

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner

v.

NINGDE AMPEREX TECHNOLOGY LTD.,
Patent Owner

Case: IPR2025-00431
U.S. Patent No. 11,799,131

SUPPLEMENTAL DECLARATION OF DEAN R. WHEELER, Ph.D., IN

SUPPORT OF PATENT OWNER'S RESPONSE

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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. 11,799,131 (the “’131 Patent”).

3. I understand that Zhuhai CosMX Battery Co., Ltd. (“Petitioner”) filed a petition for *Inter Partes* Review (“IPR”) of the ’131 Patent (“Petition”).

4. I understand that, on August 19, 2025, the Board issued a decision granting institution based on the grounds set forth in the Petition (“Institution Decision”). Paper 15. In particular, I understand that the Board instituted post grant review of claims 1-7 and 14-17 (“Challenged Claims”) on the grounds presented in the Petition as separately numbered by the Board (“Grounds”), as shown below. I understand that the Board’s Order did not institute review of claim 12. Paper 15 at 78.

Petitioner's Ground	Ground as separately numbered by Board¹	Claims	References
1A	1	1, 2, 4-7, 12, 14, 15, 17	Chinese Patent Application Publication No. 106099187A (“Zeng” or “Ex. 1006”) and Japanese Patent Application Publication No. 2009-252349 (“Sunose” or “Ex. 1010”)
1B	2	1, 2, 4-7, 12, 14, 15, 17	Zeng, Sunose, and U.S. Patent Application Publication No. 2013/0224535A1 (“Matsuoka” or “Ex. 1007”)
1C	3	1, 2, 4-7, 12, 14, 15, 17	Zeng, Sunose, and U.S. Patent Application Publication No. 2017/0288268A1 (“Kim” or “Ex. 1008”)
1C	4	1, 2, 4-7, 12, 14, 15, 17	Zeng, Sunose, Matsuoka, and Kim
2A	5	3, 16	Zeng, Sunose, and Chinese Patent No. 108023117 (“Su” or “Ex. 1012”)
2B	6	3, 16	Zeng, Sunose, Matsuoka, and Su
2C	7	3, 16	Zeng, Sunose, Su, and Kim
2C	8	3, 16	Zeng, Matsuoka, Sunose, Su, and Kim

¹ It is my understanding that the Board “separately number[ed] each of Petitioner’s grounds and alternative grounds rather than group them with Petitioner’s alphanumeric designations for the base reference combinations and additional references.” Paper 15, 8.

3A	9	1, 2, 4-7, 12, 14, 15, 17	Chinese Patent Application Publication No. 105552439A ("Zhou" or "Ex. 1014") and Sunose
3C	10	1, 2, 4-7, 12, 14, 15, 17	Zhou, Sunose, and Kim
4A	11	3, 16	Zhou, Sunose, and Su
4C	12	3, 16	Zhou, Sunose, Su, and Kim

5. I previously submitted a Declaration in this proceeding in support of Patent Owner's Preliminary Response to the Petition (Ex. 2015). 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 1-7, 12, and 14-17 of the '131 Patent are 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 (Ex. 2015) as Ex. 2016. I also previously summarized my qualifications and professional

experience in Paragraphs 7-13 of my original Declaration, and I incorporate those paragraphs by reference.^{2,3,4,5,6,7,8}

² 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)). I certify that the copy of the paper in Exhibit 2028 is to the best of my knowledge a true, accurate, and authentic copy of *Interplay of Electrode Heterogeneity and Lithium Plating*, and accurately represents the copies of the paper published by the Journal of The Electrochemical Society, which a POSITA would have known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

³ See, e.g., Ex. 2029 (Fei Sun and Dean R. Wheeler, *The Effects of Lithium Ions and pH on the Function of Polyacrylic Acid Binder for Silicon Anodes*, 170 J. Electrochem. Soc. 080502 (2023)). I certify that the copy of the paper in Exhibit 2029 is to the best of my knowledge a true, accurate, and authentic copy of *The Effects of Lithium Ions and pH on the Function of Polyacrylic Acid Binder for Silicon Anodes*, and accurately represents the copies of the paper published on August 9, 2023 by the Journal of The Electrochemical Society, which a POSITA would have

known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

⁴ See, e.g., 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)). I certify that the copy of the paper in Exhibit 2030 is to the best of my knowledge a true, accurate, and authentic copy of *The Effects of Cycling on Ionic and Electronic Conductivities of Li-ion Battery Electrodes*, and accurately represents the copies of the paper published on February 24, 2021 by the Journal of Power Sources, which a POSITA would have known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

⁵ See, e.g., 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)). I certify that the copy of the paper in Exhibit 2031 is to the best of my knowledge a true, accurate, and authentic copy of

Electrode-Level Modeling of Silicon Anodes for Improved Cell Design, and accurately represents the copies of the paper published on December 30, 2024 by the Journal of The Electrochemical Society, which a POSITA would have known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

⁶ See Ex. 2025 (*2016 Batteries Conference GRC*, <https://www.grc.org/batteries-conference/2016/> (last visited on May 12, 2025)). I certify that the copy of the paper in Exhibit 2025 is to the best of my knowledge a true, accurate, and authentic copy of *2016 Batteries Conference GRC*, and accurately represents the copies of the paper currently available at <https://www.grc.org/batteries-conference/2016/>. I personally attended, and was the chair of, the 2016 Batteries Conference, which took place from February 21, 2016 to February 26, 2016.

⁷ See Ex. 2026 (*Hubs – Department of Energy*, <https://www.energy.gov/hubs> (last visited on May 12, 2025)). I certify that the copy of the web page in Exhibit 2026 is to the best of my knowledge a true, accurate, and authentic copy of *Hubs – Department of Energy*, and accurately represents the web page currently available at <https://www.energy.gov/hubs>.

B. Materials Considered

10. The opinions contained in this Supplemental 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. Lucht (Ex. 2050), and any additional exhibits or other material cited in my original Declaration (Ex. 2015) and this Supplemental Declaration.

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.

⁸ See Ex. 2027 (*DOE Energy Innovation Hubs*, <https://science.osti.gov/bes/Research/DOE-Energy-Innovation-Hubs> (last visited on May 12, 2025)). I certify that the copy of the web page in Exhibit 2027 is to the best of my knowledge a true, accurate, and authentic copy of *DOE Energy Innovation Hubs*, and accurately represents the web page currently available at <https://science.osti.gov/bes/Research/DOE-Energy-Innovation-Hubs>.

12. As I discuss below, I disagree with Dr. Lucht's and the Board's conclusions that the subject matter of any of claims 1-7, 12, and 14-17 of the '131 Patent would have been obvious.

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.

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.

IV. TECHNOLOGY OVERVIEW

18. I provided a brief technical overview in Paragraphs 41-53 of my original Declaration (Ex. 2015), and I incorporate those paragraphs by reference herein.

19. I note that the formula contained in Paragraph 51 of my original Declaration contained a typographical error in its presentation and the formula for calculating the electrode compaction density in the '131 Patent is interpreted as:

Electrode Compaction Density

$$= \frac{(Weight\ of\ electrode - Weight\ of\ current\ collector)}{Area\ of\ electrode \times (Thickness\ of\ electrode - Thickness\ of\ current\ collector)}$$

V. LEVEL OF ORDINARY SKILL IN THE ART

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

A person of ordinary skill in the art ("POSITA") of the '131 Patent in September 2018 would have an advanced

degree in chemistry, chemical engineering, materials science, or a related field, and two or more years of experience related to the design, research, evaluation, preparation, and/or manufacture of electrochemical energy storage devices. *See* EX1003, ¶ 17; EX1001, 1:18-20. This level of skill is approximate, and more experience could compensate for less formal or different education, and vice versa.

Pet., p. 16.

21. I further understand, that for purposes of the Institution Decision, the Board adopted “Petitioner’s proposal regarding the level of ordinary skill in the art.” Paper 15, 11. 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 ¶¶ 54-56.

22. Each of the arguments below should be considered from the perspective of a POSITA in the field of the ’131 Patent and during the relevant time frame (e.g., September 2018). During that time frame, I possessed at least the qualifications of a POSITA, as defined above. 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.

VI. CLAIM CONSTRUCTION

23. I understand that although Dr. Lucht submits “no claim terms require express construction for purposes of evaluating the Grounds in [his] Declaration,” Dr. Lucht purports that he “appl[ies] the Patent Owner’s position that both claims 1 and 14 read on the same subject matter,” such “that an electrode having a current collector with both single- and double-sided coating portions satisfie[s] all limitations of claims 1 and 14.” Ex. 1003, ¶ 27.

24. I further understand that in a different declaration in support of a separate *inter partes* review Petition against the ’131 Patent, Dr. Lucht noted “that the electrode structure recited in claims 14-16—that includes first and second electrodes respectively having single- and double-sided coatings—covers the embodiment of Figures 2 and 3 in the ’131 Patent specification.” IPR2025-00722, Ex. 1003, ¶ 60.

25. I further understand, that for purposes of the Institution Decision, the Board determined “that claim construction is not necessary” and “invite[d] the parties to further brief claim construction issues—including alleged inconsistent positions—during trial, if desired.” Paper 15, 12.

VII. THE CHALLENGED CLAIMS OF THE '131 PATENT ARE NOT UNPATENTABLE

26. 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. *See also*, Ex. 2015 ¶ 57.

A. Board Ground 1/Petitioner Ground 1A: Zeng and Sunose Do Not Render Obvious Claims 1, 2, 4-7, 12, 14, 15, and 17⁹

27. It is my understanding, that for purposes of the Institution Decision, the Board held that it was “persuaded that Petitioner has shown sufficiently for purposes of [the Institution] Decision that Zeng and Sunose disclose or suggest all limitations recited in claims 2, 4-7, 12, 15, and 17 as well as independent claims 1 and 14.” Paper 15, 40.

28. As previously explained in Paragraphs 58-159 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Lucht fail to show that

⁹ It is my understanding that the Board “separately number[ed] each of Petitioner’s grounds and alternative grounds rather than group them with Petitioner’s alphanumeric designations for the base reference combinations and additional references.” Paper 15, 8.

Sunose and I incorporate those paragraphs by reference herein.^{10,11,12,13,14,15,16,17,18,19,20}

available at

63974&session=827e7984d036f173f05332b6be45e57a&.

Sheet dated September 2018). I certify that the copy of the paper in Exhibit 2018 is

to the best of my knowledge a true, accurate, and authentic copy of Safety Data Sheet, “Lithium Hexafluorophosphate in EC/EMC 3:7”, which bears a revision date of September 2018. The copy of the paper in Exhibit 2018 accurately represents copies of the paper that are currently available at https://cdn.shopify.com/s/files/1/0638/4664/6008/files/LiPF6_SDS.pdf.

¹² See, e.g., Ex. 2019 (“Lithium hexafluorophosphate solution - in ethylene carbonate and diethyl carbonate, 1.0M LiPF₆ in EC/DEC=50/50 (v/v), battery grade” Sigma-Aldrich Production Specification). I certify that the copy of the paper in Exhibit 2019 is to the best of my knowledge a true, accurate, and authentic copy of Sigma-Aldrich Product Specification, “Lithium hexafluorophosphate solution - in ethylene carbonate and diethyl carbonate, 1.0M LiPF₆ in EC/DEC=50/50 (v/v), battery grade”, and accurately represents the copies of the paper currently available at <https://www.sigmaaldrich.com/specification-sheets/269/114/746746-BULK.pdf>.

¹³ See, e.g., Ex. 2020 (“Lithium hexafluorophosphate solution - in diethyl carbonate, 1.0M LiPF₆ in DEC, battery grade” Sigma-Aldrich Production Specification) I certify that the copy of the paper in Exhibit 2020 is to the best of my knowledge a true, accurate, and authentic copy of Sigma-Aldrich Product Specification, “Lithium

hexafluorophosphate solution - in diethyl carbonate, 1.0M LiPF₆ in DEC, battery grade”, and accurately represents the copies of the paper currently available at <https://www.sigmaaldrich.com/specification-sheets/428/264/746770-BULK.pdf>.

¹⁴ See, e.g., Ex. 2021 (“Lithium hexafluorophosphate solution - in ethylene carbonate and dimethyl carbonate, 1.0M LiPF₆ in EC/DMC=50/50 (v/v), battery grade” Sigma-Aldrich Production Specification). I certify that the copy of the paper in Exhibit 2021 is to the best of my knowledge a true, accurate, and authentic copy of Sigma-Aldrich Product Specification, “Lithium hexafluorophosphate solution - in ethylene carbonate and dimethyl carbonate, 1.0M LiPF₆ in EC/DMC=50/50 (v/v), battery grade”, and accurately represents a previous version of the copies of the paper currently available at <https://www.sigmaaldrich.com/specification-sheets/155/137/746711-BULK.pdf>. The version of the paper that was included as an exhibit to my original declaration, Ex. 2015, denotes a different logo, apparent supplier, and version of the Specification, but is otherwise identical to the version currently available at the aforementioned link.

¹⁵ See, e.g., Ex. 2034 (*Lithium-ion Battery Design: Effects of Optimal Compaction Density*, <https://www.neware.net/news/lithium-ion-battery-design-effects-of->

optimal-compaction-density/230/83.html (last visited on May 23, 2025)). I certify that the copy of the web page in Exhibit 2034 is to the best of my knowledge a true, accurate, and authentic copy of *Lithium-ion Battery Design: Effects of Optimal Compaction Density*, and accurately represents the web page currently available at <https://www.neware.net/news/lithium-ion-battery-design-effects-of-optimal-compaction-density/230/83.html>.

¹⁶ See, e.g., Ex. 2035 (Shu Lu, et al., *Binder-Free LiCoO₂/Carbon Nanotube Cathodes for High-Performance Lithium Ion Batteries*, 24 Adv. Mater. 2294(2012)).

I certify that the copy of the paper in Exhibit 2035 is to the best of my knowledge a true, accurate, and authentic copy of *Binder-Free LiCoO₂/Carbon Nanotube Cathodes for High-Performance Lithium Ion Batteries*, and accurately represents the copies of the paper published on March 26, 2012 by Advanced Materials, which a POSITA would have known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

¹⁷ See, e.g., Ex. 2036 (Lei-Lei Lu, et al., *Wood-Inspired High-Performance Ultrathick Bulk Battery Electrodes*, Adv. Mater. 1706745 (2018)). I certify that the

copy of the paper in Exhibit 2036 is to the best of my knowledge a true, accurate, and authentic copy of *Wood-Inspired High-Performance Ultrathick Bulk Battery Electrodes*, and accurately represents the copies of the paper published on March 30, 2018 by Advanced Materials, which a POSITA would have known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

¹⁸ See, e.g., Ex. 2037 (Yasuhiko Takahashi, et al., *Structure and electron density analysis of electrochemically and chemically delithiated LiCoO₂ single crystals*, 180 J. Solid State Chem. 313 (2007) , <https://doi.org/10.1016/j.jssc.2006.10.018>). I certify that the copy of the paper in Exhibit 2037 is to the best of my knowledge a true, accurate, and authentic copy of *Structure and electron density analysis of electrochemically and chemically delithiated LiCoO₂ single crystals*, and accurately represents the copies of the paper published in the January 2007 issue of the Journal of Solid State Chemistry, which a POSITA would have known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

¹⁹ See, e.g., Ex. 2038 (*Carbon Black*, <https://pubchem.ncbi.nlm.nih.gov/compound/carbon%20black> (last visited on May 23, 2025)). I certify that the copy of the web page in Exhibit 2038 is to the best of my knowledge a true, accurate, and authentic copy of *Carbon Black*, and accurately represents the web page currently available at <https://pubchem.ncbi.nlm.nih.gov/compound/carbon%20black>.

