

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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SAMSUNG ELECTRONICS CO., LTD.,  
Petitioner

v.

RJ TECHNOLOGY LLC,  
Patent Owner.

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Case IPR2023-01183

Patent No. 7,749,641

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

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## I. INTRODUCTION

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

The independent claims of the '641 Patent are directed to "secondary lithium ion" batteries with a "charge cut-off voltage greater than 4.2V" (the claimed "charge cut-off voltage") and a negative to positive electrode ratio of materials, as calculated by "a theoretic capacity with a charge cut-off voltage set at 4.2V" in a range from 1-2.5 (the claimed "capacity ratio"). The dependent claims narrow the ranges for the claimed charge cut-off voltage and capacity ratio, recite safety mechanisms against overcharging, and require that secondary lithium-ion batteries retain certain minimum capacity levels after repeated charging and discharging. Critically, against the conventional wisdom as of its priority date, the '641 Patent describes the first secondary lithium-ion batteries in which the capacity ratio and charge cut-off voltages were both elevated to the claimed ranges *and* the charge cut-off voltage was elevated above 4.2V.

Petitioner's grounds assert two primary references against the independent claims (Uemura and Abe) and two secondary references against the dependent claims. Neither Uemura nor Abe teach that the combination of the claimed charge cut-off voltages and the claimed ratios would produce a functioning battery that

improves the capacity of the battery without causing capacity loss or battery damage. Such a teaching would fly in the face of conventional wisdom in the art that increasing the charge cutoff voltage above 4.2V would inevitably damage the battery and harm performance. As explained below, all of Petitioner's grounds fail, among other reasons, because neither Uemura nor Abe teaches or suggests the claimed charge cut-off voltage or capacity ratio ranges.

Uemura reports experiments and results from which a POSITA would understand that (a) batteries were charged with a maximum applied voltage of 4.3V that does not produce a battery charge cut-off voltage above 4.2V because of Uemura's charging conditions, (b) the "capacity balance" ratios relating to Uemura's examples do not fall within the claimed capacity ratio ranges because they use different electrode capacities than those required by the claims to arrive at those ratios, (c) Uemura is not an enabling reference and thus cannot anticipate or render obvious the challenged claims (and, further, its reported experimental data on which Petitioner relies for its contentions as to the claimed capacity ratios are plagued by errors so obvious that a POSITA would disregard Uemura's disclosures pertinent to Petitioner's grounds as a matter of law).

Similarly, a POSITA would understand that Abe does not disclose (a) the claimed charge cut-off voltage because it does not disclose a voltage for a secondary "*lithium-ion*" battery as required by the claims, instead it discloses a "half-cell"

voltage which—when converted to a full secondary lithium ion cell charge cut-off voltage—falls below the claimed range, and (b) the claimed capacity ratio because Abe’s ratios are calculated at voltages that produce values that likewise are not shown to fall within the claimed ranges.

Petitioner’s secondary references and a POSITA’s background knowledge do not supply these missing elements or cure the defects in the Uemura and Abe references. Accordingly, Patent Owner respectfully submits that the reasons set forth in this response, many of which were not previously presented to the Board, compel a Final Written Decision finding all challenged claims patentable over the asserted prior art.

## **II. BACKGROUND**

### **A. Procedural History**

Patent Owner (“PO”) asserted the ’641 Patent against Petitioner in *RJ Technology LLC v. Samsung Electronics Co. Ltd.*, No. 2:22-v-00401-JRG-RSP (E.D. Tex.). PO also asserted the ’641 Patent against Apple Inc. in *RJ Technology LLC v. Apple Inc.*, No. 8:22-cv-1874-JVS-JDE. Apple filed an IPR against PO in *Apple Inc. v. RJ Technology LLC*, IPR2023-01350 and sought to join this IPR.

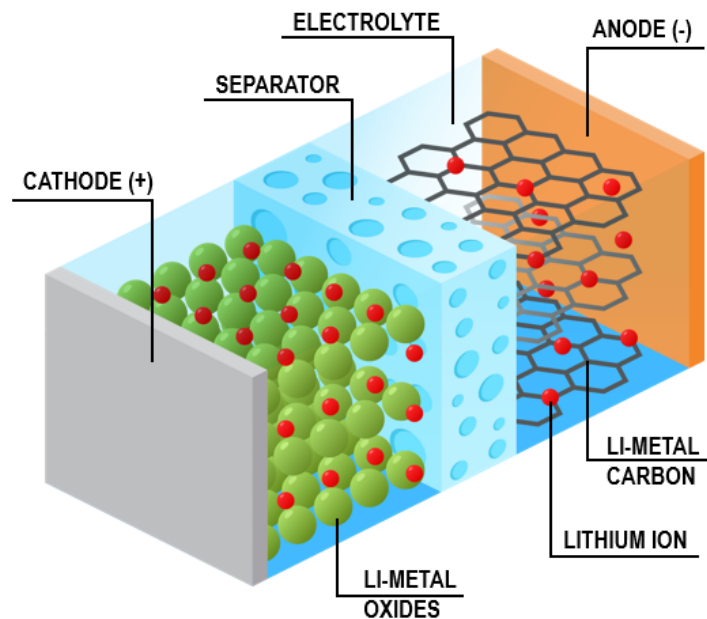
### **B. Technology Background**

#### **1. Li-ion battery basics**

Lithium-ion batteries are ubiquitous. Lithium-ion batteries used today are also typically rechargeable (also called “secondary”), such that they can be

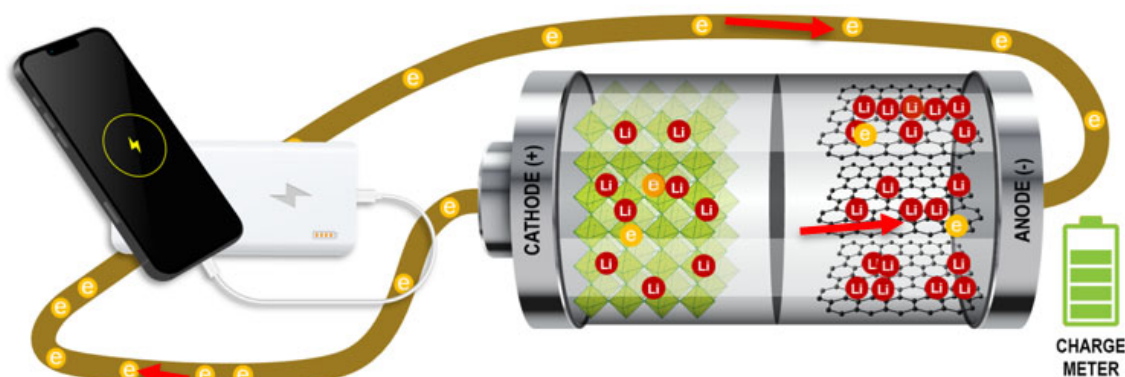
recharged numerous times without suffering heavy losses in capacity, *i.e.*, the amount of electricity the battery can store on a charge. Ex2006 (Yao Decl.), ¶¶37-38, 46.

The basic construction of lithium-ion batteries includes a positive electrode (cathode), a negative electrode (anode), an electrolyte, and a separator, among other components (Ex2006, ¶¶41-42), illustrated below:



The cathode is typically made of a lithium metal oxide compound (e.g., lithium cobalt oxide, or  $\text{LiCoO}_2$ ). The anode is commonly made of carbon material, such as graphite. The electrolyte is typically a liquid medium that facilitates movement of lithium ions between the cathode and anode. The separator physically separates the cathode from the anode, as contact between the two can cause short circuits. *Id.*

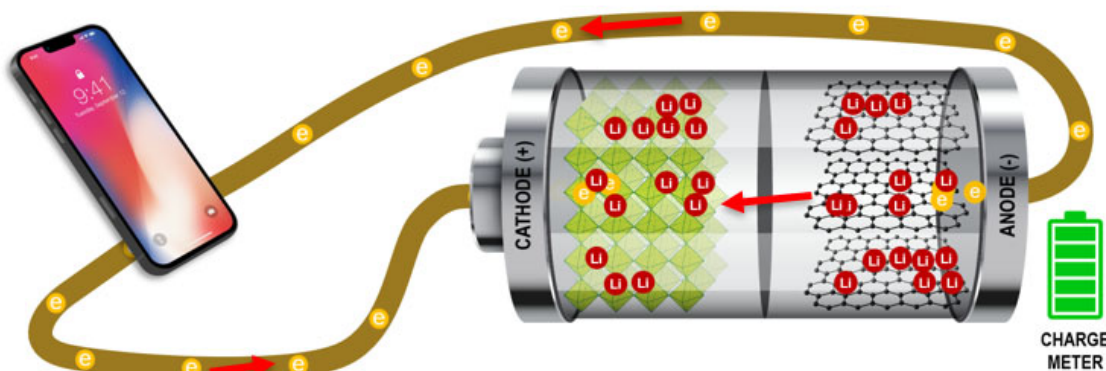
The basic operation of a lithium-ion battery is storing and releasing electricity, accomplished by the movement of positively charged lithium ions ( $\text{Li}^+$ ) and negatively charged electrons ( $e^-$ ) between the cathode and anode. Charging is illustrated below:



As shown, during charging (i.e., when electricity is applied to the battery), the cathode releases lithium ions and electrons. The lithium ions travel from the cathode to the anode through the separator in a process called intercalation; and electrons travel from the cathode, through the charging circuit, to the anode, where they combine with the lithium ions ( $\text{Li}^+$ ) to form lithium atoms ( $\text{Li}$ ), which are stored in the anode. Ex2006, ¶¶43-44.

As shown below, during discharge (e.g., to power a device), the process reverses. Electrons separate from the anode, through the external circuit and powered device, to the cathode; and (in the same molar amount as the electrons), the

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

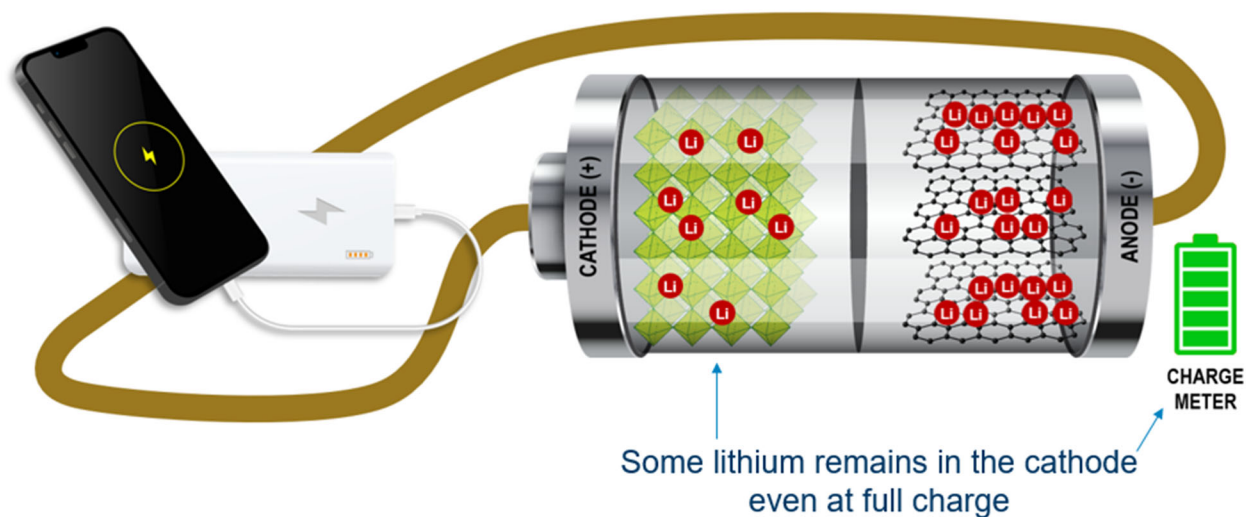


Ex2006, ¶45.

