

Supplemental Declaration of Dean R. Wheeler, Ph.D
IPR2025-00524
U.S. Patent No. 12,015,118

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,

Petitioner

v.

NINGDE AMPEREX TECHNOLOGY LIMITED,

Patent Owner

Case: IPR2025-00524
U.S. Patent No. 12,015,118

**SUPPLEMENTAL DECLARATION OF DEAN R. WHEELER, Ph.D.,
IN SUPPORT OF PATENT OWNER'S RESPONSE**

TABLE OF CONTENTS

	Page
I. INTRODUCTION	1
II. BASIS FOR OPINIONS	3
A. Qualifications	3
B. Materials Considered.....	4
III. LEGAL STANDARDS	5
IV. Claim Construction.....	6
V. Technology Overview	9
VI. LEVEL OF ORDINARY SKILL IN THE ART.....	9
VII. THE CHALLENGED CLAIMS OF THE '118 PATENT ARE NOT UNPATENTABLE.....	12
A. Ground 1: Ishigaki Does Not Anticipate Claims 1-20.....	12
1. Petitioner fails to show that Ishigaki discloses a particle size of 90% accumulative volume of the first material is less than 40 μm	13
a. Ishigaki does not disclose an accumulated volume distribution.....	16
b. Ishigaki's D90 value corresponds to a number- based distribution.....	23

2.	Petitioner fails to show that Ishigaki discloses a two-layer electrode structure with a compaction density of greater than 3.2 g/cc	27
a.	Compaction densities of single-layer electrode structures do not disclose compaction densities of two-layer electrode structures.....	28
b.	Dr. Gido's Demonstratives are not supported by Ishigaki	34
c.	Ishigaki's compaction density ranges maintain space to hold electrolyte in a single-layer electrode structure	45
3.	Claims 2-9, 11-18, and 20 are not unpatentable	46
a.	Claims 5 and 14	46
b.	Claims 6, 15, and 20	47
B.	Ground 2: Ishigaki and Kim do not render obvious claims 1-20.....	48
1.	Kim does not disclose or teach multi-layer electrodes	49
2.	Kim does not teach the density of an electrode layer	51
3.	Petitioner does not show that a POSITA would have been motivated to combine Ishigaki and Kim.....	59

4.	The '118 Patent's claimed density ranges are critical	63
5.	Claims 2-9, 11-18, and 20 are not unpatentable	67
a.	Claims 5 and 14	67
b.	Claims 6, 15, and 20	68
C.	Ground 3: Wang and Saka do not render obvious claims 1-20	68
1.	Petitioner fails to show why a POSITA would have a “desired density in mind” when combining Wang and Saka.....	69
a.	A POSITA would not look beyond Wang for a “desired density”.....	72
b.	Compaction densities of greater than 3.2 g/cc as claimed are critical.....	78
2.	Petitioner fails to show that a POSITA Would have combined Wang with Saka	82
a.	Wang and Saka focus on different cathode compositions	82
b.	Common sense alone would not lead a POSITA to higher compaction densities based on Wang and Saka.....	84

3.	Claims 2-9, 11-18, and 20 are not unpatentable	88
a.	Claims 5 and 14	88
D.	Ground 4: Wang and Li do not render obvious claims 1-20.....	89
1.	Petitioner fails to show why a POSITA would have had a “desired density in mind” greater than 3.2 g/cc when combining Wang and Li.....	89
2.	Petitioner fails to show that a POSITA would have combined Wang and Li	94
a.	Wang and Li describe cathodes with incompatible structures.....	95
b.	Petitioner fails to show that Li’s compaction density values are compatible with Wang	99
c.	Compaction densities of greater than 3.2 g/cc as claimed are critical.....	103
3.	Claims 2-9, 11-18, and 20 are not unpatentable	105
VIII.	CONCLUSION.....	105

I, Dean R. Wheeler, Ph.D., do hereby declare and say as follows:

I. INTRODUCTION

1. I have personal knowledge of the facts contained in this Declaration, am of legal age, and am otherwise competent to testify.

2. I have been retained by Ningde Amperex Technology Ltd. (“ATL” or “Patent Owner”) as an independent technical expert in this proceeding before the United States Patent and Trademark Office (“PTO”) Patent Trial and Appeal Board (“PTAB”) regarding U.S. Patent No. 12,015,118 (the “’118 Patent”).

3. I understand that Zhuhai CosMX Battery Co., Ltd. (“Petitioner”) filed a petition for *Inter Partes* Review (“IPR”) of the ’118 Patent (“Petition”).

4. I understand that, on October 24, 2025, the Board issued a decision granting institution based on the grounds set forth in the Petition (“Institution Decision”). Paper 11. In particular, I understand that the Board instituted post grant review of claims 1-20 (“Challenged Claims”) on the grounds presented in the Petition, as shown below.

Ground	Claims Challenged	35 U.S.C. §	Reference(s)/Basis
1	1–20	102(a)(1)	Ishigaki
2	1–20	103	Ishigaki, Kim
3	1–20	103	Wang, Saka
4	1–20	103	Wang, Li

5. I previously submitted a Declaration (Ex. 2015) in this proceeding in support of Patent Owner's Preliminary Response to the Petition. I stand by that Declaration and submit this additional Supplemental Declaration to address additional issues.

6. I have been asked to submit this Supplemental Declaration to analyze and respond to assertions in the Petition and Institution Decision and the evidence cited therein.

7. As explained below, in my opinion, the Petition fails to show that claims 1-20 are anticipated or rendered obvious.

8. I am being compensated for my time spent on the present matter at my customary consulting rate of \$350 per hour for preparatory work and at my customary consulting rate of \$450 per hour for depositions/trial work. I am also being compensated for expenses incurred as a result of activities performed as an expert. My compensation is in no way contingent on the nature of my opinions, the outcome of this or any other proceeding, or any of the issues involved therein. I have no other interest in this proceeding.

II. BASIS FOR OPINIONS

A. Qualifications

9. My qualifications and professional experience are described in my *curriculum vitae*, a copy of which was provided with my original Declaration as Ex. 2016. I also previously summarized my qualifications and professional experience, including relevant publications,¹ research conferences,² and other professional activities,³ in Paragraphs 7-13 of my original Declaration, and I incorporate those paragraphs by reference.

¹ See, e.g., Ex. 2028 (Amir-Sina Hamed, Fezzeh Pouraghajan, Fei Sun, Mojdeh Nikpour, & Dean R. Wheeler, *Interplay of Electrode Heterogeneity and Lithium Plating*, 169 J. Electrochem. Soc. 020551 (2022)); Ex. 2029 (Amir-Sina Hamed, Adrian Yao, Roxana Martin, Raymundo Roig, Michael Rivas Valadez, Donald Pile, Annadanesh Shellikeri, Baichuan Liu, and Dean R. Wheeler, *Multi-layer anodes for high-current applications*, 439 Electrochimica Acta 141649 (2023)); Ex. 2030 (Fezzeh Pouraghajan, Andrea I. Thompson, Emilee E. Hunter, Brian Mazzeo, Jake Christensen, Ram Subbaraman, Michael Wray, & Dean Wheeler, *The Effects of Cycling on Ionic and Electronic Conductivities of Li-ion Battery Electrodes*, 492 J. of Power Sources 229636 (2021)); Ex. 2031 (Amir-Sina

B. Materials Considered

10. The opinions contained in this Declaration are based on the documents I reviewed, as well as my education, years of professional experience, and knowledge. In forming my opinions expressed in this Supplemental Declaration, I further reviewed the Petition and all exhibits or other material cited therein, the Patent Owner's Preliminary Response and all exhibits or other material cited therein, the Board's Institution Decision, the deposition transcript of Dr. Gido (Ex. 2050), and any additional exhibits or other material cited in my original Declaration (Ex. 2015) and this Supplemental Declaration. Ex. 2015 ¶ 14.

Hamedi, Edmund M. Shumway, & Dean R. Wheeler, *Electrode-Level Modeling of Silicon Anodes for Improved Cell Design*, 171 J. Electrochem. Soc. 120539 (2024)).

² See Ex. 2025 (2016 Batteries Conference GRC, <https://www.grc.org/batteries-conference/2016/> (last visited on May 12, 2025)).

³ See Ex. 2026 (*Hubs – Department of Energy*, <https://www.energy.gov/hubs> (last visited on May 12, 2025)); Ex. 2027 (*DOE Energy Innovation Hubs*, <https://science.osti.gov/bes/Research/DOE-Energy-Innovation-Hubs> (last visited on May 12, 2025)).

11. This Supplemental Declaration presents the opinions I have formed at the present time, and I reserve the right to revise, supplement, or amend my opinions stated in this Supplemental Declaration based on any new information that I may be asked to review. Ex. 2015 ¶ 15.

12. As I discuss below, I disagree with Dr. Guido's and the Board's conclusions that the subject matter of any of claims 1-20 of the '118 patent was anticipated or would have been obvious. Ex. 2015 ¶ 16.

III. LEGAL STANDARDS

13. I provided a summary of my understanding of certain legal standards in Paragraphs 17-40 of my original Declaration (Ex. 2015), and I incorporate those paragraphs by reference herein. Ex. 2015 ¶¶ 17-40.

14. I am informed that in order to be enabling, the specification of a patent must teach those skilled in the art how to make and use the full scope of the claimed invention without "undue experimentation."

15. It is my understanding that the following factors provide a guide in determining whether a particular disclosure would require undue experimentation: 1) the quantity of experimentation necessary; 2) the amount of direction or guidance presented; 3) the presence or absence of working examples; 4) the nature of the

invention; 5) the state of the prior art; 6) the relative skill of those in the art; 7) the predictability or unpredictability of the art; and 8) the breadth of the claims.

16. It is my further understanding that these factors need not be applied rigidly in every case and not all of the factors need to favor nonenablement to find that practicing the full scope of the claimed invention requires undue experimentation.

17. As I explained in my original Declaration, I am not an attorney and I am relying only on instructions from Patent Owner's legal counsel for these legal standards. Ex. 2015 ¶ 17.

IV. CLAIM CONSTRUCTION

18. I understand that, although Petitioner states that no term of the challenged claims requires construction to resolve the challenges in this Petition beyond its plain meaning in view of the specification (Pet. 9), Dr. Guido construes two terms in the '118 patent claims—"compaction density" and "average particle size." Ex. 1010 ¶¶ 67-71; Ex. 2015 ¶ 18-23.

19. For example, Dr. Guido explains that "compaction density" refers to the density of a complete electrode, such as "the density of the electrode active material layer (including all components of this layer: active material powder, binder polymer, and conductive additive)." Ex. 1010, ¶ 68; Ex. 2050, 12:14-13:2. This is

not the density of the active material alone (as Kim defines the term “press density”). Ex. 1009 ¶¶ [0035]-[0037]. Dr. Gido (and the Board) both agree with this general distinction. Paper 11, 52-54; Ex. 2050, 124:5-125:18, 128:2-9, 128:19-129:9, 131:3-21. For example, during his deposition, Dr. Gido stated that press densities “certainly are not the same thing” as compaction densities, and compaction densities can be lower than Kim’s description of active material press densities. Ex. 2050, 124:5-125:18, 128:2-9, 128:19-129:9, 131:3-21. This is consistent with what would be understood by a POSITA – that an electrode density is not the density of an electrode active material. For example, low-density additives (e.g., binders and conductors) may create a lower-density electrode (e.g., when mixed with the electrode active material), and compaction pressures for a complete electrode may be lower than what Kim describes for the press density. *Id.* Based at least on this distinction, Kim’s discussion of electrode active material “press density” values cannot be used as target “compaction density” values for an electrode layer, especially an electrode layer and its included components.

20. Dr. Gido provides an explanation of “average particle size” in paragraph 69 of his Declaration (Ex. 1010) that is ambiguous and undercuts later testimony regarding particle size distribution. In paragraph 69 of his Declaration, Dr. Gido states “average particle size” “is ambiguous because there are different

mathematical ways to determine averages, and different concepts in physics and chemistry of how to define the size of a particle.” Ex. 1010 ¶ 69. That is, Dr. Gido is clear that just knowing “average particle size” is not enough information to determine a particle size distribution. Ex. 2050, 16:11-17:3 (when asked about his understanding of the term average particle size, Dr. Gido stated “Right. Well, the particles are not all the same size. It is not a mono dispersed size of sample. There is a distribution of sizes and the average particle size is an average that is taken of that distribution. And as defined in the ’118 patent, they specifically say is a type of average called Dv50.”); 17:8-15 (when asked if Dv50 is different from median particle size, Dr. Gido stated “It is different from the number-based median. I mean, there could be a volume-based median or a number-based median or a surface area based median. It is the middle of the distribution on whatever basis you are looking at the distribution or representing the distribution.”); 17:16-18:9 (when asked if average and median are always the same value, Dr. Gido stated, “I mean, you know, just in general statistics, they are not necessarily. So the median is the average value and in a distribution -- or is the middle value in a distribution and the average is basically adding up all of the values in the distribution with some kind of a weighting factor, which could just be their number or could also be volume or something and dividing by the number that are there. So they’re statistically not exactly the same

thing, but in this particular patent in the '118 patent, they are defining Dv50 and an average in a way that is basically the median of the volume distribution.”).

21. As discussed in greater detail below, Dr. Gido’s distinction between particle size measurements and construction of particle size distributions highlights that a POSITA cannot inherently determine what type of particle size distribution was used to describe a set of particles based on the method for measuring particle sizes.

22. I further understand, that for purposes of the Institution Decision, the Board determined “that no term of the challenged claims requires construction beyond the ordinary and customary meaning of the terms, as understood by a person of ordinary skill in the art at the time of the invention.” Paper 11, 9.

V. TECHNOLOGY OVERVIEW

23. I provided a brief technical overview in Paragraphs 41-52 of my original Declaration (Ex. 2015), and I incorporate those paragraphs by reference herein. Ex. 2015 ¶¶ 41-52.

VI. LEVEL OF ORDINARY SKILL IN THE ART

24. I understand that Petitioner provides the following definition of a POSITA:

A POSA at the claimed priority date would have had at least an undergraduate degree in chemistry, chemical engineering, polymer

science and engineering, or materials science and engineering and two years of experience in the field of battery materials and construction. A higher level of education, such as a Master's Degree in one of these same fields, could substitute for work experience.

Pet., 9.

25. I further understand, that for purposes of the Institution Decision, the Board adopted "Petitioner's proposed definition as defining a person of ordinary skill in the art." Paper 11, 8. For purposes of this Supplemental Declaration in support of Patent Owner's Response, I offer no independent opinion of the level of ordinary skill in the art but have adopted the definition proposed by Petitioner. *See also*, Ex. 2015 ¶¶ 53-55.

26. Each of the arguments below should be considered from the perspective of a POSITA in the field of the '118 Patent and during the relevant time frame (e.g., February 2018). During that time frame, I possessed at least the qualifications of a POSITA, as defined above. For instance, as explained in my original Declaration, I received a Ph.D. in Chemical Engineering in 2002 under the advisement of Professor John Newman, arguably the world's foremost leader in understanding battery materials through computer simulations. Ex. 2015 ¶ 8. I have also published papers related to both battery materials and construction, including papers on the subjects of electrode structures and compaction, interactions of solids, binders, and

electrolytes, interfaces between electrodes and electrolytes, and how all these factors relate to battery longevity.⁴ Ex. 2015 ¶ 11. Furthermore, I am familiar with the level of skill in the art that a POSITA would have had at the time, as during the relevant time frame I regularly supervised, interacted with, and taught persons who had this level of skill. Ex. 2015 ¶ 8-13.

⁴ See, e.g., Ex. 2028 (Amir-Sina Hamed, Fezzeh Pouraghajan, Fei Sun, Mojdeh Nikpour, & Dean R. Wheeler, *Interplay of Electrode Heterogeneity and Lithium Plating*, 169 J. Electrochem. Soc. 020551 (2022)); Ex. 2029 (Amir-Sina Hamed, Adrian Yao, Roxana Martin, Raymundo Roig, Michael Rivas Valadez, Donald Pile, Annadanesh Shellikeri, Baichuan Liu, and Dean R. Wheeler, *Multi-layer anodes for high-current applications*, 439 Electrochimica Acta 141649 (2023)); Ex. 2030 (Fezzeh Pouraghajan, Andrea I. Thompson, Emilee E. Hunter, Brian Mazzeo, Jake Christensen, Ram Subbaraman, Michael Wray, & Dean Wheeler, *The Effects of Cycling on Ionic and Electronic Conductivities of Li-ion Battery Electrodes*, 492 J. of Power Sources 229636 (2021)); Ex. 2031 (Amir-Sina Hamed, Edmund M. Shumway, & Dean R. Wheeler, *Electrode-Level Modeling of Silicon Anodes for Improved Cell Design*, 171 J. Electrochem. Soc. 120539 (2024)).

VII. THE CHALLENGED CLAIMS OF THE '118 PATENT ARE NOT UNPATENTABLE

27. I understand that in an *inter partes* review, Petitioner bears the burden of proving by a preponderance of the evidence on a claim-by-claim basis for each challenged claim that such a claim is unpatentable over the prior art. For at least the reasons I explain below, it is my opinion that none of the Challenged Claims are unpatentable.

A. Ground 1: Ishigaki Does Not Anticipate Claims 1-20

28. It is my understanding that, for purposes of the Institution Decision, the Board held that “Petitioner has met its burden of demonstrating a reasonable likelihood of prevailing at trial in showing that Ishigaki anticipates the challenged claims.” Paper 11, 28, 38. It is also my understanding that the Board reached this conclusion in view of Hutin, a reference introduced by the Board, and which was not cited in the Petition. Paper 11, 31-32. It is further my understand that the Director determined that “the Board erred in introducing its own evidence with respect to the Ishigaki-based grounds following its own extra-record factfinding, and that unforced error is not harmless with respect to those grounds. As a result, the portion of the Decision addressing the Ishigaki-based grounds is herewith vacated.” Paper 17, 3. In view of the Director’s decision to vacate the Boards institution decision to the extent it relied on Hutin, I have not addressed the Hutin reference.