²⁰ See, e.g., Ex. 2039 (Sankar Mandal, et al., *The Role of Carbon Black in LiMn₂O₄-Based Composites as Cathodes for Rechargeable Lithium Batteries*. 148 J. Electrochem. Soc. A24 (2001)). I certify that the copy of the paper in Exhibit 2039 is to the best of my knowledge a true, accurate, and authentic copy of *The Role of Carbon Black in LiMn₂O₄-Based Composites as Cathodes for Rechargeable Lithium Batteries*, and accurately represents the copies of the paper published in the January 2001 issue of the Journal of The Electrochemical Society, which a POSITA would have known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

1. Petitioner Fails to Show that Zeng and Sunose Renders Obvious Independent Claims 1 and 14

a. Zeng

29. Paragraph [0037] of Zeng recites, *inter alia*, “lithium hexafluorophosphate [LiPF₆] of a concentration of 1.0 mol/L is slowly added to the mixed solution.” Ex. 1006 ¶ [0037].

30. As previously set forth in my original Declaration, it is my opinion that “for the addition of lithium hexafluorophosphate, no final concentration of the total electrolyte solution is specified by Zeng, only an addition of the lithium hexafluorophosphate salt solution that has a certain concentration” and “[t]o a POSITA, Zeng’s express teaching that ‘lithium hexafluorophosphate of a concentration of 1.0 mol/L is slowly added to the mixed solution’ necessarily implies the presence of a salt solution, without the need for an explicit reference to the solvents of the solution or the volume of the added LiPF₆ solution.” Ex. 2015 ¶¶ 108, 114.

31. It is my further understanding that the Board held that “[a]t this stage in the proceeding, we do not find that the text in Zeng leads to the assertedly straightforward interpretation proffered by Patent Owner and Dr. Wheeler” and “[t]o the extent Patent Owner raises a potential issue of fact, the issue is better addressed at trial.” Paper 15, 25.

32. It is my understanding that the Board held that “a POSITA in possession of Zeng would more readily understand that LiPF₆ ‘of a concentration of 1.0 mol/L is slowly added to the mixed solution’ means that a measure weight of solid LiPF₆ is added to a specified volume of the identified electrolyte solute to create an electrolyte solution that has a resulting concentration of 1.0 M LiPF₆ dissolved in it.” Paper 15, 28-29. It is my further understanding that the Board held that my “conclusion requires a POSITA to interpret Zeng as failing to provide (1) any information as to an undisclosed solvent in which solid LiPF₆ is to be dissolved to a concentration of 1.0M LiPF₆ before that unspecified combination is added to the electrolyte solvent, or (2) any information as to how much of such LiPF₆ in solution with the undisclosed solvent is to [sic] added to what amount of the electrolyte solvent.” Paper 15, 25-26.

33. The language of Zeng speaks for itself - “lithium hexafluorophosphate [LiPF₆] of a concentration of 1.0 mol/L is slowly added to the mixed solution.” Ex. 1006 ¶ [0037]. Paragraph [0037] of Zeng does NOT read that LiPF₆ is added *up to* a concentration of 1.0 mol/L. The terms “of a concentration” and “mol/L” are indisputably present in the wording which necessarily imply the existence of a solution. A POSITA would interpret Zeng as adding the lithium hexafluorophosphate in the form of a 1.0 mol/L LiPF₆ solution (i.e., a solid solute

dissolved in a liquid solvent to form a liquid solution, such as a premixed “battery grade” 1.0 M LiPF_6 solution).^{21,22} And without additional volume information, Zeng does not provide the POSITA with sufficient information to produce a mass fraction

²¹ Dr. Lucht himself admits that “[m]olarity is moles per liter,” “[m]olarity is a measurement of something being dissolved into a liquid,” “[a] solid salt would not have a molarity,” and that “concentration of 1 mol/L” “is a context used in terms of liquid solutions and liquid electrolytes of lithium batteries.” Ex. 2050 75:8-16, 83:6-20. Dr. Lucht also uses molarity in his own publications when referring to solutions. *See e.g.*, Ex. 2045, Alison L. Michan, et al., *Fluoroethylene Carbonate and Vinylene Carbonate Reduction: Understanding Lithium-ion Battery Electrode Additives and Solid Electrolyte Interphase Formation*, Chemistry of Materials 2016 28 (22), 8149-8159, 8150 (“8.00 mL of 0.273 M FEC in THF was stirred vigorously and 1.00 mL of 0.546M Lithium naphthalenide solution in THF was added drop by drop to the solution at room temperature.”). *See also*, Ex. 2050, 232:14-234:14 (Dr. Lucht testifying that he is an author of Ex. 2045 and that Ex. 2045 is true and accurate copy). Indeed, consistent with Dr. Lucht’s testimony, the very definition of molarity or molar concentration is the number of moles of solute per liter of solution (Ex. 2049, p. 1401), which necessarily requires a mixture of more than one species.

of the lithium salt in the total electrolyte solution. Therefore, a POSITA cannot determine the weight percentage (or mass fraction) of the non-additive constituents (i.e. salt and solvents) in the total electrolyte mixture. Additionally, with respect to Dr. Lucht's recitation of Zeng's "carefully-crafted solvent," while I do not agree that there is sufficient information from which to determine the exact composition of the total electrolyte solution, if there were sufficient information, it is my further opinion that the POSITA would not be motivated to alter the base solvent mixture of Zeng at least in view of the complexities and unpredictability of battery chemistry. Electrolyte components are subject to a complex matrix of requirements and tradeoffs and interactions such that successfully adding or removing components would require extensive experimentation.

34. It is my further understanding that the Board held that my "testimony that 'the applicant and inventors of Zeng knew what language to use to indicate to a POSITA that lithium salt is added, in solid form, to a solvent mixture to obtain a target concentration of the salt in the solvent mixture, but chose not to' is unavailing

²² Ex. 2049 (Academic Press Dictionary of Science and Technology (Christopher Morris ed., 1992)).

because Exhibit 2022 does not support Dr. Wheeler's interpretation of Zeng." Paper 15, 26. I disagree.

35. In my opinion, Ex. 2022 is clear as to what is intended when forming its electrolyte solvents in that particular reference, namely a solid salt is added to a liquid solvent. If the inventors of Zeng had intended to disclose dissolving a solid lithium salt into the liquid solvent mixture, they could have used wording or descriptions similar to Ex. 2022. Instead, the Zeng inventors chose to describe "lithium hexafluorophosphate [LiPF₆] of a concentration of 1.0 mol/L is slowly added to the mixed solution." Ex. 1006 ¶ [0037].

36. To disregard the explicit and unambiguous language of Zeng with respect to this mixing step essentially rewrites Zeng and disregards its disclosure and what it would have meant to a POSITA.

37. Next, it is my understanding that with respect to the disclosure in the '131 Patent that "[t]he present inventors unexpectedly found that by using a mixture of a dinitrile compound, a trinitrile compound and propyl propionate, a firm protective film which is not easily decomposed on the surface of the cathode at a high potential can be formed," the Board held that "[t]he '131 Patent does not state that the *specific weight percentage ratio ranges* unexpectedly were found to provide the benefits [of 'provid[ing] a firm, protective SEI film on the surface of the cathode

that was not easily decomposed].” Paper 15, 39 (emphasis added). I disagree for the reasons set forth below.

38. As set forth in the ’131 Patent:

At a high voltage, the oxidizability of the cathode material is increased, and the stability is lowered, which makes the electrolyte easily decompose on the surface of the positive electrode or results in deterioration of the materials of the electrochemical device, so that the capacity of the electrochemical device is decreased. *Prior to the present application, the primary solution is to add a film-forming additive to the electrolyte. However, doing so will cause an increase in the DC internal resistance of the battery, thereby resulting in a decrease in the cycle performance and a decrease in the capacity retention rate.*

Ex. 1001, 22:24-34 (emphasis added).

39. As further provided by the ’131 Patent:

An embodiment of the present application provides an electrolyte and an electrochemical device containing the electrolyte, wherein the electrolyte comprises a compound comprising two cyano groups (herein also referred to as “a dinitrile compound”), a compound comprising three cyano groups (herein also referred to as “a trinitrile

compound”), and propyl propionate. *The dinitrile compound can form a protective film on the cathode of the electrochemical device, so as to inhibit the decomposition of the solvent in the electrochemical device. However, since the protective film itself is decomposed on the surface of the cathode at a high potential, the effect of inhibiting decomposition of the solvent cannot be sustained for a long time.* The present inventors unexpectedly found that by using a mixture of a dinitrile compound, a trinitrile compound and propyl propionate, a firm protective film which is not easily decomposed on the surface of the cathode at a high potential can be formed. *The electrolyte according to the embodiment of the present application can effectively inhibit the increase in DC internal resistance of the electrochemical device.*

Ex. 1001, 1:43-62 (emphasis added).

40. Although a dinitrile compound can form a protective film on the cathode of the electrochemical device, such protective film itself is decomposed on the surface of the cathode at a high potential and causes an increase in the DC internal resistance of the battery. The mixture of a dinitrile compound, a trinitrile compound, and propyl propionate contributes to the stability of the protective film and the specific weight range ratio of Y/Z being within the claimed range of 0.01-

0.3 is critical to providing a better inhibition effect on the increase in DC internal resistance, which is a requirement of such stability of the composite protective film. *See* Ex. 1001, 28:59-64 (“The ratio of the content of the trinitrile compound to the content of propyl propionate has great effect on the change in DC internal resistance of the battery. ***When Y/Z is within the range of 0.01-0.3, a better inhibition effect on the increase in DC internal resistance is achieved.***”) (emphasis added). Indeed, at least Table 2 of the ’131 patent reflects such better inhibition effects. According to the ’131 Patent, “[d]ifferent amounts of a compound comprising two cyano groups, a compound comprising three cyano groups and/or propyl propionate as shown in Table 2 were added to the base electrolyte. The electrolyte was injected into a battery prepared according to the above method. The DC internal resistant at 20% SOC of the battery was tested. The test results are shown in Table 2” (Ex. 1001 28:22-29):

TABLE 2

	C (Z wt %)	A ₁ (X wt %)	B ₁ (Y wt %)	Y/Z	DC internal resistance (mΩ) at 20% SOC		
					Fresh battery	After 200 cycles	After 400 cycles
S1-1	30	4	1	0.03	50.8	84.3	91.2
S2-1	5	4	1	0.2	68.7	85.2	97.6
S2-2	10	4	1	0.1	60.3	83.1	95.7
S2-3	20	4	1	0.05	56.1	81.6	93.9
S2-4	40	4	1	0.025	47.5	78.2	87.2
S2-5	50	4	1	0.02	56.3	82.6	98.3
S2-6	10	4	3	0.3	64.3	89.5	97.7
S2-7	50	4	0.5	0.01	53.2	84.3	94.1
D2-1	4	4	1	0.25	72.1	108.5	118.9
D2-2	60	4	1	0.017	42.0	100.1	113.9
D2-3	10	4	5	0.5	62.3	85.4	111.3
D2-4	50	4	0.1	0.0025	53.2	89.3	109.4

Ex. 1001, Table 2. As reflected in Table 2, a better inhibition effect with respect to the increase in the DC internal resistance after 400 cycles can be seen in Example S2-2 (95.7 mΩ) compared to Example D2-3 (111.3 mΩ), wherein the Y/Z value of Example S2-2 (0.1) falls in the critically claimed Y/Z range of “about $0.01 \leq (Y/Z) \leq$ about 0.3” and the Y/Z value of Example D2-3 (0.5) does not. Similarly, a better inhibition effect with respect to the increase in the DC internal resistance after 400 cycles can be seen in Example S2-5 (98.3 mΩ) compared to Example D2-4 (109.4 mΩ), wherein the Y/Z value of Example S2-5 (0.02) falls in the critically claimed Y/Z range of “about $0.01 \leq (Y/Z) \leq$ about 0.3” and the Y/Z value of Example D2-4 (0.0025) does not. Accordingly, it is my opinion that the ’131 Patent establishes the

criticality of the specific weight percentage ratio range of “about $0.01 \leq (Y/Z)$ about 0.3” in claims 1 and 14.

b. Zeng and Sunose

41. It is my understanding, that for purposes of the Institution Decision, the Board found Petitioner’s assertion that “a POSITA would have adopted Sunose’s electrode configuration because Zeng’s focus is on the electrolyte composition rather than electrode structure and Sunose’s electrode configuration is advantageous because it maximized electrode area, increasing battery capacity and performance, and rolling the electrode to Sunose’s disclosed compaction density ratios N/M reduces electrode breakage and improves adhesion” and that “[a] POSITA would have had a reasonable expectation of success using Sunose’s electrode configuration in Zeng’s batteries” “to be persuasive and supported by the evidence.” Paper 15, 32-33. I disagree.

42. Dr. Lucht opined that “Zeng focuses on electrolyte compositions and omits configuration details for the electrode assembly. Thus, in [Dr. Lucht’s] opinion, a POSITA reading Zeng would have looked to other references, like Sunose, for electrode assembly implementation details. *The need to use some rolled electrode configuration in Zeng’s batteries would have prompted a POSITA to adopt Sunose’s electrode configuration.*” Ex. 1003 ¶ 123 (emphasis added). Yet,

Dr. Lucht never explains in his Declaration why or where such alleged “need to use some rolled electrode configuration in Zeng’s batteries” arises.²³ *Id.* Indeed, Dr. Lucht advocates a completely different narrative in his declaration in support of the petition in IPR2025-00722, in which the ’131 Patent was also at issue and wherein Dr. Lucht advocates the POSITA would have looked from Zeng to a laminated battery structure for alleged “large battery applications”. IPR2025-00722, Ex. 1003 ¶ 112 (“Zeng does not specify a particular physical embodiment for its batteries” and “it is my opinion that a POSITA would have needed to choose a battery/electrode embodiment to implement Zeng’s electrolyte solutions, and Hirai [a laminated battery structure] provides a suitable solution.”), ¶ 113 (“a POSITA would have looked to Hirai’s laminated battery structure in particular because Zeng identifies large-battery applications for its electrolytes, such as in the ‘...energy storage, power, and military aerospace fields.”). Dr. Lucht purports there is a “need to use some rolled electrode configuration in Zeng’s batteries,” however, also purports that

²³ Indeed, Dr. Lucht relies on the alleged assertion that Zeng “omits configuration details for the electrode assembly” so such purported “need to use some rolled electrode configuration in Zeng’s batteries” cannot arise from Zeng itself. Ex. 1003 ¶ 123.

“Zeng identifies large-battery applications for its electrolytes.” Compare Ex. 1003 ¶ 123 with IPR2025-00722, Ex. 1003 ¶ 113.

43. However, a spiral/wound or “rolled” configuration to which Dr. Lucht refers does not necessarily mean application in a small-battery application and a laminated configuration does not necessarily mean application in a large-battery application. For instance, it is well-known that Tesla manufactures spirally wound cells for its electric vehicles while other manufacturers choose to use laminated cell geometries for the same EV application. There are a multitude of engineering and economic considerations that go into such design decisions.