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

electrical current the battery can deliver in one hour. For example, a battery with 1 mAh capacity could deliver 1 mA of current for an hour. Ex2006, ¶¶46-47.

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



Elevating the battery voltage can increase its capacity, as more lithium ions are extracted from the cathode. When the battery is fully charged to a higher voltage, the anode stores more lithium and electricity. It thus has greater capacity even at the same battery size. However, it is possible to overcharge a battery by charging it to a voltage greater than its chemical structure is capable of handling. Overcharging can cause serious problems, including fires and explosions, or degrade the battery causing it to lose capacity after successive charges and recharges; battery engineers have thus historically avoided charging batteries to voltages that could damage the battery or shorten its useful life. Ex2006, ¶¶48-50.

## 2. The 4.2V charge cut-off voltage limit

The charge cut-off voltage<sup>1</sup> of lithium-ion batteries is a critical design parameter for battery performance and safety. As of the priority date of the '641 Patent, it was well-known in the art that the charge cut-off voltage could not exceed 4.2V, *regardless of the materials used*. Ex1001, 1:46-51. For example, it was widely believed that charging LiCoO<sub>2</sub> (a widely used cathode material with high energy density) to voltages above 4.2V would lead to the cathode releasing oxygen thus increasing the risk of a “thermal runaway” phenomenon that could lead to fires or explosions. Ex1001, 1:55-63. Higher voltages were also known to degrade the LiCoO<sub>2</sub> crystal structure, thus rapidly shortening battery life. Ex2006, ¶¶51-53.

Charging batteries with spinel lithium manganese oxide (“LiMn<sub>2</sub>O<sub>4</sub>” – another common cathode material made with manganese, which is cheaper and less toxic than LiCoO<sub>2</sub>) to voltages above 4.2V was likewise known to cause manganese dissolution into the electrolyte, thus degrading battery performance over time. Ex2020, A55; Ex2006, ¶54. Petitioner’s expert Mr. Juzkow testified that (i) spinel LiMn<sub>2</sub>O<sub>4</sub> has “a lower capacity per gram” and is “less stable at high temperatures”

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<sup>1</sup> As explained below in section IIIA, the “charge cut-off voltage” is the “maximum voltage to which the battery is configured to be charged,” *i.e.*, equal to the maximum full-cell voltage between the battery’s electrodes for which a battery is configured.

at which “manganese will come out of the material [,] dissolve into the electrolyte and poison the anode,” and (ii) such issues were known to occur at 4.2V. Ex2008 (Juzkow Dep. Tr), 100:14-20, 102:7-15, 123:15-24; 124:21-25. In short, as of the priority date, POSITAs knew to limit the charge cut-off voltage of  $\text{LiMn}_2\text{O}_4$  to less than 4.2V. Ex1013, 8:65-9:3; *see also* Ex1011, 16:23-37; Ex2020, A55; Ex2014, Fig. 1.

### **3. The electrode capacity ratio**

The electrode capacity ratio—*i.e.*, the ratio of the capacity of the anode to that of the cathode—is another design parameter relevant to this case. As of the priority date, unlike the charge cut-off voltage, there was no specific cut-off with respect to the capacity ratio. Technical literature and industry guidelines provided little to no specific guidance, and POSITAs had different approaches to setting the capacity ratio on a case-by-case basis. Ex2006, ¶55.

Contrary to Mr. Juzkow’s assertion that POSITAs universally designed batteries with greater anode than cathode capacity (e.g., Ex1002, ¶¶21-26), there was ample guidance teaching that the cathode should have greater capacity than the anode to compensate for potential losses of lithium ions during the initial charging cycles. *See, e.g.*, Ex2023, 3650 (“the common procedure is to assemble cells having a greater than theoretical amount of positive-electrode mass, thus allowing for losses of cyclable lithium during operation by initially providing extra lithium”); Ex1012,

4 (for Sony’s lithium-ion battery, showing that it has more cathode active material capacity than anode active material capacity); Ex2006, ¶56.

POSITAs knew as of the priority date that lithium-ion batteries undergo irreversible capacity loss (i.e., loss of lithium ions) during initial charging cycles, attributable to lithium-ion attachment to parts of anode and, as well as similar phenomena in the electrode and the cathode. Ex2006, ¶56; Ex1013, 1:64-2:4, 2:20-26. These initial losses “are usually compensated by adding an excess amount of lithium containing transition metal compound to the battery.” *Id.*, 2:50-53.

Likewise, POSITAs designed batteries with equal anode and cathode capacities, as well as greater anode capacity. Critically, setting the electrode capacity ratio was not considered in connection with—let alone disclosed as a parameter that could help with—increasing the charge cut-off voltage. Rather, the conventional wisdom was that batteries should not be charged to a voltage above 4.2V, irrespective of the design of the capacity ratio. Ex2006, ¶57.

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

The ’641 Patent tackles the charge cut-off voltage and the capacity ratio in tandem, for the first time in the art, to raise the charge cut-off voltage and improve battery energy density while maintaining superior cycle life. Rather than develop new battery materials, the inventors improved utilization of existing cathode materials by adjusting the anode to cathode capacity ratio to an appropriate range

such that the charge cut-off voltage could safely exceed 4.2V without substantial performance loss. The novel combination of these two battery design parameters was allowed by the patent examiner, resulting in the issuance of the '641 Patent. Ex2006, ¶59.

The '641 Patent is titled “Secondary lithium ion cell or battery, and protecting circuit, electronic device, and charging device of the same” and claims priority to a Chinese patent application dated September 28, 2001, which is assumed to be its priority date for purposes of this IPR. Petitioner challenges all 18 claims of the patent.

The patent includes two independent claims. Claim 5 is representative:

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

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

Claims 2-3 depend from claim 1 and narrow the charge cut-off voltage range to 4.3-5.2V and 4.3-4.8V, respectively. Claim 4 also depends from claim 1 and

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

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

Claims 11-18 depend from claim 1 or 5 and require that the battery maintain certain capacity levels after 400 cycles.

### **C. Petitioner's Cited References**

#### **1. Uemura (Ex1009)**

Uemura purports to describe a lithium-ion battery with a "Li deficient type lithium manganese oxide of a layer structure as a positive electrode material." Ex1009, Abstract. Uemura is directed to improving the stability of layered LiMnO<sub>2</sub> by decreasing the amount of lithium circulating in a lithium-ion battery. Ex2006, ¶¶68-71.

Uemura acknowledges that layered LiMnO<sub>2</sub> was known not to have a stable structure and to lose capacity rapidly when used as a cathode active material. Ex1009, ¶11; Ex2006, ¶¶64-67; Ex2009, 500. Uemura teaches that *reducing* the amount of lithium ions of the cathode in circulation could address this issue, *first*, by making the layered LiMnO<sub>2</sub> lithium deficient and doping it with other elements,

and, *second*, by using an anode with higher irreversible capacity than conventional anode materials, which Uemura state could further deplete the lithium of the cathode thus further enhancing cathode stability. Ex1009, ¶¶25-26, 35. In short, Uemura teaches decreasing the utilization of the lithium available during the battery's charge and discharge cycles. Ex2006, ¶¶68-71.

Uemura's approach is thus the *opposite* of the '641 Patent, which teaches raising the charge cut-off voltage above 4.2V to *increase* lithium utilization in the cathode. *Id.* Also, Uemura does not disclose elevating the charge cut-off voltage (as explained below, Uemura teaches an *externally applied* voltage as high as 4.3V, not a battery voltage, as required by the parties' construction); and a POSITA would understand from Uemura's teaching (to decrease lithium utilization) that raising the charge cut-off voltage (which increases lithium utilization) would further destabilize the cathode structure and thus be counterproductive to Uemura's objective of improving cathode stability. In contrast, the '641 Patent teaches increasing lithium extraction and a battery's energy density. Ex2006, ¶71.

## 2. Abe (Ex1005)

Abe is directed to safety concerns that arise when batteries are charged or discharged at what were considered in the art high current.<sup>2</sup> See Ex1005, ¶¶11, 13-17, 30.

Abe describes a form of anode made of “graphitized vapor-phase-grown carbon fiber” characterized by its large surface area, “average aspect ratio,” and average diameter, and teaches that maintaining the surface area of the carbon fiber in a specific range “[reduces] the electrolytic catalysis of the solvent” thus achieving better safety. Ex1005, ¶¶22-33. According to Abe, these parameters are designed to reduce electrolyte reactions thus avoiding decomposition or gas production at higher currents. *Id.*

Unlike the '641 Patent, which teaches raising the charge cut-off voltage above 4.2V, Abe discloses a number of examples in all of which batteries were charged with a maximum voltage of 4.1V. *Id.*, ¶¶95, 97, 104, 110, 119. It also explains that “if the cut-off voltage at the time of charging is limited to 4.1V, a longer-lived non-

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<sup>2</sup> Abe’s high current values are different than high “voltage” values, as a high charge/discharge current does not necessarily imply a high voltage. Ex2006, ¶46; Ex2008, 104:12-13. In any event, as discussed below, Abe does not disclose charge cut-off voltages above 4.2V.

aqueous electrolyte-based secondary battery can also be obtained.” *Id.*, ¶80. According to Abe, charging to a voltage above 4.2V was hazardous (*see* Ex1005, ¶9); and Abe prioritizes safety and longevity over the higher performance goals of the ’641 Patent. Ex2006, ¶74.

### **3. Guyomard (Ex1008)**

Guyomard is directed exclusively to improvements in the electrolyte material used in lithium-ion batteries, and does not purport to improve a battery’s charge cut-off voltage or electrode capacity ratios. For example, Guyomard’s claims are drawn to a purportedly new electrolyte, without reference to a battery’s charge cut-off voltage. Ex1008, 10-12; Ex2006, ¶76.

Guyomard explains that “when cells comprising these previously-available electrolytes are cycled to a voltage even slightly greater than 4.3V, electrolyte oxidation occurs.” *Id.* at 3:9-11. In contrast, batteries using its purported new electrolyte did not lose a significant amount of capacity due to electrolyte decomposition, one cause of which was known to be the charge voltage. Guyomard also reports testing in which “the cell capacities after 500 cycles were only about 10% less than 5 cycles” when  $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$  was used as the cathode, carbon (graphite or petroleum coke) as the anode, and the cell was charged at temperatures of 25°C and 55°C and at voltages of 4.9V and 4.5V, respectively. *Id.* at 9:5-8.

Consistent with its focus on electrolyte behavior, Guyomard does not disclose information required to assess the total capacity loss in the tests performed (e.g., the capacity at the start of the testing or the capacity loss between the first cycle and the 5th cycle) or any details about the performance of the cathode and anode (as would be needed to determine whether Guyomard's battery remains functional at the voltage levels disclosed). In short, Guyomard only discloses electrolyte-focused experiments at voltage conditions that were known to be extreme, without reporting whether a secondary lithium-ion battery could operate safely or effectively at those conditions. Ex2006, ¶78.