29. As previously explained in Paragraphs 57-90 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Guido fail to show that claims 1-20 of the '118 Patent are anticipated by Ishigaki, and I incorporate those paragraphs by reference herein. Ex. 2015 ¶¶ 57-90.

1. Petitioner fails to show that Ishigaki discloses a particle size of 90% accumulative volume of the first material is less than 40 μm

30. Each of the Challenged Claims of the '118 Patent requires, *inter alia*, a first layer comprising a first material, wherein the first layer is arranged between the current collector and a second layer, and a particle size of 90% accumulative volume of the first material is less than 40 μm . Ex. 1001, Claims 1, 10, and 19; Ex. 2015 ¶¶ 57, 59.

31. As previously explained in my original Declaration (Ex. 2015), it is my opinion that Ishigaki fails to disclose a particle size of 90% accumulative volume of the first material is less than 40 μm . Ex. 2015 ¶¶ 59-77.

32. Ishigaki explains that its positive active material includes larger “secondary particles,” which are formed from aggregating smaller “primary particles.” Ex. 1004 ¶ [0092] (“a slurry obtained by wet-pulverizing a raw material compound and additive is spray-dried to obtain a powder in which primary particles are aggregated to form secondary particles). Ex. 2015 ¶ 60. Dr. Guido asserts that

Ishigaki's secondary particles "are the relevant comparison to the particle size recited in the '118 patent," (Ex. 1010 ¶ 111) and points to the secondary particles as allegedly disclosing "a particle size of 90% accumulative volume of the first material is less than 40 μm ." Ex. 1010 ¶¶ 81-84; *see also* Pet. at 14-15; Ex. 2015 ¶ 61. Dr. Gido also asserts that "Ishigaki discloses that the first positive electrode active material has particles with 90% **cumulative diameter** less than 10 μm ... Therefore, Ishigaki discloses that a particle size of 90% **accumulative volume** of the first active material is less than 40 μm ." Ex. 1010 ¶ 81 (emphasis added). I disagree.

33. As acknowledged by the Board, there is no disclosure of 90% accumulative volume values for any of Ishigaki's particles. Paper 11, 30 ("Ishigaki discloses values of "D90" as opposed to "Dv90."). Instead, Ishigaki only refers to the term "90% cumulative diameter (D90)". Ex. 1004 ¶ 38; Ex. 2015 ¶ 62. As previously described in my original Declaration, Dr. Gido's assumption that Ishigaki's "90% cumulative diameter" values correspond to "a 90% accumulative volume" is misguided. *Id.*

34. Petitioner and Dr. Gido point to Ishigaki's discussion of 90% cumulative diameter (D90) values as allegedly disclosing the claimed particle size of 90% accumulative volume of the first material is less than 40 μm . Ex. 1010 ¶ 81. Dr. Gido states:

Ishigaki discloses that the first positive electrode active material has particles with 90% cumulative diameter less than 10 μm . EX1004, ¶38; see also EX1004, ¶39 (“[T]he 90% cumulative diameter (D90) are measured by a well-known laser diffraction/scattering particle size distribution measuring device... and a particle diameter standard as a volume standard.”) (emphasis added). Ishigaki’s particle size is therefore measured by volume, which corresponds to Dv90 (the volume standard). EX1004, ¶39; EX1018 (ISO 13320-1 standard explaining that laser diffraction is a volume-based measurement). Therefore, Ishigaki discloses that a particle size of 90% accumulative volume of the first active material is less than 40 μm .

Ex. 1010 ¶ 81; Ex. 2015 ¶ 63. It is my understanding that, for purposes of the Institution Decision, the Board agreed that the use of a well-known laser diffraction/scattering particle size distribution measuring device and a particle diameter standard as a volume standard “confirms that Ishigaki is indeed disclosing a Dv90 volume-weighted distribution.” Paper 11, 32-33. However, Dr. Gido’s suggestion that laser diffraction/scattering devices using a particle diameter standard as a volume standard would necessarily output cumulative volume distributions is incorrect.

a. Ishigaki does not disclose an accumulated volume distribution

35. Ishigaki discloses that D90 is “measured by a well-known laser diffraction/scattering particle size distribution measuring device, with a set refractive index of 1.60a 0.10i, and a particle diameter standard as a volume standard.” Ex. 1004 ¶ [0039]; Ex. 2015 ¶¶ 64-65. Ishigaki’s stated settings – the refractive index and “particle diameter standard as a volume standard” describe how the device *measures* particle sizes. *Id.* These settings do not influence how the device reports a *calculated particle distribution* – i.e., how the device summarizes the measurement data.

36. A POSITA would have understood that laser diffraction/scattering devices *indirectly* measure particle sizes (based on a determination of how much the particle diffracts light from its original path). Ex. 2015 ¶ 65. That is, these devices measure the intensity and angle of diffracted light and then use algorithms, such as Mie theory or Fraunhofer theory, to estimate particle sizes. Ex. 2018;⁵ Ex. 2015 ¶ 65. Mie theory differs from Fraunhofer theory in that Mie theory allows for the particles

⁵ Ex. 2018. Laser diffraction for particle sizing – Anton Paar, available at: <https://wiki.anton-paar.com/en/laser-diffraction-for-particle-sizing> (last accessed on July 30, 2025).

to be somewhat transmissive of the laser light and, as such, considers the refractive index of the materials being probed. Ex. 2018, 7. Thus, Ishigaki's disclosure that D90 is "measured by a well-known laser diffraction/scattering particle size distribution measuring device, with a set refractive index of 1.60a 0.10i, and a particle diameter standard as a volume standard" would at best teach a POSITA that the representative diameter of a particle could be determined from the volume of the particle estimated using Mie theory. Ex. 1004 ¶ [0039]; Ex. 2015 ¶¶ 64-65. In other words, this disclosure in Ishigaki only describes the measurement of individual particle diameters on which the D90 values are based. *See* Ex. 1004 ¶ [0039]. Ex. 2015 ¶¶ 66-69. Nowhere does Ishigaki describe the type of distribution to which its D90 values correspond.

37. Dr. Guido testified that converting particle diameters determined from the estimated volume of the particle into a non-volume based distribution, such as a number-based distribution or area-based distribution, necessitates additional calculations,⁶ but a POSITA would have understood that a "laser

⁶ Ex. 2050, 41:15-43:17 (when asked if it is possible for a laser diffraction machine to output a number-based particle size distribution, Dr. Guido stated "The machine outputs a volume-based distribution. Somebody would have to do an additional

diffraction/scattering particle size distribution measuring device,” is well equipped to perform such calculations in the background without any effort from the user.

38. Indeed, a POSITA would have understood that, even if particle sizes are determined from the estimated volume, laser diffraction devices are capable of using the particle sizes to generate *and output* any of multiple different particle size distributions, including numbers-based distributions, area-based distributions, volume-based distributions, and others. Ex. 2051, 4 (Product data sheet for the Microtrac Particle Size Analyzer S3500, stating that the data output includes “Volume, number and area distributions as well as percentile and other summary data”); Ex. 2052 ¶ [0025] (U.S. Patent Publication No. US 2016/0326003 A1 to Ishizuka, stating, “The number-average particle diameter is determined by use of a laser diffraction particle size analyzer in accordance with JIS Z8825: 2013 (corresponding to ISO 13320) {e.g., Microtrac series manufactured by Leeds & Northrup and Partica LA series manufactured by HORIBA, Ltd.}”); Ex. 2053, 78 (User’s Manual dated September 2019 for the Beckman Coulter LS 13 320 Laser Diffraction Particle Size Analyzer showing that a user can select whether the particle

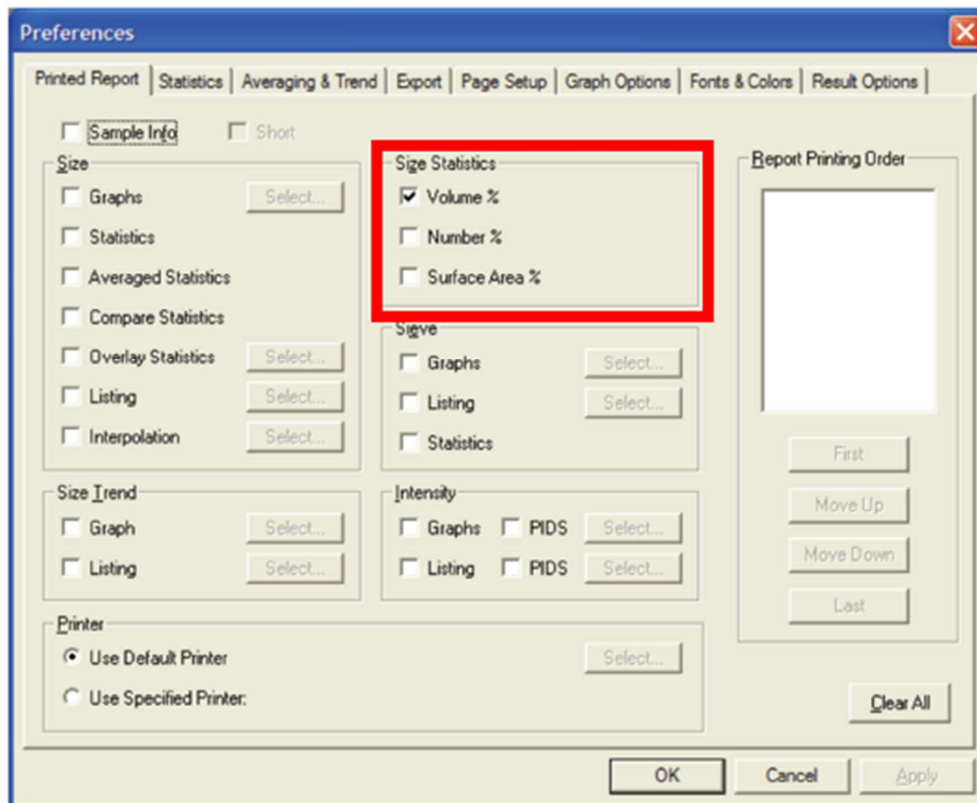
calculation making assumptions, which may or may not be justified, to convert that into a number distribution.”)

size statistics are output as “Volume %”, “Number %”, or “Surface Area %”); Ex. 2054, 70 (User’s Manual dated October 2011 for the Beckman Coulter LS 13 320 Laser Diffraction Particle Size Analyzer showing the same options for selecting particle size statistics have been unchanged since at least 2011);⁷ Ex. 2055 ¶ [0067] (U.S. Patent Publication No. US 2024/0291110 A1 to Lee et al., explaining that D50 can be measured by “obtaining the particle diameter at 50% of the cumulative distribution of the number of particles sorted by the particle diameter”); Ex. 2046 (U.S. Patent Publication No. US 2021/0214234 A1 to Lee et al.); Ex. 2047 (U.S. Patent Publication No. 2022/0403062 A1 to Cha et al.). In practice, these instruments have a graphical user interface that allows a user to select whichever type of distribution they like. An example of such a user interface is shown below with the relevant choice of size statistics emphasized with a red outline.

⁷ I note that I have included two versions of the User’s Manual for the Beckman Coulter LS 13 320 Laser Diffraction Particle Size Analyzer to illustrate that a POSITA’s understanding of this laser diffraction technology has not changed since the priority date of the ’118 Patent, including a user interface that allows the user to select whether the particle size statistics are output as “Volume %”, “Number %”, or “Surface Area %”.

LS 13 320 Software
Preference Options

- **Interpolation:** analysis using user-selectable channel boundaries
- **Size Trend Graph:** trend data graphical and tabular format options
- **Trend Listing:** trend data in a tabular format
- **Sieve:** presents size data (tabular or graphical) using sieve format by mesh size or mesh number



Size Graphs

This option displays the **Size Graphs** tab box. Your first selection determines the default format for the graph display format. Additional selections determine the other types of graphical presentations to be included in your report. Up to 12 distribution types may be selected in the desired printing order. Both the x-axis and y-axis can be printed using a log or a linear scale.

Ex. 2053, 7878; *see also* Ex. 2054, 70 (*emphasis added*).

39. The term “D90” only indicates that the associated value corresponds to the 90th percentile of some distribution of diameters. In other words, a D90 value is

a diameter that splits some distribution with 90% below and 10% above the diameter. Similarly, a D50 value is a diameter that splits the distribution with 50% below and 50% above the diameter. The terms D90 and D50 are not informative of the distribution to which they correspond, including whether the distribution is a volume-based distribution, number-based distribution, area-based distribution, or some other type of distribution.

40. A POSITA would have understood that assuming D90 corresponds to Dv90 or that D50 corresponds to Dv50 runs the risk of relying on inaccurate values. Indeed, some references that measure particle sizes with laser diffraction instruments use the D50 notation for number-based distributions. Ex. 2055 ¶ [0067] (“the average particle diameter D_{50} refers to the particle diameter at 50% in the cumulative distribution of particles sorted by the particle diameter. *The average particle diameter D_{50} may be measured using a laser diffraction method.* Specifically, after the particles to be measured are dispersed in a dispersion medium, the dispersion is introduced into a commercially available laser diffraction particle diameter analyzer (for example, Microtrac S3500), and the difference in diffraction pattern according to the particle diameter is measured when the particles pass through a laser beam. From the diffraction pattern differences, the particle diameter distribution can be calculated. *By obtaining the particle diameter at 50% of the cumulative*

distribution of the number of particles sorted by the particle diameter, the D_{50} can be measured.”).

41. Therefore, at least because Ishigaki provides no indication about which type of particle distribution is used to describe its “D90” values, a POSITA would not have understood Ishigaki’s D90 values to be D_{v90} values. Ex. 2015 ¶¶ 67-70.

42. Understanding the type of distribution to which reported values correspond (e.g., D90 values, D_{50} values) is critical to understanding the particle sizes used in an electrode composition. See Ex. 2015 ¶ 68. For instance, as Dr. Gido acknowledges, “[t]hese different accumulation averages do not necessarily yield the same number values.” Ex. 1010 ¶ 83; Ex. 2015 ¶ 68. Indeed, D_{v90} (D90 of a volume-based distribution) and D_{n90} (D90 of a number-based distribution) values will only be the same if all particles are the same size, which, as Dr. Gido acknowledges, does not occur in realistic manufacturing processes. Ex. 2015 ¶ 68; Ex. 2050, 97:20-98:13 (when asked why a battery designer would use a range of particle sizes instead of using a uniform particle size in an active material layer, Dr. Gido stated, “Well, there really is no such thing as a uniform particle size. There is always a range, because these are made by some kind of a, you know, random processes of both, you know, crystal growth followed by pulverization or grinding. And these all lead to a distribution, so you always have a distribution.”); see also

e.g., Ex. 1004 ¶ [0089] (Ishigaki describing that its materials are pulverized, preferably using wet pulverization). For any continuous non-uniform distribution (i.e. for a range of particle sizes), the measured Dv90 value will always be greater than the Dn90 value. Ex. 2015 ¶ 68.

b. Ishigaki's D90 value corresponds to a number-based distribution

43. As previously mentioned, a POSITA would not run the risk of assuming that D90 corresponds to a particular type of distribution without sufficient information, which Ishigaki does not provide. But even if a POSITA were to guess what Ishigaki's D90 values correspond to, in my opinion, a POSITA would determine that Ishigaki's 90% cumulative diameter measurement (D90) corresponds to a number-based distribution based on Ishigaki's teachings as a whole, not a volume-based distribution. Ex. 2015 ¶¶ 71-77.

44. Ishigaki explains that the secondary particles, which Dr. Gido claims "are the relevant comparison to the particle size recited in the '118 patent," are formed from primary particles. Ex. 1010 ¶ 111; Ex. 1004 ¶ [0092]. The size of the primary particles therefore impacts the size of the secondary particles, and Ishigaki is careful to explain that the size of the primary particles impacts the performance of the electrode. *Id.*; see also Ex. 1004 ¶ [0041] ("If the average primary particle diameter exceeds the upper limit, powder packing properties may be adversely

affected and the specific surface area may be reduced, which may increase the possibility of a decrease in battery performance such as rate characteristics and output characteristics. If the lower limit is exceeded, crystals do not fully develop, which may result in issues such as poor reversibility of charging and discharging.”). For at least these reasons, Ishigaki stipulates limits on both the size of the secondary particles and the size of the primary particles. Ex. 1004 ¶ [0041].

45. Ishigaki uses two separate methods to measure the size of the primary and secondary particles, which is common in cases where primary particles are aggregated into secondary particles or in cases where primary particles are particularly difficult to disperse. Ex. 1004 ¶¶ [0038], [0039],[0041], [0042], [0185]; Ex. 2015 ¶ 71. That is, when particles are readily separated from one another, their size may be measured using laser diffraction. But when particles are connected to each other, the size of any individual particle cannot be determined by laser diffraction because the laser must interact with each particle independently. Aggregated or agglomerated particles such as Ishigaki’s primary particles must instead be measured using another technique. For instance, Anton Paar’s Wiki website (Ex. 2018) states “In order to get a clear diffraction, it is necessary to have a proper dispersion of the sample. This means that each particle should be visible as a single particle in front of the laser, moving through either liquid medium or air.”

Ex. 2018, 4. Thus, Ishigaki describes the secondary particle diameters as being measured using a laser diffraction instrument and the primary particle diameters as being measured by means of particle size *counting* using SEM images. Ex. 1004 ¶¶ [0041], [0185].

46. As explained in my original Declaration, it would be common to use SEM imaging to generate images of the primary particles, and then to manually measure diameters of primary particles visible within the generated image. Ex. 2015 ¶¶ 71-75; *see also* Ex. 1010 ¶ 270. SEM images only provide a 2D view of an ensemble of particles and thus a technique that relies on particle size counting using SEM images, such as is used in Ishigaki for the primary particles, inherently lacks the capability to measure particle sizes on the basis of volume. *Id.* ¶ 74. Instead, such a technique necessarily uses number-based distributions. *Id.* Therefore, a POSITA would have understood that Ishigaki's use of SEM to measure the primary particles' diameters is indicative of a number-based (not a volume-based) distribution. Ex. 1004 ¶ [0185]; Ex. 2015 ¶75.

