

1 **UNITED STATES DISTRICT COURT**
2 **CENTRAL DISTRICT OF CALIFORNIA**
3 **SOUTHERN DIVISION**

4
5 RJ TECHNOLOGY LLC

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

6 Plaintiff,

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

7 vs.

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9 APPLE INC.,

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

2 1. My name is Yan Yao, and as mentioned in my Expert Declaration
3 served on June 23, 2023, I have been retained by RJ Technology LLC (“RJ
4 Technology”), through counsel, as an expert in the lawsuit captioned above.

5 2. This responsive declaration provides my opinions and the bases for
6 these opinions as they relate to the Declaration of Quinn Horn, Ph.D. in Support of
7 Defendant Apple Inc.’s Opening Claim Construction Brief (“Horn Decl.”). In
8 preparing this responsive declaration, I have relied upon my accumulated scientific
9 knowledge and experience. I have also reviewed Apple’s opening claim
10 construction brief and the exhibits identified in Yungmoon Chang’s accompanying
11 declaration as well as Dr. Horn’s declaration and the documents cited therein.

12 **I. Disputed Claim Terms**

13 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

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19 3. Dr. Horn relies on certain statements from the specification of the ’641
20 Patent, though he does not explain why those portions of the specification support
21 Apple’s construction for this term. For example, Dr. Horn cites column 2, lines 38-
22 41 of the specification, which states that “In 1990, Sony Corporation issued the
23 lithium ion cell using coke as negative electrode, which has a charge cut-off voltage
24 of not more than 4.20 V, and it is accepted as a common technical requirement of
25 lithium ion cells thereafter.” This statement by the inventors merely reflects that
26 the fact that a charge cut-off voltage of 4.2 V was the industry standard at the time
27 of the invention, and it does not say the term denotes a particular charging algorithm,
28 namely constant current/constant voltage charging (“CC/CV charging”).

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1 4. Dr. Horn also argues that a POSA reading RJ Technology's proposed
2 construction would not know when the voltage changes from constant current
3 charging to constant voltage charging. I disagree. When a battery is being charged
4 by CC/CV charging, the voltage increases until it reaches the maximum value to
5 which the battery is configured to be charged. Then the charging voltage is held
6 constant and the current decreases slowly. In other words, the voltage when the
7 charging switches from constant current charging to constant voltage charging in a
8 CC/CV charging mode is the maximum voltage to which the battery is configured
9 to be charged. But even though the voltage at which the charging switches to
10 constant voltage in CC/CV is the charge cutoff voltage, that does not mean that the
11 charge cutoff voltage is *always* that voltage in CC/CV. Other charging algorithms
12 can be used to implement the charge cutoff voltage.

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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”

5. Dr. Horn appears to suggest that the terms “theoretical capacity” and “theoretic capacity” can only mean the theoretical maximum capacity. Based on my experience and my review of the literature, that is not the case in the industry, either at the time of the invention or now. Researchers in the field use the term “theoretical capacity” in two different manners. Sometimes it is referred to as the theoretical maximum capacity, and sometimes it is referred to as the capacity at a particular voltage. *See* Dkt. 70-1, Yao Opening Decl., ¶ 46. A POSA in the field would understand what it means based on the context and how a reference describes the term.

6. For example, Masaki Yoshio et al. published an article in 1999 studying the properties of lithiated manganese dioxide, $\text{Li}_{0.33}\text{MnO}_2$. *See* Masaki

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1 Yoshio et al., *Lithiated manganese dioxide, $\text{Li}_{0.33}\text{MnO}_2$, as a 3V cathode for lithium*
2 *batteries*, *Electrochimica Acta* 45 (1999) 273-283 (“Yoshio 1999”). The authors
3 found that this material “delivers a **theoretical initial capacity** of 210 mAh/g and
4 shows an especially satisfactory cycling behavior with a rechargeable capacity of
5 180 mAh/g over 60 cycles.” *Id.* at 282 (emphasis added). The “theoretical initial
6 capacity” there refers to the capacity when approximately 67% of lithium ions are
7 intercalated into the cathode, not the theoretical maximum, when 100% of lithium
8 ions are intercalated or extracted. *Id.* at 279 (“This compound has an initial
9 discharge capacity of 210 mAh/g, corresponding to 0.67 molar Li^+ intercalating into
10 the $\text{Li}_{0.33}\text{MnO}_2$ framework, which is close to the theoretical value based on the
11 following reaction: $\text{Li}_{0.33}\text{MnO}_2 + 0.67\text{Li}^+ + 0.67\text{e} = \text{LiMnO}_2$ ”).