#### **4. Iwaizono (Ex1007)**

Iwaizono describes a “protective circuit for protecting a rechargeable battery from battery breakdown caused by prolonged overcharging.” Ex1007, Abstract. Iwaizono notes that “[l]ithium-based rechargeable batteries are particularly susceptible to deterioration or damage when operated at a voltage exceeding a predetermined range[; and it] is therefore the normal practice to provide a battery protection device for protecting the battery from improper use.” *Id.*, 1:13-19. Just like Abe, because Iwaizono focuses on safety, its examples were charged up to the traditional limit of 4.2V. *Id.*, 15:34-40.

#### **D. Level of Ordinary Skill**

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

### **III. CLAIM CONSTRUCTION**

Petitioner purports to base its challenges on the constructions that PO proposed (and the district court adopted) in the Apple litigation. Pet., 8; Ex2010. However, Petitioner has failed to apply or misapplied these constructions. As explained below, Petitioner has (i) failed to provide—and its expert has not applied—the construction of “charge cut-off voltage” (*see* Ex1002, ¶¶76-83, 113, 126 (failing to construe “charge cut-off voltage” in analyzing elements [1A], [5A], [2], [3], [6], [7] reciting this term); misapplied the construction of the claimed capacity ratios, including improperly ignoring claim language that must be considered alongside the construed term (e.g., the requirement “as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2V” in claim 5).

Accordingly, PO proposes the constructions set forth below, consistent with the intrinsic record (including the claims where those terms appear), a POSITA's understanding, and the testimony of the experts (including that of Samsung's expert), and needed to elucidate the terms, particularly in light of Petitioner's misapplication of PO's constructions from the Apple litigation.

**A. “charge cut-off voltage”**

In the Apple litigation, PO proposed, and the district court agreed, to construe “charge cut-off voltage” as “the maximum voltage to which the battery is configured to be charged.” Ex1016, 1; Ex2010, 11. Petitioner likewise agreed with this construction in the Samsung litigation (*see* Ex2011, 6), as did Petitioner’s expert in his deposition in this IPR.<sup>3</sup>

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

As Dr. Yao (and Mr. Juzkow) explain, a POSITA would know that the battery voltage (including “the maximum voltage to which a battery is configured to be charged”) is different than the voltage applied to the battery during charging

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<sup>3</sup> *See* Ex2008, 217:6-11 (“Q. It also says that if this term needs construction, it should be afforded its plain and ordinary meaning, which is the maximum voltage to which the battery is configured to be charged, right? A. Right. That’s the plain and ordinary meaning that I agree with”). Notwithstanding his deposition testimony, Petitioner’s expert did not apply this construction in his declaration. Ex1002, ¶¶76-83, 113, 126. As discussed below in Sections IV & VI, his failure to do so has created dispositive errors in his analysis of the “charge cut-off voltage” ranges.

(including the maximum externally applied voltage). Ex2006, ¶84; Ex2008, 57:1-5 (“So in order to move ions from the cathode to anode, one would have to apply a voltage external to the battery that is greater than the open circuit voltage. Correct? A. Yes.”).

In particular, a POSITA would know that the battery voltage to which a battery is charged is equal to the voltage between the cathode and the anode (or the difference between the voltage of the cathode versus lithium metal and the voltage of the anode versus lithium metal). When no current is flowing between the electrodes, and the battery is in equilibrium, the battery voltage is known as the “equilibrium potential.” When the battery is disconnected from a power source, e.g., at the end of charging, the measured voltage between the electrodes is known as the “open circuit voltage.” Ex2006, ¶¶86-91; Ex2008, 56:3-9.

In contrast, a POSITA would know that the battery is charged at an externally applied voltage (applied, e.g., with a charger) that causes electrons and lithium ions to flow from the cathode to the anode. Ex2006, ¶¶88-89. A POSITA would also know that the applied voltage at which the battery is charged is always higher than the battery voltage because an external voltage greater than the battery voltage (i.e., the voltage difference between the cathode and anode) is needed to drive lithium ions from the cathode to the anode. *Id.*; Ex2008, 56:14-57:5.

The difference between the battery voltage and the applied voltage (also referred to in the art as the “overpotential”) depends on various factors, including the charging current and the duration of the charging, which are principal drivers of measured differences between applied voltage and battery voltage. Ex2006, ¶¶89-90.

For example, when the current increases and the charging time decreases, *i.e.*, in fast charging conditions, the overpotential increases. *Id.*; Ex2008, 58:18-20. In contrast, lower charging current (and slower charging) decreases the overpotential. Ex2006, ¶90.

Likewise, the use of a constant current for charging (*i.e.*, a method whereby the current is kept constant until reaching a certain applied voltage) will lead to a greater overpotential than the more commonly applied constant current/constant voltage charging method (*i.e.*, a method in which a constant current is followed by a constant voltage at varying current, such that the battery charge is topped off). *Id.*, Ex2008, 58:18-20.

A POSITA would also know that the applied voltage depends upon factors external to the battery, such as the charger’s settings. In contrast, “the maximum voltage *to* which the battery is ***configured to be charged***” (*i.e.*, the charge cut-off voltage) is dictated by the battery’s structure (*i.e.*, the chemistry and design), and

exceeding it can cause battery degradation or hazardous operating conditions. Ex2006, ¶92.

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

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

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

In addition, consistent with the claim language and PO's proposed construction, a POSITA would understand that "charge cut-off voltage" in the claims of the '641 Patent refers to the voltage of the battery as a whole, i.e., the full-cell voltage. The full-cell voltage of a battery is the voltage difference between the cathode and the anode. Ex2006, ¶94; Ex2008, 110:20-24. It is distinct from a half-cell voltage, which is the voltage difference between a working electrode (i.e., cathode or anode) and a reference electrode, such as lithium metal. The half-cell voltage is typically used as a research tool to understand and design batteries but does not reflect the battery voltage when the cathode and anode are assembled to form a complete battery. Ex2006, ¶¶94-96.

The '641 Patent contrasts the claimed charge cut-off voltage range above 4.2V from higher voltages used in half-cell setups, explaining that "as to lithium cobalt oxide[] that is used as positive electrode material in [] most commercial lithium ion batteries, the charge cut-off voltage is limited to below 4.2V ... *although many documents indicate that the charge cut-off voltage can be over 4.2V for a test cell using metallic lithium as counter electrode.*" Ex1001, 1:64–2:3. The '641 Patent thus clarifies that the claims are specifically directed to full cells (and full-cell voltages) rather than experimental half-cell set-ups. Ex2006, ¶97. Indeed, in the Apple litigation, PO and Apple agreed that "charge cut-off voltage" refers to the full-cell voltage, which the Apple district court also adopted. See Ex2010, 16 ("The

Court additionally clarifies that the [term] ‘charge cut-off voltage’ refers to the full-cell voltage, rather than the half-cell voltage”); *see also* Ex2012, 12. For the additional reason that Petitioner adopted PO’s constructions in the Apple litigation, the Board should construe “charge cut-off voltage” to include only full-cell voltages for purposes of this IPR.

Accordingly, the Board should construe “charge cut-off voltage” as “the maximum voltage *to* which the battery is *configured to be charged*,” distinguished from (i) the externally applied voltage with which a battery may be charged and (ii) voltages pertaining to half-cell configurations.

**B. “capacity ratio range”**

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.

As an initial matter, the active material included in PO’s construction is the material “that is involved in the intercalation and deintercalation of lithium ions.”

Ex2008, 85:9-11; Ex2006, ¶¶101-103. For carbon-based anodes, “active material” includes only carbon-based materials in the anode and excludes non-carbon material. *Id.*; Ex2008, 20:20-23.

Further, Petitioner agrees that the claimed capacity ratio should be calculated “by applying ‘a theoretic capacity with a charge cut-off voltage set at 4.2V.’” Pet. at 10; Ex2010, 14 (the ratio should be calculated “by applying ‘a theoretic capacity with a charge cut-off voltage set at 4.2V’”). Such a construction reflects the plain and ordinary meaning of the term and is supported by intrinsic evidence.

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.*

Claim 5 expressly recites the claimed ratio is “calculated by a *theoretic capacity with a charge cut-off voltage set at 4.2V*,” as opposed to the theoretical

maximum capacity or some other definition of capacity. Ex1001, 17:10-11 (emphasis added). As the Apple district court explained, “when modified with a particular charge cut-off voltage, thereby limiting the amount of lithium that is extracted, the term refers to the amount that the theoretic capacity has been limited by setting a particular charge cut-off voltage.” Ex2010, 15.<sup>4</sup>

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.

In the co-pending IPR initiated by Apple, Apple’s expert, Louis Hruska, opined that “it was conventional for capacity values to be determined and/or provided with respect to a 4.2 V charge cut-off voltage,” because “many batteries as

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<sup>4</sup> Mr. Juzkow asserted that there is no theoretical capacity (only an experimentally determined practical capacity) at a particular voltage. Ex2008, 71:11-16. The academic literature shows otherwise. *See* Ex2006, ¶112 (collecting references). The evidence overwhelmingly shows the Apple Court to be correct and Petitioner has presented no evidence to demonstrate otherwise. *Id.*; Ex2010, 15.

of the Critical Date were operated with a 4.2 V charge cut-off voltage.” Ex2030, ¶81. Mr. Hruska further explained the advantages of using the theoretical capacity at 4.2V, as opposed to the practical specific capacity:

a POSITA would have recognized advantages in using a theoretic capacity for the calculation (e.g., *as opposed to an empirical value determined via experimental testing*). For instance, use of a theoretical value rather than an actual value brings *efficiencies* and *predictability* to the design process, e.g., in that less experimental characterization need be carried out.

*Id.*, ¶81 (emphases added). Accordingly, when calculating the claimed ratio, the theoretical capacity at 4.2V should be used.

As discussed *infra*, though Petitioner has adopted PO’s construction, its expert has misapplied that construction, using a purportedly experimentally determined specific capacity instead of the theoretical specific capacity at 4.2V required by the claims. The Board should reject Petitioner’s misapplication of PO’s construction, which is not what PO proposed in the Apple litigation and is in any event not supported by the record. Indeed, Mr. Juzkow has not offered any opinions as to the appropriate construction of this term and has instead opted to misapply PO’s construction from the Apple litigation. Ex1002, ¶82.

#### **IV. UEMURA DOES NOT TEACH OR SUGGEST EVERY LIMITATION OF CLAIMS 1-8 OF THE '641 PATENT (GROUNDS 1-2)**

Grounds 1 and 2 of the Petition assert that Uemura alone anticipates or renders obvious claims 1-8 of the '641 Patent. Pet., 7. As explained in detail below, Grounds 1 and 2 fail because Uemura: (i) does not disclose the charge cut-off voltage disclosing instead an applied voltage; (ii) does not disclose the claimed capacity ratio, disclosing instead “capacity balances” outside the claimed ranges when converted to the claimed capacity ratios; (iii) is not an enabling reference, as a POSITA following Uemura cannot practice the claimed inventions without undue experimentation. Further, Uemura contains major and readily apparent errors that plague its portions upon which Petitioner relies for its challenge, which a POSITA would thus disregard, and the effect of which is that Uemura cannot be relied upon to teach claimed elements of the '641 Patent.