47. Ishigaki gives no explanation as to how or why the purported primary particle sizes might differ in statistical approach, if any, from the purported secondary particle sizes, but a POSITA would have understood that a direct, apples-

to-apples comparison of the primary particle sizes to the secondary particle sizes would require the statistical approach to be the same. Ex. 2015 ¶¶ 73-74.

48. As explained in my original Declaration, and as acknowledged by Dr. Gido (Ex. 1010 ¶ 83), a POSITA would have understood that number-based and volume-based distribution methods will not yield the same values (and the Dv90 value will be larger than the Dn90 value for a continuous distribution of unequally-sized particles), and so comparing the size distributions of the primary particles and secondary particles would require using the same statistical approach (e.g., using a Dn90 or a Dv90 for both). Since volume data could not be directly obtained for the primary particles, it would have been most convenient for Ishigaki to use a number-based distribution for both types of particles so that their respective size distributions could be directly compared. Ex. 2015 ¶ 74. In other words, a POSITA would have expected, and it would be most convenient, to use the number-based particle distribution for both the primary particles and the secondary particles of Ishigaki so that a D90 value determined for the primary particles could be directly compared to a D90 value for the secondary particles. Ex. 2015 ¶ 75. The POSITA would also expect internal usage of the same metric to be consistent.

49. Thus, at least because underlying volume data are unavailable for the primary particles, it is my opinion that the D90 metric in Ishigaki corresponds to a cumulative number (not volume) distribution. *Id.*

50. Thus, contrary to Dr. Gido's assertion, a POSITA reading Ishigaki reference would not assume that Ishigaki's D90 metric "corresponds to Dv90 (the volume standard)" but instead that it corresponds to a number-based particle distribution standard. Ex. 2015 ¶ 77.

2. Petitioner fails to show that Ishigaki discloses a two-layer electrode structure with a compaction density of greater than 3.2 g/cc

51. Each of the Challenged Claims of the '118 Patent also requires, *inter alia*, a first layer and a second layer, wherein a total compaction density of the first layer and the second layer is greater than 3.2 g/cc. Petitioner fails to show that Ishigaki discloses these claim requirements. Ex. 1001, Claims 1, 10, and 19; Ex. 2015 ¶ 78.

52. As explained in my original Declaration, the only density value disclosed in Ishigaki for a two-layer electrode structure is 2.4 g/cc, which is well below the claimed range of greater than 3.2 g/cc. Ex. 1004 ¶ [0366]; 2015 ¶¶ 86-87. That is, while Ishigaki provides a range of values for the "mixture density" and "electrode density" of a single layer of an electrode (Ex. 1004 ¶¶ [0025], [0151]),

the only time Ishigaki discloses any density value for a two-layer electrode structure, it is a single mixture density value of 2.4 g/cc. Ex. 1004 ¶ [0366]. For at least this reason, and the reasons discussed below, it is my opinion that Petitioner fails to show that Ishigaki discloses these claim requirements.

a. Compaction densities of single-layer electrode structures do not disclose compaction densities of two-layer electrode structures

53. As explained in my original Declaration, and as acknowledged by Dr. Gido, the densities described in paragraphs [0025] and [0151] of Ishigaki, on which Dr. Gido and Petitioner rely, are described for only a single layer. Ex. 1004 ¶¶ [0025], [0151]; Ex. 1010 ¶¶ 87-88; Ex. 2015 ¶ 81; Ex. 2050, 107:2-4 (when asked if paragraph [0025] of Ishigaki discusses multiple layers, Dr. Gido stated, “It is talking about a layer.”). Ex. 2050, 107:5-108:3 (when asked if paragraph 151 of Ishigaki discusses a single layer, Dr. Gido stated “Yes. And well in reading this, when I read it and also a POSA when they would read it, would understand that this is either a single layer or it is the first layer of 2 layers, because further on down they put the second layer on, so either.”). Ishigaki states:

The **mixture density** of the electrode of the present invention is characterized as 2.0 g/cm³ or more, and from the viewpoint of increasing capacitance density, it is preferably 2.0 g/cm³ or more, and particularly preferably 2.5 g/cm³ or more. The upper limit is not

particularly limited, but since space is required in the positive electrode plate to hold the electrolyte in the electrode plate and to supply lithium ions, the upper limit is preferably 3.6 g/cm³ or less, more preferably 3.5 g/cm³ or less, and particularly preferably 3.4 g/cm³ or less.

The thickness of **the positive electrode active material layer** is usually about 10 to 200 μm.

...

The **electrode density** of the positive electrode after pressing has a lower limit of normally 2.0 g/cm³ or more, preferably 2.4 g/cm³ or more, and particularly preferably 2.6 g/cm³ or more, and an upper limit of normally 4.2 g/cm³ or less, preferably 4.0 g/cm³ or less, and particularly preferably 3.8 g/cm³ or less.

Note that **the positive electrode active material layer** obtained by coating and drying is preferably compressed by a roller press or the like in order to increase the packing density of the positive electrode active material.

Thus, the positive electrode for lithium rechargeable batteries of the present invention can be prepared.

Ex. 1004 ¶¶ [0025] and [0151] (emphasis added).

54. That is, both paragraphs [0025] and [0151] refer only to “the positive electrode active material **layer**,” which a POSITA would interpret as a *single* layer, such as the first layer of a two-layer electrode structure. Ishigaki provides no information suggesting that the provided densities also apply to multi-layer electrode (cathode or anode) structures. *Id.*

55. Indeed, contrary to Dr. Gido's claim that "[a]ll of these disclosures describe individual preferred embodiments of Ishigaki in which the compaction density is greater than 3.2 g/cc," and "anticipate[s] the claim limitation," nothing in Ishigaki would lead a POSITA to consider the range of densities described in paragraphs [0025] and [0151] of Ishigaki as being applicable to a two-layer electrode structure. *Id.* ¶ 88; *see also* Ex. 1004 ¶¶ [0025], [0151]; Ex. 2015 ¶ 81.

56. Instead, as explained in my original Declaration, a POSITA would have understood that the design requirements to allow for suitable movement and reaction of lithium ions and electrons throughout a two-layer electrode structure are different from that of a single-layer electrode structure, such that a POSITA would not assume that densities designed for a single-layer electrode structure would be applicable to a two-layer electrode structure. Ex. 2021⁸; Ex. 2015 ¶ 81.

57. For example, a POSITA would have understood that when Ishigaki's second, wet electrode layer is applied to Ishigaki's first, pre-dried layer, the solvent of the second layer re-wets the first layer, causing the two layers to partially mix and

⁸ Ex 2021. Liu, Chen, Liu, Chu, and Tiu, "Improvement of Lithium-Ion Battery Performance by Two-Layered Slot-Die Coating Operation," *Energy Technology* 2017, 5, 1235–1241 [<https://onlinelibrary.wiley.com/doi/10.1002/ente.201600536>]

to change the compaction of the first layer. Ex. 2015 ¶ 82 (citing Ex. 1004 ¶ [0366] (“Next, the slurry 1 was applied and dried on one side of aluminum foil (thickness 15 μm) of the current collecting foil using a doctor blade. Then, the slurry 2 was applied to one side of the substrate using a doctor blade and dried.”))); *see also* Ex. 2019, 51. Dr. Guido testified that multiple layers of electrode materials are analogous to multiple layers of “paint” – wherein a first layer would generate a permanent “skin” that would remain after the second layer is coated thereon. Ex. 2050, 23:3-16, 79:9-80:19. This is simply untrue.

58. First, a POSITA would have understood that, because electrode layers are thin—about the thickness of a human hair, they tend to dry nearly uniformly under commercially acceptable drying temperatures. Ex. 2021, 3-4 (describing that differences in the SEM images among single-layer and two-layer electrodes were indistinguishable and that there is little gradient in binder concentration); Ex. 2029, 3 (Fig. 1 showing SEM cross-section images of multi-layer electrodes); Ex. 2056, 11 (showing cross sections from electrodes dried at different temperatures)⁹. Stating

⁹ Ex. 2056. M Nikpour, B Liu, P Minson, Z Hillman, BA Mazzeo, DR Wheeler, “Li-ion electrode microstructure evolution during drying and calendering,” *Batteries* 8 (9), 107. <https://www.mdpi.com/1807812>

that a “skin” forms on the surface of a layer during drying, and especially that the skin is akin to a thick layer of paint drying, is inconsistent with the knowledge of a POSITA and is also inconsistent with my own laboratory experience in fabricating and analyzing such electrode layers. *Id.* Second, even if something that could be compared to a skin formed on the surface of the first layer, it would rewet when a second layer is applied, thereby eliminating such a skin. Ex. 2019, 51. Dried latex paint does not behave like a battery electrode layer at least because the latex particles in paint adhere strongly to each other and are not easily separated even if water were subsequently added to the dried surface.

59. A POSITA would have understood that two-layer electrode structures are complex and may have different structural characteristics in each individual layer. For example, two-layer electrode structures can have different densities/porosities in each layer, different active material compositions in each layer, or other structural differences that need to be thoughtfully considered in view of the particular application of the corresponding battery. Thus, a POSITA reviewing Ishigaki’s disclosed electrode density range of 2.0 g/cc to 3.6 g/cc (for mixture density) or 4.2 g/cc (for electrode density) would recognize that this range is only applicable to single-layer electrode structures. Ex. 2050, 107:2-4 (when asked if paragraph [0025] of Ishigaki discusses multiple layers, Dr. Gido stated, “It is talking

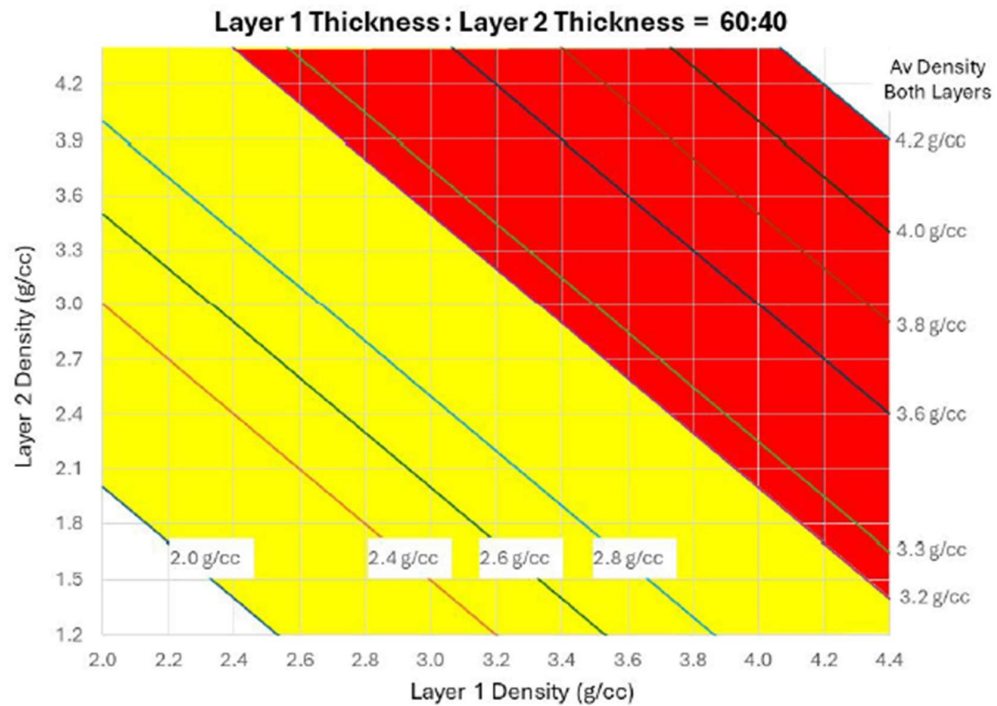
about a layer.”). Ex. 2050, 107:5-108:3 (when asked if paragraph 151 of Ishigaki discusses a single layer, Dr. Guido stated “Yes. And well in reading this, when I read it and also a POSA when they would read it, would understand that this is either a single layer or it is the first layer of 2 layers, because further on down they put the second layer on, so either.”).

60. As explained in my original Declaration, a POSITA would also have understood that the compaction of an individual layer would change when a second layer is applied (to form a two-layer structure) such that a POSITA could not accurately predict the overall density of Ishigaki’s two-layer structure from Ishigaki’s single layer densities alone. Ex. 2015 ¶ 82. That is, a POSITA would have understood that, in Ishigaki’s two-layer system, when the second layer is applied to the first layer, complex interactions develop between the two layers during the manufacturing process that result in unexpected changes in density both before and after compaction.¹⁰ Ex. 1004 ¶ [0366]; Ex. 2015 ¶ 82.

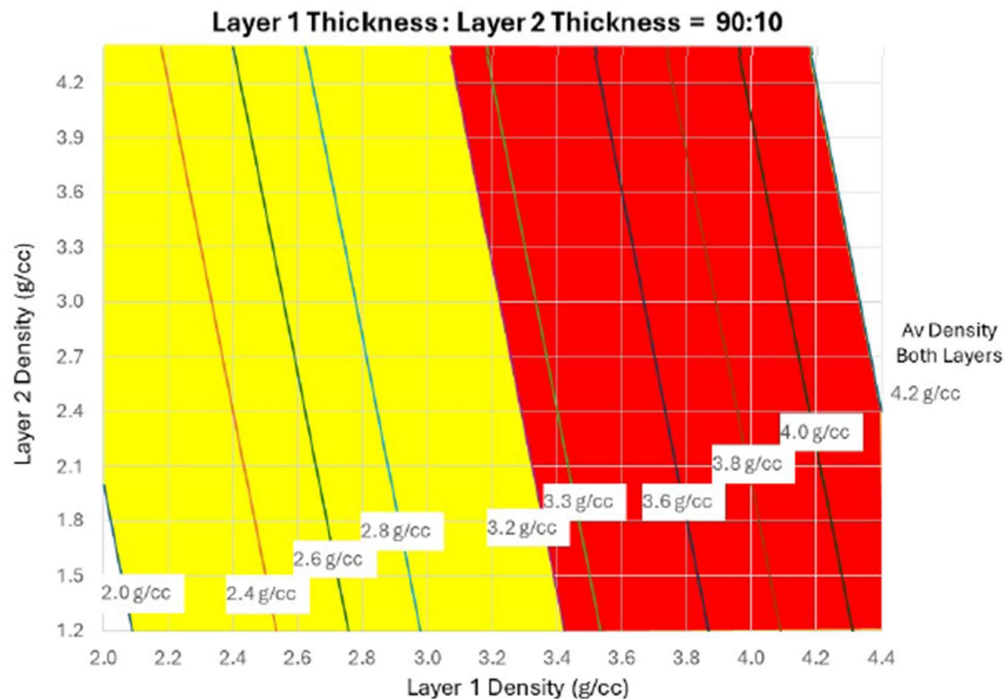
¹⁰ Ex. 2019. Understanding the Mechanical and Electrochemical Impacts of Binder Systems on Silicon Anodes in Lithium-Ion Batteries – BYU Scholars Archive, available at: <https://scholarsarchive.byu.edu/etd/10449> (accessed on 30 July 2025)

b. Dr. Gido's Demonstratives are not supported by Ishigaki

61. I understand that Dr. Gido provides multiple color-coded Demonstratives (including Demonstratives 7 and 8, shown below) in support of his argument that Ishigaki's disclosure covers two-layer electrode structures having a density greater than 3.2 g/cc. Ex. 1010 ¶¶ 90-92, as well as Demonstratives 7 and 8.



Gido Demonstrative 7.



Gido Demonstrative 8.

62. I have reviewed these Demonstratives and find that they do not accurately portray Ishigaki's disclosure for several reasons.

63. Dr. Gido's Demonstratives misleadingly suggest (a) that it is possible to achieve a density of 4.4 g/cc based on Ishigaki's disclosure (despite Ishigaki never disclosing a density above 4.2 g/cc), (b) that it is possible to achieve identical densities in both layers of a two-layer structure, despite Ishigaki's teaching that each layer should have a different structure, and (c) that it is possible to achieve a combined average density of greater than 3.2 g/cc, even though Ishigaki's only disclosure of a two-layer structure has a density of 2.4 g/cc.

64. First, nothing in Ishigaki suggests that it is possible to achieve a density of 4.4 g/cc in a single-layer electrode structure, much less a two-layer electrode structure. *See e.g.*, Ex. 1004 ¶ [0151]. The value 4.4 g/cc, on which Dr. Gido bases the calculations for his Demonstratives, corresponds to a theoretical maximum calculated by Dr. Gido based on the densities of the components (active particles, conductive additive, and polymer binder) included in the active layer of Ishigaki's Example 2. Ex. 1010 ¶ 89. This value is not disclosed in Ishigaki. Dr. Gido states:

I note that there is a physical constraint on the upper possible limit of the density of the Ishigaki cathode layers of 4.4 g/cm³. This is based on the densities of the components (active particles, conductive additive, and polymer binder) in the layer, in the amounts taught by Ishigaki,

when the porosity of the layers is zero. Lower densities than this maximum, such as the 2.0 g/cm³ to 4.2 g/cm³ range taught by Ishigaki, are due to the presence of porosity, which adds empty space into the layers.

Id. In other words, despite Dr. Guido being well aware that the optimum porosity (and therefore density) for an electrode necessarily depends on the particular application for the electrode, and that Ishigaki limits single layer electrode structures to a maximum density of 4.2 g/cc (*see e.g.*, Ex. 1004 ¶ [0151]), Dr. Guido ignores the clear density limits taught in Ishigaki in favor of using his own theoretical maximum calculation of 4.4 g/cc. Ex. 1010 ¶ 89; Ex. 2050, 58:1-14 (when asked if it is always desirable to increase compaction density, Dr. Guido stated, “Not necessarily. I mean it depends again on what you’re trying to achieve.”), 58:20-22 (when asked if a lower compaction density would increase rate performance, Dr. Guido stated “Potentially, yes.”), 59:1-3 (when asked if a higher density conversely would decrease rate performance, Dr. Guido stated “Potentially, yes.”).

