220
Example 15	Niobium(II) oxide	$\text{Li}_{0.83}\text{Mn}_{0.75}\text{Nb}_{0.25}\text{O}_{2-\delta}$	0.17	0.25	15	2.24	6.2	2.36	0.002	(1:1.3)	0.1	190
Example 16	Tantalum(V) oxide	$\text{Li}_{0.83}\text{Mn}_{0.75}\text{Ta}_{0.25}\text{O}_{2-\delta}$	0.17	0.25	15	2.24	6.2	2.36	0.002	(1:1.3)	0.1	180
Example 17	Titanium(IV) oxide	$\text{Li}_{0.83}\text{Mn}_{0.75}\text{Ti}_{0.25}\text{O}_{2-\delta}$	0.17	0.25	15	2.24	6.2	2.36	0.002	(1:1.3)	0.1	250
Comparative example		$\text{LiMnO}_2-\delta$	0	0	15	2.7	10	—	—	(1:1.3)	—	10



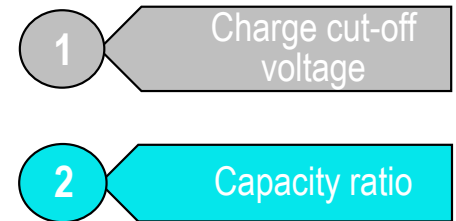
Petition 17-27; Ex. 1009, FIG. 3.

A POSITA Would Understand that Uemura Teaches “As Calculated . . . With a Charge Cut-Off Voltage Set at 4.2V”



117. (2) *Uemura’s capacity ratio is calculated at the voltage it is intended to operate at—i.e., 4.3 V.* A PHOSITA approaching Uemura’s disclosure would have understood that Uemura calculates capacities at the voltage Uemura’s battery is designed to operate at—specifically 4.3 V.¹⁰⁸ The PHOSITA would have reached this conclusion based on how Uemura explains the consequences of having a capacity ratio of less than 1:1. In this respect, Uemura says:

*If the capacity balance ratio B/A is below 1, lithium ion holding sites on the negative electrode material becomes insufficient. As the result, branch-shaped or needle-shaped crystal (dendrite crystal) tends to occur during the charge to cause a short circuit phenomenon between the positive electrode and the negative electrode.*¹⁰⁹

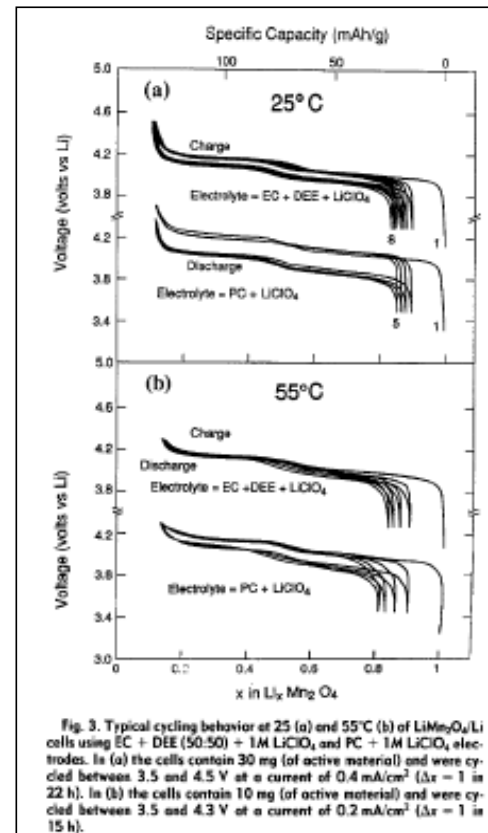


Petition 20-24; Ex. 1002, ¶¶117-120.

A POSITA Would Understand that Uemura Teaches “As Calculated . . . With a Charge Cut-Off Voltage Set at 4.2V”



122. The PHOSITA would have been confident that with a decrease in the charge cutoff voltage of 0.1 V, the amount of lithium extracted from the cathode would not have been 2.5 times less. This is reflected in the known charge/discharge curves for lithium manganese oxides, which show that the capacity does not change rapidly with the addition (or subtraction) of additional voltage above about 4.2 V.¹²¹



- 1 Charge cut-off voltage
- 2 Capacity ratio

Petition 24-27; Ex. 1002, ¶¶121-123.

RJ Tech's Responses to Grounds 1 and 2

- Uemura does not disclose the charge cut-off limitation
- Uemura does not disclose the capacity ratio limitation
- Uemura is not enabled
- Uemura has obvious errors such that a POSITA would ignore it

RJ Tech's POPR Admitted Uemura Applies Constant Current Charging

POPR

Uemura also discloses a voltage range—under constant current conditions—that partially overlaps with the claimed charge cut-off voltage range in the patent.¹

The charge-discharge was repeatedly performed at a constant current of 0.5 mA/cm and a voltage ranging from 4.3 V to 2.0 V at an atmospheric temperature of 60° C. by the use of the made sealed type non-aqueous solvent battery cell. Ex. 1009, [0081].

Uemura does not on its face require that a battery be charged to the upper boundary of this range or provide any other disclosure of a voltage above 4.2V. Also, Uemura does not teach applying a voltage for the purpose

a particular battery as Petitioner asserts (and must assert to anticipate) or (ii) simply a *potential* maximum value in a set of experiments that a PHOSITA may or may not follow (e.g., Uemura discloses charging at a “constant current” (Ex. 1009 at [0081]) the import of which Dr. Juzkow and Petitioner fail to address anywhere in their papers). For this reason—and given that Petitioner has not offered any explanation

Uemura

[0081] The charge-discharge was repeatedly performed at a constant current of 0.5 mA/cm² and a voltage ranging from 4.3 V to 2.0 V at an atmospheric temperature of 60° C. by the use of the made sealed type non-aqueous solvent battery cell. The number of cycles taken to a point where the discharge capacity becomes less than 90% of the initial discharge capacity was obtained. Thus, the resistance was evaluated. A result thereof is shown in Table 1 together with the other values.

POPR at 14, 36; Ex. 1009, ¶[0081].

RJ Tech Told The Court it is Well-Known Constant Current Charging is Applied Until The Battery Reaches its Charge Cut-Off Voltage



6 32. Apple's construction refers to a specific type of charging algorithm—
7 CC/CV. Pursuant to that algorithm, the battery is charged using a constant current
8 until it reaches a maximum configured voltage, at which point it is charged at that
9 voltage until charging is complete. The constant current stage allows the battery to
10 be charged quickly and efficiently. During the constant voltage stage, the battery is
11 slowly charged to its full capacity, and this constant voltage stage prevents the
12 battery from being overcharged, *i.e.*, charging to a level higher than the charge
13 cutoff voltage.

