

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

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**DECLARATION OF MARC JUZKOW**

## **TABLE OF CONTENTS**

|              |                                                                                                                                                                                                                                                                                                                                                                                                                               |           |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I.</b>    | <b>BACKGROUND AND QUALIFICATIONS.....</b>                                                                                                                                                                                                                                                                                                                                                                                     | <b>1</b>  |
| <b>II.</b>   | <b>TECHNICAL OVERVIEW .....</b>                                                                                                                                                                                                                                                                                                                                                                                               | <b>4</b>  |
|              | A. GENERAL PRINCIPLES OF LITHIUM-ION BATTERIES .....                                                                                                                                                                                                                                                                                                                                                                          | 5         |
|              | B. MATERIALS USED IN LI-ION BATTERIES.....                                                                                                                                                                                                                                                                                                                                                                                    | 14        |
|              | C. CHARGE CUTOFF VOLTAGE AND DESIGN CAPACITY OF ELECTRODES .....                                                                                                                                                                                                                                                                                                                                                              | 16        |
|              | D. BATTERY PROTECTION CIRCUITS.....                                                                                                                                                                                                                                                                                                                                                                                           | 22        |
| <b>III.</b>  | <b>MATERIALS CONSIDERED .....</b>                                                                                                                                                                                                                                                                                                                                                                                             | <b>25</b> |
| <b>IV.</b>   | <b>SUMMARY OF MY OPINIONS AND ANALYSIS.....</b>                                                                                                                                                                                                                                                                                                                                                                               | <b>27</b> |
| <b>V.</b>    | <b>LEGAL PRINCIPLES .....</b>                                                                                                                                                                                                                                                                                                                                                                                                 | <b>28</b> |
|              | A. PERSON HAVING ORDINARY SKILL IN THE ART .....                                                                                                                                                                                                                                                                                                                                                                              | 28        |
|              | B. CLAIM CONSTRUCTION .....                                                                                                                                                                                                                                                                                                                                                                                                   | 29        |
|              | C. LEGAL STANDARDS FOR ANTICIPATION.....                                                                                                                                                                                                                                                                                                                                                                                      | 30        |
|              | D. LEGAL STANDARDS FOR OBVIOUSNESS .....                                                                                                                                                                                                                                                                                                                                                                                      | 31        |
|              | E. ANALOGOUS ART .....                                                                                                                                                                                                                                                                                                                                                                                                        | 35        |
| <b>VI.</b>   | <b>THE QUALIFICATIONS OF THE PHOSITA .....</b>                                                                                                                                                                                                                                                                                                                                                                                | <b>36</b> |
| <b>VII.</b>  | <b>OVERVIEW OF THE '641 PATENT .....</b>                                                                                                                                                                                                                                                                                                                                                                                      | <b>40</b> |
|              | A. THE '641 PATENT DESCRIPTION .....                                                                                                                                                                                                                                                                                                                                                                                          | 40        |
|              | B. EFFECTIVE FILING DATE.....                                                                                                                                                                                                                                                                                                                                                                                                 | 42        |
| <b>VIII.</b> | <b>THE CLAIMS OF THE '641 PATENT .....</b>                                                                                                                                                                                                                                                                                                                                                                                    | <b>42</b> |
| <b>IX.</b>   | <b>CLAIM CONSTRUCTION.....</b>                                                                                                                                                                                                                                                                                                                                                                                                | <b>48</b> |
|              | A. ELEMENT [1P]: “A METHOD FOR IMPROVING . . . CHARACTERIZED IN THAT” ..                                                                                                                                                                                                                                                                                                                                                      | 48        |
|              | B. “A RATIO OF POSITIVE ELECTRODE MATERIAL TO NEGATIVE ELECTRODE<br>MATERIAL OF THE SECONDARY LITHIUM ION CELL OR BATTERY IS FROM 1:1.0<br>TO 1:2.5 AS CALCULATED BY A SPECIFIC CAPACITY WITH A CHARGE VOLTAGE<br>LIMITED TO 4.2 V” (CLAIM 1); “A RATIO OF POSITIVE ELECTRODE MATERIAL TO<br>NEGATIVE ELECTRODE MATERIAL AS CALCULATED BY A THEORETIC CAPACITY<br>WITH A CHARGE CUT-OFF VOLTAGE SET AT 4.2 V” (CLAIM 5) ..... | 49        |
|              | C. “AT LEAST 7500 OF CAPACITY” (CLAIM 11) .....                                                                                                                                                                                                                                                                                                                                                                               | 52        |
| <b>X.</b>    | <b>PRIOR ART STATUS OF REFERENCES AND ANALOGOUS ART.....</b>                                                                                                                                                                                                                                                                                                                                                                  | <b>52</b> |
|              | A. THE FIELD OF ENDEAVOR OF THE '641 PATENT.....                                                                                                                                                                                                                                                                                                                                                                              | 53        |

|                                                                                                           |           |
|-----------------------------------------------------------------------------------------------------------|-----------|
| B. UEMURA (EX1009) IS ANALOGOUS ART.....                                                                  | 55        |
| C. ABE (EX1005) IS ANALOGOUS ART. ....                                                                    | 58        |
| D. GUYOMARD (EX1008) IS ANALOGOUS ART.....                                                                | 62        |
| E. IWAIZONO (EX1007) IS ANALOGOUS ART.....                                                                | 67        |
| <b>XI. DETAILED DISCUSSION OF MY OPINIONS REGARDING<br/>INVALIDITY. ....</b>                              | <b>70</b> |
| A. GROUND 1: UEMURA ANTICIPATES CLAIMS 1-8.....                                                           | 70        |
| 1. Claims 1 and 5.....                                                                                    | 70        |
| 2. Claims 2-4 and 6-8.....                                                                                | 93        |
| B. GROUND 2: UEMURA RENDERS CLAIMS 1-8 OBVIOUS AND GROUND 3:<br>UEMURA RENDERS CLAIMS 11-18 OBVIOUS. .... | 95        |
| 1. Claims 1-8 .....                                                                                       | 96        |
| 2. Claims 11-18 .....                                                                                     | 101       |
| C. GROUND 4: UEMURA AND GUYOMARD RENDER CLAIMS 11-18 OBVIOUS....                                          | 106       |
| 1. Claims 11-18: Remaining Capacities After 400 Cycles .....                                              | 106       |
| D. GROUND 5: ABE ANTICIPATES CLAIMS 1-8 AND GROUND 6: ABE RENDERS<br>OBVIOUS CLAIMS 1-8. ....             | 113       |
| 1. Claims 1 and 5.....                                                                                    | 114       |
| 2. Claims 2-3 and 6-7 .....                                                                               | 123       |
| 3. Claims 4 and 8.....                                                                                    | 124       |
| E. GROUND 7: ABE AND GUYOMARD RENDER CLAIMS 2-4, 6-8, AND 11-18<br>OBVIOUS.....                           | 124       |
| 1. Claims 2-3 and 6-7.....                                                                                | 126       |
| 2. Claims 4 and 8.....                                                                                    | 129       |
| 3. Claims 11-18 .....                                                                                     | 135       |
| 4. A PHOSITA Would Have Found It Obvious To Combine Abe with<br>Guyomard. ....                            | 137       |
| F. GROUND 8: UEMURA AND IWAIZONO RENDER CLAIM 9 OBVIOUS.....                                              | 150       |
| 1. Claim 9 .....                                                                                          | 150       |
| G. GROUND 9: UEMURA, IWAIZONO, AND GUYOMARD RENDER CLAIMS 9-10<br>OBVIOUS.....                            | 163       |
| 1. Claims 9 and 10.....                                                                                   | 163       |
| H. GROUND 10: ABE, GUYOMARD, AND IWAIZONO RENDER CLAIMS 9-10                                              |           |

|                               |            |
|-------------------------------|------------|
| OBVIOUS.....                  | 168        |
| 1. Claims 9 and 10.....       | 168        |
| <b>XII. DECLARATION .....</b> | <b>171</b> |

I, Marc Juzkow, hereby declare as follows:

**I. BACKGROUND AND QUALIFICATIONS**

1. My name is Marc Juzkow, and I have been retained on behalf of Samsung Electronics Co., Ltd. to provide my opinions on the patentability of the claims of United States Patent No. 7,749,641 (“the ’641 patent”). I understand that this declaration may be submitted to the Patent Trial and Appeal Board at the United States Patent and Trademark Office as part of an *inter partes* review proceeding related to the ’641 patent. I am being compensated at my customary rate for the time I spend on this matter. My compensation is not contingent on the content of my opinions nor the outcome of the *inter partes* review proceeding. I have no direct financial interest in any of the parties or this proceeding.

2. In formulating my opinions, I have relied on my knowledge, training, and experience in the relevant field, which I have summarized below. My *curriculum vitae*, which includes a more detailed summary of my background, experience, and publications, is attached to this declaration as Appendix 1.

3. I am a General Partner of Lithiumion Expert Services, LLC. I am also Cell Supplier Lead of Joby Aviation, LLC. I am an expert in the field of lithium-ion cells. I have studied, researched, and practiced in the field of electrochemical cells and packaging for more than 37 years.

4. I received my Bachelor of Science (BSc) degree in the field of Chemistry from Simon Fraser University in Burnaby, British Columbia in 1985. I received my Master of Science (MSc) degree in the same field from the same university in 1989.

5. I began my career as a Research Scientist with Moli Energy Limited in Vancouver, British Columbia in 1985. Initially, my work involved lithium metal cells. But, by the early 1990's the work I was doing transitioned to developing lithium-ion cells. I worked at Moli Energy between 1985 and 1996. During this time I had various titles and leadership positions. I was a research technologist and scientist, a Manager of Product Evaluation, a Manager of Product Development, and a Manager of Sales & Marketing. While I was at Moli Energy the company became the first North American company to commercialize lithium-ion technology. Among the projects I was involved in was the development of the first BB-2847 lithium-ion battery for the U.S. Army.

6. Between 1996 and 2000 I was Director of Sales and Marketing for PolyStor Corporation out of California. During my time at PolyStor, I was involved with the development of the BB-2590/U lithium-ion battery for the United States Army.

7. Between 2000 and 2003, I transitioned into electrochemical double layer capacitor devices. During this time I was with Cooper Electronic Technologies, PowerStor Corporation and was involved with development of spirally wound cells.

8. I have had various high-level roles in companies over the last 20 years. The details of these roles can be found in my attached CV, but I summarize a few of them here. For instance, between 2007 and 2014 I was Vice President of Research and Development at Leyden Energy. At Leyden we designed and assembled lithium-ion cylindrical and pouch cells. Leyden subcontracted the manufacturing of both polymer pouch and cylindrical cells and over 2 million cells were assembled. I had responsibility for all R&D efforts including the development of novel lithium-ion cell and battery technologies.

9. After my time at Leyden Energy, I hired five engineers and assembly technicians, purchased equipment and die sets, and started a contract services company, Iontensity. Our typical customer was either a start-up or a large industrial chemical company that had new lithium-ion cell components but were not skilled in the art of lithium-ion cell assembly, nor had the equipment required. We also subcontracted on several U.S. Department of Energy (DOE) contracts, providing cell design, assembly and testing services. At Iontensity, we assembled and tested coin cells and Al foil-polymer laminate packaged lithium-ion cells for our customers who typically provided us with one of the many components that make up a lithium-ion

cell. We were responsible for chemical and mechanical cell design, assembling electrodes, final cell assembly and testing. During this time I developed a cell design modeling tool to calculate matching electrode formulations and structures, adjusting the specific areal capacities of the electrodes to provide high capacity and specific energy lithium ion cell designs.

10. As I was the leader of a small group of engineers and technicians, it was important to be hands-on in my role as a team member and for training additional personnel we hired. I personally mixed cathode and anode slurries, coated electrodes on a 2m long roll-to-roll coater, punched electrodes, assembled coin cells and pouch cells, and ran performance testing. Following Iontensity, I was the Principal Cell Specialist at NIO, responsible for the lithium-ion cell technology for this electric vehicle company.

11. All told, I have over three decades of experience with secondary batteries including lithium metal and lithium-ion secondary batteries.

## **II. TECHNICAL OVERVIEW**

12. The '641 patent says that it “relates to a new method for improving capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery, and to a secondary lithium ion cell or battery prepared by using the method, a protecting circuit adapted for the secondary lithium ion cell or battery, a electronic device using the secondary lithium ion cell or battery, and a charging

device for the secondary lithium ion cell or battery.”<sup>1</sup> In this section I provide some technical information that I believe is relevant to an understanding of the ’641 patent and how the prior art reveals that what is being claimed was not patentable.

#### **A. General Principles of Lithium-ion Batteries**

13. I base this section in part off a description provided by the U.S. Department of Energy related to “How Lithium-ion Batteries Work”<sup>2</sup> and cite some additional materials herein. These principles were known in the field by the 1990s.

14. Lithium-ion batteries are generally made up of a positive electrode (often called a cathode) consisting of an active material coated onto a current collector, a negative electrode (often called an anode) consisting of an active material coated onto a current collector, an electrolyte, a separator, and a container or cell case.<sup>3</sup> These elements are illustrated below:

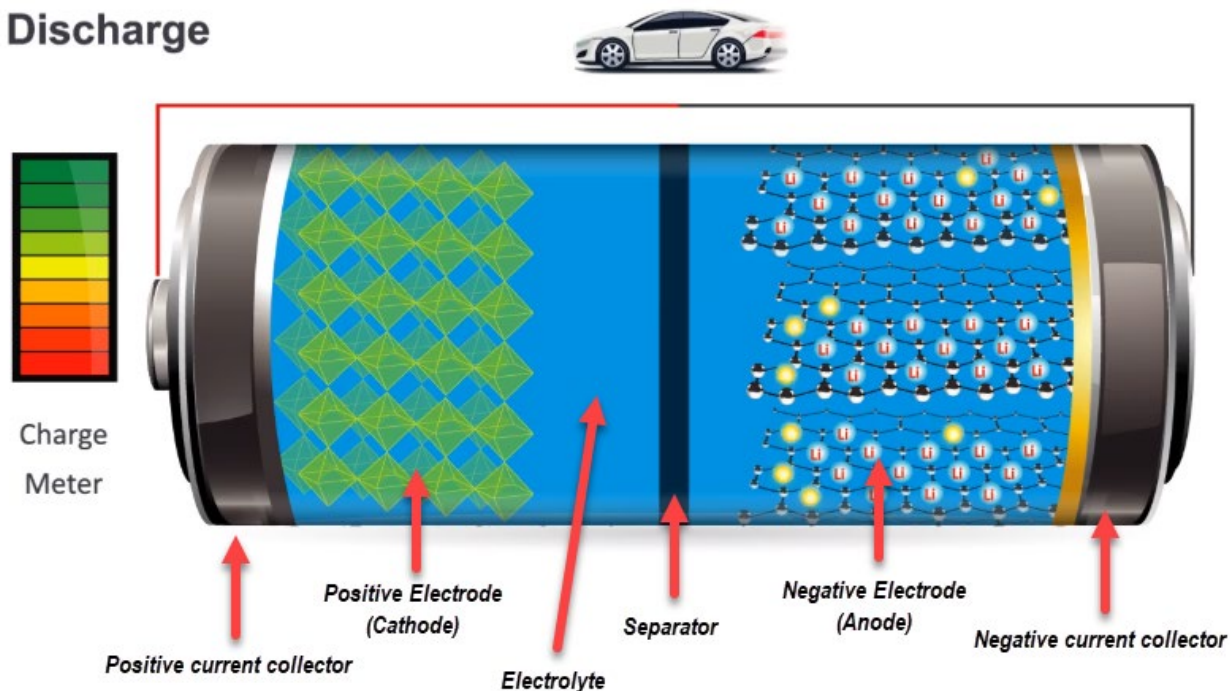
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<sup>1</sup> EX1001 (’641 pat.), 1:8-15.

<sup>2</sup> See <https://www.energy.gov/energysaver/articles/how-lithium-ion-batteries-work>.

<sup>3</sup> See, e.g., <https://www.energy.gov/energysaver/articles/how-lithium-ion-batteries-work>; EX1011 (U.S. Pat. No. 5,871,863), 2:12-15 (“[T]he present invention resides in a lithium ion secondary battery comprising a positive electrode, a negative electrode, non-aqueous electrolyte, and a container sealing the electrodes and electrolyte therein”); EX1012 (Au), pp.3-4 (describing components in Sony battery

## Discharge



15. The positive electrode stores lithium atoms and releases the lithium as ions when the battery is being charged. The negative electrode stores lithium atoms and releases the lithium as ions when the battery is being discharged. The electrolyte is located between the negative and positive electrodes and includes mobile lithium ions.<sup>4</sup> The separator, filled with electrolyte, can allow the lithium ions to flow from

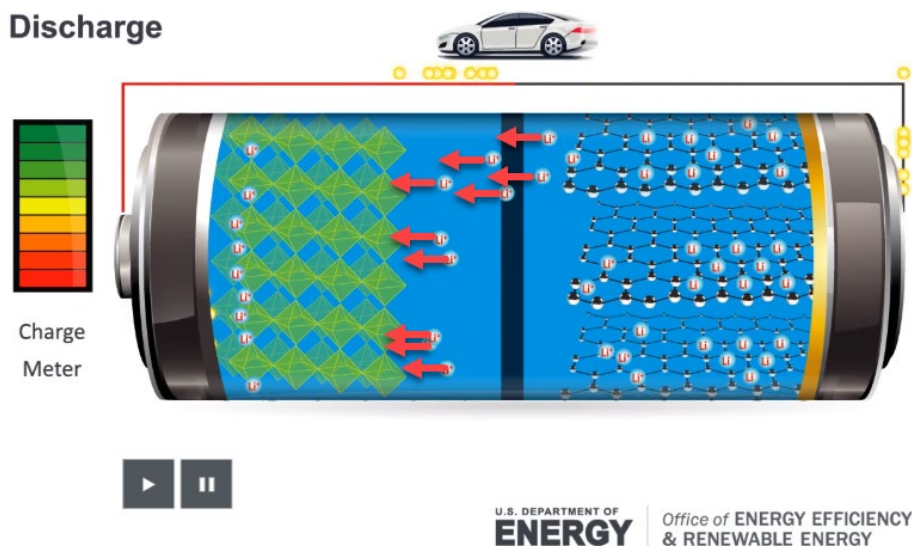
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including electrodes, separator, electrolyte solution, separator, and cell case); EX1005 (Abe), ¶[0004] (“Typically, the non-aqueous electrolyte-based secondary battery will have a negative electrode, a separator, a positive electrode, and an electrolyte solution.”).

<sup>4</sup> EX1013 (U.S. Pat. No. 5,721,067), 1:11-17 (“Most rechargeable lithium ion

the negative electrode to the positive electrode and vice versa, while providing an electrically insulating barrier.

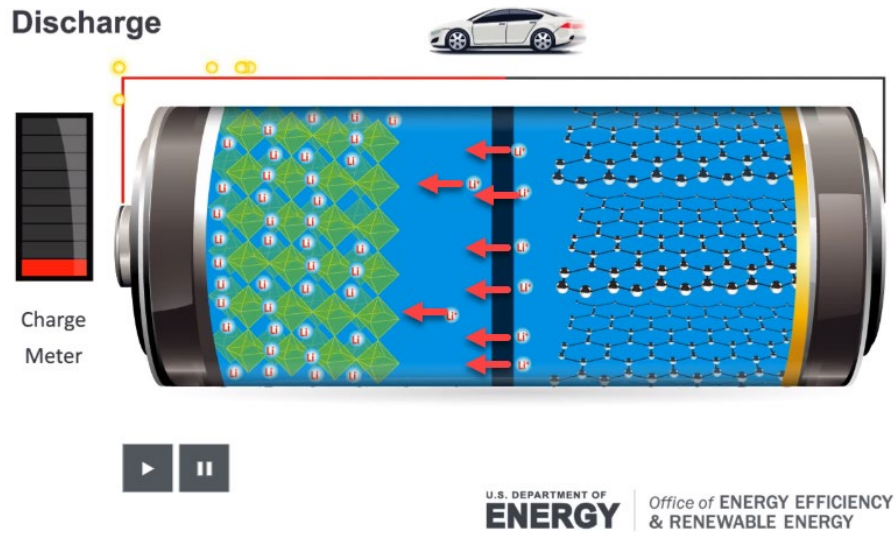
16. During the discharge of the battery, lithium ions move from the negative electrode to the positive electrode as illustrated below:



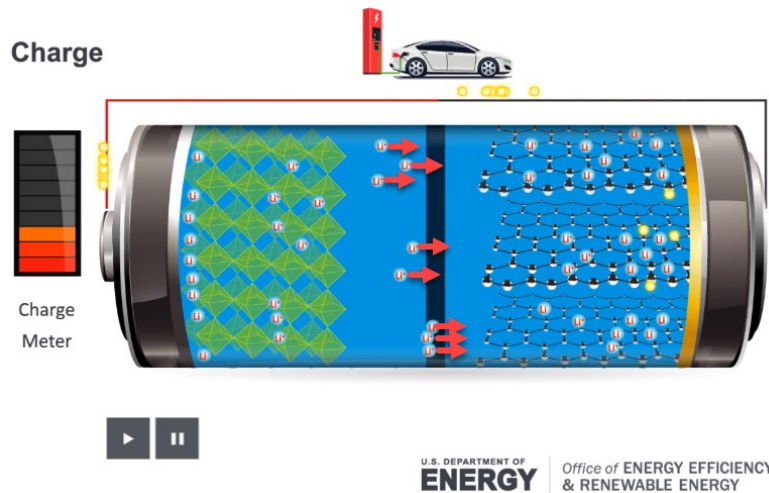
As more lithium ions move from the negative electrode to the positive electrode, the battery's charge is depleted and the lithium ions are incorporated into the positive electrode material structure.

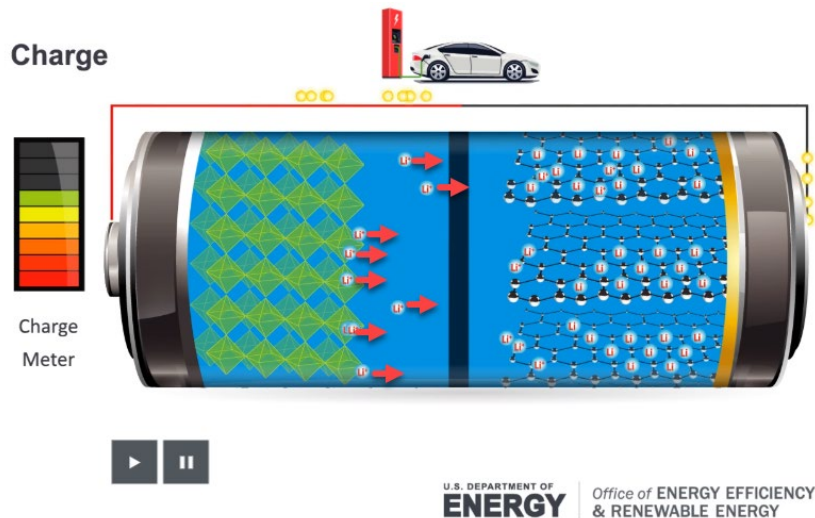
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batteries have a negative electrode containing elemental lithium, which is usually intercalated in some carbonaceous substance, a positive electrode bearing a chalcogenide, which is capable of incorporating lithium ions in its structure, an electrolyte containing mobile lithium ions, located between the negative and positive electrodes and, optionally, a separator.”).



The when the battery is charged, the flow of lithium ions is reversed and the ions are inserted into the structure of the negative electrode as illustrated below.





17. The process by which lithium is inserted into the structure of the positive and negative electrode materials is called “intercalation.”<sup>5</sup> These types of secondary or rechargeable lithium-ion batteries were known as “rocking chair” type secondary batteries because the lithium would be “rocked” back and forth between the electrodes.<sup>6</sup> As the ’641 patent explains, common positive electrode materials

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<sup>5</sup> EX1018 (U.S. Pat. No. 5,853,914), 1:8-14 (“The present invention relates to a highly reliable rechargeable lithium battery using intercalation and deintercalation reactions of lithium ions in charging and discharging. The rechargeable lithium battery using intercalation and deintercalation reactions of lithium ions in charging and discharging will be hereinafter simply referred to as rechargeable lithium battery.”).

<sup>6</sup> EX1012, p.1 (“Rechargeable batteries which contain lithium intercalation compounds, instead of the free lithium metal, should be much safer and have a

included lithium cobalt oxide and this material “has a theoretical capacity of 248 mAh/g . . . .”<sup>7</sup> But, “the actually used capacity of it is merely about 140 mAh/g, i.e.,

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greater cycle life. Such systems are called ‘rocking chair’ types, since the lithium-ions move back and forth, between the cathode and anode on charge and discharge. The Sony Corp produced a lithium-ion rechargeable battery which is incorporated into cellular phone equipment only in Japan. . . . Eighteen batteries and two chargers were obtained and subjected to the evaluation described in this report.”); EX1008 (Guyomard), 1:20-30 (“A more advanced and inherently safer approach to rechargeable lithium batteries is to replace lithium metal with a material capable of reversibly intercalating lithium ions, thereby providing the so-called ‘rocking-chair’ battery in which lithium ions ‘rock’ between the intercalation electrodes during the charging/recharging cycles. Such a Li metal-free ‘rocking-chair’ battery may thus be viewed as comprising two lithium-ion-absorbing electrode ‘sponges’ separated by a lithium-ion conducting electrolyte usually comprising a Li<sup>+</sup> salt dissolved in a non-aqueous solvent or mixture of such solvents.”); EX1025 (Dahn), p.2208 (discussing “the selection of appropriate materials for the electrodes of ‘rocking chair’ cells” and showing that “cycle testing these cells . . . demonstrate that most of the disadvantages associated with secondary Li cells are eliminated”).

<sup>7</sup> EX1001 (’641 pat.), 1:40-42.

about half of said theoretic capacity is not utilized.”<sup>8</sup> The capacity, however, increases when a higher charge cutoff voltage is applied. For instance, the ’641 patent discusses a publication by Pistoia et al. that reports “the capacity of lithium cobalt oxide reaches 159 mAh/g when the charge cut-off voltage is 4.35V . . . .”<sup>9</sup> Those knowledgeable about secondary lithium-ion batteries were aware that applying additional voltage would extract more lithium ions from the cathode than a lower voltage. For example, a patent publication by Watanabe et al. explains:

[I]n lithium ion secondary batteries, when they are charged in excess of a given charging voltage due to, for example, troubles of charging control circuits, they are in overcharged state, and lithium ions in the positive electrode are excessively extracted and migrate to negative electrode to cause absorption of lithium in an amount larger than the prescribed design capacity in the negative electrode or to cause precipitation of lithium as metallic lithium on the surface of negative electrode.<sup>10</sup>

This passage shows that additional lithium is extracted from the positive electrode at higher voltages. It also indicates that the plating of metallic lithium on the negative

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<sup>8</sup> *Id.*, 1:42-44.

<sup>9</sup> *Id.*, 2:15-25.

<sup>10</sup> EX1019 (U.S. Pat. App. Pub. No. 2003/0118912), ¶[0005].

electrode was undesirable.<sup>11</sup> Based on these realities, those in the field knew to ensure that the negative electrode had sufficient capacity to avoid plating or precipitating lithium.<sup>12</sup> In other words the negative electrode should have at least as

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<sup>11</sup> EX1005 (Abe), ¶[0009] (“[I]n general, in the case of overcharging lithium-ion secondary batteries or when the charging current is increased, etc., needle-like lithium may be precipitated on the surface of the negative electrode, interposed between the positive electrode and the negative electrode, making it easier to break through the separator and short out. As a result, lithium-ion secondary batteries may also explode and ignite.”).

<sup>12</sup> EX1023 (U.S. Patent No. 5,618,640), 1:17-26 (“To solve the problem, a calcined carbonaceous material capable of intercalating and deintercalating lithium has recently been put to practical use. However, since the carbonaceous material has electrical conductivity by itself, metallic lithium is sometimes precipitated on the carbonaceous material at the time of an overcharge or a rapid charge. It eventually follows that lithium grows dendritically thereon. This problem has been dealt with by altering a charger or reducing the amount of positive electrode active material to prevent an overcharge.”); EX1009 (Uemura), ¶[0033] (“If the capacity balance ratio B/A is below 1, lithium ion holding sites on the negative electrode material become insufficient. As the result, branch-shaped or needle-shaped crystal (dendrite crystal)

much capacity as the positive electrode—and in many cases the negative electrode was over-designed to avoid the possibility of plating lithium.

18. The reason that the negative electrode should have at least as much capacity as the positive electrode can be explained with an analogy. Take two vessels one can hold 10 gallons of water and the other can hold only 5 gallons of water. Start with 10 gallons of water in the larger vessel. The water in this instance represents the lithium in a positive electrode. Then imagine a pump that removes a specific amount of that water and places that water in the second container before shutting off. This pump is analogous to the voltage applied to cause the lithium to be extracted from the positive electrode and the second container is analogous to the negative electrode. If the pump is configured to extract only 5 gallons of water from the 10 gallon vessel, then it can be entirely held within the 5 gallon vessel. That amount of water can move back and forth between the two vessels without problem. But, assume that the pump is adjusted to extract 5.5 gallons of water. This is analogous to the application of additional voltage (e.g., an overvoltage condition based on the cell design). In this case, after 5 gallons are moved into the 5 gallon container, the container is full and can no longer hold any more water. It starts spilling out of the

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tends to occur during the charge to cause a short circuit phenomenon between the positive electrode and the negative electrode.”).

container. This is analogous to what happens when the negative electrode can no longer incorporate any more lithium ions—dendrites can form and lithium can plate on the surface of the electrode thus deteriorating and damaging the battery and potentially leading to a dangerous condition. For this reason, those in the field knew to design their “water-receiving vessel” such that it could receive at least as much “water” as would be extracted by the pump. And, having slightly more space in the water receiving vessel would ensure that if the pump ran a little longer than expected, the additional water could be accommodated without spillage.

**B. Materials Used In Li-Ion Batteries.**

19. Those working in the field of lithium-ion batteries knew that common materials for lithium-ion batteries included lithium composite oxides used for the positive electrode and carbonaceous materials used for the negative electrodes.<sup>13</sup>

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<sup>13</sup> EX1005 (Abe), ¶¶[0005]-[0006] (“Materials used in negative electrodes can include carbonaceous materials such as natural graphite, artificial graphite, refractory carbon, also called hard carbon, MesoCarbon MicroBeads, pitch-based carbon fibers, vapor-phase grown carbon fibers, etc. Substances used in the positive electrode can include lithium-containing composite oxides, such as lithium cobaltate ( $\text{LiCoO}_2$ ), lithium manganate ( $\text{LiMn}_2\text{O}_4$ ,  $\text{LiMnO}_2$ ), lithium nickelate ( $\text{LiNiO}_2$ ), etc.”); EX1008 (Guyomard), 2:3-14 (“Among the alternative materials that can

Examples of commonly used materials for positive electrodes in lithium ion materials included lithium cobalt oxides ( $\text{LiCoO}_2$ ), lithium manganate oxides ( $\text{LiMn}_2\text{O}_4$ ), or lithium nickel oxides ( $\text{LiNiO}_2$ ).<sup>14</sup> Combinations of lithium metal oxides with certain metals such as nickel and cobalt, forming, for example,  $\text{LiNi}_{0.2}\text{Co}_{0.8}\text{O}_2$  were also known.<sup>15</sup>

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effectively replace lithium metal as the negative electrode, carbon provides the best compromise between large specific capacity and good reversible cycling behavior. . . . To compensate for the loss of voltage associated with the negative electrode, a strongly oxidizing intercalation material is preferably used as the positive electrode.”).