65. Therefore, even if one were to assume that a POSITA would base the overall density of a two-layer structure on density values provided for single-layer structures, which a POSITA would not do, any density presented in Dr. Guido’s Demonstratives that assumes a single-layer density below 2.0 g/cc and/or a single-

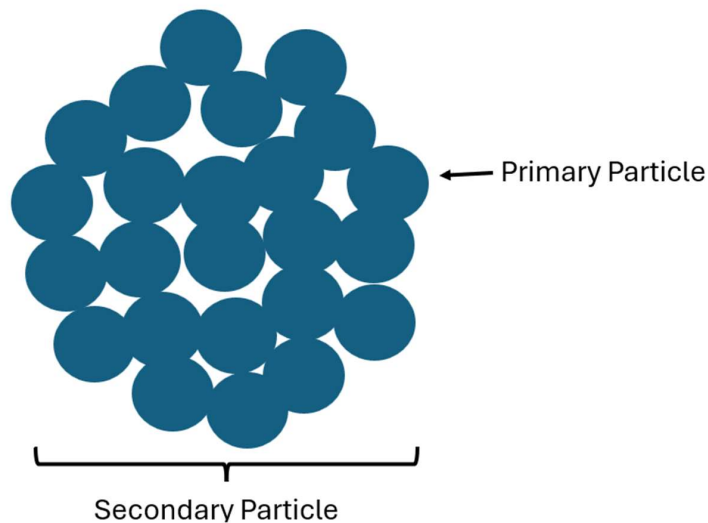
layer density above 4.2 g/cc would not be applicable in view of Ishigaki's teachings.

Id.; Ex. 1004 ¶¶ [0025], [0151].

66. Second, Ishigaki explicitly teaches that, when a second layer is applied, it should have different characteristics than the first layer. *See e.g.*, Ex. 1004 ¶ [0153] (Ishigaki explaining that, “with a positive electrode for lithium rechargeable batteries—which is characterized by having laminated: a first positive electrode mixture layer containing a first positive electrode active material possessing the current collecting foil surface structure described above, and a second positive electrode mixture layer containing a second positive electrode active material whose particle diameter is larger than that of the first positive electrode active material.”).

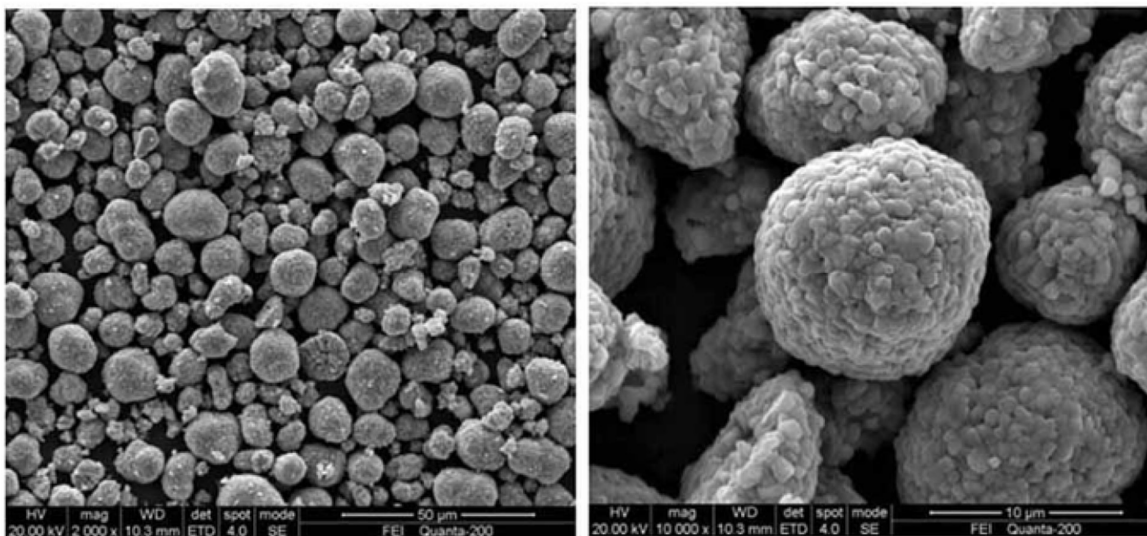
67. Moreover, as Dr. Gido acknowledges, individual layers in a two-layer structure will compact differently depending on their structure. Ex. 2050, 86:12-87:9 (when asked, if compacting two layers, are you going to have the same compaction density across both layers, Dr. Gido stated “Not necessarily”), 87:18-88:3 (when asked if the different layers may have different compressibilities, Dr. Gido stated, “They may, they may have different compressibilities for various reasons”], 88:4-88:19 (when again asked about the compressibility of the different layers, Dr. Gido stated “they may respond differently [to the same compression force] because of differences in their structure.”).

68. Another issue that the POSITA would need to consider, but which Dr. Gido does not directly address, is the porosity that is intrinsic to the secondary particles of Ishigaki. Ishigaki explicitly designs and sets as an objective that the secondary particles should have substantial internal porosity resulting from a carefully controlled sintering process and the use of specific additives (Ex. 1004, Claim 5, ¶¶ 26, 29, 30, 80, 81, 86, 87, 94, 103, 109). A secondary particle comprising much smaller primary particles sintered together with intentional gaps or pores between the primary particles can be illustrated as follows:



69. Dr. Gido himself illustrates from a source other than Ishigaki the concept that secondary particles can have internal porosity *See* Ex. 1010 ¶ 108 (showing a figure from Ex 1013, reproduced below). This internal porosity of the secondary particles is one component of the overall porosity of Ishigaki's electrodes

(the other component being the larger pores formed by gaps between the secondary particles, the binder, and the carbon additive). This secondary particle internal porosity decreases the density of the electrode relative to that of the crystalline density of the active material. So, for instance, when Dr. Guido purports to calculate the maximum density of the electrode by starting with the crystalline density of the active material (*see* Ex. 1010 ¶ 90), his calculations do not, indeed cannot, incorporate the unknown porosity intrinsic to Ishigaki's secondary particles.



Ex 1013 (showing SEM images of secondary particles comprised of primary particles and internal pores, at low (left) and high (right) magnification.)).

70. Indeed, a POSITA would have understood that a two-layer structure may incorporate multiple different layer structures into the electrode. Ex. 2029. For example, a battery designer may use a two-layer structure to achieve lower porosity

(higher density) closer to the current collector and higher porosity (lower density) closer to the separator. *See* Ex. 2029 and references cited therein. A POSITA would have understood that any compaction density teaching cannot be viewed in a vacuum, and should consider other structural considerations of the intended electrode structure. Thus, even if one were to assume that a POSITA would base the overall density of a two-layer structure on density values provided for single-layer structures, which a POSITA would not do, any density presented in Dr. Gido's Demonstratives that assumes the same density across both layers would not be applicable in view of Ishigaki's teachings.

71. Third, nothing in Ishigaki suggests that the density of a two-layer structure would be greater than 2.4 g/cc, much less greater than 3.2 g/cc. *See* Ex. 1004 ¶ [0366]. Indeed, Ishigaki's only disclosure of a two-layer structure has a density of 2.4 g/cc. Petitioner and Dr. Gido attempt to justify the higher density values presented in Dr. Gido's Demonstratives by stating that a POSITA would "understand that it is advantageous from the perspective of maximizing the energy density of the electrode to work in the higher density ranges taught by Ishigaki, i.e., the red portions of the graphs." Ex. 1010 ¶ 93; Pet. 16.

72. Contrary to Dr. Gido's assertion that a POSITA would "work in the higher density ranges taught by Ishigaki," (Ex. 1010 ¶ 93) Ishigaki's examples teach

a POSITA to work in the **lower** density ranges provided in Ishigaki, and in particular, in a range below 2.6 g/cc. Ex. 2015 ¶¶ 86-88. Petitioner and Dr. Guido fail to address Ishigaki's examples or provide any explanation as to why the only two-layer electrode structure example in Ishigaki is (1) at the lower limit of Ishigaki's disclosed range, (2) lower than all other disclosed examples, and (3) well below the claimed 3.2 g/cc compaction density. *Id.*

73. As mentioned above, Dr. Guido's Demonstratives are based on the assumption that the highest density achievable in Ishigaki for a single layer is 4.4 g/cc (despite Ishigaki never disclosing a density above 4.2 g/cc). Ex. 1010 ¶ 89; Ex. 1004 ¶¶ [0025], [0151]. Even if Ishigaki were to instruct a POSITA to choose "the highest density possible," which Ishigaki does not, the POSITA would have understood, and Dr. Guido acknowledges, that the highest density achievable for an electrode structure depends on factors beyond the theoretical compaction density of the active material, including whether or not that electrode has one or multiple layers. Ex. 2050, 31:18-32:6 (when asked if the compaction characteristics of an active material layer depend more on the active materials or on the polymer binder, Dr. Guido stated "certainly the particle size and particle size distributions depends on [the density] or influences [the density] as does the binder. How much of the binder is in there, what are the viscoelastic properties of the binder and so forth."), 67:10-15

(when asked if the density of an electrode impacts how thick it can be, Dr. Gido stated, “Yeah, to a certain degree. If is too thick and it is too dense you have problems getting the electrolyte and lithium-ions in and out of it.”), 68:2-8 (when asked if porosity impacts density, Dr. Gido stated, “it does” and agreed then that “[h]igher porosity leads to lower density and vice versa”), 69:12-17 (when asked if the shapes or sizes of particles impact density, Dr. Gido stated, “They can. I mean, that is -- that is one factor. It is not solely determining, but it certainly influences how the particles can and do pack.”), 69:18-70:8 (when asked if you achieve a certain compaction density with one set of particles that have specific sizes and specific shapes are you certain to be able to get the same compaction density using different particles with different sizes and different shapes, Dr. Gido stated, “I mean, again -- well, these are tradeoffs. Certainly if the particles pack differently, you know, you may need to adjust something else to compensate for that to achieve similar densities, right. So you might have to compact more or use more binder, less binder, you know. These are all different design choices.”). This is particularly true when implemented in a two-layer structure in which each individual layer has different structural characteristics and will compact differently.

74. Further showing that Dr. Gido’s Demonstratives go beyond the disclosure of Ishigaki, Ishigaki’s examples show that its two-layer electrode

structures have a **lower** compaction density than its single-layer electrode structures. Ex. 1004 ¶¶ [0348]-[0349], [0356]-[0357], [0361]-[0363], [0366]; Ex. 2015 ¶ 85. As I mentioned previously, Ishigaki's only discussion of a density of a two-layer electrode structure has an overall density of 2.4 g/cc, whereas comparable example single-layer electrode structures have a density of 2.6 g/cc. *Id.*

75. Indeed, even Dr. Gido admits that all values shown within his Demonstratives "might not be achievable under the teachings of Ishigaki" and that whether or not they could be achieved would require "some experimentation." Ex. 2050, 115:12-19 (when asked if he knows whether every combination of layer 1 density and layer 2 density that he depicted in Demonstrative 7 is achievable, Dr. Gido stated, "I'm not sure. I didn't -- I didn't look into that. This is -- this is just simply a construction based on density ranges taught by Ishigaki.>").

76. Therefore, at least because Ishigaki does not provide explicit density ranges usable for two-layer electrode structures and Ishigaki's only two-layer electrode structure example has a density less than single-layer electrode structure examples, a POSITA would have understood that substantial portions of Ishigaki's density ranges would not be applicable to a two-layer electrode structure. Ex. 2015 ¶ 85-88.

c. Ishigaki's compaction density ranges maintain space to hold electrolyte in a single-layer electrode structure

77. Moreover, the theoretical average densities provided by Dr. Gido also fail to consider that the compaction density values provided in Ishigaki for a single-layer electrode (e.g., in at least Ishigaki's Paragraph [0025]) are only described as being sufficient to leave adequate space "to hold the electrolyte," in the single-layer electrode. Ex. 1004 ¶ [0025]; Ex. 2015 ¶¶ 83-84. That is, the density values relied on by Dr. Gido are only described as being suitable for the specific particle size distribution, active material densities, and additive concentration in a single layer. Ishigaki provides no indication that such densities would also be applicable to the overall density of a two-layer electrode structures, and neither Petitioner nor Dr. Gido explains that Ishigaki's disclosed compaction density values for single-layer electrode structures would have provided adequate space for a two-layer electrode structure to "hold the electrolyte," as Ishigaki requires. Ex. 1004 ¶ [0025]; Ex. 2015 ¶ 84.

78. Therefore, at least inasmuch as Ishigaki teaches that two-layer electrode structures should be provided with lower densities as compared with single-layer electrode structures—and with a density well below 3.2 g/cc—a POSITA would have understood that the upper limit of Ishigaki's density range are not applicable to a two-layer electrode structure. Ex. 2015 ¶ 89.

3. Claims 2-9, 11-18, and 20 are not unpatentable

79. Claims 2-9, 11-18, and 20 are not unpatentable for the same reasons as discussed above with respect to independent claims 1, 10, and 19.

a. Claims 5 and 14

80. Moreover, Ishigaki does not disclose claims 5 and 14. As discussed above with respect to the independent claims, Ishigaki does not disclose a range of density values for a two-layer electrode structure. *See Supra* Section VII.A.2. As Dr. Gido acknowledges, the density ranges described in paragraphs [0025] and [0151] of Ishigaki, on which Dr. Gido relied, are relevant to a single-layer electrode structure or the first layer only of a two-layer electrode structure. Ex. 2050, 107:2-4 (when asked if paragraph [0025] of Ishigaki discusses multiple layers, Dr. Gido stated, “It is talking about a layer.”); Ex. 2050, 107:5-108:3 (when asked if paragraph 151 of Ishigaki discusses a single layer, Dr. Gido stated “Yes. And well in reading this, when I read it and also a POSA when they would read it, would understand that this is either a single layer or it is the first layer of 2 layers, because further on down they put the second layer on, so either.”). Ishigaki only discloses one compaction density value for a two-layer electrode structure: Ishigaki’s Example 2 has a combined density of 2.4 g/cc. Ex. 1004 ¶ [0366]. Thus, contrary to Dr. Gido’s assertions, Ishigaki does not “lead[] to a range of combinations for the individual densities of layers 1 and 2,” (Ex. 1010 ¶ 121) and by extension, cannot anticipate “a

compaction density of the first layer is greater than 2.8 g/cc, and a compaction density of the second layer is greater than 3.3 g/cc.” as recited in claims 5 and 14.

b. Claims 6, 15, and 20

81. With respect to claims 6, 15, and 20, which recite “wherein the first layer has a lower compaction density than the second layer,” Petitioner and Dr. Gido point to Ishigaki’s discussion of the bulk densities of Ishigaki’s active materials that can be subsequently mixed into electrode layers. Pet., 23; Ex. 1010 ¶ 124; Ex. 1001, Claims 6, 15, and 20. However, the bulk density of an active material is merely a manner of comparing characteristics of different electrode active material powders and the ease with which they might be compacted – but it does not inform how much a complete electrode is ultimately compacted, specifically the compaction density. Ex. 2048.

82. Petitioner and Dr. Gido also rely on additional Demonstratives (Demonstratives 11 and 12) created by Dr. Gido to suggest that Ishigaki’s disclosed compaction density ranges would anticipate these dependent claims. Pet., 24; Ex. 1010 ¶ 126. However, like Demonstratives 7 and 8, these Demonstratives show compaction densities that are not disclosed by Ishigaki (e.g., compaction densities above 4.2 g/cc) and that Dr. Gido admits would require “some experimentation” to determine whether or not they are even achievable. Ex. 2050, 115:12-19 (when

asked if he knows whether every combination of layer 1 density and layer 2 density that he depicted in Demonstrative 7 is achievable, Dr. Gido stated, “I’m not sure. I didn’t -- I didn’t look into that. This is -- this is just simply a construction based on density ranges taught by Ishigaki.”). A POSITA would recognize that Dr. Gido’s mathematical calculations do not demonstrate that Ishigaki discloses an embodiment in which the Layer 1 electrode density is lower than the Layer 2 electrode density, and Dr. Gido does not explain whether such a combination would be physically possible based on Ishigaki’s disclosure. Pet., 23-24; Ex. 1010 ¶¶ 124-126. Accordingly, Petitioner has not demonstrated that claims 6, 15, and 20 are anticipated by Ishigaki.

B. Ground 2: Ishigaki and Kim do not render obvious claims 1-20.

83. It is my understanding that, for purposes of the Institution Decision, the Board determined that “Petitioner has met its burden of demonstrating a reasonable likelihood of prevailing at trial in showing that the challenged claims are obvious over Ishigaki and Kim.” Paper 11, 51, 54.

84. As previously explained in Paragraphs 91-140 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Gido fail to show that claims 1-20 of the ’118 Patent are obvious over Ishigaki and Kim, and I incorporate those paragraphs by reference herein. Ex. 2015 ¶¶ 91-140.

85. It is my understanding that Petitioner and Dr. Guido rely on the disclosure of Ishigaki for all elements of independent claims 1, 10, and 19, except for elements [1.5], [10.5], and [19.5], which recite, wherein a total compaction density of the first layer and the second layer is greater than 3.2 g/cc, for which Petitioner and Dr. Guido rely on the disclosure of Kim. Ex. 1010 ¶¶ 216-220; Ex. 2015 ¶ 92.

86. Dr. Guido asserts that Kim “discloses an average particle size (Dv50) from 5 – 50 µm,” and “a cathode layer density of 3.31 g/cc or greater, and preferably of 3.4 to 4.0 g/cc.” Ex. 1010 ¶ 65 (citing Ex. 1009 ¶ 36). Dr. Guido also asserts that “Kim explains that compaction densities below 3.31 g/cc ‘may be too small to obtain a high electrical capacity.’” *Id.*; *see also* ¶¶ 218-219; Ex. 2015 ¶ 93. Dr. Guido further asserts that a POSITA would “already be motivated to choose densities at the higher end of the range disclosed in Ishigaki, and would thus look to the density range disclosed in Kim to improve the battery’s electrical capacity within his practicing the teachings of Ishigaki.” Ex. 1010 ¶ 214; Ex. 2015 ¶ 94. I disagree.