14 33. At the time of the invention, and still today, CC/CV charging was a
15 common way of charging a lithium-ion battery, and regarded as a sound means to
16 strike a balance between fast charging and safe charging. But CC/CV charging is
17 not the only way to charge a battery. A charge cutoff voltage can be implemented
18 by other charging algorithms. For example, in many laboratory settings, batteries
19 are charged at a constant current without a constant voltage stage. Once the battery
20 reaches a predetermined voltage (*i.e.*, the charge cut-off voltage), the charging
21 stops. Sometimes the battery is charged at a constant voltage, without first being
22 charged at a constant current. Sometimes pulse charging is used, which involves
23 delivering charging current in pulses rather than a continuous stream. In each of
24 these cases, there is a charge cut-off voltage, which is the maximum voltage to
25 which the battery is configured to be charged.

Pet. Reply, 12; Ex. 2022, ¶¶32-33.

RJ Tech Told The Court it is Well-Known Constant Current Charging is Applied Until The Battery Reaches its Charge Cut-Off Voltage



What Dr. Yao Told the Court

4 Q. Right. So you told the court in your
5 declaration that with constant current charging,
6 the battery is charged until a predetermined
7 voltage, i.e., the charge cut-off voltage, and
8 then it stops; correct?

9 A. The charge stops, yes.

10 Q. So you agree with me that constant
11 current charging involves charging the battery at
12 a constant current until it reaches the charge
13 cut-off voltage; correct?

14 MR. STAMATOPOULOS: Object to
15 form.

16 A. Yes.

What Dr. Yao Told the Board

119. All Uemura discloses is an applied voltage of 4.3V. Uemura does not disclose what the battery voltage or the open circuit voltage was when the applied voltage reached 4.3V. Instead, because the batteries in Uemura were purportedly only charged with a constant current,⁶⁴ and there was no constant voltage phase, the batteries were not fully charged when the applied voltage reached 4.3V. Instead, the charge cutoff voltage as claimed by the '641 Patent, which refers to the battery voltage or the open circuit voltage, must be lower than 4.3V. For this reason, Uemura does not disclose a charge cutoff voltage of 4.3V and cannot anticipate claims 2, 3, 6, or 7, or render them obvious.

Ex. 1043, 20:10-20; Ex. 2006, ¶119.

RJ Tech's POR is Inconsistent with its Previous Statements Concerning Constant Current Charging

What RJ Tech Told the Court

17 The algorithms regulate the amount of voltage and current that are fed to the
18 battery, usually to maximize the amount of electricity the battery can store, while
19 minimizing damage to the battery. Some commonly used charging algorithms are:

- 20 • **Constant Voltage (CV):** The battery is charged at a constant voltage until
21 fully charged.
- 22 • **Constant Current (CC):** The battery is charged at constant current until
23 it reaches the charge cut-off voltage.
- 24 • **Constant Current/Constant Voltage (CC/CV):** The battery is first
25 charged at constant current up to a specific voltage (typically in the prior
26 art 4.2V) and then charged at constant voltage until the battery is fully
27 charged.
- 1 • **Pulse Charging:** The battery is charged by intermittent pulses of charging
2 current rather than a continuous stream.

3 In each case, there is a maximum voltage to which the battery is configured to be
4 charged. This is called the charge cutoff voltage. Yao Decl., ¶ 33. It can also be
5 referred to as the cutoff voltage, the potential limit, the upper voltage limit or the
6 upper charge limit, but in each case, it refers to the designed maximum charging
7 limit of the battery. *Id.*, ¶ 26.

RJ Tech's POR

In particular, Uemura discloses charging batteries with a constant current at 0.5 mA/cm² at a maximum applied voltage equal to 4.3V. Ex1009, ¶81. A POSITA would understand that in Uemura's constant current charging the battery charging stops once the applied voltage reaches 4.3V. Ex2006, ¶119. A POSITA would also

Pet. Reply, 12; Ex. 1032, 9-10; POR, 29.

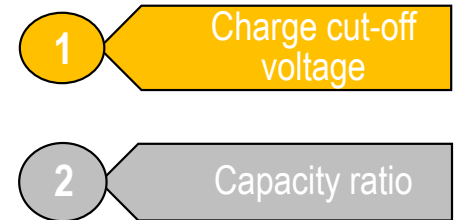
RJ Tech's POR is Inconsistent with its Previous Statements Concerning Constant Current Charging

[1A]: "the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V;"

[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"



57. RJ Tech mistakenly argues that Uemura discloses "an applied voltage equal to 4.3V" (POR at 28; EX2006, ¶¶118-120). But Uemura does not disclose an applied voltage and RJ Tech cites nothing supporting that position. Uemura indicates that the batteries were charged using a constant current of 0.5 mA/cm² until the battery reached a voltage of 4.3V and then it was discharged until the battery reached a voltage of 2.0V. EX1009, ¶[0081]. Thus, Uemura discloses that the battery was charged to a maximum voltage of 4.3V.



Pet. Reply, 11-12; Ex. 1044, ¶57.

RJ Tech's Interpretation of Charge Cut-Off Voltage is Different from What it Told the Court



8 Q. (BY MR. COLIN) Well, it's your opinion
9 that charge cut-off voltage is a measured value;
10 you actually have to measure the battery voltage
11 to see it. Correct?
12 A. Yes.

6 Q. (BY MR. COLIN) So it's your opinion to
7 the board that Uemura actually needs to show an
8 electrochemical measurement indicating it was
9 fully charged to 4.3 volts to meet the limitation,
10 under your understanding?
11 MR. STAMATOPOULOS: Object to
12 form.
13 A. Yes, that's correct.

2 Q. (BY MR. COLIN) But you're not applying
3 "configured to be charged"; right? You're saying
4 the battery must be charged to 4.3 volts; correct?
5 MR. STAMATOPOULOS: Object to
6 form.
7 A. I don't know what's the difference.
8 Q. (BY MR. COLIN) You don't know what the
9 difference between being configured to be charged
10 versus actually charged is?
11 MR. STAMATOPOULOS: Object to the
12 form.
13 A. My interpretation is "configured to be
14 charged" means you're fully charged to reach
15 equilibrium. You know, after you're charged, you
16 may not reach equilibrium. You may or may not.
17 Depends on your charging algorithms.

Pet. Reply, 1, 3-4, 6; Ex. 1043, 49:8-12, 197:6-13, 201:2-17.

RJ Tech Failed to Apply the Court's Claim Construction for the Capacity Ratio Limitation

RJ Tech Purports to Follow the Court's Claim Construction

Petitioner proposes adopting PO's construction from the Apple litigation for the "capacity ratio" limitations in claims 1 and 5 (Pet., 9-10).

The claimed ratio limitation in claims 1 and 5 is calculated as "the product of the capacity of the cathode active material per mass unit and the amount of the cathode active material in the same mass unit divided by the product of the capacity of the anode active material per mass unit and the amount of the anode active material in the same mass unit, when the charge cut-off voltage is 4.2V." Ex2010, 16.