44. Once again, Petitioner’s and Dr. Lucht’s argument that Zeng omits essential implementation details boils down to the argument that Zeng’s disclosure is fundamentally flawed. The purported “need” for a POSITA to find implementation as alleged by Petitioner is unfounded as Zeng managed to generate results for its electrolyte formulations with commercially accessible cell materials. Ex. 1006 ¶ [0040]. Moreover, ensuring compatibility between electrode and electrolyte designs requires extensive testing and even minor changes to one may result in large changes to the other. *See e.g.*, Ex. 2050, 62:18-64:5 (Dr. Lucht testifying that “typically you would do a whole bunch of testing” and that both small and large changes can result in large differences). Indeed, the surface chemistry and

the design of compatibility of electrodes and electrolyte is so complex, one would not simply combine Zeng and Sunose without a contrived, hindsight-driven motivation. Indeed, the combination of Sunose's electrodes may deteriorate the performance in Zeng.

45. It is my further understanding that the Board held that "[t]o the extent that Sunose's Table 1 may include packing densities that exceed the crystalline density of LCO, it is insufficient to conclude that (1) the packing densities identified for Sunose's Examples 2-4 are not electrode compaction densities and (2) that the ratios (M/N) [sic] for Sunose's identified packing densities for Examples 2-4 are incommensurable with the claimed ratio (D2/D1) [sic]." Paper 15, 36. The Board further noted that "Patent Owner acknowledges that 'some physical origin' underlies Sunose's packing densities and ratios" and held that "[i]f some physical origin underlies Sunose's packing densities for Examples 2-4 and these identified packing density values are not challenged as 'physically impossible,' then it is not readily apparent that the ratios (M/N) [sic] for Sunose's Examples 2-4 are incommensurable

with the claimed ratio (D2/D1) [sic] as Patent Owner asserts.” Paper 15, 36.²⁴ I disagree.

(i) **Physically Impossible Density Values**

46. The physically allowable density for a porous composite solid material is not a matter of opinion or conjecture, rather is one that has a correct answer.

47. As discussed in my original Declaration, the M values (allegedly corresponding to the single-side coated portions) of Embodiments 1 and 2 and Comparative Examples 2 and 3 of Sunose are denoted as 5.7 g/cc, 5.0 g/cc, 6.5 g/cc, and 8.0 g/cc, respectively. Ex. 1010, Table 1, ¶¶ [0031], [0032], [0036], [0037].

48. As further explained in my original Declaration, each of the purported values of at least 5.7 g/cc, 6.5 g/cc, and 8.0 g/cc as electrode compaction density values of the single-sided coated portion of a cathode is *physically impossible* because each value exceeds the true or crystalline density of LiCoO₂ (LCO) active material, which is around 5.1 g/cm³, not to mention that the presence of binder and

²⁴ I note that the claimed ratio set forth in independent Claims 1 and 14 of the ’131 Patent is D1/D2, not “D2/D1” as set forth in the Institution Decision and the alleged ratio set forth in Sunose is N/M, not “M/N” as set forth in the Institution Decisions. Paper 15, 36.

carbon black additive would further lower the upper bound of possible electrode densities of an LCO active material. Ex. 2015 ¶¶ 71, 133. Indeed, as previously explained in my original Declaration, 4.5 g/cm³ is the theoretical maximum compaction density of the active material composite of the embodiments and comparative examples of Sunose. *Id.* ¶¶ 71, 133, 137-143; Exs. 2034-2039. Accordingly, 5.7 g/cc, 5.0 g/cc, 6.5 g/cc, and 8.0 g/cc, corresponding to Embodiments 1 and 2 and Comparative Examples 2 and 3 of Sunose, respectively, each far exceed such theoretical maximum compaction density of the active material composite such that they are *physically impossible* electrode compaction density values. *Id.*

49. Sunose additionally does not disclose if or how the “prescribed densit[ies],” “packing densit[ies],” or “active material densit[ies]” were experimentally measured or somehow calculated. *See e.g.*, Ex. 1010 ¶ [0008] (“when rolling the coated and dried electrodes to a ***prescribed density***...”), ¶ [0010] (“If an attempt is made to set a ***prescribed density*** for the single-sided active material layer portion...”), ¶ [0015] (“When changing the density of the active material, it is difficult to intermittently change the thickness with a rolling machine to achieve a ***prescribed active material density***, because rolling machines press at a fixed size. In a fixed pressure press, when a single-sided portion is ***set to a prescribed density***, the

density of the two-sided coated portion becomes excessive, making it difficult *to achieve the prescribed density* for both the single-sided and two-sided portions simultaneously.”).

50. In response to being asked “if the same method of calculating compaction density in Sunose was used for every embodiment,” even Dr. Lucht admitted that he did not recall “Sunose specifically saying how they measured the compaction density” and “[i]t is possible they measured it wrong.” Ex. 2050, 119:2-7. However, despite not confirming how such “packing densities” or “active material densities” were even measured in Sunose or even considering the physical impossibility of several of the purported active material density values, Dr. Lucht simply cherry-picked certain embodiments to use, such as “particularly embodiment 2 or embodiment 3, the active material densities that are listed there are very reasonable numbers and those are the embodiments that I go to in my declaration” and” “particularly embodiment 3 and embodiment 4” which he indicated “have active material densities that appear to be reasonable and correct and those are the ones that [he] utilized.” Ex. 2050, 116:20-118:8, 119:10-14. Moreover, Dr. Lucht confirms that “[Sunose doesn’t] specify how they measure the compaction densities,” and “[he doesn’t] know if their method of calculating the active material density ratio is wrong or not.” Ex. 2050, 144:13-145:1, 119:21-120:8 (“Q. If

Sunose's measurement of compaction density was wrong, would that affect your calculations? A. I'm not – I don't know if their method of calculating the active material density ratio is wrong or not. I said that I don't know of that, but if any value in any published or patented thing is wrong, then if you try and calculate something from that number, then the number might not be correct either.”).

51. Dr. Lucht in deposition further acknowledged that the density of a composite could not exceed that of any of its constituents. Ex. 2050, 87:18-89:4 (“I would agree with [the statement] that [if the other materials all have a lower density than LCO, you could not exceed the maximum density of LCO for your compaction density], yeah. You could not do that.”). Therefore, if one of the constituents in an electrode is LCO with a density of 5.1 g/cm^3 , and the others are carbon-based materials with much lower densities, Dr. Lucht admits that the composite electrode could not have a density that exceeds 5.1 g/cm^3 , even setting aside the density-dilution effects of the carbon materials and of porosity. *Id.*

52. In my opinion, in the absence of Sunose indicating otherwise, a POSITA would understand Sunose to use the same methodology across all embodiments and comparative examples to measure, calculate, or otherwise prescribe the alleged active material densities. Accordingly, it is my further opinion, the POSITA would interpret the *physical impossibility* of the purported density

values of the single-side coated portions of at least Embodiments 1 and 2 and Comparative Examples 2 and 3 to be a result of a *fundamental error* in Sunose’s methodology, whatever it may be, for measuring, calculating, or otherwise prescribing the alleged active material densities of *all* of the embodiments and comparative examples, even those identified by Dr. Lucht as purportedly having “active material densities that appear to be reasonable and correct” (Ex. 2050, 119:10-14) or else must be a reference to some other physical characteristic that is *not* compaction density and *cannot* be quantitatively compared to compaction density. That is, a POSITA would understand Sunose to have used a clearly erroneous density methodology, the results of which permeate all such purported density values in Sunose such that a POSITA would discount the accuracy of all of Sunose’s purported “prescribed densit[ies],” “packing densit[ies],” and “active material densities” and would not interpret *any* of the listed “prescribed densit[ies],” “packing densit[ies],” or “active material densities” as corresponding to the claimed “electrode compaction density” of the ’131 Patent.

53. In response to being asked if he reviewed whether the densities in Table 1 are actually measured active material densities, rather than calculated, prescribed, or dictated, Dr. Lucht stated that “the tables and the embodiments in Table 1 describe active material densities. My understanding of the researchers is that they understand

how to make their coatings that they're making, and those are the values that they determined. Now, how exactly they determined the value, I'm not certain. I wasn't an author on the patent. But as a POSITA I can look at the values and see what the active material densities are." Ex. 2050, 145:15-146:6. For purportedly having a "fairly good understanding of electrode materials and the electrode process" (Ex. 2050, 231:12-17), it is my opinion that the Board should discount Dr. Lucht's opinions with respect to Sunose as he purported to "look at the values and see what the active material densities are" without considering or even realizing the physical impossibility of certain such values or the effect of an erroneous density determination methodology on the remaining density values. Ex. 2050, 145:15-146:6.

54. The erroneous "active material layer weights" or "coating amounts" recited in Sunose also support my opinion of Sunose clearly using an erroneous density methodology. *See* Ex. 1010 ¶¶ [0029]-[0030]. As explained in my original Declaration, the "active material layer weights" recited in Embodiment 1 of Sunose (and by extension the other embodiments) are also clearly erroneous. The "active material layer weights" are given as values in the range 120-200 g/cm². *Id.*, Ex. 2015 ¶ 153. Coating weight or loading values for cathodes would be expected to be around 100-200 g/m², thus differing from Sunose by a factor of roughly 10,000, such that

100-200 g/m² = 0.01-0.02 g/cm². Ex. 2015 ¶ 153. A factor not addressed or even realized by Dr. Lucht at all in his Declaration and which he admitted was an error only *after* reviewing my original Declaration. Ex. 2050, 98:10-12 (“I believe that I agree with - - Dr. Wheeler in his - - in his assessment that that is a typographical error.”), 98:16-18 (“I don’t think I noticed that as I was writing my declaration. It was a good catch by Dr. Wheeler.”).

55. Moreover, the fact that the single-side portion of the electrode plate in Comparative Example 3 broke during rolling in the roll press machine such that there would not be an “active material density M of [the] single-side coated portion” from which a measurement or calculation could be performed, let alone a purported density of 8 g/cc (which corresponds to the density of solid steel) as indicated in Sunose, further supports my opinion that Sunose clearly uses an erroneous density methodology across all embodiments and comparative examples. Ex. 1010 ¶ [0037], Table 1. A POSITA would also have understood that the compaction density of an electrode is calculated *after* the electrode has been constructed and involves the measurement of various values to include weight and thickness (as set forth in the ’131 Patent), and there would not be a single-side active material layer or any “compacted” single-side active material layer left to be measured or otherwise determined in Comparative Example 3. Even Dr. Lucht admits that electrode

compaction density “would typically be measured after [compressing the electrode] because that is when you need to do it. Which is as is stated there in paragraph 31, rolling was performed using a roll press machine to obtain the density of the active material there.” Ex. 2050, 98:19-99:9.

56. Accordingly, it is my opinion that *none* of the alleged “active material densit[ies]” identified in Sunose, including for Sunose’s Examples 2-4, are electrode compaction densities.

(ii) Lack of Enablement

57. It is also my opinion that a POSITA reading Sunose would not find Sunose to be enabled for the purposes of preparing at least the electrode plates of Embodiments 2-4 and Comparative Examples 1-3, and thus would expressly reject its teachings when preparing electrode(s) for an electrochemical device. In other words, a POSITA would understand that Sunose offers no teaching to enable electrodes having electrode compaction densities or ratios thereof in the way taught and claimed by the ’131 Patent.

58. Sunose purportedly sets forth the steps for forming an electrode plate in Embodiment 1. Ex. 1010 ¶¶ [0029]-[0030]. Each of Embodiments 2-4 and Comparative Examples 1-3 necessarily rely on the disclosure of Embodiment 1 as each Embodiment or Comparative Example refers to creating each respective

positive electrode plate “by rolling after changing the coating amount of the single-sided coated portion 1” or “by rolling without changing the coating amount of the single-sided coated portion 1” and only the description of Embodiment 1 sets forth purported “coating amounts” or “active material layer weights” that would be necessary for creating each respective single-sided coated portion 1 of a positive electrode plate. Ex. 1010 ¶¶ [0029]-[0037]. Indeed, none of Embodiments 2-4 or Comparative Examples 2-3 identify to even what “coating amount” the single-side coated portion is purportedly changed nor does Sunose provide thicknesses of such single-side coated portions.²⁵ Ex. 1010 ¶¶ [0032]-[0037]. Even Dr. Lucht admits that the active material weights or “coating amounts” are not disclosed in Sunose. Ex. 2050, 123:10-126:14 (“They don’t specify how much material was layered on

²⁵ Sunose purports that “by varying the thickness of the single-sided active material portion and the thickness of the two-sided active material portion during the application of the active material, and performing a fixed-size press using a rolling machine, the prescribed active material density ratio is obtained.” Ex. 1010 [0016]. However, Sunose never discloses thickness measurements for any of its embodiments or comparative examples.

additionally or less for the – for the single layer.”).²⁶ As such, the POSITA would not be able to create the positive electrode plates of Embodiments 2-4 or Comparative Examples 2-3.²⁷

²⁶ Dr. Lucht argues that although the amount of coating used for the single-side coated portions in at least Embodiments 2-4, upon which he relies, is not disclosed in Sunose, in his opinion, “a POSITA would put the value of a single-side, the active material density of the single-side coated portion[,] a POSITA would be able to do that” because Sunose “*shows you how to make the layer that has the single-sided coated portion or the - - for the [Embodiment] 1 density, the 5.7 density*. You would vary the amount of material that you put on there. You would put - - get the lower - - the lower number, you would put less material on.” Ex. 2050, 124:11-125:15 (emphasis added). At least inasmuch as the purported coating amount of the single-side coated portion of Embodiment 1 results in the physically impossible density value of 5.7 g/cc as discussed in Section VII.A.1.b(i), *supra*, Dr. Lucht fails to explain how a POSITA would vary the coating amount in such physically impossible electrode.

59. In my opinion, Sunose is not enabled according to at least the following independent factors: (1) The quantity of experimentation or amount of effort and testing required to make and use the electrodes of Sunose would be insurmountable in view of the missing and/or erroneous information as described hereinabove; (2) Sunose fails to provide sufficient direction or guidance for how much “coating amount” or “active material layer weight” or even at what thickness a POSITA would apply such coating amount to the respective single-sided coated portions of Embodiments 2-4 or Comparative Examples 2-3 and only supplies a “coating amount” for the single-sided coated portion of Embodiment 1 that is clearly erroneous and off by a factor of roughly 10,000; (3) a POSITA would not be able to replicate any of the examples of Sunose as Sunose fails to provide a single working example of an electrode with accurate or listed coating amounts AND physically possible compaction densities; (4) the nature of Sunose’s invention is clearly not electrodes having compaction densities and ratios thereof that meet the claims of the ’131 Patent; (5) the state of the prior art concerning electrode compaction density

²⁷ Notably, the POSITA also would not be able to create the positive electrode plate of Embodiment 1 due to the physically impossible density value of 5.7 g/cc of the single-side coated portion. *See* Section VII.A.1.b(i), *supra*.

was not understood well enough to allow Sunose to omit such instructions; (6) the POSITA's level of knowledge and experience in electrodes does not make up for the lack of teachings in Sunose; and (7) the predictability or unpredictability of electrodes also does not make up for the lack of teachings in Sunose. With respect to factors (5) and (6), I further note that there are multiple methods of achieving a given compaction density that nevertheless will have differing effects on the porous structure and therefore on cell performance. Sunose's method appears to have unique and unexpected aspects with respect to thickness, pressure, and density control and Sunose's incomplete and erroneous descriptions cannot be overcome by an appeal to standard or expected operating procedures a POSITA could be expected to know. With respect to factor (7), there is no single customary expected value of thickness or of compaction density. They are part of the core cell design that must be disclosed in order to replicate or learn from Sunose.