1. Kim does not disclose or teach multi-layer electrodes

87. Kim does not disclose a two-layer structure at all, much less a two-layer structure having a *total* compaction density of greater than 3.2 g/cc. Ex. 2015 ¶ 107.

88. As acknowledged by Dr. Gido, and as explained in my original Declaration, Kim *only* discloses a composite cathode active material that is used in a single-layer structure. Ex. 1010 ¶ 65; Ex. 2015 ¶108. Kim states “a *mixture* of at least two cathode active materials with different particle diameters or a cathode active material with 2 or more peaks in particle size distribution may be used to improve filling density of the cathode active material.” Ex. 1009 ¶ [0006]. To that end, Kim describes “a composite cathode active material with high energy density and improved thermal stability,” formed from mixing at least two cathode active materials. *Id.* ¶ [0008]. Kim explains that “the composite cathode active material, a conducting agent, a binder, and a solvent are mixed to prepare the cathode active material composition,” which “may be directly coated on a metallic current collector to prepare a cathode plate.” *Id.* ¶ [0040]. Thus, the densities described in Kim *only* apply to single-layer electrode structures, as Dr. Gido acknowledges. Ex. 1009 ¶ [0006]; Ex. 1010 ¶ 65 (“Kim’s electrode structure is described in terms of a single active material layer.”); Ex. 2015 ¶¶ 108-116. Therefore, even if a POSITA could compare Kim’s press densities to the mixture densities in Ishigaki, which the POSITA could not do, the POSITA would have no motivation to look to Kim to modify the *single* mixture density provided in Ishigaki for a two-layer electrode

structure because Kim does not contain any disclosure related to two-layer electrode structures. Ex. 2015 ¶109.

2. Kim does not teach the density of an electrode layer

89. A POSITA would not be motivated to combine Kim and Ishigaki at least because Kim does not disclose density values of an electrode that a POSITA could compare to Ishigaki. That is, while Ishigaki describes the “mixture density” values of films *including* an electrode active material, conductive materials, and binders, Kim describes “press density” values of an electrode active material alone – *without* conductive materials and binders or other additives. *See e.g.*, Ex. 1004 ¶¶ [0347]-[0348] (Ishigaki describing the mixture density and components of the coating layer in Example 1); Ex. 1009 ¶ [0037] (Kim describing that the term “press density” refers to “an apparent press density when the composite cathode active material powder is pressed at a pressure of 2.5 ton/cm².”); Ex. 2015 ¶ 96. In other words, as Dr. Guido acknowledges, the press density of an active material is not the same as a compaction density of an active material layer. Ex. 2050, 124:20-125:4 (when asked if press density of an active material is a different characteristic than compaction density of an active material layer, Dr. Guido stated that they are related “but they certainly are not the same thing.”). Indeed, Kim’s “press density” values are never used in the context of an actual electrode. *See* Ex. 1009 ¶ [0080] (Kim

merely stating that the electrode plate “was pressed into a sheet form using a roll press.”); *see also* Ex. 2050, 129:1-5 (Dr. Guido acknowledging that Kim “simply says the cathode plate was pressed into a sheet form using a rolled press, that is all it says.”). A POSITA would have understood that Kim’s press density values might have been motivated as an alternative comparison to tap density, a powder property that allows cell designers to estimate the degree active particle shapes and sizes might pack together to allow a desired electrode density. Ex. 2048.¹¹

90. As Dr. Guido acknowledges, the density of a complete electrode depends on the pressure at which it is pressed. Ex. 2050, 128:7-9 (when asked if the density would be different if a different pressure were to be applied, Dr. Guido stated, “It could.”). As Dr. Guido also acknowledges, Kim provides no guidance on (1) what pressure to apply when forming a complete electrode, (2) what porosity to use for a complete electrode, or (3) what target density to achieve in a complete electrode. Ex. 2050, 128:19-129:9 (when asked if paragraphs [0079]-[0081] of Kim, which describe formation of Kim’s complete electrode, tell a POSITA what pressure to

¹¹ Ex. 2048. Yang, S., et al. High Tap Density Spherical $\text{Li}[\text{Ni}_{0.5}\text{Mn}_{0.3}\text{Co}_{0.2}]\text{O}_2$ Cathode Material Synthesized via Continuous Hydroxide Coprecipitation Method for Advanced Lithium-Ion Batteries. *Int. J. Electrochem.*, 9 (2012).

apply, Dr. Gido stated, “It simply says the cathode plate was pressed into a sheet form using a rolled press, that is all it says.”), 129:10-15 (when asked if paragraphs [0079]-[0081] of Kim tell a POSITA what porosity to use for the active material layer, Dr. Gido stated, “Well, it doesn’t. I mean, I just did a search and the word porosity does not appear in Kim.”), 129:16-130:1 (when asked if paragraphs [0079]-[0081] of Kim tell a POSITA what density to use for the overall active material layer of Kim, Dr. Gido stated “Kim talks about density. I mean Kim -- Kim has teachings about density at least with respect to this press density”), 130:2-6 (when asked if press density is only measured when pressure is applied to Kim’s composite cathode active material alone, Dr. Gido states “That is what Kim does in, I believe, paragraph 37.”).

91. Even if Kim’s complete cathode (i.e. with pores and binder and carbon additive) were to be pressed with the same pressure at which the press density values of Kim are achieved (2.5 ton/cm²), a POSITA would have understood that the resultant cathode would be unusable in a battery because that high of a compaction pressure would eliminate almost all of the porosity and cause cracking of active material particles, fusion of particles into agglomerates, and indentation of particles

into and deformation of the current collector. Ex. 2049.¹² Even Dr. Guido admits that 2.5 ton/cm² would be a “very, very large” pressure to apply when forming the electrode layer. Ex. 2050, 127:12-128:1 (when asked if 2.5 ton/cm² is the same pressure applied when forming the active material layer, Dr. Guido stated, “I will say that that number sounds, you know, very, very large, but it might not actually be that hard to apply that much pressure with a roller that has got like a small point of contact or a small like of contact. So I’m not sure, I haven’t thought about it.”).

92. In other words, Kim only describes “press densities” of composite active materials *that may be mixed into a complete cathode*.

93. Dr. Guido contends that “Kim discloses a cathode layer density of 3.31 g/cc or greater, and of 3.4 to 4.0 g/cc.” Ex. 1010 ¶ 218 (citing Ex. 1009 ¶ [0036]). But, as the Board acknowledges, this is not what Kim discloses. Paper 11, 53. As explained in my original Declaration, Kim’s “press density” and “volume density” are for its *active materials* only and do not correspond to a “mixture density” or “electrode density” of *Ishigaki’s electrode (which includes a conductive material*

¹² Ex. 2049. Zhang J, Huang H, Sun J. *Investigation on mechanical and microstructural evolution of lithium-ion battery electrode during the calendaring process*. Powder Technology, 2022, 409: 117828.

of between 1 mass% to 15 mass%). Ex. 1004 ¶ [0110]; Ex. 1009 ¶¶ [0036]-[0037].

Ex. 2015 ¶ 99-106. Indeed, Kim states:

In some embodiments, a *press density of the composite cathode active material* may be about 3.31 g/cm³ or greater. In some embodiments, a *press density of the composite cathode active material* may be from about 3.4 g/cm³ to about 4.0 g/cm³. In some embodiments, *volume density of the composite cathode active material* may be too small to obtain a high electrical capacity when the *press density of the composite cathode active material* is less than 3.31 g/cm³. In some embodiments, the *volume density of the composite cathode active material* may exceed a conventional density range, and the composite cathode active material may be broken if the *press density of the composite cathode active material* is greater than 4.0 g/cm³.

In some embodiments, a *press density of the large-diameter active material of the composite cathode active material* may be from about 2.5 g/cm³ to about 4.0 g/cm³, and a *press density of the small-diameter active material* may be from about 1.0 g/cm³ to about 4.0 g/cm³. As used therein, the terms “*press density*” refer to an apparent press density when *the composite cathode active material powder* is pressed at a pressure of 2.5 ton/cm². In some embodiments, *the mixture of the large-diameter active material and small-diameter active material may have a reduced press density* when the press densities of the large-diameter active material and small-diameter active material are smaller than the lower limits of the above-mentioned density ranges. In some

embodiments, high-rate discharge characteristics of the lithium battery may be deteriorated when the *press densities of the large-diameter active material and small-diameter active material* are greater than the upper limits of the above-mentioned density ranges.

Ex. 1009 ¶¶ [0036]-[0037] (emphasis added); Ex. 2015 ¶ 100.

94. A POSITA would therefore interpret “press density” to mean a density measurement made after a compaction process has taken place, and would interpret “of the composite cathode active material” to mean that the press density values do not apply to the entire cathode, but rather to *only* the active material constituent of the cathode (e.g., an active material selected from Formulas 1-10 of Kim). Ex. 1009 ¶¶ [0036]; [0079]; Ex. 2015 ¶¶ 101-102. In contrast to Kim, Ishigaki provides “mixture density” and “electrode density” values of a positive electrode active material layer that includes an active material, a conductive material, a binder, and a solvent that is subsequently removed by drying. Ex. 1004 ¶¶ [0025], [0151], [0349]; Ex. 2015 ¶ 103. Thus, Kim’s press densities are fundamentally different from, and cannot be compared to, Ishigaki’s densities. Ex. 2015 ¶¶ 104-107.

95. Kim’s only discussion of a complete electrode (a cathode) is with respect to Example 6, but neither this discussion nor any other portions of Kim contemplate what the density of Kim’s complete cathode is. *See* Ex. 1009 ¶ [0080] (Kim merely stating that the cathode plate “was pressed into a sheet form using a

roll press.”); *see also* Ex. 2050, 129:1-5 (Dr. Gido acknowledging that Kim “simply says the cathode plate was pressed into a sheet form using a rolled press, that is all it says.”). As explained above, Kim’s “press density” values are merely an alternative comparison to tap density that allows cell designers to estimate maximum density that could be achieved with the active material and are in no way determinative of the compaction density that would be achieved in Kim’s (or any other) complete cathode. Ex. 2048.

96. Further, no portion of Kim suggests electrodes with densities greater than 3.2 g/cc. As Dr. Gido acknowledges, active materials are generally the highest density component of an electrode, and so the compaction density of the active material alone is greater than the compaction density of an electrode layer that includes additives such as binder and/or conductive carbon materials. Ex. 1010 ¶ 85. As Dr. Gido also acknowledges, a POSITA would have understood that working electrodes require a minimum amount of porosity (which reduces the density), whereas Kim’s laboratory comparisons of active material densities are not so limited and are performed under high pressure to minimize total porosity below typical electrode porosity levels, and thereby further increase the compaction density to direct comparisons between material densities. Ex. 2050, 73:9-13 (when asked what the typical porosity in lithium-ion battery would have been at the time of the

invention of the '118 patent, Dr. Gido stated, “It would probably be at least about 20 percent.”).

97. Kim provides no guidance on the porosity or overall density of the active material layer in its cathodes—after the active material has been mixed with additives and coated (in any number of layers) onto a current collector. *See* Ex. 1009 ¶ [0080] (Kim merely stating that the cathode plate “was pressed into a sheet form using a roll press.”); *see also* Ex. 2050, 129:1-5 (Dr. Gido acknowledging that Kim “simply says the cathode plate was pressed into a sheet form using a rolled press, that is all it says.”). A POSITA would therefore have understood that Kim’s disclosure of “the composite cathode active material ha[ving] a press density of about 3.31 g/cm³ or greater” is *only* informative about the active material itself and provides no guidance on, much less suggests meaningful values for, the overall density of the active layer in Kim’s cathodes. Indeed, comparing Kim’s press densities to the densities disclosed in Ishigaki would be incorrectly equating numerically and conceptually distinct scientific quantities. Even Dr. Gido himself acknowledges that the press density of an active material gives no indication of what the compaction density of an active layer, much less a two-layer electrode structure. Ex. 2050, 59:8-19 (when asked about the density of lithium iron phosphate (LFP), Dr. Gido stated, “NCM (sic) 4.8, LFP 3.6 grams per cc.);”), 60:11-61:11 (when

asked if a POSITA would expect the compaction density of an active layer containing lithium iron phosphate, which has a lower density than NMC, to be lower than the density for an active layer containing NMC all else being equal, Dr. Gido stated, “Well, also not necessarily. It depends on the relative sizes of the particles. So for instance, if the LFP particles are small enough that they can fit in between the [NMC] particles -- you know, basically adding a lighter material like a lighter active material or a polymer binder or carbon black or anything like that, will increase the density to the extent that if you add it it also increases sort of the nominal overall dimensions of the layer by the same amount that, you know, you added. But if it goes into, like, nooks and crannies basically and doesn’t increase the overall volume or doesn't completely increase the overall volume by the volume you add then it might not, so you know it depends”). For at least these reasons, the press densities disclosed in Kim cannot be compared to, or used to inform the selection of, mixture densities disclosed in Ishigaki. Ex. 2015 ¶¶ 104-106.

98. Therefore, Ishigaki and Kim fail to render obvious claims 1-20 of the ’118 Patent.

3. Petitioner does not show that a POSITA would have been motivated to combine Ishigaki and Kim

99. A POSITA would not have been motivated to combine Ishigaki with Kim as alleged by Dr. Gido. Ex. 1010 ¶¶ 214, 219.

100. First, as discussed with respect to Ground 1, Ishigaki's examples teach a POSITA to work in the *lower* density ranges provided by Ishigaki. *Supra* Section VII.A.2; Ex. 1004 ¶¶ [0348]-[0349]; [0356]-[0357]; [0361]-[0363]; [0366]; Ex. 2015 ¶ 95. The broadest range of densities disclosed in Ishigaki (which are for single-layer electrode structures) is 2.0 g/cc to 4.2 g/cc. For Ishigaki's only Example (and only disclosure) of a two-layer electrode structure, Ishigaki chose a compaction density of 2.4 g/cc. Ex. 1004 ¶ [0366]. It therefore follows that, with Ishigaki in hand, a POSITA would be motivated to choose densities at the lower end of the range disclosed in Ishigaki because (1) Ishigaki doesn't disclose any density values above 2.4 g/cc for two-layer electrode structures and (2) 2.4 g/cc was apparently sufficient to meet Ishigaki's goals. *Id.* ¶¶ [0382]-[0383]; Ex. 2015 ¶¶ 97-98.

101. Therefore, a POSITA starting with Ishigaki's two-layer electrode structure would have no reason to look to Kim's teachings regarding the density of an active material subsequently used in a *single-layer* cathode structure. *Id.*

102. Second, as explained in my original Declaration, Ishigaki is concerned with preventing short circuits due to recesses and teaches that densities well below 3.2 g/cc are sufficient to meet Ishigaki's objectives. Ex. 1004 ¶¶ [0013], [0014], [0152], [0382]-[0383]; Ex. 2015 ¶ 98. That is, Ishigaki's short circuit test illustrates that Ishigaki achieved its goal of reducing short circuits with fewer recess when the

densities of the electrodes are less than 2.6 g/cc, well below the upper end of Ishigaki's disclosed density ranges. Ex. 1004 ¶¶ [0348]-[0349], [0356]-[0357], [0361]-[0363], [0366], (showing densities of Example 1, Comparative Example 1, Comparative Example 2, and Example 2); and ¶¶ [0382]-[0383] (showing short circuit test results).

103. Example 1, Example 2, Comparative Example 1, and Comparative Example 2 each have a density of 2.6 g/cc or less. Ex. 1004 ¶¶ [0348]-[0349], [0356]-[0357], [0361]-[0363], [0366]. Ishigaki's tests demonstrate that other characteristics are more important for achieving Ishigaki's goals: Examples 1 and 2 each have a depression ratio and an average depth of depressions in the current collector that are lower than that of Comparative Examples 1 and 2, and Examples 1 and 2 passed the short circuit test, while Comparative Examples 1 and 2 failed. Ex. 1004 ¶¶ [0378] (Table 2 showing "Depression ratio of current collecting foil"), [0379] (Table 3 showing "Average depth of depressions in current collecting foil"), [0382] (Table 6 showing short circuit test results for electrode laminate"). Thus, Ishigaki expressly teaches that densities of well below 3.2 g/cc are sufficient to meet Ishigaki's objectives.

104. Kim aims to maximize energy density *of the active material* by using a composite cathode active material formed by mixing two different active materials

into an otherwise homogenous cathode, such that there is only a single layer. Ex. 1009 ¶ [0006]; Ex. 2015 ¶¶ 127-128. Kim does not discuss the compaction density of a complete electrode, much less how compaction densities of an electrode could influence electrode performance.

105. Third, as described in my original Declaration, Kim and Ishigaki are directed to different electrode materials, and the densities provided in Kim are specific to the composite cathode active materials described in Kim. Ex. 2015 ¶¶ 117-121. In other words, the densities provided in Kim relate to materials that were tailored to address the problems of Kim and would not have been applicable to other electrode materials. *Id.* Kim itself teaches that the densities provided for its composite cathode active materials are higher than “conventional cathode active materials,” such as those used in Ishigaki. Ex. 1009 ¶¶ [0036], [0042], Ex. 2015 ¶ 120. According to Kim, its densities are only applicable to Kim’s composite cathode active material and any changes in composition and/or particle diameter relative to Kim’s composite cathode active material will necessarily result in changes to the associated density. *Id.*

106. For at least these reasons, a POSITA would not be motivated to combine Kim with Ishigaki, nor would the POSITA have a reasonable likelihood of success doing so. Ex. 2015 ¶ 128.

4. The '118 Patent's claimed density ranges are critical

107. First, even if one were to assume that Dr. Gido's flawed assumptions regarding the densities of Ishigaki are reasonable and justified, and that Ishigaki discloses a range of compaction density values that fall within or overlap the claimed ranges of independent claims 1, 10, and 19, it is my opinion that the '118 Patent establishes that the claimed density range in independent claims 1, 10, and 19 are critical to providing the advantages that the '118 Patent's invention provides, whereas Ishigaki does not. Ex. 2015 ¶ 129.