##### **A. Uemura discloses an applied voltage rather than a charge cutoff voltage**

Independent claims 1 and 5 recite a secondary lithium-ion battery with a charge cut-off voltage “greater than 4.2V but less than 5.8V.” Ex1001, 16:56-58, 17:6-7. Petitioner asserts that this limitation is met by Uemura’s disclosure of examples in which batteries were purportedly charged and discharged with “a constant current of 0.5 mA/cm<sup>2</sup> and a voltage ranging from 4.3V to 2.0V at an atmospheric temperature of 60 °C.” Pet., 17. Petitioner is wrong.

The claimed charge cut-off voltage is the “the maximum voltage to which the battery is configured to be charged,” *i.e.*, a battery voltage. *Supra*, III.A. In contrast, Uemura discloses an ***applied voltage*** ranging from 2-4.3V, which is ***not a battery voltage***, let alone a charge cut-off voltage above 4.2V. *Id.* As conceded even by Samsung’s own expert, an applied voltage is not a battery voltage. *Id.*

Further, Uemura’s disclosure of an applied voltage equal to 4.3V does not translate to a disclosure of a battery voltage above 4.2V. First, as Petitioner’s expert testified, the applied voltage is always higher than the battery voltage:

Q. And the charge voltage is higher than the open circuit voltage. Correct?

A. Yes.

Ex2008, 58:2-4; 57:1-5. Mr. Juzkow also testified that it is not possible to determine the battery voltage (*i.e.*, open circuit voltage) in Uemura from Uemura’s disclosure. *See* Ex2008, 59:13-18.

Moreover, consistent with Mr. Juzkow, Dr. Yao opines that a POSITA would understand from Uemura’s disclosures in question that: (i) Uemura does not disclose a battery voltage, (ii) it is not possible to determine the battery voltage that might correspond to Uemura’s applied voltage with reasonable certainty; and (iii) Uemura’s applied voltage is likely lower than 4.2V. Ex2006, ¶118.

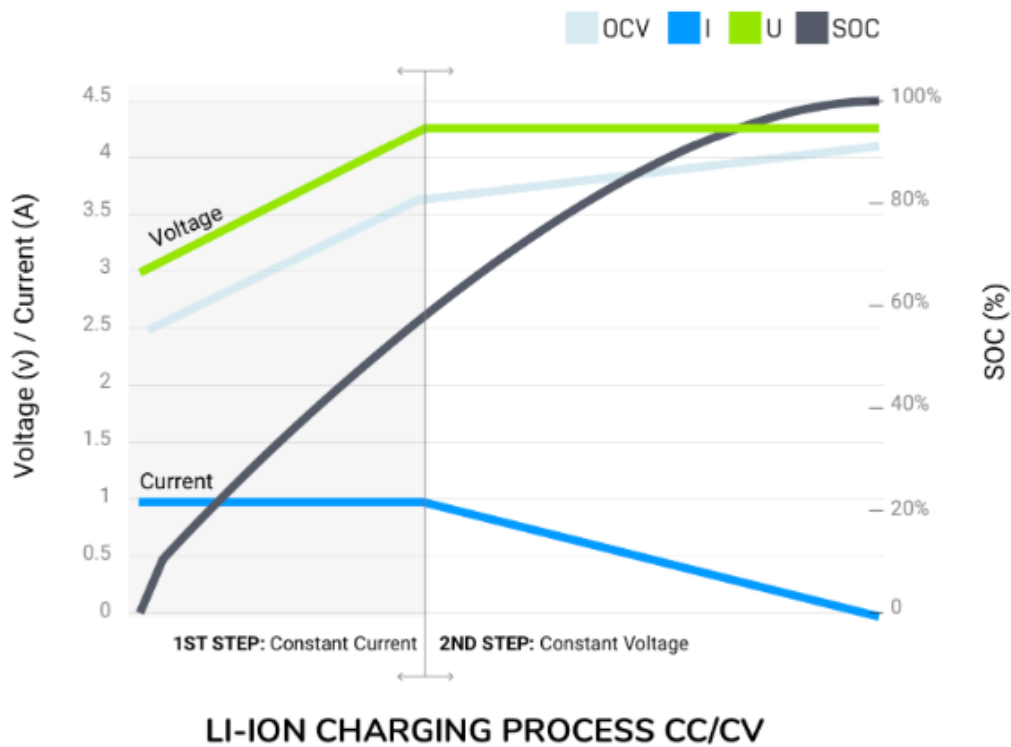
In particular, Uemura discloses charging batteries with a constant current at 0.5 mA/cm<sup>2</sup> at a maximum applied voltage equal to 4.3V. Ex1009, ¶81. A POSITA would understand that in Uemura's constant current charging the battery charging stops once the applied voltage reaches 4.3V. Ex2006, ¶119. A POSITA would also understand that charging a battery *to* the maximum voltage for which it was configured (i.e., the charge cut-off voltage) typically required applying an external voltage (equal to or slightly higher than the charge cut-off voltage) in a constant voltage charging phase that follows the constant current phase described in Uemura.<sup>5</sup>

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<sup>5</sup> Though it is possible to fully charge a battery using only a constant current, the current must be lower and the charging slower than what is disclosed in Uemura. Ex2008, 113:13-16. Uemura does not clarify whether the current used, i.e., 0.5 mA/cm<sup>2</sup>, constitutes slow or fast charging. Ex2008, 118:8-11 (“it’s difficult for the amount of information [Uemura] give[s] you whether or not that’s a low or a high rate”). Mr. Juzkow, in his deposition, describes the current rate used in Uemura as “in the middle” between slow and fast (Ex2008, 117:16-20), yet he also acknowledges the difficulty in categorizing the rate due to insufficient information. *Id.* at 118:8-11; 118:17-119:1. Accordingly, Petitioner cannot meet its burden to show that the batteries in Uemura would have been fully charged and had a charge cut-off voltage at 4.3V. Ex2006, n.64.

*Id.* Using a constant voltage after the constant current charging was known in the art to be a typical way to obtain a battery voltage that approximates the applied voltage (e.g., 4.2V), and as Mr. Juzkow testified was referred to as constant current/constant voltage (“CC/CV charging”). *Id.*, ¶91; Ex2008, 105:12-17.

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



Ex2013. As shown, in CC/CV charging (i) the battery is charged with a constant current until the applied voltage reaches a specified voltage (e.g., the maximum battery voltage), (ii) as the current gradually decreases, the applied voltage is kept constant for time enough to allow the battery voltage (light blue line) to increase and gradually approximate the applied voltage (green line), and (iii) when the current

approximates zero, and the battery voltage is practically equal to the applied voltage, the charging stops. At this point, the battery is considered fully charged. Ex2006, ¶91.

A POSITA would thus understand that obtaining with reasonable certainty a battery voltage above 4.2V would typically require applying a constant voltage above 4.2V for a sufficient amount of time as to allow the battery voltage to approximate the applied voltage. *Id.*, ¶¶91, 119.

Critically, a POSITA would reasonably expect that the difference between Uemura's applied voltage and the battery voltage in Uemura's examples is greater than 0.1V, such that the battery voltage in Uemura is less than 4.2V. Ex2006, ¶¶121-122. For example, the literature reports that for a battery with a LiCoO<sub>2</sub> cathode, when the applied voltage reached 4.2V for the first time under the constant current charging phase, its capacity was only 60%, when the current was 1A. Ex2014, 217; Ex2006, ¶¶121-122. Such a state of charge could correspond to an open circuit voltage of smaller than 4V. *Id.*; Ex2015, 326. Mr. Juzkow also agreed. Ex2008, 106:9-14 ("If you only did a constant current charge, you might only get, let's say, 80 percent charge if you don't do the full charge. If you charge at a very high rate, like a 2C rate, you might only get 60 percent capacity in the cell if you only do the constant current portion"). Even if the expected difference were less than 0.1V (it is not), Uemura's disclosures regarding charging voltage could not anticipate claim

7 because that claim requires a charge cut-off voltage “within a range from 4.3V to 4.8V.” Because it is undisputed that the applied voltage must be less than the battery voltage, then claim 7 at least is patentable over Uemura.

PO attempted to reproduce Uemura’s experiments to ascertain the corresponding battery voltage from the charging described in Uemura. PO’s expert charged a battery similar to Uemura’s Example 2 with a current density lower than  $0.5 \text{ mA/cm}^2$ ; but the battery cell began to degrade before the applied voltage reached 4V. Ex2031, ¶¶45-46; Ex2006, ¶123. A POSITA would understand from these results that “the maximum voltage to which the [Uemura] battery is configured to be charged” does not exceed 4.2V, as required by the claims. *Id.*

In any event, Uemura does not disclose information sufficient to determine the difference between the applied voltage and the corresponding battery voltage for its examples. This difference depends on several factors, including the charging current and the battery’s DC resistance, as Mr. Juzkow explained:

Q. The DC resistance of the cell is one principal parameter that a person of ordinary skill in the art would need to know to determine the difference between an applied voltage and the open circuit voltage at the end of charging. Correct?

A. Yes.

Ex2008, 59:13-18; *see also* Ex2006, ¶120. As Mr. Juzkow also testified, the DC resistance required to determine the difference between the applied voltage and the battery voltage (*see supra* at section III.A. explaining that the open circuit voltage is the battery voltage at the end of charging) also depends on multiple factors, which are not given in Uemura (in fact, Mr. Juzkow could not identify them at his deposition). Ex2008, 58:24-59:10. Thus, a POSITA would not be able to determine the battery voltage in Uemura's examples because Uemura does not provide the information needed to do so. *See, e.g., Wasica Fin. GmbH v. Continental Auto. Sys., Inc.*, 853 F.3d 1272, 1284 ("it has long been understood that ambiguous references do not, as a matter of law, anticipate a claim").

In summary, Uemura discloses constant current charging (Ex2006, ¶119; Ex2008, 119:15-18) with an applied voltage (Ex1009, ¶81) rather than a battery voltage; and a POSITA would understand that the corresponding battery voltage for Uemura's batteries could not exceed 4.2V, because (i) the applied voltage always exceeds the battery voltage at equilibrium, (ii) the applied constant current was not followed by a constant voltage that would charge the battery to such a voltage level, and (iii) replicating Uemura's charging conditions demonstrates that Uemura's battery is not configured to a maximum battery voltage above 4.2V, notwithstanding that Uemura reports an *applied voltage* that exceeds 4.2V. Ex2006, ¶¶116-123.

Accordingly, Uemura does not teach a charge cut-off voltage higher than 4.2V and for this reason does not anticipate or render obvious the challenged claims.

**B. Uemura does not disclose the claimed ratio limitation**

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.<sup>6</sup> Petitioner asserts that Uemura discloses this limitation in a description of tests purportedly conducted on 17 exemplary batteries with “capacity balance Pc:Nc” ranging from 1:1 to 1:1.5 (cathode to anode). Ex1009, Fig. 3; *id.*, ¶33.

Uemura purports to calculate the reported “capacity balance” ratios based on the “total capacity” of the electrodes without defining “total capacity” (*Id.*) but purporting that the “total capacity” data reported (in Fig. 3) were experimentally determined by charging each battery using a constant current of 0.5 mA/cm<sup>2</sup> and a voltage between 4.3V and 2V at a temperature of 60 °C. *Id.*, ¶81; Ex2006, ¶132. Uemura’s “capacity balance” determination does not purport to use the theoretical capacities or to account for the active material of the anode.