60. Thus, it is my opinion that a POSITA reading Sunose would not find Sunose to be enabled for the purposes of preparing electrode(s) and therefore, a POSITA would expressly reject the teachings of Sunose and would not be motivated to utilize or rely on its teachings when preparing electrode(s) for an electrochemical device.

(iii) Sunose's N/M ratios for Examples 2-4 are incommensurable with the claimed D1/D2 ratio

61. The possibility that “some physical origin” underlies Sunose’s packing densities (as they appear to correlate with crack rate outcomes) does not equate to the N/M ratios for Sunose’s Examples 2-4 being commensurable with the claimed D1/D2 ratio as asserted by the Board. Paper 15, 36. Indeed, even Dr. Lucht admits that “if any value in any published or patented thing is wrong, then if you try and calculate something from that number, then the number might not be correct either.” Ex. 2050, 119:21-120:8. Rather, because Sunose’s purported prescribed densities, packing densities, and active material densities (M and N) clearly do not correspond to the claimed electrode compaction densities as discussed in Section VII.A.1.b(i), *supra*, nor are Sunose’s Examples 2-4 (upon which Dr. Lucht relies) enabled as discussed in Section VII.A.1.b(ii), *supra*, the range of $0.7 < N/M < 1.0$ disclosed in Sunose also cannot be directly compared with the compaction density ratio range of claims 1 and 14.

62. Thus, the combination of Zeng and Sunose does not render claims 1 and 14 obvious for these additional reasons.

2. Petitioner Fails to Show that Zeng and Sunose Renders Obvious Claims 2, 4-7, 12, 15, and 17

63. Claims 2, 4-7, 12, 15, and 17 are not unpatentable for the same reasons as discussed above with respect to independent Claims 1 and 14.

B. Board Ground 2/Petitioner Ground 1B: Zeng, Sunose, and Matsuoka Do Not Render Obvious Claims 1, 2, 4-7, 12, 14, 15, and 17²⁸

64. It is my understanding, that for purposes of the Institution Decision, the Board held that it had “reviewed Petitioner’s arguments and evidence and [] found them to be sufficient to meet the threshold of 314(a).” Paper 15, 41.

65. As previously explained in Paragraphs 160-191 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Lucht fail to show that claims 1, 2, 4-7, 12, 15, and 17 of the ’131 Patent are rendered obvious by Zeng, Sunose, and Matsuoka, and I incorporate those paragraphs by reference herein. Ex. 2015 ¶¶ 160-191.

1. Petitioner Fails to Show that Zeng, Sunose, and Matsuoka Renders Obvious Independent Claims 1 and 14

66. It is my understanding that the Board found that “Patent Owner’s position [that ‘Zeng already provides the POSITA with the necessary amount of PP to include in a relative mass ratio of the base solvent mixture’] is inconsistent with

²⁸ It is my understanding that the Board “separately number[ed] each of Petitioner’s grounds and alternative grounds rather than group them with Petitioner’s alphanumeric designations for the base reference combinations and additional references.” Paper 15, 8.

its position that the disclosure of Zeng does not provide sufficient detail that would allow the POSITA to determine that Zeng discloses the claimed weight percentages of propyl propionate (Z).” Paper 15, 44. It is my further understanding that the Board found “Patent Owner’s argument [that Petitioner fails to show that a POSITA would have selected PP from Matsuoka’s numerous non-nitrile additives] unavailing because Petitioner relies on Zeng’s disclosure to include PP in the solvent, not Matsuoka, and alternatively relies on Matsuoka in addition to Zeng for an appropriate amount of PP.” Paper 15, 44. It is my further understanding that the Board held that “[t]he combination of Matsuoka with Zeng and Sunose is sufficiently supported for the purposes of this [Institution] Decision because a POSITA, seeking enhancement based on Zeng, would recognize from Matsuoka that PP effectively suppresses rise in internal resistance.” Paper 15, 48. I disagree.

67. As previously explained in my original Declaration, it is my opinion that nothing in Zeng would instigate, prompt, or motivate the POSITA to look beyond Zeng to “consider Matsuoka’s teachings about appropriate amounts of PP to include in Zeng’s electrolytes” as alleged by Dr. Lucht. Ex. 1003 ¶ 174; Ex. 2015 ¶ 155.

68. As explained in my original Declaration, Zeng provides an “appropriate amount” of propyl propionate to include in relative mass ratio *in its base solvent*

mixture. The Board's assertion that "Patent Owner's position [that 'Zeng already provides the POSITA with the necessary amount of PP to include in a relative mass ratio of the base solvent mixture'] is inconsistent with its position that the disclosure of Zeng does not provide sufficient detail that would allow the POSITA to determine that Zeng discloses the claimed weight percentages of propyl propionate (Z)" (Paper 15, 44) misinterprets my testimony and the motivations of the POSITA.

69. First, the fact that Zeng does not disclose its amount of propyl propionate in terms of the weight percentage of propyl propionate *based on a total weight of the electrolyte* (nor can such weight percentage of propyl propionate *based on a total weight of the electrolyte* be calculated from Zeng) does not mean that "Zeng's recipe is hypothetically unclear about how much PP to use" or "prompt[] the POSITA to consider Matsuoka's teachings about appropriate amounts of PP to include in Zeng's electrolytes," as alleged by Dr. Lucht. Ex. 1003 ¶ 174. Rather, Zeng's "recipe" is very clear about much propyl propionate to use in its base solvent mixture – a specified mass ratio to other solvents. After making its base solvent mixture, however, Zeng is not concerned with nor is Zeng motivated to even identify the weight percentage of propyl propionate *based on a total weight of the electrolyte*, *i.e.*, after adding lithium salt and various additives. Absent using the '131 Patent as a guide or otherwise contriving some purpose in hindsight, there is no reason why a

POSITA would look beyond Zeng for “appropriate amounts of PP to include in Zeng’s electrolytes.” Ex. 1003 ¶ 174.

70. Second, inasmuch as Petitioner purportedly “relies on Zeng’s disclosure to include PP in the solvent, not Matsuoka, and alternatively relies on Matsuoka in addition to Zeng for an appropriate amount of PP,” as the Board asserts (Paper 15, 44), Dr. Lucht and Petitioner have failed to explain why the POSITA would not also or instead rely on Matsuoka for an appropriate amount of fluoroethylene carbonate (FEC), vinylene carbonate (VC), ethyl propionate (EP), 1,3-propane sultone (PS), and/or fluorobenzene (FB), each of which is also contained in Zeng’s Embodiments 4 and 6. *Compare* Ex. 1007 ¶¶ [0038], [0040] to Ex. 1006 ¶¶ [0037], [0046], [0048]-[0049]. Indeed, any such alleged motivations by Dr. Lucht would equally apply to FEC, VC, EP, PS, and/or FB in Zeng, if not more so for FEC, VC, and PS.

71. For example, inasmuch as Dr. Lucht purports that “Zeng uses the solvent ‘[f]luoroethylene carbonate (FEC), which has good film-forming properties and resistance to oxidation’ and ‘ensures good high voltage cycling performance of the battery without seriously affecting the high-temperature performance of the battery’ such that “a POSITA would have considered Matsuoka” as “[l]ikewise, Matsuoka uses its non-nitrile additive such as PP to form a stable protective file on

the negative electrode, suppressing side reactions that generate gas and rise in internal resistance that can damage the battery and/or hurt cycling performance,” Dr. Lucht fails to explain why a POSITA would not simply apply Matsuoka’s purported teachings with respect to non-nitrile additives to FEC in Zeng’s Embodiments 4 and 6 which is also identified as a non-nitrile additive in Matsuoka. Ex. 1003 ¶ 172; Ex. 1007 ¶¶ [0038], [0040]. Indeed, 4-fluoro-1,3-dioxolane-2-one is identified as a “typical example” of an FEC and is used in many Examples and Comparative Examples in Matsuoka as a non-nitrile additive (A1). Ex. 1007 ¶¶ [0038], [0040], [0108], Table 2 (identifying additives used in Examples and Comparative Examples), Table 3 (identifying A1 as an additive in S3, S15, S18, S22), Table 4 (identifying A1 as an additive in S23-S27, S32, and S33), Table 6 (Examples 2, 4, and 13 use S3 electrolyte solution; Example 14 uses S15 electrolyte solution), Table 8 (Examples 16 and 17 use S3 electrolyte solution), Table 9 (Examples 21 and 25 use S3 electrolyte solution; Example 22 uses S18 electrolyte solution; Comparative Example 9 uses S22 electrolyte solution), Table 10 (Examples 26 and 27 use S3 electrolyte solution; Comparative Example 11 uses S22 electrolyte solution), Table 11 (Example 28 uses S23 electrolyte solution; Example 29 uses S24 electrolyte solution; Example 30 uses S25 electrolyte solution), Table 12 (Example 31 uses S26 electrolyte solution; Example 32 uses S27 electrolyte solution).

72. In another example, inasmuch as Dr. Lucht purports that “to the extent Zeng’s recipe is hypothetically unclear about how much PP to use, that would have prompted the POSITA to consider Matsuoka’s teachings about appropriate amounts of PP to include in Zeng’s electrolyte” and “a POSITA would have noted Matsuoka’s ‘off-the-shelf’ preferred weight proportion ranges for PP, a non-nitrile additive, to fine-tune the weight percentage Z of PP in Zeng’s Embodiments 4 and 6,” such alleged motivations equally apply to EP and FB, which are also used in Zeng’s base solvent mixture, and therefore, Zeng’s recipe would also or instead appear to be “hypothetically unclear” about how much EP and/or FB to use. Ex. 1003 ¶ 174; Ex. 1006 ¶¶ [0037], [0046], [0048]-[0049]. Yet, Dr. Lucht singles out PP with no apparent teaching or motivation to do so that does not also or instead apply to other overlapping non-nitrile additives.

73. In still another example, Dr. Lucht purports that “Matsuoka explains that its preferred weight proportion ranges for non-nitrile additives like PP balance competing advantages of electrolyte stability and high-rate performance at low temperatures,” “Matsuoka explains that increasing the amount by weight of the non-nitrile additive improves electrolyte stability, which comes at the cost of low-temperature performance, and vice versa,” and “[b]y calibrating the non-nitrile additive in Matsuoka’s preferred weight proportion ranges, however, ‘all of the

cycling performance of the electrolyte solution, high-rate performance under a low temperature environment, and other battery characteristics can be further improved,” such that “the desire for balanced performance, as taught by Matsuoka, would have, in [Dr. Lucht’s] opinion, motivated the POSITA to use Matsuoka’s preferred weight proportion ranges as the amount of PP in Zeng’s Embodiment 4 and 6 electrolytes.” Ex. 1003 ¶ 175. Any such alleged motivations by Dr. Lucht would equally apply to FEC, VC, EP, PS, and/or FB from Zeng, and Dr. Lucht fails to explain why the POSITA would be only motivated to adjust PP and not FEC, VC, EP, PS, and/or FB in addition to or in place of PP.

74. As stated above, vinylene carbonate (VC), a component of Zeng’s Embodiments 4 and 6, is identified in Matsuoka’s list of specific examples of non-nitrile additives. Ex. 1007 ¶¶ [0038], [0040]. In addition, VC is used in many Examples and Comparative Examples in Matsuoka as a non-nitrile additive (A3). Ex. 1007 ¶ [0108], Table 2 (identifying additives used in Examples and Comparative Examples), Table 3 (identifying A3 as an additive in S8, S9, S14, S19), Table 4 (identifying A3 as an additive in S28-S31 and S37-S45), Table 5 (identifying A3 as an additive in S46 and S47), Table 6 (Example 6 uses S8 electrolyte solution; Example 7 uses S9 electrolyte solution; Example 12 use S14 electrolyte solution; Example 14 uses S15 electrolyte solution), Table 8 (Example 18 uses S8 electrolyte

solution), Table 9 (Example 23 uses S19 electrolyte solution), Table 12 (Example 33 uses S28 electrolyte solution; Example 37 uses S29 electrolyte solution; Example 38 uses S30 electrolyte solution; Example 39 uses S31 electrolyte solution; Example 45 uses S37 electrolyte solution; Example 46 uses S38 electrolyte solution; Example 47 uses S39 electrolyte solution; Example 48 uses S40 electrolyte solution; Example 49 uses S41 electrolyte solution; Example 50 uses S42 electrolyte solution; Example 51 uses S43 electrolyte solution), Table 13 (Example 52 uses S44 electrolyte solution; Example 53 uses S45 electrolyte solution).

75. Moreover, Matsuoka discloses a significance of vinylene carbonate as compared to other non-nitrile additives with respect to improving the durability of the SEI. For example, paragraph [0044] of Matsuoka provides:

[0044] In the present embodiment, *from the viewpoint of the improvement of the durability of SEI, particularly in a case in which two or more non-nitrile additives are used in combination, the non-nitrile additives preferably comprise one or more compounds selected from the group consisting of carbonates, namely, compounds having CO₃ in its molecule*. In addition, the carbonates are preferably organic carbonates, more preferably cyclic carbonates, and further preferably compounds having a carbon-carbon double bond. *In particular, in a*

case in which the non-nitrile additives contain vinylene carbonate as a main ingredient, namely, in a case in which the non-nitrile additives contain vinylene carbonate in the largest amount, the durability of SEI is significantly improved, when compared with a case in which such vinylene carbonate is used alone. This may be because such carbonates easily undergo a copolymeric decomposition reaction, that is, they easily form copolymers with other non-nitrile additives, so that the flexibility or difficult solubility of SEI can be enhanced. However, the factors are not limited thereto.

Ex. 1007 ¶ [0044] (emphasis added). Dr. Lucht fails to explain why the POSITA would be only motivated to adjust PP and not VC in addition to or in place of PP.

76. As stated above, 1,3-propane sultone (PS), a component of Zeng's Embodiments 4 and 6, is also identified in Matsuoka's list of specific examples of non-nitrile additives. Ex. 1007 ¶¶ [0038], [0040]. In addition, PS is used in at least one Example in Matsuoka as a non-nitrile additive (A14). Ex. 1007 ¶ [0108], Table 2 (identifying additives used in Examples and Comparative Examples), Table 4 (identifying A14 as a second non-nitrile additive in S37, which also includes VC as a first non-nitrile additive), Table 12 (Example 45 uses S37 electrolyte solution).

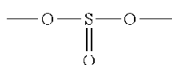
77. Moreover, Matsuoka discloses a significance of PS as compared to other non-nitrile additives with respect to improving the durability of the SEI. For example, paragraphs [0045], [0052], [0056], and [0057] of Matsuoka provide:

[0045] In the present embodiment, *from the viewpoint of the improvement of the durability of SEI, particularly in a case in which two or more non-nitrile additives are used in combination, the non-nitrile additives preferably comprise one or more compounds selected from the group consisting of compounds represented by the following formula (2)* (hereinafter referred to as “Compound (2)”):

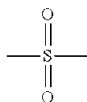


[0046] Herein, in the above formula (2), R^1 and R^2 each independently represent an alkyl group optionally substituted with an aryl group or a halogen atom or an aryl group optionally substituted with an alkyl group or a halogen atom, or R^1 and R^2 bind to each other, together with A, to form a cyclic structure optionally having an unsaturated bond; and A represents a divalent group having a structure represented by any one of the following formulae (3) to (7):

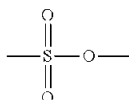
[Formula 2]



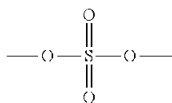
(3)



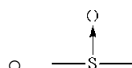
(4)



(5)



(6)



(7)

[0052] *Specific examples of the Compound (2), wherein A is a divalent group having the structure represented by the above formula (5), include:* acyclic sulfonates such as methyl methanesulfonate, ethyl methanesulfonate, propyl methanesulfonate, methyl ethanesulfonate, ethyl ethanesulfonate, propyl ethanesulfonate, methyl benzenesulfonate, ethyl benzenesulfonate, propyl benzenesulfonate, phenyl methanesulfonate, phenyl ethanesulfonate, phenyl

propanesulfonate, benzyl methanesulfonate, benzyl ethanesulfonate, and benzyl propanesulfonate; cyclic sulfonates such as *1,3-propane sultone*, 1,4-butane sultone, 3-phenyl-1,3-propane sultone, and 4-phenyl-1,4-butane sultone; and halides of the above described acyclic sulfonates and cyclic sulfonates.