Dr. Yao Did Not Apply the Court's Construction



11 Q. Okay. The court's construction for the
12 capacity ratio limitation does not include the
13 word "theoretic" or "theoretical"; correct?

14 A. Yes.

15 Q. In your opinion to the board and the
16 claim construction you apply in the IPR, you
17 require capacity to be theoretic capacity;
18 correct?

19 A. Yes.

14 Q. Practical specific capacity is a type of
15 capacity?

16 A. That's correct.

17 Q. But in your analysis, a practical
18 specific capacity does not meet the court's claim
19 construction; correct?

20 MR. STAMATOPOULOS: Object to
21 form.

22 A. You are correct.

Pet. Reply, 13-14; POR, 22; Ex. 1043, 121:11-19, 134:14-22.

RJ Tech's Argument is Not Supported By Intrinsic Evidence

RJ Tech Tells the Board Theoretic Capacity is the “Maximum Capacity” Without Intrinsic Support

A POSITA would know further that the theoretical capacity of an electrode when the voltage is 4.2V is the maximum capacity of that electrode (e.g., the cathode) when the battery voltage is set at 4.2V. Ex2006, ¶104.

A POSITA would also know that the theoretical capacity at 4.2V is different from (i) the theoretical maximum capacity of an electrode, which corresponds to the maximum amount of lithium ions that can be extracted from (or stored in) the electrode irrespective of the battery voltage applied and dependent only upon the chemistry of the electrode and (ii) the experimentally determined specific capacity (also known as “practical specific capacity”) of an electrode material in different experimental conditions, including different battery voltages. *Id.*

1 My question is simply, you don't cite
2 anywhere in the '641 patent where it provides an
3 example or a teaching of how to determine the
4 theoretic capacity of 4.2 volts for any material;
5 correct?
6 MR. STAMATOPOULOS: Object to
7 form.
8 A. I didn't cite any in the '641 patent,
9 that's correct.



Pet. Reply, 13-14; POR at 24; Ex. 1043, 127:1-9.

RJ Tech's Argument is Inconsistent with Dr. Yao's Prior Testimony

RJ Tech Tells the Board Theoretic Capacity is the "Maximum Capacity"

A POSITA would know further that the theoretical capacity of an electrode when the voltage is 4.2V is the maximum capacity of that electrode (e.g., the cathode) when the battery voltage is set at 4.2V. Ex2006, ¶104.

A POSITA would also know that the theoretical capacity at 4.2V is different from (i) the theoretical maximum capacity of an electrode, which corresponds to the maximum amount of lithium ions that can be extracted from (or stored in) the electrode irrespective of the battery voltage applied and dependent only upon the chemistry of the electrode and (ii) the experimentally determined specific capacity (also known as "practical specific capacity") of an electrode material in different experimental conditions, including different battery voltages. *Id.*

Dr. Yao Told the Court it is Not a Maximum

8 46. This was well-known at the time of the invention. Indeed, some
9 references contemporaneous with the '641 Patent simply use the term "theoretical
10 capacity" to mean the specific capacity at 4.2 V. For example, the HANDBOOK OF
11 BATTERIES, which was frequently used as a textbook for college students, describes
12 the "theoretical capacity" of LiCoO_2 to be 137 mAh/g. *See* Ex. 6. (LINDEN D,
13 HANDBOOK OF BATTERIES, (2001)) at 1.10-1.11 & Table 1.1 (.137 Ah/g is 137
14 mAh/g). The HANDBOOK OF BATTERIES also explains that the 137 number is based
15 on "x=0.5," which is the percentage of lithium extracted from the cathode active
16 material, even though "higher values may be obtained in practice." *Id.* at 1.11. In



Pet. Reply, 13-14; POR at 24; Ex. 2022, ¶46.

RJ Tech's Argument is Inconsistent with the Intrinsic Evidence

109. Applying the same equation to LiCoO_2 at 4.2V, it is well-known that half of the lithium ions of that material is extracted from the cathode, $x=0.5$, and so the theoretical capacity at 4.2V for LiCoO_2 is 137 mAh/g.

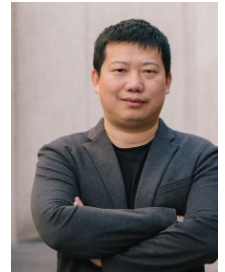
2 Q. Okay. And you see where the patent says,
3 "For lithium cobalt oxides as a positive electrode
4 material with secondary lithium ion cell has a
5 theoretical capacity of 248 milliamp-hours per
6 gram or the actually used capacity of it is merely
7 about 140 milliamp-hours per gram -- i.e., about
8 half of said theoretic capacity -- is not
9 utilized." Do you see that?

10 A. Yes.

11 Q. Okay. So it's your opinion that if you
12 refer to actually used capacity for a material,
13 that doesn't fall under the claim construction for
14 the capacity ratio limitation; correct?

15 MR. STAMATOPOULOS: Object to
16 form.

17 A. I do not see the connection of this place
18 with the claim file. But you are right. I think
19 the theoretical capacity in Claim 5.



Pet. Reply, 1-2, 7-9, 13-14; Ex. 2006, ¶109; Ex. 1043, 124:2-19.

RJ Tech Asserts “Theoretic” Capacity is Not Measured, But Admits Measurement is Required

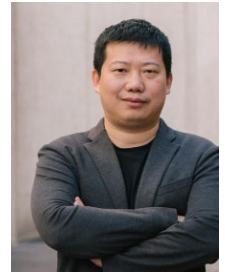
RJ Tech Asserts “Capacity” Does Not Include Experimentally Determined Capacity

A POSITA would know further that the theoretical capacity of an electrode when the voltage is 4.2V is the maximum capacity of that electrode (e.g., the cathode) when the battery voltage is set at 4.2V. Ex2006, ¶104.

A POSITA would also know that the theoretical capacity at 4.2V is different from (i) the theoretical maximum capacity of an electrode, which corresponds to the maximum amount of lithium ions that can be extracted from (or stored in) the electrode irrespective of the battery voltage applied and dependent only upon the chemistry of the electrode and (ii) the experimentally determined specific capacity (also known as “practical specific capacity”) of an electrode material in different experimental conditions, including different battery voltages. *Id.*

Dr. Yao Admits Experimentation is Required

11 Q. (BY MR. COLIN) Okay. So experiments
12 need to be performed to derive an X factor;
13 correct?
14 MR. STAMATOPOULOS: Object to
15 form.
16 A. People reporting in the literature, and
17 it's become accepted knowledge in the field. You
18 don't need to repeat every time. It's become
19 knowledge. Yeah.
20 Q. (BY MR. COLIN) Okay. X is not
21 determined based on some calculation; correct?
22 It's based on people in the field performing
142
1 experiments?
2 MR. STAMATOPOULOS: Object to
3 form.
4 A. Yes.
5 Q. (BY MR. COLIN) Okay. And you can't tell
6 me an X value for an unknown material; correct?
7 If you develop a new cathode material, brand-new
8 material, you can't just tell me an X factor
9 without doing the experiments; correct?
10 A. You are correct.
11 Q. And for -- if you create a material that
12 is doped, you can't figure out an X factor without
13 doing the experiments; correct?
14 MR. STAMATOPOULOS: Object to
15 form.
16 A. You need do experiment. But some people
17 write down the experiment, you can rely on their
18 data to predict.