12 7. Similarly, S. Ohta et al. reported that “[t]he theoretical electrochemical
13 capacity of LCO is 137 mAh g^{-1} , which corresponds to 0.5 Li per CoO_2 .” See S.
14 Ohta et al., *Electrochemical performance of an all-solid-state lithium ion battery*
15 *with garnet-type oxide electrolyte*, *Journal of Power Sources* 202 (2012) 332-335.
16 In other words, the authors there did not identify the theoretical capacity of LiCoO_2
17 as the theoretical maximum capacity (274 mAh/g). Instead, they identified the
18 capacity at 4.2 V as the theoretical capacity. In fact, consistent with the general
19 practice in the industry, numerous articles refer to “theoretical capacity” to mean
20 the capacity at a particular voltage. See, e.g., Eiji Hosono et al., *Synthesis of single*
21 *crystalline electro-conductive $\text{Na}_{0.44}\text{MnO}_2$ nanowires with high aspect ratio for the*
22 *fast charge-discharge Li ion battery*, *Journal of Power Sources* 182 (2008) 349-352
23 at 350 (identifying 137 mAh/g as the “theoretical capacity” for LiCoO_2); Kaoru
24 Dokko et al., *Solvate Ionic Liquid Electrolyte for Li-S Batteries*, *Journal of the*
25 *Electrochemical Society*, 160 (8) A1304-A1310 (2013) at A1304 (“The cathode
26 materials currently in use consist of transition metal compounds such as LiCoO_2
27 and LiFePO_4 , which have **theoretical capacities of 137 and 170 mAh g^{-1}** ,
28 respectively”) (emphasis added); Kai Chen et al., *High capacity and cyclic*

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1 performance in a three-dimensional composite electrode filled with inorganic solid
2 electrolyte, Journal of Power Sources 249 (2014) 306-310 at 307 (“A rather high
3 specific discharge capacity of 131 mAh g⁻¹ (or a high surface capacity of 5 mAh
4 cm⁻²) was achieved in a 100-μm-thick composite electrode, which is up to 96% of
5 **the theoretical capacity of LiCoO₂ (137 mAh g⁻¹)** (emphasis added); Zhanpeng
6 Huang et al., *High-capacity and stable sodium-sulfur battery enabled by confined*
7 *electrocatalytic polysulfides full conversion*, Adv. Funct. Mater. 2021, 31, 2100666
8 (identifying 137 mAh g⁻¹ as the “theoretical discharge capacity” of LiCoO₂). These
9 references all confirm that the meaning of “theoretical capacity” depends on the
10 context, and it does not always refer to the theoretical maximum.

11 8. I have also reviewed a submission made by the inventors of the ’641
12 Patent during the prosecution history of the Chinese patent (ZL 0114165.7), which
13 I understand is directly related to the ’641 Patent. In the Chinese patent prosecution
14 history, the inventors explained to the examiner in China that to calculate the
15 claimed ratio, the capacity at a charge cut-off voltage of 4.2 V should be used. See
16 Ex. 3, Chinese Patent Application Statement of Argument for Application No.
17 01141615.7 (October 19, 2004). That is consistent with my reading of the claims
18 in the ’641 Patent.