[0056] The content of the Compound (2) in the non-aqueous electrolyte solution is not particularly limited. The content of the Compound (2) is preferably 0.05 to 30 vol %, more preferably 0.1 to 20 vol %, and further preferably 0.5 to 10 vol %, based on the total amount of ingredients contained in the non-aqueous electrolyte solution, other than the organic lithium salt, and further, in a case in which the non-aqueous electrolyte solution contains an inorganic lithium salt, based on the total amount of ingredients contained in the non-aqueous electrolyte solution, other than the organic lithium salt or the inorganic lithium salt. The Compound (2) includes a compound that is in the state of a solid at a room temperature (25° C.). Such a compound may be used in the range of its saturation in acetonitrile or less, preferably at 60% by mass or less of the saturation, and more preferably at 30% by

mass or less of the saturation. *By adjusting the content of the Compound (2) in the above described range, significant effects can be obtained by the combined use of two or more of the non-nitrile additives of the present embodiment, and the durability of SEI can be significantly improved in comparison with the use of a single type of the non-nitrile additive of the present embodiment.*

[0057] *When the Compound (2) is used as an ingredient of the non-nitrile additive, it plays a role as a comonomer in a polymeric decomposition reaction. Thus, addition of the Compound (2) is considered to contribute to the significant improvement of the durability of SEI.* However, factors for the improvement of the durability of SEI are not limited thereto. When such a reaction mechanism is assumed, the Compound (2) preferably forms a cyclic structure from the viewpoint of ring-opening polymerization. In particular, by adding one or more compounds selected from the group consisting of ethylene sulfite, propylene sulfite, butylene sulfite, pentene sulfite, sulfolane, 3-methyl sulfolane, 3-sulfolene, *1,3-propane sultone*, 1,4-butane sultone, 1,3-propanediol sulfate, and tetramethylene sulfoxide, as an ingredient(s) of the non-nitrile additive,

it becomes possible for the non-aqueous electrolyte solution of the present embodiment to continuously exhibit higher performance even under a severe use environment, such as high-temperature charge and discharge, or charging storage.

Ex. 1007 ¶¶ [0045], [0046], [0052], [0056], [0057] (emphases added). Dr. Lucht fails to explain why the POSITA would be only motivated to adjust PP and not PS in addition to or in place of PP.

78. Moreover, inasmuch as Dr. Lucht asserts that “a POSITA, seeking enhancements based on Zeng, would recognize from Matsuoka that PP effectively suppresses rise in internal resistance” and that “[a] POSITA would therefore have adjusted the PP content in Zeng’s Embodiments 4 and 6 within Matsuoka’s preferred ranges of 0.1-10 wt% and 0.1-30 wt%, seeking to optimize the PP proportion for suppressing rise in internal resistance,” (Ex. 1003 ¶ 180) and the Board similarly held that “[a] POSITA would therefore be able to adjust the PP content in Zeng’s Embodiments 4 and 6, experimenting within Matsuoka’s preferred ranges of 0.1-10 wt% and 0.1-30 wt% to identify an optimum PP proportion for suppressing rise in internal resistance,” (Paper 15, 48) I disagree.

79. Dr. Lucht fails to address, and the Board failed to appreciate, the fact that adjusting the PP content in Zeng’s electrolyte solvent would necessarily cause

changes in the amounts of the other solvent components in the base solvent mixture of Zeng's Embodiments 4 and 6 – i.e., you necessarily must have less of something else, in terms of mass or volume fractions. That is, Zeng's solvent components are “mixed at a [specific] mass ratio” (Ex. 1006 ¶ [0037]) such that their amounts are dependent on each other. In the words of Dr. Lucht, adjusting the PP content “would disrupt the carefully-crafted solvent...central to Zeng's invention.” Ex. 1003, n.6 (in discussing purported effect of “adding some premixed solution of LiPF_6 ”). Notably, Dr. Lucht offers no opinion as to why adjusting PP amounts (based on Matsuoka) in Zeng's solvent components mixed at a specified mass ratio would not disrupt the carefully-crafted solvent central to Zeng's invention.

80. As I explained in my original Declaration, electrolyte components are subject to a complex matrix of requirements and tradeoffs and there is no obvious choice of such components for every application and objective. Ex. 2015 ¶¶ 274-275. That is, there is no component that is universally beneficial, which makes it a complex decision on whether to include a component and how much to include of such component. *Id.* Moreover, interactions in an electrolyte system are nonlinear, meaning, for example, that if an amount of a component is doubled, it does not necessarily double the “effect” of that component because the molecules in a liquid mixture interact in non-ideal ways with each other. *Id.* Indeed, in forming the SEI

from the electrolyte, multiple components and reactions are needed as recognized by Matsuoka. *See generally*, Ex. 1007. Indeed, Dr. Lucht himself in a prior scientific publication has confirmed these nonlinear and unpredictable electrolyte constituent interactions, requiring a non-trivial amount of experimentation to understand:

Although it has been widely accepted that forming “good SEI” is the most effective and important way to improve the [low-temperature] battery performance, and many encouraging results have been reported, these efforts are still mainly empirical approaches. This is due to the lack of clear picture about how a “good SEI” is formed, what are the key functioning components of it and what are the functionalities of these key components.

Ex. 2046, p. 32.²⁹

²⁹ Ex. 2046 (Sha Tan, et al., Review on Low-Temperature Electrolytes for Lithium-Ion and Lithium Metal Batteries, *Electrochemical Energy Reviews* (2023) 6:35, <https://doi.org/10.1007/s41918-023-00199-1>). *See also*, Ex. 2050, 232:14-234:14 (Dr. Lucht testifying that he is an author of Ex. 2046 and that Ex. 2046 is true, accurate, copy).

Electrolyte engineering is especially useful in optimizing electrolyte components to maximize the synergistic effects of multiple components. Such optimization usually requires large number of experiments and a suitable screening method, playing a critical role for designing novel high performance electrolytes.

Ex. 2046, p. 31.

81. Continuing my explanation of SEI formation along these lines, each electrolyte constituent reacts at its own rate with the highly reducing anode surface and these reactions are taking place in parallel and forming a composite structure that has a mixture of many reaction products. This is inherently nonlinear and leads to unexpected results depending on what additives are added to an electrolyte solution and at in what amounts. Accordingly, simply adjusting PP amounts in Zeng's solvent components would not lead to expected results or a reasonable expectation of success.

82. Additionally, I note that ethylene carbonate (EC) is identified as an additive (A10) in Table 2 of Matsuoka. Ex. 1007 ¶ [0108], Table 2. EC is a solvent

component in Zeng's Embodiments 4 and 6.³⁰ Ex. 1006 ¶¶ [0037], [0045], [0046]. Notably, in Matsuoka, a lithium salt is added to a solvent to first form a mother electrolyte solution (D), and any additive(s) are added thereafter to the mother electrolyte solution (D) to form a (final) electrolyte solution (d). Ex. 1007 ¶ [0109]. Accordingly, all additives, including the purported "non-nitrile additives" are added to the mother electrolyte solution (D) and Matsuoka's disclosure regarding mass % of non-nitrile additives applies to this preparation method. EC (A10) is added as an

³⁰ Notably, EC is part of the solvent mixture in S19 (in mass ratio of the solvent mixture), S20 (in mass ratio of the solvent mixture), and S21 (in a volume ratio of the solvent mixture) and Matsuoka does not purport that such EC is an "additive" in those examples. Ex. 1007, Table 3. Even Matsuoka does not attempt to apply such non-nitrile additive content ranges when the subject component is considered a "solvent." To Matsuoka and the POSITA, it matters what role the molecule is serving. For example, when a component is a "solvent," its purpose is to be a host and allow ions to move around and when a component is an "additive," it has a more specific purpose such as forming a passivating film. A POSITA would not apply such alleged PP "non-nitrile additive" teachings of Matsuoka to the PP "solvent component" of Zeng.

additive at 5 mass % of the entire electrolyte solution in S17. Ex. 1007 ¶ [0108], Table 3. That is, after forming a mother electrolyte solution (D) of acetonitrile and an organic lithium salt of LiBOB, EC was added to the mother electrolyte solution (D) to the predetermined concentration of 5 mass % to obtain the (final) electrolyte solution (d). Ex. 1007 ¶ [0109]. Thus, Dr. Lucht and Petitioner not only fail to address the fact that adjusting PP amounts in Zeng's solvent components mixed at a specified mass ratio would disrupt the carefully-crafted solvent central to Zeng's invention, Dr. Lucht and Petitioner fail to address the fact that the purported mass % ranges of the non-nitrile additives in Matsuoka are determined based on the "additive" being added *after* formation of a mother electrolyte solution (solvent and lithium salt) and how that requirement also affects the carefully-crafted solvent mass ratio of Zeng. For example, Dr. Lucht and Petitioner do not explain if any such "appropriate amount" of PP "non-nitrile additive" allegedly taught by Matsuoka is applied to Zeng by a POSITA instead of or in addition to the PP in the base solvent mixture of Zeng. Regardless, Dr. Lucht fails to explain how the POSITA adds PP as an additive after formation of Zeng's base solvent mixture and lithium salt addition yet maintains Zeng's "carefully-crafted solvent mass ratio." Ex. 1003 ¶ 174, n. 6.

83. It is my further understanding that "[b]ased on the current record, [the Board did] not consider Matsuoka's disclosure to 'criticize[,] discredit, or otherwise

discourage' investigation into use of mixed solvents such as Zeng. The data in Matsuoka's Table 9 supports Dr. Wheeler's testimony that the acetonitrile-only solvents have better *low temperature* performance than the mixed solvents" but "[t]he same cannot be said of a comparison of performance at 25°C, however, where the mixed solvent examples demonstrate better performance than the acetonitrile-only solvents" and "Zeng is drawn to wide-temperature-range homogeneous non-aqueous electrolyte solutions, not low-temperature non-aqueous electrolyte solutions." Paper 15, 47.

84. Table 9 of Matsuoka (reproduced below) sets forth the measurement results for discharge capacity [mAh] at various temperatures [-30°C, -20°C, 25°C] for some example monolayer laminate batteries (SL1) and small batteries (SC1) with various electrolyte solutions:

TABLE 9

	Elec- trolyte		Battery evaluation	Discharge capacity [mAh]		
	solution	Battery		-30° C.	-20° C.	25° C.
Example 21	S3	SL1	2-1	5.37	7.36	8.40
Example 22	S18	SL1	2-1	4.73	7.21	8.42
Example 23	S19	SL1	2-1	3.61	6.73	8.50
Example 24	S20	SL1	2-1	2.80	6.45	8.31
Comparative Example 8	S21	SL1	2-1	1.32	6.33	8.50
Example 25	S3	SC1	2-2	2.11	2.34	3.20
Comparative Example 9	S22	SC1	2-2	1.53	2.08	3.13

Ex. 1007, Table 9.

85. It is my opinion that the Board's assessment that the mixed solvent examples demonstrate better performance than the acetonitrile-only solvents at 25°C runs counter to its assertions that Zeng is drawn to wide-temperature-range homogeneous non-aqueous electrolyte solutions. Paper 15, 47.

86. Indeed, all examples set forth in Table 9, regardless of solvent mixture, have functionally comparable discharge capacity at 25°C for the corresponding battery type. However, a POSITA would look at Table 9 for all it discloses and understand that when acetonitrile is used as the only solvent, such as in Matsuoka's Examples 21 and 22 of the prepared monolayer laminate batteries (SL1), the discharge capacity of the corresponding battery across all temperatures tested in Table 9, specifically -30°C, -20°C, 25°C, *on the whole*, is higher than that of the mixed solvent systems (mixed solvents containing acetonitrile such as Examples 23 and 24 and mixed solvents without acetonitrile (Comparative Example 8)). In other words, although Comparative Example 8, which contains ethylene carbonate and methyl ethyl carbonate in a 3/7 volume ratio (Ex. 1007, Table 3, Table 9) does have a slightly higher discharge capacity of 8.50 mAh at 25°C compared to Examples 21 and 22 having discharge capacity values of 8.40 mAh and 8.42 mAh, respectively, such discharge capacity values are within 1% of Comparative Example 8's 25°C discharge capacity value. Moreover, the POSITA would be deterred by the discharge

capacity values of Comparative Example 8 (mixed solvent) at lower temperatures, specifically -30°C, as it is significantly lower (approximately 75% lower) than the discharge capacity values of Examples 21 and 22 at the same temperature. The Board asserts that Zeng is not drawn to “low-temperature non-aqueous electrolyte solutions” and “Zeng discusses problems in electrolyte solutions at both high temperature and low temperatures.” Paper 15, 47. Although Zeng is not drawn to low-temperature non-aqueous electrolyte solutions only, the Board overlooked the fact that stability of electrolyte solutions at -30°C is one focus of Zeng, including a specific storage test conducted by Zeng at -30°C with respect to its wide-temperature range homogenous non-aqueous electrolyte solution. Ex. 1006 ¶ [0038]. Indeed, in my opinion, the performance or stability at low temperatures better distinguishes electrolyte options in Zeng’s established framework, especially solubility. In other words, for Zeng, if an electrolyte solution fails or does not perform as well at low temperature due to some components freezing or crystalizing out, then that is sufficient evidence to remove that electrolyte from further consideration, as reflected in Zeng’s choice of which experiments are labeled as “Embodiments” vs. “Comparison Examples”. Ex. 1006 ¶¶ [0045]-[0047]. In my opinion, the variation in results corresponding to the testing of the examples conducted at -30°C in Table

9 of Matsuoka would be more significant to a POSITA than the non-discriminating results corresponding to the testing conducted at 25°C.

87. Accordingly, in my opinion, a POSITA considering Matsuoka, particularly Table 9 as set forth in Paragraph [0177], would be deterred from applying Matsuoka's teachings to mixed solvents, with or without acetonitrile.

88. It is my further understanding that "at this stage in the proceeding[, the Board does] not consider Matsuoka's limited data comparing an organic lithium ion in acetonitrile to LiPF₆ in acetonitrile sufficient to discredit or otherwise discourage the use of LiPF₆ [sic] in mixed solvents for electrolyte solutions." Paper 15, 47-48. The Board further specifies that "Dr. Wheeler asserts that Matsuoka requires an organic lithium salt with specified LUMO and HOMO energy ranges" but Matsuoka "provides one comparison of an organic lithium ion in acetonitrile to LiPF₆ in acetonitrile, and discloses that the acetonitrile/LiPF₆ electrolyte solution has much lower discharge capacity." Paper 15, 48. I disagree at least inasmuch as the Board misinterprets my opinion as the requirements of the lithium salts used in the electrolyte systems of Zeng and Matsuoka are so materially different such that a POSITA would not be motivated to apply the teachings of Matsuoka to the electrolyte solvent of Zeng.