<sup>14</sup> EX1005 (Abe) ¶[0006]; EX1015 (Guyomard-1992), p.937 (“The layered compounds  $\text{LiNiO}_2$  and  $\text{LiCoO}_2$  and the three-dimensional compound  $\text{LiMn}_2\text{O}_4$  with the spinel structure, are the only phases presently known to intercalate Li reversibly at voltage larger than 3.5V vs. Li.”); EX1025 (Dahn), pp.2207-2208 (discussing  $\text{Li}_{1-y}\text{Mn}_2\text{O}_4$  and  $\text{Li}_{1-y}\text{NiO}_2$  cells).

<sup>15</sup> EX1015 (Guyomard-1992), p.937; EX1009 (Uemura), FIG. 3 (showing examples of various lithium complex oxides).

20. These materials were known to have different electrochemical properties including sensitivities to different voltages, heat, and exhibit different cyclability properties.

### **C. Charge Cutoff Voltage and Design Capacity of Electrodes**

21. As I mentioned above, the concept of the charge cutoff voltage and the design capacity of the electrodes are related. To avoid plating lithium and forming metal dendrites on the outer surface of the negative electrode, it was important to ensure that the negative electrode had at least as much capacity as the positive electrode based on the voltage to be applied to the cell or battery.<sup>16</sup> This was common

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<sup>16</sup> See, e.g., EX1005 (Abe), ¶¶[0018], [0078]; EX1009 (Uemura), ¶[0033]; EX1020 (U.S. Patent No. 6,872,491), 25:2-7 (“In preparing the positive electrode and the negative electrode, the loading density and the electrode length were adjusted to permit a ratio (capacity balance) of the design capacity of the negative electrode to the design capacity of the positive electrode after pressing to fall within a range of between 1.03 and 1.1.”); EX1021 (U.S. Patent No. 6,926,992), 15:53-58 (“In preparing the negative electrode, the loading density and the electrode length were adjusted so as to allow the ratio (capacity balance) of the design capacity of the negative electrode after the pressing step to the design capacity of the positive electrode after the pressing step to be not smaller than 1.05 and not larger than 1.1.”);

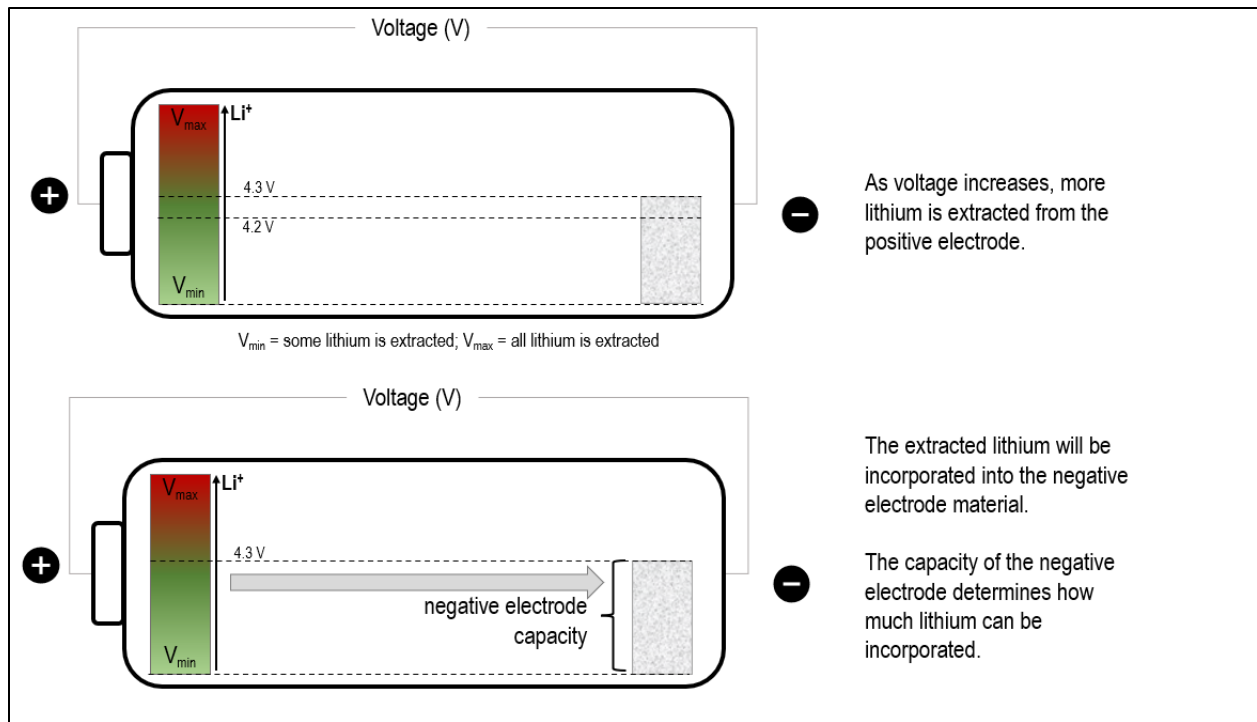
in commercial batteries of the time and was a technique I was familiar with during my time at Moli Energy.<sup>17</sup>

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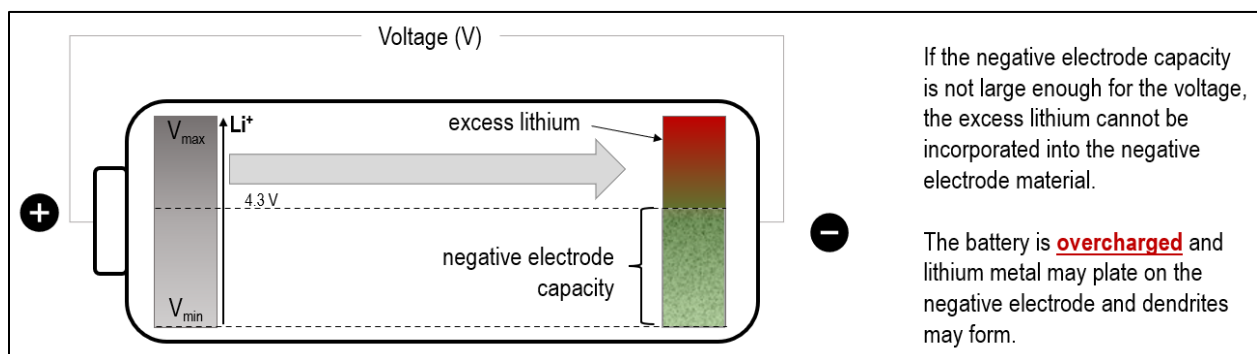
EX1023 (U.S. Patent No. 5,618,640), 1:17-26 (“To solve the problem, a calcined carbonaceous material capable of intercalating and deintercalation lithium has recently been put to practical use. However, since the carbonaceous material has electrical conductivity by itself, metallic lithium is sometimes precipitated on the carbonaceous material at the time of an overcharge or a rapid charge. It eventually follows that lithium grows dendritically thereon. This problem has been dealt with by altering a charger or reducing the amount of positive electrode active material to prevent an overcharge.”).

<sup>17</sup> EX1022 (U.S. Patent No. 6,800,399), 13:41-50 (“Here, for the purpose of evaluating the characteristics of the nickel positive electrode in particular, that is to say, in order to avoid the effect of the characteristics of the negative electrode on the cell performances as much as possible, the standard battery is made to have a theoretic capacity of the negative electrode as much as 1.8 times as large as that of the positive electrode by adjusting the normally designed capacity balance of the positive and negative electrodes. For reference, commercially used batteries have the negative electrodes which are 1.3 to 1.6 times as large.”).

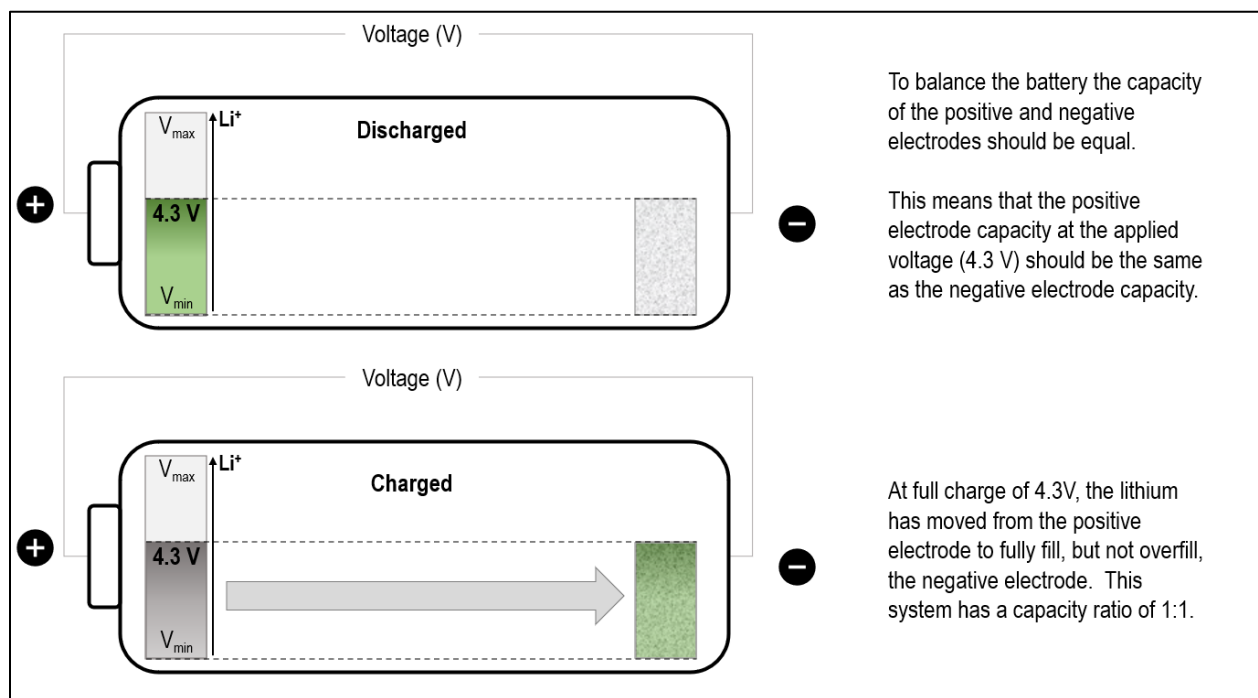
22. To explain this concept a bit further I rely on several illustrations. I come back to these illustrations in discussing the prior art—particularly the disclosures related to ratio in Uemura and Abe. The following illustration is a diagram of a battery with the positive electrode illustrated by the bar on the left (the green-red gradient) and the negative electrode illustrated by the bar on the right (grey textured block). The green represents the typical amount of lithium that is rocked back and forth reversibly to the positive electrode and no lithium plating on the negative electrode. The red indicates additional lithium that is normally not extracted during operation. If extracted this generally conveys the concept of an overcharged state and potential damage to the structure of the positive electrode material. As seen here, the amount of lithium extracted is dependent on the voltage applied to the battery with more lithium being extracted as voltage increases.



23. As reflected by various prior art including Uemura and Abe, if there is not enough capacity in the negative electrode to accommodate all of the lithium extracted at a particular voltage the battery becomes overcharged, metallic lithium can be deposited on the surface of the negative electrode, and dendrites may form. This damages the battery. This is illustrated below as all of the lithium being extracted from the positive electrode and the negative electrode not being able to accommodate all of the lithium.

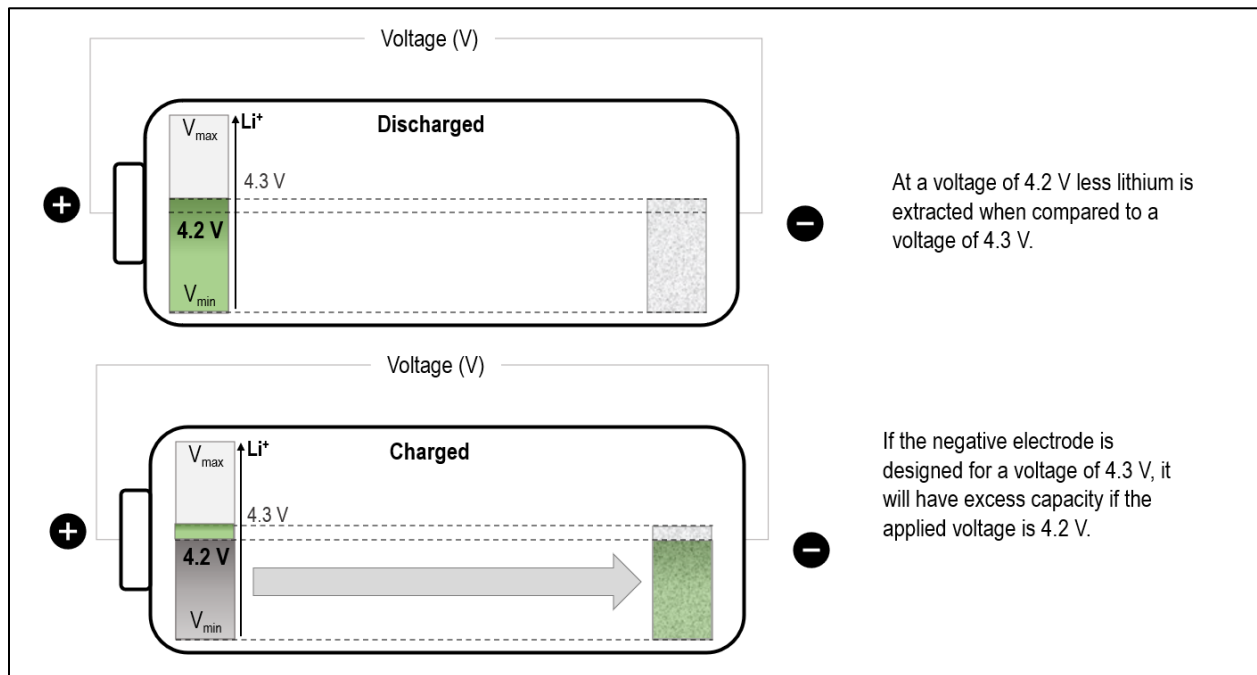


24. Using Uemura as an example, this reference discloses a charge cutoff voltage of 4.3V.<sup>18</sup> When a voltage of 4.3V is applied to Uemura's batteries a certain amount of lithium will intercalate. This means it moves from the positive electrode to the negative electrode. In the situation in which the negative electrode can accommodate the precise amount of lithium that is extracted at the 4.3V cutoff voltage then the battery is said to be balanced, which means that the ratio of capacity of the positive electrode and the negative electrode is 1:1 at 4.3V. This is illustrated generally below where the amount of lithium extracted at 4.3V is illustrated in green. As can be seen the negative electrode accommodates the extracted lithium at 4.3V.



<sup>18</sup> EX1009 (Uemura), ¶[0081].

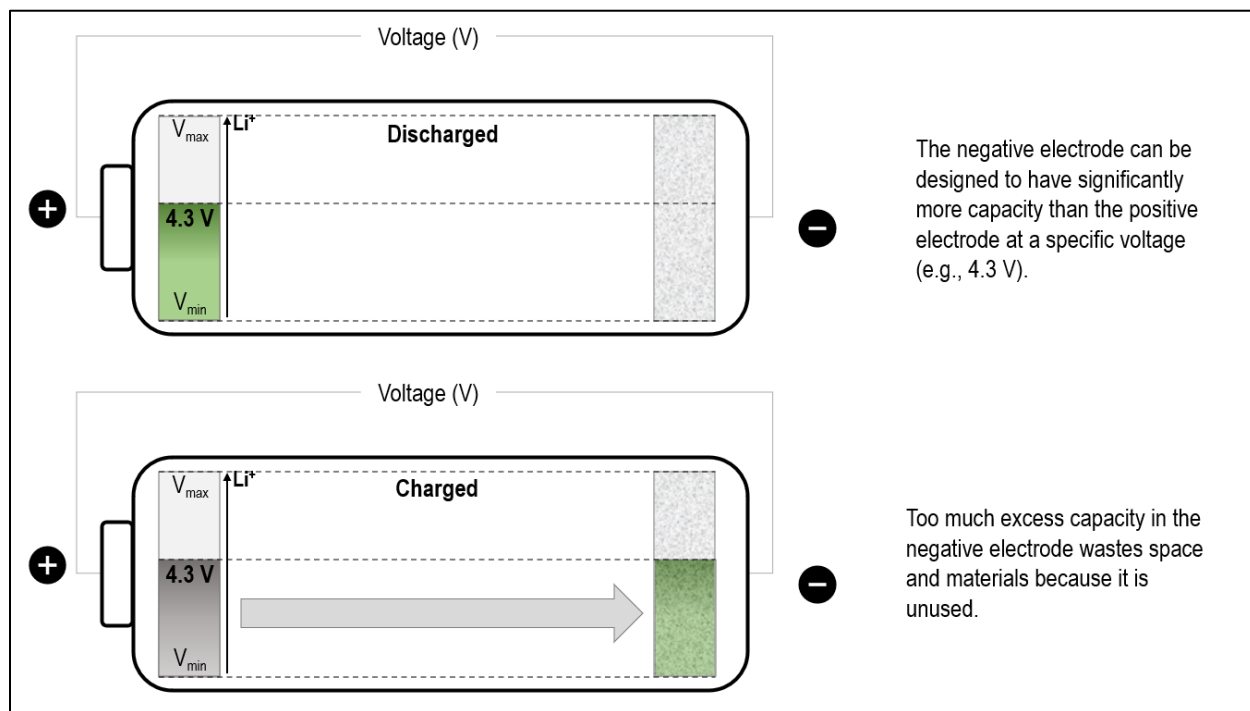
25. Now consider the case in which an electrode is designed at one voltage, but the battery is operated at a different voltage. For instance, if the capacities of the positive and negative electrodes are determined at 4.3V but the voltage applied is lower, such as, for example, 4.2V the negative electrode ends up having excess capacity as shown in the figure below.



26. On the other hand, if the negative electrode is designed to have significantly more capacity than the capacity of the positive electrode at a particular voltage (e.g., 4.3V), then it can accommodate all of the lithium but much of the capacity of the negative electrode is not used.<sup>19</sup> This is conceptually illustrated below

<sup>19</sup> EX1009 (Uemura), ¶[0033].

where the grey textured bar is considerably higher than the green bar representing the amount of lithium extracted from the positive electrode at 4.3V.



This excess negative electrode active material occupies space in batteries that could otherwise be used for additional cathode material, and results in a battery with lower capacity. Excessive capacity in the negative electrode is thus something that those skilled in the art sought to avoid.

#### **D. Battery Protection Circuits**

27. As I explained above an increase in voltage generally caused the extraction of more lithium from the positive electrode. If the negative electrode was not designed to accommodate that additional lithium, metallic lithium could form on the negative electrode. One known solution to this problem was to alter how the

charging of the battery was accomplished to regulate the voltage thus ensuring that too much lithium would not be extracted from the positive electrode material. For instance, U.S. Patent No. 5,618,640 explains:

metallic lithium is sometimes precipitated on the carbonaceous material *at the time of an overcharge* or a rapid charge. It eventually follows that lithium grows dendritically thereon. *This problem has been dealt with by altering a charger* or reducing the amount of positive electrode active material to prevent an overcharge.

EX1023 (U.S. Patent No. 5,618,640), 1:20-26 (emphasis added).

28. Circuits were available to engineers in the field that could limit the overcharge of the battery to a specified voltage. For instance, Seiko Instruments published datasheets for integrated circuits used for providing a battery with overcharge protection.<sup>20</sup> Overcharging can also lead to electrolyte damage and cause

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<sup>20</sup> EX1010 (Seiko S-8491 datasheet), p.1. This datasheet is of the type that is commonly used by those in the industry to identify parts that may be useful in certain battery applications. Another common source for single cell pack protection circuits in the 1990's was Unitrode. *See, e.g.*, EX1007 (Iwaizono), 11:43-47 ("This main protective circuit C consisting of the main control means 6 and the first FET 14 is available as an integrated circuit chip from Unitrode Inc., and is disclosed in U.S. Pat. No. 5,581,170."). Two benefits of the Unitrode IC were that they did not require

the generation of heat and gases. Circuits were provided to avoid overcharging of batteries. As U.S. Patent No. 6,577,105 explains:

Charging of rechargeable batteries beyond their suitable charge conditions leads to the generation of gas or heat due to decomposition of electrolyte and may cause breakdown or deterioration of the battery. Lithium-based rechargeable batteries are particularly susceptible to deterioration or damage when operated at a voltage exceeding a predetermined range. It is therefore the normal practice to provide a battery protection device for protecting the battery from improper use.<sup>21</sup>

Such integrated circuits included circuits that were “mounted in the rechargeable battery itself” and had the ability to “shut[] off the charging and discharging circuit of the rechargeable battery in response to an abnormal state, for instance.”<sup>22</sup>

29. Once a circuit causes the battery to stop charging, it must also be configured to allow it to start charging again once it is back within acceptable ranges. Thus, these circuits were known to provide an overcharge protection release voltage

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external FETs or sense resistors. In 1999, Texas Instruments bought Unitrode and incorporated their battery pack protection line into the TI catalog.

<sup>21</sup> EX1007 (Iwaizono), 1:11-19.

<sup>22</sup> EX1007 (Iwaizono), 1:20-26.

as is reflected in the Seiko datasheet, for example.<sup>23</sup> These voltages are below the overcharge protection voltage and generally slightly below the charge cutoff voltage to allow charging of the battery to resume.<sup>24</sup>

### III. MATERIALS CONSIDERED

30. In developing my opinions, I have considered and relied upon the materials cited herein, including the following materials:

| Exhibit No. | Description                                                                                                                  |
|-------------|------------------------------------------------------------------------------------------------------------------------------|
| 1001        | U.S. Patent No. 7,749,641 to Ren, et al.                                                                                     |
| 1003        | Prosecution History of U.S. Patent Application No. 10/491,134 as obtained from the USPTO Patent Center                       |
| 1004        | Prosecution History of U.S. Patent Application No. 12/817,028 as obtained from the USPTO Patent Center                       |
| 1005        | JPH10189052 to Abe et al. (including Declaration of Yoshiko Ishikawa and translation) (“Abe”)                                |
| 1006        | B. Kennedy, et al., <i>Use of lithium-ion batteries in electric vehicles</i> , J. Power Sources, Vol. 90 (2000), pp.156-162. |
| 1007        | U.S. Patent No. 6,577,105 to Iwaizono (“Iwaizono”)                                                                           |

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<sup>23</sup> EX1010 (Seiko S-8491 datasheet), p.1 (“Excess charge release voltage.”)

<sup>24</sup> *Id.*; see also EX1007 (Iwaizono), 10:1-3 (“The first FET 11 is kept OFF by the main control means 1 until a first charge-permitting voltage that is lower than the first charge-prohibiting voltage is detected.”), 14:48-52.

| Exhibit No. | Description                                                                                                                                                                                                                              |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1008        | PCT Publication No. 93/21665 to Guyomard (“Guyomard”)                                                                                                                                                                                    |
| 1009        | U.S. Patent Application Publication No. 2002/0012830 to Uemura et al. (“Uemura”)                                                                                                                                                         |
| 1010        | Seiko Instruments, Inc., Battery Protection IC S-8491 Series.                                                                                                                                                                            |
| 1011        | U.S. Patent No. 5,871,863 to Miyasaka                                                                                                                                                                                                    |
| 1012        | George Au, <i>et al.</i> , <i>Performance of the Sony Lithium-Ion Rechargeable Battery</i> , Report No. ARL-TR-71 (Army Research Lab. (Mar. 16, 1994)) (“Au”).                                                                           |
| 1013        | U.S. Patent No. 5,721,067 to Jacobs, et al.                                                                                                                                                                                              |
| 1014        | Proof of Service in <i>RJ Technology, LLC v. Samsung Electronics Co., Ltd.</i> , No. 2:22-cv-00401-JRG-RSP, Dkt. 8 (Oct. 18, 2022)                                                                                                       |
| 1015        | D. Guyomard, et al., “Li metal-free rechargeable LiMn <sub>2</sub> O <sub>4</sub> /Carbon Cells: Their understanding and optimization,” <i>J. Electrochemical Science and Technology</i> , vol. 139, No. 4, April 1992 (“Guyomard-1992”) |
| 1016        | Exhibit A to the Parties’ Joint Claim Construction and Prehearing Statement filed in <i>RJ Technology, LLC v. Apple Inc.</i> , No. 8:22-cv-01874-JVS-JDE, Dkt. 67-1 (May 31, 2023).                                                      |
| 1017        | Exhibit A-138 to Plaintiff’s Infringement Contentions                                                                                                                                                                                    |
| 1018        | U.S. Patent No. 5,853,914 to Kawakami                                                                                                                                                                                                    |
| 1019        | U.S. Patent Application Publication No. 2003/0118912 to Watanabe, et al.                                                                                                                                                                 |
| 1020        | U.S. Patent No. 6,872,491 to Kanai et al.                                                                                                                                                                                                |
| 1021        | U.S. Patent No. 6,926,992 to Isozaki et al.                                                                                                                                                                                              |
| 1022        | U.S. Patent No. 6,800,399 to Matsumoto                                                                                                                                                                                                   |
| 1023        | U.S. Patent No. 5,618,640 to Idota                                                                                                                                                                                                       |

| Exhibit No. | Description                                                                                                                                                               |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1024        | J. M. Tarascon & D. Guyomard, <i>The <math>Li_{1+x}Mn_2O_4/C</math> Rocking-Chair System: A Review</i> , <i>Electrochimica Acta</i> , Vol. 38, No. 9, pp.1221-1231 (1993) |
| 1025        | J.R. Dahn, U. von Sacken, M.W. Juzkow and H. Al-Janaby, “Rechargeable $LiNiO_2$ /Carbon Cells”, <i>J. Electrochem. Soc.</i> , Vol. 138, No. 8, August 1991.               |

#### IV. SUMMARY OF MY OPINIONS AND ANALYSIS

31. Based on my consideration of the materials identified above, my perspectives about the knowledge of a person having ordinary skill in the art (“PHOSITA”) in the field of secondary lithium-ion batteries and assessment of the ’641 patent including its claims, I have formed the following opinions.

32. A PHOSITA in the field of the ’641 patent in the 2000-2001 timeframe would have a Master’s degree or equivalent in materials science engineering, chemical engineering, chemistry, or a related field, and four years of practical experience in designing, testing, and making lithium-ion batteries. Those skilled in the art would have been familiar with the principles I discuss above in the technical background and generally throughout this Declaration.

33. The following references are “analogous art” to the ’641 patent under the legal test I was instructed to apply (see below): Uemura (EX1009), Abe (EX1005), Guyomard (EX1008), and Iwaizono (EX1007).

34. Below is a table summarizing my opinions:

| Ground | Claims             | Basis and Reference(s)                                       |
|--------|--------------------|--------------------------------------------------------------|
| 1      | 1-8                | Anticipated by Uemura                                        |
| 2      | 1-8                | Obvious over Uemura                                          |
| 3      | 11-18              | Obvious over Uemura                                          |
| 4      | 11-18              | Obvious over Uemura in view of Guyomard                      |
| 5      | 1-8                | Anticipated by Abe                                           |
| 6      | 1-8                | Obvious over Abe                                             |
| 7      | 2-4, 6-8 and 11-18 | Obvious over Abe in view of Guyomard                         |
| 8      | 9                  | Obvious over Uemura in view of Iwaizono                      |
| 9      | 9-10               | Obvious over Uemura in view of Iwaizono in view of Guyomard. |
| 10     | 9-10               | Obvious over Abe in view of Guyomard in view of Iwaizono     |

## V. LEGAL PRINCIPLES

35. I am not an attorney and I do not expect to offer any opinions regarding the law or legal principles in this proceeding. I have been given certain instructions regarding the law and have been asked to apply those instructions in rendering my opinions. I have done so. I outline those legal principles below.

### A. Person Having Ordinary Skill in the Art

36. I understand that patents and publications are to be understood from the perspective of a PHOSITA. I further understand that the words of the claims are to

be understood from the perspective of a PHOSITA. Finally, I understand that the questions of anticipation and obviousness of a patent claim are evaluated from the understanding of the PHOSITA.

37. I understand and have been informed that the factors I should consider in determining the ordinary level of skill in the art include:

- (i) the levels of education and experience of persons working in the field;
- (ii) the types of problems encountered in the field; and
- (iii) the sophistication of the technology.

38. I understand that a PHOSITA is not a specific real individual, but rather a hypothetical individual having the qualities reflected by the factors above. This hypothetical person has knowledge of all prior art in the relevant field as if it were arranged on a workshop wall and takes from each reference what it would teach to a person having the skills of a PHOSITA. I have provided my opinion and reasons therefor below. *Infra* §XI.

## **B. Claim Construction**

39. I understand that in an *inter partes* review, claim terms are to be given their ordinary and customary meaning as understood by a PHOSITA in the context of the entire disclosure at the time of the invention. I understand that one must be careful not to read a specific embodiment appearing in the written description into the claim if the claim language is broader than the embodiment. I further understand

that any special definition for a claim term must be set forth with reasonable clarity, deliberateness, and precision.

40. Unless I explicitly state that I was instructed to apply a specific claim construction in performing my analysis (and I was, as indicated below), I am applying the ordinary and customary meaning of claim terms as they would have been understood by the PHOSITA based on the specification of the patent unless otherwise noted. I understand that this standard is the same as that used in United States district courts, in which claim terms are given their ordinary and customary meaning as would be understood by a PHOSITA at the time of the invention and have taken into consideration the language of the claims, the specification, and the prosecution history of record.

### **C. Legal Standards for Anticipation**

41. I understand that for a claim to be anticipated under §102, every limitation or feature of the claimed invention must be found in a single prior art reference, either expressly or inherently. The reference must also enable a person of ordinary skill in the art to make and use the subject matter claimed.

42. I understand that a claim element is inherently present in a prior art reference if the element is “necessarily present” in the device, structure, or method described in the reference. I understand that inherent anticipation does not require

that a PHOSITA would have recognized the inherent disclosure at some specific point in time.

43. I have been informed that it may be appropriate in certain circumstances to look at multiple references when considering the question of whether a claim is anticipated. Additional references may inform an anticipation evaluation: (1) to prove that the primary reference has an enabling disclosure, (2) to explain the meaning of a term used in the primary reference, or (3) to show that a characteristic not expressly called out in a reference is inherent.

**D. Legal Standards for Obviousness**

44. I understand that a claim may be invalid under §103(a) if the subject matter described by the claim as a whole would have been obvious to a hypothetical person of ordinary skill in the art in view of a prior art reference, or in view of a combination of references at the time the claimed invention was made. Therefore, I understand that obviousness is determined from the perspective of a hypothetical person of ordinary skill in the art, and that the asserted claims of the patent should be read from the point of view of such a person at the time the claimed invention was made. I further understand that a hypothetical person of ordinary skill in the art is assumed to know and to have all relevant prior art in the field of endeavor covered by the patent in suit and all analogous prior art. I understand that the standard for

obviousness in an *inter partes* review proceeding is by a preponderance of the evidence, meaning that a fact must be more likely true than not true.