Pet. Reply, 13-14; POR at 24;
Ex. 1043, 141:11-142:18.

RJ Tech Asserts “Theoretic” Capacity is Not Measured, But Applies a Measured Value in Manipulating Uemura’s Capacity Ratio

RJ Tech Asserts “Capacity” Does Not Include Experimentally Determined Capacity

A POSITA would know further that the theoretical capacity of an electrode when the voltage is 4.2V is the maximum capacity of that electrode (e.g., the cathode) when the battery voltage is set at 4.2V. Ex2006, ¶104.

A POSITA would also know that the theoretical capacity at 4.2V is different from (i) the theoretical maximum capacity of an electrode, which corresponds to the maximum amount of lithium ions that can be extracted from (or stored in) the electrode irrespective of the battery voltage applied and dependent only upon the chemistry of the electrode and (ii) the experimentally determined specific capacity (also known as “practical specific capacity”) of an electrode material in different experimental conditions, including different battery voltages. *Id.*

But RJ Tech Asserts the “Theoretic” Capacity For Uemura is a Measured Value

Uemura’s examples purport to use layered LiMnO_2 as the cathode material (Ex1009, Fig. 3), which was known in the art to have a theoretical capacity at 4.2V approximately equal to 270 mAh/g. Ex2006, ¶¶64-67. (citing Ex2009, 500).

4 Q. Okay. So going back to Armstrong to talk
5 about this 270 milliamp-hour. So Armstrong
6 indicates that the material has an initial
7 measured capacity of 270 milliamps-hour per gram;
8 correct?
9 A. That's correct.
10 Q. And that's an experimentally measured
11 number; correct?
12 MR. STAMATOPOULOS: Object to
13 form.
14 A. Yes.

Pet. Reply, 13-14; POR at 24, 36; Ex. 1043, 167:4-14; Ex. 2009, 500.

RJ Tech Asserts “Theoretic” Capacity is Reversible Capacity, But Applies Irreversible Capacity in Manipulating Uemura’s Capacity Ratio

RJ Tech Asserts “Theoretic” Capacity is the Reversible Capacity

in Uemura includes the capacity attributable to this non-carbon content. When it is excluded, the total reversible capacity of the active material (i.e., what should be used to calculate the claimed ratio) is shown below in the right-hand column:

But RJ Tech Applies an “Initial” Capacity at 4.3V That Declines Rapidly Upon Cycling

4 Q. Okay. So going back to Armstrong to talk
5 about this 270 milliamp-hour. So Armstrong
6 indicates that the material has an initial
7 measured capacity of 270 milliamps-hour per gram;
8 correct?

9 A. That's correct.

67. However, while this layered cathode structure discussed in Armstrong 1996 has a large initial charge capacity, when the battery “was cycled at a constant current density of 0.5 mA cm⁻² between the potential limits 3.4 and 4.3 V,” the capacity declined rapidly.²⁵ Fig. 3 of Armstrong 1996 demonstrates this significant

Pet. Reply, 13-14; POR at 39; Ex. 1043, 167:4-9; Ex. 2006, ¶¶67.

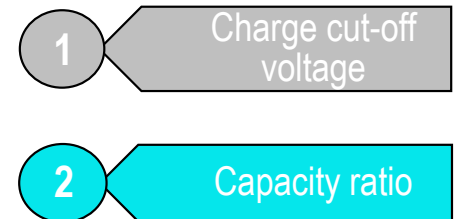
RJ Tech's "Theoretic" Capacity is Not Based on a Charging Rate a POSITA Would Use



62. Notably, the 270 mAh/g value is determined using a charging current of "10 $\mu\text{A cm}^{-2}$ ". EX2009, p.500. When Armstrong applied a "much higher current density of 0.5 mA cm^{-2} " (a current density 50 times higher) he obtained a specific capacity of 200 mAh/g. *Id.*

63. Notably, Uemura also used the "much higher current density" of 0.5 mA/cm^2 . Dr. Yao asserted that Uemura's current density equated to a C-rate of C/3-C/4. EX2006, ¶119n.64 ("According to the capacity data reported in Uemura, the charging for each of the examples in Fig. 3 lasted between 3-4 hours.").

64. Thus, the current density that Dr. Yao relies on for achieving the theoretic capacity of LiMnO_2 at 4.2V is a C-rate of C/150-C/200, meaning it will take 150-200 hours per each charge and discharge of the battery. Using a C-rate of C/150-C/140 is not disclosed by the '641 patent, is not required by the claims of the '641 patent, and is inconsistent with charge-discharge conditions that a POSITA would apply.

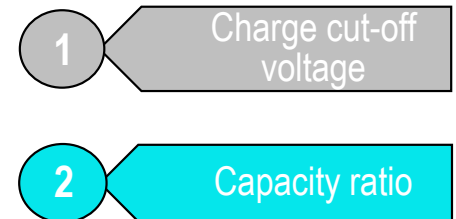


Ex. 1044, ¶¶62-64.

RJ Tech is Incorrect About Uemura's Anodes in Manipulating Uemura's Capacity Ratio



52. Dr. Yao attempts to reduce the reported capacities of Uemura's example anode materials by subtracting capacities allegedly attributable to inactive material (EX2006, ¶¶140-142). However, a POSITA would understand the term "inactive material" in relation to battery electrodes as material that doesn't have or affect capacity. Just because a material in an anode is "non-carbon content," as stated by Dr. Yao, does not mean that materials is "inactive." By definition and as understood by a POSITA, an active electrode material has capacity, and an inactive electrode material does not have capacity.



Pet. Reply, 14; Ex. 1044, ¶¶52-55.

Prior art printed publications are presumed to be enabling.

In re Antor Media Corp.,
689 F.3d 1282, 1288-89 (Fed. Cir. 2012)



A prior art reference “need not enable it’s full disclosure, but instead, it only needs to enable the portions of its disclosure alleged to anticipate the claimed invention.”

Id. at 1290

Pet. Reply, 15-16.

Uemura Enables Each Element of the Claims

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.

[0002] The present invention relates to a non-aqueous electrolytic rechargeable lithium battery, more particularly, to a negative electrode material and a positive electrode material for improving cyclic resistance.

Preamble

[0081] The charge-discharge was repeatedly performed at a constant current of 0.5 mA/cm² and a voltage ranging from 4.3 V to 2.0 V at an atmospheric temperature of 60° C. by the use of the made sealed type non-aqueous solvent battery cell. The number of cycles taken to a point where the discharge capacity becomes less than 90% of the initial discharge capacity was obtained. Thus, the resistance was evaluated. A result thereof is shown in Table 1 together with the other values.