89. In particular, Matsuoka is directed to a non-aqueous electrolyte system containing acetonitrile and an organic lithium salt, wherein the organic lithium salt has an anion meeting certain LUMO and HOMO energy requirements as compared to acetonitrile so that the anion is “able to suppress the reductive composition of acetonitrile and an increase in internal resistance.” Ex. 1007 ¶¶ [0020], [0022]. Indeed, as a whole, Matsuoka requires at least acetonitrile and an organic lithium salt. Ex. 1007 ¶ [0014]. Matsuoka takes great pains to explain LUMO and HOMO energies and how ranges of same are used to select the non-nitrile additives. Ex. 1007 ¶¶ [0036]-[0040]. The non-nitrile additives are selected for their potential ability to be more reactive than acetonitrile and thereby form a protective film on the anode before acetonitrile has time to react—it’s basically a race to the bottom. Inability of acetonitrile to form a protective film is a noted shortcoming of acetonitrile, a shortcoming that must be solved because acetonitrile is one of two central and irreplaceable components of the electrolyte in Matsuoka (the other component being the organic lithium salt). *See also*, Ex. 2046, p. 10 (Dr. Lucht’s publication showing that one must be careful in extrapolating behavior from one electrolyte system to another, even when they comprise solvents from the same chemical families).

90. To the extent that an inorganic lithium salt, such as LiPF_6 , is present in electrolyte solutions of Matsuoka, Matsuoka teaches that “the inorganic lithium salt needs to be used to such an extent that it does not impair the effect of SEI formation by the organic lithium salt” and “[p]referably, the molar quantity of the inorganic lithium salt does not exceed the molar quantity of the organic lithium salt contained [in the electrolyte solution].” Ex. 1007 ¶ [0031]. Indeed, Matsuoka further discloses that, if an inorganic lithium salt is present, it is preferable for the organic lithium salt to be present in a molar amount 1-20 times more than the inorganic lithium salt. Ex. 1007 ¶¶ [0031]-[0032]. Accordingly, it is my opinion that the electrolyte systems of Zeng and Matsuoka are so materially different such that a POSITA would not be motivated to apply the teachings of Matsuoka to Zeng and even if a POSITA were motivated to apply the teachings of Matsuoka to Zeng, the POSITA would also incorporate Matsuoka’s disclosure with respect to organic lithium salt and acetonitrile, substantially altering the electrolyte system of Zeng. Moreover, Dr. Lucht acknowledges that all of the embodiments in Matsuoka require *organic* lithium salt.³¹

³¹ Ex. 2050, 162:15-20 (when asked if Matsuoka always requires organic lithium salt, Dr. Lucht stated “I haven't looked through all of it, but it appears that most of

91. With respect to Sunose, I incorporate by reference my additional discussion of Sunose at Paragraphs 41-62 above with respect to Ground 1. Thus, the combination of Zeng, Sunose, and Matsuoka does not render claims 1 and 14 obvious for these additional reasons.

2. Petitioner Fails to Show that Zeng, Sunose, and Matsuoka Renders Obvious Claims 2, 4-7, 12, 15, and 17

92. Claims 2, 4-7, 12, 15, and 17 are not unpatentable for the same reasons as discussed above with respect to independent Claims 1 and 14.

them, if not all of them, are these organic -- organic lithium salts”), 165:22-166:18 (when asked if Matsuoka allows for an inorganic lithium salt, but requires an organic lithium salt, Dr. Lucht stated “[Matsuoka] says, moreover the content of the organic lithium salt is preferably 0.1 to 30 percent mass. So it does appear that it requires or has that as part of the organic lithium salt”).

C. Board Grounds 3 and 4/Petitioner Ground 1C: Zeng, Sunose, Kim, with or without Matsuoka, Do Not Render Obvious Claims 1, 2, 4-7, 12, 14, 15, and 17³²

93. It is my understanding, that for purposes of the Institution Decision, the Board held that it had “reviewed Petitioner’s arguments and evidence and [] found them to be sufficient to meet the threshold of 314(a).” Paper 15, 49, 56.

94. As previously explained in Paragraphs 192-215 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Lucht fail to show that claims 1, 2, 4-7, 12, 15, and 17 of the ’131 Patent are rendered obvious by Zeng,

³² It is my understanding that the Board “separately number[ed] each of Petitioner’s grounds and alternative grounds rather than group them with Petitioner’s alphanumeric designations for the base reference combinations and additional references.” Paper 15, 8.

Sunose, and Kim, with or without Matsuoka, and I incorporate those paragraphs by reference herein.^{33,34,35} Ex. 2015 ¶¶ 192-215.

³³ See, e.g., Ex. 2032 (Jerome Workman, Jr., *A Comprehensive Review of Spectroscopic Techniques for Lithium-Ion Battery Analysis*, 39 *Spectroscopy* 6 (2024), <https://doi.org/10.56530/spectroscopy.ii3689u3>). I certify that the copy of the paper in Exhibit 2032 is to the best of my knowledge a true, accurate, and authentic copy of *A Comprehensive Review of Spectroscopic Techniques for Lithium-Ion Battery Analysis*, and accurately represents the copies of the paper published on December 4, 2024 by *Advances in Lithium-Ion Battery Analysis for Today's Spectroscopists*, which a POSITA would have known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

³⁴ See, e.g., Ex. 2033 (Anup Barai et al., *A Comparison of Methodologies for the Non-Invasive Characterisation of Commercial Li-Ion Cells*, 72 *Prog. Energ. Combust. Sci.* 1 (2019)). I certify that the copy of the paper in Exhibit 2033 is to the best of my knowledge a true, accurate, and authentic copy of *A Comparison of Methodologies for the Non-Invasive Characterisation of Commercial Li-Ion Cells*,

1. Petitioner Fails to Show that Zeng, Sunose, and Kim, with or without Matsuoka, Renders Obvious Independent Claims 1 and 14

95. It is my understanding that the Board found that “Petitioner identifies motivations to combine Kim with Zeng to adjust the relative amounts of trinitrile and PP” because “Petitioner explains how Kim’s disclosure of using PP along with a dinitrile and a trinitrile in both Examples was more successful that [sic] the _____ and accurately represents the copies of the paper published on January 14, 2019 by Progress in Energy and Combustion Science, which a POSITA would have known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

³⁵ See, e.g., Ex. 2040 (*Ethylene Carbonate*, https://www.m-chemical.co.jp/en/products/departments/mcc/c2/product/1200981_7910.html (last visited on June 8, 2025)). I certify that the copy of the web page in Exhibit 2040 is to the best of my knowledge a true, accurate, and authentic copy of *Ethylene Carbonate*, and accurately represents the web page currently available at https://www.m-chemical.co.jp/en/products/departments/mcc/c2/product/1200981_7910.html.

Comparative Examples, none of which employed all three components.” Paper 15, 56.

96. I note that Dr. Lucht’s reliance on Examples 1 and 2 of Kim is misguided and fails to address the fact that Examples 1 and 2 do not contain diethyl carbonate (DEC). Ex. 1008 ¶ [0090], Table 1; Ex. 1003 ¶¶ 182-196. For example, in addition to removing HTCN from Comparative Example 1 and removing PP and EP from Comparative Examples 1 and 2, Comparative Examples 1 and 2 also *add* DEC to the solvent mixture. Kim does not disclose, nor does Dr. Lucht address, the effect DEC has on the examples of Kim. For example, the presence of DEC in such a large volume % in Comparative Examples 1 and 2 may also be affecting the performance thereof. Accordingly, Kim teaches a POSITA to remove DEC from Zeng’s solvent mixture, which would affect the carefully-crafted solvent ratio.

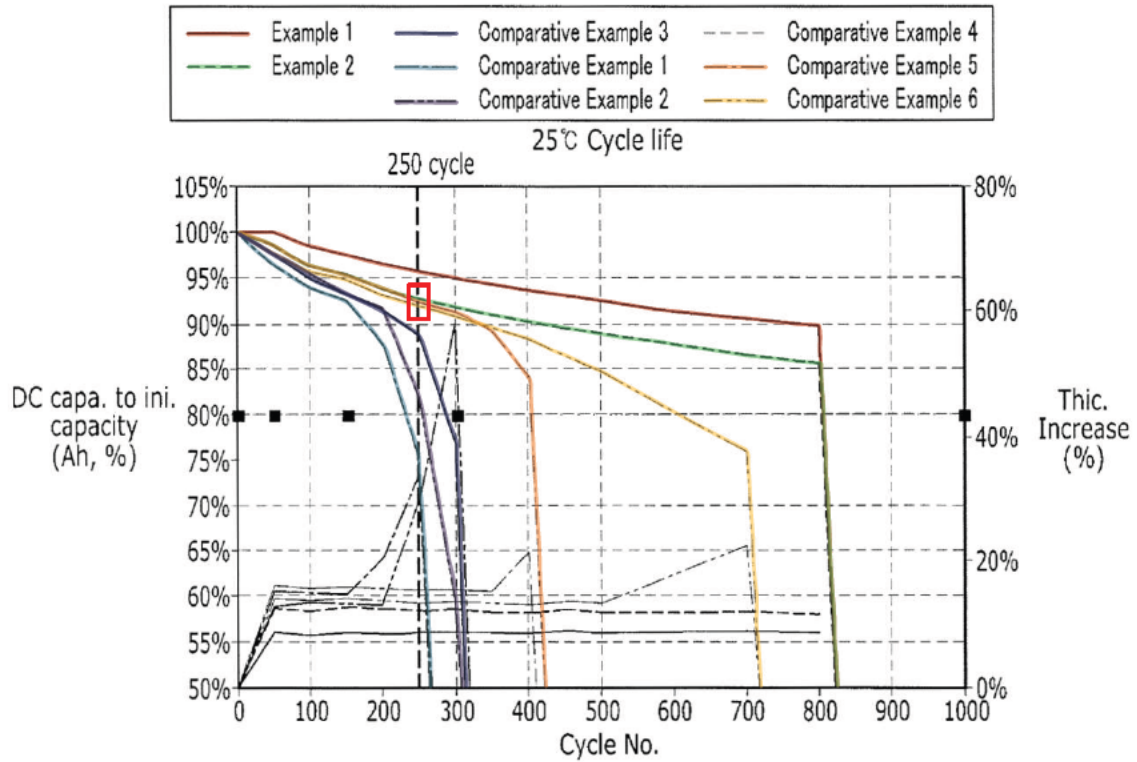
97. A POSITA would understand that DEC and similar linear carbonates are not idle spectators in electrolyte behavior, rather they substantially impact freezing behavior, bulk ionic transport, solvation/desolvation, and the SEI reactions on both electrodes. As Dr. Lucht notes in a prior scientific publication: “In addition to ion transport properties, SEI properties vary with the type of linear carbonates introduced” (Ex. 2046, p. 7), meaning these components are selected for their specific set of behaviors that is generally empirically determined.

98. Moreover, Kim's summary of cycle life in Table 4 is inconsistent with the cycle life data presented in FIG. 7. For example, a POSITA would conclude using test calculations that the "Capacity retention" values in Table 4 of Kim were computed as the ratio of "Capacity after 250 cycles" to "Initial capacity" in Table 4. Thus, "Capacity retention" in Kim's Table 4 corresponds directly to "DC capa. to ini. capacity" in Figure 7 of Kim. Ex. 2015 ¶ 204. This correspondence between Table 4 and Figure 7 is consistent for Examples 1 and 2 and Comparative Examples 1 and 2, which are shown as being 95.7%, 92.7%, 75.1%, and 82.0%, respectively, in both Table 4 and Figure 7. Ex. 1008, Table 4, Figure 7. However, when comparing the capacity retention values for the remaining Comparative Examples, including Comparative Examples 3-6, a POSITA would note significant discrepancies. In Figure 7, for example, Comparative Examples 5 and 6 are shown as having a 250-cycle capacity retention of around 92.5% and 92.3%, respectively, as reflected in the annotated Figure 7³⁶:

³⁶ I note that the lines designating Comparative Examples 1 and 2 are similar to, but distinguishable from, the lines designating Comparative Examples 5 and 6, respectively. For instance, the lines designating Comparative Examples 1 and 2 are thicker (bolded) relative to the lines designating Comparative Examples 5 and 6. I

have annotated the Figure to more easily distinguish between the different lines. Other than for Comparative Examples 5 and 6, the “DC capa. To ini. Capacity (Ah, %)” values at the “250 cycle” mark match that which is provided in Table 4 below. For example, the line designated for Comparative Example 1 crosses the “250 cycle” mark in Figure 7 at 75.1% and the capacity retention value provided in Table 4 for Comparative Example 1 is 75.1%. Similarly, the line designated for Comparative Example 2 crosses the “250 cycle” mark in Figure 7 at 82.0% and the capacity retention value provided in Table 4 for Comparative Example 2 is 82.0%. However, the line designated for Comparative Example 5 crosses the “250 cycle” mark in Figure 7 at 92.5% and the capacity retention value provided in Table 4 for Comparative Example 1 is 75.8%. Similarly, the line designated for Comparative Example 6 crosses the “250 cycle” mark in Figure 7 at 92.3% and the capacity retention value provided in Table 4 for Comparative Example 1 is 75.3%.

FIG. 7



However, in Table 4, these same capacity retentions are reported for the same Comparative Examples 5 and 6 at much lower values of 75.8% and 75.3%,

respectively:

TABLE 4

	initial capacity [mAh]	Capacity after 250 cycles [mAh]	Capacity retention	Initial thickness [mm]	Thickness after 250 cycles [mm]	Thickness variation ratio
Example 1	2112	2021	95.7%	3.32	3.61	8.7%
Example 2	2109	1956	92.7%	3.30	3.60	9.2%
Comparative Example 1	2040	1532	75.1%	3.27	4.39	34.4%
Comparative Example 2	2099	1720	82.0%	3.25	4.23	30.2%
Comparative Example 3	2061	1895	92.0%	3.28	3.73	13.6%
Comparative Example 4	2105	1870	88.9%	3.29	3.71	12.8%
Comparative Example 5	2122	1608	75.8%	3.26	3.78	15.7%
Comparative Example 6	2060	1551	75.3%	3.28	3.73	13.6%

Similarly, in Figure 7, the 250-cycle capacity retention of Comparative Example 3 is shown as around 88.9%, whereas in Table 4 the 250-cycle capacity retention of the same Comparative Example 3 is 92.0%. Meanwhile, there is no capacity retention curve for Comparative Example 4 in Figure 7 to compare against Table 4. Thus, the combination of Zeng, Sunose, and Kim, with or without Matsuoka, does not render claims 1 and 14 obvious for these additional reasons.

99. Moreover, as discussed in my original Declaration, Kim's data shows, but Kim does not discuss, that its capacity results are highly dependent on cell format. Ex. 2015 ¶¶199-200; Ex. 1008 [0095], [0099], Tables 2-3. Kim at Paragraph [0095] describes that Examples 1 and 2 and Comparative Examples 1-6 are embodied in *prismatic* cells, but at Paragraph [0099], Kim describes embodiments of the same Examples 1 and 2 and Comparative Examples 1-6 as *pouch* cells. A POSITA comparing "recovery capacity" results from the prismatic Example 1 (Ex. 1008, Table 2) and from the pouch Example 1 (*id.* Table 3) would see a notable capacity difference of 4.5%, which exceeds the capacity differences between Example 1 and Comparative Examples 2-4 and 6 in Table 2. A POSITA would not be confident in the individual measurements due to their manifest differences by cell format and could not infer or make any conclusory judgements about the purported efficacy embodied in Examples 1 and 2 compared to Comparative Examples, because such comparisons cannot be reliably made. *See also*, Ex. 2046 (Dr. Lucht's review of battery community research on low-temperature electrolytes states, "[i]t should be noted that *caution should be taken in comparing the performance since the results from different chemistry and cell designs are not comparable*") (emphasis added).