19 9. Dr. Horn states that he “disagree[s] that ‘theoretic capacity’ should be
20 construed as ‘capacity.’” Horn Dec. ¶ 45. But the ’641 Patent says the opposite,
21 that “‘theoretical capacities of positive electrode and negative electrode’ means **the**
22 **capacities** of the positive electrode and the negative electrode calculated with a
23 charge cut-off voltage set at 4.2V.” ’641 Patent, 4:5-9 (emphasis added). Again,
24 this definition is consistent with general usage in the industry, and further clarifies
25 that as used in the claims “as calculated by a theoretic capacity with a charge cut-
26 off voltage set at 4.2V” means “as calculated by a capacity with a charge cut-off
27 voltage set at 4.2V.”
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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

10. Dr. Horn does not explain why he believes his cited sources support Apple's construction for this term. I reiterate my opinions set out in my opening declaration with regard to this term.

d. Overcharging Protection Voltage / Overcharging Protection Release Voltage
Voltage 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

11. Similar to the term above, Dr. Horn also does not explain why he believes the inventors disclaimed a secondary lithium ion cell or battery that implements overcharging protection voltage or overcharging protection release

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voltage in a protection circuit. I was informed by RJ Technology’s counsel that Apple makes this argument based on certain restriction requirements imposed by the examiner during the prosecution of the ’641 Patent. I am not a lawyer so I will not comment on the legal impact of the restriction requirement. However, here again, my original declaration explains why RJ Technology’s proposed construction is correct and I reiterate those opinions now.

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

12. I disagree with Dr. Horn that this term is indefinite. *First*, Dr. Horn argues that a POSA would not understand what “capacity” this term refers to. In this context, it is clear that the “capacity” here refers to the amount of electricity a battery can store, usually in milliampere hours (mAh) or ampere-hours (Ahs). *See* Dkt. 72-6 at RJ00003152 (defining capacity as “the total number of ampere-hours (Ah) that can be withdrawn from a fully charged cell or battery under specified conditions of discharge.”). It does not refer to specific capacity or theoretical capacity. Capacity testing was common in the art at the time of the patent and is common today – as demonstrated by the fact that Apple itself uses the word “capacity” when it says in advertisements and warranties that “Your battery is designed to retain up to 80% of its original capacity at 500 complete charge cycles.” Dkt. 71-7 at RJ00000878_Apple. A POSA would understand what “capacity” means in Apple’s advertisements, and would understand what it means in the ’641 Patent.

13. *Second*, I disagree with Dr. Horn that a POSA would not know the parameters to conduct the cycling testing. A POSA, reading the claims in light of

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1 the specification and the prosecution history, would understand that the cycling test
2 should be performed to approximate the normal operation of a commercial lithium-
3 ion battery.

4 14. As an initial matter, I disagree with Dr. Horn that “it was common
5 practice at the time of the ’641 Patent to disclose specific conditions of cycle testing.”
6 To the contrary, at the time and now, studies routinely fail to specify all of the testing
7 parameters for capacity loss after a given number of cycles. *See, e.g.*, Yoshio 1999
8 at Fig. 9 (no temperature was specified, no rest time was specified); Bradely
9 Johnson & Ralph White, *Characterization of commercially available lithium-ion*
10 *batteries*, Journal of Power Sources 70 (1998) 48-54 (“Johnson 1998”) at Fig. 7 (no
11 discharge cutoff voltage was specified; no rest time was specified). As just one
12 example, the literature often did not provide the temperature of testing. But this did
13 not render the tests uncertain or unintelligible. A POSA would understand that
14 where no temperature is provided the testing would be done at room temperature.
15 This is common sense: in order to test at a temperature other than room temperature,
16 the researcher would need an oven or heater (for above room-temperature testing)
17 or a refrigerator or freezer (for below room-temperature testing). But if a study does
18 not describe such equipment, and does not suggest that testing under some unusual
19 temperature conditions would be investigated, then the natural conclusion would be
20 that no heat or cooling was applied. Of course, testing at room temperature is more
21 convenient for the tester, as such equipment would not be needed. And it would
22 also be more relevant to a reader interested in the performance of the tested battery
23 for general use such as is described in the ’641 Patent. Those batteries would be
24 generally used at room temperature.