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<sup>6</sup> Claim 1 contains a similar limitation with the same construction.

In contrast to Uemura, the claimed capacity ratios in the '641 Patent are calculated with the *theoretical* capacities of the cathode and anode *active* material at 4.2V. Ex1001, 17:7-11; Ex2006, ¶¶130-131.

As explained below, Uemura's "capacity balance" is different from the claimed ratios in at least two ways:

- The total capacity of the cathode in Uemura is purportedly the practical specific capacity of the cathode when it was charged at 4.3V. It is not the theoretical capacity of the cathode at 4.2V, i.e., the maximum capacity that could be obtained at 4.2V.
- The total capacity of the anode in Uemura is not the theoretical capacity of the anode *active* material, i.e., carbon, but includes capacity attributable to non-carbon content, which is *inactive* material. *Id.*

As shown below, calculating the claimed capacity ratios for Uemura's 17 examples (by converting the total capacity balances in Uemura to the claimed ratios of the '641 Patent) yields capacity ratios that fall outside the claimed range in the '641 Patent.

**1. The total cathode capacity used to calculate Uemura's capacity balance ratio is lower than the theoretical capacity at 4.2V required for the claimed capacity ratio.**

As discussed *supra* (IIIB), the claimed ratio of the '641 Patent is calculated using the *theoretical* capacity of the cathode active material when the charge cut-off

voltage is 4.2V. Ex2010, 14; Ex2006, ¶99. This theoretical value is the maximum capacity of the cathode material at 4.2V. *Supra*, III.B.; Ex2006, ¶104.

Uemura's examples purport to use layered LiMnO<sub>2</sub> 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). However, in contrast to the theoretical value known in the art—and that should be used to calculate the claimed ratio according to the construction of this term—Uemura reports that the layered LiMnO<sub>2</sub> in its comparative example has a specific capacity of 180 mAh/g and uses this different value to calculate its “capacity balance.” Ex2006, ¶134; Ex1009, Fig. 3. The cathode material (layered LiMnO<sub>2</sub>) in each of the seventeen examples was purportedly prepared based on the same comparative example. Ex1009, ¶35; Ex2006, ¶135.

Using the theoretical capacity at 4.2V for the cathode materials in each of Uemura's 17 examples (following Uemura's approach), Dr. Yao demonstrates that the cathode capacity values that should be used to calculate the claimed capacity ratio are much greater than the total cathode capacity values reported in Uemura and used to arrive at Uemura's capacity balance ratio, as shown in the table below: Ex2006, ¶138.

| Example             | Pc: total capacity of cathode (mAh) as reported in Uemura | Theoretical Capacity at 4.2V (mAh) |
|---------------------|-----------------------------------------------------------|------------------------------------|
| 1                   | 1.8                                                       | 2.71                               |
| 2                   | 2.24                                                      | 3.36                               |
| 3                   | 2.6                                                       | 3.92                               |
| 4                   | 2.6                                                       | 3.92                               |
| 5                   | 2                                                         | 3.04                               |
| 6                   | 2.24                                                      | 3.36                               |
| 7                   | 2.24                                                      | 3.36                               |
| 8                   | 2.24                                                      | 3.36                               |
| 9                   | 2.24                                                      | 3.36                               |
| 10                  | 2.24                                                      | 3.36                               |
| 11                  | 2.24                                                      | 3.36                               |
| 12                  | 2.24                                                      | 3.36                               |
| 13                  | 2.24                                                      | 3.36                               |
| 14                  | 2                                                         | 3.04                               |
| 15                  | 2.24                                                      | 3.36                               |
| 16                  | 2.24                                                      | 3.36                               |
| 17                  | 2.24                                                      | 3.36                               |
| Comparative Example | 2.7                                                       |                                    |

As demonstrated below, using the theoretical capacity calculation that is called for by the ‘641 Patent’s claims (i.e., the values shown in the rightmost column above), none of the examples of Uemura fall within the claimed ranges.

**2. Contrary to the ‘641 Patent, Uemura’s capacity balance ratio is calculated with an anode capacity that includes inactive material.**

The claimed ratio should be calculated using the theoretical capacity of the anode *active* material when the charge cut-off voltage is 4.2V, as required by PO’s proposed construction. Ex2010, 14; Ex2006, ¶100. In the Samsung litigation,

Petitioner also agreed that the claimed ratio should be calculated based upon the capacity of the active material. Ex2011, 7.

A POSITA would understand that the “active” material in a secondary lithium-ion battery is that which allows for the reversible storage and release of lithium ions and contributes positively to the battery’s capacity and cycling. Ex2006, ¶¶102-103; Ex2008, 85:9-11 (“active material is material that is involved in the intercalation and deintercalation of lithium-ions”). A POSITA would understand further that the active material for the anode is the carbon content of the battery and does not include non-carbon content. Ex2006, ¶¶102-103, 141. Consistent with this understanding, Uemura discloses that the irreversible capacity of the anode is proportional to the amount of non-carbon content such that the irreversible capacity is greater as the level of non-carbon material increases. Because the non-carbon content does not contribute to the battery’s cyclable capacity, a POSITA would not consider it as active material. *Id.*

Mr. Juzkow readily agrees:

Q. The active material of the anode of a lithium-ion battery would be carbon within the anode. Correct?

A. Yes.

Ex2008, 20:20-23; *see also id.* at 14-19 (“Q. What is the active material? A. The active material would be carbon”).

Uemura discloses that the battery anodes in Examples 3-5 have substantial non-carbon content. Ex1009, ¶¶84-86. The total capacity of the anode as reported 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:

| Examples | Total Anode Capacity (mAh) as reported in Uemura | Total irreversible capacity of anode (mAh) as reported in Uemura | Total reversible capacity of anode (mAh) based on data reported in Uemura |
|----------|--------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------------------|
| 2        | 3.41                                             | 0.44 (carbon content 95.5%)                                      | 2.97                                                                      |
| 3        | 3.27                                             | 1.18 (carbon content 83.5%)                                      | 2.09                                                                      |
| 4        | 2.6                                              | 0.94 (carbon content 83.5%)                                      | 1.66                                                                      |

See Ex1002, ¶141. Using the active material capacities—as required by the claims—to calculate the claimed ratios with respect to Uemura’s examples, all of Uemura’s examples have capacity ratios that fall outside the claimed range (which is greater than 1 for all claims) (*Id.*, ¶142):

| Uemura Example | Theoretical capacity of cathode at 4.2V (mAh) | Total capacity of the anode <i>active</i> material (mAh) based on data reported in Uemura | Capacity Balance Nc/Pc reported in Uemura | Claimed ratio of the '641 Patent |
|----------------|-----------------------------------------------|-------------------------------------------------------------------------------------------|-------------------------------------------|----------------------------------|
| 1              | 2.71                                          | 2.358                                                                                     | 1.3                                       | 0.87                             |
| 2              | 3.36                                          | 2.97                                                                                      | 1.5                                       | 0.88                             |
| 3              | 3.92                                          | 2.09                                                                                      | 1.3                                       | 0.53                             |

| Uemura Example | Theoretical capacity of cathode at 4.2V (mAh) | Total capacity of the anode <i>active</i> material (mAh) based on data reported in Uemura | Capacity Balance Nc/Pc reported in Uemura | Claimed ratio of the '641 Patent |
|----------------|-----------------------------------------------|-------------------------------------------------------------------------------------------|-------------------------------------------|----------------------------------|
| 4              | 3.92                                          | 1.66                                                                                      | 1.0                                       | 0.42                             |
| 5              | 3.04                                          | 2.358                                                                                     | 1.2                                       | 0.78                             |
| 6              | 3.36                                          | 2.358                                                                                     | 1.1                                       | 0.70                             |
| 7              | 3.36                                          | 2.358                                                                                     | 1.1                                       | 0.70                             |
| 8              | 3.36                                          | 2.358                                                                                     | 1.1                                       | 0.70                             |
| 9              | 3.36                                          | 2.358                                                                                     | 1.1                                       | 0.70                             |
| 10             | 3.36                                          | 2.358                                                                                     | 1.1                                       | 0.70                             |
| 11             | 3.36                                          | 2.358                                                                                     | 1.1                                       | 0.70                             |
| 12             | 3.36                                          | 2.358                                                                                     | 1.1                                       | 0.70                             |
| 13             | 3.36                                          | 2.358                                                                                     | 1.1                                       | 0.70                             |
| 14             | 3.04                                          | 2.358                                                                                     | 1.2                                       | 0.78                             |
| 15             | 3.36                                          | 2.358                                                                                     | 1.1                                       | 0.70                             |
| 16             | 3.36                                          | 2.358                                                                                     | 1.1                                       | 0.70                             |
| 17             | 3.36                                          | 2.358                                                                                     | 1.1                                       | 0.70                             |

Accordingly, when the “capacity balance” ratio reported in Uemura is converted to the claimed capacity ratio, Uemura does not disclose the claimed ratio limitation of any claim of the '641 Patent.

**C. Uemura is not enabling and therefore cannot anticipate the claims or render them obvious as a matter of law.**

**1. Prior art must enable a claimed invention to anticipate it or render it obvious.**

For prior art to anticipate or render obvious a claimed invention, its disclosure must enable possession of the invention. *E.g., Elan Pharms., Inc. v. Mayo Found. for Med. Educ. & Res.*, 346 F.3d 1051, 1054-55 (Fed. Cir. 2003) (“It is well settled

that prior art under 35 U.S.C. § 102(b) must sufficiently describe the claimed invention to have placed the public in possession of it.”); *Raytheon Techs. Corp. v. Gen. Elec. Co.*, 993 F.3d 1374, 1380 (Fed. Cir. 2021) (“To render a claim obvious, the prior art, taken as a whole, must enable a skilled artisan to make and use the claimed invention,” citing *In re Kumer*, 418 F.3d 1361, 1368 (Fed. Cir. 2005)). “It is insufficient to name or describe the desired subject matter, if it cannot be produced without undue experimentation.” *Elan*, 346 F.3d at 1055.

Moreover, “even though a non-enabling reference can play a role in an obviousness analysis, the evidence of record must still establish that a skilled artisan could have made the claimed invention.” *Raytheon*, 993 F.3d at 1381. “In the absence of such other supporting evidence to enable a skilled artisan to make the claimed invention, a standalone §103 reference must enable the portions of its disclosure being relied upon.” *Id.* The substantive test for enablement “requires that ‘the prior art reference must teach one of ordinary skill in the art to make or carry out the claimed invention without undue experimentation.’” *Id.* at 1054. The following factors enumerated in *In re Wands*, 858 F.2d 731 (Fed. Cir. 1998) guide the inquiry:

- (1) the quantity of experimentation necessary,
- (2) the amount of direction or guidance presented,
- (3) the presence or absence of working examples,

- (4) the nature of the invention,
- (5) the state of the prior art,
- (6) the relative skill of those in the art,
- (7) the predictability or unpredictability of the art, and
- (8) the breadth of the claims.