2. Petitioner Fails to Show that Zeng, Sunose, and Kim, with or without Matsuoka, Renders Obvious Claims 2, 4-7, 12, 15, and 17

100. Claims 2, 4-7, 12, 15, and 17 are not unpatentable for the same reasons as discussed above with respect to independent Claims 1 and 14.

D. Board Ground 5/Petitioner Ground 2A: Zeng, Sunose, and Su Do Not Render Obvious Claims 3 and 16³⁷

101. It is my understanding that for purposes of the Institution Decision, the Board held that it had “reviewed Petitioner’s arguments and evidence and find them sufficient to meet the threshold of § 314(a).” Paper 15, 57.

102. As previously explained in Paragraphs 216-217 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Lucht fail to show that claims 3 and 16 of the ’131 Patent are rendered obvious by Zeng, Sunose, and Su, and I incorporate those paragraphs by reference herein. Ex. 2015 ¶¶ 216-217.

103. Claims 3 and 16 of the ’131 Patent recite:

³⁷ It is my understanding that the Board “separately number[ed] each of Petitioner’s grounds and alternative grounds rather than group them with Petitioner’s alphanumeric designations for the base reference combinations and additional references.” Paper 15, 8.

3. The electrochemical device according to claim 1, wherein the electrode is an anode, and $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$.

16. The electrochemical device according to claim 14, wherein the first electrode is an anode, the second electrode is an anode, and $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$.

104. For at least the reasons discussed above with respect to Board Ground 1 and Petitioner's Ground 1A, it is my opinion that claims 3 and 16 are also not unpatentable. It is my further opinion that Su does not and cannot cure the deficiencies of Zeng and Sunose.

105. It is my understanding that a dependent claim, such as Claim 3, is construed to include all the limitations of the claim incorporated by reference into such dependent claim. Dependent Claim 3, for example, incorporates all of the limitations of Claim 1. *See e.g.*, Ex. 1001, 33:57-59 ("3. The electrochemical device according to claim 1...") Accordingly, dependent Claim 3 is interpreted as:

An electrochemical device, comprising:
an electrode; and
an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate; wherein,
based on a total weight of the electrolyte, a weight percentage of the dinitrile compound is X, and a weight percentage of the trinitrile compound is Y; wherein,
about $2 \text{ wt \%} \leq (X+Y) \leq \text{about } 8 \text{ wt \%}$, and
about $0.1 \leq (X/Y) \leq \text{about } 6$; wherein,
the electrode comprises a current collector, a single-sided coating and a double-sided coating;

a first part of the current collector is provided with the single-sided coating and a second part of the current collector is provided with the double-sided coating; and

an electrode compaction density of the electrode corresponding to the first part with the single-sided coating is $D1$, and, an electrode compaction density of the electrode corresponding to the second part with the double-sided coating is $D2$, wherein the electrode is an anode, and $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$, wherein, about $0.8 \leq D1/D2 \leq \text{about } 1.2$;

wherein based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z ; wherein, about $0.01 \leq (Y/Z) \leq \text{about } 0.3$;

wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof.

Claim 3 written so as to reflect the incorporation of all of the limitations of Claim 1 and wherein the further limitations of Claim 3 are highlighted in blue.

106. Accordingly, “the electrode” of Claim 3 is “the electrode” of Claim 1, such that “the electrode” of Claim 3 must meet both claimed formulas of “the electrode”: “ $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$ ” and “about $0.8 \leq D1/D2 \leq \text{about } 1.2$ ”. Because Claim 3 requires “the electrode” of Claim 1 to be “an anode”, the “anode” must meet both claimed formulas of “the electrode”: “ $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$ ” and “about $0.8 \leq D1/D2 \leq \text{about } 1.2$ ”.

107. However, when discussing independent Claim 1, Dr. Lucht and Petitioner rely on the disclosure of a cathode in Sunose as purportedly meeting the claimed formula “about $0.8 \leq D1/D2 \leq$ about 1.2”. Ex. 1003 ¶ 115-119.

108. Dr. Lucht and Petitioner appear to rely on Zeng as purportedly disclosing the limitation of Claim 3 requiring “wherein the electrode is an anode.” Pet. 45; Ex. 1003 ¶ 152.

109. To the extent Dr. Lucht and Petitioner rely on Su as further disclosing that the anode meets the claimed formula “ $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$ ”, Dr. Lucht and Petitioner fail to also present arguments that Su also meets the other required claimed formula of the anode: “about $0.8 \leq D1/D2 \leq$ about 1.2”. Ex. 1003 ¶¶ 152-155 (asserting that “Su’s Examples 2 and 3 batteries had the following single- and double-sided coating compaction densities D1, D2 for the negative electrode (anode)” and providing a table setting forth Examples 2 and 3 of Su having a purported D2 of 1.8 g/cm^3 and 1.5 g/cm^3 , respectively, but failing to provide any such purported single-sided coating compaction densities D1 or otherwise providing any argument or evidence that “about $0.8 \leq D1/D2 \leq$ about 1.2” is met by the anode of Su).

110. Moreover, neither Petitioner nor Dr. Lucht argue, nor can they argue, that the Sunose cathode is *modified* by Su such that a modified Sunose cathode is somehow also or instead the claimed anode that meets both formulas. *See e.g.*, Ex.

1003 ¶ 153 (“In my opinion, by definition, a lithium-ion battery requires a cathode and an anode (among other things).”), ¶ 157 (“Sunose describes a rolled electrode configuration and focuses primarily on the positive electrode (cathode), leaving out anode implementation details. But, in my opinion, a POSITA would need anode implementation details, too, to implement the Zeng/Sunose battery.”) As noted, Sunose does not teach anything about an anode. Ex. 1003 ¶ 153 (Dr. Lucht opining that “while Zeng and Sunose do not disclose focus on anodes, in my opinion, Su does.”).

111. Moreover, only Su is cited for allegedly disclosing the $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$ formula. *See e.g.*, Ex. 1003 ¶¶153-155.

112. Petitioner and Dr. Lucht make no argument to, nor would a POSITA, combine Sunose and Su to form a cathode that meets both the formulas required in Claim 3.

113. My opinion that Dr. Lucht and Petitioner fail to also present arguments that Su also meets the other required claimed formula of the anode(s) - “ $0.8 \leq D1/D2 \leq \text{about } 1.2$ ” - applies to Claim 16 as well. That is, Claim 16 is a dependent claim construed to include all the limitations of the claim incorporated by reference into such dependent claim. Therefore, dependent Claim 16 incorporates all of the limitations of Claim 14. *See e.g.*, Ex. 1001, 36:28-30 (“16. The electrochemical

device according to claim 14...”) Accordingly, dependent Claim 16 is interpreted as:

An electrochemical device, comprising:
electrodes; and
an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate; wherein,
based on a total weight of the electrolyte, a weight percentage of the dinitrile compound is X, and a weight percentage of the trinitrile compound is Y; wherein,
about $2 \text{ wt \%} \leq (X+Y) \leq \text{about } 8 \text{ wt \%}$, and
about $0.1 \leq (X/Y) \leq \text{about } 6$; wherein,
the electrode comprises a first electrode and a second electrode,
wherein
the first electrode comprises a first current collector and a single-sided coating;
the second electrode comprises a second current collector and a double-sided coating; and
an electrode compaction density of the first electrode comprising the single-sided coating is D1, and, an electrode compaction density of the electrode of the second electrode comprising the double-sided coating is D2, wherein the first electrode is an anode, the second electrode is an anode, and $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$, wherein, about $0.8 \leq D1/D2 \leq \text{about } 1.2$;
wherein based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z; wherein,
about $0.01 \leq (Y/Z) \leq \text{about } 0.3$;
wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof.

Claim 16 written so as to reflect the incorporation of all of the limitations of Claim 14 and wherein the further limitations of Claim 16 are highlighted in blue.

114. Moreover, Dr. Lucht confirms that both claims 1 and 14 read on the same subject matter—“an electrode having a current collector with both single- and double-sided coating portions.” Ex. 1003 ¶ 62. Accordingly, the same result of Claim 3 applies with respect to Claim 16

115. Thus, the combination of Zeng, Sunose, and Su does not render claims 3 and 16 obvious for these additional reasons.

E. Board Ground 6/Petitioner Ground 2B: Zeng, Sunose, Matsuoka, and Su Do Not Render Obvious Claims 3 and 16³⁸

116. It is my understanding that for purposes of the Institution Decision, the Board held that it had “reviewed Petitioner’s arguments and evidence and find them sufficient to meet the threshold of § 314(a).” Paper 15, 59.

117. As previously explained in Paragraph 218 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Lucht fail to show that claims 3 and

³⁸ It is my understanding that the Board “separately number[ed] each of Petitioner’s grounds and alternative grounds rather than group them with Petitioner’s alphanumeric designations for the base reference combinations and additional references.” Paper 15, 8.

16 of the '131 Patent are rendered obvious by Zeng, Matsuoka, Sunose, Su, and I incorporate this paragraph by reference herein. Ex. 2015 ¶ 218.

118. Moreover, for at least the reasons discussed above with respect to Board Grounds 1, 2, and 5 (Petitioner's Grounds 1A, 1B, and 2A), claims 3 and 16 are not unpatentable and Petitioner/Dr. Lucht fail to show that Zeng, Matsuoka, Sunose, and Su render obvious claims 3 and 16.

F. Board Grounds 7 and 8/Petitioner Ground 2C: Zeng, Sunose, Su, and Kim, with or without Matsuoka, Do Not Render Obvious Claims 3 and 16³⁹

119. It is my understanding that for purposes of the Institution Decision, the Board held that it had "reviewed Petitioner's arguments and evidence and find them sufficient to meet the threshold of § 314(a)." Paper 15, 59; *see also, id.* at 60.

120. As previously explained in Paragraph 219 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Lucht fail to show that claims 3 and 16 of the '131 Patent are rendered obvious by Zeng, Sunose, Su, and Kim, with or without Matsuoka, and I incorporate this paragraph by reference herein.

³⁹ It is my understanding that the Board "separately number[ed] each of Petitioner's grounds and alternative grounds rather than group them with Petitioner's alphanumeric designations for the base reference combinations and additional references." Paper 15, 8.

121. Moreover, for at least the reasons discussed above with respect to Board Grounds 1-6 (Petitioner's Grounds 1A, 1B, 1C, 2A, and 2B), claims 3 and 16 are not unpatentable and Petitioner/Dr. Lucht fail to show that Zeng, Sunose, Su, and Kim, with or without Matsuoka, render obvious claims 3 and 16

G. Board Ground 9/Petitioner Ground 3A: Zhou and Sunose Do Not Render Obvious Claims 1, 2, 4-7, 12, 14, 15, and 17⁴⁰

122. It is my understanding, that for purposes of the Institution Decision, the Board held that “on this preliminary record, we find that Petitioner demonstrates sufficient argument and evidence to show that it is more likely than not that claim 1 would have been obvious over Zhou and Sunose.” Paper 15, 73.

123. It is my further understanding, that for purposes of the Institution Decision, the Board held that “[o]n this preliminary record, we find that Petitioner demonstrates sufficient argument and evidence to show that it is more likely than not that claim 14 would have been obvious over Zhou and Sunose.” Paper 15, 74.

⁴⁰ It is my understanding that the Board “separately number[ed] each of Petitioner's grounds and alternative grounds rather than group them with Petitioner's alphanumeric designations for the base reference combinations and additional references.” Paper 15, 8.

124. As previously explained in Paragraphs 220-281 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Lucht fail to show that claims 1, 2, 4-7, 12, 15, and 17 of the '131 Patent are rendered obvious by Zhou and Sunose, and I incorporate those paragraphs by reference herein.^{41,42} Ex. 2015 ¶¶ 220-281.

⁴¹ See, e.g., Ex. 2023 (Wenbo Zhang et al., *Interfacial processes and influence of composite cathode microstructure controlling the performance of all-solid-state lithium batteries*, 9 ACS Applied Materials & Interfaces 17835 (2017)). I certify that the copy of the paper in Exhibit 2023 is to the best of my knowledge a true, accurate, and authentic copy of *Interfacial processes and influence of composite cathode microstructure controlling the performance of all-solid-state lithium batteries*, and accurately represents the copies of the paper published on May 8, 2017 by the journal ACS Applied Materials & Interfaces, which a POSITA would have known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

⁴² See, e.g., Ex. 2024 (BYU DIPPR® (Design Institute for Physical Properties) Thermophysical Properties Laboratory Data Information Sheet for n-Propyl

1. Petitioner Fails to Show that Zhou and Sunose Renders Obvious Independent Claims 1 and 14

125. It is my understanding that the Board held that “Patent Owner’s issues regarding multiple alleged errors in Zhou and by Dr. Lucht, are better addressed through the discovery process in which experts for both sides can state and defend their positions.” Paper 15, 67.

126. It is also my understanding that the Board held that “[c]onsidering Zhou’s identification of PP as a linear carboxylic acid ester for use in Zhou’s electrolyte, Petitioner sufficiently shows for purposes of institution that Zhou discloses this limitation of claim 1.” Paper 15, 68; *see also, id.*, 74-75 (claim 14).

Propionate). I certify that the copy of the paper in Exhibit 2024 is to the best of my knowledge a true, accurate, and authentic copy of BYU DIPPR® (Design Institute for Physical Properties) Thermophysical Properties Laboratory Data Information Sheet for n-Propyl Propionate, and accurately represents the copies of the paper publicly available as of May 6, 2025 in the BYU DIPPR® database, from which I personally accessed a copy of the paper that was included as an exhibit to my original declaration, Ex. 2015.

127. However, a POSITA grasping the complexities and unpredictable nature of battery chemistry, and specifically SEI chemistry, would understand that, just because two molecules share a functional group, does not mean that they can be used interchangeably without impacting performance. One well known example of small differences in chemical structure causing large differences in battery performance is the so-called “EC-PC disparity.” Ex. 2048.⁴³ Although ethylene carbonate (EC) and propylene carbonate (PC) differ by only one methyl substituent, EC is well-known to contribute positively to SEI formation, while PC is found to

⁴³ Ex. 2048 Lidan Xing et al., *Deciphering the Ethylene Carbonate–Propylene Carbonate Mystery in Li-Ion Batteries*, 51 Accounts of Chemical Research 282-289 (2018), <https://doi.org/10.1021/acs.accounts.7b00474>. I certify that the copy of the paper in Exhibit 2048 is to the best of my knowledge a true, accurate, and authentic copy of *Deciphering the Ethylene Carbonate–Propylene Carbonate Mystery in Li-Ion Batteries*, and accurately represents the copies of the paper published on January 30, 2018 by Accounts of Chemical Research, which a POSITA would have known about and would have been able to access. Publications from established scientific journals have reliable publication dates and are publicly available from multiple sources.

not form any protective interphase and indeed to contribute to the exfoliation (flaking off) of graphite anodes. *Id.*

128. Returning to the issue of PP and other linear carboxylic acid esters, and the complexity of attempting to substitute one constituent for a seemingly chemically similar other, Dr. Lucht's prior summary and review of battery community research on this issue in the context of low-temperature electrolytes is informative:

Linear carbonates and carboxylic esters are always desirable for LT [low-temperature] electrolytes, owing to their low viscosity and low melting points (Fig. 3). We would like to point out that Fig. 3 only uses two parameters, i.e., the viscosity and the melting point. However, other properties, such as good electrochemical and chemical stability, miscibility with other cosolvents, and a wide liquidus range should also be considered for LT electrolyte solvents.