108. As explained in my original Declaration, the '118 Patent describes a two-layer electrode structure that improves safety by avoiding internal short circuits of the lithium-ion battery caused by external forces puncturing the battery. Ex. 1001, 1:45-49; Ex. 2015 ¶ 130. The first layer, closest to the current collector, comprises smaller particles to promote adhesion, but it also tends to have lower compaction density, and consequently a lower capacity of the electrode and hence the energy density of the cell. Ex. 1001, 3:50-63; 4:55-67; 5:14-18. Therefore, the '118 Patent teaches the use of a second layer that has larger particles and higher compaction density, leading to higher overall energy storage in the cell. *Id.*, 6:4-12; 6:20-27. The '118 Patent explains that its specific electrode compaction densities, including a compaction density value greater than 3.2 g/cc for all active material layers in the

two-layer electrode structure, is required to ensure the desired energy density of a lithium-ion battery. *Id.*; Ex. 2015 ¶¶ 122, 131.

109. Ishigaki never mentions a compaction density value greater than 3.2 g/cc for a two-layer structure, nor any advantages of a compaction density greater than 3.2 g/cc for the two-layer structure. Dr. Guido never explains that the POSITA would have known of the unexpected benefits discovered by the inventors of the '118 Patent. Ex. 2015 ¶ 132.

110. The densities for the single-layer electrodes structure and the two-layer electrode structure in Ishigaki's examples are in the narrow range of 2.4-2.6 g/cc, where the single-layer electrode structures have densities at the upper limit of that range (e.g., 2.6 g/cc) and the two-layer electrode structure has a density at the lower limit of that range (e.g., 2.4 g/cc). Ex. 1004 ¶¶ [0348]-[0349], [0356]-[0357], [0361]-[0363], [0366]; Ex. 2015 ¶ 133. None of the electrode structures described in Ishigaki have a density greater than 2.6 g/cc and the only example with multiple layers (Example 2) has a density of only 2.4 g/cc, the lowest density among all of the examples in Ishigaki. *Id.* Moreover, the only direct comparison of all four of Ishigaki's electrode structures, which is also Ishigaki's only comparison of a single-layer electrode structure to a two-layer electrode structure, is a short circuit test that showed no distinction in the performance between a single-layer electrode structure

and a two-layer electrode structure. *Id.* ¶ [0382] (Table 6); Ex. 2015 ¶ 134-137. Rather, the short circuit test showed a distinction in performance between the single-layer electrode structures, all of which have the same density. *Id.* Thus, while Ishigaki's experiments do not seek to illustrate how electrode compaction density impacts performance, they inadvertently show that density has no impact on the performance of its electrodes.

111. Instead, Ishigaki explains that its experiments serve to illustrate how the amount of recesses impact the performance of electrodes. Ex. 1004 ¶ [0383]; Ex. 2015 ¶ 138. This is consistent with the focus of Ishigaki: to solve problems that result from recesses in the surface of the current collector. Ex. 1004, Claim 1 (“a total length of the recessed portions of the parallel line is ΔL , and a ratio of the recessed portions per unit length is $\Delta L/L$, where $\Delta L/L$ is 5% or less.”), ¶ [0152] (“by controlling the shape between the mixture and the current collecting foil to have few recesses as specified in the claims of the present application, it is expected the electrode plate of the present invention achieves high safety by generating resistance at the interface between the mixture layer and the current collecting foil.”).

112. Second, like Ishigaki, Kim never mentions advantages of *electrode* compaction densities above 3.2 g/cc provide. Ex. 2015 ¶¶ 123-124. To the extent that Kim teaches “volume density of the *composite* cathode active material may be

too small to obtain a high electrical capacity when the press density of the *composite* cathode active material is less than 3.31 g/cm³”, a POSITA would have understood that (1) this press density range is only applicable to the particular *composite* cathode active material described in Kim, and (2) this press density range is *only* informative about the active material itself and does not suggest any meaningful values for the overall density of electrodes. *See Supra* Section VII.B.2.

113. The '118 Patent is directed to a completely different problem than Ishigaki (avoiding direct contact between the negative electrode active material layer and the positive electrode current collector due to puncturing) and Kim (increasing electrical capacity using a composite cathode active material) and the claimed density ranges in the '118 Patent are critical to solving the '118 Patent's problem. Ex. 1001, 3:21-30; Ex. 2015 ¶ 139. Because Ishigaki's and Kim's disclosures are directed to completely different problems from each other and the '118 Patent, Ishigaki and Kim—alone or in combination—would not lead a POSITA to the '118 Patent's critical range of density values for a two-layer electrode structure and certainly does not address the criticality of doing so. *Id.*

114. Thus, it is my opinion that Ishigaki and Kim fail to render obvious at least a two-layer electrode with a compaction density of greater than 3.2 g/cc. Ex. 2015 ¶ 140.

5. Claims 2-9, 11-18, and 20 are not unpatentable

115. Claims 2-9, 11-18, and 20 are not unpatentable for the same reasons as discussed above with respect to independent claims 1, 10, and 19.

a. Claims 5 and 14

116. As discussed above, Kim does not discuss a two layer electrode structure, nor does Kim discuss an electrode compaction density at all. *See Supra* Section VII.B.1. A POSITA would not interpret Kim's cathode active material press densities as being informative of compaction densities achievable or desirable in a complete electrode. Accordingly, a POSITA reviewing Kim and Ishigaki would not have determined that Kim suggests "a compaction density of the first layer is greater than 2.8 g/cc, and a compaction density of the second layer is greater than 3.3 g/cc." as recited in claims 5 and 14.

117. Moreover, as discussed above, the recited "compaction density of the all [*sic*] active material layers is greater than 3.2 g/cc" and the recited "compaction density of the first active material layer is greater than 2.8 g/cc, [and] the compaction density of the second active material layer is greater than 3.3 g/cc," are critical to solving the problems discussed in the '118 Patent. Ex. 1001, 3:21-30, 6:20-27. More specifically, the aim of the '118 Patent is to "ensure the energy density of a lithium-ion battery," while avoiding "the short circuit of the positive current collector-negative electrode active material layer." *Id.* The '118 Patent explains that the two-

layer electrode structure improves safety by avoiding the internal short circuits and these density values are critical to ensuring appropriate energy density, since “the positive electrode active material of the first active material layer has a small particle size, the compaction density thereof will be relatively low.” *Id.*, 6:4-27. Neither Petitioner nor Dr. Gido explains that a POSITA would have known of the unexpected benefits discussed in the ’118 Patent for a two-layer electrode structure satisfying claims 5 and 14 based on Ishigaki or Kim. Therefore, Ishigaki and Kim fail to render obvious the claimed ranges in dependent claims 5 and 14.

b. Claims 6, 15, and 20

118. It is my understanding that Petitioner and Dr. Gido rely entirely on the disclosure of Ishigaki as allegedly teaching these the limitations of these claims. For at least the reasons discussed in reference to Ground 1, Ishigaki and Kim, do not suggest “wherein the first layer has a lower compaction density than the second layer.”

C. Ground 3: Wang and Saka do not render obvious claims 1-20

119. As previously explained in Paragraphs 141-165 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Gido fail to show that claims 1-20 of the ’118 Patent are obvious over Wang and Saka, and I incorporate those paragraphs by reference herein. Ex. 2015 ¶¶ 141-165.

120. It is my understanding that, Petitioner asserts and Dr. Guido opines that Wang and Saka render obvious claims 1-20 of the '118 Patent. Pet., 35-59; Ex. 1010 ¶¶ 250-401. I disagree. Wang discusses cathodes defining a gradient of particle sizes and/or porosity values. Ex. 2015 ¶ 141. Neither Wang nor Saka provides any indication that a POSITA would look to Saka's compaction density values for implementing with Wang's disclosure, instead of simply optimizing the porosity values discussed in Wang—a characteristic that may be determined from compaction density. *Id.*

1. Petitioner fails to show why a POSITA would have a “desired density in mind” when combining Wang and Saka

121. As explained in my original Declaration, Wang discloses a gradient, multi-layer cathode with different target porosity levels in each layer. Ex. 1005, *Abstract*; Ex. 2015 ¶ 142. Wang focuses on implementing specific porosity targets in each layer (Ex. 1005 ¶ [0056]) and a POSITA would not need to have a “desired density in mind,” because the density values would be redundant characteristics of the cathode. *Id.* In other words, Wang's porosity targets are sufficient to identify cathode densities, and so a POSITA would not need a density “in mind” when implementing Wang. Ex. 2050, 68:2-8 (Dr. Guido acknowledging that (1) porosity impacts density, (2) density and porosity have an approximate inverse relationship, and (3) that higher porosity leads to lower density and vice versa). Any density that

a POSITA would have in mind when implementing Wang would already be defined by Wang's porosity targets, active material selection, particle size selection, binder selection, conductor selection, and other characteristics of the specific cathode materials described in Wang. Wang recognizes this, stating that in certain embodiments "at least one of the first porous layer 210 and the second porous layer 220 is exposed to a compression process such as a calendaring process to increase the density of and decrease the porosity of the first porous layer 210 and/or the second porous layer 220." Ex. 1005 ¶ [0058]. This compression process enables Wang to achieve the described porosity targets to provide a gradient cathode structure.

122. Paragraphs [0067] and [0073] of Wang describe the compression process used to reach those porosity targets, stating:

In block 330, the first porous layer [similar to first porous layer 210] may be exposed to an optional compression process. After the particles are deposited over the conductive substrate, *the particles may be compressed using compression techniques, for example, a calendaring process, to achieve a desired net density of compacted particles* while planarizing the surface of the layer. In certain embodiments, it is desirable to perform a calendaring process after deposition of the first porous layer in order to increase the net density of the first porous layer.

...

In block 350, the second porous layer [similar to second porous layer 220] may be exposed to an optional compression process. After the particles are deposited over the conductive substrate, *the particles may be compressed using compression techniques, for example, a calendaring process, to achieve a desired net density of compacted particles* while planarizing the surface of the layer. In certain embodiments, it is desirable to perform a calendaring process after deposition of the second porous layer in order to increase the net density of the second porous layer relative to the first porous layer. In certain embodiments, a drying process similar to the process of block 330 is performed.

Ex. 1005 ¶¶ [0067], [0073];¹³ *see also* Ex. 1005 ¶¶ [0060] (“In block 320, a first porous layer similar to first porous layer 210 having a first porosity is deposited over the conductive substrate.”), [0069] (“In block 340, a second porous layer similar to second porous layer 220 having a second porosity is deposited over the first porous layer 210.”).

123. It is my understanding that the Board held that “Wang’s paragraph [0067] directly invites those of ordinary skill in the art to select a compaction density

¹³ These quotes in Wang refer to “calendaring”, which is a misspelling of the term “calendering”.

that best suits their needs.” Paper 11, 72. However, a POSITA need not look beyond the explicit disclosure of Wang for identifying a compaction density.

a. A POSITA would not look beyond Wang for a “desired density”

124. As Dr. Guido acknowledges, the density of an electrode layer is a function of its porosity and the properties of the materials being used, both of which are provided in Wang’s disclosure. *See e.g.*, Ex. 1005 ¶¶ [0050]-[0058]; *see also* Ex. 2050, 135:3-8 (when asked if the density is a function of the physical properties of the materials that are being used and the porosity, Dr. Guido stated “Well, [density] is a function of the properties of the materials being used and the porosity, yes.”); Ex. 1010 ¶ 89 (Dr. Guido stating, “Lower densities than [a theoretical maximum], such as 2.0 g/cm³ to 4.2 g/cm³ range taught by Ishigaki, are due to the presence of porosity, which adds empty space into the layers.”). Thus, a POSITA need not seek additional guidance on how to select “a desired net density” because such a density will be inherent to whatever porosity is selected by the POSITA from the target values outlined by Wang. *Id.* Even Dr. Guido himself admits that density is merely an alternative to porosity. Ex. 2050, 139:22-140:8 (when asked why a POSITA implementing Wang would need to know a density, Dr. Guido stated “Well, I mean, they would *want* to know the density, you know, if nothing else, that may be an

easier property to measure than porosity ... it may be more convenient to work with density rather than porosity.”).

125. While paragraphs [0067] and [0073] of Wang describe the compression process as “optional” to “achieve a desired net density,” Wang is careful to provide guidance on such a “desired net density,” by imposing constraints on the porosity of the resultant layers. Ex. 1005 ¶¶ [0067], [0073], [0077]-[0079]. For example, Wang explains that “where the first porous layer 410 has greater density than the second porous layers 420a, 420b the first porous layer may be exposed to an optional compression process similar to the compression process described in block 330,” so that “the second porous layers 420a, 420b [has] a porosity between about 40% and about 50% as compared to a solid film formed from the same material and the first porous layer 410 has a porosity between about 30% and about 35% as compared to a solid film formed from the same material.” Ex. 1005 ¶ [0079].

126. Indeed, Wang explains that the disclosed “compression steps” are necessary to achieve a cathode structure that satisfies certain target porosity values for each cathode layer (and so that the porosity of the cathode layers does not remain identical and a gradient can be achieved, to achieve thicker cathodes with increased capacity for active materials). *Id.* ¶¶ [0058], [0067], [0073], [0077]-[0079], [0092]; Ex. 2015 ¶¶ 143-146. As explained above, the density is mathematically related to

the porosity and so a POSITA can use the desired porosity to determine the desired density and vice versa. Dr. Gido himself demonstrates this, explaining that the desired density range in Ishigaki is due to the “presence of porosity.” Ex. 1010 ¶ 89. That is, for Ishigaki, the level of porosity need not be separately determined because it is inherent to the provided densities. Similarly, for Wang, the density need not be separately determined because it is inherent to the provided porosities.

127. As explained in my original Declaration, Wang expressly discloses preferred porosity targets, and by extension, the densities inherent thereto. Ex. 2015 ¶¶ 145-148; Ex. 1005 ¶¶ [0035]-[0036]. Wang teaches that, when the layer adjacent to the current collector is provided with a higher porosity (lower density) to achieve higher power performance, layers further way from the current collector are provided with a lower porosity (higher density) to increase the voltage of the cathode. Ex. 1005 ¶¶ [0035], [0036], [0129], [0130]; Ex. 2015 ¶¶ 146-147. Wang also teaches that, for thick cathodes, providing the porosity gradient is superior to having uniform porosity. Ex. 1005 ¶¶ [0129]-[0130]. Ex. 2015 ¶ 147. Consistent with my own scientific work, Wang further teaches that higher porosity (and by extension, lower density) should be employed closer to the separator rather than the current collector in order to maximize ionic transport where it is most needed and thereby allow thicker and higher-energy cathodes. Ex. 1005 ¶ [0130]; Ex. 2029 and

references therein; Ex. 2015 ¶ 148. Thus, Wang provides reasoning for its disparate porosity targets, including explicit reasoning for selecting high porosity values (and consequently, low density values) where there are clear engineering purposes to do so, such as near the separator.

128. At least because Wang provides explicit reasoning for selecting high porosity values (and consequently, low density values), Dr. Guido's suggestion that "common sense dictates choosing the highest compaction density that is workable for a given application" (Ex. 1010 ¶ 281) is unsupported and is inconsistent with Wang's actual teachings. Ex. 2015 ¶ 149.

129. Additionally, as explained in my original Declaration, Dr. Guido's suggestion that "a POSA knows that the reason for achieving [Wang's] 'desired net density' is to increase the energy density of the cathode and therefore to increase the energy density, and the capacity, of the lithium-ion battery" (Ex. 1010 ¶ 255) is not consistent with the actual knowledge of a POSITA, nor is it consistent with Wang's disclosure. Ex. 2015 ¶ 150. Indeed, as Dr. Guido acknowledges, and as is well-established in the battery field, the optimum porosity (and therefore density) for an electrode (a cathode or an anode) necessarily depends on the particular application for the electrode. *See* Exs. 2029 and 2017; *see also* Ex. 2050, 58:1-14 (when asked if it is always desirable to increase compaction density, Dr. Guido stated, "Not

necessarily. I mean it depends again on what you're trying to achieve.”), 58:20-22 (when asked if a lower compaction density would increase rate performance, Dr. Gido stated “Potentially, yes.”), 59:1-3 (when asked if a higher density conversely would decrease rate performance, Dr. Gido stated “Potentially, yes.”), 142:19-143:9 (when asked what the optimum porosity for an active material layer comprising LCO is, Dr. Gido stated “it depends on what you are trying to optimize ... So I think the optimum [porosity] depends on what you are trying to do.”); 151:6-17 (when asked if it is always desirable to increase compaction density, Dr. Gido stated “You don’t want to [increase compaction density] willy-nilly. You need to -- you want to work at higher compaction densities within other constraints that are important to you in designing the battery, right. So you -- you certainly need this porosity. And depending on what your goals are, you want -- may want more porosity or less porosity.”).

130. Moreover, if a POSITA was specifically looking to implement high density values disclosed in other references, particularly in the absence of any indication why high density values are more desirable than other density values, the POSITA would be deterred from implementing Wang, which expressly teaches to increase porosity in a graded cathode structure. *See e.g.*, Ex. 1005 ¶ [0036]; *see also* Ex. 2015 ¶¶ 152-155.

131. Even if a POSITA were to look beyond Wang for a desired density, which the POSITA would not do, Saka's disclosure expressly teaches away from using a compaction density of greater than 3.2 g/cc. All of Saka's disclosed example batteries have density values of 3.0 g/cc or less. Ex. 1006, FIG. 7 (Table 1). Beyond these examples, Saka provides no guidance that would have suggested to a POSITA to pursue density values greater than 3.0 g/cc – near the upper end of a mixture density range between 2.5 g/cc to 3.5 g/cc for its positive electrode (i.e., cathode) mixture layer. Saka teaches away from using compaction densities in the upper end of this range, as the Board acknowledges, "Saka teaches that battery performance decreases at compaction densities greater than 3.0 g/cm³." Paper 11, 73 ("Patent Owner's point that Saka teaches that battery performance decreases at compaction densities greater than 3.0 g/cm³ is well taken."). As pointed out above, in Section VII.B.4, the claimed compaction density range of greater than 3.2 g/cc for a two-layer electrode structure is critical and provide unexpected results to ensure the desired energy density of a lithium-ion battery. *Supra* Section VII.B.4; Ex. 1001, 1:45-49; Ex. 2015 ¶¶ 129-130.