45. I also understand that an analysis of whether a claimed invention would have been obvious should be considered in light of the scope and content of the prior art, the differences (if any) between the prior art and the claimed invention, and the level of ordinary skill in the pertinent art involved. I understand as well that a prior art reference should be viewed as a whole. I understand that in considering whether an invention for a claimed combination would have been obvious, I may assess whether there are apparent reasons to combine known elements in the prior art in the manner claimed in view of interrelated teachings of multiple prior art references, the effects of demands known to the design community or present in the marketplace, and/or the background knowledge possessed by a person of ordinary skill in the art. I also understand that other principles may be relied on in evaluating whether a claimed invention would have been obvious, and that these principles include the following:

- A combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results;
- When a device or technology is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the

same field or in a different one, so that if a person of ordinary skill in the art can implement a predictable variation, the variation is likely obvious;

- If a technique has been used to improve one device, and a person of ordinary skill in the art would have recognized that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill;
- An explicit or implicit teaching, suggestion, or motivation to combine two prior art references to form the claimed combination may demonstrate obviousness, but proof of obviousness does not depend on or require showing a teaching, suggestion, or motivation to combine;
- Market demand, rather than scientific literature, can drive design trends and may show obviousness;
- In determining whether the subject matter of a patent claim would have been obvious, I understand that it is not a relevant matter what reasons or motivations caused the inventor to take a particular action or to include particular components;
- One of the ways in which a patent's subject can be shown to be obvious is by noting that there existed at the time of invention a known problem for which there was an obvious solution encompassed by the patent's claims;

- Any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed;
- “Common sense” teaches that familiar items may have obvious uses beyond their primary purposes, and in many cases a PHOSITA will be able to fit the teachings of multiple patents together like pieces of a puzzle;
- A PHOSITA is also a person of ordinary creativity, and is not an automaton;
- A patent claim can be proved obvious by showing that the claimed combination of elements was “obvious to try,” particularly when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions such that a PHOSITA would have had good reason to pursue the known options within his or her technical grasp; and
- One should be cautious of using hindsight in evaluating whether a claimed invention would have been obvious.

46. I understand that, in making a determination as to whether or not the claimed invention would have been obvious to a PHOSITA, the Board may consider certain objective factors if they are present, such as: commercial success of product(s) practicing the claimed invention; long-felt but unsolved need; teaching away; unexpected results; copying; and praise by others in the field. These factors

are generally referred to as “secondary considerations” or “objective indicia” of non-obviousness. I understand, however, that for such objective evidence to be relevant to the obviousness of a claim, there must be a causal relationship (called a “nexus”) between the claim and the evidence. I also understand that this nexus must be based on a novel element of the claim rather than something in the prior art. I also understand that there are instances when secondary considerations are unable to overcome primary evidence of obviousness (*e.g.*, motivation to combine with predictable results) that is sufficiently strong.

47. I have also been informed that when a range in the prior art discloses a range that overlaps with a claimed range, the range in the prior art renders the claimed range *prima facie* obvious. I understand that this means that if overlapping ranges are shown between the prior art and the patent claims, that the patentee must show that the range encompassed by the claim exhibits some unexpected or surprising results or that the differences between the ranges disclosed in the prior art and those recited in the patent claim are critical to the operation of the claimed subject matter.

#### **E. Analogous Art**

48. I understand that a consideration for an obviousness analysis is whether the prior art being relied upon is “analogous art.” I understand that to be analogous art, a prior art reference must either be (1) from the same field of endeavor as the

patent, or (2) if not from the same field, then it must still be reasonably pertinent to the particular problem with which the inventors were concerned.

## VI. THE QUALIFICATIONS OF THE PHOSITA

49. I have been asked to provide my opinion on the qualifications of the PHOSITA in the field of the '641 patent. I provide my opinion below. To reach my opinion, I have applied the legal framework summarized above. *Supra* §V. I have been instructed that the qualifications of a PHOSITA should be defined as of September 28, 2001.

50. I have reviewed the '641 patent, considered the prior art cited herein, and used my personal experience and education in formulating my opinions. The '641 patent relates to rechargeable lithium ion batteries, also known as “secondary” batteries. The premise of the alleged invention is that by choosing a proper ratio of positive electrode capacity to negative electrode capacity and increasing the charge cutoff voltage the “capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery” can be increased.<sup>25</sup> In large part, the '641 patent describes the components of the allegedly inventive battery as “conventional,” including:

- ***Positive Electrode.*** The '641 patent does not describe any allegedly

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<sup>25</sup> EX1001 ('641 pat.), 1:8-11, 3:7-15, 3:17-25.

inventive positive electrode materials. Instead, it says that “[t]he positive electrode active substance used in the present invention is lithium-containing compound” and while “the examples use lithium cobalt oxides (lithium cobalt composite oxides), lithium manganese oxides and lithium nickel oxides . . . it is understood that the practice of the present invention is not limited to the specific properties of said lithium-containing composite oxides, rather a wide range of positive electrode active substances can be used in the present invention.”<sup>26</sup> The positive electrode can use “conventional conducting agent and binder” materials and can be mixed in ratios “well known in the art.”<sup>27</sup>

- **Negative Electrode.** The negative electrode materials are “carbonaceous or non-carbonaceous substance[s] capable of doping and dedoping lithium ion . . . .”<sup>28</sup> Various known materials are identified including “graphite,” “coke,” and “mesophase asphalt based carbon fiber or mesophase asphalt based spherical carbon . . . .”<sup>29</sup> “The

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<sup>26</sup> *Id.*, 8:11-19.

<sup>27</sup> *Id.*, 8:38-41.

<sup>28</sup> *Id.*, 8:56-58.

<sup>29</sup> *Id.*, 8:64-9:4.

mesophase asphalt based carbon fiber or mesophase asphalt based spherical carbon can be obtained according to the conventional method.”<sup>30</sup>

- ***Separator.*** “The separator used in the present invention is a separator well known in the art.”<sup>31</sup>
- ***Electrolyte.*** “Without any specific restriction, non-aqueous electrolytes and shells of the type well known in the art can be used in the present invention.”<sup>32</sup>
- ***Charge and Discharge Parameters.*** “Except voltage, all process parameters for charge and discharge are commonly used in the art.”<sup>33</sup>
- ***Protecting Circuit.*** “The type and structure of the protecting circuit for said secondary lithium ion cell or battery shall not be specifically restricted, i.e., the well known structure can be used, provided” adjustments are made to accommodate the higher cutoff voltage.<sup>34</sup>

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<sup>30</sup> *Id.*, 9:5-7.

<sup>31</sup> *Id.*, 8:43-47.

<sup>32</sup> *Id.*, 9:8-10.

<sup>33</sup> *Id.*, 9:22-23.

<sup>34</sup> *Id.*, 9:29-36.

These conventional components and materials would have been something that those skilled in the art would have been aware of.

51. Additionally, the PHOSITA would have been aware of familiar battery failure modes including dendrite formation and metal plating which could lead to catastrophic battery failure and electrolyte oxidation and other forms of breakdown. These were critical pieces of knowledge for those working in the field because if mishandled or designed improperly, lithium-ion batteries could be quite dangerous and potentially cause explosions or fires. A PHOSITA would have thus been familiar with how to avoid potentially dangerous effects. I certainly would have expected people in my laboratories to be familiar with these things; otherwise working conditions could be unsafe. Based on my education, experience, the '641 patent, and the state of the art, it is my opinion that a PHOSITA would have had a Master's degree in material science, chemical engineering, chemistry, or a similar field and four years of experience designing, testing, and building secondary lithium batteries. Additional formal education focusing on secondary lithium batteries may substitute for practical experience and additional practical experience can substitute for less education. For instance, I also believe that someone with six years of industry experience and a Bachelor's degree is also going to have the skills of the ordinary skilled artisan.

## VII. OVERVIEW OF THE '641 PATENT

### A. The '641 Patent Description

52. The '641 patent is entitled “Secondary lithium ion cell or battery, and protecting circuit, electronic device, and charging device of the same.”<sup>35</sup> The '641 patent explains that by choosing a proper ratio of positive electrode capacity to negative electrode capacity and increasing the charge cutoff voltage the “capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery” can be increased.<sup>36</sup>

53. The allegedly inventive technique requires applying a cut-off voltage of greater than 4.2 V but less than 5.8 V and a “ratio of positive electrode material to negative electrode material of a single cell is from 1:1.0 to 1:2.5” as calculated by either the specific capacity or theoretic capacity with the charge voltage limited to 4.2 V.<sup>37</sup> The '641 patent attributes the ability to raise the cutoff voltage without damaging the battery or cell to having more capacity at the negative electrode than at the positive electrode—this “avoids the deposition of lithium ions on the surface of the negative electrode as metallic lithium” thus avoiding “attenuation of capacity

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<sup>35</sup> EX1001 ('641 pat.), [54].

<sup>36</sup> *Id.*, 1:8-11, 3:7-15, 3:17-25.

<sup>37</sup> *E.g., id.*, 3:17-33, 6:43-58.

of [the] cell.”<sup>38</sup> As I have explained above, this was a known technique used by battery designers to avoid the formation of dendrites or the deposition of lithium metal on the negative electrode. *Supra* §II.A, II.C.

54. The cells or batteries of the '641 patent are otherwise largely conventional as I explain above. *Supra* §VI. The positive electrode material can be chosen from “a wide range of positive electrode active substances” and “the practice of the present invention is not limited to the specific properties of said lithium-containing composite oxides.”<sup>39</sup> A “conventional conducting agent and binder” and the mixture ratios for the materials “can be those well known in the art.”<sup>40</sup> “The separator used in the present invention is a separator well known in the art.”<sup>41</sup> The anode can be “mesophase asphalt based spherical carbon” which may be “obtained according to the conventional method.”<sup>42</sup> Electrolytes and shells “of the type well known in the art can be used in the present invention.”<sup>43</sup> The charge and discharge

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<sup>38</sup> *Id.*, 4:64-5:7.

<sup>39</sup> *Id.*, 8:11-19.

<sup>40</sup> *Id.*, 8:38-41.

<sup>41</sup> *Id.*, 8:43-44.

<sup>42</sup> *Id.*, 9:5-7.

<sup>43</sup> *Id.*, 9:8-10.

parameters—except, allegedly, voltage—are “commonly used in the art.”<sup>44</sup> The “well known” type and structure of the voltage protection circuit can also be used.<sup>45</sup>

## **B. Effective Filing Date**

55. I have been asked to assume that the '641 patent is entitled to an effective filing date of no earlier than September 28, 2001. I have further been asked to assume that this is the date of the invention for purposes of my obviousness analysis.

## **VIII. THE CLAIMS OF THE '641 PATENT**

56. I have been asked to provide opinions related to the patentability of the claims of the '641 patent. The text of each claim is reproduced below with indicators to identify specific limitations of the claims.

57. Claim 1 of the '641 patent is called an “independent claim.” I understand that this means that the claim does not refer to any other claims.

### **58. Claim 1.**

[1P] A method for improving the capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery, characterized in that  
[1A] the charge cut-off voltage of the secondary lithium

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<sup>44</sup> *Id.*, 9:22-23.

<sup>45</sup> *Id.*, 9:29-36.

ion cell or battery is greater than 4.2 V but less than 5.8 V;  
and

**[1B]** a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5 as calculated by a specific capacity with a charge voltage limited to 4.2 V.

59. I understand that claim 2 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 1. Claim 2 provides:

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

60. I understand that claim 3 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 1. Claim 3 provides:

**Claim 3.** A method according to claim 1, characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is within a range from 4.3 V to 4.8 V.

61. I understand that claim 4 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 1. Claim 4 provides:

**Claim 4.** A method according to claim 1, characterized in that the ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.15 to 1:2.5.

62. Claim 5 of the '641 patent is an independent claim. Claim 5 provides:

**Claim 5. [5P]** A secondary lithium ion cell or battery,

[5A] characterized in that the secondary lithium ion cell or battery has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V, and<sup>46</sup>

[5B] a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5, as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2 V.<sup>47</sup>

63. I understand that claim 6 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 5. Claim 6 provides:

**Claim 6.** A secondary lithium ion cell or battery according to claim 5, characterized in that the secondary lithium ion cell or battery has a charge cut-off voltage within a range from 4.3 V to 5.2 V.

64. I understand that claim 7 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 5. Claim 7 provides:

**Claim 7.** A secondary lithium ion cell or battery according to claim 5, characterized in that the secondary lithium ion cell or battery has a charge cut-off voltage within a range from 4.3 V to 4.8. V.

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<sup>46</sup> Claims 1A and 5A are collectively referred to herein as the “Charge Cutoff Limitation.”

<sup>47</sup> Claims 1B and 5B are collectively referred to herein as the “Ratio Limitation.”

65. I understand that claim 8 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 5. Claim 8 provides:

**Claim 8.** A secondary lithium ion cell or battery according to claim 5, characterized in that the ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.15 to 1:2.5.

66. I understand that claim 9 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 5. Claim 9 provides:

**Claim 9.** A secondary lithium ion cell or battery according to claim 5, characterized in that the secondary lithium ion cell or battery has a first overcharging protection voltage of greater than 4.35 V, and an overcharging protection release voltage of greater than 4.15 V.

67. I understand that claim 10 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claims 5 and 9. Claim 10 provides:

**Claim 10.** A secondary lithium ion cell or battery according to claim 9, characterized in that the secondary lithium ion cell or battery has a first overcharging protection voltage of greater than 4.45 V, and an overcharge protection release voltage of greater than 4.25 V.

68. I understand that claim 11 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 5. Claim 11 provides:

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

69. I understand that claim 12 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 5. Claim 12 provides:

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

70. I understand that claim 13 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 5. Claim 13 provides:

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

71. I understand that claim 14 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 5. Claim 14 provides:

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

72. I understand that claim 15 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 1. Claim 15 provides:

**Claim 15.** A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 75% of capacity after 400 cycles.

73. I understand that claim 16 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 1. Claim 16 provides:

**Claim 16.** A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 75.83% of capacity after 400 cycles.

74. I understand that claim 17 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 1. Claim 17 provides:

**Claim 17.** A method according to claim 1, wherein the

secondary lithium ion cell or battery maintains at least 80% of capacity after 400 cycles.

75. I understand that claim 18 is a “dependent claim” and it includes all of the elements of the claim(s) to which it refers. Here, that is claim 1. Claim 18 provides:

**Claim 18.** A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 80.72% of capacity after 400.

## **IX. CLAIM CONSTRUCTION**

76. I have not been asked to render any opinions on claim construction. Instead, I was I was asked to apply certain claim constructions that I understand were provided by the Patent Owner in co-pending district court litigation involving the ’641 patent. I was also asked to apply a claim construction for the “method” of claim 1. I provide the claim constructions I was asked to apply in this proceeding below.

### **A. Element [1P]: “A method for improving . . . characterized in that”**

77. I have been asked to interpret the claimed “method for improving” to be satisfied in an instance when the device claimed after the “characterized in that” limitation is *used*. In other words, I was instructed to evaluate whether the prior art disclosed or rendered obvious using a secondary lithium ion cell or battery “characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V; and a ratio of positive electrode

material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5 as calculated by a specific capacity with a charge voltage limited to 4.2 V.”<sup>48</sup>

**B. “a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5 as calculated by a specific capacity with a charge voltage limited to 4.2 V” (claim 1); “a ratio of positive electrode material to negative electrode material as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2 V” (claim 5)**

78. I understand that Patent Owner has proposed the following interpretation of the requirement in claim 5 that the battery or cell have “a ratio of positive electrode material to negative electrode material as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2 V”:

the ratio calculated as the product of the capacity of the cathode active material per mass unit and the amount of the cathode active material in the same mass unit divided by the product of the capacity of the anode active material per mass unit and the amount of the anode active material in the same mass unit, when the charge cutoff voltage is 4.2 V.<sup>49</sup>

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<sup>48</sup> EX1001 (’641 pat.), 16:56-61.

<sup>49</sup> EX1016 (Exhibit A to Parties’ Joint Claim Construction and Prehearing Statement), p.4.

I have been instructed to apply this construction to the applicable phrase in claim 5 for the purposes of my analysis.

79. I have been asked to review a document bearing “Exhibit A-138” with the subtitle “Claim Chart for Note 10+.”<sup>50</sup> I have been informed that this document was provided by Patent Owner in co-pending litigation against Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. I was asked whether I believed that Patent Owner was applying the same interpretation of the two ratio phrases in claims 1 and 5.

80. After reviewing Exhibit 1017, I believe Patent Owner is interpreting the ratio requirement of claims 1 and 5 in the same way. First, as indicated above, Patent Owner’s proposed construction of the ratio limitation of claim 5 in litigation is that the ratio reflects a ratio of “capacity” of “active material” in the cathode and anode.<sup>51</sup> While Exhibit 1017 repeats the respective claim language of claims 1 and 5 in the allegations regarding the “Accused Device,”<sup>52</sup> to make the allegation that the same batteries practice both claims 1 and 5, the Patent Owner is interpreting both ratio

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<sup>50</sup> EX1017 (Exhibit A-138).

<sup>51</sup> EX1016 (Exhibit A to Parties’ Joint Claim Construction and Prehearing Statement), p.4.

<sup>52</sup> EX1017 (Exhibit A-138), pp.3-4, 8-9.

limitations in the same manner and treating both “specific capacity” and “theoretic capacity” as being a “capacity.” And, with respect to the difference between “charge voltage being limited to 4.2 V” (claim 1) and “charge cutoff voltage set at 4.2 V,” Exhibit 1017 indicates that Patent Owner is equating charge voltage being limited to a specific voltage and a charge cutoff voltage. For instance, in the allegation that the “Accused Device” includes a “charge cutoff-voltage of the secondary lithium ion cell or battery is within a range from 4.3 V to 5.2 V,” Exhibit 1017 says that “the batteries in the Accused Device are used in such a manner as to have a charging voltage of 4.4 V.”<sup>53</sup> This further confirms that Patent Owner is interpreting the ratio limitations of claims 1 and 5 in the same way.

81. Based on the understanding that Patent Owner is at least implicitly interpreting the ratio limitations of claims 1 and 5 in the same manner, I have been instructed to apply Patent Owner’s proposed interpretation of the ratio limitation of claim 5 to claim 1.

82. I have not been asked to and have not formulated any independent opinions of the meaning of these limitations of the claims. I understand that to do so I would need to apply legal principles of claim construction as discussed above. I

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<sup>53</sup> EX1017, p.4.

have not undertaken that exercise and instead am applying the interpretations that I have been instructed by counsel to apply.

**C. “at least 7500 of capacity” (claim 11)**

83. I have been instructed to interpret the language “at least 7500 of capacity” as meaning “at least 75% of capacity.” I have done so in rendering my opinions.

**X. PRIOR ART STATUS OF REFERENCES AND ANALOGOUS ART**

84. Unless indicated otherwise, I have been asked to presume that the various documents I identify in my analysis of the patentability of the claims are prior art. I have not undertaken an independent analysis of whether this is true unless otherwise noted.

85. I have been asked whether each of the Uemura (EX1009), Abe (EX1005), Guyomard (EX1008), and Iwaizono (EX1007) are “analogous art” to the ’641 patent. As discussed above, I understand and have been informed that a reference is “analogous art” when it is either: (1) from the same field of endeavor as the patent, or (2) if not from the same field, then it must still be reasonably pertinent to the particular problem with which the inventors were concerned. Each of these prior art references is analogous because they satisfy both of these requirements.

**A. The Field of Endeavor of the '641 Patent.**

86. To determine whether Uemura, Abe, Guyomard, and Iwaizono are analogous prior art, I first need to determine what the field of endeavor of the '641 patent is. This is clear from the patent itself from the section of the patent titled “TECHNICAL FIELD.”<sup>54</sup> That portion of the patent states

The present invention relates to a new method for improving capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery prepared by using the method, a protecting circuit adapted for the secondary lithium ion cell or battery, a electronic device using the secondary lithium ion cell or battery, and a charging device for the secondary lithium ion cell or battery.<sup>55</sup>

87. This passage indicates that the field of the invention is secondary lithium ion cells or batteries, “protecting circuit[s]” for those batteries, charging devices, and devices using those batteries. Moreover, the '641 patent reveals that a goal—or the particular problem with which the inventors were concerned—was to improve capacity, average operating voltage and specific energy of those batteries.

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<sup>54</sup> EX1001 ('641 pat.), 1:6-15.

<sup>55</sup> *Id.*, 1:8-15.

I observe that these are long-held goals for those working in the industry and is accomplished by increasing the charge cut-off voltage of the battery.<sup>56</sup>

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<sup>56</sup> The '641 patent purports to accomplish this by raising the charge cutoff voltage. It had been known long before the '641 patent that raising the charge cutoff voltage would improve battery performance. *See, e.g.*, EX1012 (Au), p.7 (“In figure 14, where the charge voltage was 4.25 volts, the initial capacity is approximately 12% higher than for the 4.1 volt charge cutoff voltage. . . . Additional cell cycling at these and slightly higher voltages should establish the charging voltage to achieve optimum capacity and cycle life.”); *id.*, p.8 (“[V]oltages as high as 4.25 volts appear to yield an acceptable cycle life.”). I note that the cells described in Au were designed for a cutoff voltage of 4.1 volts. *Id.*, p.1 (“Sony Charging Method. It consists of essentially a constant potential charge with a 1.1 ampere limit to 4.1 volts.”). Au is an Army Research Laboratory Report from December 1993. The '641 patent explains that by 2001 the commercially used voltages for LiCoO<sub>2</sub> cells was 4.2 V (not the 4.1 V initially used by Sony in its initial rocking-chair type lithium-ion cells)—thus showing that those in the field were raising the charge cutoff voltage. EX1001 ('641 pat.), 1:21-24 (“Up to 2000, the manufacturers of lithium ion battery around the world compete allsidedly for improving the competitive power of their products mainly around the key issue, the capacity of lithium ion battery.”), 1:46-49

**B. Uemura (EX1009) is Analogous Art.**

88. Uemura is in the same technical field of endeavor as the '641 patent. Specifically, Uemura is in the field of secondary lithium ion batteries. Uemura is titled "RECHARGEABLE LITHIUM BATTERY."<sup>57</sup> Uemura's Abstract states that "the rechargeable lithium battery having a large capacity and high cyclic resistance at high temperature can be provided by the use of Li deficient type lithium manganese oxide of a layer structure as a positive electrode material."<sup>58</sup> Uemura also explains that the "Field of the Invention" "relates to a non-aqueous electrolytic rechargeable lithium battery, more particularly, to a negative electrode material and a positive electrode material for improving cyclic resistance."<sup>59</sup>

89. Uemura is also reasonably pertinent to the problems that the '641 patent inventors were seeking to solve. For instance, Uemura is concerned with lithium ion cells for electric vehicles and explains that "a rechargeable lithium battery among

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("At present, the charge-cut-off voltage of single secondary lithium ion cell is limited to no more than 4.2 V, and this is well accepted as a technical requirement in the industry of manufacture of secondary lithium ion battery."), 2:38-41.

<sup>57</sup> EX1009 (Uemura), [54].

<sup>58</sup> *Id.*, Abstract.

<sup>59</sup> *Id.*, ¶¶[0001]-[0002].

various secondary batteries has been expected as a secondary battery for an electric vehicle because it has a high charge-discharge voltage and a large charge-discharge capacity.”<sup>60</sup> Like the ’641 patent, Uemura discloses the use of a lithium manganese complex oxide material as the positive electrode material.<sup>61</sup> And like the ’641 patent, the positive electrode material is not particularly limited.<sup>62</sup>

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<sup>60</sup> *Id.*, ¶[0004].

<sup>61</sup> EX1009 (Uemura), ¶[0035] (“A type of the positive electrode material used in combination with the negative electrode material described above is not particularly limited, but Li deficient type lithium manganese complex oxide of a layer structure which is represented by a general formula  $\text{Li}_{1-x}\text{MnO}_2$ ,  $\text{Li}_{1-x}\text{Mn}_{1-y}\text{O}_2$  or  $\text{Li}_{1-x}\text{Mn}_{1-y}\text{M}_y\text{O}_{2-\delta}$ , is desirably used.”); EX1001 (’641 pat.), 8:31-38 (“Among these positive electrode materials, . . . lithium manganese composite oxides (such as  $\text{LiMn}_2\text{O}_4$ ) . . . and lithium manganese cobalt composite oxides (such as  $\text{LiMn}_x\text{Co}_{1-x}\text{O}_2$ ), which have higher cell voltage, are preferably used.”).

<sup>62</sup> EX1009 (Uemura), ¶[0035] (“A type of the positive electrode material used in combination with the negative electrode material described above is not particularly limited . . . .”); EX1001 (’641 pat.), 8:11-19 (“The positive electrode active substance used in the present invention is lithium-containing compound. Although the examples use lithium cobalt oxides (lithium cobalt composite oxides), lithium

90. And, like the '641 patent, Uemura also uses a charge cutoff voltage of greater than 4.2V and describes adjusting the ratio of the positive electrode material capacity to the negative electrode material capacity. Specifically, Uemura explains that:

Furthermore, a capacity balance ratio  $B/A$  of the total capacity  $B$  of the negative electrode material to the total capacity  $A$  of the positive electrode material is preferably fixed at a range of 1 to 1.5. If the capacity balance ratio  $B/A$  is below 1, lithium ion holding sites on the negative electrode material becomes insufficient. As the result, branch-shaped or needle-shaped crystal (dendrite crystal) tends to occur during the charge to cause a short circuit phenomenon between the positive electrode and the negative electrode. If the capacity balance ratio  $B/A$  exceeds 1.5, negative electrode sites that do not contribute to the charge-discharge are increased, leading to the wasteful use of materials.<sup>63</sup>

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manganese oxides and lithium nickel oxides as positive electrode material, it is understood that the practice of the present invention is not limited to the specific properties of said lithium-containing composite oxides, rather a wide range of positive electrode active substance can be used in the present invention.”).

<sup>63</sup> EX1009 (Uemura), ¶[0033].

The charge-discharge was repeatedly performed at a constant current of 0.5 mA/cm<sup>2</sup> and a voltage ranging from 4.3 V to 2.0 V at an atmospheric temperature of 60°C. by the use of the made sealed type non-aqueous solvent battery cell.<sup>64</sup>

91. Uemura is in the same technical field of endeavor as the '641 patent and is reasonably pertinent to the problems that the '641 patent inventors were seeking to solve. It is analogous art. In fact, as I explain in more detail below, it provides the same teachings to the PHOSITA that the '641 patent claims as being the alleged invention in many claims.

**C. Abe (EX1005) is Analogous Art.**

92. Abe is analogous art to the '641 patent because it is in the same field of endeavor and is at least reasonably pertinent to the problem being solved by the inventors of the '641 patent as I explain below. I note here that I do not read Japanese and I understand that Abe is written in Japanese.<sup>65</sup> I have been provided a translation of the Abe reference and I have relied upon that translation in rendering my opinions.<sup>66</sup>

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<sup>64</sup> *Id.*, ¶[0081].

<sup>65</sup> EX1005 (Abe), pp.3-13.

<sup>66</sup> EX1005 (Abe), pp.15-31. This document includes a declaration that attests to the accuracy of the translation that I have relied upon. *Id.*, p.1.

93. Abe is titled “NON-AQUEOUS ELECTROLYTE-BASED SECONDARY BATTERY.”<sup>67</sup> In the “Field of the Invention” section, Abe states: “The present invention relates to non-aqueous electrolyte system secondary batteries, and more particularly to non-aqueous electrolyte system secondary batteries with improved safety and load characteristics.”<sup>68</sup> Like the ’641 patent, Abe explains that the positive electrode can be either “lithium-containing composite oxides” or “LiMn<sub>2</sub>O<sub>4</sub>.”<sup>69</sup>

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<sup>67</sup> *Id.*, [54].

<sup>68</sup> *Id.*, ¶[0001].

<sup>69</sup> EX1005 (Abe), ¶¶[0006], [0018], [0060] (“[m]ore preferred lithium-containing composite oxides include, for example, lithium cobaltate (LiCoO<sub>2</sub>, lithium manganate (LiMn<sub>2</sub>O<sub>4</sub>), lithium nickelate (LiNiO<sub>2</sub>), etc. The lithium-containing composite oxide can also be used alone or in combinations of two or more.”); EX1001 (’641 pat.), 8:11-19 (“The positive electrode active substance used in the present invention is lithium-containing compound. Although the examples use lithium cobalt oxides (lithium cobalt composite oxides), lithium manganese oxides and lithium nickel oxides as positive electrode material, it is understood that the practice of the present invention is not limited to the specific properties of said lithium-containing composite oxides, rather a wide range of positive electrode active

94. Abe is also reasonably pertinent to the problems that the inventors of the '641 patent sought to solve. Specifically, in Abe's "Problems to be Solved by the Invention" section, Abe explains that "non-aqueous electrolyte-based secondary batteries with high energy density and excellent cycle characteristics have attracted attention as large-scale batteries, such as batteries for electric vehicles and household power storage systems."<sup>70</sup> Abe further recognizes that when the voltage applied to these batteries is such that the battery enters an "overcharge" state dendrites can form based on the precipitation of lithium on the negative electrode.<sup>71</sup> This problem is

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substance can be used in the present invention."), 8:31-38 ("Among these positive electrode materials, . . . lithium manganese composite oxides (such as  $\text{LiMn}_2\text{O}_4$ ) . . . which have higher cell voltage, are preferably used.").

<sup>70</sup> EX1005 (Abe), ¶[0008].

<sup>71</sup> *Id.*, ¶[0009] ("Incidentally, in general, in the case of overcharging lithium-ion secondary batteries or when the charging current is increased, etc., needle-like lithium may be precipitated on the surface of the negative electrode, interposed between the positive electrode and the negative electrode, making it easier to break through the separator and short out. As a result, lithium-ion secondary batteries may also explode and ignite.").

recognized in the '641 patent too.<sup>72</sup> Another problem recognized by Abe is that electrolytes can break down thus reducing the cycle life of the lithium-ion battery.<sup>73</sup> This problem is also recognized by the '641 patent.<sup>74</sup>

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<sup>72</sup> EX1001 ('641 pat.), 4:57-64 (“After the elevation of charge cut-off voltage, the amount of lithium ion dedoped from the positive electrode greatly increases, which renders an unmatched state to the original negative electrode material and deposition of excessive lithium ions on the surface of negative electrode as metallic lithium, which jam part of the channel for passing lithium ions and result in the reduction of capacity and the deterioration of recycle property.”).

<sup>73</sup> EX1005 (Abe), ¶[0009] (“In the case where the electrolyte has broken down due to overcharging, the cycle life of the lithium-ion secondary battery is reduced.”).

<sup>74</sup> EX1001 ('641 pat.), 2:54-57 (“The elevated charge cut-off voltage may decompose the electrolyte solution, and the loss of electrolyte solution renders the transportation of lithium ion more difficult, and thus the recycle life of cell is seriously affected.”), 5:19-25 (“Within a certain range of charge cut-off voltage, the decomposition of little electrolyte solution brings about negligible effect on the recycle property of the cell. . . . The decomposition of electrolyte solution mainly occurs on the positive electrode.”).

95. Abe is in the same technical field of endeavor as the '641 patent and is reasonably pertinent to the problems that the '641 patent inventors were seeking to solve. It is analogous art. In fact, as I explain in more detail below, it provides the same teachings to the PHOSITA that the '641 patent claims as being the alleged invention in many claims.