Ex. 2046, pp. 5-6 (showing that even for initial screening, where one is mostly looking at single-component properties, there are many factors to consider).

It was concluded that esters with shorter alkyl chains have the advantage in getting better ionic conductivity for the bulk electrolyte,

but the disadvantage in forming more resistive and less protective SEIs
as compared to longer chain counterparts.

Ex. 2046, p. 9 (showing that small changes to the number of carbons on the ends of
the ester can have a big effect).

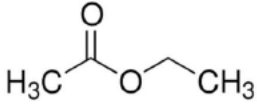
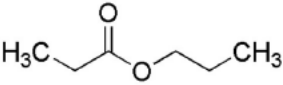
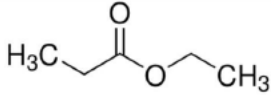
Some examples of LT electrolytes using linear carbonates and
carboxylic esters as cosolvents are listed in Table 1. It should be noted
that caution should be taken in comparing the performance since the
results from different chemistry and cell designs are not comparable.

Ex. 2046, p. 10 (showing that one must be careful in extrapolating behavior from
one electrolyte system to another, even when they comprise solvents from the same
chemical families).

129. In other words, a POSITA would have the same understanding as
summarized in Dr. Lucht's article and would understand that swapping one molecule
out for another, even if they are both linear carboxylic acid esters, cannot be done
without impacting performance. Moreover, even if a POSITA were to swap one
linear carboxylic acid ester out for another, a POSITA would not assume that the

optimal amount of one linear carboxylic acid ester would also be the optimal amount of another linear carboxylic acid ester.

130. Because of the unpredictable nature of battery chemistry, a POSITA would not solely rely on single-molecule physical properties (e.g., melting and boiling point) when determining whether to include it in an electrolyte formulation. However, even if a POSITA did use such physical properties of the molecules to guide its electrolyte formulation, the POSITA would understand that different linear carboxylic acid esters can have markedly different physical properties. For example, as illustrated in the table below, the boiling point of ethyl acetate (EA) and propyl propionate (PP) differs by more than 45 °C and the molar mass of EA and PP differs by more than 30%:

Molecule	Formula	Structure	Molar Mass (g/mol)	Melting Point	Boiling Point
Ethyl Acetate	C ₄ H ₈ O ₂		88.106	-84°C	77.1°C
Propyl Propionate	C ₆ H ₁₂ O ₂		116.16	-75.9°C	122.5°C
Ethyl Propionate	C ₅ H ₁₀ O ₂		102.13	-73°C	99°C

131. Dr. Lucht opines that “[a]lthough Example 8 lacks PP, Zhou lists eight linear carboxylic acid esters that are suitable replacements for EA, one being PP. It would have been obvious to replace EA with PP, a compound with a very similar structure.” Ex. 1003 ¶ 220. In my opinion, this is an oversimplification of battery chemistry. Even if a POSITA were to consider the structures of EA and PP to be similar, these “similar structures” result in substantially different physical properties (e.g., molecular weight, melting point, boiling point) and a POSITA would not assume that EA could be swapped out for PP without impacting the performance of the resultant battery. Dr. Lucht’s own words support this point as cited in Paragraph 128 above.

132. Dr Lucht also opines that “Kim had also disclosed that PP improves electrolyte performance, and [PP and EA] have a similar structure except for PP’s two additional methyl groups relative to EA, so a POSITA would expect replacing EA with PP in Zhou’s electrolyte to work predictably and as Zhou describes.” Ex. 1003 ¶ 224. This logic is flawed, especially in view of Kim.

133. For example, Zhou is interested in improving cycle performance ((Ex. 1014 ¶ [0059]) (“[i]n the above solvent system, the present invention improves the battery cycle performance with the help of certain special film-forming additives to make up for the incompatibility of the other negative electrodes”)) and, contrary to Dr. Lucht’s assertion that “Kim had also disclosed that PP improves electrolyte performance,” Kim’s Table 4 shows that increasing PP vol% while decreasing EP vol% actually results in a 3% decrease in cycle performance. Ex. 1008, Table 4.

134. That is, as acknowledged by Dr. Lucht, Examples 1 and 2 have the same dinitrile and trinitrile contents, but PP increases from 40 vol% (Example 1) to 60 vol% (Example 2) and EP decreases from 30 vol% (Example 1) to 0 vol% (Example 2). Ex. 1008, Table 1; Ex. 1003 ¶ 191. While Tables 2 and 3 of Kim show that increasing the PP vol% and decreasing the EP vol% results in a modest increase in recovery capacity after being allowed to stand at 60 °C for 4 or 3 weeks (0.6% increase when allowed to stand at 60 °C for 4 weeks and 1.2% increase when allowed

to stand at 60 °C for 3 weeks), Table 4 of Kim shows that increasing the PP vol% and decreasing the EP vol% results in a relatively large (3%) decrease in recovery capacity after being cycled 250 times. At best, Kim shows that battery chemistry is complex and unpredictable such that one molecule cannot be simply swapped out for another, even if they are both linear carboxylic acid esters. Again, Dr. Lucht has taught this very principle as cited in paragraph 128, although PP as a named constituent does not show up in Dr. Lucht's cited electrolyte review paper. Ex. 2046.

135. Moreover, as shown in the table above, EA is more dissimilar to PP than is EP (differing by two carbon groups rather than one), suggesting that swapping EA for PP could result in an even larger decrease in cycle performance. Because Zhou does not provide any examples with PP, a POSITA would not know how much PP to use in the electrolyte of Zhou's Example 8, much less be able to predict how swapping PP for EA would impact the performance of the resultant battery.

136. It is my understanding that the Board held that "[w]e do not read Zhou as explicitly teaching away from implementing Example 8" but "[r]ather, Zhou seems to encourage use of HTC_N, the trinitrile used in Example 8." Paper 15, 70. I disagree.

137. Zhou's analysis in Paragraph [0059] states "1,3,6-hexane trinitrile is particularly preferred." Ex. 1014 ¶ [0059]. Indeed, Zhou prefers HTCEN over compounds with fewer nitrile groups, because with HTCEN "the density of nitrile groups per unit volume is higher" and "[i]t has better compatibility with the negative electrode and is easier to protect the positive electrode. The high temperature improvement effect of other dinitrile compounds or mononitrile compounds is relatively poor." *Id.* Then Zhou concludes the analysis by contrasting the earlier statements, showing that HTCEN is not an unmitigated benefit: "However, excessive addition of nitrile has a negative effect on the cycle performance, especially in the case of fast charging, this phenomenon is more obvious, and the cycle performance will drop rapidly." *Id.* So, the POSITA is left with the picture that nitrile can be beneficial or harmful, depending on amount and temperature and cycling conditions. And if one is going to use it, a POSITA would gather, it is better to use a trinitrile as opposed to dinitrile or mononitrile, with no indication that there is benefit to, and actually a teaching against, having a mixture of trinitrile and dinitrile.

138. It is my understanding that the Board held that "[b]ased on the current record, we find Petitioner's position that a POSITA would have had a reason to combine Sunose's electrode configuration comprising a cathode having single- and double-sided coating positions on its current collector with Zhou's battery for the

benefit disclosed by Sunose.” Paper 15, 71-72. It is my further understanding that the Board held “to the extent that Sunose’s Table 1 may include packing densities that exceed the crystalline density of LCO, it is insufficient to conclude that (1) the packing densities identified for Sunose’s Examples 2-4 are incommensurable with the claimed ratio (D2/D1)” and “[i]f some physical origin underlies Sunose’s packing densities for Examples 2-4 and these identified packing density values are not challenged as ‘physically impossible,’ then it is not readily apparent that the ratios (M/N) for Sunose’s Examples 2-4 are incommensurable with the claimed ratio (D2/D1) as Patent Owner asserts.” Paper 15, 72-73. I disagree.

139. For at least the reasons discussed above in Paragraphs 45-61, which I incorporate here, Sunose is replete with values that are either based on a fundamentally flawed density methodology such that all purported density values are completely erroneous or which otherwise must correspond to some physical characteristic other than electrode compaction density, Sunose lacks enablement such that a POSITA would be deterred from its teachings, and Sunose’s N/M ratios are incommensurable with the claimed D1/D2 ratio. Indeed, the compatibility between electrode and electrolyte designs, including interactions on surfaces, requires extensive testing and any changes thereto may result in large performance differences. *See e.g.*, Ex. 2050, 62:18-64:5 (Dr. Lucht testifying that “typically you

would do a whole bunch of testing” and that both small and large changes can result in large differences). Given the complexity, one would not simply combine Zhou and Sunose without a contrived, hindsight-driven motivation. Indeed, the combination of Sunose’s electrodes may deteriorate the performance in Zhou.

140. Thus, the combination of Zhou and Sunose does not render claims 1 and 14 obvious for these additional reasons.

2. Petitioner Fails to Show that Zhou and Sunose Renders Obvious Claims 2, 4-7, 12, 15, and 17

141. Claims 2, 4-7, 12, 15, and 17 are not unpatentable for the same reasons as discussed above with respect to independent Claims 1 and 14.

H. Board Ground 10/Petitioner Ground 3C: Zhou, Sunose, and Kim Do Not Render Obvious Claims 1, 2, 4-7, 12, 14, 15, and 17⁴⁴

142. It is my understanding the Board held that “Petitioner has shown sufficiently for purposes of this [Institution] Decision that Zhou, Sunose, and Kim disclose or suggest all limitations recited in claims 1, 2, 4-7, 14, 15, and 17.” Paper 15, 76.

⁴⁴ It is my understanding that the Board “separately number[ed] each of Petitioner’s grounds and alternative grounds rather than group them with Petitioner’s alphanumeric designations for the base reference combinations and additional references.” Paper 15, 8.

143. As previously explained in Paragraphs 282-287 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Lucht fail to show that claims 1, 2, 4-7, 12, 15, and 17 of the '131 Patent are rendered obvious by Zhou, Sunose, and Kim, and I incorporate those paragraphs by reference herein. Ex. 2015 ¶¶ 282-287.

1. Petitioner Fails to Show that Zhou, Sunose, and Kim Renders Obvious Independent Claims 1 and 14

144. It is my understanding that “[a]t this stage in the proceeding, [the Board found] Petitioner sufficiently identifies a motivation to combine Kim with Zhou to adjust the relative amounts of trinitrile and PP” because “Petitioner explains how Kim’s disclosure of using PP along with a dinitrile and a trinitrile in both Examples was more successful than [sic] the Comparative Examples, none of which employed all three components.” Paper 15, 76.

145. However, as discussed herein at Paragraphs 95-99, which are incorporated here, Kim’s disclosure is not so clear. Dr. Lucht fails to address the effect of DEC on Examples 1 and 2 vs. Comparative Examples 1 and 2 and at least Comparative Examples 5 and 6 (which contain no PP) have similar capacity retention values—around 92.5% and 92.3%, respectively—to Example 2 in FIG. 7 of Kim. Thus, the combination of Zhou, Sunose, and Kim does not render claims 1 and 14 obvious for these additional reasons.

2. Petitioner Fails to Show that Zhou, Sunose, and Kim Renders Obvious Claims 2, 4-7, 12, 15, and 17

146. Claims 2, 4-7, 12, 15, and 17 are not unpatentable for the same reasons as discussed above with respect to independent Claims 1 and 14.

I. Board Ground 11/Petitioner Ground 4A: Zhou, Sunose, and Su Do Not Render Obvious Claims 3 and 16⁴⁵

147. It is my understanding the Board held that “[b]ased on the evidence in the present record, we are persuaded that Petitioner has shown sufficiently for purposes of this [Institution] Decision that Zhou, Sunose, and Su disclose or suggest all limitations recited in claims 3 and 16.” Paper 15, 77.

148. As previously explained in Paragraph 288 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Lucht fail to show that claims 3 and 16 of the ’131 Patent are rendered obvious by Zhou, Sunose, and Su, and I incorporate this paragraph by reference herein. Ex. 2015 ¶ 288.

149. Claims 3 and 16 of the ’131 Patent recite:

⁴⁵ It is my understanding that the Board “separately number[ed] each of Petitioner’s grounds and alternative grounds rather than group them with Petitioner’s alphanumeric designations for the base reference combinations and additional references.” Paper 15, 8.

3. The electrochemical device according to claim 1, wherein the electrode is an anode, and $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$.

16. The electrochemical device according to claim 14, wherein the first electrode is an anode, the second electrode is an anode, and $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$.

150. For at least the reasons discussed above with respect to Board Ground 9 and Petitioner's Ground 3A, which I incorporate here, it is my opinion that claims 3 and 16 are also not unpatentable. It is my further opinion that Su does not and cannot cure the deficiencies of Zhou and Sunose.

151. For at least the reasons discussed above in Paragraphs 103-114, which I incorporate here, Ground 11 also fails due to Dr. Lucht's and Petitioner's failure to present arguments that the anode of Su simultaneously meets both "about $0.8 \leq D1/D2 \leq \text{about } 1.2$ " and " $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$ " and because Petitioner cannot fix its absence of argument, Petitioner forfeits any challenge of Claims 3 and 16.

152. Thus, the combination of Zhou, Sunose, and Su does not render claims 3 and 16 obvious for these additional reasons.

J. Board Ground 12/Petitioner Ground 4C: Zhou, Sunose, Su, and Kim Do Not Render Obvious Claims 3 and 16⁴⁶

153. It is my understanding that the Board indicated “[i]t is not clear from the Petition why this ground is raised” but “[b]ecause we determine that Petitioner has shown sufficiently for purposes of this [Institution] Decision that Zhou, Sunose, and Su disclose or suggest all limitations recited in claims 3 and 6, and because we find evidence to support Kim’s disclosure of using PP along with a dinitrile and a trinitrile in both Examples was more successful that [sic] the Comparative Examples[], we determine Petitioner’s arguments to be sufficient to meet the threshold of § 314(a) for this ground.” Paper 15, 77-78.

154. As previously explained in Paragraph 289 of my original Declaration (Ex. 2015), in my opinion, Petitioner and Dr. Lucht fail to show that claims 3 and 16 of the ’131 Patent are rendered obvious by Zhou, Sunose, Su and Kim, and I incorporate this paragraph by reference herein. Ex. 2015 ¶ 289.

⁴⁶ It is my understanding that the Board “separately number[ed] each of Petitioner’s grounds and alternative grounds rather than group them with Petitioner’s alphanumeric designations for the base reference combinations and additional references.” Paper 15, 8.

155. Moreover, for at least the reasons discussed above with respect to Board Grounds 9-11 (Petitioner's Grounds 3A, 3C, and 4A), which I incorporate here, claims 3 and 16 are not unpatentable and Petitioner/Dr. Lucht fail to show that Zhou, Sunose, Su, and Kim render obvious claims 3 and 16.

VIII. CONCLUSION

156. In sum, it is my opinion that Board Grounds 1-12, corresponding to Petitioner's Grounds 1A, 1B, 1C, 2A, 2B, 2C, 3A, 3C, 4A, and 4C, do not render Claims 1-7, 12, and 14-17 of the '131 Patent unpatentable as 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 November 12, 2025, in Provo, Utah.

A handwritten signature in black ink, reading "Dean R. Wheeler", written over a horizontal line.

Dean R. Wheeler