

**UNITED STATES DISTRICT COURT
CENTRAL DISTRICT OF CALIFORNIA
SOUTHERN DIVISION**

RJ TECHNOLOGY LLC

Plaintiff,

vs.

APPLE INC.,

Defendant.

Case No. 8:22-CV-1874-JVS-JDE

**DECLARATION OF DR. YAN YAO
IN SUPPORT OF PLAINTIFF RJ
TECHNOLOGY LLC'S OPENING
CLAIM CONSTRUCTION BRIEF**

**DECLARATION OF DR. YAO IN SUPPORT OF PLAINTIFF RJ
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1 I, Dr. Yan Yao declare and state as follows:

2 1. I am a professor in the Cullen College of Engineering at the University
3 of Houston. I am also a Fellow of the Royal Society of Chemistry, a senior member
4 of the National Academy of Inventors, and a senior member of the Institute for
5 Electrical and Electronics Engineers. I received Bachelor of Science and Master of
6 Science degrees from Fudan University in China, where I studied materials science.
7 I received my Ph.D. from the University of California, Los Angeles, where I studied
8 Materials Science and Engineering. I was also appointed to be a Postdoctoral
9 Scholar at Stanford University, where I spent two years conducting battery research.
10 The focus of my research is batteries, particularly lithium ion batteries and
11 rechargeable batteries using non-lithium ions, and I have published over 100 papers
12 on the topic. A copy of my CV is attached here as **Exhibit A**.

13 **I. Scope of Work**

14 2. I have been retained by Plaintiff RJ Technology LLC (“RJ
15 Technology”), and their counsel, Kobre & Kim LLP, as an expert in the lawsuit
16 captioned above. I understand that RJ Technology has asserted U.S. Patent No.
17 7,749,641 (“’641 Patent”) against Apple, accusing Apple smartphones, watches,
18 tablets, and airpod cases of infringement. My hourly rate is \$500 per hour.

19 3. I have reviewed the ’641 Patent, the file history, and all of the intrinsic
20 and extrinsic evidence identified by the parties in their joint claim construction
21 statement (Dkt. 67). A complete list of the materials I have considered in
22 preparation for this declaration can be found in **Exhibit B**.

23 4. I understand that the parties are currently engaged in a process called
24 claim construction, whereby the Court must determine the meaning of certain
25 disputed terms of the ’641 Patent. I understand that the parties dispute the following
26 terms and have asked the Court to provide their meaning:

27 a. Charge Cutoff Voltage
28

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- b. Ratio of Positive Electrode Material to Negative Electrode Material as Calculated by a Theoretic Capacity with a Charge Cut-off Voltage Set at 4.2V
- c. A Secondary Lithium Ion Cell or Battery
- d. Overcharge Protection Voltage/Overcharging Protection Release Voltage/Overcharge Protection Release Voltage
- e. Maintains at Least ... Capacity after 400 Cycles

Each term or phrase is commonly used in the field, and each has a well-known meaning.

5. I understand that the Court must determine the meaning of these terms by assessing how a person of ordinary skill in the art (the “POSA”) would have understood them at the time of the invention. I have been informed that the claim construction inquiry begins with the claim language itself. A claim term must be read in light of the specification and other intrinsic evidence of the patent, such as the prosecution history. Extrinsic evidence, such as dictionaries and articles in the field, can help further explain the meaning of a claim term. If, however, a person of ordinary skill cannot ascertain the scope of the claimed invention with reasonable certainty, when read in view of the specification and prosecution history of a patent, I understand that the Court would consider the term “indefinite.”

6. I further understand that Apple argues that the following terms are indefinite:

- a. Ratio of Positive Electrode Material to Negative Electrode Material as Calculated by a Theoretic Capacity with a Charge Cut-off Voltage Set at 4.2V
- b. Maintains at Least ... Capacity after 400 Cycles

As further explained below, Apple is incorrect. Each of these phrases and their constituent terms is well known and commonly used in the industry, and a POSA would readily and easily ascertain the scope of the relevant claims with reasonable certainty—especially when read in the context of the specification and prosecution history. These terms are not indefinite.

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II. Technical Background

7. Lithium ion batteries have become ubiquitous. They are now used not only to power personal electronic devices, such as the phones, tablets, watches, and airpods cases accused in this case, but also to power electric vehicles and even to store power for residential homes and for municipal and private electric utilities.

8. Lithium ion batteries in use today are rechargeable. Rechargeable batteries are also called secondary batteries, and non-rechargeable batteries are called primary batteries. The terms “primary” and “secondary” are used to distinguish these two types of batteries based on their rechargeability, rather than their quality or performance.

9. Charging refers to the process of replenishing the energy stored in a battery. During charging, an external power source is connected to the battery. Discharging is the process of releasing the stored energy from the battery to power another device.