*Id.* at 737.<sup>7</sup> Also, “failure by others skill in the art (having possession of the information disclosed by the publication) [is] strong evidence that the disclosure of the publication is nonenabling.” *In re Donohue*, 766 F.2d 531, 533 (Fed. Cir. 1985); *Forest Lab’ys, Inc. v. Ivax Pharms., Inc.*, 501 F.3d 1263, 1268-69 (Fed. Cir. 2007) (affirming district court’s finding that prior art reference was not enabling where district court relied upon evidence that many scientists had tried and failed to recreate chemical compound disclosed in prior art). If a skilled artisan cannot make and use the subject matter disclosed in the reference (i.e., be “self-enabling”), whether based on the reference alone or in view of the supporting evidence in the record, that

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<sup>7</sup> A *Wands* analysis need not discuss every factor. *See Amgen, Inc. v. Chugai Pharm. Co.*, 927 F.2d 1200, 1213 (Fed. Cir. 1991). For example, the “breadth of the claims” factor does not apply to whether the prior art is enabling. *See Schering Corp. v. Geneva Pharms.*, 339 F.3d 1373, 1381 (Fed. Cir. 2003). Accordingly, the final *Wands* factor not pertinent here is not discussed below.

reference cannot anticipate a claim or render it obvious. *See Raytheon*, 993 F.3d at 1381.

**2. Uemura does not enable the claimed secondary lithium-ion battery with the claimed charge cut-off voltage and capacity ratio ranges.**

As discussed below, a POSITA cannot practice the claimed secondary lithium-ion battery by using (i) the cathode preparation method disclosed in Uemura because it results in an inoperable cathode, (ii) evidence outside of Uemura's disclosure (e.g., methods known in the art to be more effective than Uemura's) because the resulting secondary lithium-ion battery has a charge cut-off voltage that is lower than the claimed range (i.e., is not above 4.2V). Accordingly, a POSITA could not use Uemura's teachings to practice the claimed secondary lithium-ion battery without undue experimentation or with a reasonable expectation of success.

PO's expert, Dr. Liang, tried to replicate Uemura's batteries<sup>8</sup> using the cathode preparation method disclosed in Uemura. However, Dr. Liang was

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<sup>8</sup> Dr. Liang tried to prepare the cathode active materials in Examples 1-4, and assemble the battery described in Example 2. Ex2031, ¶14. The cathode active materials in Examples 1-4 are representative of the remaining examples in Uemura and the literature also has data to confirm whether the synthesis was successful. The (continued...)

unsuccessful in synthesizing the Co-doped layered  $\text{LiMnO}_2$  cathode material described by Uemura. In particular, the synthesized materials had minimal capacity and could not thus be used for a secondary lithium-ion battery cathode. Dr. Liang also tried to improve Uemura's experimental procedures. However, even with his modifications, the resulting cathode materials still did not possess the required layered structure and had very low capacity when tested. Ex2031, ¶¶16-35; Ex2006, ¶¶148-152.

Dr. Liang's failure to replicate Uemura's cathode preparation is consistent with the work of scientists and researchers in the field of lithium-ion batteries in the approximately 20 years since Uemura's publication. Researchers that tried to synthesize cathode materials similar to those described in Uemura's Examples 1-4 (Ex2016, 6684) found that the preparation method described in Uemura (coprecipitation method, Ex1009, ¶71) has consistently failed to produce layered  $\text{LiMnO}_2$  (the cathode material described in Uemura) with properties that would make it a suitable cathode material (e.g., adequate crystallinity). Ex2016, 6684; Ex2006,

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battery in Example 2 purportedly has one of the best cycle lives among the seventeen examples and embodies all alleged features of Uemura, i.e., a lithium deficient Co-doped  $\text{LiMnO}_2$  and an anode material with more than 10% irreversible capacity. Ex1009, Fig. 3; Ex2006, ¶147.

¶151. Accordingly, Uemura fails to disclose a cathode preparation method that would enable a POSITA to practice a “secondary lithium-ion battery.”

Based upon an article (“Kajiyama”) published in 2002, after the ’641 Patent’s priority date, Dr. Liang used a different method (the “ion-exchange method”) to successfully synthesize  $\text{Li}_{0.8}\text{Mn}_{0.5}\text{Co}_{0.5}\text{O}_2$  with a well-defined layered structure, *i.e.*, a cathode material consistent with that described in Uemura’s Example 2 ( $\text{Li}_{0.83}\text{Mn}_{0.5}\text{Co}_{0.5}\text{O}_2$ ). Ex2017.<sup>9</sup> Following Uemura’s testing procedure, Dr. Liang tested this cathode material in a full battery, with a hard carbon anode. The resulting battery exhibited significant degradation and capacity loss at an applied voltage of 4V, well below the applied voltage described in Uemura (*i.e.*, 4.3V). A POSITA would recognize that continuing to charge the battery under the conditions described in Uemura would exacerbate battery damage and lead to severe safety risks. In short, a POSITA could not practice a secondary lithium-ion battery with a charge cut-off voltage higher than 4.2V following Uemura even if such a POSITA were to use a

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<sup>9</sup> It is worth noting that the cathode active material in Examples 3-4 is still not obtainable by following the guidance from Kajiyama. Kajiyama acknowledges that synthesizing  $\text{LiMn}_{0.5}\text{Co}_{0.5}\text{O}_2$ , similar to that used in Examples 3-4 ( $\text{Li}_{0.967}\text{Mn}_{0.5}\text{Co}_{0.5}\text{O}_2$ ), was not successful as of that time. Ex2017, 42. A 2019 paper further confirms this. Ex2016, 6684.

cathode preparation method known in the art to be superior than Uemura's method. Ex2031, ¶¶36-46; Ex2006, ¶¶153-154. Further, a POSITA would recognize that following Uemura would not lead to a secondary lithium-ion battery that could maintain the level of capacity after 400 cycles, as required by claims 11-18 of the '641 Patent. *Id.*

Accordingly, because a POSITA could not follow Uemura's disclosure to practice the claimed invention, Uemura is not enabling and cannot qualify as an anticipating reference. *See In re Donohue*, 766 F.2d 531, 533 (Fed. Cir. 1985).

Further, because there is no other evidence in the record that would enable a POSITA to practice the claimed invention by adapting Uemura's teachings, Uemura cannot render the challenged claims obvious as a standalone §103 reference. *See Raytheon*, 993 F.3d at 1381.

The *Wands* factors overwhelmingly support this conclusion:

***Nature of the invention, state of the art, unpredictability of the art (Wands factors 4, 5, and 7):*** Uemura's purported invention involves doping a highly unstable cathode material (layered LiMnO<sub>2</sub>). Around the priority date, research on doping cathode materials was in its nascency. The manner in which doping influences battery performance was not well-understood and required extensive empirical testing and refinement. Ex2006, ¶¶156-157.

***Absence of working examples and absence of direction or guidance (Wands factors 2, 3):*** Uemura provides insufficient guidance on preparing its battery, as the synthesis methods it purports to describe have been proven unworkable. Further, Uemura fails to disclose credible working examples, as all of its examples are plagued by capacity data obviously erroneous to a POSITA. *See infra* section IV.C.3. Dr. Liang's testing demonstrates that Uemura's examples are unworkable, as his significant efforts (i.e., of a person with skill beyond that of a POSITA) were insufficient to successfully replicate Uemura's reported results or to even create an operable secondary lithium-ion battery. Ex2006, ¶¶158-159.

***Quantity of experimentation, relative skill in the art (Wands factors 1, 6):*** The lack of working examples or substantive guidance in Uemura, combined with the significant unpredictability inherent in modifying layered  $\text{LiMnO}_2$  with various doping elements, demonstrates that undue experimentation is needed to reproduce Uemura's purported invention, a point further underscored by Dr. Liang's testing experience. Indeed, Dr. Liang's extensive and unsuccessful attempts to replicate Uemura's purported invention, demonstrate that a POSITA would likely fail to practice Uemura and the challenged claims even with undue experimentation. Ex2006, ¶160.

In sum, the *Wands* factors demonstrate that Uemura does not enable the claimed invention of the '641 Patent for obviousness purposes.

**3. A POSITA would disregard Uemura's disclosures because they contain serious and obvious errors.**

Uemura is non-enabling for the additional reason that—even assuming that its “capacity balance” ratios fell within the claimed capacity ratio ranges (they do not)—Uemura’s data are marred by errors that “would be apparent to one of ordinary skill in the art who would mentally disregard the errant information as a misprint or mentally substitute it for the correct information.” *See LG Elecs. Inc. v. ImmerVision, Inc.*, 39 F.4th 1364, 1372 (Fed. Cir. 2022) (citation omitted). Further, because the errors are “obvious to one of ordinary skill in the art” and are not limited to typographical or immaterial mistakes but plague disclosures upon which Petitioner relies for the claimed capacity ranges—the errant information concerning Uemura’s capacity balance ratios “cannot be said to describe or suggest” the capacity ratio ranges in all of the challenged claims. *In re Yale*, 434 F.2d 666, 668-669 (C.C.P.A. 1970) (immervision).

Petitioner asserts that the capacity balance ratios disclosed in Examples 1-17 fall within the claimed capacity ratio ranges in the '641 Patent. Uemura’s 17 capacity balance ratios (Ex. 1009, Fig. 3) are calculated as the ratio of the total capacity of the cathode and that of the anode. *Id.* Uemura purports that the total capacity for each of the 17 cathodes in its examples was experimentally determined. *Id.*, ¶81. However, it would be obvious to a POSITA that the values reported as the cathode total capacities were neither experimentally determined nor accurate.

*First*, Uemura reports identical weights and total cathode capacities (equal to 2.24) for examples 2, 6-13, and 15-17. *Id.* It also reports that these examples were charged and discharged under the same conditions. *Id.*, ¶81. However, the cathode materials for several of these examples have different theoretical maximum capacities: for instance, the cathode in Example 16 has a theoretical maximum capacity equal to approximately 179 mAh/g, and the cathode in Example 8 has theoretical maximum capacity equal to approximately 260 mAh/g, *i.e.*, 45% higher than that of Example 8. A POSITA would understand that it is impossible for cathodes with different theoretical maximum capacities, charged under the same conditions and with identical weights to yield the same total capacities, as reported in Uemura. A POSITA would conclude that the total capacity figures in Uemura are erroneous on their face and therefore unreliable. Ex2006, ¶¶163-173.

*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 can never be perfectly controlled, and even nearly identical experiments will always yield results with some degree of variability. A POSITA would expect variability

due to inevitable experimental error, minor variance in experimental conditions (e.g., temperature, pressure, etc.), as well as differences between the cathode materials in these examples. Uemura's total cathode capacity data have *no* variability, which a POSITA would immediately recognize as a sign that the data are spurious (or simply wrong) and thus unreliable. Ex2006, ¶177.

*Third*, a POSITA would know that the doping materials used in the cathode significantly affect the cathode capacity, which is likewise inconsistent with Uemura's results. Uemura discloses use of a doping element in its cathode (Ex1009, Fig. 3; ¶35), which a POSITA would understand that could significantly affect the cathode's total capacity. Dr. Yao provides numerous studies which clearly demonstrate that doping materials affect the total capacity of cathodes derived from layered LiMnO<sub>2</sub>, such as those used in Uemura. Ex2006, ¶¶175-76. Petitioner's expert in the district court litigation, Dr. Fuller, confirms that "the inclusion of a doping element to LiCoO<sub>2</sub> – *or any other electrode material* – can *significantly* alter the relationship between capacity and potential." Ex2019, ¶ 115 (emphases added); *see also id.* ("it was known to a POSITA that a small amount of doping could significantly change the measured capacity by about 20 percent"). Contrary to that understanding—evidenced in the academic literature, and the opinions of Dr. Yao as well as Dr. Fuller—Uemura reports that different doping elements do not change the cathode's capacity. Ex2006, ¶¶174-176.