**D. Guyomard (EX1008) is Analogous Art.**

96. Guyomard is analogous art to the '641 patent because it is in the same field of endeavor and is at least reasonably pertinent to the problem being solved by the inventors of the '641 patent as I explain below.

97. Guyomard is in the same technical field of endeavor because it relates to secondary lithium ion batteries and relates to solutions for increasing the charge cut-off voltage. Guyomard is titled “HIGH-VOLTAGE STABLE ELECTROLYTES FOR  $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$ /CARBON SECONDARY BATTERIES.”<sup>75</sup> Guyomard explains that “[t]his invention relates to non-aqueous electrolyte compositions for secondary (rechargeable) lithium battery cells and, more particularly, to electrolyte compositions that are capable of resisting decomposition normally resulting from oxidation which occurs in  $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$  / carbon cells during

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<sup>75</sup> EX1008 (Guyomard), [54].

recharging under conditions of greater than about 4.5 V or 55°C.”<sup>76</sup> Like the ’641 patent, Guyomard describes “rocking-chair” batteries “in which lithium ions ‘rock’ between the intercalation electrodes during the charging/recharging cycles.”<sup>77</sup> And, like the ’641 patent, Guyomard describes using lithium manganese oxide as the positive electrode material and carbon as the negative electrode material.<sup>78</sup>

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<sup>76</sup> *Id.*, 1:9-15.

<sup>77</sup> EX1008 (Guyomard), 1:20-26; *see* EX1001 (’641 pat.), 4:57-5:18.

<sup>78</sup> EX1008 (Guyomard), 2:3-6 (“Among the alternative materials that can effectively replace lithium metal as the negative electrode, carbon provides the best compromise between large specific capacity and good reverse cycling behavior.”), 2:11-18 (“To compensate for the loss of voltage associated with the negative electrode, a strongly oxidizing intercalation material is preferably used as the positive electrode. Such an electrode material is the spinel phase  $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$ , usually combined with a small amount of carbon black to improve electrical conductivity and provide the practical composite electrode, that can reversibly intercalate lithium at a voltage of 4.1 V vs. Li.”); EX1001 (’641 pat.), 8:11-19 (“The positive electrode active substance used in the present invention is lithium-containing compound. Although the examples use lithium cobalt oxides (lithium cobalt composite oxides), lithium manganese oxides and lithium nickel oxides as positive electrode material, it is understood that the

98. Guyomard is reasonably pertinent to the problems that the '641 patent inventors were seeking to solve because it describes techniques for raising the charge cutoff voltage of secondary lithium ion cells. Guyomard observes that “[w]hen cells comprising these previously-available electrolytes are cycled to a voltage even slightly greater than 4.3 V, electrolyte oxidation occurs. Although small, this oxidation can jeopardize the capacity, cycle life, and safety of the battery cell.”<sup>79</sup> According to Guyomard the invention was in the identification of a class of electrolytes that was particularly well suited for use with strongly oxidizing positive electrode materials that was useful over broad temperature, have a high ionic

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practice of the present invention is not limited to the specific properties of said lithium-containing composite oxides, rather a wide range of positive electrode active substance can be used in the present invention.”), 8:31-38 (“Among these positive electrode materials, . . . lithium manganese composite oxides (such as  $\text{LiMn}_2\text{O}_4$ ) . . . which have higher cell voltage, are preferably used.”), 12:60-64 (“Using lithium manganese oxide as positive electrode active material. Lithium ion cells are prepared according to the aforesaid method, wherein the positive electrode slurry consists of 4 g lithium manganese oxide, 0.6 g carbon black, . . .”).

<sup>79</sup> EX1008 (Guyomard), 3:9-13.

conductivity, and should avoid oxidation even at high charge cutoff voltages.<sup>80</sup> The charge cutoff voltages achievable using Guyomard's electrolyte in connection with the lithium manganese oxide/carbon cells was "up to about 5 V vs. Li," thus showing that Guyomard was directed to achieving higher voltage cells with greater specific energy, average operating voltages, and overall cell capacity.<sup>81</sup> Indeed, "[t]he ability

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<sup>80</sup> *Id.*, 3:34-37 ("The present invention provides a class of electrolyte compositions that is exceptionally useful in minimizing electrolyte decomposition in secondary batteries comprising strongly oxidizing positive electrode materials."), 4:13-16 ("Ideally, the temperature range of fluidity should be broad, the ionic conductivity should be high, and the charging cut-off voltage which avoids electrolyte oxidation should be high.").

<sup>81</sup> *Id.*, 8:10-21 ("The outstanding oxidation resistant characteristics of the preferred electrolyte compositions may be observed, with reference to the earlier-noted  $\text{LiClO}_4$  composition, in FIG. 3 at room temperature and in FIG. 4 at 55°C. The negligible current increase, after the reversible Li intercalations, at voltages up to about 5 V vs. Li indicates this remarkable stability which enables enhanced cell capacity not only in the 'rocking chair' cells comprising negative electrodes of carbon, e.g., petroleum coke, but also in Li negative electrode cells. Such a lithium metal cell utilizing a  $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$  positive electrode may be reasonably expected to

of [Guyomard's] electrolyte to extend the cycle life of the batteries was amply demonstrated by the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.”<sup>82</sup> Both Guyomard and the '641 patent are directed to solving the problem of maintaining high capacity after a number of cycles.<sup>83</sup>

99. Guyomard is thus in the same technical field of endeavor as the '641 patent and is reasonably pertinent to the problems that the '641 patent inventors were seeking to solve. It is analogous art.

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achieve normal operating ranges of about 4.3 to 5.1 V.”).

<sup>82</sup> *Id.*, 9:5-8.

<sup>83</sup> EX1008, 9:5-8; EX1001 ('641 pat.), 7:1-8 (“It can be seen that the capacity, specific energy and average operating voltage of secondary lithium ion cell can be greatly improved by elevating the charge cut-off voltage and by appropriately adjusting the ratio of positive electrode material to negative electrode material calculated by the theoretical capacity, while the recycle property of cell is not affected, which renders the lithium ion cell possess more commercial value and broader application range.”).

**E. Iwaizono (EX1007) is Analogous Art.**

100. One of the aspects of the '641 patent relates to “a protecting circuit adapted for the secondary lithium ion cell or battery.”<sup>84</sup> The '641 patent mentions that it is an “object of the present invention is to provide a protecting circuit adapted for the secondary lithium ion cell or battery, said protecting circuit having a first overcharging protection voltage of greater than 4.35 V, and an overcharge release voltage of greater than 4.15 V.”<sup>85</sup> While the “type and structure of the protecting circuit for said secondary lithium ion cell or battery shall not be specifically restricted” the voltages are adjusted to provide proper voltages to accommodate the higher cutoff voltage.<sup>86</sup> Thus, protection circuits used in secondary batteries is part of the field of endeavor of the '641 patent.

101. Iwaizono is in this field of endeavor. Specifically, Iwaizono describes “[a] protective circuit for protecting a rechargeable battery from battery breakdown caused by prolonged overcharging . . . .”<sup>87</sup> “The present invention relates to a protective circuit and a protective element incorporated therein for protecting a

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<sup>84</sup> EX1001 ('641 pat.), 1:11-13.

<sup>85</sup> *Id.*, 3:34-38.

<sup>86</sup> *Id.*, 9:24-36.

<sup>87</sup> EX1007 (Iwaizono), Abstract.

rechargeable battery such as a lithium ion rechargeable battery against overcharging.”<sup>88</sup>

102. Iwaizono also addresses problems that are reasonably pertinent to the problems allegedly being solved by the ’641 patent inventors. Specifically, both Iwaizono and the ’641 patent seek to avoid damage to the batteries caused by overcharging. For instance, Iwaizono explains:

Charging of rechargeable batteries beyond their suitable charge conditions leads to the generation of gas or heat due to decomposition of electrolyte and may cause breakdown or deterioration of the battery. Lithium-based rechargeable batteries are particularly susceptible to deterioration or damage when operated at a voltage exceeding a predetermined range. It is therefore the normal practice to provide a battery protection device for protecting the battery from improper use.<sup>89</sup>

\* \* \* \* \*

The proper operation of an overcharging protective circuit is essential with rechargeable batteries of high energy density, such as a lithium ion rechargeable battery, and it is necessary to be able to ensure the reliability of individual batteries or battery packs by testing the

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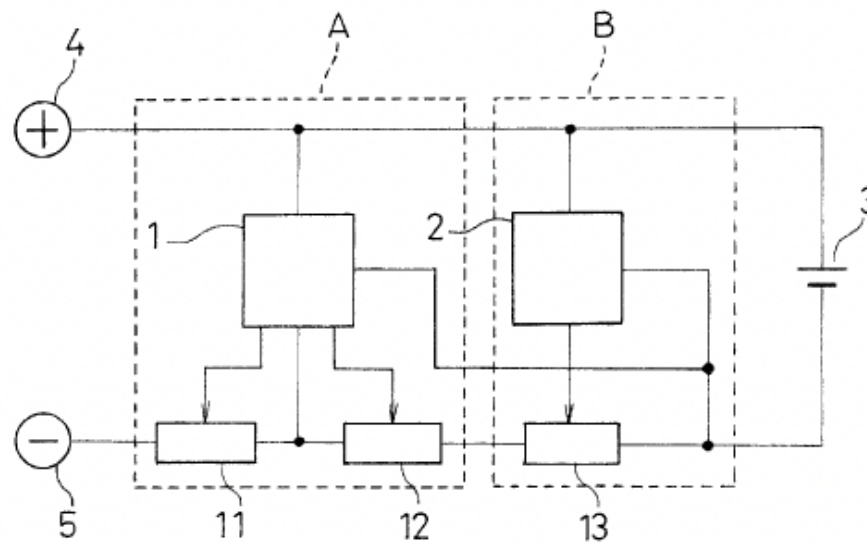
<sup>88</sup> *Id.*, 1:6-10.

<sup>89</sup> *Id.*, 1:10-19.

operation of the protective circuit.<sup>90</sup>

\* \* \* \* \*

FIG. 1 is a block diagram of the structure of the battery protective circuit according to a first embodiment of the present invention. A rechargeable battery 3, comprising a lithium ion rechargeable battery here, is equipped with a main protective circuit A that protects the battery against overcharging, overdischarging, and over-current, and a sub-protective circuit B that redundantly protects the rechargeable battery 3 against overcharging in conjunction with the main protective circuit A.<sup>91</sup>



<sup>90</sup> *Id.*, 2:31-36.

<sup>91</sup> *Id.*, 9:31-39, FIG. 1.

103. Iwaizono is thus in the same technical field of endeavor as the '641 patent and is reasonably pertinent to the problems that the '641 patent inventors were seeking to solve. It is analogous art.

## **XI. DETAILED DISCUSSION OF MY OPINIONS REGARDING INVALIDITY.**

104. In the sections below, I explain in detail how claims 1-18 of the '641 patent are not patentable over the prior art.

### **A. Ground 1: Uemura Anticipates Claims 1-8.**

105. Uemura describes a lithium-ion cell or battery that has all of the features required by claims 1-8 of the '641 patent based on the claim constructions I was asked to apply. This means that these claims are “anticipated” by Uemura. In the following sections I provide a detailed discussion of how Uemura discloses each of the limitations of claims 1-8.

#### *1. Claims 1 and 5*

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

**[5P]: “A secondary lithium ion cell or battery, characterized in that”**

106. I understand these aspects of claims 1 and 5 are called the “preambles” of claims 1 and 5. I understand and have been informed that certain legal rules apply to determine whether or not a claims preamble provides a limitation of the claim. I

have not been asked to apply those legal principles in my analysis. I have instead been asked to presume that these preambles are limiting.

107. As discussed above, I have been instructed to interpret the “method” of claim 1 as a method of using the device recited after the “characterized in that” phrase. *Supra* §IX.A. I do that here and note that Uemura describes the use of the batteries disclosed in the reference because those batteries are cycled—meaning that they are charged and discharged repeatedly.<sup>92</sup>

108. Uemura’s batteries improve the capacity, average operating voltage, and specific energy of a lithium ion cell or battery. The ’641 patent explains that these characteristics are improved by increasing the charge cutoff voltage above 4.2 V and using the disclosed ratio of positive electrode material to negative electrode material. For instance, the ’641 patent states that the “method for improving capacity, average operating voltage and specific energy of a secondary lithium ion

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<sup>92</sup> EX1009 (Uemura), ¶[0081] (“The charge-discharge was repeatedly performed at a constant current of 0.5 mA/cm<sup>2</sup> and a voltage ranging from 4.3 V to 2.0 V at an atmospheric temperature of 60°C. by the use of the made sealed type non-aqueous solvent battery cell. The number of cycles taken to a point where the discharge capacity becomes less than 90% of the initial discharge capacity was obtained.”), FIG. 3.

battery or cell” is “achieved by means of properly adjusting the ratio between a positive material and negative material . . . and properly increasing charge cut-off voltage.”<sup>93</sup> Further according to the ’641 patent lower capacities in commercial lithium-ion cells were due to “the limitation of charge-cutoff voltage commonly used in the art.”<sup>94</sup> The inventors apparently understood that the state of the art was a cutoff voltage of 4.2 V.<sup>95</sup> Here, Uemura teaches a charge cutoff voltage of 4.3 V and, as I explain in more detail below, Uemura also teaches adjusting the ratio of the positive electrode material capacity to the negative electrode material capacity to achieve the same results articulated by the ’641 patent.<sup>96</sup>

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<sup>93</sup> EX1001 (’641 pat.), Abstract.

<sup>94</sup> *Id.*, 1:44-45.

<sup>95</sup> *Id.*, 1:64-67 (“For instance, as to lithium cobalt oxides that is used as positive electrode material in the most commercial lithium ion batteries, the charge cut-off voltage is limited to below 4.2 V . . .”), 2:38-41 (“In 1990, Sony Corporation issued the lithium ion cell using coke as the negative electrode, which has a charge cut-off voltage of not more than 4.20 V, and it is accepted as a common technical requirement of lithium ion cells thereafter.”).

<sup>96</sup> EX1009 (Uemura), ¶¶[0033], [0081]; EX1001 (’641 pat.), 4:57-5:18.

109. Uemura also discloses a “secondary lithium ion cell or battery” throughout its disclosure. For instance, Uemura refers to a “rechargeable lithium battery.”<sup>97</sup> Rechargeable batteries are also known as “secondary” batteries.<sup>98</sup> Uemura also explains that in a “rechargeable lithium battery, lithium ions” move back and forth between a positive electrode and a negative electrode during charging and discharging of the battery.<sup>99</sup> Uemura’s batteries have high cyclability at a cutoff

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<sup>97</sup> EX1009 (Uemura), ¶[0002].

<sup>98</sup> *Id.*, ¶[0004] (“As a power source for such an electric vehicle, a rechargeable lithium battery among various secondary batteries has been expected as a secondary battery for an electric vehicle because it has a high charge-discharge voltage and a large charge-discharge capacity.”); *see also* EX1008 (Guyomard), 1:9-10 (“This invention relates to non-aqueous electrolyte compositions for secondary (rechargeable) lithium battery cells . . . .”); EX1015 (Guyomard-1992), p.947 (“In this study we optimized the behavior of rechargeable rocking-chair secondary cells . . . .”); EX1019 (U.S. Pat. App. Pub. No. 2003/0118912), Abstract (“In a rechargeable non-aqueous electrolyte secondary battery using positive electrodes, negative electrodes and a non-aqueous electrolytic solution . . . .”).

<sup>99</sup> EX1009 (Uemura), ¶[0021].

voltage of 4.3 V.<sup>100</sup> Therefore, the battery described by Uemura is a secondary (rechargeable) lithium ion battery.

110. Uemura describes its rechargeable battery as having “a large capacity.”<sup>101</sup> By using certain positive electrode materials disclosed in Uemura, “the capacity of the battery can be increased and the resistance thereof can be improved in comparison with a typical active material of spinel structure.”<sup>102</sup>

111. Uemura also describes repeatedly charging a battery to a charge cutoff voltage of 4.3V and discharging the battery to 2.0V.<sup>103</sup> The charge cutoff voltage of 4.3V is higher than a charge cutoff voltage of 4.2V of other batteries at the time, such as those discussed in the Background Art section of the '641 patent.<sup>104</sup> The higher cutoff voltage (i.e., 4.3 V, which is higher than 4.2 V) as described in Uemura results in an increase in the specific energy as reflected by the fact that the '641

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<sup>100</sup> EX1009 (Uemura), FIG. 3 (right-most column providing results of cycling tests), ¶[0081] (explaining that the battery was cycled to 4.3 V and the number of cycles until the remaining capacity was 90% of the initial capacity).

<sup>101</sup> *Id.*, Abstract & ¶[0012].

<sup>102</sup> *Id.*, ¶[0039].

<sup>103</sup> *Id.*, ¶[0081], FIG. 3.

<sup>104</sup> EX1001 ('641 pat.), 1:46-67.

patent recognizes that the specific energy is “increased” by increasing voltage as I explained above.

112. Therefore, Uemura discloses a method of improving the capacity, average operating voltage, and specific energy of a secondary lithium ion cell or battery. Uemura also discloses a secondary lithium ion cell or battery. And, Uemura discloses cycling the secondary lithium-ion battery thus describing its use to the PHOSITA. Based on this, Uemura discloses the preambles of claims 1 and 5.

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

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

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

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<sup>105</sup> EX1009 (Uemura), ¶[0081].

**[1B]: “a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5 as calculated by a specific capacity with a charge voltage limited to 4.2 V”**

**[5B]: “a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5, as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2 V.”**

114. Uemura describes a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery that is from 1:1.0 to 1:2.5 as calculated by a capacity with a charge cut-off voltage set at 4.2 V under the claim construction I understand the Patent Owner has proposed in litigation and which I have been asked to apply here. The reasons for my conclusion are explained here in four subparts. First, I explain how Uemura discloses the claimed ratio under the claim construction advanced by the Patent Owner. Second, I explain why Uemura’s ratio would have been understood to have been calculated at a charge cut-off voltage of 4.3 V—and not 4.2 V as recited in the ’641 patent claims. Third, I explain why Uemura’s ratio would have fallen within the range of the ’641 patent when determined at a charge cutoff voltage of 4.2 V instead of 4.3 V. Fourth, I show that the rationale that Uemura provides for setting the ratio to be within the claimed range is the same as that discussed by the ’641 patent further showing that the Uemura ratio is the same as that recited in these claims.

115. (1) *Uemura discloses the capacity ratio calculated as required by the claim construction I was asked to apply.* There are two aspects of Uemura that are significant to my analysis. The first is found at paragraph 33 and provides:

Furthermore, a capacity balance ratio  $B/A$  of the total capacity  $B$  of the negative electrode material to the total capacity  $A$  of the positive electrode material is preferably fixed at a range of 1 to 1.5. If the capacity balance ratio  $B/A$  is below 1, lithium ion holding sites on the negative electrode material becomes insufficient. As the result, branch-shaped or needle-shaped crystal (dendrite crystal) tends to occur during the charge to cause a short circuit phenomenon between the positive electrode and the negative electrode. If the capacity balance ratio  $B/A$  exceeds 1.5, negative electrode sites that do not contribute to the charge-discharge are increased leading to the wasteful use of materials.<sup>106</sup>

Additionally, Uemura FIG. 3—which is also referred to as “Table 1” by Uemura—provides Capacity balance  $P_c:N_c$ , similar to  $B/A$ , where both  $P_c$  and  $A$  are fixed at 1, and where  $N_c$  is equivalent to  $B$ :<sup>107</sup>

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<sup>106</sup> EX1009 (Uemura), ¶[0033].

<sup>107</sup> *Id.*, FIG. 3, ¶[0081] (“The number of cycles taken to a point where the discharge capacity becomes less than 90% of the initial discharge capacity was obtained. Thus,

FIG.3

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

the resistance was evaluated. A result thereof is shown in Table 1 together with the other values.”). I observe that a couple of examples have obvious errors in them. For instance, some of the values in the “Capacity balance” column of Uemura FIG. 3 appear to incorrectly list 1:1.3 when they should be listed as 1:1.1 (*see, e.g.,* Examples 6-13 and 15-17). This can be seen by dividing the “Total capacity” values in the table (*e.g.,* in example 6 2.36 divided by 2.24 works out to 1.053, which rounds to 1:1.1). However, there are examples included in FIG. 3 that correctly list 1:1, 1:1.3, and 1:1.5 (*see, e.g.,* Examples 1-5 and 14).

116. These aspects of Uemura disclose the ratio under the claim construction I was asked to apply in my analysis. Under that construction the claimed capacity ratio limitation means: “the ratio calculated as the product of the capacity of the cathode active material per mass unit and the amount of cathode active material in the same mass unit divided by the product of the capacity of the anode active material per mass unit at the amount of the anode active material in the same mass unit.” In other words, the value on the positive side of the expression is specified in terms of, for example,  $\frac{mAh}{g}$  times the mass of the positive electrode (cathode) active material in grams, which yields units of  $mAh$ . Using Uemura’s Example 1

$$P_c(mAh) = 1.8 mAh$$

$$mass = 15 mg = 0.015 g$$

$$\frac{1.8 mAh}{0.015 g} = 120 \frac{mAh}{g}$$

From this, one can see that the capacity of Uemura example 1 capacity of the cathode active material per mass unit is  $120 \frac{mAh}{g}$  and when the product of this and the amount of cathode active material in the same mass unit (i.e., grams) is taken this yields 1.8  $mAh$ . Thus, on the cathode side of the expression we have 1.8. The same exercise can be performed on Uemura’s anode material:

$$N_c(mAh) = 2.36 mAh$$

$$mass = 6.2 mg = 0.0062 g$$

$$\frac{2.36 \text{ mAh}}{0.0062 \text{ g}} = 380.65 \frac{\text{mAh}}{\text{g}}$$

Thus, on the right hand side of the ratio associated with the capacity of the negative electrode (anode), we see that the capacity of the anode active material per mass unit is  $380.65 \frac{\text{mAh}}{\text{g}}$  and when the product of this and the amount of anode active material in the same mass unit (i.e., grams) is taken this yields  $2.36 \text{ mAh}$ . Thus the ratio of positive to negative electrode capacities can be expressed as 1.8:2.36 or, normalizing the left hand side of the expression to 1:

$$1.8:2.36 = \frac{1.8}{1.8} : \frac{2.36}{1.8} = 1:1.31 \cong 1:1.3$$

In other words, the ratio of positive to negative electrode material taught by Uemura is calculated as recited in claims 1 and 5 under the claim construction I was asked to apply.

117. *(2) Uemura’s capacity ratio is calculated at the voltage it is intended to operate at—i.e., 4.3 V.* A PHOSITA approaching Uemura’s disclosure would have understood that Uemura calculates capacities at the voltage Uemura’s battery is designed to operate at—specifically 4.3 V.<sup>108</sup> The PHOSITA would have reached

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<sup>108</sup> See EX1009 (Uemura), ¶[0081] (“The charge-discharge was repeatedly performed at a constant current of 0.5 mA/cm<sup>2</sup> and a voltage ranging from 4.3 V to

this conclusion based on how Uemura explains the consequences of having a capacity ratio of less than 1:1. In this respect, Uemura says:

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

118. Because Uemura's charge cutoff voltage is 4.3 V, this passage tells the PHOSITA that the "capacity balance ratio" is determined at 4.3 V. This is because those skilled in the art were aware that the voltage bears a direct relationship to the amount of lithium extracted from the cathode material.<sup>110</sup> This can be seen from

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2.0 V at an atmospheric temperature of 60°C. by the use of the made sealed type non-aqueous solvent battery cell.”).

<sup>109</sup> EX1009 (Uemura), ¶[0033].

<sup>110</sup> EX1019 (U.S. Pat. App. Pub. No. 2003/0118912), ¶[0005] (indicating that when excess “charging voltage” is applied and batteries “are in overcharged state,” “lithium ions in the positive electrode are excessively extracted”). This is recognized by the '641 patent too. EX1001 ('641 pat.), 2:3-8 (“[a]ccording to MIZUSHIMAK et al. . . . the quantity of dedoped lithium ion increases with the increase of charge voltage, and the electrochemical capacity of lithium cobalt oxides increases

numerous publications, such as J. M. Tarascon & D. Guyomard, *The  $Li_{1+x}Mn_2O_4/C$  Rocking-Chair System: A Review*, *Electrochimica Acta*, Vol. 38, No. 9, pp.1221-1231 (1993).<sup>111</sup> The Tarascon paper shows the “typical cycling behavior at 25 and 55°C for a  $LiMn_2O_4/EC+DEE(50:50) + 1\text{ M }LiClO_4/Li(a) \dots$ .”<sup>112</sup> Tarascon provides the following plot to show the charge and discharge properties of the  $Li_xMn_2O_4$  positive electrode:<sup>113</sup>

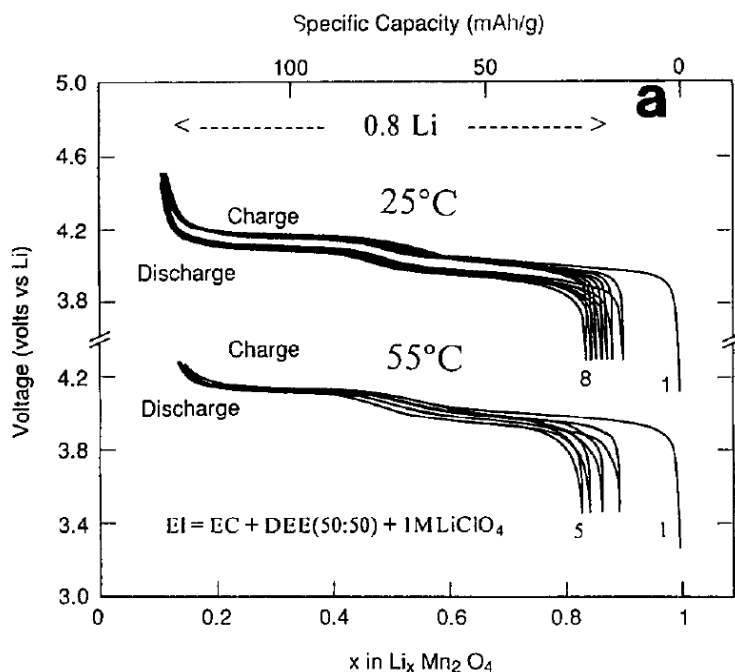
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accordingly.”).

<sup>111</sup> EX1024. I am personally familiar with this paper and have been for many years. I know Tarascon and Guyomard from collaborations that Moli Energy did with AT&T Bell Labs and further note that my work is cited in this paper. *See* EX1024 (Tarascon), p.1230 (footnote 17). This paper would have been known to the PHOSITA before the date of the invention in September 2001.

<sup>112</sup> EX1024 (Tarascon), p.1223.

<sup>113</sup> *Id.* (Fig. 3(a)).



As can be seen here, as the voltage is increased, the specific capacity increases. This is shown by the y-axis which reflects the applied voltage and the top x-axis which shows the specific capacity increasing from right to left. The higher the voltage, the more specific capacity the  $\text{Li}_x\text{Mn}_2\text{O}_4$  will have because of the amount of lithium that is extracted at the higher voltage.

119. A similar figure is found in Guyomard-1992 again showing that higher voltage results in a higher specific capacity.<sup>114</sup>

<sup>114</sup> EX1015 (Guyomard-1992), p.939.

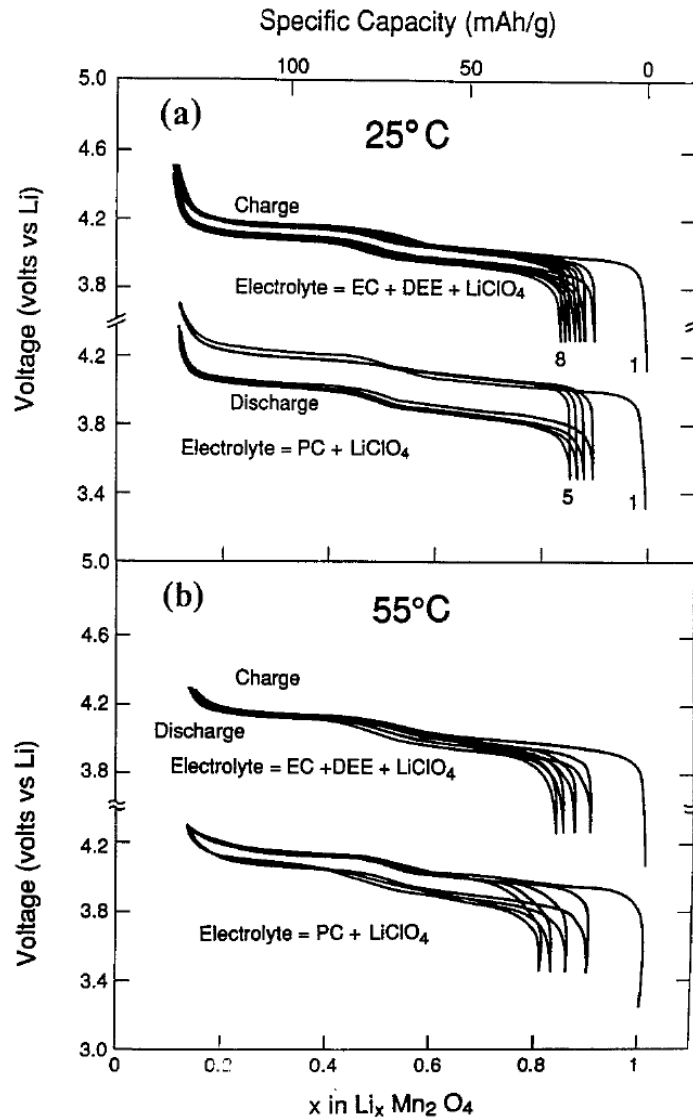


Fig. 3. Typical cycling behavior at 25 (a) and 55°C (b) of  $\text{LiMn}_2\text{O}_4/\text{Li}$  cells using EC + DEE (50:50) + 1M  $\text{LiClO}_4$  and PC + 1M  $\text{LiClO}_4$  electrolytes. In (a) the cells contain 30 mg (of active material) and were cycled between 3.5 and 4.5 V at a current of  $0.4 \text{ mA/cm}^2$  ( $\Delta x = 1$  in 22 h). In (b) the cells contain 10 mg (of active material) and were cycled between 3.5 and 4.3 V at a current of  $0.2 \text{ mA/cm}^2$  ( $\Delta x = 1$  in 15 h).