Charge cut-off voltage

[0033] Furthermore, a capacity balance ratio B/A of the total capacity B of the negative electrode material to the total capacity A of the positive electrode material is preferably fixed at a range of 1 to 1.5. If the capacity balance ratio B/A is below 1, lithium ion holding sites on the negative electrode material become insufficient. As the result, branch-shaped or needle-shaped crystal (dendrite crystal) tends to occur during the charge to cause a short circuit phenomenon between the positive electrode and the negative electrode. If the capacity balance ratio B/A exceeds 1.5, negative electrode sites that do not contribute to the charge-discharge are increased, leading to the wasteful use of materials.

Capacity ratio

Pet. Reply, 15-17;
Ex. 1001, 17:5-11;
Ex. 1009, ¶¶[0002],
[0033], [0081].

RJ Tech Provided No Evidence That Examples 5-17 Are Not Enabled And Thus Cannot Rebut The Presumption of Enablement



3 Q. (BY MR. COLIN) Dr. Yao, that didn't
4 answer my question. My question was simply, you
5 provide no analysis regarding the two different
6 synthesis methods of examples 1 to 9 and examples
7 10 to 17 of Uemura; correct?

8 MR. STAMATOPOULOS: Object to
9 form.

10 A. Because I only instruct Dr. Liang to
11 synthesize examples 1 to 4; so, you are right, I
12 didn't provide a comparative analysis on these two
13 methods.

18 Q. My question is simply, you provide no
19 analysis showing that the anode of example 2,
20 which you indicate is a higher irreversible
21 capacity than conventional anode materials, is
22 representative of an anode that is precycled to

1 have an extremely low irreversible capacity such
2 as the anode in example 9 and 10; correct?

3 MR. STAMATOPOULOS: Object to
4 form.

5 A. Although I didn't present the
6 analytical -- analytics in my declaration, you
7 know, I can tell you now that...

Pet. Reply, 15-17; Ex. 1043, 244:3-13, 248:18-249:7.

Dr. Liang's Testing is Flawed



Dr. Liang and Dr. Yao*

- LiBeyond, Dr. Yao's own company, performed the testing
- Only tried to synthesize Examples 1-3 one time allegedly using "Uemura's process"
- Did not employ Uemura's process parameters
- First time Dr. Liang ever tried to synthesize layered complexes based on lithium, manganese, and other metals, but did not modify any parameters even though he obtained the wrong color and did not produce Uemura's materials
- Failed to use proper experimental controls
- Failed to record material aspects of his testing

Pet. Reply, 17-20; Ex. 1044, ¶¶17-27.
*<https://www.uh.edu/news-events/stories/2019/october-2019/10102019-yao-doe-lithium.php>

Dr. Liang Did Not Even Try to Recreate Uemura's Examples



	Uemura's Disclosure	Dr. Liang's Testing
1. Color	"brown slurry" and "brown powder"	"deep gray powder"
2. Pre-annealing step	N/A	500°C for several hours
3. Coprecipitation method	Use of citric acid or ammonium bicarbonate	N/A
4. Control particle size	Grinding material "to 20 µm or smaller in average particle diameter"	N/A
5. Pressure to form electrode	Two tons per square centimeter	Hand-operated mortar and pestle
6. Heat electrode to remove moisture	150°C for 16 hours	N/A
7. Current collector	Stainless steel	Molybdenum
8. Electrode dimensions	12mm diameter disk	7.14mm self-standing electrode

Pet. Reply, 17-19; Ex. 1044, ¶¶28-43.

Dr. Liang Did Not Even Try to Recreate Uemura's Examples



	Uemura's Disclosure	Dr. Liang's Testing
9. Separator	Polypropylene film	Polyethylene
10. Control partial pressure of oxygen during baking	Carbon black, acetylene black, or citric acid	N/A
11. Examples	17 examples and 1 comparative example	3 examples

Pet. Reply, 17-19; Ex. 1044, ¶¶28-43.

Dr. Liang's Testing is Unreliable and Unscientific



6. Dr. Liang's testing purporting to evaluate Uemura (EX1009) is unreliable and unscientific for multiple reasons. These reasons include: 1) he performed the testing only once, which is insufficient to form reasonable conclusions about Uemura's process for synthesizing certain cathode materials, 2) he failed to include proper controls, which further undermines the reliability of his testing, 3) he failed to follow Uemura's teachings in numerous respects without acknowledging or justifying the reasons for the variations (i.e., he produced something *other than* Uemura's materials), 4) he failed to consider and record material aspects of the testing, which further undermines its reliability, and 5) he failed to record where he obtained certain "standards" from and used his own testing as an alleged "standard."

Pet. Reply, 17-19; Ex. 1044, ¶6.

Multiple Prior Art Publications Contradict RJ Tech's Criticisms of Uemura's Method of Synthesis

Identification of cathode materials for lithium batteries guided by first-principles calculations

G. Ceder, Y.-M. Chiang, D. R. Sadoway, M. K. Aydinol, Y.-I. Jang & B. Huang

To test the predictions of the computations we developed a method to synthesize homogeneous $\text{Li}(\text{Co},\text{Al})\text{O}_2$ solid solutions in the $\alpha\text{-NaFeO}_2$ structure. First, mixed cobalt–aluminium hydroxides were precipitated from mixed aqueous solutions containing $\text{Co}(\text{NO}_3)_2$ and $\text{Al}(\text{NO}_3)_3$, added dropwise to a continuously stirred LiOH aqueous solution kept at pH 10.5. Nitrate ions were removed from the precipitate through a rinsing procedure described in ref. 12. Lithium was then added through a freeze-drying procedure, in which the mixed hydroxide was dispersed in aqueous LiOH solution yielding a total $\text{Li}/(\text{Co} + \text{Al})$ molar ratio of unity, the suspension was atomized into liquid nitrogen, and the frozen droplets were freeze-dried.

Stabilization of LiMnO_2 in the $\alpha\text{-NaFeO}_2$ Structure Type by LiAlO_2 Addition

Young-Il Jang,* Biying Huang, Yet-Ming Chiang,**,* and Donald R. Sadoway**

A $\text{LiAl}_x\text{Mn}_{1-x}\text{O}_2$ solid solution can be crystallized in the monoclinic derivative of the $\alpha\text{-NaFeO}_2$ structure upon firing in a reducing environment to control the Mn^{3+} content. During electrochemical cycling, this compound develops two voltage plateaus (4 and 3 V, vs. a lithium anode), suggesting spinel-like cation ordering, as previously observed for $o\text{-LiMnO}_2$ and $m\text{-LiMnO}_2$ prepared by other methods. However, the resulting material shows excellent cycleability and high reversible capacity when cycled over both voltage plateaus, unlike the LiMn_2O_4 spinels. A composition $\text{LiAl}_{0.25}\text{Mn}_{0.75}\text{O}_2$ exhibited 148 mAh/g reversible capacity at C/5 rate (450 Wh/kg energy density) and 182 mAh/g at C/15 rate (545 Wh/kg). $m\text{-LiAl}_x\text{Mn}_{1-x}\text{O}_2$ solid solutions may therefore be attractive cathode materials for low-cost, high-energy-density lithium rechargeable batteries.