132. Moreover, Saka teaches that superior battery performance was achieved with a cathode compaction density of 2.8 g/cc, and that its measured battery performance decreased when density values reached 3.0 g/cc. Ex. 1006 ¶ [0179]; Ex.

2015 ¶¶ 161-162. Saka attributes this decrease in performance of example high-density batteries (having density values of 3.0 g/cc) to the collapse of pores during pressing, which resulted in the pore size of the cathode mixture layer being small. *Id.* Therefore, at best, Saka teaches using a density no greater than 2.8 g/cc when implementing a cathode with a desired pore size, and a POSITA reading Saka would have expected even more pore collapse and smaller pore sizes (and worse performance) with density values higher than 3.0 g/cc. *Id.*

b. Compaction densities of greater than 3.2 g/cc as claimed are critical

133. As explained above with respect to Ground 2, the '118 Patent establishes that the claimed density range in independent claims 1, 10, and 19 are critical to providing the advantages that the '118 Patent's invention provides. *Supra* Section VII.B.4; Ex. 1001, 1:45-49; Ex. 2015 ¶¶ 129-130. Neither Wang nor Saka provides any reason to specifically select compaction density values greater than 3.0 g/cc, much less 3.2 g/cc as claimed.

134. First, as described above, Wang's lengthy discussion of its "compression steps" does not suggest that higher density/lower porosity would be desirable and nothing in Wang would have led a POSITA to a density that is greater than 3.2 g/cc. *See e.g.*, Ex. 1005 ¶¶ [0058], [0067], [0073], [0077]-[0079], [0092].

Instead, Wang's disclosure suggests that higher porosity/lower density values are desirable for increased rate performance. *See e.g.*, Ex. 1005 ¶ [0036].

135. Second, in contrast to the '118 Patent, and as acknowledged by the Board, Saka teaches that the onset of decreasing performance occurs when the density reaches 3.0 g/cc. Ex. 1006 ¶ [0179], Figure 11 (Table 5); Ex. 2015 ¶ 162; Paper 11, 73 ("Patent Owner's point that Saka teaches that battery performance decreases at compaction densities greater than 3.0 g/cm³ is well taken."). For at least this reason, Saka cannot be said to teach a POSITA to reach the claimed density range of greater than 3.2 g/cc.

136. Although Saka generally mentions that compaction densities of "2.5 g/cm³ to 3.5 g/cm³" are achievable for its cathode mixture layer (Ex. 1006 ¶ [0051]), a POSITA reading Saka would have been dissuaded from using densities equal to or greater than 3.0 g/cm³ (3.0 g/cc) at least because Saka's examples show that such densities result in poor battery performance. Ex. 1006 ¶ [0179], Figure 11 (Table 5, compare capacity retention and amount of gas produced during overcharge of battery A15, which has a density of 3.0 g/cc, to batteries A10-A14, all of which have a density of 2.8 g/cc).

137. Saka is primarily concerned with improving battery performance by increasing the amount of gas produced during overcharge so that current interrupt

devices are more effectively triggered to stop overcharging. Ex. 1006 ¶¶ [0008], [0009], ¶ [0011]. Saka explains why higher densities result in decreased performance, as these higher densities cause “the amount of gas produced during overcharge decreases.” *Id.* Saka states:

when the mixture density increases, the area of pores in the layer decreases, and the amount of an electrolytic solution which can be stored in the positive electrode mixture layer decreases. As a result, a contact ratio between the positive electrode active material and the gas producing agent contained in the electrolytic solution decreases, and the amount of gas produced during over-charge decreases. Further, there is a possibility in that the internal pressure cannot be efficiently increased due to a decrease in the area of a discharge path for the produced gas.

Ex. 1006 ¶ [0008] (emphasis added). In other words, Saka teaches that higher mixture densities lead to worse performance due to (1) less electrolyte solution being stored in the cathode mixture layer, (2) less gas being produced during over-charge, and (3) lower internal pressure that does not effectively trigger current interrupt devices in those cells.

138. This decrease in performance at higher densities is reflected by Saka’s examples. Specifically, Saka’s examples show that mixture densities above 2.8 g/cc, resulted in poor performance. Ex. 1006 ¶¶ [0179]-[0180]. For example, Saka states:

As shown in Table 5 of FIG. 11, the BET specific surface area of LFP (e) in which a decrease in output in a low SOC was verified is $6.8 \text{ m}^2/\text{g}$. *When the BET specific surface area of LFP was in a range of $8.6 \text{ m}^2/\text{g}$ to $13.2 \text{ m}^2/\text{g}$ [and the mixture density was 2.8 g/cm^3], a balance between the output in a low SOC; and the amount of gas produced during overcharge and charging-discharging cycle characteristics was superior. However, it was found that, when the BET specific surface area of LFP is $14.6 \text{ m}^2/\text{g}$ [and the mixture density was 3.0 g/cm^3], the amount of gas produced decreases (battery A15).* The reason is not clear at the moment, but is presumed to be as follows: when the BET specific surface area of LFP is excessively large, the pore size of the powder increases, the pores are likely to be collapsed during the pressing of the positive electrode mixture layer, and the pore size of the positive electrode mixture layer is small.

It can be said from the above results that the BET specific surface area of LFP is preferably $8.6 \text{ m}^2/\text{g}$ to $13.2 \text{ m}^2/\text{g}$, more preferably $8.6 \text{ m}^2/\text{g}$ to $11.6 \text{ m}^2/\text{g}$ and still more preferably $8.6 \text{ m}^2/\text{g}$ to $9.5 \text{ m}^2/\text{g}$.

Id. (emphasis added). Consequently, a POSITA with Saka in hand would be deterred from using compaction densities equal to or greater than 3.0 g/cc .

139. Therefore, neither Wang nor Saka provides any reason to specifically select compaction density values greater than 3.2 g/cc , as claimed, and a POSITA reviewing these references would not seek to select any density values greater than 3.0 g/cc – the highest density value of Saka's examples.

2. Petitioner fails to show that a POSITA Would have combined Wang with Saka

140. Neither Petitioner nor Dr. Gido have explained why Saka's density range is relevant to Wang's disclosed porosity values. Ex. 2015 ¶ 157; *see also* Ex. 1010 ¶ 276 (Dr. Gido merely stating that Wang "teaches the method one would use to achieve any such density").

a. Wang and Saka focus on different cathode compositions

141. A POSITA would have recognized that the differences between Wang and Saka's respective cathode compositions would necessitate differences in compaction density between these structures, such that a POSITA would not cherry-pick Saka's density ranges for use with Wang's cathode structure. Ex. 2015 ¶ 157

142. As discussed above, and as acknowledged by Dr. Gido, Wang discloses a combination of characteristics, including a range of suitable porosities, that would be sufficient for a POSITA to construct Wang's cathode layer for a lithium ion battery. Ex. 1005 ¶¶ [0051], [0056]-[0057]; Ex. 2015 ¶ 158; Ex. 2050, 146:12-149:22 (when asked if a POSITA could manufacture a working battery using Wang's disclosure, Dr. Gido stated "I think that Wang does have teaching in it on how to make a battery"). A POSITA would not need to separately consider a compaction density, as the porosity value ranges in Wang dictate the possible density values achievable using Wang's cathode manufacturing method. *See Supra* VII.C.1.

Petitioner and Dr. Gido ignore these inherent compaction density limitations imposed by Wang's disclosure and instead look at Saka for a "desired" density. Ex. 1010 ¶ 276; Ex. 2015 ¶ 159. However, Saka discloses a different cathode structure with different active materials, different particle size distributions, and different additives. Ex. 1006 ¶¶ [0051], [0073], [0079]; Ex. 1005 ¶ [0051], [0056]-[0075], [0081]-[0083]; Ex. 2015 ¶¶ 158-160. A POSITA would have understood that density values used for a particular electrode structure/composition may not even be achievable in other electrode structures/compositions. *Id.* That is, the highest density value disclosed in Saka (3.5 g/cc) may not be desirable (or even achievable) in Wang's cathodes, which target a high porosity. *Id.* As Dr. Gido acknowledged, a density selected for an electrode (a cathode or an anode) must consider the desired porosity, and so to the extent a POSITA would have sought to optimize a compaction density based on Wang's disclosure, a POSITA would have looked at Wang's disclosure alone. Neither Petitioner nor Dr. Gido provides any discussion to demonstrate that Saka's density values would have been compatible with Wang's porosity values. *Id.*; Ex. 2050 151:6-17 (when asked if it is always desirable to increase compaction density, Dr. Gido stated "You don't want to [increase compaction density] willy-nilly. You need to -- you want to work at higher compaction densities within other constraints that are important to you in designing

the battery, right. So you -- you certainly need this porosity. And depending on what your goals are, you want -- may want more porosity or less porosity.”).

b. Common sense alone would not lead a POSITA to higher compaction densities based on Wang and Saka

143. Dr. Gido attempts to show that Saka suggests that high electrode density values—values within the claimed range of greater than 3.2 g/cc—would have been desirable for any lithium-ion battery. Ex. 1010 ¶ 281 (“common sense dictates choosing the highest compaction density that is workable for a given application”); Ex. 2015 ¶ 161. But Dr. Gido’s rationale is based on *a different reference*—Kim—saying “densities less than 3.31 g/cc ‘may be too small to obtain a high electrical capacity.’” Ex. 1010 ¶ 281 (*citing* Ex. 1009 ¶ [0036]). As explained in my original Declaration, Kim’s disclosure is entirely irrelevant as it provides a density of a cathode active material (and *not* a complete cathode) and because it relates to a single-layer, composite cathode structure comprising a mixture of different cathode active materials, whereas Wang discusses a multi-layer cathode structure with defined porosity targets and Saka discusses multi-layer cathode structures with compaction densities of 3.0 g/cc or less. Ex. 2015 ¶ 161 (citing Ex. 1006, FIGS. 7, 8, 10, 11). Any reference to Kim is therefore irrelevant. Ex. 1006, FIGS. 7, 8, 10, 11 (corresponding to Tables 1, 2, 4, and 5, respectively, which show the mixture density value for each of Saka’s examples); Ex. 2015 ¶¶ 161-164.

144. As explained in my original Declaration, a POSITA would have understood that compaction densities (and porosities) of electrode materials are not based solely on the densities of the contained components (e.g., active materials and/or additives), but also depend on other characteristics of the mixture, such as possible interactions between the various materials in an electrode (e.g., between the multiple active materials discussed in Saka), how the various particles “fit” into the interstices of one another (i.e., how a smaller particle fills the space between adjacent larger particles), and whether the resulting mixture leaves sufficient space for lithium ion movement during charging and discharging processes. Ex. 2015 ¶ 164. In short, a POSITA would have understood that workable density values are specific to the materials used in a particular electrode and cannot be substituted based on the teachings of entirely different electrode structures. Ex. 2015 ¶ 165. Saka and Wang disclose fundamentally different compositions (e.g., Saka’s disclosure of mixtures of different active materials in each cathode layer, whereas Wang discloses layers each containing only one type of active material) and Dr. Guido does not discuss how or why a POSITA would have specifically looked at the density values of Saka to modify Wang. *Id.*

145. More generally, a POSITA would have understood that selections of a particular electrode density value are based on desired applications of the resulting

electrode, and so “common sense” would not drive a POSITA to seek out higher density values. Ex. 2050, 15:8-20 (when asked what is the minimum amount of porosity required in an active layer, Dr. Guido stated, “I’m not sure. I would -- certainly -- certain aspects of the battery like the rate performance will be better if you have higher porosity. So as you reduce the porosity, certain characteristics like that degrade. So there is some lower value, but you know, these are tradeoffs.”; 58:1-14 (when asked if it is always desirable to increase compaction density, Dr. Guido stated, “Not necessarily. I mean it depends again on what you’re trying to achieve. You know typically people may be trying to achieve certain characteristics to do with safety or rate performance or something like this which, you know, may have other imperatives, I suppose, on the density.”), 151:6-17 (when asked if it is always desirable to increase compaction density, Dr. Guido stated “You don’t want to [increase compaction density] willy-nilly. You need to -- you want to work at higher compaction densities within other constraints that are important to you in designing the battery, right. So you -- you certainly need this porosity. And depending on what your goals are, you want -- may want more porosity or less porosity.”) As examples, higher density values may provide lower safety or lower rate performance, and so a POSITA would have considered the intended application of an electrode when selecting a density value. *See id.*, 58:20-59:3 (when asked if a lower compaction

density would increase rate performance, Dr. Gido stated “Potentially, yes.”); *see also id.*, 64:14-17 (when asked if lower porosity might result in slower rate performance, Dr. Gido stated, “Potentially, yes.”),

146. Saka and Wang disclose fundamentally different active material compositions because they focus on providing solutions to different and unrelated problems. Wang is focused on providing graded cathode structures that overcome limitations associated with “both the utilization and mechanical properties of the materials currently used [as active materials in battery electrodes] so that manufacturers can produce thicker electrodes,” which would “significantly reduce the production costs for battery cells.” Ex. 1005 ¶¶ [0007]-[0010]. Wang thus focuses on higher porosity values to increase performance of thicker cathodes. In contrast to Wang, Saka focuses on increasing the area of pores in a cathode mixture layer so that “a large amount of gas is produced during overcharge such that the CID [current interrupt device] can be rapidly operated.” Ex. 1006 ¶¶ [0007], [0008], [0011]. Neither of these references discuss benefits specifically for increasing electrode density.

147. For at least these reasons, a POSITA would have no motivation to combine Wang with Saka and would have no reasonable expectation of success in doing so.

3. Claims 2-9, 11-18, and 20 are not unpatentable

148. Claims 2-9, 11-18, and 20 are not unpatentable for the same reasons as discussed above with respect to independent claims 1, 10, and 19.

a. Claims 5 and 14

149. Petitioner and Dr. Gido admit that “Wang may not explicitly teach the numeric values of the compaction densities for the two layers.” Pet., 49; Ex. 1010 ¶ 276. Instead, Petitioner and Dr. Gido point to Saka as allegedly teaching this feature. *Id.* However, Petitioner and Dr. Gido only rely on Saka’s examples as allegedly teaching a first layer compaction density greater than 2.8 g/cc. Pet., 51-52; Ex. 1010 ¶¶ 291-316. But those examples disclose total compaction densities of 3.0 g/cc or less. Ex. 1006, FIGS. 7, 8, 10, 11 (corresponding to Tables 1, 2, 4, and 5, respectively, which show the mixture density value for each of Saka’s examples is 3.0 g/cc or less). Nothing in Saka suggests that those examples could be modified to increase the overall density of the combined layers without substantial modifications thereof. Neither Petitioner nor Dr. Gido explains what those modifications would be, nor how those modifications could be implemented.

150. As discussed in reference to Ground 2, the density values recited in dependent claims 5 and 14 are critical and provide unexpected benefits for the performance of a two-layer electrode. *See supra*, at VII.B.5.a. Accordingly, Wang and Saka fail to render obvious the claimed ranges in dependent claims 5 and 14.

D. Ground 4: Wang and Li do not render obvious claims 1-20

151. It is my understanding that, for purposes of the Institution Decision, the Board held that “Petitioner has met its burden of demonstrating a reasonable likelihood of prevailing at trial in showing that the challenged claims are obvious over Wang and Li, for the same reasons we explained with respect to Ground 3.” Paper 11, 81.

152. As previously explained in Paragraphs 166-182 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Gido fail to show that claims 1-20 of the ’118 Patent are obvious over Wang and Li, and I incorporate those paragraphs by reference herein. Ex. 2015 ¶¶ 166-182.

153. It is my understanding that in Ground 4, Petitioner asserts and Dr. Gido opines that Wang and Li render obvious claims 1-20 of the ’118 Patent. Pet., 59-70; Ex. 1010 ¶¶ 402-528. I disagree for at least the following reasons.

1. Petitioner fails to show why a POSITA would have had a “desired density in mind” greater than 3.2 g/cc when combining Wang and Li

154. Petitioner argues that a POSITA would have had a “desired density in mind” (Ex. 1010 ¶ 428) that is greater than 3.2 g/cc when implementing Wang. But this argument is unsupported by the disclosure of Wang or the knowledge of a POSITA. Ex. 2015 ¶ 167.

155. As described above with respect to Ground 3, Wang focuses on implementing specific porosity targets in each layer (Ex. 1005 ¶ [0056]), and a POSITA would not need to have a “desired density in mind,” because the density values would be redundant characteristics of the cathode. Ex. 2015 ¶ 168. That is, the density of Wang’s cathode layer directly depends on its porosity, and a POSITA need not seek additional guidance on how to select “a desired net density” because such a density will be inherent to whatever porosity is selected by the POSITA from the target values outlined by Wang. *Id.*; *see also* Ex. 1010 ¶ 89 (Dr. Gido stating, “Lower densities than [a theoretical maximum], such as 2.0 g/cm³ to 4.2 g/cm³ range taught by Ishigaki, are due to the presence of porosity, which adds empty space into the layers.”). Indeed, the composite electrode density is proportional to volume fraction of solids, which in turn is the complement of porosity (i.e. they sum to one), such that a POSITA may relate porosity and the material composition of the electrode to a corresponding density. Dr. Gido himself demonstrates this, explaining that the desired density range in Ishigaki is due to the “presence of porosity.” Ex. 1010 ¶ 89. In Ishigaki, the level of porosity need not be separately determined because it is inherent to the provided densities. Similarly, in Wang, the density need not be separately determined because it is inherent to the provided porosities.