120. The PHOSITA approaching Uemura's ratio would have understood, then, that an increase in the charge cutoff voltage would result in additional extraction of lithium, thus making the cutoff voltage and the amount of extracted lithium related properties: more cutoff voltage, more lithium extracted (and higher

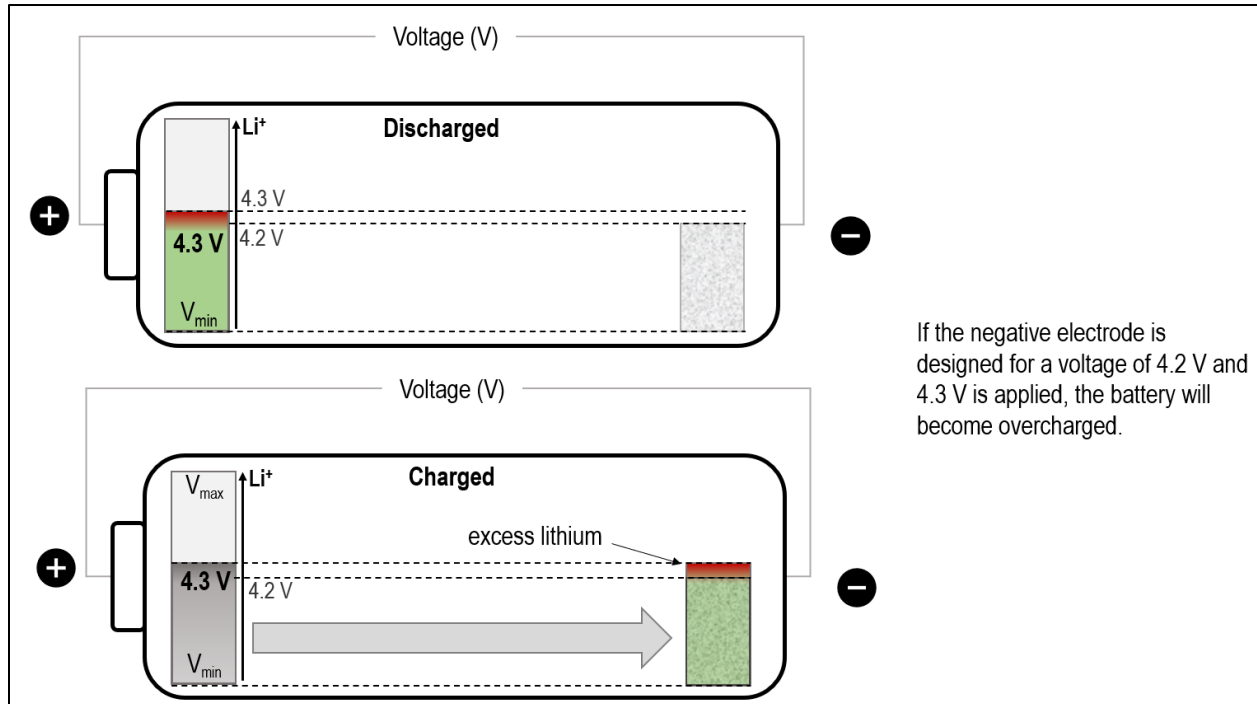
capacity).<sup>115</sup> Uemura's statement that "[i]f the capacity balance is below 1," dendrites may form is a clear indication that the voltage at which capacity is determined is at 4.3 V. Take the water vessel analogy I provided above. *Supra* §II.A. A capacity ratio of 1:1 (i.e., B/A of 1 or Pc:Nc of 1:1 in Uemura's terms) would mean that the pump is configured to move exactly as much water from the 10 gallon vessel as the 5 gallon vessel is able to receive (i.e., 5 gallons). In my analogy the amount of water the pump can move represents the charge cutoff voltage. The ability of the pump to move more water reflects a higher cut-off voltage. This leads to a couple of key takeaways that the PHOSITA would have understood when evaluating Uemura's ratio:

- Uemura would not have calculated the ratio at a voltage of less than 4.3 V because—using my analogy—doing so would have resulted in a pump that could move more water than the receiving vessel could hold. In other words,

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<sup>115</sup> *E.g.*, EX1019 (U.S. Pat. App. Pub. No. 2003/0118912), ¶[0005] (indicating that when excess "charging voltage" is applied and batteries "are in overcharged state," "lithium ions in the positive electrode are excessively extracted"). This is recognized by the '641 patent too. EX1001 ('641 pat.), 2:3-8 ("[T]he quantity of dedoped lithium ion increases with the increase of charge voltage, and the electrochemical capacity of lithium cobalt oxides increases accordingly.").

if Uemura calculated the capacity ratio at 4.2 V, when 4.3 V is applied as described in Uemura a ratio of 1:1 (which is used in Example 4) would not be sufficient to avoid depositing lithium on the electrode—the “lithium ion holding sites on the negative electrode material becomes insufficient” if the capacity ratio is determined at a voltage of say, 4.2 V, contrary to Uemura’s teachings.<sup>116</sup> This is conceptually shown in the illustration below where the red shading reflects excess lithium.



- Similarly, Uemura would not have calculated the ratio at a voltage above 4.3 V because doing so would be contrary to Uemura’s teaching that “[i]f the

<sup>116</sup> EX1009 (Uemura), ¶[0033], Fig. 3.

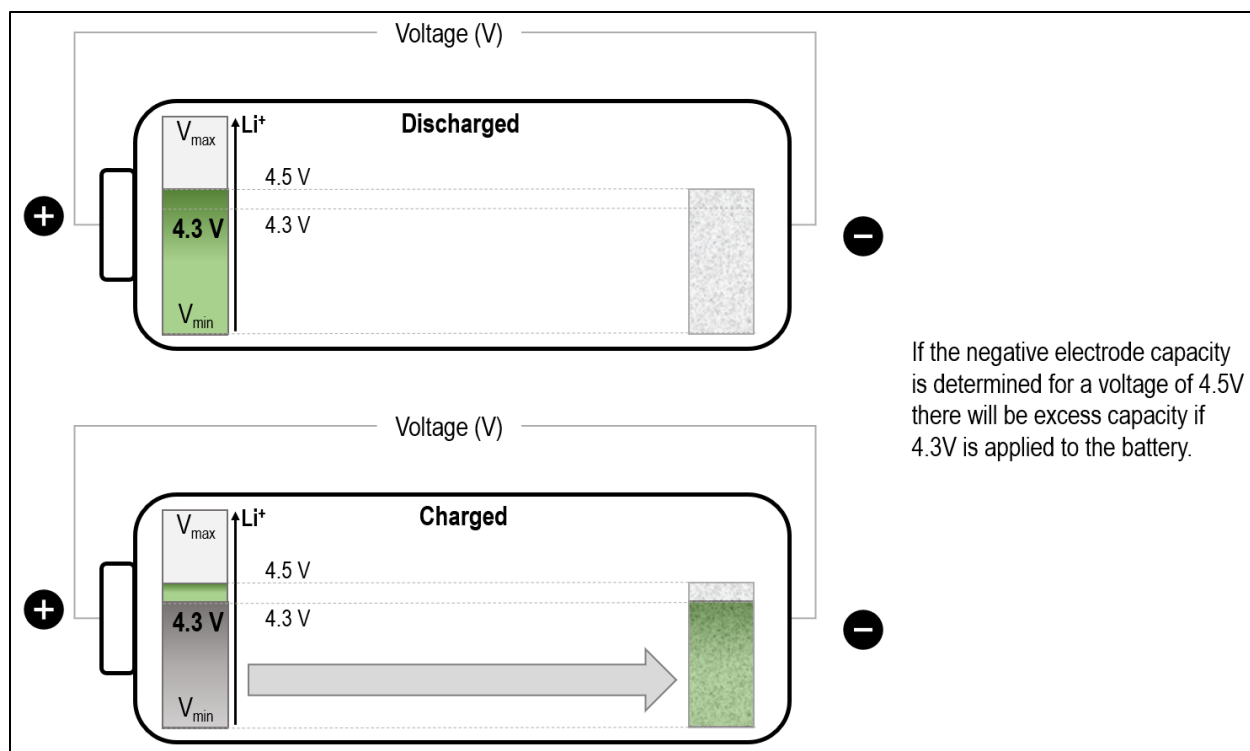
capacity balance ratio B/A exceeds 1.5, negative electrode sites that do not contribute to the charge-discharge are increased, leading to the wasteful use of materials.”<sup>117</sup> If the capacity ratio was calculated at 4.4 V (for example), then the capacity of the negative electrode, for at least Example 2, is over-designed for the intended charge cutoff voltage of 4.3 V because the ratio will increase to higher than 1:1.5 at 4.3 V for the reasons discussed above.<sup>118</sup> This means that the ratio at the actual cutoff voltage would have been higher than at the design voltage (e.g., 4.5 V), thus leading to the “wasteful use of materials” that Uemura was seeking to avoid.<sup>119</sup> This is shown in the illustration below, which shows the excess capacity if the negative electrode capacity is determined using a charge cutoff voltage of 4.5 V. This means that there will be excess negative electrode capacity if the battery will only be used at 4.3 V.

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<sup>117</sup> *Id.*, ¶[0033].

<sup>118</sup> *Id.*, Fig. 3.

<sup>119</sup> *Id.*



Based on this discussion, the PHOSITA reading Uemura would have understood that the capacity ratio was calculated using the charge cutoff voltage that Uemura was applying to the batteries—i.e., 4.3 V.<sup>120</sup>

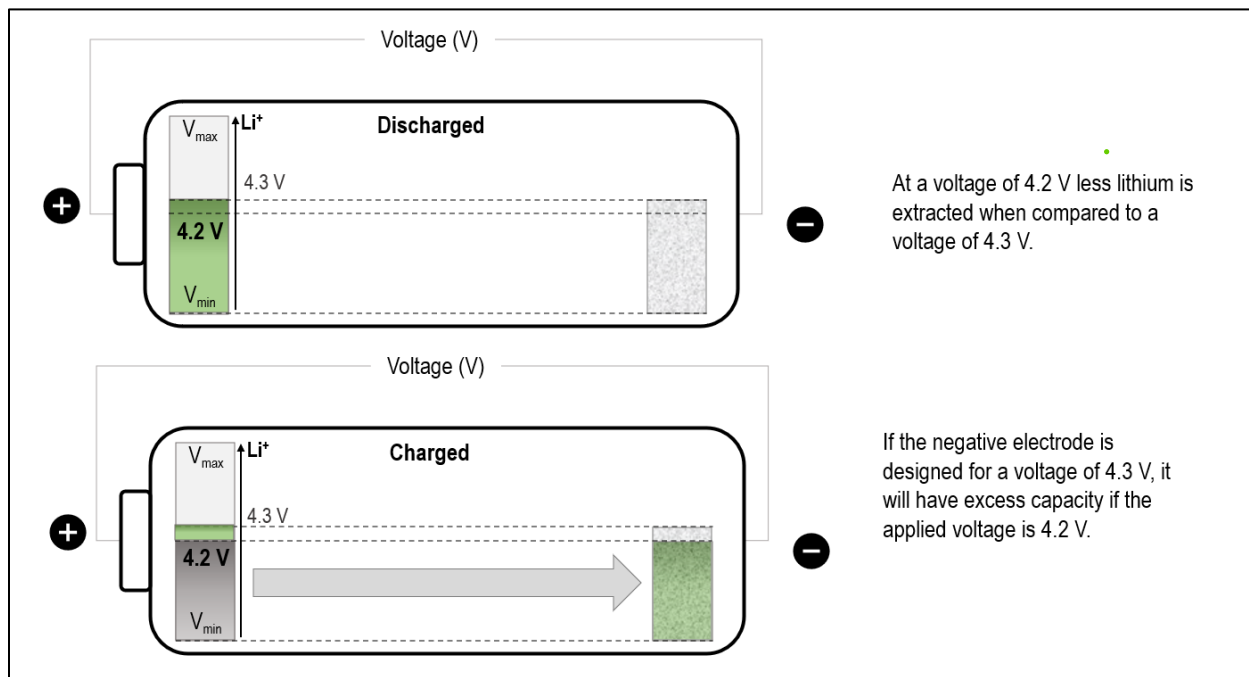
121. (3) *Uemura would have been understood by the PHOSITA to have a capacity ratio of greater than 1:1.0 if the calculation of the ratio is undertaken at a lower voltage including 4.2 V, but that ratio would still be less than 1:2.5.* Even though Uemura teaches a capacity ratio determined at a cutoff voltage of 4.3 V, a PHOSITA would have recognized that as the charge cutoff voltage is dropped, the negative electrode will have additional excess capacity because less lithium will be

<sup>120</sup> *Id.*, ¶[0081].

extracted from the positive electrode. *Supra* §II.A. Therefore, if the capacity ratio of the cells disclosed by Uemura were performed at 4.2 V instead of 4.3 V, the PHOSITA would have understood that the negative electrode side of the ratio would increase relative to the positive electrode side. In other words:

$$1:1 \text{ (at } 4.3\text{V)} \rightarrow 1:1.x \text{ (at } 4.2\text{ V)}$$

This concept is illustrated below where the excess grey at the top of the bar after the lithium is inserted into the negative electrode at a voltage of 4.2V is intended to reflect the excess capacity when a lower voltage is applied to the battery (thus extracting less lithium from the positive electrode).



122. The PHOSITA would have been confident that with a decrease in the charge cutoff voltage of 0.1 V, the amount of lithium extracted from the cathode

would not have been 2.5 times less. This is reflected in the known charge/discharge curves for lithium manganese oxides, which show that the capacity does not change rapidly with the addition (or subtraction) of additional voltage above about 4.2 V:<sup>121</sup>

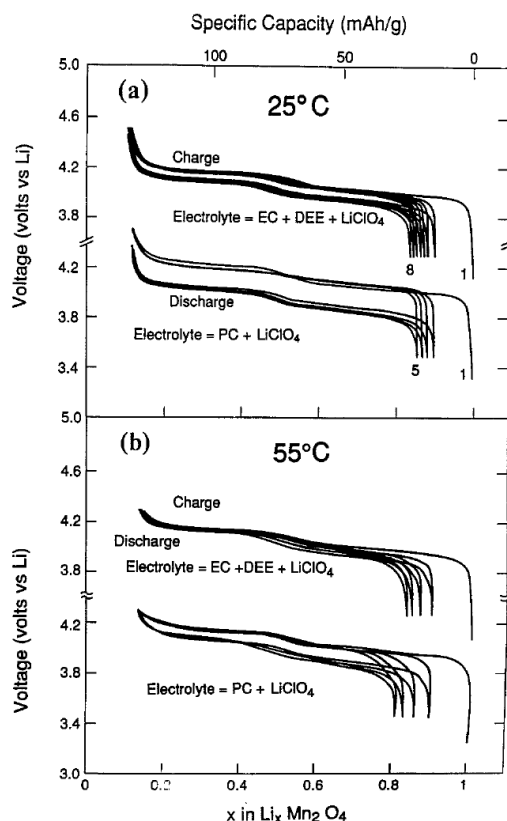


Fig. 3. Typical cycling behavior at 25 (a) and 55°C (b) of  $\text{LiMn}_2\text{O}_4/\text{Li}$  cells using EC + DEE (50:50) + 1M  $\text{LiClO}_4$  and PC + 1M  $\text{LiClO}_4$  electrolytes. In (a) the cells contain 30 mg (of active material) and were cycled between 3.5 and 4.5 V at a current of  $0.4 \text{ mA/cm}^2$  ( $\Delta x = 1$  in 22 h). In (b) the cells contain 10 mg (of active material) and were cycled between 3.5 and 4.3 V at a current of  $0.2 \text{ mA/cm}^2$  ( $\Delta x = 1$  in 15 h).

These plots show that the most lithium is extracted between voltages of about 3.5 V and about 4.1 V or 4.2 V, and that a significantly smaller amount of lithium is extracted as the voltage is increased over 4.3 V. This certainly does not reflect a 2.5 times increase in the extraction of lithium ions between cutoff voltages of 4.2 V and

<sup>121</sup> EX1015 (Guyomard-1992), p.939.

4.3 V. The PHOSITA would understand that this is typical behavior for lithium-ion cells (i.e., that as the charge cutoff voltage increases, there are diminishing returns in the amount of lithium that can be extracted from the positive electrode).

123. Based on the foregoing, even though Uemura does not say that the capacity ratio is determined at a charge cutoff voltage of 4.2 V, the PHOSITA would have understood that Uemura's capacity ratio of between 1:1 and 1:1.5 would have been slightly higher at a cutoff voltage of 4.2 V, but would still have fallen within the range of between 1:1.0 and 1:2.5 as recited in claims 1 and 5 of the '641 patent.

124. *(4) The reason for the capacity ratio in Uemura is the same as that in the '641 patent.* Uemura and the '641 patent both express the same rationales for the capacity ratio being configured the way that is claimed. I have put the explanations from both the '641 patent and Uemura side-by-side below:

| '641 Patent (EX1001)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Uemura (EX1009)                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>“After the elevation of the charge cut-off voltage, the amount of lithium ion dedoped from the positive electrode greatly increases, which renders an unmatched state to the original negative electrode material, and deposition of excessive lithium ions on the surface of negative electrode as metallic lithium, which jam part of the channel for passing lithium ions and result in the reduction of capacity and the deterioration of recycle property. The increase of the amount of negative electrode material meets the requirement of doping the relatively</p> | <p>“Furthermore, a capacity balance ratio B/A of the total capacity B of the negative electrode material to the total capacity A of the positive electrode material is preferably fixed at a range of 1 to 1.5. if the capacity balance ratio B/A is below 1, lithium ion holding sites on the negative electrode material become insufficient. As the result, branch-shaped or needle-shaped crystal (dendrite crystal) tends to occur during the charge to cause a short circuit</p> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| excessive lithium ions, and avoids the deposition of lithium ions on the surface of negative electrode as metallic lithium, and thus the maintaining properties (self-discharge properties) and recycle property are not affected. The suitable ratio of positive electrode material to negative electrode material will avoid the deposition of metallic lithium on the surface of negative electrode and the obstruction of channel for passing lithium ions, and consequently avoid the attenuation of capacity of cell.” <sup>122</sup> | phenomenon between the positive electrode and the negative electrode.” <sup>123</sup> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|

The deposition of lithium on the negative electrode is thus something that both the ’641 patent and Uemura seek to avoid. Both accomplish this by ensuring that there is at least as much capacity at the negative electrode as there is at the positive electrode and define a ratio of material capacity to do so.

125. *Conclusion: Uemura conveys the claimed capacity ratio to the PHOSITA.* Based on the foregoing analysis, a PHOSITA would have recognized that Uemura teaches a solution to dendrite formation and the plating of lithium metal on the negative electrode in a secondary lithium-ion cell or battery that is within the scope of the claimed ratio of the ’641 patent.

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<sup>122</sup> EX1001 (’641 pat.), 4:57-5:7.

<sup>123</sup> EX1009 (Uemura), ¶[0031].

2. *Claims 2-4 and 6-8.*

**[2] [3]: “A method according to claim 1, characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is within a range from” [2]: “4.3 V to 5.2 V” [3]: “4.3 V to 4.8 V.”**

**[6] [7]: “A secondary lithium ion cell or battery according to claim 5, characterized in that the secondary lithium ion cell or battery has a charge cut-off voltage within a range from” [6]: “4.3 V to 5.2 V” [7]: “4.3 V to 4.8 V.”**

126. Uemura discloses a charge cutoff voltage of the secondary lithium ion cell or battery that is within a range from 4.3V to 5.2V (claims 2 and 6) and within a range from 4.3V to 4.8V (claims 3 and 7). As discussed above in connection with my analysis of the independent claims, Uemura states that the “charge-discharge was repeatedly performed at a constant current of 0.5 mA/cm<sup>2</sup> and a voltage ranging from 4.3 V to 2.0 V.....”<sup>124</sup> By cycling the battery between 4.3V and 2.0V, Uemura used a charge cutoff voltage of 4.3V. Thus, Uemura describes a charge cutoff voltage within the ranges of claims 2-3 and 6-7.

**[4] [8]: “characterized in that the ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.15 to 1:2.5.”**

127. Uemura describes a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery that is from 1:1.15 to

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<sup>124</sup> EX1009 (Uemura), ¶[0081].

1:2.5. Uemura explains that “a capacity balance ratio B/A of the total capacity B of the negative electrode material to the total capacity of the positive electrode material is preferably fixed at a range of 1 to 1.5.”<sup>125</sup> Uemura includes examples in which the capacity ratio is, for example, 1:1.3 and 1:1.5:<sup>126</sup>

FIG.3

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

128. As I have explained above, these ratios were calculated at Uemura’s charge cutoff voltage of 4.3 V and performing the calculation at 4.2 V would have increased the relative capacity of the negative electrode because less lithium would

<sup>125</sup> *Id.*, ¶[0031].

<sup>126</sup> *Id.*, FIG. 3 (highlight added).

have been extracted from the cathode thus making the negative electrode appear relatively “larger” vis-à-vis the positive electrode. *Supra* §XI.A.1 (limitations [1B] & [5B]). And, for the reasons I explain above, even though the ratio would be slightly different and the negative electrode would have a capacity slightly more than 1.3 or 1.5 times the capacity of the positive electrode, the change in voltage for the calculation would not have resulted in the negative electrode having a capacity of as much as 2.5 times larger than the positive electrode. *Id.*

129. Therefore, for these reasons and the reasons I provided with respect to claims 1 and 5, Uemura’s examples having a capacity ratio of 1:1.3 or 1:1.5 are within the claimed range of “from 1:1.15 to 1:2.5,” as recited in claims 4 and 8.

**B. Ground 2: Uemura Renders Claims 1-8 Obvious and Ground 3: Uemura Renders Claims 11-18 Obvious.**

130. Uemura also renders claims 1-8 and 11-18 obvious. I first explain the differences between the analysis of obviousness and my analysis of anticipation and explain why claims 1-8 would have been obvious over Uemura. I then turn to an analysis of claims 11-18, which are each directed to an amount of remaining capacity after 400 cycles.

1. *Claims 1-8*

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

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

[3]: A method according to claim 1, characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is within a range from 4.3 V to 4.8 V.

[4]: A method according to claim 1, characterized in that the ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.15 to 1:2.5.

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

[6]: A secondary lithium ion cell or battery according to claim 5, characterized in that the secondary lithium ion cell or battery has a charge cut-off voltage within a range from 4.3 V to 5.2 V.

**[7]: A secondary lithium ion cell or battery according to claim 5, characterized in that the secondary lithium ion cell or battery has a charge cut-off voltage within a range from 4.3 V to 4.8 V.**

**[8]: A secondary lithium ion cell or battery according to claim 5, characterized in that the ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.15 to 1:2.5.**

131. I have discussed the teachings of Uemura at some length above and I incorporate that analysis here instead of repeating it all here. *Supra* §XI.A. Uemura also renders the claimed ratio obvious. Here, I explain why calculating the capacity ratio at 4.3 V—Uemura’s charge-cutoff voltage—would have been obvious even if it was not readily apparent to the PHOSITA.

132. For the reasons I have explained above, the PHOSITA would have understood that Uemura’s capacity ratio is calculated at a charge cutoff voltage of 4.3 V. *Supra* §XI.A. Even if it was not actually calculated at that voltage it certainly would have been obvious to do so because that is the voltage that the Uemura batteries are designed to operate at.<sup>127</sup> Calculating the capacity ratio at the voltage that the battery is designed to operate at would have been advisable because it would have allowed the battery designer to ensure that there was sufficient negative electrode material to allow intercalation of the lithium ions extracted from the

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<sup>127</sup> EX1009 (Uemura), ¶[0081].

positive electrode without plating lithium metal and thus the deleterious formation of dendrites. Calculating a capacity balance (e.g., for the 1:1 ratio of Example 4) at a voltage less than the intended voltage would have resulted in an overcharge situation when the battery was charged to the intended voltage, which would have been understood to be inadvisable and potentially dangerous.<sup>128</sup> And, calculating the

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<sup>128</sup> EX1009 (Uemura), ¶[0033]; EX1019 (U.S. Pat. App. Pub. No. 2003/0118912), ¶[0005] (indicating that when excess “charging voltage” is applied and batteries “are in overcharged state,” “lithium ions in the positive electrode are excessively extracted” thus causing “absorption of lithium in an amount larger than the prescribed design capacity in the negative electrode or to cause precipitation of lithium as metallic lithium on the surface of the negative electrode”); EX1005 (Abe), ¶[0009] (“Incidentally, in general, in the case of overcharging lithium-ion secondary batteries or when the charging current is increased, etc., needle-like lithium may be precipitated on the surface of the negative electrode, interposed between the positive electrode and the negative electrode, making it easier to break through the separator and short out. As a result, lithium-ion secondary batteries may also explode and ignite.”); EX1001 (’641 pat.), 2:3-8 (“[T]he quantity of dedoped lithium ion increases with the increase of charge voltage, and the electrochemical capacity of lithium cobalt oxides increases accordingly.”).

capacity ratio at a voltage higher than that used to charge the battery could have led to an excessive use of negative electrode material, thus occupying more space than necessary in the battery.<sup>129</sup> Therefore, it at the very least would have been obvious to determine the capacity ratio at a charge cutoff voltage of 4.3 V in the context of Uemura.

133. As I explain above, when the claimed capacity ratio is calculated at 4.3 V and is between 1:1 and 1:1.5 as taught by Uemura, it will also be within the claimed range of 1:1 and 1:2.5 if calculated at a charge cutoff voltage of 4.2 V. That is because the amount of negative electrode capacity will increase relative to the capacity of the positive electrode at the lower voltage. *Supra* §XI.A.1 (limitations [1B] & [5B]).

134. And, as I have been informed by counsel, if the prior art discloses a range that overlaps with a claimed range, that range would have been obvious absent a showing of importance or “criticality” of the range claimed. Here, the range in Uemura falls within the range claimed in the ’641 patent and would have achieved the purpose that the range does in the ’641 patent as I have explained above. *Supra* §XI.A.1 (limitations [1B] & [5B]). The PHOSITA would have expected to succeed

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<sup>129</sup> EX1009 (Uemura), ¶[0033] (describing too much negative electrode material as a “wasteful use of materials”).

in calculating the ratio at a different voltage than the design voltage because it was a matter of simple arithmetic once the weights and capacities are known. The PHOSITA would thus have been easily able to determine the ratio at any voltage as long as the resulting capacities were such that the resulting battery was not put in an overcharged state as part of its intended operation. Therefore, in addition to anticipating claims 1-8, Uemura would have rendered claims 1-8 obvious for these additional reasons.

2. *Claims 11-18*

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

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

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

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

**15. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 75% of capacity after 400 cycles.**

**16. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 75.83% of capacity after 400 cycles.**

**17. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 80% of capacity after 400 cycles.**

**18. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 80.72% of capacity after 400.**

135. Claims 11-14 depend from claim 5 and claims 15-18 depend from claim

1. Each of these claims recites the percentage of capacity that is maintained in the

secondary lithium ion cell or battery after 400 cycles. The highest percentage, and therefore most restrictive, is recited in claims 14 and 18, which state that “at least 80.72% of capacity” is maintained after 400 cycles. Therefore, I understand that if the prior art teaches or renders obvious a cell or battery within the remaining capacity limitation of claims 14 and 18, it anticipates or renders obvious claims 11-13 and 15-17 too.

136. In September 2001, a PHOSITA would have known that increasing the cycle life of batteries was desired for improved performance, and people in the industry had been actively developing and achieving lithium-ion batteries that had high cyclability including cyclability that fell within the claimed ranges recited in claims 11-18. Indeed, Uemura suggests that the batteries disclosed therein were capable of achieving high cyclability likely meeting the claimed cyclability properties. But, even if Uemura’s batteries were incapable of meeting these requirements, it would have been obvious to achieve these properties based on the teachings of Uemura. Indeed, based on Uemura alone the claimed ranges would have been obvious.

137. Uemura reflects efforts to develop batteries that could maintain at least 80.72% of capacity after 400 charging and discharging cycles. Thus, Uemura at the very least suggests each of the limitations of claims 11-18.

138. Uemura discloses batteries “having a large capacity and high cyclic resistance....”<sup>130</sup>

139. Uemura tested batteries with various electrode compositions and other features to determine the number of charge-discharge cycles that could be performed while maintaining 90% capacity.<sup>131</sup> In particular, Uemura states, “The number of cycles taken to a point where the discharge capacity becomes less than 90% of the initial discharge capacity was obtained,” and the results were shown in the table of FIG. 3.<sup>132</sup>

140. As can be seen in the “Number of cycles” column of FIG. 3, the various battery configurations achieved between 95 cycles and 350 cycles before dropping to 90% of initial capacity.<sup>133</sup> Eight example battery configurations from Uemura in

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<sup>130</sup> EX1009 (Uemura), Abstract; see also *id.*, ¶¶[0002] (“a negative electrode material and a positive electrode material for improving cyclic resistance”), [0012]-[0015] (discussing the objects or goals of Uemura, including “improving the cyclic resistance” and “resulting in an increase of the cyclic resistance of the rechargeable lithium battery.”).

<sup>131</sup> *Id.*, ¶[0081].

<sup>132</sup> *Id.*

<sup>133</sup> *Id.*, FIG. 3.

which the remaining capacity was 90% at 300 or more cycles are highlighted below in blue.

FIG.3

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

And, as I have explained above, each of these batteries had the claimed capacity ratio within the scope of the claims and a charge cutoff voltage of 4.3 V—also within the claimed range.

141. Although Uemura does not explicitly say how far the battery capacity dropped when reaching 400 cycles as recited in claims 11-18, it would have been obvious to a PHOSITA that at least the batteries reaching 330 or 350 cycles before dropping to 90% capacity would also have likely maintained at least 80.72% of initial capacity upon reaching 400 cycles. Indeed, as I explained above, Uemura

teaches using a charge cutoff voltage within the claimed range (4.3 V) and a capacity ratio within the claimed range. *Supra* §§XI.A.1 (limitations [1A] & [5A]), XI.A.1 (limitations [1B] & [5B]). Based on this, a PHOSITA would have reasonably expected and found it obvious that the batteries with a decrease of 90% after 330 or 350 cycles would have had at least 80.72% of remaining capacity after 400 cycles. Indeed, the PHOSITA would have been able to adjust aspects of the battery, including reducing the charge cutoff voltage to, for example, 4.25 V, altering the electrolyte composition, or cycling the battery at a somewhat lower temperature. A PHOSITA would have reasonably expected to achieve the battery cyclability recited in claims 11-18 based on the teachings of Uemura, which render it highly likely that the batteries disclosed actually would have exhibited more than 80.72% of remaining capacity after cycles since they teach 90% remaining capacity after 350 and 330 cycles.

142. Based on the teachings of Uemura, a PHOSITA would have found it obvious to achieve remaining capacity of greater than 80.72% after 400 cycles. This would also have rendered obvious the additional remaining capacities (i.e., 80%, 75.83%, 75%) recited in the dependent claims. Therefore, it would have been obvious to a PHOSITA to arrive batteries that meet the claimed capacity limitations recited in claims 11-18 after 400 cycles based on Uemura.

**C. Ground 4: Uemura and Guyomard Render Claims 11-18 Obvious.**

*1. Claims 11-18: Remaining Capacities After 400 Cycles*

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

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

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

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

**15. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 75% of capacity after 400 cycles.**

**16. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 75.83% of capacity after 400 cycles.**

**17. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 80% of capacity after 400 cycles.**

**18. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 80.72% of capacity after 400.**

143. Even though Uemura does not publish a number for the remaining capacity of the batteries after 400 cycles and even if those batteries would not have achieved “at least 80.72%” capacity after 400 cycles it would have been obvious to further improve the cyclability of Uemura’s batteries based on the teachings of Guyomard (EX. 1008) to reach the claimed “at least 80.72%” of capacity after 400 cycles.