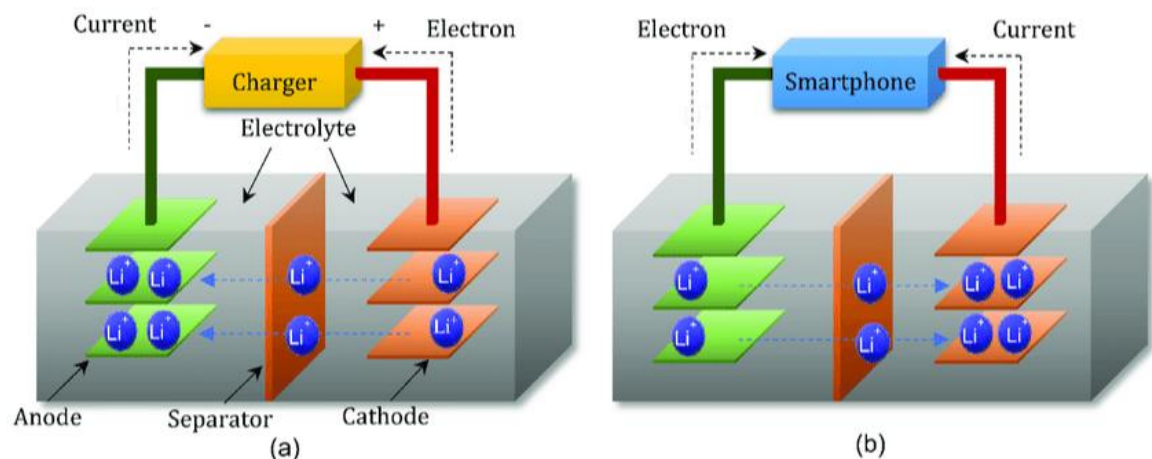
10. One reason lithium ion batteries have become so widely used is because they have a high energy density, meaning that they efficiently store a lot of power in a relatively small volume. However, that density comes at a cost. Lithium ion batteries can be dangerous. The chemical reactions that power these batteries are inherently unstable and need to be conscientiously controlled and monitored. Otherwise, the batteries may overcharge, overheat, and degrade, or worse. In extreme cases, the batteries may reach a state called thermal runaway, which may lead to fires and explosions.

11. Let’s first discuss the basic anatomy of a secondary lithium-ion battery. Most relevant to these proceedings are the two electrodes: the anode (negative electrode) and the cathode (positive electrode). The cathode is typically made of a compound of lithium, another element, and oxygen. At the time of the invention, a common cathode material was lithium cobalt oxide (LiCoO_2). A common anode material is graphite, which is made of sheets of carbon (C_6).

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12. Other lithium ion battery components include the electrolyte, which allows the flow of lithium ions between the electrodes while preventing the direct flow of electrons, the separator, which acts as a barrier to prevent direct contact of the electrodes, the current collector, which collects current from each electrode as the electrochemical reactions occur, and the case, which houses the battery. The battery typically also contains circuitry that regulates charge and discharge of the battery—sometimes called the battery management system.

13. Next, I will describe the chemical reactions that occur during the charging and discharging of the battery. Lithium ion batteries use what is known as a “rocking chair” mechanism to charge and discharge the battery. The rocking chair mechanism derives its name from the analogy of the back-and-forth motion of lithium ions, resembling the motion of a rocking chair. This is illustrated in the images below:

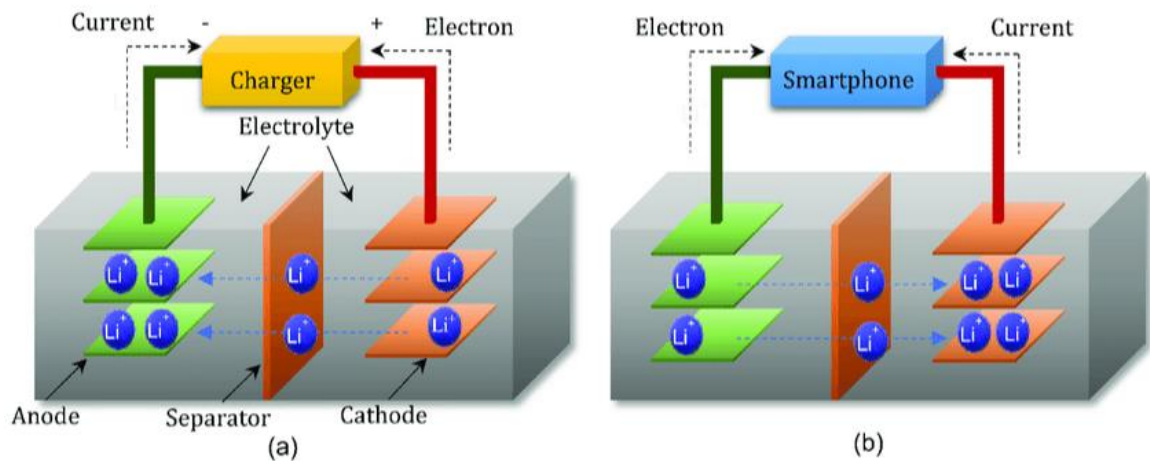


14. Diagram “(a)” on the left above illustrates charging of the battery. As shown in that image, when electrical current is applied to charge the battery, the cathode undergoes a process where both electrons and lithium ions are released. The lithium ions traverse the electrolyte to reach the anode, while the electrons flow through the external circuit and also reach the anode. Once the lithium ions reach the anode, they intercalate into the anode. One key function the anode plays is to

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store the lithium ions which have been pulled from the cathode through this charging process in a way that can be easily removed.

15. Let's now discuss discharge, which is shown in diagram "(b)" on the right (reproduced again below for ease of reference). Discharge refers to the use of the battery to power a device, such as a smartphone. As the battery discharges, the anode releases electrons into the external circuit, where they then flow into the device as electricity, giving it power. At the same time, the lithium ions leave the anode and travel back through the electrolyte to intercalate back into the cathode. As the battery continues to discharge, more lithium ions traverse the electrolyte and intercalate into the cathode until the battery is fully discharged.



16. I will now describe some of the basic measurements for key attributes of the battery which are of relevance to this case. But first, a useful analogy. Electricity can be viewed as behaving like water in that it has both flow (current) and pressure (voltage). Current describes the flow of electricity, and is measured in amperes (A). Voltage describes the amount of "pressure," e.g., the strength at which the electrons flow, and is measured in volts (V). Voltage can be thought as the driving force behind the flow of current. The greater the voltage, the stronger the force, and the higher the current will be. Taken together, higher voltage and current mean more energy in the system.