Accordingly, a POSITA would readily recognize that Uemura's total cathode capacity data used to calculate Uemura's "capacity balance" ratios are erroneous and mentally disregard those "capacity balance" ratios, which cannot thus disclose claimed capacity ratio ranges.

Moreover, these errors are readily "obvious to one of ordinary skill." *In re Yale*, 434 F.2d at 668-669; *ImmerVision*, 39 F.4th at 1372. Even Petitioner's expert, Mr. Juzkow, testified that he decided to double check some of Uemura's examples after noticing the similarities in Uemura's data discussed above. Ex2008, 169:16-19, 177:10-22, 169:23-170:6 ("Q. So why did you decide to perform that calculation? A. You know, when I was drilling down into the numbers, you see all the total capacities, and there's many of them that are similar. And there's a few that are higher and lower. And I was wondering, how did they come up with those values? ... Was it experimental? Theoretical calculations?").

In particular, Mr. Juzkow (i) calculated the theoretical maximum capacities for some of Uemura's examples, (ii) divided the total capacities of those examples as reported in Uemura by the theoretical maximum capacities, (iii) used the resulting ratio as a measure for how much lithium was extracted in each of the examples, (iv) observed that the ratios were "very, very similar," and (v) on this basis concluded that Uemura must have obtained the total capacity data it reports using a theoretical calculation and assuming that the amount of lithium-ion extracted in each example

would be the same under the same charging conditions. Ex2033; Ex2008, 170:17-180:6, 171:3-6; Ex2006, ¶¶162-173.

However, Mr. Juzkow's assumption is incorrect. Uemura in fact discloses cathodes made from different materials and with different doping elements; and, further, reports that its total cathode capacities were experimentally determined. Ex1009, ¶81. Thus, Mr. Juzkow's assumptions and conclusions are both contradicted by Uemura, which (i) raises serious concerns about the provenance, accuracy, and reliability of Uemura's data, and (ii) gravely undermines Mr. Juzkow's analysis, which depends upon this data for the opinion that Uemura's capacity balance ratios fall within the ranges of the theoretical capacity ratios measured at 4.2V, as required by the claims. Ex1002, ¶115.

In any event, because Uemura includes obvious errors, a POSITA would not consider the disclosures plagued by these errors, which do not thus here teach or suggest the claimed capacity ratio ranges. *In re Yale*, 434 F.2d at 668-669.

**V. CLAIMS 9-18 ARE NOT OBVIOUS OVER UEMURA ALONE OR IN VIEW OF GUYOMARD AND/OR IWAIZONO (GROUNDS 3-4, 8-9).**

Grounds 3-4 and 8-9 assert Uemura in combination with Guyomard and/or Iwaizono to challenge dependent claims 9-18, all of which depend from independent claims 1 and 5. Pet., 7. Because Uemura fails to teach key limitations in the independent claims, Petitioner's grounds with respect to the dependent claims likewise fail.

Further, neither Guyomard nor Iwaizono cures Uemura's erroneous disclosures that render Uemura unreliable and non-enabling. First, Guyomard is not directed to the cathode material in Uemura (layered  $\text{LiMnO}_2$ ) but to a cathode material that Uemura teaches away from (spinel  $\text{LiMn}_2\text{O}_4$ ). Ex1009, ¶9 (“ $\text{LiMn}_2\text{O}_4$  of spinel structure cannot be said to be sufficient in cyclic resistance and the capacity thereof is small though it is stabler than  $\text{LiCoO}_2$ ”). Second, Iwaizono contains no disclosures about layered  $\text{LiMnO}_2$ . Accordingly, combining Uemura with either of these references would not enable a skilled artisan to practice the inventions in the independent claims. *Raytheon*, 993 F.3d at 1381.

## **VI. ABE DOES NOT TEACH OR SUGGEST EVERY LIMITATION OF CLAIMS 1-8 OF THE '641 PATENT (GROUNDS 5-6)**

Grounds 5-6 assert that Abe alone anticipates or renders obvious challenged claims 1-8. Pet., 34. These grounds fail because Abe does not teach the claimed charge cut-off voltage, at least because the voltage on which Petitioner relies is not the voltage of a secondary “lithium-ion” cell or battery, as required by the claims of the '641 Patent. Abe also does not disclose the claimed ratio limitation expressly or inherently with sufficient precision and detail.

### **A. Abe does not disclose the claimed charge cut-off voltage for a secondary lithium-ion cell**

Petitioner contends that Abe discloses the claimed charge cut-off voltage based on a description of an experiment in which the “predetermined voltage” for a

test-battery cathode “is set to a range in which no electrolyte decomposition occurs, and no irreversible structural breakdown of the positive electrode active material occurs” and a statement that “[f]or example, [the voltage range for]  $\text{LiMn}_2\text{O}_4$  is 4.2-4.3 V[.]” Ex1005, ¶78. Petitioner’s contention fails, however, because Abe discloses a 4.2-4.3V voltage for a half-cell battery with a lithium anode, not the charge cut-off voltage for a secondary lithium-ion cell, as claimed.

First, the claims of the ’641 Patent are directed to a secondary lithium-ion battery or cell. Ex1001, 17:5-11. As Dr. Yao opines and Mr. Juzkow testified, a POSITA would understand that secondary lithium-ion batteries do not use lithium metal as the anode. Ex2006, ¶191; Ex2008, 28:1-7 (“‘Secondary’ is analogous to rechargeable. ‘Lithium’ is the material that’s used in the battery. When you say ‘lithium-ions,’ that will mean that you do not use lithium metal anodes”). Indeed, as Mr. Juzkow testified, secondary lithium-ion batteries replaced lithium metal batteries in the market, including for safety reasons. *See, e.g., id.* at 34:9-14; 77:2-5 (“We were very cautious about the technology, especially Moli Energy, where we had many fires and explosions in the field when we were selling lithium metal rechargeable batteries”). The claims indisputably recite a lithium-ion battery. Ex1001, 17:5-11. A POSITA would understand, and Mr. Juzkow confirmed, that a battery with a lithium anode is not a lithium-ion battery. The battery disclosed in paragraph 78 of Abe, which is the *only* disclosure on which Petitioner relies for the

charge cutoff voltage limitation, uses a lithium metal battery, therefore it is not a lithium-ion battery as claimed.

Second, as discussed *supra* in III.A., a POSITA would understand that the claimed charge cut-off voltage pertains to a battery's full-cell voltage, not to a half-cell voltage, *i.e.*, the voltage difference between a working electrode (*i.e.*, cathode or anode) and a reference electrode, *e.g.*, lithium metal. Ex2006, ¶¶93-97. Unlike the claims—which are directed to a full-cell voltage—Abe's disclosure on which Petitioner relies describes an experiment in which a half-cell (not a complete cell) is used to ascertain the capacity of a cathode:

The charging capacity can be obtained, for example, by continuously recording a voltage that changes over time by applying a constant current using a *three-electrode cell in which both the counter and the reference pole are made of metal lithium*. ... *In the triode cell*, the starting voltage when using a vapor-phase-grown carbon fiber negative electrode as the working electrode is 3 V, and the charge (*applying current from the working electrode to the counter electrode*) proceeds and decreases toward 0V. 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*[.]...

Ex1005, ¶78 (emphases added). A POSITA would understand from Abe's disclosure of a "three-electrode cell" with a "reference pole made of metal lithium"

(i.e., a reference electrode made of lithium) that Abe is disclosing an experiment in which a half-cell voltage is determined with respect to the cathode. Ex2006, ¶192; Ex1005, ¶78; Ex2008, 109:13-15 (“Q. And are reference electrodes used to establish the capacities of the anode and cathode respectively? A. Yes.”).

Again, unlike secondary lithium-ion batteries, half-cells like the one disclosed in Abe are intended for experiments and are not final, complete batteries. *Id.* at 109:6-9 (“Q. And is the reference electrode used in lithium-ion batteries that are sold to consumers as a final product? A. No.”). Given that Abe’s disclosure on which Petitioner relies describes a half-cell with a lithium metal reference electrode, a POSITA would understand that 4.2-4.3V range in Abe is the half-cell voltage, not a full-cell battery voltage required by the claims. Ex2006, ¶192.

Third, a POSITA would know that Abe’s disclosure of a 4.2-4.3V half-cell cathode voltage corresponds to at most a 4.2V full-cell voltage, which falls outside the claimed range. In particular, Abe discloses a battery with  $\text{LiMn}_2\text{O}_4$  as the cathode and carbon material as the anode, for example, a “graphitized vapor-phase-grown carbon.” Ex1005, ¶¶99, 102. A POSITA would also know that the half-cell voltage of the cathode like the one in Abe is typically 0.1V higher than the full-cell voltage of a battery with the same cathode and a carbon-based anode:

$\text{LiNiO}_2$  shows a specific capacity up to 203 mAh/g (cf. 160 mAh/g for  $\text{LiCoO}_2$ ) when cycled between 2.75 and 4.3 V vs. Li metal. ***This potential (4.3V vs. Li metal)***

*corresponds approximately to a 4.2V charging voltage for a practical Li-ion cell*, because the potential of an incompletely charged carbon anode in the cell at the end of charge is approximately 0.1 V vs. Li.

Commercially available Li-ion cells containing LiCoO<sub>2</sub> as the cathode material are typically charged to *two different cut-off voltages, i.e., 4.1 and 4.2V, which corresponds to approximately 4.2 and 4.3 V vs. Li, respectively.*

Ex2018 (Cho 2000), 15 (emphasis added); Ex2006, ¶¶193-195.

Mr. Juzkow likewise testified that (i) “the full-cell potential between the anode and the cathode will be equal to the difference between the half-cell potentials of the anode and the cathode,” (Ex2008, 110:20-24) and (ii) the half-cell voltage of a graphite cathode is approximately 0.1-0.2V. *Id.* at 79:8-18 (“the average plateaus [of graphite] are probably in the 0.1 to 0.2-volt range over the bulk of the ... charge.”). Thus, the full cell voltage of a battery with Abe’s cathode (4.2-4.3V) and anode (graphite with a 0.1-0.2 half-cell voltage) would be in the range of 4.0-4.2V.

Petitioner’s expert in the Samsung litigation likewise confirms that the full-cell voltage of a battery with a graphite anode has a full-cell voltage approximately 0.1V below the half-cell voltage of the battery’s cathode.<sup>10</sup>

Fourth, a POSITA would not adjust Abe’s voltage range (or the 4.0-4.2V for a full-cell secondary battery to which Abe’s range would correspond) upward to practice the claimed range in light of Abe’s teaching *against* raising the charge cut-off voltage to above 4.1V. *Id.*, ¶80. In particular, Abe notes that “if the cut-off voltage at the time of charging is limited to 4.1V, a longer-lived non-aqueous electrolyte-based secondary battery can be obtained.” *Id.* Indeed, all examples in Abe were charged and discharged in the same manner as Embodiment 1, which was charged with a maximum applied voltage of 4.1V. Ex1005, ¶¶97, 104, 110, 119. All embodiments in Abe thus have a full cell voltage of 4.1V, including the *only*

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<sup>10</sup> See Ex2019, ¶179 (“When graphite is used, the potential of the positive electrode relative to lithium is  $\phi_p = 4.2 + \phi_{n, \text{graphite}} \approx 4.3 \text{ V}(\text{Li}/\text{Li}^+)$ .”).  $\phi_p$  is the half-cell voltage of the cathode and  $\phi_{n, \text{graphite}}$  is the half-cell voltage of the graphite anode. 4.2V is the charge cut-off voltage.

example  $\text{LiMn}_2\text{O}_4$  cell.<sup>11</sup> *Id.* Abe’s teaching is thus consistent with the body of literature which consistently demonstrates that a POSITA would not raise the charge cutoff voltage above 4.2V. *See supra* section B.2.; *see also* Paper 7, 40-41.