144. Uemura and Guyomard both teach example batteries that use  $\text{LiPF}_6$  as a source of lithium ions in their electrolyte and both use a solvent comprising dimethyl carbonate (DMC) and ethylene carbonate (EC). Uemura states:

As an electrolyte, a solution obtained by dissolving  $\text{LiPF}_6$  with concentration of 1 mol/l to a mixed solvent of ethylene carbonate and dimethyl carbonate with a volume ratio of 2:1 was used.<sup>134</sup>

145. Guyomard teaches a similar electrolyte composition used with lithium manganese composite oxide cells. Specifically, Guyomard explains:

[W]e have discovered that an exceptional, wide temperature range, oxidation resistant electrolyte for a  $\text{LiMn}_2\text{O}_4$  positive electrode intercalation battery cell, particularly one utilizing the preferred  $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$  ( $0 < x < 1$ ) electrode, may be realized in a 0.5 M to 2 M solution of  $\text{LiPF}_6$ , or  $\text{LiPF}_6$  with up to about an equal

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<sup>134</sup> EX1009 (Uemura), ¶0078].

amount of  $\text{LiBF}_4$  added, in a mixture of dimethylcarbonate (DMC) and ethylene carbonate (EC) within the weight percent ratio range from about 95 DMC : 5 EC to 20 DMC : 80 EC. In a preferred such [sic] electrolyte solution the solvent ratio range is about 80 DMC : 20 EC to 20 DMC : 80 EC. An optimum composition for operation at room temperature and below is approximately 1 M  $\text{LiPF}_6$  solution in a solvent mixture of about 33 DMC : 67 EC, while a battery operating at higher temperatures in the range of  $55^\circ\text{C}$  optimally utilizes an electrolyte consisting essentially of an approximately 1.5M  $\text{LiPF}_6$  solution in a solvent combination of about 67 DMC : 33 EC.<sup>135</sup>

This electrolyte solution described by Guyomard provides “outstanding oxidation resistant characteristics,” and Guyomard explains that “negligible current increase, after the reversible Li intercalations, at voltages up to about 5 V vs. Li indicates this remarkable stability which enables enhanced cell capacity not only in the ‘rocking chair’ cells comprising negative electrodes of carbon, e.g., petroleum coke, but also in Li negative electrode cells.”<sup>136</sup> Guyomard’s optimized electrolyte compositions provides high cyclability: “The ability of the electrolyte to extend the cycle life of

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<sup>135</sup> EX1008 (Guyomard), 7:26-8:6.

<sup>136</sup> EX1008 (Guyomard), 8:10-18.

the batteries was amply demonstrated by the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.”<sup>137</sup>

146. The PHOSITA would have observed that Uemura lists a number of lithium salts, including  $\text{LiPF}_6$  and  $\text{LiBF}_4$  among others, that could be used in battery electrolytes.<sup>138</sup> Ultimately,  $\text{LiPF}_6$  was used for the tests that were performed by Uemura and specifically Uemura used a 1 mol/l  $\text{LiPF}_6$  in a solvent of two parts ethylene carbonate (EC) to one part dimethylcarbonate (DMC) (or 67 EC : 33 DMC).<sup>139</sup>

147. Uemura teaches that the positive electrodes of its batteries can have “a general formula  $\text{Li}_{1-x}\text{MnO}_2$ ,  $\text{Li}_{1-x}\text{Mn}_{1-y}\text{M}_y\text{O}_2$  or  $\text{Li}_{1-x}\text{Mn}_{1-y}\text{M}_y\text{O}_{2-\delta}$  . . . ,” where the “M” is a placeholder for a metal element.<sup>140</sup> Uemura also uses a carbon negative electrode.<sup>141</sup>

148. Guyomard says that “exceptional electrolyte results are obtained from a composition of about 0.5M to 2M solution of  $\text{LiPF}_6$ , or  $\text{LiPF}_6$  to which up to about

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<sup>137</sup> EX1008 (Guyomard), 9:5-8.

<sup>138</sup> EX1009 (Uemura), ¶[0064].

<sup>139</sup> *Id.*, ¶[0078].

<sup>140</sup> *Id.*, ¶¶[0035]-[0036], [0041]-[0042].

<sup>141</sup> *Id.*, ¶[0077].

an equal amount of  $\text{LiBF}_4$  has been added, dissolved in a mixture of dimethylcarbonate (DMC) and ethylene carbonate (EC)....”<sup>142</sup> Guyomard teaches using between 0.5 and 2.0 M (mol/l)  $\text{LiPF}_6$  and a mixture preferably between 80 DMC : 20 EC to 20 DMC : 80 EC and a 1.5 M  $\text{LiPF}_6$  solution in a solvent combination of about 67 DMC : 33 EC was “optimally utilize[ed]” for a cell operating at 55°C.<sup>143</sup> This electrolyte was excellent at extending the cyclability of the battery. Guyomard also taught that the “ability of the electrolyte to extend the cycle life of the batteries was amply demonstrated by the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.”<sup>144</sup> Thus, over the 495 cycles after the initial 5 cycles, the capacity only dropped 10%.

149. A PHOSITA would have found it obvious to slightly adjust Uemura’s electrolyte composition using Guyomard’s optimized high temperature electrolyte solution to improve the cyclability of the batteries. A PHOSITA would have been led to do this because Uemura’s electrolyte composition is the composition that Guyomard suggests is optimal for lower temperatures of about 25°C as seen in the table below:

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<sup>142</sup> EX1008 (Guyomard), 4:30-37.

<sup>143</sup> EX1008 (Guyomard) 7:27-37, 8:2-6.

<sup>144</sup> EX1008 (Guyomard), 9:5-9.

| Uemura (EX1009)                                                                                                                                                                                                                                                                   | Guyomard (EX1008)                                                                                                                                                                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>“As an electrolyte, a solution obtained by dissolving LiPF<sub>6</sub> with concentration of 1 mol/l to a mixed solvent of ethylene carbonate and dimethyl carbonate with a volume ratio of 2:1 was used.”<sup>145</sup></p> <p>i.e., DMC 33 : 67 EC with LiPF<sub>6</sub></p> | <p>“An optimum composition for operation at room temperature and below is an approximately 1 M LiPF<sub>6</sub> solution in a solvent mixture of about 33 DMC : 67 EC . . . .”<sup>146</sup></p> |

150. Based on this comparison, a PHOSITA would have observed that Uemura was using Guyomard’s optimum electrolyte for “room temperature and below,”<sup>147</sup> while Uemura was cycling the disclosed batteries at a higher temperature of 60°C.<sup>148</sup> The PHOSITA considering both Uemura and Guyomard together would have immediately been drawn to use Guyomard’s electrolyte for “a battery operating at higher temperatures in the range of 55°C,” which “optimally utilizes an electrolyte consisting essentially of an approximately 1.5M LiPF<sub>6</sub> solution in a solvent

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<sup>145</sup> EX1009 (Uemura), ¶[0064].

<sup>146</sup> EX1008 (Guyomard), 7:35-8:2.

<sup>147</sup> EX1008 (Guyomard), 7:35-8:2.

<sup>148</sup> EX1009 (Uemura), ¶[0081] (“The charge-discharge was repeatedly performed at a constant current of 0.5 mA/cm<sup>2</sup> and a voltage ranging from 4.3 V to 2.0 V at an atmospheric temperature of 60°C by the use of the made sealed type non-aqueous solvent battery cell.”).

combination of about 67 DMC : 33 EC”—in other words adding more lithium ions to the electrolyte solvent to accommodate for the higher temperature cycling. This would have led the PHOSITA to expect to provide a battery according to Uemura’s design using Guyomard’s optimal electrolyte for higher temperature operation and obtain a battery that had an even further extended cycle life consistent with Guyomard’s observation of “the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.”<sup>149</sup> This would have led the PHOSITA to arrive at the remaining capacities after 400 cycles recited in the claims even if Uemura did not do so on its own.

151. I have been asked to consider whether a PHOSITA would have had a reasonable expectation of succeeding in combining Uemura and Guyomard to arrive at the claimed remaining capacities recited in claims 11-18. The PHOSITA would have been able to easily apply Guyomard’s high temperature optimal electrolyte solution to Uemura’s batteries because the same compositions are being used and Guyomard teaches that a 0.5 M increase in  $\text{LiPF}_6$  yields an optimal electrolyte for higher temperatures. Given the level of detail provided in Uemura and Guyomard, the similarities in electrolyte chemistries, and similar battery materials, a PHOSITA would have had a reasonable expectation of succeeding at even further improving

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<sup>149</sup> EX1008 (Guyomard), 9:5-8.

the cyclability of Uemura’s batteries to fall within the claimed percentages of remaining capacity after 400 cycles.

152. Therefore, it would have been obvious to a PHOSITA to combine the teachings of Uemura and Guyomard in a manner that meets the limitations of claims 11-18.

**D. Ground 5: Abe Anticipates Claims 1-8 and Ground 6: Abe Renders Obvious Claims 1-8.**

153. I have also considered the Abe reference—and specifically an English-language translation of the Abe reference.<sup>150</sup> Based on my analysis of Abe and applying the claim constructions I was instructed to apply, Abe discloses all features of claims 1-8 of the ’641 patent and therefore “anticipates” those claims. Abe also renders these claims obvious by disclosing a range of charge cutoff voltages and capacity ratios that overlaps with the claimed range. I explain the basis for my analysis in the sections that follow.

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<sup>150</sup> EX1005 (Abe).

1. *Claims 1 and 5.*

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

**[5P] A secondary lithium ion cell or battery,**

154. I understand these aspects of claims 1 and 5 are called the “preambles” of claims 1 and 5. I understand and have been informed that certain legal rules apply to determine whether or not a claims preamble provides a limitation of the claim. I have not been asked to apply those legal principles in my analysis. I have instead been asked to presume that these preambles are limiting.

155. As discussed above, I have been instructed to interpret the “method” of claim 1 as a method of using the device recited after the “characterized in that” phrase. *Supra* §IX.A. I do that here and note that Abe describes the use of the batteries disclosed in the reference because those batteries are cycled—meaning that they are charged and discharged repeatedly.<sup>151</sup>

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<sup>151</sup>EX1005 (Abe), ¶¶[0102]-[0103] (“LiMn<sub>2</sub>O<sub>4</sub> was used instead of LiCoO<sub>2</sub>, and the positive electrode was made in the same manner as in Embodiment 1, except that the filling density was set to 2.9 g/cm<sup>3</sup>. A cylindrical non-aqueous electrolyte-based secondary battery was made in the same manner as in Embodiment 1 using a negative electrode, a cathode, and electrolyte solution similar to that in Embodiment 1. The (negative electrode design capacity/positive electrode design capacity) value

156. Abe describes secondary lithium ion batteries that “exhibit high capacity,”<sup>152</sup> and which have “high energy density and excellent cycle characteristics.”<sup>153</sup> These batteries can have a cutoff voltage of, for example, 4.3V, which is a higher average operating voltage than batteries with a 4.2 V cutoff voltage discussed in the ’641 patent.<sup>154</sup>

157. Abe further explains that:

the design capacity of the negative electrode is a non-aqueous electrolyte-based secondary battery having a design capacity greater than that of the positive electrode, (5) a non-aqueous electrolyte-based secondary battery according to (4) having a design capacity of more than 1 and less than or equal to 1.6 for the design capacity of the positive electrode described in (4) [i.e., one with a graphitized vapor-phase grown carbon fiber negative

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of this non-aqueous electrolyte secondary battery was adjusted to 1.1, and the value is shown in Table 1.”) Table 3 shows “Discharge capacity at 50th cycle [mAh],” which shows that the disclosed batteries were used—and were intended to be used as would have been appreciated by the PHOSITA. EX1005 (Abe), ¶¶[0097]-[0098].

<sup>152</sup> EX1005 (Abe), ¶¶[0011], [0017].

<sup>153</sup> *Id.*, ¶[0008].

<sup>154</sup> *Id.*, ¶[0078]; EX1001(’641 pat.), 1:46-49, 2:38-41.

electrode and a lithium-containing composite oxide positive electrode].<sup>155</sup>

158. Additionally, Abe describes a “design ratio” of 1:1.1 in the case of the example using a  $\text{LiMn}_2\text{O}_4$  positive electrode active material, which is charged to a cutoff voltage between 4.2-4.3 V,<sup>156</sup> as discussed below. *Infra* §XI.D.1 (limitations [1B] & [5B]). Therefore, Abe has all of the features which the ’641 patent says leads to the characteristics recited in the preamble<sup>157</sup> and discloses how it can achieve the goals recited in claim 1. As discussed above, all other aspects of the disclosed batteries are deemed to be conventional by the ’641 patent. *Supra* §VI.

159. Therefore, Abe discloses a method for improving the capacity, average operating voltage, and specific energy of a secondary lithium ion cell, or battery because it discloses use of a secondary lithium ion battery having the claimed design characteristics and Abe discloses a lithium-ion cell or battery.

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<sup>155</sup> EX1005 (Abe), ¶[0018].

<sup>156</sup> *Id.*, ¶¶[0078], [0094].

<sup>157</sup> EX1001 (’641 pat.), 3:7-16.

**[1A]: the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V; and; [5A] the secondary lithium ion cell or battery has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V, and**

160. Abe discloses that the charge cutoff voltage is greater than 4.2 V but less than 5.8 V as recited in these limitations.

161. Abe teaches that, for secondary lithium ion batteries using  $\text{LiMn}_2\text{O}_4$  as the positive electrode material, “the voltage is set to a range in which no electrolyte deposition occurs, and no irreversible structural breakdown of the positive electrode active material occurs” and that range “is 4.2-4.3 V . . . .”<sup>158</sup> A charge cut-off voltage of 4.2-4.3V includes values “greater than 4.2 V,” including, for example, 4.25 V and 4.3 V. Abe thus teaches and renders obvious this limitation because it discloses cut-off voltages encompassed by the claimed range of greater than 4.2 V but less 5.8 V, as required by claims 1 and 5.

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<sup>158</sup> EX1005 (Abe), ¶[0078] (“For example,  $\text{LiMn}_2\text{O}_4$  is 4.2–4.3 V . . .”).

**[1B] a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5 as calculated by a specific capacity with a charge voltage limited to 4.2 V;**

**[5B] a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5, as calculated by a theoretic capacity with a charge cut-off voltage set at 4.2 V.**

162. Abe describes a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery that is from 1:1.0 to 1:2.5 as calculated by a capacity with a charge cut-off voltage set at 4.2 V under the claim construction I understand the Patent Owner has proposed in litigation and which I have been asked to apply here. The reasons for my conclusion are explained here. First, I explain how Abe discloses the claimed ratio under the claim construction advanced by the Patent Owner. Second, I explain why Abe's ratio would have been understood to have been calculated at a charge cut-off voltage of somewhere between 4.2 V and 4.3 V. Third, I explain why Abe's design capacity ratio would have fallen within the range of the '641 patent when determined at a charge cutoff voltage of 4.2 V instead of something greater than 4.2 V, such as a charge cutoff voltage of up to 4.3 V.

163. *(1) Abe discloses a "design capacity" ratio that is calculated consistent with the construction I was asked to apply.* Abe explains that "the design capacity of the negative electrode is a non-aqueous electrolyte based secondary

battery having a design capacity greater than that of the positive electrode,” and the “design capacity of more than 1 and less than or equal to 1.6 for the design capacity of the positive electrode . . . .”<sup>159</sup> Abe also says that “the design capacity of the negative electrode is adjusted so that the design capacity of the negative electrode is greater than the design capacity of the cathode.”<sup>160</sup> A specific example is provided by Abe for a  $\text{LiMn}_2\text{O}_4$  cell in which the design capacity ratio is 1:1.1.<sup>161</sup>

164. Abe explains that the calculation of the positive electrode and negative electrode design capacities is done as a function of capacity at a predetermined charging voltage and is based on the product of the capacity and mass (weight). Specifically, Abe says:

The design capacity is determined, for example, from the initial charge capacity per unit weight of the active material in a predetermined charging voltage range and the amount of active material coated on the current collector. 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

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<sup>159</sup> EX1005 (Abe), ¶[0018].

<sup>160</sup> EX1005 (Abe), ¶[0078].

<sup>161</sup> *Id.*, ¶[0103].

of metal lithium. The charge capacity is the amount of charge until a predetermined voltage is reached. . . . The design capacity of the negative electrode active material can be the theoretical capacity indicated by the capacity per unit weight of carbon in the negative electrode, or 372 mAh/g, if the graphitization of the negative electrode active material is complete . . . .<sup>162</sup>

165. The phrase “the initial charge capacity per unit weight” refers to, for example a capacity in a unit such as,  $\frac{mAh}{g}$ . This would be multiplied by the “amount of active material coated on the current collector” thus producing the “design capacity” of the electrode.<sup>163</sup> Thus, the design capacity of the positive electrode (cathode) and the design capacity of the negative electrode (anode) is calculated as the product of the “ratio calculated as the product of the capacity of the cathode active material per mass unit and the amount of the cathode active material in the same mass unit divided by the product of the capacity of the anode active material per mass unit and the amount of the anode active material in the same mass unit, when the charge cutoff voltage is 4.2 V” under the claim construction I was asked to apply for the purposes of my analysis.

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<sup>162</sup> EX1005 (Abe), ¶[0078].

<sup>163</sup> *Id.*, ¶[0078].

166. (2) *Abe's design capacity is determined at a cutoff voltage between 4.2 V to 4.3 V.* The PHOSITA would have understood the “design capacity” reflected the capacity over the voltages which the battery was intended to be charged to (the charge cutoff voltage). Abe says as much. For instance Abe says “[t]he design capacity is determined, for example, from the initial charge capacity per unit weight of the active material *in a predetermined charging voltage range* and the amount of active material coated on the current collector.”<sup>164</sup> For Abe's battery using  $\text{LiMn}_2\text{O}_4$  as the active positive electrode material, this capacity is determined using a cutoff voltage of between 4.2 V and 4.3 V.<sup>165</sup> Therefore, a PHOSITA would have understood that the claimed ratio was calculated at a charge cutoff voltage that depended on the charge cutoff voltage used for the battery. Insofar as Abe's design capacity is determined at 4.2 V the disclosed example satisfies the ratio limitation because the ratio is actually determined at 4.2 V. In the event that the battery is operated using a charge cutoff voltage of 4.3 V, Abe's “design capacity” of between 1:1 and 1:1.6, such as 1:1.1, would have been calculated at a charge cutoff voltage of 4.3 V.<sup>166</sup>

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<sup>164</sup> EX1005 (Abe), ¶[0078].

<sup>165</sup> *Id.*, ¶¶[0078], [0102]-[0103].

<sup>166</sup> *Id.*, ¶¶[0018], [0102].

167. (3) *When Abe's design capacity ratio is determined at 4.3 V, the design capacity ratio will fall within the claimed ratios when calculated at 4.2 V.*

As I explained above in connection with my discussion of the Uemura reference, the PHOSITA would have known that when the design capacity ratio discussed by Abe is calculated at 4.3 V, the negative electrode capacity will increase relative to the positive electrode capacity at the lower voltage. *Supra* §§ II.A, XI.A.1 (limitations [1B] & [5B].) The reasons I have explained for this phenomena are equally applicable here. And for those reasons, a PHOSITA reading Abe would have appreciated that Abe disclosed a design capacity ratio, calculated in a manner consistent with the claim construction that I was asked to apply. *Id.* Moreover, for the reasons I have already explained, for reasons that parallel those I have given in the context of Uemura, given the change in capacity at different voltages for Abe's  $\text{LiMn}_2\text{O}_4$  material, a PHOSITA would not have understood the increase in capacity to be significant enough to take a ratio that was set between 1:1 and 1:1.6 as taught by Abe (if calculated at 4.2V) to be beyond 1:2.5. *Supra* §XI.A.1 (limitations [1B] & [5B]); EX1015, p.939 (showing change in capacity of  $\text{LiMn}_2\text{O}_4$  as voltage changes).

168. Accordingly, a PHOSITA would have understood that Abe discloses and renders obvious a battery having “a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0

to 1:2.5 as calculated by a specific or theoretic capacity with a charge voltage limited to or set at 4.2 V” under the claim construction that I was instructed to apply.

2. *Claims 2-3 and 6-7*

**[2] [3]: “A method according to claim 1, characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is within a range from” [2]: “4.3 V to 5.2 V” [3]: “4.3 V to 4.8 V.”**

**[6] [7]: “A secondary lithium ion cell or battery according to claim 5, characterized in that the secondary lithium ion cell or battery has a charge cut-off voltage within a range from” [6]: “4.3 V to 5.2 V” [7]: “4.3 V to 4.8 V.”**

169. Claims 2 and 6 both require a charge cutoff voltage “from 4.3 V to 5.2 V.”<sup>167</sup> Claims 3 and 7 narrow the top end of this range and recite a charge cutoff voltage “from 4.3 V to 4.8 V.”<sup>168</sup> As I explained above, Abe’s battery using  $\text{LiMn}_2\text{O}_4$  as the positive electrode material has a charge cutoff voltage that ranges from 4.2 V to 4.3 V.<sup>169</sup> Therefore, Abe discloses a range that includes 4.3 V, which is claimed by the ’641 patent claims 2-3 and 6-7 and therefore Abe discloses and renders obvious these aspects of the claims too.

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<sup>167</sup> EX1001 (’641 pat.), 16:62-64, 17:12-15.

<sup>168</sup> *Id.*, 16:65-67, 17:16-19.

<sup>169</sup> EX1005 (Abe), ¶[0078].

3. *Claims 4 and 8*

**[4] [8]: “characterized in that the ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.15 to 1:2.5.”**

170. These claims require the ratio of positive electrode material to negative electrode material to be between 1:1.15 and 1:2.5.<sup>170</sup> This is taught by Abe, which explains that the ratio should be between 1:1 and 1:1.6. Specifically, Abe explains that “the design capacity of the negative electrode is a non-aqueous electrolyte-based secondary battery . . . having a design capacity of more than 1 and less than or equal to 1.6 for the design capacity of the positive electrode . . . .”<sup>171</sup> Therefore, Abe teaches and renders obvious a range that includes the range claimed in claims 4 and 8 of the ’641 patent.

**E. Ground 7: Abe and Guyomard Render Claims 2-4, 6-8, And 11-18 Obvious.**

171. A PHOSITA would have looked at the teachings of Abe and Guyomard (EX. 1008) together and in doing so, would have realized that higher capacity and specific energy batteries could be developed using Guyomard’s electrolyte in combination with Abe’s  $\text{LiMn}_2\text{O}_4$  positive electrode battery designs. Using Guyomard’s electrolytes, the PHOSITA would have determined the “design

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<sup>170</sup> EX1001 (’641 pat.), 17:1-4, 17:20-23.

<sup>171</sup> EX1005 (Abe), ¶[0018].

capacity” of Abe at higher voltages, such as 4.5 V or 4.9 V because those are the cutoff voltages that Guyomard says are enabled by the disclosed electrolytes.<sup>172</sup> When determining the design capacity at a higher cutoff voltage according to the combined teachings of Abe and Guyomard, a PHOSITA would have recognized that the ratio would have further increased the relative capacity of the negative electrode when determined at a charge cutoff voltage of 4.2 V for all of the reasons I have explained above. *Supra* §§II.A, XI.A.1 (limitations [1B] & [5B]). The combined teachings of Abe and Guyomard and how they render claims 2-4, 6-8, and 11-18 obvious are discussed in more detail below.

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<sup>172</sup> EX1008 (Guyomard), 8:32-9:5 (“A set of such tests cells with the separator element comprising an electrolyte of 1 M LiPF<sub>6</sub> in 95 DMC : 5 EC and a carbon (graphite or petroleum coke) negative electrode were repeatedly charged and discharge[d] over two hours cycles at about 25°C and 55°C and at charging cut-off voltages of 4.9 V and 4.5 V, respectively. Even at this cycling rate and high charging voltage, the voltage polarization was unusually small, confirming the high ionic conductivity of the electrolyte, and there was no significant loss of cell capacity, verifying the high voltage stability of the electrolyte.”).

1. *Claims 2-3 and 6-7.*

**[2] [3]: “A method according to claim 1, characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is within a range from” [2]: “4.3 V to 5.2 V” [3]: “4.3 V to 4.8 V.”**

**[6] [7]: “A secondary lithium ion cell or battery according to claim 5, characterized in that the secondary lithium ion cell or battery has a charge cut-off voltage within a range from” [6]: “4.3 V to 5.2 V” [7]: “4.3 V to 4.8 V.”**

172. Claims 2 and 6 both require a charge cutoff voltage “from 4.3 V to 5.2 V.”<sup>173</sup> Claims 3 and 7 narrow the top end of this range and recite a charge cutoff voltage “from 4.3 V to 4.8 V.”<sup>174</sup> As I explained in connection with my discussion of claim 1, Abe discloses a charge cutoff voltage of 4.3V, which is “within a range from 4.3V to 5.2 V.”<sup>175</sup> In addition to Abe disclosing these additional limitations, the combination of Abe with Guyomard also renders claims 2-3 and 6-7 obvious because Guyomard tells the PHOSITA that if an appropriate electrolyte solution is used in a cell with a positive electrode material including lithium manganese oxides,

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<sup>173</sup> EX1001 (’641 pat.), 16:62-64, 17:12-15.

<sup>174</sup> *Id.*, 16:65-67, 17:16-19.

<sup>175</sup> EX1005 (Abe), ¶[0078].

the charge cutoff voltage can be increased up to 5V, including specific examples at 4.5 V and 4.9 V (depending on temperature).<sup>176</sup>

173. I have discussed Guyomard in more detail above. *Supra* § XI.C. I incorporate that discussion here. In summary, Guyomard describes secondary lithium ion cells using  $\text{LiMn}_2\text{O}_4$  as the active positive electrode material and explains that using specific electrolytes enable the battery to reliably reach high cutoff voltages without damaging the battery while exhibiting “remarkable” cycle life properties.<sup>177</sup> Guyomard discloses using  $\text{LiPF}_6$  as the lithium-ion source and a “mixture of dimethylcarbonate (DMC) and ethylene carbonate (EC) within the weight percent ratio range from 95 DMC : 5 EC to 20 DMC : 80 EC” in a battery using  $\text{LiMn}_2\text{O}_4$  as the positive electrode active material and carbon as the negative

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<sup>176</sup> EX1008 (Guyomard), 4:7-10 (“[W]e have discovered a group of electrolyte compositions whose range of effective stability extends up to about 5.0 V at 55°C, as well as at room temperature (about 25°C).”), 8:33-37 (discussing cycling “over two hours cycles [sic] at about 25°C and 55°C and at charging cut-off voltages of 4.9 V and 4.5 V, respectively”).

<sup>177</sup> EX1008 (Guyomard), 7:26-8:18, 8:23-9:8 (describing an “exceptional” electrolyte that provides “outstanding oxidation resistant characteristics” and which “extend[s] the cycle life of the batteries”).

electrode active material, to provide a battery with a cutoff voltage of, for example, 4.5V that exhibits high cyclability (*e.g.*, 495 cycles with only 10% loss in capacity).<sup>178</sup> As I explain further below, Abe also discloses a battery that includes a positive electrode active material of  $\text{LiMn}_2\text{O}_4$  and a negative electrode active material of carbonaceous material.<sup>179</sup> Additionally, Abe discloses the use of electrolytes that include  $\text{LiPF}_6$  and a solvent of “cyclic carbonate and chain carbonate” such as “ethylene carbonate” and “dimethyl carbonate.”<sup>180</sup> The specific electrolyte solution used in Abe’s examples differs somewhat from that disclosed by Guyomard and includes “propylene carbonate” along with EC and DEC in specified ratios.<sup>181</sup>

174. The reasons that a PHOSITA would have looked to the combined teachings of Abe in view of Guyomard and used Guyomard’s electrolyte compositions in connection with the example using a  $\text{LiMn}_2\text{O}_4$  positive electrode and the carbonaceous negative electrode disclosed in Abe is explained below.<sup>182</sup> The

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<sup>178</sup> EX1008 (Guyomard), 7:26-35, 8:32-37, 9:5-8.

<sup>179</sup> EX1005 (Abe), ¶¶[0078], [0099], [0102]-[0103].

<sup>180</sup> *Id.*, ¶¶[0071]-[0075].

<sup>181</sup> *Id.*, ¶¶[0093], [0103].

<sup>182</sup> *Id.*, ¶¶[0102]-[0103].

resulting battery would have had a charge cutoff voltage of, for example, 4.5 V in accordance with Guyomard's teachings related to the electrolyte enabling higher charge cutoff voltages to be employed with batteries using  $\text{LiMn}_2\text{O}_4$  as the positive electrode active material. *Infra* §XI.E.4. As I explain in further detail below and based on the discussion above, the combined teachings of Abe and Guyomard discloses and renders obvious the claimed charge cutoff voltage ranges in claims 2-3 and 6-7.

2. *Claims 4 and 8.*

**[4] [8]: “characterized in that the ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.15 to 1:2.5.”**

175. These claims require the ratio of positive electrode material to negative electrode material to be between 1:1.15 and 1:2.5.<sup>183</sup> In addition to Abe disclosing this additional limitation, the combination of Abe with Guyomard also renders claims 4 and 8 obvious.

176. As I have explained above, Guyomard discloses batteries that have a  $\text{LiMn}_2\text{O}_4$  positive electrode and a carbonaceous negative electrode and which includes an electrolyte that allows for the charge cut-off voltage to be raised to, for

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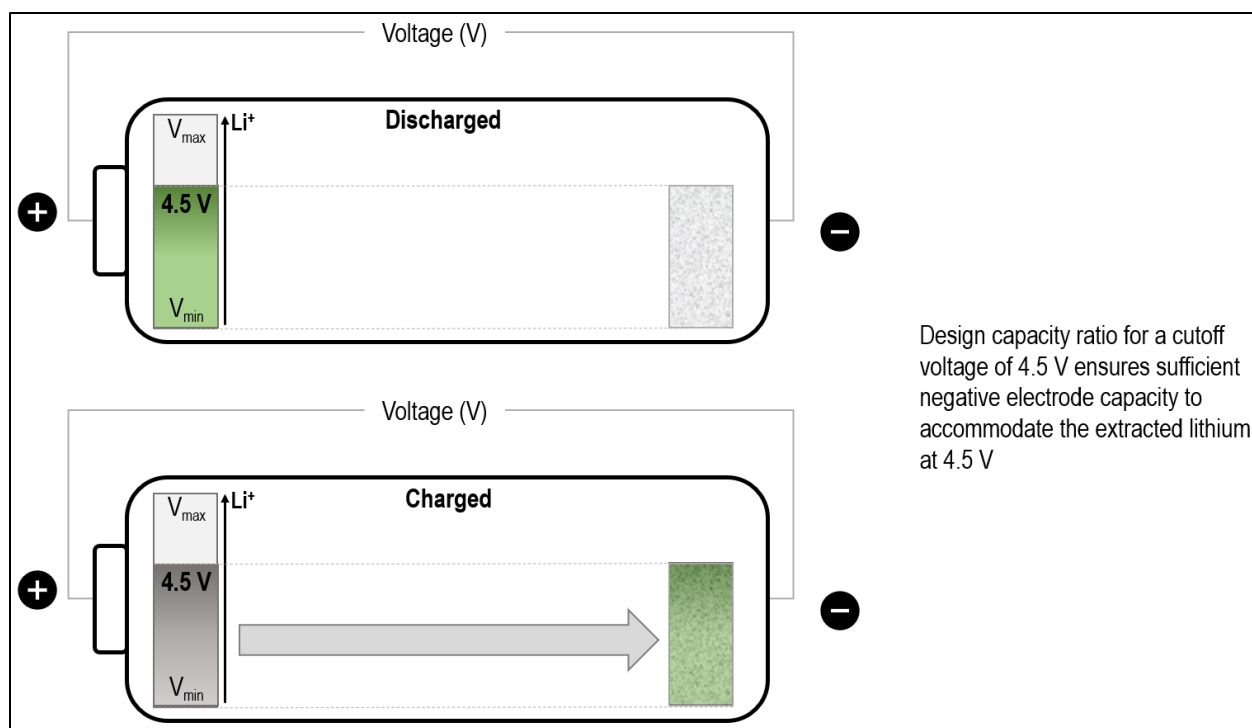
<sup>183</sup> EX1001 ('641 pat.), 17:1-4, 17:20-23.

example, 4.5 V and beyond.<sup>184</sup> When the PHOSITA raised the cutoff voltage to extract additional lithium from the positive electrode—as they would have in light of Guyomard’s teachings showing that a charge cut-off voltage of 4.5 V (or higher)—the PHOSITA would have understood to calculate the claimed ratio at the

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<sup>184</sup> EX1008 (Guyomard), 4:6-10 (“As a result of these extensive investigations, we have discovered a group of electrolyte compositions whose range of effective stability extends up to about 5.0 V at 55°C, as well as at room temperature (about 25°C).”), 8:13-18 (“The negligible current increase, after the reversible Li intercalations, at voltages up to about 5 V vs. Li indicates this remarkable stability which enables enhanced cell capacity not only in the ‘rocking chair’ cells comprising negative electrodes of carbon, e.g., petroleum coke, but also in Li negative electrode cells.”), 8:32-9:5 (“A set of such test cells with the separator element comprising an electrolyte of 1 M LiPF<sub>6</sub> in 95 DMC:5 EC and a carbon (graphite or petroleum coke) negative electrode were repeatedly charged and discharge[d] over two hours cycles at about 25°C and 55°C and at a charging cut-off voltages of 4.9 V and 4.5 V, respectively. Even at this cycling rate and high charging voltage, the voltage polarization was unusually small, confirming the high ionic conductivity of the electrolyte, and there was no significant loss of cell capacity, verifying the high voltage stability of the electrolyte.”).