25 15. In addition, the ’641 Patent has already provided a host of details
26 regarding how to conduct the cycling test. The ’641 Patent explains how to prepare
27 the cathode, the anode, and how to build a battery with the key components.
28 *See* ’641 Patent at 9:61–10:25. In the examples, the ’641 Patent also provides the

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1 claimed capacity ratio of the positive electrode material to the negative electrode
2 material, and the charge cut-off voltage. *Id.* at 10:29–15:54. Further, the ’641
3 Patent is clear that the invention is focused on commercial batteries for generally
4 applicable uses. *Id.* at 1:19-28 (noting the focus on “improvement of capacity of
5 commercialized secondary lithium ion battery”); 1:64-67; 4:43-53 (explaining that
6 the invention achieves “substantial improvement of the specific energy of
7 commercial lithium ion cells...”); 7:1-8; 9:45-48 (explaining that the invention is
8 directed to devices such as “notebook type computer, PDA, electromotive bicycle,
9 and electromotive automobile, etc.”); 16:45-51 (“[T]he present invention possesses
10 a great commercial value...”). Finally, the patent states that “[e]xcept voltage, all
11 process parameters for charge and discharge are commonly used in the art.” *Id.* at
12 9:22–23. In other words, a POSA reading the ’641 Patent would understand that
13 the charge and discharge conditions for the cycling test would not be outside the
14 normal operating conditions for a commercial device of general applicability. For
15 example, a POSA would not use high temperature to potentially dramatically reduce
16 the cycle life of the batteries they would be testing. They instead would use typical
17 charging and discharging conditions that would lead to the normal and expected
18 behavior of the batteries being tested.

19 16. Various industry standards available at the time of the invention teach
20 how to conduct cycle life testing, and the conditions used there also approximate
21 the normal operation of a battery. The testing conditions disclosed there show a
22 high level of consistency. For example, the PRC national standard for general
23 specification of lithium-ion battery for cellular phones (the 2000 version), which is
24 relied upon by Dr. Horn, discloses the specifics for cycle life testing:

25 5.3.6 Cycle life

26 5.3.6.1 The battery cycle life test shall be performed at an ambient
temperature of 20°C±5°C.

27 5.3.6.2 Charge the battery at 1 C₅A at an ambient temperature of
28 20°C±5°C, and switch to constant voltage charging when the voltage
at battery side reaches limited charge voltage until charging current

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1 is less than or equal to 20mA. Stop charging, and lay it aside for 0.5h
2 – 1h, then discharge it to cut-off voltage at 1 C₅A. After completing
3 discharging, lay it aside for 0.5h – 1h, and perform the next
4 charge/discharge cycle until the duration of 2 successive discharges
is less than 36min. it is assumed that the battery life ends. Lifecycle
of the battery shall comply with the specification in section 4.6.

5 See Dkt. 69-8 at 2. Charging the battery at 1 C₅A means that the battery will be
6 charged to its full capacity in an hour. Similarly, discharging the battery at 1 C₅A
7 means the battery will be fully discharged within an hour. A POSA doing the cycle
8 life testing would look to standards such as this PRC national standard for guidance.

9 17. Similarly, the 1999 version of the Underwriters Laboratory (UL)
10 Standard for Safety for Lithium Batteries, UL 1642 states that for charge-discharge
11 cycling test, batteries should be tested at 25 °C (77 °F), i.e., ambient temperature.
12 See Ex. 4, UL 1642 3rd Ed. (1999 rev.) at 12. UL 1642 also states that “[c]ells are
13 continuously cycled as per the manufacturer’s specifications.” *Id.*

14 18. Dr. Horn cites a data sheet for a lithium-ion battery from Panasonic.
15 There, Panasonic states that cycle life testing is done at 20 °C, i.e., ambient
16 temperature. See Panasonic, “Lithium Ion Batteries: Individual Data Sheet CGR
17 18650,” Cycle Life Characteristics. The data sheet further specifies that the
18 charging rate is 910 mA (max) for 2 hours and the discharge rate is 1300 mA. *Id.*
19 The battery has a rated capacity of 1400 mAh. *Id.* A POSA would understand that
20 the charging rate is 0.5C and the discharge rate is approximately 1C, similar to the
21 requirements of the PRC standard.