Pet. Reply, 19-20; Ex. 1044, ¶¶46-51; Ex. 1047, 695; Ex. 1045, 16.

RJ Tech Has Not Shown Errors in Uemura That Would Cause a POSITA to Ignore its Disclosures

RJ Tech Criticizes the Uniformity of Uemura's Cathode Capacities

Second, a POSITA would immediately recognize that Uemura's total cathode capacity data evince a level of uniformity that is implausible for experimentally determined results. Even assuming the cathode materials in examples 2, 6-13, and 15-17 had identical theoretical maximum capacities (they do not)—it would be impossible to conduct experiments that would yield identical total capacity values for those examples, as reported in Uemura. This is because experimental conditions

Dr. Yao Admitted Uemura Calculated Cathode Capacity



13 Q. (BY MR. COLIN) Let me ask you about
14 that, then. It's your opinion that as you --
15 you've said a few times you believe that Uemura
16 just multiplied the amount of lithium by 180
17 milliamp-hours per gram in Figure 3; correct?
18 That's how he got his values?

19 MR. STAMATOPOULOS: Object to
20 form.

21 Q. (BY MR. COLIN) That's what you say in
22 paragraph 165 and 166.

184
1 MR. STAMATOPOULOS: Object to
2 form.

3 A. That's my analysis of the Figure 3 in
4 Uemura's patent. And that's how I render my
5 opinion in the paragraph 132 to 133, and that's --
6 that's how I understand the data.

7 Q. (BY MR. COLIN) Okay. So based on your
8 review of Figure 3 in Uemura, you believe that
9 Uemura multiplied the molar amount of lithium by
10 180 milliamp-hours per gram to get his capacity
11 values for the cathode; right?

12 A. That's correct.

Pet. Reply 20-21; POR, 49; Ex. 1043, 183:13-184:12.

Claims 1-8: Anticipated and Rendered Obvious by Abe

(Grounds 5-6)

There is No Dispute Abe Discloses the Preambles

[1P] “A method for improving the capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery, characterized in that”;
[5P] “A secondary lithium ion cell or battery, characterized in that”

(54) [Title of Invention] **NON-AQUEOUS ELECTROLYTE-BASED SECONDARY BATTERY**

[0017] The object of the present invention is to provide a non-aqueous electrolyte-based secondary battery having a high electrical conductivity of the electrode itself, excellent cycle characteristics, and good stability against higher loads, that is, a non-aqueous electrolyte-based secondary battery having a high capacity even with charging and discharging at a high current value.

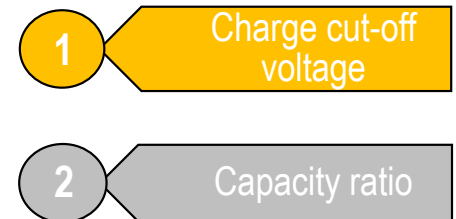
rises with charging (applying current from the counter electrode to the working electrode). The predetermined voltage is 0 V at the vapor-phase-grown carbon fiber negative electrode, and at the positive electrode, the voltage is set to a range in which no electrolyte decomposition occurs, and no irreversible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

Petition, 34-35; Ex. 1005, ¶¶[0017], [0078].

Abe Discloses the Charge Cut-Off Voltage

[1A]: “the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V;”
[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”

risks with charging (applying current from the counter electrode to the working electrode). The predetermined voltage is 0 V at the vapor-phase-grown carbon fiber negative electrode, and at the positive electrode, the voltage is set to a range in which no electrolyte decomposition occurs, and no irreversible structural breakdown of the positive electrode active material occurs. For example, LiMn_2O_4 is 4.2–4.3 V, preferably 4.2 V, and LiCoO_2 and LiNiO_2 are 4.1–4.2 V, preferably 4.1 V. The design capacity of the



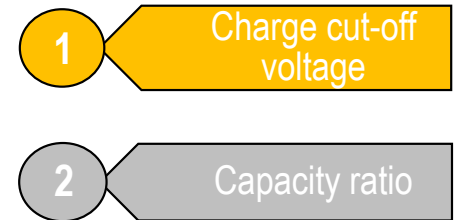
Petition, 35; Ex. 1005, ¶¶0078; Ex. 1002, ¶¶160-161.

Abe Discloses the Charge Cut-Off Voltage

[1A]: “the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V;”
[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”



161. Abe teaches that, for secondary lithium ion batteries using LiMn_2O_4 as the positive electrode material, “the voltage is set to a range in which no electrolyte deposition occurs, and no irreversible structural breakdown of the positive electrode active material occurs” and that range “is 4.2-4.3 V”¹⁵⁸ A charge cut-off voltage of 4.2-4.3V includes values “greater than 4.2 V,” including, for example, 4.25 V and 4.3 V. Abe thus teaches and renders obvious this limitation because it discloses cut-off voltages encompassed by the claimed range of greater than 4.2 V but less 5.8 V, as required by claims 1 and 5.



Petition, 35; Ex. 1005, ¶[0078]; Ex. 1002, ¶161.

RJ Tech's POPR Admits That Abe's Voltage Range Partially Overlaps with the Claimed Range

[0078]. Further, Abe provides the following ranges of upper voltage values at which “no electrolyte decomposition, and no structural breakdown of the positive electrode active material occurs” for potential exemplary cathode materials: “[f]or example, LiMn_2O_4 is 4.2-4.3 V, preferably 4.2 V, and LiCoO_2 and LiNiO_2 are 4.1-4.2 V, preferably 4.1 V.” *id.*

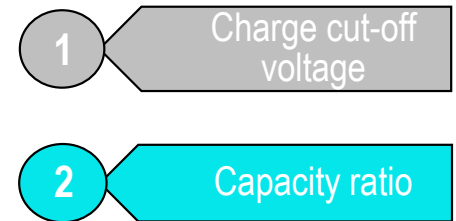
The first of these ranges only partially overlaps with the claimed charge cut-off voltage range in the '641 Patent, *i.e.*, greater than 4.2V and less than 5.8V. Abe

POPR at 15; Pet. Reply, 22-25.

Abe Discloses the Capacity Ratio Limitation By Disclosing a Range

[1B]: “a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5 as calculated by a specific capacity with a charge voltage limited to 4.2 V”;
[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, as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2 V.”