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1 17. The capacity of the battery measures the amount of electrical charge
2 the battery can store. Returning to the water analogy, it would be the size of the
3 reservoir. Capacity is often measured in Ampere-hours (Amp-hours) or milliamp-
4 hours (mAh), which indicates how many amperes or milliamperes of current the
5 battery can deliver over a period of one hour. For example, per its label, the Apple
6 Watch Series 7 has a capacity of 309 mAh. Dkt. 51 at 11. That means the Apple
7 Watch Series 7 should be able to deliver a current of 309 milliamperes for one hour
8 before it is completely discharged.

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.

18 19. The failure modality most relevant to the '641 Patent is called
19 overcharging. When a battery is overcharged, it is charged at a voltage higher than
20 its chemistry can accommodate. As discussed above, a battery's voltage can be
21 thought of as the pressure by which the components of the battery, including the
22 lithium ions, are pushed or pulled. Overcharging pushes the lithium ions too hard
23 and will break the battery if done for long enough or at a high enough voltage. In
24 the most extreme case, charging the battery at too high a voltage will cause the
25 cathode to collapse and cause the electrolyte to oxidize, releasing flammable gasses,
26 which ultimately causes the battery to catch fire or explode.

27 20. In the less extreme case, applying too much voltage can cause the
28 lithium ions to irreversibly wedge themselves in the anode in the incorrect sites.

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1 This limits the amount of lithium ions that can traverse the electrolyte between the
2 anode and cathode as some lithium ions can become metallic lithium. This
3 phenomenon, known as lithium plating, can cause the formation of potentially tree-
4 like structures on the surface of the anode that penetrate the separator, potentially
5 leading to short circuit and ultimately resulting in battery failure.

6 21. Each electrode has a different capacity, determined by the material
7 used and its size. The total capacity of the battery is limited by the lower capacity
8 of the two electrodes. The excess capacity of the other electrode is not used and
9 therefore is wasted. If, for example, the anode has far more capacity than the
10 cathode, the excess capacity is not used and is instead dead weight, making the
11 battery larger, heavier, and more expensive.

12 22. Therefore, it is important for battery manufacturers to know the
13 capacity of each electrode to ensure that the battery is properly balanced. To
14 perform such balancing, the battery manufacturer will carefully design and measure
15 the mass, area, volume, and/or capacity of the active material of each electrode.

16 23. As the battery is charged and discharged over successive cycles, it
17 loses capacity, regardless of the charging voltage (though this process is slower
18 when the battery is charged at or below the charge cutoff voltage). Capacity can be
19 lost at any charging voltage because of issues like the occurrence of side reactions,
20 degradation of the cathode chemistry, denaturation of the electrolyte, and lithium
21 plating. Therefore, practitioners not only track the capacity of the battery when it
22 is being manufactured, they track it over time, referring to the diminished capacity
23 as a percentage of the original capacity of the battery.

24 **III. Person of Ordinary Skill in the Art**

25 24. In my opinion, the '641 patent is directed to a person of ordinary skill
26 in the art who at that time would have had at least a master's degree in electrical
27 engineering, material science, or a related field and would have been working in the
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field of battery design for at least three years, with some direct experience with lithium-ion batteries.

IV. Disputed Claim Terms

a. Charge Cut-off Voltage

RJ Technology's Construction	Apple's Construction
Plain and ordinary meaning , which is the maximum voltage to which the battery is configured to be charged.	The voltage at which the charging changes from constant current charging to constant voltage charging

25. I understand the parties dispute the definition of the term “charge cutoff voltage,” and I further understand that the disputed positions are included in the table above.

26. A POSA would readily understand that the charge cutoff voltage of a battery, as that term is used in the '641 Patent, is the maximum voltage to which the battery is configured to be charged. The charge cutoff voltage is a fundamental design feature of a lithium ion battery. Each lithium ion battery is configured with this design feature in mind, and the charge cutoff voltage is determined through extensive research, testing and consideration of the specific chemistry inside the battery. Depending on the context, the term “charge cut-off voltage” is used synonymously with several other terms in the industry, which all refer to the maximum voltage to which the battery is configured to be charged. These include the upper charge limit, the upper voltage limit, the cutoff voltage, or the potential limit.

27. The '641 Patent's use of “charge cutoff voltage” confirms that the term is being used to describe the maximum voltage to which the battery is configured to be charged. For example, the patent explains that, at the time of the invention, “the charge cut-off voltage . . . is limited to no more than 4.2V, and this is well accepted as a technical requirement in the industry of manufacture of secondary lithium ion battery.” '641 Patent at 1:46-49. The '641 Patent further explains that

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1 charging the battery above this voltage (*i.e.*, overcharging) can lead to a number of
2 undesirable side effects: “the positive electrode materials and the negative electrode
3 materials will undergo structure change, the electrolyte may decompose, and the
4 recycle property of the cell will be adversely affected.” ’641 Patent at 1:55-63. In
5 all these instances, the ’641 Patent refers to the “charge cut-off voltage” as the
6 charging maximum.

7 28. A POSA would understand that during normal use of a battery, the
8 charging voltage should not exceed this charge cutoff voltage. However, a battery
9 may experience charging voltage that exceeds the charge cutoff voltage in certain
10 scenarios. For example, a failure in the charging system may lead to unintentionally
11 charging the battery to a voltage higher than the charge cut-off voltage. The battery
12 has protection mechanisms to address these scenarios, which are discussed further
13 below. However, the battery is not configured, *i.e.*, designed and manufactured, to
14 be charged higher than the charge cutoff voltage.

15 29. I have reviewed the file history of the patent as well, which further
16 supports my opinion regarding the meaning of charge cutoff voltage. Neither the
17 patentee, nor the patent examiner appears to have used the term to refer to a specific
18 charging algorithm like constant current/constant voltage charging (as provided in
19 Apple’s construction). *E.g.*, Ex. 2, (’641 Patent File History (“File History”)) at
20 Nov. 13, 2009, Applicant’s Remarks at 8; Ex. 2 (File History) at Notice of
21 Allowability at 2-3.