“design capacity” associated with the charge cutoff voltage of, for example, 4.5 V in light of the combined teachings of the references and particularly Abe’s teaching that design capacity is determined “in a predetermined voltage range.”<sup>185</sup> *Supra* §XI.A.1 (limitations [1B] & [5B]). The following illustration generally shows a battery with a design capacity ratio of 1:1 as calculated at 4.5V. As can be seen the negative electrode has sufficient capacity to accommodate all lithium extracted from the positive electrode at 4.5V.



As I have explained above, Abe teaches a design capacity ratio of 1:1 to 1:1.6, and

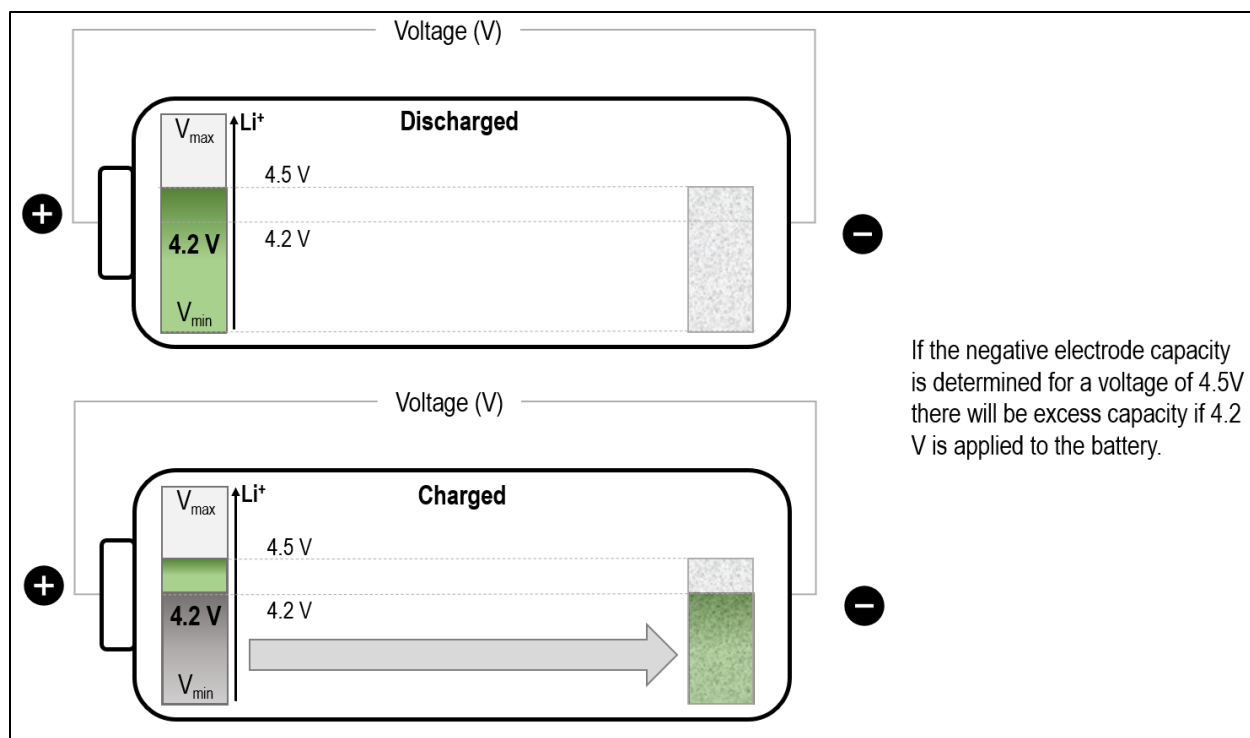
<sup>185</sup> EX1005 (Abe), ¶[0078].

an example in which the design capacity ratio 1:1.1.<sup>186</sup> This is calculated based on charge cutoff voltage described in Abe—i.e., 4.2 V to 4.3 V for the reasons I have explained above.<sup>187</sup> *See supra* §XI.D.1 (limitations [1B] & [5B]). When the design capacity ratio is calculated at a lower charge cutoff voltage of 4.2 V (as recited in the claims of the '641 patent), the design capacity ratio will be in excess of 1:1.15 as calculated at the claimed charge cutoff voltage of 4.2V because performing the calculation of the ratio at 4.2 V would have required adding more capacity at the negative electrode to accommodate the increased cutoff voltage taught by Guyomard (i.e., 4.5V)—something that the PHOSITA would have found important to avoid overcharging the battery when the cutoff voltage of 4.5V is applied which would have resulted in the plating of lithium and potential formation of dendrites, thus damaging the battery. *Supra* §§II.A, XI.A.1 (limitations [1B] & [5B]). This is illustrated in the diagram below, which shows that the negative electrode has excess capacity when designed to accommodate a charge cutoff voltage of 4.5V but a voltage only 4.2V is applied.

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<sup>186</sup> EX1005 (Abe), ¶¶[0018], [0103].

<sup>187</sup> EX1005 (Abe), ¶[0078] (explaining that the design capacity is determined “in a predetermined charging voltage range.”).



177. Additionally, because it was known and desirable to keep the battery as small as reasonably possible, having too much excess negative electrode material (and thus excess negative electrode capacity) would have been unnecessary thus providing an upper practical limit on the amount of negative electrode material capacity such that it was less than 2.5 times greater than the positive electrode material capacity.<sup>188</sup> Accordingly, in this case, the ratio disclosed by the combination

<sup>188</sup> EX1005 (Abe), ¶¶[0018], [0103]; EX1009 (Uemura), ¶[0033] (“If the capacity balance ratio B/A exceeds 1.5, negative electrode sites that do not contribute to the charge-discharge are increased, leading to the wasteful use of materials.”).

of Abe and Guyomard renders obvious the claimed ratio at 4.2 V of 1:1.15 to 1:2.5 as recited in these claims.

178. The reasons that a PHOSITA would have looked to the combined teachings of Abe in view of Guyomard and used Guyomard's electrolyte compositions in connection with the example using a  $\text{LiMn}_2\text{O}_4$  positive electrode and the carbonaceous negative electrode disclosed in Abe is explained below.<sup>189</sup> *Infra* §XI.E.4. As I explain in further detail below and based on the discussion above, the combined teachings of Abe and Guyomard discloses and renders obvious the claimed capacity ratio ranges in claims 4 and 8.

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<sup>189</sup> EX1005 (Abe), ¶¶[0102]-[0103].

3. *Claims 11-18*

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

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

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

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

**15. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 75% of capacity after 400 cycles.**

**16. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 75.83% of capacity after 400 cycles.**

**17. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 80% of capacity after 400 cycles.**

**18. A method according to claim 1, wherein the secondary lithium ion cell or battery maintains at least 80.72% of capacity after 400.**

179. Claims 11-14 depend from claim 5 and claims 15-18 depend from claim 1.<sup>190</sup> Each of these claims recites the percentage of capacity that is maintained in the secondary lithium ion cell or battery after 400 cycles. The highest percentage, and therefore most restrictive, is recited in claims 14 and 18, which state that “at least 80.72% of capacity” is maintained after 400 cycles. Therefore, I understand that if the prior art teaches or renders obvious a cell or battery within the remaining capacity limitation of claims 14 and 18, it anticipates or renders obvious claims 11-13 and 15-17 too. As explained in more detail below, the PHOSITA reviewing the disclosures of Abe and Guyomard would have found these claims of the ’641 patent obvious.

180. While Abe does not explicitly disclose the claimed capacity percentages or cycling data associated with Abe’s  $\text{LiMn}_2\text{O}_4$  battery at the number of cycles specified in the claims (*i.e.*, 400 cycles), Guyomard, shows that the claimed percentages of remaining capacity after 400 cycles and further explains how to achieve such cyclability using a battery having a positive electrode of  $\text{LiMn}_2\text{O}_4$  and a carbonaceous negative electrode—namely by using a specific electrolyte

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<sup>190</sup> See EX1001 (’641 pat.), 18:4-28 (reciting 75% (claims 11 & 15), 75.83% (claims 12 and 16), 80% (claims 13 and 17), and 80.72% (claims 14 and 18) capacity after 400 cycles.)

composition.<sup>191</sup> Particularly, Guyomard explains that, between charge cycles 5 and 500, “[t]he ability of the electrolyte to extend the cycle life of [LiMn<sub>2</sub>O<sub>4</sub>] batteries was amply demonstrated by the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.”<sup>192</sup>

181. A PHOSITA would have understood that Guyomard’s disclosure of a LiMn<sub>2</sub>O<sub>4</sub> battery having 10% capacity loss between cycle number 5 and 500 exceeds 80.72% after 400 cycles because it describes a capacity loss of only 10% after 495 cycles (i.e., between cycles 5 and 500).<sup>193</sup> I explain the reasons that a PHOSITA would have found it obvious to combine Abe in Guyomard in the section that follows.

4. *A PHOSITA Would Have Found It Obvious To Combine Abe with Guyomard.*

182. A PHOSITA would have been motivated to combine the teachings of Abe with Guyomard for several reasons.

183. First, Abe identifies a known problem to which Guyomard provides a known solution. Abe explains that the voltage in LiMn<sub>2</sub>O<sub>4</sub> batteries must be “set to a range [*i.e.*, 4.2-4.3V] in which no electrolyte decomposition occurs, and no

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<sup>191</sup> EX1008 (Guyomard), 9:5-8.

<sup>192</sup> *Id.*

<sup>193</sup> *Id.*

irreversible structural breakdown of the positive electrode active material occurs.”<sup>194</sup>

That said, the PHOSITA knew that it was desirable to raise the charge cutoff voltage because doing so would have increased the average operating voltage and specific energy of the battery. Not only does Guyomard teach that this would be advantageous, but also that it could have been accomplished using the specific electrolytes disclosed by Guyomard. For instance, Guyomard describes an “exceptionally useful” electrolyte for minimizing electrolyte decomposition.<sup>195</sup>

Guyomard discovered an “exceptional, wide temperature range, oxidation resistant electrolyte for a  $\text{LiMn}_2\text{O}_4$  positive electrode intercalation battery cell, particularly one utilizing the preferred  $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$  ( $0 < x < 1$ ) electrode . . . .”<sup>196</sup> Abe uses a  $\text{Li}_{1+x}\text{Mn}_2\text{O}_4$  electrode where  $x = 0$ .<sup>197</sup> Guyomard further explains that there is an “optimum composition for” various temperature ranges and that the result is

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<sup>194</sup> EX1005 (Abe), ¶[0078].

<sup>195</sup> EX1008 (Guyomard), 3:34-37 (“The present invention provides a class of electrolyte compositions that is exceptionally useful for minimizing electrolyte decomposition in secondary batteries comprising strongly oxidizing electrode materials.”).

<sup>196</sup> EX1008 (Guyomard), 7:27-31.

<sup>197</sup> EX1005 (Abe), ¶¶[0102]-[0103].

“outstanding oxidation resistant characteristics of the preferred electrolyte compositions . . . .”<sup>198</sup> The electrolyte gives “remarkable stability,” allowing high voltage charging of cells with carbonaceous negative electrodes along with metal lithium electrodes.<sup>199</sup> The cells exhibited “remarkable” cyclability using this electrolyte despite the higher voltage.<sup>200</sup> The PHOSITA would have found it obvious to use this touted electrolyte in connection with Abe’s battery to allow the Abe battery to be charged at a higher charge cutoff voltage, and exhibit good cyclability properties (falling within claims 11-18 of the ’641 patent) thus improving the resulting battery’s properties.

184. Both Abe and Guyomard mention the fact that conventional thinking was that  $\text{LiMn}_2\text{O}_4$  was not to be charged at a voltage of over 4.3 V. For instance, Abe explains that “the voltage is set to a range in which no electrolyte decomposition occurs, and no irreversible structural breakdown of the positive electrode active material occurs. For example,  $\text{LiMn}_2\text{O}_4$  is 4.2-4.3 V, . . . .”<sup>201</sup> But, after reading Guyomard, the PHOSITA would have recognized that using Guyomard’s electrolyte

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<sup>198</sup> EX1008 (Guyomard), 7:35-8:2, 8:10-11.

<sup>199</sup> *Id.*, 8:13-18.

<sup>200</sup> *Id.*, 8:37-9:8.

<sup>201</sup> EX1005 (Abe), ¶[0078].

could lead to improved cyclability and better battery performance at even higher charge cutoff voltages, thus unlocking additional, untapped capacity in Abe's batteries. For instance, Guyomard explains in the background the same general conventional understanding held by Abe:

Thus, to operate such a cell in the higher temperature ambient, one must reduce the charging cut-off voltage to a level below about 4.3 V in order to avoid electrolyte oxidation. Because of this lower cut-off voltage, the available capacity of the cell at about 55°C is only 75% of that at room temperature. When cells comprising these previously-available electrolytes are cycled to a voltage even slightly greater than 4.3 V, electrolyte oxidation occurs. Although small, this oxidation can jeopardize the capacity, cycle life, and safety of the battery cell. For example, the electrolyte oxidation reaction consumes part of the charging current which is then not recovered when discharging the cell, resulting in a continuous loss in the cell capacity over subsequent cycles.<sup>202</sup>

Guyomard solved this issue using new electrolytes and allowed a battery including  $\text{LiMn}_2\text{O}_4$  to be charged to 4.5 V or even 4.9 V at temperatures of 55°C.<sup>203</sup>

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<sup>202</sup> EX1008 (Guyomard), 3:2-16.

<sup>203</sup> *Id.*, 8:23-9:8.

185. Guyomard further discloses optimal amounts of electrolyte materials and accommodates for different ambient temperatures.<sup>204</sup> The PHOSITA would have appreciated that the electrolytes disclosed by Guyomard are among those described in Abe. For instance, Abe explains:

The non-aqueous electrolyte-based secondary batteries according to the present invention can be manufactured using a negative electrode, a cathode, and a non-aqueous electrolyte solution.

The non-aqueous electrolyte solution contains a lithium salt. The concentration of the lithium salt is typically 0.8 to 2.0 mol/L, preferably 1 to 1.8 mol/L, and further preferably 1 to 1.6 mol/L. If the concentration of the lithium salt is within the above range, the object of the present invention can be better achieved, resulting in an advantage of superior cycle characteristics at high or low temperatures.

The lithium salt can include  $\text{LiClO}_4$ ,  $\text{LiPF}_4$ ,  $\text{LiBF}_4$ ,  $\text{LiAsF}_6$ ,  $\text{LiCF}_3\text{SO}_3$ , etc., and these can be used alone or in combination with two or more of these. Of these,  $\text{LiPF}_6$  is preferred.

The solvent of the non-aqueous electrolyte solution is a mixed solvent of cyclic carbonate and chain carbonate.

The cyclic carbonate includes ethylene carbonate,

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<sup>204</sup> EX1008 (Guyomard), 7:26-8:8.

propylene carbonate, butylene carbonate, etc., and can be used alone or in combination of two or more. In addition, the chain carbonate includes dimethyl carbonate, diethyl carbonate, methyl ethyl carbonate, etc. and can be used alone or in combination of two or more. Examples of combinations of two or more carbonates include ethylene carbonate and dimethyl carbonate, ethylene carbonate and diethyl carbonate, ethylene carbonate and dimethyl carbonate and diethyl carbonate, ethylene carbonate and propylene carbonate and dimethyl carbonate, ethylene carbonate and propylene carbonate and diethyl carbonate, etc.<sup>205</sup>

Abe's examples use a mixed solvent of EC / PC / DEC in a 2/1/2 volume ratio—i.e., ethylene carbonate, propylene carbonate, and diethyl carbonate and a concentration of LiPF<sub>6</sub> of 1.2 mole.<sup>206</sup> From this, the PHOSITA would have seen that Guyomard discloses an optimized electrolyte composition from the electrolyte materials that Abe indicates would work well and have good cyclability properties.

186. *Teaching, Suggestion, or Motivation from Abe and Guyomard.* As I explained above, I was given a list of considerations to evaluate in deciding whether a patent claim is directed to something that is obvious. *Supra* § V.D. One of those

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<sup>205</sup> EX1005 (Abe), ¶¶[0070]-[0074].

<sup>206</sup> *Id.*, ¶¶[0093], [0103].

considerations is whether the prior art provides an explicit or implicit teaching, suggestion, or motivation to combine two prior art references to form a claimed combination. This consideration is present here and would have led to the obviousness of claims 2-4, 6-8, and 11-18 of the '641 patent. The following observations are relevant to my conclusion:

- Both Abe and Guyomard show that it was a commonly-held belief that lithium ion batteries having  $\text{LiMn}_2\text{O}_4$  positive electrodes and carbonaceous negative electrodes could be charged to no more than 4.3 V without potentially damaging the battery and reducing its cyclability.<sup>207</sup>

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<sup>207</sup> EX1005 (Abe), ¶[0078] (“[T]he voltage is set to a range in which no electrolyte decomposition occurs, and no irreversible structural breakdown of the positive electrode active material occurs. For example,  $\text{LiMn}_2\text{O}_4$  is 4.2-4.3 V, . . . .”); EX1008 (Guyomard), 3:2-16 (“Thus, to operate such a cell in the higher temperature ambient, one must reduce the charging cut-off voltage to a level below about 4.3 V in order to avoid electrolyte oxidation. Because of this lower cut-off voltage, the available capacity of the cell at about 55°C is only 75% of that at room temperature. When cells comprising these previously-available electrolytes are cycled to a voltage even slightly greater than 4.3 V, electrolyte oxidation occurs. Although small, this oxidation can jeopardize the capacity, cycle life, and safety of the battery cell. For

- Both Abe and Guyomard explain that choosing the correct electrolytes can improve the cyclability of the battery.<sup>208</sup>
- Both Abe and Guyomard disclose lithium-ion batteries with  $\text{LiMn}_2\text{O}_4$  positive electrodes and carbonaceous negative electrodes.<sup>209</sup>
- Guyomard explicitly observes that limiting the charge cutoff voltage to 4.3 V in an effort to avoid electrolyte oxidation leads to a reduction in utilized capacity of the battery.<sup>210</sup>
- Finally, Guyomard touts the specific electrolytes as being superior to other known electrolytes. Specifically, Guyomard’s “exceptionally useful”

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example, the electrolyte oxidation reaction consumes part of the charging current which is then not recovered when discharging the cell, resulting in a continuous loss in the cell capacity over subsequent cycles.”).

<sup>208</sup> EX1005 (Abe), ¶¶[0071] (explaining that the correct concentration of lithium salt can result “in an advantage in superior cycle characteristics at high or low temperature.”); EX1008 (Guyomard), 8:23-9:8 (identifying particular electrolyte compositions and observing “the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.”).

<sup>209</sup> EX1005 (Abe), ¶¶[0102]-[0103]; EX1008 (Guyomard), 7:26-8:21.

<sup>210</sup> EX1008 (Guyomard), 2:34-3:7.

electrolyte are used to reduce electrolyte decomposition,<sup>211</sup> have an “exceptional, wide temperature range, oxidation resistant” properties,<sup>212</sup> and explains that the electrolytes provide an “optimum composition for” various temperature ranges and that the result is “outstanding oxidation resistant characteristics of the preferred electrolyte compositions . . . .”<sup>213</sup> The cells exhibited “remarkable” cyclability using this electrolyte despite the higher voltage.<sup>214</sup>

These disclosures would have provided an explicit and implicit motivation for the PHOSITA to incorporate the Guyomard electrolyte into the Abe  $\text{LiMn}_2\text{O}_4$  battery to (1) increase its capacity by increasing the charge cutoff voltage, and (2) increase or maintain its cyclability at the higher charge cutoff voltage. It also would have led

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<sup>211</sup> EX1008 (Guyomard), 3:34-37 (“The present invention provides a class of electrolyte compositions that is exceptionally useful for minimizing electrolyte decomposition in secondary batteries comprising strongly oxidizing electrode materials.”).

<sup>212</sup> *Id.*, 7:27-31.

<sup>213</sup> *Id.*, 7:35-8:2, 8:10-11.

<sup>214</sup> *Id.*, 8:37-9:8.

the PHOSITA to increase the amount of negative electrode active material (and thus its capacity) when the ratio is determined at 4.2V.

187. *Applying Guyomard's Known Electrolyte to Abe's Similar Battery To Improve Capacity Through Raising the Charge Cutoff Voltage While Maintaining High Cyclability.* Second, I have been further informed that if a technique has been used to improve one device and the PHOSITA would have recognized that it would have improved a similar device in the same way, using the technique is obvious unless the application is beyond his or her skill. This consideration is present here too. Specifically, as I have explained in considerable detail above, Guyomard teaches a known technique of using an optimized electrolyte to allow the charge cutoff voltage of a lithium-ion battery that used a  $\text{LiMn}_2\text{O}_4$  positive electrode and a carbonaceous negative electrode to be raised to 4.5 V or even 4.9 V.<sup>215</sup> This allows an improvement to lithium-ion batteries that have this structure because it allows a charge cutoff voltage to be increased thus increasing the overall capacity of the battery.<sup>216</sup> Applying this technique to Abe, which also uses a  $\text{LiMn}_2\text{O}_4$  positive

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<sup>215</sup> *Id.*, 8:23-9:8.

<sup>216</sup> EX1008 (Guyomard), 3:2-16 (“Thus, to operate such a cell in the higher temperature ambient, one must reduce the charging cut-off voltage to a level below about 4.3 V in order to avoid electrolyte oxidation. Because of this lower cut-off

electrode and a carbonaceous negative electrode and an electrolyte in which the source of ions is  $\text{LiPF}_6$  would have merely applied Guyomard's known electrolyte to Abe's similar battery to improve it in the same way—i.e., by allowing the charge cutoff voltage to be raised to, e.g., 4.5 V. And such an increase in cutoff voltage would have necessitated an increase in the ratio of positive to negative electrode material. Therefore, a PHOSITA would have known to provide more capacity in the negative electrode to accommodate the additional capacity being utilized from the positive electrode due to the increase in voltage. That Abe lists the same types of electrolyte materials and battery compositions that are discussed in Guyomard shows that combining Guyomard's electrolyte with Abe's battery design would have been

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voltage, the available capacity of the cell at about 55°C is only 75% of that at room temperature. When cells comprising these previously-available electrolytes are cycled to a voltage even slightly greater than 4.3 V, electrolyte oxidation occurs. Although small, this oxidation can jeopardize the capacity, cycle life, and safety of the battery cell. For example, the electrolyte oxidation reaction consumes part of the charging current which is then not recovered when discharging the cell, resulting in a continuous loss in the cell capacity over subsequent cycles.”).

within the grasp of the PHOSITA—and something that would have been easy to do given the teachings of the references.<sup>217</sup>

188. I understand that a combination is not an obvious choice if the PHOSITA would not have had a reasonable expectation of success in achieving the results sought by making the combination. That is not the case here. A PHOSITA would have readily expected to succeed in making the combination of Guyomard (and specifically Guyomard's electrolyte) with Abe's lithium-ion batteries for the reasons I have already explained including:

- Both Abe and Guyomard disclose lithium-ion batteries with  $\text{LiMn}_2\text{O}_4$  positive electrodes and carbonaceous negative electrodes.<sup>218</sup>
- Both Abe and Guyomard explain that choosing the correct electrolytes can improve the cyclability of the battery.<sup>219</sup>

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<sup>217</sup> EX1005 (Abe), ¶¶[0070]-[0074], [0097], [0103]; EX1008 (Guyomard), 7:35-8:2.

<sup>218</sup> EX1005 (Abe), ¶¶[0102]-[0103]; EX1008 (Guyomard), 7:26-8:21.

<sup>219</sup> EX1005 (Abe), ¶[0071] (explaining that the correct concentration of lithium salt can result “in an advantage in superior cycle characteristics at high or low temperature.”); EX1008 (Guyomard), 8:23-9:8 (identifying particular electrolyte compositions and observing “the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.”).

- The groups of electrolyte materials mentioned in Abe include the compositions optimized by Guyomard.<sup>220</sup>

Based on this, a PHOSITA would have reasonably expected to achieve similar results to those achieved by Guyomard because the use of Guyomard’s “exceptionally useful” electrolyte would have been expected to reduce electrolyte decomposition,<sup>221</sup> have an “exceptional, wide temperature range, oxidation resistant” properties,<sup>222</sup> and would have been expected to provide an “optimum composition for” various temperature ranges and that the result is “outstanding oxidation resistant characteristics of the preferred electrolyte compositions . . . .”<sup>223</sup>

189. Making the combination of Abe and Guyomard would have allowed for a further increase in the battery’s capacity because the charge cutoff voltage would have been raised to unlock this additional capacity. For the reasons I have explained

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<sup>220</sup> EX1005 (Abe), ¶¶[0070]-[0074], [0097], [0103]; EX1008 (Guyomard), 7:35-8:2.

<sup>221</sup> EX1008 (Guyomard), 3:34-37 (“The present invention provides a class of electrolyte compositions that is exceptionally useful for minimizing electrolyte decomposition in secondary batteries comprising strongly oxidizing electrode materials.”).

<sup>222</sup> *Id.*, 7:27-31.

<sup>223</sup> *Id.*, 7:35-8:2, 8:10-11.

above in connection with claims 2-3 and 6-7, this would have led to a battery charged using a charge cutoff voltage within the claimed ranges. *Supra* §XI.E.1. It would have also resulted in the ratio of positive electrode material to negative electrode material—i.e., Abe’s “design capacity” ratio—to be between 1:1.15 and 1:2.5 as recited in claims 4 and 8 for the reasons I have explained above. *Supra* §XI.E.2. And, this would have further improved the cycling characteristics of Abe’s batteries such that a PHOSITA would have expected to be able to cycle the battery 400 times while maintaining a capacity of at least 80.72% (and thus at least 80%, 75.83%, and 75%) as recited in claims 11-18 for the reasons I have explained above. *Supra* §XI.E.3.

190. Accordingly, a PHOSITA would have found claims 2-4, 6-8, and 11-18 obvious over Abe and Guyomard.

**F. Ground 8: Uemura And Iwaizono Render Claim 9 Obvious.**

*1. Claim 9*

**9. A secondary lithium ion cell or battery according to claim 5, characterized in that the secondary lithium ion cell or battery has a first overcharging protection Voltage of greater than 4.35V, and an overcharging protection release Voltage of greater than 4.15 V.**

191. Claim 9 of the ’641 patent requires that the cell or battery “has a first overcharging protection voltage of greater than 4.35 V, and an overcharging

protection release voltage of greater than 4.15 V.”<sup>224</sup> Including a circuit in the battery to provide an overcharging protection voltage of more than 4.35 V and an overcharging release voltage of greater than 4.15 V would have been obvious to the PHOSITA based on the combined teachings of Uemura and Iwaizono.

192. Those skilled in the art knew that they should avoid overcharging the lithium-ion batteries. For instance, those skilled in the art were aware that “there is a problem in that a lithium dendrite is often generated upon overcharging to cause internal-shorts between the anode and cathode, where a large electric current suddenly flows causing temperature rise in the battery whereby the organic solvent of the electrolyte solution is decomposed to increase the internal pressure of the battery.”<sup>225</sup> An “overcharge preventative circuit” installed in the battery was one known solution to this problem.<sup>226</sup>

193. Iwaizono provides a known protective circuit to address this problem. Iwaizono explains that “[c]harging of rechargeable batteries beyond their suitable charge conditions leads to the generation of gas or heat due to decomposition of the

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<sup>224</sup> EX1001 (’641 pat.), 17:24-27.

<sup>225</sup> EX1018 (U.S. Pat. No. 5,853,914), 2:42-48.

<sup>226</sup> *Id.*, 2:54-56.

electrolyte and may cause breakdown or deterioration of the battery.”<sup>227</sup> Iwaizono explains that “the normal practice” is to “provide a battery protection device for protecting the battery from improper use.”<sup>228</sup> Such devices can be “mounted in the rechargeable battery itself . . . .”<sup>229</sup> When the circuitry determines that “a voltage [is] over a predetermined charge-permitting voltage,” a MOSFET is switched to an “OFF” state and “the charging and discharging circuit is shut off,” leading to termination of the charging current supplied to the battery.<sup>230</sup> Iwaizono explains that these circuits may fail and overcharging will cause the battery to degrade, thus causing a dangerous condition.<sup>231</sup> Iwaizono seeks to provide a “protective circuit with a compact structure that affords reliable protection of a rechargeable battery, and at the same time, a protective element that is compatible with this protective circuit.”<sup>232</sup> The improved protective circuit includes a “switching means” which “turns off the second switching means through detection of the second charge-

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<sup>227</sup> EX1007 (Iwaizono), 1:10-14.

<sup>228</sup> *Id.*, 1:17-19.

<sup>229</sup> *Id.*, 1:20-21.

<sup>230</sup> *Id.*, 1:46-52.

<sup>231</sup> *Id.*, 1:60-65.

<sup>232</sup> *Id.*, 2:55-59.

prohibiting voltage, and maintains this OFF state until a second charge-permitting voltage is detected.”<sup>233</sup> This “second charge-permitting voltage” is “set below the first charge-prohibiting voltage.”<sup>234</sup>

194. Iwaizono provides an example of a “first charge-prohibiting voltage” of 4.3 V.<sup>235</sup> If this first charge-prohibiting voltage is reached, a FET is switched “OFF” and it stays this way “until a first charge-permitting voltage that is lower than the first charge-prohibiting voltage is detected.”<sup>236</sup> In the case of a malfunction of the protective circuit, a sub-protective circuit “B” is used and “if it detects a voltage over a second charge-prohibiting voltage (such as 4.45 V) that is higher than the first charge-prohibiting voltage detected by the main control means 1 for the purpose of

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<sup>233</sup> *Id.*, 3:48-55.

<sup>234</sup> *Id.*, 3:52-55.