22 19. Dr. Horn also relies upon an article written by Yoshio Nishi et al. in
23 1998 titled “The Development of Lithium-Ion Secondary Battery Systems for EV
24 and HEV” (“Nishi 1998”). That article is also consistent with the standards and
25 manufacturer specification noted above. In Figure 5 of Nishi 1998, which is
26 reporting the “preserving capacity ratio through durability test,” a POSA would
27 understand this is reporting the cycle life of the tested battery, a 1C discharging rate
28 was used, which is the same as the PRC standard and the Panasonic data sheet. *Id.*

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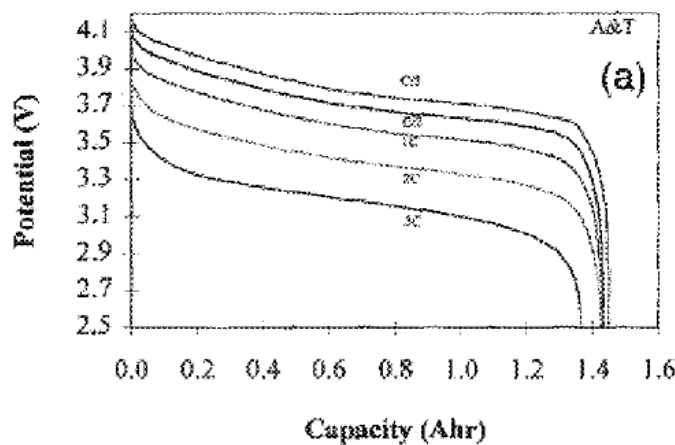
1 at 33. Dr. Horn cites page 36 of Nishi 1998 to support his contention that it is
2 “critical to specify the conditions of that cycling testing.” Horn Decl., ¶ 27.
3 However, the figure that Dr. Horn pur ports to rely on, Figure 15, is reporting how
4 high-rate discharge (90A) will affect cycle life, compared to the standard discharge
5 rate of 1C. Unlike Figure 5, Figure 15 is not reporting cycle life under normal
6 conditions. Again, it is common sense that if one were to test under unusual
7 conditions then one would say so. But if certain conditions are left unspecified, one
8 would safely presume that ordinary conditions were used. Demonstrating this point,
9 in Figure 15 the *only* testing condition disclosed by the authors is the discharge rate.
10 Finally, Nishi 1998 reports that “[t]he results showed that no capacity drop was
11 detected due to the high-rate discharge mode.” *Id.* at 36. In other words, even
12 though the authors there changed the discharge rate, the cycle life remained largely
13 the same.

14 20. The absence of a detailed laundry list of cycling test conditions in
15 the ’641 Patent is also consistent with my experience and the literature, as discussed
16 above. It is common for literature to not disclose every minute detail of a testing
17 procedure. When one detail is not specified, a POSA would understand that the
18 typical condition would be used. For example, the Panasonic data sheet does not
19 specify other details that Dr. Horn alleges as necessary for the cycling test, such as
20 the charge end condition and rest time. Nishi 1998 only reports the discharge rate
21 and the charge end condition for its cycling test in Figure 5; it did not specify most
22 of the parameters that Dr. Horn claims are necessary for disclosure. A POSA would
23 use conditions that mirror normal operation of a lithium-ion battery, as discussed
24 above, for the cycling test.

25 21. Finally, to the extent that there are minor variances between the
26 conditions described in standards or manufacturer specifications, those differences
27 would not produce materially different results. While extreme temperatures do
28 severely limit performance, lithium ion batteries can safely operate within a very

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1 broad range of temperatures (-20°C to 60°C / -4°F to 108°F) and they maintain
2 excellent cycle life under a narrower but still very broad range of temperatures, for
3 example, 15°C to 35°C (59°F to 95°F). As a further example, Bradley Johnson and
4 Ralph White surveyed commercially available lithium-ion batteries in 1998 and
5 they tested the capacity of those batteries with different discharge rates. *See*
6 Johnson 1998. They found that when the batteries were being discharged at a rate
7 of 2C or less (*i.e.*, within a normal range), the capacity was consistent across the
8 different discharge rates. *See, e.g., id.* at Fig. 5(a).



17 II. Conclusion

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

20 Executed on July 14, 2023

22 Dr. Yan Yao

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