(4) A negative electrode formed by a graphitized vapor-phase-grown carbon fiber having a specific surface area of 5 m²/g and an average aspect ratio of 2 to 30, a cathode having a lithium-containing composite oxide, and an electrolyte solution obtained by dissolving a lithium salt in a mixed solvent of cyclic carbonate and chain carbonate, wherein the design capacity of the negative electrode is a non-aqueous electrolyte-based secondary battery having a design capacity greater than that of the positive electrode, (5) a non-aqueous electrolyte-based secondary battery according to (4) having a design capacity of more than 1 and less than or equal to 1.6 for the design capacity of the positive electrode described in (4), (6) a lithium-



[0078] In a non-aqueous electrolyte-based secondary battery according to the present invention, the design capacity of the negative electrode is adjusted so that the design capacity of the negative electrode is greater than the design capacity of the cathode. The design capacity is determined, for example, from the initial

Petition, 37-40; Ex. 1005, ¶¶[0018], [0078].

Abe Discloses the Capacity Ratio Limitation By Disclosing A Specific Embodiment

[Table 1]

	Specific surface area m ² /g	Aspect ratio	Negative electrode filling density g/cm ³	Negative electrode/cathode design capacity ratio
Embodiment 1	1.4	12	1.6	1.2
Embodiment 2	2.4	8	1.8	1.1
Comparative Example 1	7.0	1.2	1.1	1.1
Comparative Example 2	7.0	1.2	0.9	0.6
Comparative Example 3	6.0	—	1.1	0.8

1 Charge cut-off voltage

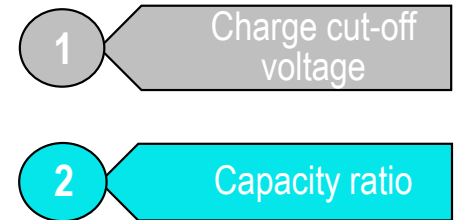
2 Capacity ratio

Petition, 37-40; Ex. 1005, ¶¶[0102]-[0103], Table 1.

A POSITA Would Understand that Abe Teaches “As Calculated . . . With a Charge Cut-Off Voltage Set at 4.2V”



166. (2) Abe's design capacity is determined at a cutoff voltage between 4.2 V to 4.3 V. The PHOSITA would have understood the “design capacity” reflected the capacity over the voltages which the battery was intended to be charged to (the charge cutoff voltage). Abe says as much. For instance Abe says “[t]he design capacity is determined, for example, from the initial charge capacity per unit weight of the active material in a predetermined charging voltage range and the amount of active material coated on the current collector.”¹⁶⁴ For Abe's battery using LiMn_2O_4 as the active positive electrode material, this capacity is determined using a cutoff voltage of between 4.2 V and 4.3 V.¹⁶⁵ Therefore, a PHOSITA would have understood that the claimed ratio was calculated at a charge cutoff voltage that depended on the charge cutoff voltage used for the battery. Insofar as Abe's design capacity is determined at 4.2 V the disclosed example satisfies the ratio limitation because the ratio is actually determined at 4.2 V. In the event that the battery is operated using a charge cutoff voltage of 4.3 V, Abe's “design capacity” of between 1:1 and 1:1.6, such as 1:1.1, would have been calculated at a charge cutoff voltage of 4.3 V.¹⁶⁶

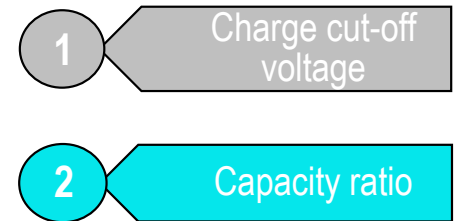


Ex. 1002, ¶166; Petition, 38-39; Ex. 1005, ¶[0078].

A POSITA Would Understand that Abe Teaches “As Calculated . . . With a Charge Cut-Off Voltage Set at 4.2V”



167. (3) *When Abe’s design capacity ratio is determined at 4.3 V, the design capacity ratio will fall within the claimed ratios when calculated at 4.2 V.* As I explained above in connection with my discussion of the Uemura reference, the PHOSITA would have known that when the design capacity ratio discussed by Abe is calculated at 4.3 V, the negative electrode capacity will increase relative to the positive electrode capacity at the lower voltage. *Supra* §§ II.A, XI.A.1 (limitations [1B] & [5B].) The reasons I have explained for this phenomena are equally applicable here. And for those reasons, a PHOSITA reading Abe would have appreciated that Abe disclosed a design capacity ratio, calculated in a manner consistent with the claim construction that I was asked to apply. *Id.* Moreover, for



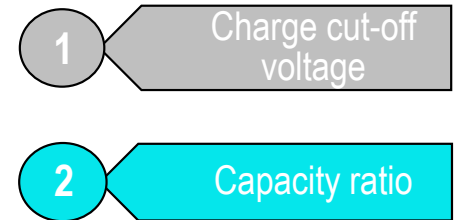
Ex. 1002, ¶167; Petition, 39-40.

RJ Tech's Expert Admits it was Conventional to Use 4.2V to Determine a Capacity Ratio



6 Q. (BY MR. COLIN) Right. In paragraph 18
7 where Abe discloses that the battery should have a
8 design capacity of more than 1 and less than or
9 equal to 1.6 for the design capacity of the
10 positive electrode, it does not disclose that that
11 capacity ratio should be determined at any
12 particular voltage; correct?
13 MR. STAMATOPOULOS: Object to
14 form.
15 A. That's correct.

22 Q. (BY MR. COLIN) Let me restate. It's
1 your opinion that it's conventional to use a
2 charge cut-off voltage of 4.2 volts to determine a
3 capacity ratio; correct?
4 MR. STAMATOPOULOS: Object to
5 form.
6 A. That's correct.



Ex. 1043, 265:6-15, 265:22-266:6; Petition, 40; Pet. Reply, 25.

RJ Tech's Responses to Grounds 4 and 5

- Abe does not disclose the charge cut-off limitation
- Abe does not disclose the capacity ratio limitation

Charge Cut-Off Voltage: RJ Tech's Expert Provided No Opinions on the Key Portion of Abe



When a positive electrode is used for the working electrode, *the voltage at the start is the potential difference between the metal lithium and the positive electrode material*, and the voltage rises with charging (applying current from the counter electrode to the working electrode) ... and at the positive electrode, the voltage is set to ... range in which no electrolyte decomposition occurs, and no irreversible structural breakdown of the positive electrode active material occurs. For example, LiMn_2O_4 is 4.2-4.3 V, preferably 4.2 V, and LiCoO_2 and LiNiO_2 are 4.1-4.2 V, preferably 4.1 V.¹²³

Omits key text

22 Q. (BY MR. COLIN) So it's correct that,
1 sitting here today, you can't point to anywhere in
2 your declaration where you discuss the language of
3 paragraph 78 of Abe that you intentionally struck
4 out with ellipses; correct?

5 MR. STAMATOPOULOS: Object to
6 form.

7 A. We didn't have that. That's why we
8 didn't talk about that. I don't know what's the
9 question you're trying to ask.