22 30. Apple’s proposed claim construction defines charge cutoff voltage to
23 be limited to one particular and common charging algorithm: the constant
24 current/constant voltage algorithm (“CC/CV”). But a POSA would understand that
25 other charging algorithms could be used and that “charge cutoff voltage” does not
26 refer exclusively to any single algorithm.

27 31. As discussed above, it is important to carefully control the mechanism
28 through which a battery is charged, to ensure its safety, longevity, and performance.

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1 Researchers in the field thus have developed various charging algorithms to charge
2 the battery. Typically, a charging algorithm is controlled through the battery
3 management system, which is a circuit included within the battery. However, the
4 algorithms may also be controlled through other components such as the power
5 supply (the charger), or through software, such as the operating system.

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.

26 34. I have reviewed the sources that Apple relies upon for its construction.
27 Apple cites a technical dictionary, which defines the term "cutoff voltage" as
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1 1. The electrode voltage that reduces the dependent variable of an
2 electron-tube characteristic to a specified value. *See also* critical
3 voltage. 2. The voltage at which the discharge is considered complete.
This need not be a very low voltage.

4 Ex. 5. (Graf, R., Modern Dictionary of Electronics (7th ed. 1999)) at 167. The first
5 definition of “cutoff voltage” is not relevant to a lithium-ion battery, as it concerns
6 electron-tubes. The second definition of “cutoff voltage” is the voltage at which the
7 battery stops discharging (*i.e.*, powering the device). In other words, it is the
8 *discharge* cutoff voltage, instead of *charge* cutoff voltage. Neither of these
9 definitions is relevant here. Apple also cites the handbook by David Linden and
10 Thomas B. Reddy. Similarly, there the “cut-off voltage” is “designated as the end
11 of the discharge. Usually, it is the voltage above which most of the capacity of the
12 cell or battery has been delivered.” Ex. 6. (LINDEN D, HANDBOOK OF BATTERIES,
13 (2001)) at 3.2.1. This too is not relevant, because the phrase “cut-off voltage” is
14 used to refer to a totally different concept from “charge cutoff voltage” as used in
15 the ’641 patent.

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b. Ratio of Positive Electrode Material to Negative Electrode Material as Calculated by a Theoretic Capacity with a Charge Cut-off Voltage set at 4.2V

RJ Technology's Construction	Apple's Construction
Plain and ordinary meaning. 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.	Indefinite. In the alternative, the ratio calculated as the product of the theoretic 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 cell charge cutoff voltage is set at 4.2 V, wherein “theoretic capacity” means “theoretical, rather than actual, capacity that assumes all of the active substances participate in the reaction of the battery”

35. As discussed above, the capacity of the battery is determined by the capacity of the electrode material. More specifically, the battery's capacity is limited by the capacity of the electrode which has the least capacity. To the extent the other electrode has more capacity, that capacity is wasted. Because of this, it is important to determine the right ratio of positive to negative electrode materials to optimize overall capacity and minimize waste. This process is sometimes called “balancing” and refers to achieving the right balance between electrode materials.

36. The claim language at issue here concerns that balancing process. At a broad level, the patent instructs practitioners to compare the capacity of the anode material (negative electrode material) to that of the cathode material (positive

1 electrode material) in the form of a ratio. This is a common way in the industry of
2 describing the electrode capacity ratio and of measuring it.

3 37. The claim language provides that the ratio be calculated as the product
4 of the capacity of the cathode active material per mass unit and the amount of the
5 cathode active material in the same mass unit divided by the product of the capacity
6 of the anode active material per mass unit and the amount of the anode active
7 material in the same mass unit, when the charge cutoff voltage is 4.2 V.

8 38. This can be reflected in the following equation:

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

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10
11 where C_p is the specific capacity of the cathode active material (typically measured
12 in milliamperes per gram, or “mAh/g”), m_p is the mass of the cathode active material
13 (here measured in grams), C_n is the specific capacity of the anode active material
14 (in mAh/g), and m_n is the mass of the anode active material (in grams). The final
15 ratio is stated as a ratio of cathode capacity (in mAh) to anode capacity (in mAh).

16 39. The ratio refers to a ratio based on specific capacity. Specific capacity
17 is simply the capacity of the material divided by a specific unit measure, most
18 commonly mass. Here, the specific capacity of the material is multiplied by the
19 amount of material to get to the capacity. For example, graphite (a common anode
20 material), has a specific capacity of 372 mAh/g, which means for 1 gram of graphite,
21 it will have a capacity of 372 mAh. Under the claim language in the patent, the
22 capacity of the anode is determined by multiplying this figure by the mass of the
23 active material in the anode.

24 40. The capacity of the cathode would be determined in the same manner.
25 For example, LiCoO_2 has a specific capacity of 137 mAh/g when charged at 4.2V,
26 which is half of its maximum specific capacity (274 mAh/g). The reason for this,
27 as discussed further below, is that at 4.2V, only 50% of the lithium ions are removed
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1 from LiCoO₂. Other materials may have different amounts of lithium extracted at
2 that voltage, up to and including 100%, and therefore different capacities.

3 41. Apple's construction follows the general calculation approach above,
4 except that Apple defines "theoretic capacity" to mean "theoretical, rather than
5 actual, capacity that assumes all of the active substances participate in the reaction
6 of the battery." While I agree that the term "theoretic" means "theoretical" and
7 therefore refers to the battery's theoretical capacity, in my opinion the remainder of
8 Apple's construction is incorrect.

9 42. In providing that "all of the active substances participate in the reaction
10 of the battery" Apple's construction appears to require that to calculate the ratio, a
11 POSA should assume that all of the lithium is extracted from the cathode and
12 therefore "participate[s] in the reaction of the battery." But that construction is
13 contrary to the plain language of the claim term, which requires that the capacity be
14 calculated using "a charge cutoff voltage set at 4.2V." As discussed above, the
15 specification of a charge cutoff voltage means that *not* all of the lithium is extracted
16 from the cathode. Instead, the voltage provides for a lesser number—for example,
17 50% for LiCoO₂, which is 137 mAh/g.