156. Wang recognizes this, stating that in certain embodiments “at least one of the first porous layer 210 and the second porous layer 220 is exposed to a compression process such as a calendaring process to increase the density of and decrease the porosity of the first porous layer 210 and/or the second porous layer 220.” Ex. 1005 ¶ [0058];¹⁴ Ex. 2015 ¶ 168. Wang provides lengthy descriptions of these “compression steps,” which are described so that the resulting cathode structure satisfies the target porosity values for each cathode layer. *Id.* ¶¶ [0058], [0067], [0073], [0077]-[0079], [0092]; Ex. 2015 ¶¶ 169-170.

157. Since Wang focuses on achieving porosity targets by using compression steps, Wang does not explicitly provide the net density values corresponding to those porosity targets. Ex. 2015 ¶ 171; *see also* Ex. 1010 ¶ 407. However, as explained in my original Declaration, Dr. Gido misconstrues Wang’s disclosure when stating that Wang “does not explicitly provide the reason a particular net density is more desirable than another.” Ex. 1010 ¶ 428; Ex. 2015 ¶ 171.

¹⁴ This quote in Wang refers to “calendaring”, which is a misspelling of the term “calendering.”

158. Wang provides clear reasoning for its porosity targets, and by extension, the densities inherent thereto. Ex. 1005 ¶¶ [0035]-[0036]; Ex. 2015 ¶ 171. For example, Wang is clear that a higher porosity (and by extension, a lower density) is desirable near a cathode current collector, and a lower porosity (i.e., higher density) is desirable farther away from the current collector. Ex. 1005 ¶ [0036]; Ex. 2015 ¶ 171.

159. At least because Wang provides explicit reasoning for selecting high porosity values (and consequently, low density values), Dr. Guido's suggestion that "common sense dictates choosing the highest compaction density that is workable for a given application" (Ex. 1010 ¶ 399) is unsupported and is inconsistent with Wang's actual teachings. Ex. 2015 ¶ 172.

160. Moreover, Dr. Guido's suggestion that "a POSA knows that the reason for achieving [Wang's] 'desired net density' is to increase the energy density of the cathode and therefore to increase the energy density, and the capacity, of the lithium-ion battery" (Ex. 1010 ¶ 407) is not consistent with the actual knowledge of a POSITA. As explained in my original Declaration, a POSITA would have understood that there are many reasons for choosing different compaction density values, including reasons why a lower density might be desirable. Ex. 2015 ¶ 173. Indeed, as acknowledged by Dr. Guido, and as is well-established in the battery field,

the optimum porosity (and therefore density) for an electrode (e.g., a cathode or an anode) necessarily depends on the particular application for the electrode. *See* Exs. 2029 and 2017; *see also* Ex. 2050, 15:8-20 (when asked what is the minimum amount of porosity required in an active layer, Dr. Gido stated, “I’m not sure. I would -- certainly -- certain aspects of the battery like the rate performance will be better if you have higher porosity. So as you reduce the porosity, certain characteristics like that degrade. So there is some lower value, but you know, these are tradeoffs.”); 58:1-14 (when asked if it is always desirable to increase compaction density, Dr. Gido stated, “Not necessarily. I mean it depends again on what you’re trying to achieve. You know typically people may be trying to achieve certain characteristics to do with safety or rate performance or something like this which, you know, may have other imperatives, I suppose, on the density.”); 151:6-17 (when asked if it is always desirable to increase compaction density, Dr. Gido stated “You don’t want to [increase compaction density] willy-nilly. You need to -- you want to work at higher compaction densities within other constraints that are important to you in designing the battery, right. So you -- you certainly need this porosity. And depending on what your goals are, you want -- may want more porosity or less porosity.”). As examples, higher density values may provide lower safety or lower rate performance, and so a POSITA would have considered the intended application

of an electrode when selecting a density value. *See id.*, 58:20-59:3 (when asked if a lower compaction density would increase rate performance, Dr. Gido stated “Potentially, yes.”), 64:14-17 (when asked if lower porosity might result in slower rate performance, Dr. Gido stated, “Potentially, yes.”).

161. Finally, even if a POSITA reviewing Wang had a “desired density in mind,” that density would be driven by Wang’s porosity values, active material selection, particle size selection, binder selection, conductor selection, and other characteristics of the specific cathode materials described in Wang and the POSITA would not have been driven to select a density for Wang’s cathodes using Dr. Gido’s inaccurate suggestion that the POSITA “would be motivated to look to another reference, *such as Li*, for numerical values of a desired cathode density.” Ex. 1010 ¶¶ 407-408; Ex. 2015 ¶ 174.

2. Petitioner fails to show that a POSITA would have combined Wang and Li

162. As explained in my original Declaration, Petitioner and Dr. Gido’s suggestion to modify Wang to use a density value disclosed in Li, which discusses different electrode compositions, is not supported by the disclosure of the cited references. Ex. 1010 ¶ 406; Pet., 60; Ex. 2015 ¶¶ 175-176.

a. Wang and Li describe cathodes with incompatible structures

163. Li's focus is on something entirely unrelated to compaction density—or the overall composition of an electrode. Ex. 2015 ¶ 180. Instead, as described above, Li's disclosure is focused on improving battery performance by optimizing the electrode geometry, and more specifically by optimizing the placement of thin areas in an electrode using “gap coating”. Ex. 1003 ¶ [0038]; Ex. 2015 ¶ 180. Li does not comprehensively describe *any* example electrode compositions in sufficient detail to allow a POSITA to fully replicate the examples. *Id.* That is, Li's examples only provide sufficient detail for a POSITA to replicate the described geometry of the example electrodes. *Id.* In fact, Li teaches that the composition of its electrodes is not important and teaches that the same composition is applied for every coating step. *Id.* ¶¶ [0026] (“There are no special requirements for the positive electrode active material.”); [0044] (describing that the same electrode slurry was coated in each coating layer). Therefore, Li's example compaction densities would not be applicable to Wang's gradient cathode structure that has different compositions and porosity targets for each layer.

164. Instead of distinguishing between the densities of multiple layers, Li merely describes that an electrode composition is coated and compacted to a density of 3.8 g/cc and then the same material is “gap coated” onto the first coating and

compacted such that the overall density is 4.1 g/cc. Petitioner and Dr. Gido acknowledge that Li is unclear as to whether the first electrode material application is compacted further or not (Pet., 65-66; Ex. 1010 ¶ 444), but given that the first application remains exposed in the “gaps” of the second application, a POSITA would assume that a calender roller or any other tool used during a second compaction step would apply a further compaction pressure to the first application, causing the first application to be compacted to a density similar to the density of the second application (potentially creating a homogenous, single layer structure) to achieve Li’s average compaction density of 4.1 g/cc. A POSITA would have understood this to mean that Li seeks an at least substantially uniform electrode construction throughout its entire geometry (in terms of both composition and compaction), with the electrode laminate only decreasing in thickness at precise locations along the length of the electrode, so that it can be bent around tight corners without unduly pinching or stretching the material, which would otherwise tend to deform and thus alter electrode thickness, density, or both. In effect, Li is correcting for the curvature of the electrode laminate so that it behaves *more* uniformly, not less.).

165. A POSITA would have understood that maintaining a consistent active material composition across the entire structure as discussed in Li is necessary so

that the resulting electrode does not have different discharge characteristics or utilization at different points along its length, which depends on density or thickness. Ex. 2057.¹⁵ A POSITA would not have interpreted Li's examples as providing relevant density values for two-layer electrode structures having different electrode compositions in each layer (as described in Wang), not least because such a structure would result in some areas of Li's electrode that do *not* have the gradient structure (i.e., the areas where only a single layer is applied).

166. In stark contrast to Li's attention to the problem of bending a uniform electrode around tight corners, Wang is focused on gradient cathode structures perpendicular to the film and expressly teaches that individual layers should have different porosities, and therefore different densities. Ex. 1005 ¶ [0010] ("The graded cathode structure comprises a conductive substrate, a first porous layer comprising a first cathodically active material having a first porosity formed on the conductive substrate, and a second porous layer comprising a second cathodically

¹⁵ Ex. 2057. H. Zheng, J. Li, X. Song, G. Liu, V. S. Battaglia, "A comprehensive understanding of electrode thickness effects on the electrochemical performances of Li-ion battery cathodes," *Electrochimica Acta* 71 (2012) 258– 265.
<http://dx.doi.org/10.1016/j.electacta.2012.03.161>

active material having a second porosity formed on the first porous layer. In certain embodiments, the first porosity is *greater* than the second porosity. In certain embodiments, the first porosity is *less* than the second porosity.”); [0055] (“In one embodiment, the first cathodically active material 212 and the second cathodically active material 222 are different materials selected to *vary the properties of each layer.*”); [0058] (“it should be understood that any number of layers comprising different materials, particle sizes, and/or density may be used to form the porous cathode structure described herein”); [0130] (“The plot [1210] demonstrates a 12% improvement in specific energy for a 200 micron thick electrode having graded porosity ($\epsilon = \epsilon_{ave} \pm 0.3 \epsilon_{ave}$) in comparison with a 200 micron electrode having uniform porosity ($\epsilon = \epsilon_{ave}$).”). Thus, whereas Li desires the same structure throughout the entire electrode so that the gap coated regions have similar discharge characteristics as the twice-coated regions, Wang explicitly seeks a different structure in each layer to provide the described gradient cathode structure. *Id.*

167. Nothing in Li or Wang suggests that different electrode characteristics at different locations along the length of an electrode would have been desirable and nothing in Li suggests any benefits related to the disclosed 4.1 g/cc density upon compaction of the completed electrode. For at least these reasons, a POSITA reviewing Li in light of Wang would have determined that Li’s gap coating method

would not be applicable for electrodes such as Wang’s cathode, which have an intentional gradient between the separator and current collector.

b. Petitioner fails to show that Li’s compaction density values are compatible with Wang

168. Dr. Guido asserts that Li “provides the specific numeric densities that result from the compaction steps of a process like Wang’s.” Ex. 1010 ¶ 428; Ex. 2015 ¶ 180. However, Li’s examples—including the portions cited by Dr. Guido—provide compaction density values but they do not provide other electrode characteristics, including target porosity values, particle size distributions, electrode thicknesses, etc., that a POSITA would need to consider in order to determine whether such densities are even achievable in other electrodes, such as Wang’s cathode. Ex. 1003 ¶¶ [0038], [0044]; Ex. 2015 ¶ 180. Consequently, a POSITA would not have been able to replicate Li’s examples based on the provided disclosure, nor could a POSITA determine whether Li’s density values are usable with Wang’s disclosure, as Dr. Guido argues. Ex. 2015 ¶ 180. Moreover, Dr. Guido acknowledges that electrode characteristics that impact compaction density are not disclosed by Li. Ex. 2050, 31:18-32:6 (when asked if the compaction characteristics of an active material layer depend more on the active materials or on the polymer binder, Dr. Guido stated “certainly the particle size and particle size distributions depends on [the density] or influences [the density] as does the binder. How much

of the binder is in there, what are the viscoelastic properties of the binder and so forth.”), 67:10-15 (when asked if the density of a cathode impacts how thick it can be, Dr. Guido stated, “Yeah, to a certain degree. If is too thick and it is too dense you have problems getting the electrolyte and lithium-ions in and out of it.”), 68:2-8 (when asked if porosity impacts density, Dr. Guido stated, “it does” and agreed then that “[h]igher porosity leads to lower density and vice versa”), 69:12-17 (when asked if the shapes or sizes of particles impact density, Dr. Guido stated, “They can. I mean, that is -- that is one factor. It is not solely determining, but it certainly influences how the particles can and do pack.”), 69:18-70:8 (when asked if you achieve a certain compaction density with one set of particles that have specific sizes and specific shapes are you certain to be able to get the same compaction density using different particles with different sizes and different shapes, Dr. Guido stated, “I mean, again -- well, these are tradeoffs. Certainly if the particles pack differently, you know, you may need to adjust something else to compensate for that to achieve similar densities, right. So you might have to compact more or use more binder, less binder, you know. These are all different design choices.”). This is particularly true when implemented in a two-layer structure in which each individual layer has different structural characteristics and will compact differently; 166:17-21 (when asked if there anything in Li that confirms that Li’s active materials have the same

particle sizes as Wang's active materials, Dr. Guido stated "I think we just discussed that Li does not say anything about particle sizes."); 166:22-167:5 (when asked if there is anything in Li that tells you what its porosities are in Li's active material layer, Dr. Guido stated "Not that I recall, although let me do a quick search. It doesn't appear -- it doesn't appear that [Li] does.").

169. Wang's disclosure provides sufficient information to manufacture a working battery. It therefore follows that a POSITA would not be motivated to look to Li (or any other reference) for a numerical density value for Wang's cathodes, especially if the POSITA does not know whether such a numerical density value satisfies Wang's porosity constraints.

170. To the extent that Li discloses that "the coating density was 4.1 g/cm^3 for the positive electrode," a POSITA would have understood that this coating density is achieved using particular weight percentages of LiCoO_2 , acetylene black, and PVDF, as well as "an appropriate amount of nitrogen-methylpyrrolidone" in both application of Li's electrode composition and, despite Dr. Guido acknowledging that the composition and porosity of a coating impacts the density, neither Petitioner nor Dr. Guido have addressed whether the target porosities provided in Wang would be achievable with those components in those particular weight percentages. Ex. 1003 ¶ [0044]; Ex. 2050 74:22-75:8 (when asked, if you have two different cathodes

that use the same active material, the same additives, and the same polymers, but they use different ratios of those materials, would those cathodes have different densities, Dr. Gido stated, “Well, they could unless you adjusted something else, for instance, the porosity.”). Indeed, a POSITA would have understood that Li’s compaction density ranges are not immediately combinable with Wang’s gradient cathode structure. Ex. 2015 ¶¶ 180-181.

171. Moreover, Li’s disclosure is insufficient to show any benefits of a density that is greater than 3.2 g/cc. That is, Li does not discuss how the electrode composition would impact cell performance at all; Li only focuses on the geometry created by the disclosed gap coating method. Ex. 2015 ¶ 181. Indeed, Petitioner and Dr. Gido do not base their opinions that a POSITA would have been motivated to combine these two references based on any teachings contained within the references themselves. *Id.* Instead, Dr. Gido generalizes—again without support in the cited references—that a POSITA would seek to incorporate the higher density values disclosed in Li when implementing Wang. *Id.*

172. Finally, to the extent that Li’s examples suggest high density, a POSITA would recognize that the density value achieved in Li’s examples applies only to the (undisclosed) particle size distribution of Li’s example. In other words, a POSITA would have understood that the density of 4.1 g/cc is within the working

density range for the exact, undisclosed configuration of Li's example. Ex. 1003 ¶ [0044]. To the extent a POSITA reviews this teaching in light of Wang, a POSITA is faced with (a) the Li reference that doesn't teach specific particle size ranges and (b) the Wang reference that teaches porosity but doesn't teach density values (and suggests lower density is better). Simply because Li teaches one example high density value does not mean that a POSITA would think that value is achievable within the confines of Wang's teachings of a gradient porosity. Ex. 2015 ¶¶ 177-179. Petitioner has not shown that this density value is achievable with Wang's porosity targets, and if it is not achievable, such a modification would change the principle of operation of Wang's cathode structure. Beyond stating that the active material could be the same, Petitioner has not and cannot point to any disclosure (particle size distribution or otherwise) in these references suggesting the aims of both references are achievable.

173. Therefore, in my opinion, a POSITA would not have been motivated to combine Wang and Li.

c. Compaction densities of greater than 3.2 g/cc as claimed are critical

174. As explained above with respect to Grounds 2 and 3, the '118 Patent establishes that the claimed density range in independent claims 1, 10, and 19 are critical to providing the advantages that the '118 Patent's invention provides. *Supra*

Sections VII.B.4, VII.C.2; Ex. 2015 ¶ 129. Neither Wang nor Li provides any reason to specifically select compaction density values greater than 3.2 g/cc as claimed.

175. First, as described above, Wang’s lengthy discussion of its “compression steps” does not suggest that higher density/lower porosity would be desirable and nothing in Wang would have led a POSITA to a density that is greater than 3.2 g/cc. *See e.g.*, Ex. 1005 ¶¶ [0058], [0067], [0073], [0077]-[0079], [0092]. Instead, Wang’s disclosure suggests that higher porosity/lower density values are desirable for increased rate performance *See e.g.*, Ex. 1005 ¶ [0036].

176. Second, Li’s disclosure is focused on improving battery performance by optimizing the electrode geometry, and more specifically by optimizing the placement of thin areas in an electrode using “gap coating”. Ex. 1003 ¶ [0038]; Ex. 2015 ¶¶ 180-181. While Li discloses a single compaction density value (4.1 g/cc) for its electrode structure, Li provides no discussion on how that density impacted the performance of the electrode structure, much less benefits associated with that density. Ex. 1003 ¶ [0044]. Indeed, Li is unconcerned with compaction density and teaches applying the same electrode composition twice to form the electrode geometry described therein (with thick and thin regions along its length). *Id.* ¶¶ [0026] (“There are no special requirements for the positive electrode active

material.”); [0044] (describing that the same electrode slurry was coated in each coating).

177. Therefore, at least because neither Wang nor Li provides any reason, much less benefit, to specifically select compaction density values in the claimed range of greater than 3.2 g/cc, Wang and Li fail to render obvious at least a two-layer electrode with a compaction density of greater than 3.2 g/cc.

3. Claims 2-9, 11-18, and 20 are not unpatentable

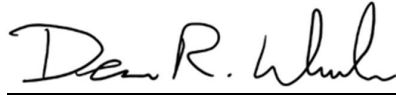
178. Claims 2-9, 11-18, and 20 are not unpatentable for the same reasons as discussed above with respect to independent claims 1, 10, and 19. I reserve the right to address claims 2-9, 11-18, and 20 individually if this proceeding is instituted.

VIII. CONCLUSION

179. In sum, it is my opinion that Grounds 1-4 of the Petition do not render claims 1-20 of the '118 Patent unpatentable as anticipated or obvious for the reasons I discuss above.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on the 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 Section 1001 of Title 18 of the United States Code.

Executed on January 27, 2026.

A handwritten signature in black ink, appearing to read "Dean R. Wheeler", is written over a horizontal line.

Dean R. Wheeler