Pet. Reply, 22-24; Ex. 2006, ¶188 (annotated); Ex. 1043, 262:22-263:9.

Capacity Ratio Limitation: RJ Tech Failed to Apply the Court's Claim Construction



11 Q. Okay. The court's construction for the
12 capacity ratio limitation does not include the
13 word "theoretic" or "theoretical"; correct?

14 A. Yes.

15 Q. In your opinion to the board and the
16 claim construction you apply in the IPR, you
17 require capacity to be theoretic capacity;
18 correct?

19 A. Yes.

14 Q. Practical specific capacity is a type of
15 capacity?

16 A. That's correct.

17 Q. But in your analysis, a practical
18 specific capacity does not meet the court's claim
19 construction; correct?

20 MR. STAMATOPOULOS: Object to
21 form.

22 A. You are correct.

1 Charge cut-off voltage

2 Capacity ratio

Pet. Reply, 25-26; POR, 61-62; Ex. 1043, 121:11-19, 134:14-22.

**Claims 9-18:
Anticipated and Rendered Obvious by Uemura in
View of Iwaizono and/or Guyomard
(Grounds 3-4, 8-9)**

The POR Failed To Raise Any Independent Issues With Grounds 3-4 and 8-9

- The POR did not raise any issues with Grounds 3-4 and 8-9 beyond its arguments concerning independent claims 1 and 5
- Thus, for the unrebutted reasons discussed in the Petition, if the claims 1-8 are invalidated under Grounds 1 or 2, claims 9-18 must be invalidated as well

POR, 52-53; Petition, 28-34, 51-60; Pet. Reply, 22.

**Claims 2-4, 6-18:
Anticipated and Rendered Obvious by Abe in View
of Iwaizono and/or Guyomard
(Grounds 7, 10)**

RJ Tech Does Not Dispute That the Combination of Abe, Guyomard, and Iwaizono Teaches the Additional Limitations of Claims 2-4 and 6-18

- The POR did not raise any issues with Claims 2-4 and 6-18 beyond its arguments concerning independent claims 1 and 5
- The POR only asserts:
 1. There is no motivation to combine Abe with Guyomard
 2. There is no reasonable expectation of success

POR, 62-65; Petition, 41-51, Pet. Reply, 26, 28.

There is an Explicit Motivation to Combine Abe with Guyomard and a Reasonable Expectation of Success

From this electrolyte oxidation screening, we have discovered that an exceptional, wide temperature range, oxidation resistant electrolyte for a LiMn_2O_4 positive electrode intercalation battery cell, particularly one utilizing the

Abe's
 LiMn_2O_4 cell

+

Guyomard's
electrolyte for a
 LiMn_2O_4 cell

=

Secondary LiMn_2O_4 cell
charged to 4.5V, retains 90%
capacity after 500 cycles

a battery operating at higher temperatures in the range of 55° C optimally utilizes an electrolyte consisting essentially of an approximately 1.5M LiPF_6 solution in a solvent combination of about 67 DMC:33 EC. An additionally useful electrolyte consists

Petition, 48-51; Ex. 1002, ¶¶182-190; Pet. Reply, 26-28.

RJ Tech's POPR

[0078]. Further, Abe provides the following ranges of upper voltage values at which “no electrolyte decomposition, and no structural breakdown of the positive electrode active material occurs” for potential exemplary cathode materials: “[f]or example, LiMn_2O_4 is 4.2–4.3 V, preferably 4.2 V, and LiCoO_2 and LiNiO_2 are 4.1–4.2 V, preferably 4.1 V.” *id.*

The first of these ranges only partially overlaps with the claimed charge cut-off voltage range in the '641 Patent, *i.e.*, greater than 4.2V and less than 5.8V. Abe

POPR, 15.

RJ Tech's Criticisms of the Motivation to Combine Based on Guyomard Lack Merit

RJ Tech's Argument

what Abe tries to avoid. Ex1005, ¶78. Guyomard does not address this issue—which pertains to the cathode—because it is directed exclusively to issues pertaining to the electrolyte. *See supra* section II.D.3. Indeed, Guyomard provides no disclosure about the state of the cathode at 4.5V or 4.9V, instead focusing exclusively on whether the electrolyte could maintain its stability at those high voltages.

Guyomard's Disclosure

the electrolyte. The ability of the electrolyte to extend the cycle life of the batteries was amply demonstrated by the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.

Patent Office Characterization of Guyomard

Moreover, Guyomard discloses a battery where cut-off voltage is used up to 5 voltage for increased cycle life and enhanced cell capacity [Pages 1-4]. *Id.* Guyomard

POR, 64; Ex. 1005, 9:5-8; Ex. 1004, 18; Pet. Reply, 26-27.

RJ Tech's Criticisms of the Reasonable Expectation of Success Lack Merit

RJ Tech's Argument

Moreover, even if a POSITA were somehow motivated to combine Abe with Guyomard (she would not), she would not have had a reasonable expectation of success because Guyomard's electrolyte cannot enhance the stability of the cathode itself. Ex2006, ¶¶206-212. This is best illustrated by the fact that references

Guyomard's Disclosure

the electrolyte. The ability of the electrolyte to extend the cycle life of the batteries was amply demonstrated by the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.

Patent Office Characterization of Guyomard

Moreover, Guyomard discloses a battery where cut-off voltage is used up to 5 voltage for increased cycle life and enhanced cell capacity [Pages 1-4]. Idota/Guyomard

POR, 65; Ex. 1005, 9:5-8; Ex. 1004, 18; Pet. Reply, 27-28.

RJ Tech's New Argument Concerning Claims 11-18 in its Sur-Reply is Not Supported By Expert Testimony

Finally, because Guyomard does not disclose the capacity loss between the first and the fifth cycles, it does not disclose the capacity retention limitations in claims 11-18. POR, 16; Ex2006, ¶78; Ex1043, 107:3-108:12. Petitioner provides



16 Going back to the formation period, if a
17 person of ordinary skill in the art wanted to test the
18 performance characteristics of a battery in normal
19 operating conditions, would they conduct their testing
20 after the formation period is over?
21 ATTORNEY SOMMER: Object to form.
22 A. Yes. That's very typical.

13 Q. (BY MR. COLIN) You provide no opinion in
14 your declaration concerning whether cycling should
15 be measured preformation or postformation with
16 respect to the claims; correct?
17 A. **I think that's correct.**
18 Q. Manufacturers report the capacity of
19 batteries as the postformation capacity; correct?
20 MR. STAMATOPOULOS: Object to
21 form.
22 A. **I think that's correct.**



PO Sur-Reply, 27; Ex. 2008, 106:16-22; Ex. 1043, 108:13-22.

Conclusion

IPR2023-01183

U.S. Patent No. 7,749,641

CERTIFICATE OF SERVICE

The undersigned hereby confirms that the foregoing paper was caused to be served on the 17th of October 2024 via email upon the following counsel of record for Patent Owner:

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