18 43. Apple's construction conflicts with the claim language in another
19 respect. The claim language uses "theoretic capacity" whereas Apple's construction
20 implicates another concept: the theoretical maximum capacity.

21 44. The difference between the theoretical capacity and the theoretical
22 maximum capacity is the amount of lithium that participates in the reaction. The
23 capacity of each electrode is determined by the reactions within that electrode. If
24 more of the amount of lithium within the electrode participates in the reaction, the
25 capacity is increased.

26 45. Importantly, the voltage applied to the cathode determines the amount
27 of lithium in the cathode active material that participates in the reaction (*i.e.*, is
28 extracted from the cathode). The inventors specifically included the phrase "a

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1 charge cut-off voltage set at 4.2V” as a reference point to show how much of the
2 lithium is extracted. A POSA would use this reference number to identify the
3 theoretical capacity using well-known equations or would simply look the figure up
4 in a table. For example, at a charge cutoff voltage of 4.2V, 50% of the lithium ions
5 are extracted from a cathode made of LiCoO_2 . This means its capacity is half of its
6 theoretical maximum at this voltage. A POSA would understand this as the
7 theoretical capacity of the material at the stated voltage.

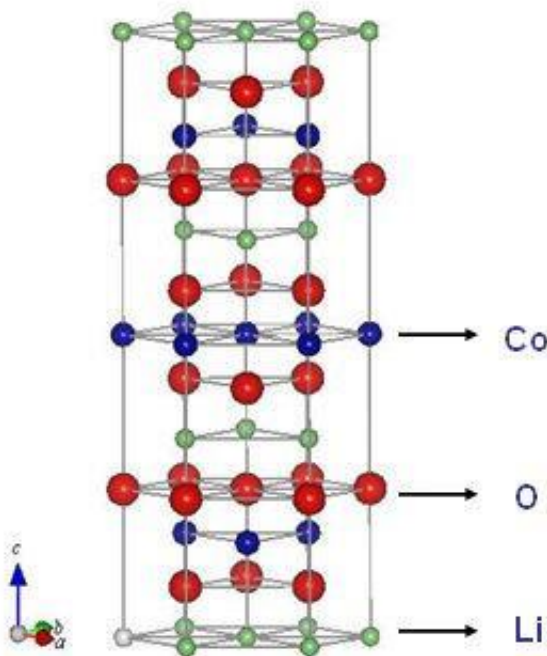
8 46. This was well-known at the time of the invention. Indeed, some
9 references contemporaneous with the '641 Patent simply use the term “theoretical
10 capacity” to mean the specific capacity at 4.2 V. For example, the HANDBOOK OF
11 BATTERIES, which was frequently used as a textbook for college students, 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
17 another article that describes the history of development of secondary lithium ion
18 batteries, the author describes 137 mAh/g as the “theoretical value” of the specific
19 capacity of lithium cobalt oxide. *See* Ex. 7. (K. Brandt, *Historical development of*
20 *secondary lithium batteries*, Solid State Ionics 69 (1994)) at 173-183 Table 3.

21 47. This understanding is consistent with the specification of the '641
22 Patent. The '641 Patent defines “theoretic capacity” of the positive electrode to
23 mean “the capacities of the positive electrode ... calculated with a charge cut-off
24 voltage set at 4.2 V.” '641 Patent at 4:5-9. The specification here does not say it is
25 the theoretical maximum, but the capacity at 4.2 V.

26 48. Using the 4.2 V theoretical capacity also makes practical sense. A
27 POSA would readily appreciate that the theoretical maximum capacity is not
28 achievable in real life. Lithium ions are a core component of the active material of

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the cathode. The cathode typically has a crystal structure, and the lithium ions are nested within this structure. An exemplary image can be found below:



H. Xia, et al., *Electrochemical behavior and Li Diffusion study of LiCoO₂ thin film electrodes prepared by PLD*, Advanced Materials for Micro- and Nano-Systems at Fig. 1 (2007) available at <https://dspace.mit.edu/handle/1721.1/35827>. As can be seen in this structure, the lithium ions support the structure. Therefore, if all of the lithium ions are removed during charging, the compound would collapse, breaking the cathode and the battery.

49. This was a well-known issue at the time of the invention, and the '641 Patent discusses it at several points in the specification. For example, in column 6, the specification discusses a situation in which "lithium ions are completely dedoped," (*i.e.*, removed) from the cathode, leading to several negative consequences including the release of oxygen gas. '641 Patent at 6:14-34.

50. In contrast, 4.2 V was the industry standard for charge cutoff voltage at that time. The specific capacity of the cathode active material at a charge cutoff voltage of 4.2 V was easily identifiable by a POSA at the time of the invention. Such specific capacity is also closer to the actually usable capacity, so it acts as a

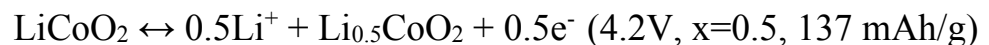
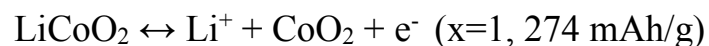
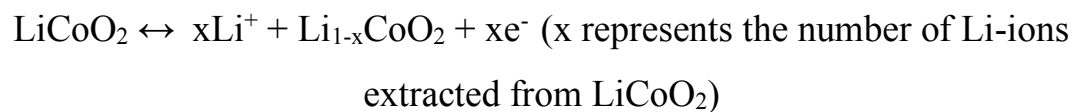
DECLARATION OF DR. YAO IN SUPPORT OF PLAINTIFF RJ TECHNOLOGY'S OPENING CLAIM CONSTRUCTION BRIEF

1 good reference point to determine how to balance the capacities of cathode and
2 anode in a battery.