In sum, Abe does not teach a charge cut-off voltage of a secondary lithium-ion battery above 4.2V because it discloses a voltage range for a half-cell cathode (not a full battery) versus lithium metal (i.e., not a lithium-ion battery), the corresponding lithium-ion battery voltage would be substantially lower (4.0-4.2V) in any event, and it also teaches against voltages above 4.1V. Accordingly, Abe does not disclose the claimed charge cut-off voltage limitation or render that limitation obvious.

**B. Abe does not disclose the claimed ratio.**

Petitioner incorrectly contends that Abe discloses the claimed capacity ratio range.

In particular, Petitioner relies upon Abe’s Embodiment 2, which is a  $\text{LiMn}_2\text{O}_4$  cell with a “design capacity” ratio of 1:1.1 (cathode to anode). Pet., 37-38; Ex1005, ¶103. Petitioner incorrectly asserts that this “design capacity” ratio falls within the

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<sup>11</sup> Because the embodiments in Abe were charged and discharged with a constant current (*see supra* at section IV.A.) at a voltage equal to 4.1V (Ex1005, ¶97), the charge cut-off voltage for those batteries was lower than 4.1V. Ex2006, ¶197.

claimed ratio range on the basis that Abe’s ratio was determined at a charge cut-off voltage between 4.2V and 4.3V. Pet., 37. As discussed *supra* at section VI.A, Abe does not disclose a charge cut-off voltage between 4.2V and 4.3V. Further, Abe discloses that in Embodiment 2 a “charge-discharge test” was “performed in the same manner as in Embodiment 1” (Ex1005, ¶104) in which the battery was charged and discharged with a constant current between 2.5 and 4.1V. *Id.*, ¶97; Ex2008, 215:2-6 (“Q. Fair to say that the capacity ratios of embodiment 1 correspond to a charge voltage no greater than 4.1 volts based on what’s stated here in Abe? A. Yes.”). Abe further discloses that the voltage applied in Embodiment 1 was limited to 4.1V consistent with Abe’s focus on safety and protection of the secondary lithium-ion battery. *Id.*, ¶80 (“if the cut-off voltage at the time of charging is limited to 4.1V, a longer-lived no-aqueous electrolyte-based secondary battery can also be obtained.”). And, similar to Embodiment 1, the voltage applied in all of Abe’s embodiments (including Embodiment 2) is likewise limited to 4.1V. Abe, ¶¶110, 119. Accordingly, similar to Embodiment 1, a POSITA would understand that the capacity ratio in Embodiment 2 was likewise calculated at 4.1V, not 4.2-4.3V as Petitioner asserts. Ex2006, ¶¶201-202.

Petitioner also asserts that Abe discloses a ratio range for the design capacity of the anode to the cathode of “more than 1 and less than or equal to 1.6.” Ex1005, ¶18. Petitioner asserts that this “design capacity” ratio was calculated at a voltage

between 4.2-4.3V and thus also falls within the claimed ratio range. Pet., 39. Not so. As an initial matter, Paragraph 18 does not specify which charge cut-off voltage is used for calculating the “design capacity” ratio, nor does it specify what electrode material is used. Ex2006, ¶¶201-202.

A POSITA would understand from the context provided in Abe that—consistent with all the embodiments described in Abe—the “design capacity” ratios were determined at 4.1V as well. Critically, with respect to both of these disclosures (i.e., Embodiment 2, ¶18), Petitioner has not argued—and its expert has not opined—that the “design capacity” ratio would fall within the claimed range if it were determined at 4.1V. And, given that the claimed capacity ratio (anode to cathode) increases as the applied voltage decreases, nothing in the record suggests that Abe’s “design capacity” ratios would fall within the claimed ranges if calculated at 4.2V (which would result in a lower capacity ratio than that disclosed), as required by the claims. Ex2006, ¶¶199-202. Accordingly, for this reason alone, Petitioner fails to meet its burden of showing Abe discloses the ratio limitation.

In addition, unlike the ’641 Patent, which uses the theoretical capacity of the cathode active material at 4.2V for calculating the ratio, Abe does not disclose the capacity measure (i.e., theoretical, specific, or other) that it uses to determine the “design capacity” of the cathode. Abe discloses that the design capacity is obtained by “continuously recording a voltage that changes over time by applying a constant

current using a three-electrode cell in which both the counter and the reference pole are made of metal lithium. The charge capacity is the amount of charge until a 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.

Therefore, Petitioner has not explained how Abe’s very different “design capacity” ratio can be translated to a capacity ratio according to the claims of the ’641 Patent. Abe therefore lacks the necessary disclosure of the claimed capacity ratio to render it unpatentable. *See, e.g., Wasica Fin.*, 853 F.3d at 1284.

## **VII. CLAIMS 2-4, 6-8, and 11-18 ARE NOT OBVIOUS OVER ABE IN VIEW OF GUYOMARD (GROUND 7)**

Petitioner asserts that claims 2-4, 6-8, 11-18 are obvious over Abe in view of Guyomard.<sup>12</sup> Pet., 42. Acknowledging that Abe does not disclose a voltage above 4.3V (as discussed above, Abe does not disclose a charge cut-off voltage above

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<sup>12</sup> Petitioner’s Grounds 2 and 5 argue that claims 1-8 are obvious over Uemura or Abe, respectively. Petitioner does not rely on Guyomard for the alleged obviousness over either independent claim (claims 1 and 5). Accordingly, Guyomard’s teachings cannot serve as a basis of obviousness for any element of any independent claim.

4.1V), Petitioner claims that a POSITA would have found it obvious to modify Abe by increasing the charge cut-off voltage to 4.5V or even 4.8V and using Guyomard's electrolytes, with a reasonable expectation of success in obtaining a secondary lithium-ion battery with excellent cycle life. Pet., 48, 51. Not so. As discussed below, a POSITA would not have been motivated to increase Abe's voltage, as Abe teaches enhancing safety and teaches away from the voltages in Guyomard. Further, a POSITA would not have had a reasonable expectation of success as charging the battery with a spinel  $\text{LiMn}_2\text{O}_4$  cathode above 4.2V would lead to dissolution of the cathode (Ex2008, 100:14-20; 123:15-24; 124:21-25), and Guyomard does not teach such a dissolution could be avoided. Indeed, Guyomard does not address issues in the cathode at all.

Moreover, Abe is focused on improving the safety of lithium-ion battery, especially when the current is high. Ex1005, ¶¶13-17. Abe warns of a risk of explosion or ignition when a battery is charged above the voltage for which it is configured (*id.*, ¶9) and advises limiting charging voltage to 4.1V (Ex1005, ¶80) to avoid such issues, despite the commercial availability of batteries with a charge cut-off voltage equal to 4.2V. See Ex2024.

With respect to spinel  $\text{LiMn}_2\text{O}_4$ , Abe states that in a half-cell, the voltage should be set where “no electrolyte decomposition occurs and no irreversible structural breakdown of the positive electrode active material occurs.” For spinel

LiMn<sub>2</sub>O<sub>4</sub>, that voltage range is between 4.2V and 4.3V, and “*preferably* 4.2V.” Ex1005, ¶78 (emphasis added). In other words, Abe teaches that for spinel LiMn<sub>2</sub>O<sub>4</sub>, electrolyte decomposition and irreversible structural breakdown of the cathode may occur between 4.2V and 4.3V. Therefore, it is safer to limit the half-cell voltage of spinel LiMn<sub>2</sub>O<sub>4</sub> to 4.2V—thus limiting the full-cell voltage to 4.1V. *Id.*

Abe’s teaching is consistent with the literature at the time of the invention. *E.g.*, Ex1011, 1:59-60 (“Li<sub>1+x</sub>Mn<sub>2</sub>O<sub>4</sub> is known to be extremely unstable and easily oxidized.”); Ex2020, A55 (limiting the charging voltage to below 4.2V for LiMn<sub>2</sub>O<sub>4</sub> to prevent oxidation of the spinel). As Mr. Juzkow testified, when LiMn<sub>2</sub>O<sub>4</sub> is used as the cathode active material, manganese will “dissolve into the electrolyte and poison the anode” at high temperatures, which occurs at 4.2V. Ex2008, 100:14-20; 123:15-24; 124:21-25. In short, a POSITA would not have been motivated to increase the charge cut-off voltage in Abe above 4.1V as Abe teaches that doing so would cause the electrolyte to decompose and break down the cathode, *i.e.*, exactly 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.

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 published years after Guyomard (i.e., 1992) consistently state that the maximum voltage to which a lithium-ion battery with  $\text{LiMn}_2\text{O}_4$  as the cathode should be charged is still 4.2V or lower—certainly not the higher levels discussed in Guyomard in connection with *electrolyte* testing. See, e.g., Ex1011 (field in 1996); Ex1013 (filed in 1996); Ex2020 (published in 2002); Ex2014 (published in 1994). Indeed, Abe was published approximately six years after Guyomard, yet Abe still advises limiting the charge voltage to 4.1V, well below the levels discussed in Guyomard. A POSITA thus would reasonably expect that while the electrolyte might be more stable, the cathode would still dissolve at voltages higher than 4.2V so the capacity cannot be maintained in subsequent charge and discharge cycles. Ex2006, ¶¶210-212.

Accordingly, a POSITA could not reasonably expect to successfully combine Abe with—or adapt Abe in view of—Guyomard to practice claims 2-4, 6-8, and 11-18, which are therefore not obvious over Abe in view of Guyomard.

### **VIII. CLAIMS 9-10 ARE NOT OBVIOUS OVER ABE IN VIEW OF GUYOMARD AND IWAIZONO (GROUND 10)**

Petitioner asserts that claims 9-10 of the '641 Patent are obvious over Abe in view of both Guyomard and Iwaizono. Pet., 60. Ground 10 only adds to Abe and Guyomard the Iwaizono reference to attempt to show that dependent claims 9-10 are obvious. However, because claims 9-10 depend from claim 5, Petitioner has failed to show that all of the limitations of claims 9-10 are disclosed by the references.

### **IX. CONCLUSION**

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

Date: May 15, 2024

Respectfully submitted,

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## **CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMITS**

This Patent Owner's Response (the "POR") consists of 13,992, excluding table of contents, table of authorities, certificate of service, this certificate, or table of exhibits. The POR complies with the type-volume limitation of 14,000 words as mandated in 37 C.F.R. § 42.24. In preparing this certificate, counsel has relied on the word count of the word-processing system used to prepare the paper (Microsoft Word).

Respectfully submitted,

/ Minghui Yang /

Date: May 15, 2024

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