<sup>235</sup> *Id.*, 9:57-63 (“The main control means 1 detects the voltage across the positive and negative electrodes of the rechargeable battery 3, and if the result is over a predetermined first charge prohibiting voltage (such as 4.30 V), which is deemed an overcharge state, then the first FET 11 is turned OFF to shut off charging current and protect the rechargeable battery 3 from overcharging.”).

<sup>236</sup> *Id.*, 10:1-3.

preventing overcharging,” then another FET is turned “OFF.”<sup>237</sup> Based on Iwaizono’s teachings, this “second charge-prohibiting voltage is set to 4.45” because “the battery voltage exceeds 4.5 V at the point when the battery temperature begins to rise sharply . . . .”<sup>238</sup> In other words, Iwaizono’s exemplary system includes a charge cutoff voltage of 4.2 V “set on the charger side” and when this configuration is used “the charge-prohibiting voltage for the main control means 1 [of circuit A] is set to 4.30 V, and the detected set voltage in a prolonged overcharging state for the sub-control means 40 [of circuit B] is set to 4.45 V.”<sup>239</sup> Iwaizono thus teaches to ensure that the charging current is shut off “before the battery temperature begins to rise sharply, whereby battery damage due to prolonged overcharging will be prevented.”<sup>240</sup>

195. Based on the foregoing, Iwaizono explains that a protective circuit should be designed with certain voltages that are tied to the relevant cutoff voltage used to charge the battery itself. Specifically, Iwaizono explains that there should be a first and second “charge prohibiting voltages” which are set at (1) the voltage

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<sup>237</sup> *Id.*, 10:55-65.

<sup>238</sup> *Id.*, 11:1-13.

<sup>239</sup> *Id.*, 15:31-40.

<sup>240</sup> *Id.*, 11:11-13.

where the battery is deemed to be in an overcharging state, such as 4.3 V, and (2) the voltage where the battery’s heat is getting too high—and “before the battery temperature begins to rise sharply,” such as 4.45 V.<sup>241</sup> The PHOSITA would also have known to set a “second charge-permitting voltage” is “below the first charge-prohibiting voltage” to allow charging to resume.<sup>242</sup> The two “charge prohibiting voltages” reflect “overcharge protection voltages” as recited in claim 9. And, the overcharge protection voltage of 4.45 V is greater than 4.35 V, as recited in claim 9. Therefore, this aspect of claim 9 is present in Iwaizono.

196. Regarding the overcharge protection release voltage, Iwaizono describes a “first charge-permitting voltage” and says that the voltage should be “lower than the first charge prohibiting voltage.”<sup>243</sup> Because this voltage is intended to permit the battery to resume charging after charging is stopped by the overcharge protection mechanism, Iwaizono’s “first charge permitting voltage” would have been understood to be an overcharge protection release voltage—i.e., it releases the overcharge protection.<sup>244</sup> Using the exemplary values provided by Iwaizono, the

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<sup>241</sup> *Id.*, 11:4-13.

<sup>242</sup> *Id.*, 3:48-55.

<sup>243</sup> *Id.*, 10:1-3.

<sup>244</sup> EX1007 (Iwaizono), 18:3-7 (“[O]nce the overcharging state goes away, the

“second charge permitting voltage”—which corresponds to the overcharge protection release voltage of the claim should thus be set to be something less than 4.3 V. Iwaizono does not explicitly say how much lower than 4.3 V this value is set at, but a PHOSITA would have brought some knowledge to bear on this issue. *First*, the PHOSITA would have understood that Iwaizono’s exemplary values are for a battery that is being charged at a cutoff voltage of 4.2 V.<sup>245</sup> This voltage was “conventional” in commercialized lithium-ion batteries as admitted by the ’641 patent.<sup>246</sup> And, the ’641 patent admits that a PHOSITA would have known at this voltage the “overcharge release voltage of [the battery’s] protection circuit is controlled below 4.15 V . . . .”<sup>247</sup> As the ’641 patent also states, the circuits used for overcharge protection and release in the claimed batteries can be the conventional

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circuit can be reset to a normal state.”).

<sup>245</sup> *Id.*, 15:31-40.

<sup>246</sup> EX1001 (’641 pat.), 2:38-41 (“In 1990, Sony Corporation issued the lithium ion cell using coke as negative electrode, which has a charge cut-off voltage of not more than 4.20 V, and it is accepted as a common technical requirement of lithium ion cells thereafter.”).

<sup>247</sup> *Id.*, 1:51-55.

type and merely have adjusted voltages to address the overcharging protection and release at the higher cutoff voltage.<sup>248</sup>

197. *Second*, conventional circuits like those mentioned in the '641 patent were known to be supplied by companies like Seiko Instruments. For instance a datasheet for the S-8491 Series Battery Protection IC describes features of a “series of lithium-ion rechargeable battery protection ICs incorporating high-accuracy voltage detectors and a delay circuit” and is “suitable for protecting a single-cell pack.”<sup>249</sup> Consistent with the description in the '641 patent, circuits with an

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<sup>248</sup> *Id.*, 9:24-36 (“Since the voltage used in the present invention is higher than the voltage currently used in the art, the necessary modification is made to the protecting circuit . . . . The type and structure of the protecting circuit . . . shall not be specifically restricted, i.e., the well known structure can be used, provided that the first overcharging protection voltage is greater than 4.35 V, and the overcharge release voltage is greater than 4.15V . . . .”).

<sup>249</sup> EX1010 (Seiko S-8491 datasheet), p.1. This data sheet relates to a series of ICs that are mentioned in a journal article called “*Use of lithium-ion batteries in electric vehicles*,” from the Journal of Power Sources, a reputable journal that covers advances in power sources such as lithium ion batteries. *See* EX1006, p.162 (end note 4). The authors explain that the Seiko datasheet provides “[a] schematic of the

overcharge protection voltage of between 4.25 V and 4.35 V were available from Seiko and those circuits had overcharge protection release voltages from 3.95 V to 4.15 V, as shown below<sup>250</sup>:

■ Features

(1) Built-in high-accuracy voltage detection circuits:

① Excess charge detection voltage  $V_{CU}$  . . .  $4.35 \pm 0.05$  V to  $4.25 \pm 0.05$  V/0.05 V step

② Excess charge release voltage  $V_{CD}$  . . . . .  $4.15 \pm 0.13$  V to  $3.95 \pm 0.13$  V/0.05 V step

\* The difference between the excess charge detection voltage and the excess charge release voltage can be selected in the range of 0.2 V to 0.3 V.

The difference between the overcharge protection voltage and the overcharge release voltage was selectable between 0.2 V and 0.3 V.<sup>251</sup> This shows that the PHOSITA approaching Iwaizono would recognize that a spread between the “first charge-prohibiting voltage” and the “second charge-permitting voltage” can be between 0.2 V and 0.3 V, as an example. This is both consistent with the admissions in the patent and the Seiko datasheet.

198. I have already explained above how Uemura describes batteries that are charged with a cutoff voltage of 4.3 V. *Supra* §XI.A.1 (limitations [1A] & [5A]). The PHOSITA would have known to use protection circuits in the lithium-ion

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protection circuit” used in an electric vehicle called the *Fuji Xerox Desert Rose. Id.*, p.160.

<sup>250</sup> EX1010 (Seiko S-8491 datasheet), p.1.

<sup>251</sup> *Id.*, p.1.

batteries of Uemura because such are conventionally included for the purpose of ensuring that issues with the charging circuits do not cause the charging voltage to exceed predetermined limits and cause damage to the battery and potentially dangerous events. I have explained this above too. *Supra* §II.D. And, the PHOSITA would have known that Iwaizono provided a battery protection circuit that had added safety features including a second charge protection voltage that was used as a failsafe to prevent thermal runaway of the battery, as I explained in the preceding paragraphs.

199. Because Uemura discloses a charge cutoff voltage over the 4.2 V charge cutoff voltage used in Iwaizono's example,<sup>252</sup> a PHOSITA would have understood that the first and second charge prohibiting voltages should be increased above 4.35 V and 4.45 V, respectively. Specifically, the PHOSITA would have found it obvious to increase the first and second charge prohibiting voltages by 0.1 V (i.e., to match the increase in the charge cutoff voltage from Iwaizono to Uemura) and thus have first and second charge prohibiting voltages of 4.40 V and 4.55 V, respectively. Additionally, a PHOSITA would have recognized that to adapt Iwaizono's battery circuit for use in Uemura's battery, Iwaizono's second charge permitting voltage would also be raised by an equal amount. And, the PHOSITA

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<sup>252</sup> EX1007 (Iwaizono), 15:31-40.

would have known that the typical difference between the first overcharge protection voltage and the overcharge protection release voltage would be between 0.2 V and 0.3 V.<sup>253</sup> The PHOSITA wishing to tightly control the overcharge protection would have chosen the 0.2 V option—which was a conventional option available to those skilled in the art—and would have selected an overcharge protection release voltage of 4.25 V.

200. When choosing a first charge prohibiting voltage a PHOSITA would also have considered the charger accuracy, typically +/- 0.05V and the first charge prohibiting voltage accuracy of +/- 0.05V. In order not to overlap, the first charge prohibiting voltage of 0.15V higher than the charging voltage should be chosen.

201. I have been further informed that if a technique has been used to improve one device and the PHOSITA would have recognized that it would have

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<sup>253</sup> EX1010 (Seiko S-8491 datasheet), p.1; EX1001 ('641 pat.), 9:24-36 (“Since the voltage used in the present invention is higher than the voltage currently used in the art, the necessary modification is made to the protecting circuit . . . . The type and structure of the protecting circuit . . . shall not be specifically restricted, i.e., the well known structure can be used, provided that the first overcharging protection voltage is greater than 4.35 V, and the overcharge release voltage is greater than 4.15V . . . .”).

improved a similar device in the same way, using the technique is obvious unless the application is beyond his or her skill. This consideration is applicable here. Specifically, a PHOSITA would have appreciated that Iwaizono teaches a known battery protection circuit that is used to provide a “protective circuit with a compact structure that affords reliable protection of a rechargeable battery.”<sup>254</sup> Such circuits were known to address a well-known problem with lithium-ion batteries: such batteries “are particularly susceptible to deterioration or damage when operated at a voltage exceeding a predetermined range.”<sup>255</sup> Thus, using a protective circuit like that disclosed by Iwaizono was part of “the normal practice . . . for protecting the battery from improper use.”<sup>256</sup> Applying Iwaizono to Uemura’s battery and adjusting the voltages such that they were suitable for Uemura’s battery would have merely applied Iwaizono’s known device to improve Uemura’s similar device (i.e., lithium-ion battery) in the same way by providing an overcharge protection circuit that used voltages within the claimed ranges for both overcharge protection and overcharge protection release to account for Uemura’s higher charge cutoff voltage of 4.3 V. The application of the Iwaizono circuit to Uemura would have required only routine

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<sup>254</sup> EX1007 (Iwaizono), 2:55-59.

<sup>255</sup> *Id.*, 1:13-16.

<sup>256</sup> *Id.*, 1:17-19.

skill associated with tailoring the voltage requirements to meet Uemura's requirements and this would have been desirable to avoid overcharging conditions which could damage the battery or create a dangerous situation. Indeed, Iwaizono suggests adaptability because it refers to "predetermined voltage[s]" for the first charge-prohibiting voltage and suggests that the voltage ranges disclosed are only exemplary.<sup>257</sup>

202. The PHOSITA would have reasonably expected to succeed in incorporating Iwaizono's protection circuit in Uemura's battery because such circuits were conventionally incorporated in lithium-ion batteries such as

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<sup>257</sup> *Id.*, 9:57-63 ("The main control means 1 detects the voltage across the positive and negative electrodes of the rechargeable battery 3, and if the result is over a predetermined first charge-prohibiting voltage (such as 4.30 V) which is deemed an overcharging state, then the first FET 11 is turned OFF . . . ."), 11:4-7 ("Since the battery voltage exceeds 4.5 V at the point when the battery temperature begins to rise sharply, if the second charge prohibiting voltage in the sub-control means 2 of the subprotective circuit B, . . . ."), 13:13-17 (referring to "a predetermined first charge-prohibiting voltage (such as 4.30 V), above which is deemed an overcharging state . . . ."), 14:41-46 (same).

Uemura's.<sup>258</sup> Moreover, as I have explained above, Iwaizono's voltages are exemplary and dependent on what is "deemed an overcharging state."<sup>259</sup> Indeed, Iwaizono provides a detailed description of the circuits allowing for them to be implemented by the PHOSITA.

**G. Ground 9: Uemura, Iwaizono, and Guyomard Render Claims 9-10 Obvious.**

*1. Claims 9 and 10*

**9. A secondary lithium ion cell or battery according to claim 5, characterized in that the secondary lithium ion cell or battery has a first overcharging protection Voltage of greater than 4.35V, and an overcharging protection release Voltage of greater than 4.15 V.**

**10. A secondary lithium ion cell or battery according to claim 9, characterized in that the secondary lithium ion cell or battery has a first overcharging protection Voltage of greater than 4.45 V, and an overcharge protection release Voltage of greater than 4.25 V.**

203. Claim 9 of the '641 patent requires that the cell or battery "has a first overcharging protection voltage of greater than 4.35 V, and an overcharging protection release voltage of greater than 4.15 V."<sup>260</sup> Claim 10 of the '641 patent requires that the cell or battery has "a first overcharging protection voltage of greater

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<sup>258</sup> EX1007 (Iwaizono), 1:13-18.

<sup>259</sup> *Id.*, 13:13-17.

<sup>260</sup> EX1001 ('641 pat.), 17:24-27.

than 4.45 V, and an overcharge protection release voltage of greater than 4.25V.”<sup>261</sup>

As I have explained above in connection with my discussion of the combination of Uemura and Guyomard, it would have been obvious to use Guyomard’s electrolyte in connection with Uemura’s battery to improve the cyclability of the battery. *Supra* §XI.C. These reasons are equally applicable in connection with my analysis of claims 9 and 10. But, the PHOSITA would have realized another benefit to using Guyomard’s electrolyte in combination with Uemura: it would allowed for the increase in the charge cutoff voltage and thus provide a battery with improved performance when compared with Uemura’s battery.<sup>262</sup> This would have permitted the charging of the battery using a charge cutoff voltage of, for example, 4.5 V.

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<sup>261</sup> *Id.*, 17:29-18:3.

<sup>262</sup> EX1008 (Guyomard), 8:32-9:5 (“A set of such tests cells with the separator element comprising an electrolyte of 1 M LiPF<sub>6</sub> in 95 DMC : 5 EC and a carbon (graphite or petroleum coke) negative electrode were repeatedly charged and discharge[d] over two hours cycles at about 25°C and 55°C and at charging cut-off voltages of 4.9 V and 4.5 V, respectively. Even at this cycling rate and high charging voltage, the voltage polarization was unusually small, confirming the high ionic conductivity of the electrolyte, and there was no significant loss of cell capacity, verifying the high voltage stability of the electrolyte.”).

204. Based on the combination of Uemura and Guyomard a PHOSITA would have readily seen that a lithium-ion battery having a charge cutoff voltage was not just desirable, but possible while still having high cycling capabilities. *See supra* §XI.C. When raising the charge cutoff voltage to Guyomard’s levels, the PHOSITA would have seen that adjustments to the overcharge protection voltage settings was required. Specifically, it would have been clear to the PHOSITA that using Guyomard’s higher voltages (*e.g.*, 4.9V or 4.5V) would require an overcharge protection voltage and overcharge protection release voltage that was higher than would be employed with lower voltages (*e.g.*, 4.3V as used in Uemura).

205. My analysis of the obviousness of the combination of Uemura and Guyomard is equally applicable here in terms of setting the claimed overcharge protection voltage and overcharge protection release voltage. I do not repeat my discussion of the obviousness of the combination of Uemura and Iwaizono here and instead refer the reader to that earlier discussion. *See supra* §XI.F. The only difference between that analysis and the one presented here is that, using Guyomard’s electrolyte and cutoff voltages means that the PHOSITA would have needed to further adjust the voltage settings because what is “deemed an overcharging state” for the resulting battery is different.<sup>263</sup> Specifically, something

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<sup>263</sup> EX1007 (Iwaizono), 10:57-61 (“The main control means 1 detects the voltage

over 4.5 V or 4.9 V (depending on the charge cutoff voltage selected from Guyomard) would be “deemed an overcharging state.”<sup>264</sup> Here, because Uemura uses a high temperature environment,<sup>265</sup> Guyomard’s charge cutoff voltage of 4.5 V would have been selected.<sup>266</sup> If the overcharge protection voltage was not raised to account for the higher cutoff voltage, charging would be limited to something below the cutoff voltage thus precluding access to the higher capacity.

206. Similarly, as discussed above with reference to claim 9, Iwaizono’s example places the first overcharge protection voltage at 0.15 V above the charge cutoff voltage, with a redundant overcharge protection voltage set at about 0.25 V above the charge cutoff voltage.<sup>267</sup> For a battery with a charge cutoff voltage of 4.5V as suggested by the combination of Uemura and Guyomard, Iwaizono would have

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across the positive and negative electrodes of the rechargeable battery 3, and if the result is over a predetermined first charge-prohibiting voltage (such as 4.30 V) *which is deemed an overcharging state, . . .*”).

<sup>264</sup> *Id.*; EX1008 (Guyomard), 8:32-9:8.

<sup>265</sup> EX1009 (Uemura), ¶[0081] (cycling “at an atmospheric temperature of 60°C”).

<sup>266</sup> EX1008 (Guyomard), 8:36-37 (referring to 4.9 V being used at 25°C and 4.5 V being used at 55°C).

<sup>267</sup> EX 1007 (Iwaizono), 15:31-40.

led the PHOSITA to set an overcharge protection voltage at, for example, 4.65 V. And, a PHOSITA knowing that the difference between an overcharging protection voltage and an overcharge protection release voltage would have been between 0.2 V and 0.3 V, as shown in the Seiko datasheet and as the '641 patent agrees,<sup>268</sup> the overcharge protection release voltage would have obviously been set at either 4.35 V (a difference of 0.3 V) or 4.45 V (a difference of 0.2 V). These values are in the ranges recited in claims 9 and 10, and arriving at these values based on the combined teachings of Uemura, Guyomard, and Iwaizono would have been obvious for the reasons I explained above. *Supra* §XI.F. Those reasons are applicable here with the adjustments made for the higher voltage of the combined Uemura / Guyomard battery. *See also supra* §XI.C.

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<sup>268</sup> EX1010 (Seiko S-8491 datasheet), p.1; EX1001 ('641 pat.), 9:24-36 ("Since the voltage used in the present invention is higher than the voltage currently used in the art, the necessary modification is made to the protecting circuit . . . . The type and structure of the protecting circuit . . . shall not be specifically restricted, i.e., the well known structure can be used, provided that the first overcharging protection voltage is greater than 4.35 V, and the overcharge release voltage is greater than 4.15V . . . .").

**H. Ground 10: Abe, Guyomard, and Iwaizono Render Claims 9-10 Obvious.**

*1. Claims 9 and 10*

**9. A secondary lithium ion cell or battery according to claim 5, characterized in that the secondary lithium ion cell or battery has a first overcharging protection Voltage of greater than 4.35V, and an overcharging protection release Voltage of greater than 4.15 V.**

**10. A secondary lithium ion cell or battery according to claim 9, characterized in that the secondary lithium ion cell or battery has a first overcharging protection Voltage of greater than 4.45 V, and an overcharge protection release Voltage of greater than 4.25 V.**

207. Claim 9 of the '641 patent requires that the cell or battery “has a first overcharging protection voltage of greater than 4.35 V, and an overcharging protection release voltage of greater than 4.15 V.”<sup>269</sup> Claim 10 of the '641 patent requires that the cell or battery has “a first overcharging protection voltage of greater than 4.45 V, and an overcharge protection release voltage of greater than 4.25V.”<sup>270</sup> As I have explained above in connection with my discussion of the combination of Abe and Guyomard, it would have been obvious to use Guyomard’s electrolyte in connection with Abe’s battery to improve the cyclability of the battery. *Supra* §XI.E. The resulting battery from the Abe/Guyomard combination would have had a charge

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<sup>269</sup> EX1001 ('641 pat.), 17:24-27.

<sup>270</sup> *Id.*, 17:29-18:3.

cutoff voltage of 4.5 V or 4.9 V and the reasons why the PHOSITA would have found it obvious to achieve such a battery based on the combined teachings of Abe and Guyomard are provided above. *Supra* §XI.E.4. After constructing the combined battery of Abe and Guyomard, the PHOSITA would have recognized that what is “deemed an overcharging state” would have been raised.<sup>271</sup> For the same reasons that I have explained in connection with the combination of Uemura and Iwaizono and Uemura, Iwaizono and Guyomard, after the attendant increase in what is deemed an overcharging state, the overcharge protection voltage and the overcharge protection release voltage would have been increased for all of the reasons I have discussed in connection with those references. *See supra* §§ XI.F, XI.G. The reasons I have explained in connection with those combinations would have led the PHOSITA to select, for example, an overcharge protection voltage of 4.65 V for the Abe/Guyomard battery charged to 4.5 V and an overcharge protection release voltage of either 4.35 V or 4.45 V for the same reasons I have discussed above. *Supra* § XI.G.

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<sup>271</sup> EX1007 (Iwaizono), 10:57-61 (“The main control means 1 detects the voltage across the positive and negative electrodes of the rechargeable battery 3, and if the result is over a predetermined first charge-prohibiting voltage (such as 4.30 V) *which is deemed an overcharging state, . . .*”).

208. The PHOSITA would have reasonably expected to succeed in incorporating Iwaizono's protection circuit in the Abe/Guyomard battery because such circuits were conventionally incorporated in lithium-ion batteries such as Abe's.<sup>272</sup> Indeed, Abe makes reference to such circuitry explicitly and this explicit reference to such circuitry would have caused the PHOSITA to obtain more details about how to design and implement such a circuit on Abe's batteries.<sup>273</sup> Moreover, as I have explained above, Iwaizono's voltages are exemplary and dependent on what is "deemed an overcharging state."<sup>274</sup> Iwaizono also provides a detailed description of the circuits allowing for them to be implemented by the PHOSITA. Therefore, the PHOSITA would have reasonably expected to succeed in implementing such conventional circuits with obvious voltage properties in the Abe/Guyomard battery.

\*\*\* SIGNATURE ON NEXT PAGE \*\*\*

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<sup>272</sup> EX1007 (Iwaizono), 1:13-18.

<sup>273</sup> EX1005 (Abe), ¶[0009] ("To avoid such problems, the lithium-ion secondary battery is supplied with a safety device to prevent overcharging or over-discharging.").

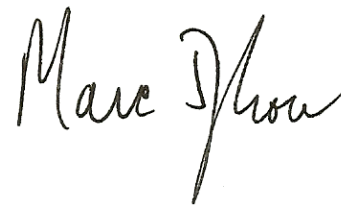
<sup>274</sup> EX1007 (Iwaizono), 13:13-17.

## **XII. DECLARATION**

209. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon. If called to testify as to the truth of the matters stated herein, I could and would testify competently.

210. I declare under penalty of perjury that the foregoing is true and correct.

211. Executed on this 21st day of July 2023, in Livermore, CA.

A handwritten signature in black ink, appearing to read "Marc Juzkow". The signature is written in a cursive, flowing style with a long, sweeping underline.

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Marc Juzkow

# Exhibit 1

**SKILLS & ACCOMPLISHMENTS**

Unique skill set including lithium battery and ultracapacitor R&D, application engineering, sales, marketing, team building and business management, with a complementary graduate education in science and business.

- 37 years in the battery industry; managed team that developed and commercialized the first lithium-ion battery in North America in the early 1990's.
- Expert witness for 50 lithium-ion related cases including IP, product liability and commercial. Declarations: 16; Depositions: 5
- Cell assembly, performance and abuse lab installation. Procedure development and training.
- Assembled and led research, product development, testing and application engineering organizations; Established international sales and technical marketing teams
- Extensive Asian experience: worked for NIO, Mitsui and NEC with significant travel to Japan, Korea and China; subcontracting and joint R&D in China; audited and maintained relations with material suppliers and subcontractors throughout Asia.
- Leading edge of battery and supercapacitor technology resulting in many invitations to speak at major U.S. and international conferences. Over 45 presentations and publications to date.
- Strong presentation; reporting; organization (personal and team); and training skills.

**PROFESSIONAL EXPERIENCE****Lithiumion Expert Services, LLC**

Consulting in all areas of lithium-ion batteries and supercapacitors (since 2000), including expert witness for IP and commercial litigation, product liability incidents (i.e. e-cigarettes, medical devices, portable devices, stationary systems and vehicles). Corporate patent and technology due diligence. New technology development assistance. Failure analysis including battery autopsies, performance and safety/abuse testing. Cell assembly, performance and abuse lab design, installation and training. Business/technology planning, go-to-market strategies.

**2021 to 2023 – Joby Aviation****Cell Supplier Lead**

Responsible for lithium-ion cells and technology at Joby, an e-VTOL company. Cell and supplier qualification. Working with developers of new cell material and component technology.

**2020 to 2021 – Feasible, Inc. (now Liminal)****Head of Product**

Led development and commercialization of non-invasive ultrasound testing for battery cells.

**2017 to 2020 - NIO, Inc****Principal Cell Specialist**

Responsible for lithium-ion cells and technology at NIO, an autonomous EV company developing from the ground up a fully autonomous vehicle. Support the battery pack team. Cell and supplier qualification. Development of new technology for use in NIO EVs.

**2014 to 2017 Iontensity, LLC****President and Founder**

Founded Iontensity to fill an important niche in the lithium-ion industry. Hired a team of scientists, engineers and technicians and set up an R&D Model Plant Facility to assemble electrodes and

cells, and perform testing. Won two government DOE contracts totaling \$1.4M. Transferred technology, trained and assembled cells for four multinational companies. Contracted with multiple start-up companies to support their efforts to bring new materials to market. Battery qualification and failure analysis for OEMs.

#### **2008 to 2014 Leyden Energy (previously Mobius Power Inc.)**

##### **VP R&D**

Responsible for all R&D efforts, technology roadmap and personnel in the development of novel lithium-ion cell and battery technologies: High Power (LMO/LTO); High Energy (Si anode); and Non-Flammable Electrolyte.

Assembled strong R&D and Engineering teams through a combination of hiring experienced scientists, engineers and technicians and mentoring new engineering graduates.

Worked directly with consumer electronics, industrial and EV customers (North America, Asia and Europe) to customize chemistry and cell/pack designs. Led development of 12V/48V batteries for industrial and micro-hybrid EV applications.

Audited many Chinese factories for material supply and subcontracting lithium-ion cell and pack manufacturing. Responsible for technology transfer for manufacturing.

Designed and implemented a Performance Testing Lab with 1800 automated testers and a Safety/Abuse Testing Lab capable of UN/DOT and UL1642 testing.

Won CEC (California Energy Commission), three DOE, and four USABC contracts worth \$16M. PM for USABC contracts.

Responsible for IP portfolio. Prepared and submitted nine U.S. and four international patent applications. Five U.S. patents granted.

#### **2005 to 2008 UNCAP, LLC**

##### **CTO, VP of Marketing and Founder**

Founder of UNCAP, LLC, a U.S. based ultracapacitor company. Designed and developed a nickel based aqueous asymmetric ultracapacitor. Built 14V and 28V, 195kJ modules for use in diesel engine starting in cold weather, no-idle solutions and Silent Watch (military). Designed ultracapacitors for lead customers in uninterruptible power supplies. Developed an Excel model of the cell components to predict performance. Prepared seven patent invention disclosures. Also responsible for administration and financial management.

#### **2004 to 2008 Mobile Power Solutions**

##### **CTO**

Set up a battery and ultracapacitor testing laboratory. Designed equipment for UL and DOT/UN transportation testing. Trained personnel. Designed custom performance and safety test programs and oversaw technical elements. Provided expert opinions on performance, safety, abuse, shipping, packaging and recycling regulations for batteries. Audited Tier 1 China cell manufacturers for large U.S. consumer electronics OEM.

#### **2003 to 2008 VoltSource, Inc.**

##### **President and Founder**

A private consulting firm in the field of batteries, supercapacitors and associated industries, specializing in product (cell and pack level), IP development (prepared ten patent disclosures for one customer), market, applications and business development, market assessment, sales, energy source selection (developed three web based battery and ultracapacitor design programs), product testing and qualification, environmental, transport and safety issues, and battery-related investment and legal work.

**2000 to 2003 Cooper Electronic Technologies, PowerStor Products, Dublin, CA**

**Director of Sales and Marketing**

Responsible for international sales and marketing, product/market development and application engineering. Identified / researched target markets enabled by this new technology. Designed and developed, evaluated and qualified ultracapacitors based on customer / application requirements.

Launched five new product lines including various cylindrical (0.22F ~ 100F) devices, higher voltage (5V ~ 20V) modules using balancing circuitry, ultra-thin flat low ESR devices using foil-polymer laminate packaging and very high capacitance (> 500F) cylindrical devices.

**1996 to 2000 PolyStor Corporation, Dublin & Livermore, CA**

**Director of Sales and Marketing**

Assembled customer service, application engineering, and sales and marketing organization.

Co-developed BB-2590/U Lithium-ion battery under US Army CECOM development contract.

**1985 to 1996 Moli Energy Limited, Vancouver, B.C. Canada**

**Manager, Sales & Marketing**

**Various Team/Project Leader Positions**

**Manager of Product Development**

**Research Technologist / Scientist**

**Manager of Product Evaluation**

Cell, product, application and market development of Moli Energy's Lithium Battery Technology. Planned and managed various cell and battery development and product evaluation projects to successful completion, including development of first lithium-ion cell in North America.

Researched new cathode, anode and electrolyte materials for lithium metal and lithium-ion.

Co-developed the first BB-2847 Lithium-ion battery for U.S. Army CECOM.

Assembled a new Sales and Marketing team following development of lithium-ion 18650 cell.

**EDUCATION**

|      |                 |                         |                       |
|------|-----------------|-------------------------|-----------------------|
| 1993 | Executive MBA   | Simon Fraser University | Vancouver, BC, Canada |
| 1989 | MSc (Chemistry) | Simon Fraser University | Burnaby, BC, Canada   |
| 1985 | BSc (Chemistry) | Simon Fraser University | Burnaby, BC, Canada   |

**PATENTS**

US 8,221,915 High performance lithium or lithium ion cell, July 17, 2012  
 US 8,465,871 Electrochemical cells with tabs, June 18, 2013  
 US 9,263,731 High performance lithium or lithium ion cell, February 16, 2016  
 US 9,343,745 Surface passivation of active material particles for use in electrochemical cells, May 17, 2016  
 US 9,350,017 High performance lithium or lithium ion cell, May 24, 2016  
 US 10,538,437 Liquid treatment using capacitive systems, January 21, 2020  
 US 10,756,391 Method and system for secondary internal current mechanisms for a lithium-ion cell, August 25, 2020  
 US 11,127,995 Lightweight thermal adsorption structure for lithium-ion cell module, September 21, 2021  
 US 11,205,809 Early detection of thermal incident in battery pack, December 21, 2021  
 US 11,233,272 Zero flammability electrolyte for lithium-ion cell, January 25, 2022  
 US 11,431,046 Lithium-ion cell using aluminum can, August 30, 2022  
 US 11,616,256 Abuse Tolerance in Battery Modules

**PUBLICATIONS & PRESENTATIONS**

Over 45 publications, seminars and presentations, including keynote, plenary and invited.