3 51. Therefore, to the extent Apple intends the phrase “all of the active
4 substances participate in the reaction of the battery” to imply that all of the lithium
5 is extracted, this is inconsistent with the plain language of the claim itself, the
6 written description in the patent and with the way the term was generally used.

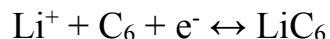
7 52. Apple’s construction is also flawed because it is ambiguous in that it
8 is unclear what Apple means by “the reaction of the battery.” In reality, there is no
9 “reaction of the battery” but instead multiple, independent reactions which
10 contribute to the energy stored within the battery as well as detrimental “side
11 reactions” which also occur.

12 53. Electrodes can be broken down into sub-components, which include
13 both the active material, *i.e.*, where the reaction occurs, as well as inert components
14 that perform necessary, non-reaction functions. There is generally one set of active
15 material in each electrode. In the cathode, it is generally the lithium metal oxide,
16 such as LiCoO_2 , discussed above. In the anode, it is generally graphite. It is
17 common to refer to them separately as they each participate in independent half
18 reactions. That is to say, the LiCoO_2 does not react directly with the graphite and
19 the graphite does not react directly with the LiCoO_2 , as separator in the battery
20 ensures that the cathode and the anode will not directly interact with each other, as
21 discussed above. Instead, both active materials independently react with lithium
22 ions. Using a battery with lithium cobalt oxide as the cathode active material and
23 graphite as the anode active material, at the cathode side, the half reaction during
24 charge can be written as below:



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1 At the anode side, the half reaction during charge can be written as below:



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3 These two half-reactions collectively represent the overall electrochemical reactions
4 taking place during the discharge and charge processes in a lithium ion battery.

5 54. In addition to the two half reactions described above, batteries can also
6 experience detrimental “side reactions.” These are reactions that are unintended
7 and do not contribute to the energy storage of the battery. It is unclear if the
8 “reaction of the battery” in Apple’s proposed construction allows for these side
9 reactions, therefore rendering it vague, imprecise, and ambiguous. A POSA would
10 not interpret the language to create such problems.

11 55. I also understand that Apple argues that this term is indefinite. I have
12 been informed that a patent claim is indefinite if, when read in light of the
13 specification and prosecution history, the claim fails to inform those skilled in the
14 art about the scope of the invention with reasonable certainty.

15 56. The ratio term is not indefinite. For the same reasons I discuss above,
16 the term is clear on its face, and would be understood with reasonable certainty by
17 a POSA. Because the term explicitly specifies the charge cutoff voltage of the
18 cathode that will be used to determine the theoretical capacity, a POSA would
19 understand that the theoretical capacity at 4.2 V should be used for the calculation,
20 instead of the theoretical maximum capacity.

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c. A Secondary Lithium Ion Cell or Battery

RJ Technology's Construction	Apple's Construction
No construction is needed.	A lithium ion battery, wherein the battery electrode materials must not be substantially changed from what was available in the art and made without substantially decomposing the electrolyte, which can be recharged to its original capacity, without any decreased capacity or cycle life at a charge cut-off voltage above 4.2V.

57. Lithium ion batteries may be rechargeable, or they may not be. Rechargeable batteries are called “secondary” batteries. Conversely, non-rechargeable batteries are called “primary” batteries. *See, e.g.*, Ex. 6 (LINDEN D, HANDBOOK OF BATTERIES, (2001)) at, A.10, A.11

58. However, even though they are not designed to operate in this way, some primary batteries can be recharged and re-used. The issue is that the recharged capacity is severely limited. Therefore, even though they can store some charge after being recharged, primary batteries are simply not meant to operate this way.

59. Conversely, even though secondary batteries may be recharged, they do not always recharge to 100% of their original capacity. In fact, after enough use, no battery can recharge to this ideal figure, and in many cases, there is irreversible capacity loss after the very first charge.

60. Even though these secondary batteries are not capable of charging to 100% of their original capacities after significant use, that does not change their character. They are still rechargeable (*i.e.*, secondary) batteries as the term is commonly understood.

61. I understand that the parties dispute the meaning of the term “Secondary Lithium Ion Cell or Battery.” As discussed previously, this term is commonly used and refers to a rechargeable lithium ion battery.

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62. Apple proposes a construction that is inconsistent with the way the term is used in the industry and again does not make sense. Apple claims that a secondary battery must be capable of “recharging to its original capacity, without any decreased capacity or cycle life at a charge cut-off voltage above 4.2V.” However, this is not how the term is used in the industry and is in conflict with scientific fact. As discussed above, *all secondary batteries* lose capacity after use. In other words, no battery exists that meets Apple’s definition. It is both inconsistent with the way the term is used in practice and inconsistent with the ways batteries operate.

63. I understand that Apple bases its construction on statements made during the prosecution history of the ’641 Patent. Specifically, Apple relies on the statement below:

Even if it is assumed, *arguendo*, that the references somehow are properly combinable under Section 103, the fact would remain that modifying the battery of Idota to include a charge cut-off voltage above 4.2V would result in a battery with decreased capacity and/or cycle life, in contrast to applicant’s claimed invention. Such a battery also would not be a ‘secondary’ lithium ion battery, as the present claims require. Put another way, even if the skilled artisan had ignored conventional wisdom and combined Idota with Tanaka or Kobayashi, the expected result would have been a lithium ion battery with very poor cyclability, *e.g.*, a capacity of 50% after the cell is depleted and recharged. Those in the battery field would not categorize such a battery as a ‘secondary’ type cell, since that appellation denotes a battery that can be recharged to capacities relatively close to the original capacity. The battery obtained by combining Idota with Tanaka or Kobayashi would meet neither these capacity requirements upon recharge nor the requirement prescribed by the present claims.

Ex. 2. (File History) at Nov. 13, 2009, Applicant Remarks at 11-12.

64. I have reviewed the prosecution history of the ’641 Patent, and I understand the patentees to have used the term “secondary battery” consistently with its plain and ordinary meaning in the prosecution history, including in the quotation above. As the patentees suggest, a secondary battery is one that is capable

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of recharging to capacities “relatively close” to its original capacity. The patentees further state that a battery that can only recharge to 50% after a single depletion and charging cycle is not secondary/rechargeable. I agree. A POSA would not consider a battery with those characteristics to be secondary because it is not practically rechargeable.

65. Therefore, Apple’s construction is inconsistent with basic science and how the term would be understood by a POSA at the time of the invention.

d. Overcharging Protection Voltage / Overcharging Protection Release Voltage / Overcharge Protection Release Voltage

RJ Technology’s Construction	Apple’s Construction
Plain and Ordinary Meaning. “overcharging protection voltage” refers to the voltage level at which the battery’s protection mechanism(s) engages to prevent the battery from being charged to a higher voltage. “overcharge/overcharging protection release voltage” refers to the voltage level at which a battery’s protection mechanism(s) disengages or resets.	Overcharging protection voltage / release voltage, implemented in the secondary lithium ion cell or battery, and not in a protection circuit.

66. As discussed above, lithium ion batteries have naturally unstable chemistries. If they are charged beyond what is recommended, battery manufacturers and users risk serious consequences such as thermal runaway, leading to fires and explosions. This is called overcharge and can happen unintentionally, such as through a short circuit.

67. Well aware of these risks, battery and device manufacturers include various mechanisms to prevent overcharge. These mechanisms operate a feedback loop that will reduce the current or even shut it off altogether if certain thresholds

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1 are exceeded. They can be implemented in the device (e.g., in circuitry or software)
2 or in the battery itself (e.g., in the battery management system). The patent
3 describes overcharge protection in terms of voltage, but it can also be implemented
4 by measuring the battery's temperature and other metrics.

5 68. The phrases in question here have a plain and ordinary meaning: the
6 voltage level at which the battery's protection mechanism or mechanisms engage to
7 prevent the battery from being charged to a higher voltage, and the voltage level at
8 which a battery's protection mechanism or mechanisms disengages or resets.

9 69. Apple's construction provides that the overcharge protection voltage
10 cannot be implemented in a protection circuit. I disagree. That interpretation is not
11 consistent with the plain meaning of overcharge protection (as it would be
12 understood by a POSA) or with how the term is used in the patent.

13 70. While it is not clear what Apple means by a protection circuit, to the
14 extent Apple is referring to the battery management system, Apple again uses the
15 term inconsistently with how it is commonly used in the industry. The battery
16 management system is a circuit that is part of the battery. *See* Ex.6. (LINDEN D,
17 HANDBOOK OF BATTERIES, (2001)) at 35.37, 35.69. During charging, current from
18 the power supply is filtered through this circuit before it reaches the battery cells.
19 As such, the circuit includes overcharge protection mechanisms. To an industry
20 professional, the term overcharge protection would be understood to include the
21 battery management system circuitry.

22 71. To the extent Apple is attempting to exclude other circuitry besides the
23 battery management system, that is inconsistent with the plain and ordinary
24 meaning of the term. Overcharge protection generally refers to all protection
25 mechanisms available to the battery, including those in the device or in software.

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e. Maintains at Least ... Capacity after 400 Cycles

RJ Technology's Construction	Apple's Construction
Plain and ordinary meaning. “maintains at least [a percentage] of capacity after 400 complete charge and discharge cycles of the battery”	Indefinite

72. As discussed above, batteries degrade after use, regardless of the configuration and charging algorithm. Battery manufacturers are well aware of this process and regularly conduct testing to determine how much of the battery's original capacity is retained after successive charge and discharge cycles, and this was done long before lithium ion batteries were invented.

73. Often, a battery's specification will demand a certain cycle life, meaning that the battery has to maintain certain capacity thresholds after a certain number of successive charge and discharge cycles. These requirements are common in the industry and would be well understood by practitioners.

74. A battery manufacturer determines how much of the battery's initial capacity is retained after successive charging cycles using basic math, as can be seen in the ratio below:

$$\frac{\text{Remaining Capacity}}{\text{Initial Capacity}}$$

75. A POSA would have understood the claim language to be referring to this calculation.

76. This concept is present in several contemporaneous publications I have reviewed. For example, in the HANDBOOK OF BATTERIES, the authors discuss “capacity fade” to refer to loss of capacity over successive charging cycles. Ex. 6. (LINDEN D, HANDBOOK OF BATTERIES (2001)) at A.4, 35.13-16, 35.42. The handbook has multiple examples of this concept, such as the figures below:

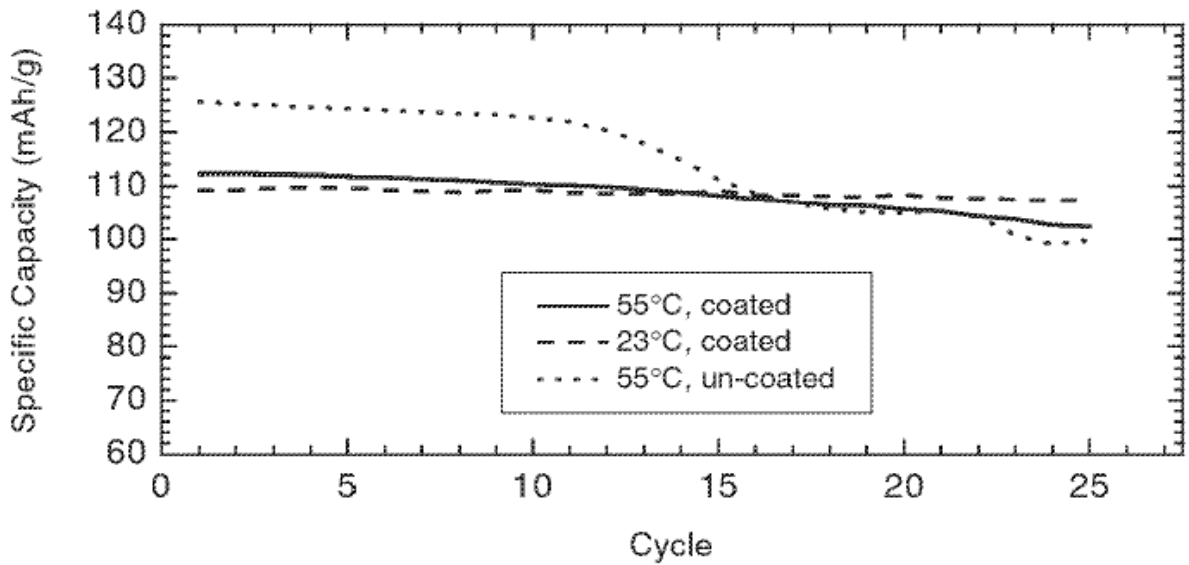


FIGURE 35.15 Specific capacity of LiCoO₂ coated and un-coated spinels cycled at the C/2 rate between 4.2 and 3.5 V at 23°C or 55°C. (Courtesy of Carus Chemical.)

Id. at 35.16.

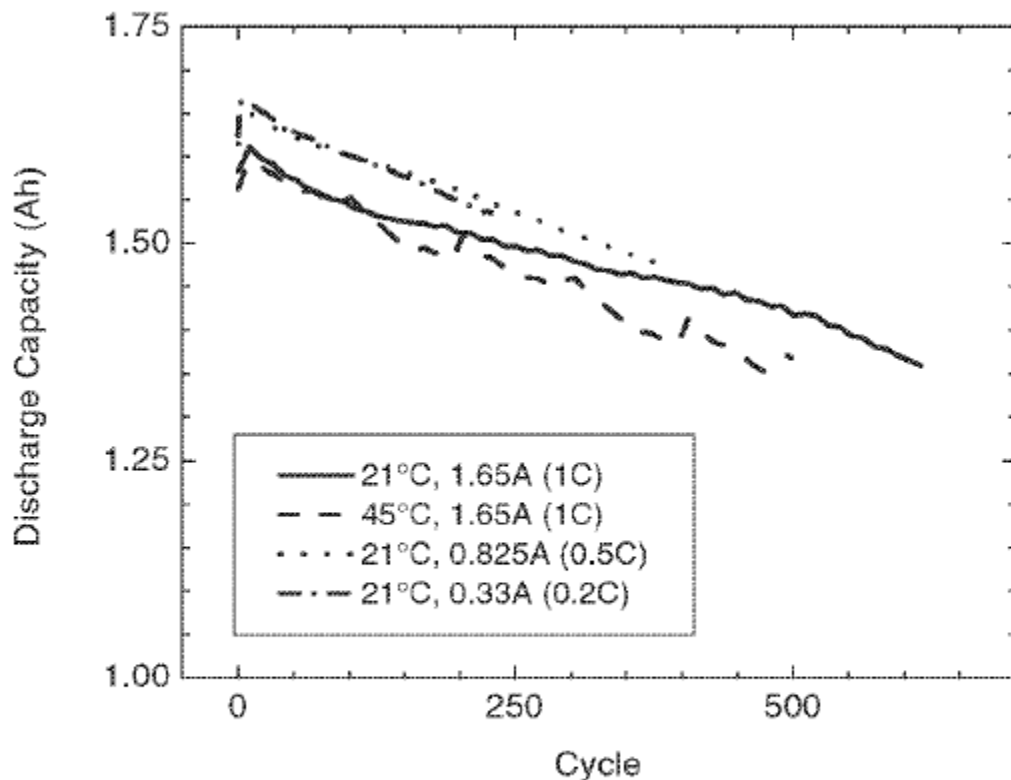


FIGURE 35.45 Capacity of 18650-type C/LiCoO₂ batteries when cycled at either 21°C or 45°C at rates from 0.2C (0.33 A) to 1.0C (1.65 A) between 4.2 V and 2.5 V. (Courtesy of NEC Moli Energy.)

Id. at 35.42.

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1 77. I understand that the patent claims similar requirements. Claims 11
2 through 18 list out battery lifespan thresholds, similar to what would be found in a
3 specification provided by a device manufacturer to a battery manufacturer. These
4 would be well understood in the industry. The same is true for Examples 1-28 in
5 the '641 Patent.

6 78. The patent also references capacity measurements, which a person of
7 skill would readily understand. For example, the patent describes the results of
8 experiments where "the capacity of lithium cobalt oxide[] reaches 159 mAh/g when
9 the charge cut-off voltage is 4.35V, but it drops to 135 mAh/g after several
10 cycles" '641 Patent at 2:20-24. In this calculation, the percentage of remaining
11 capacity would be 84.9%.

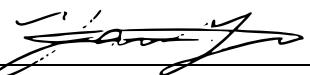
12 79. Similarly, in experiment 1, the patent describes a battery with an initial
13 capacity of 1113 mAh, that retains only 85.72% of capacity after 400 cycles. '641
14 Patent at 10:29-37. A person of skill would understand that the capacity of the
15 battery would be 954 mAh after 400 cycles (85.72% of 1113 mAh).

16 80. I understand that Apple believes these claims are indefinite. I do not
17 understand how Apple has reached this conclusion. As discussed above, this is a
18 simple calculation, and it is well known and commonly used throughout the
19 industry. In my opinion, the words used in the patent are not uncertain or
20 ambiguous.

21 **V. Conclusion**

22 81. I declare under penalty of perjury under the laws of the United States
23 of America that the foregoing is true and correct.

24
25 Executed on June 23, 2023

/s/ 

26 Dr. Yan Yao
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