

Declaration of Dean R. Wheeler, Ph.D
IPR2025-00405
U.S. Patent No. 11,769,910

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: IPR2025-00405

U.S. Patent No. 11,769,910

**DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT
OF PATENT OWNER'S PRELIMINARY 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. 11,769,910 (the “’910 Patent”).

3. I understand that Zhuhai CosMX Battery Co., Ltd. (“Petitioner”) filed a petition for *Inter Partes* Review (“IPR”) of the ’910 Patent (“Petition”), in which Petitioner asserts that:

- Claims 1-6, 11, 12, and 16-26 are obvious over Chinese Patent Application Publication No. 106099187A (“Zeng” or “Ex. 1006”) (Ground 1A);
- Claims 1-6, 11, 12, and 16-26 are obvious over Zeng and U.S. Patent Application Publication No. 2013/0224535A1 (“Matsuoka” or “Ex. 1007”) (Ground 1B);
- Claims 1-6, 11, 12, and 16-26 are obvious over Zeng, Matsuoka, and U.S. Patent Application Publication No. 2017/0288268A1 (“Kim” or “Ex. 1008”) (Ground 1C);¹
- Claims 13 and 14 are obvious over Zeng and Japanese Patent Application Publication No. 2009-252349 (“Sunose” or “Ex. 1010”) (Ground 2A);

¹ Petitioner considers Matsuoka to be optionally included as Petitioner asserts that “**Zeng or Zeng/Matsuoka**, further in view of Kim, renders obvious claims 1-6, 12, and 16-26” such that Ground 1C constitutes two grounds. Pet., 50 (emphasis added).

- Claims 13 and 14 are obvious over Zeng, Matsuoka, and Sunose (Ground 2B);
- Claims 13 and 14 are obvious over Zeng, Matsuoka, Sunose, and Kim (Ground 2C);²
- Claim 15 is obvious over Zeng, Sunose, and Chinese Patent No. 108023117 (“Su” or “Ex. 1012”) (Ground 3A);
- Claim 15 is obvious over Zeng, Matsuoka, Sunose, and Su (Ground 3B);
- Claim 15 is obvious over Zeng, Matsuoka, Sunose, Su, and Kim (Ground 3C);³
- Claims 1-6, 11, 12, and 16-26 are obvious over Chinese Patent Application Publication No. 105552439A (“Zhou” or “Ex. 1014”) (Ground 4A);
- Claims 1-6, 11, 12, and 16-26 are obvious over Zhou and Kim (Ground 4C);⁴
- Claims 13 and 14 are obvious over Zhou and Sunose (Ground 5A);

² Petitioner considers Matsuoka to be optionally included as Petitioner asserts that “**Zeng or Zeng/Matsuoka** and Sunose, further in view of Kim, renders obvious claims 13 and 14” such that Ground 2C constitutes two grounds. Pet., 50 (emphasis added); *see also*, Pet. 12 (“Zeng; Zeng/Matsuoka”).

³ Petitioner considers Matsuoka to be optionally included as Petitioner asserts that “**Zeng or Zeng/Matsuoka** and Sunose [and Su], further in view of Kim, renders obvious claim 15” such that Ground 3C constitutes two grounds. Pet., 50 (emphasis added); *see also*, Pet. 12 (“Zeng/Kim; Zeng/Matsuoka/Kim”).

⁴ Notably, Petitioner did not assert a Ground 4B.

- Claims 13 and 14 are obvious over Zhou, Sunose, and Kim (Ground 5C);⁵
- Claim 15 is obvious over Zhou, Sunose, and Su (Ground 6A); and
- Claim 15 is obvious over Zhou, Sunose, Su, and Kim (Ground 6C).⁶

4. I have been asked, for purposes of Patent Owner's Preliminary Response, to analyze and respond to particular assertions in the Petition. I reserve the right to analyze and respond to other alleged patentability challenges if this proceeding is instituted.

5. As explained below, in my opinion, the Petition fails to show that claims 1-6 and 12-26 of the '910 Patent are rendered obvious.

6. 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

7. My qualifications and professional experience are described in my *curriculum vitae*, a copy of which is provided with this Declaration as Ex. 2016. The following is a brief summary of my qualifications and professional experience.

⁵ Notably, Petitioner did not assert a Ground 5B.

⁶ Notably, Petitioner did not assert a Ground 6B.

8. I am a university professor and consultant with 28 years of experience in the fields of electrochemical engineering, materials science, and manufacturing of battery materials. I received a B.S. in Chemical Engineering from Brigham Young University in 1996, and a Ph.D. in Chemical Engineering from the University of California, Berkeley, in 2002. My Ph.D. advisor was Professor John Newman, arguably the world's foremost leader in understanding battery materials through computer simulations. Under his direction, I acquired a deep understanding of the physics and chemistry of battery materials.

9. I have taught numerous classes on electrochemical engineering and materials science during my twenty-two years at Brigham Young University, as assistant professor, associate professor, and now, full professor. I currently serve as the department chair in the Chemical Engineering Department of Brigham Young University, supervising sixteen faculty members and six full-time staff.

10. I am an inventor on two issued patents and one patent application in the field of electrochemical devices. For example, U.S. Patent No. 11,340,261, issued in 2022, describes a flexible electric probe used to determine electrical properties of thin-film battery electrodes.

11. I have also authored or co-authored 63 peer-reviewed scientific publications. My most influential paper, "Quantifying tortuosity in porous Li-ion battery materials," published in the Journal of Power Sources in 2009, has been cited more than 600 times, and describes the movement of ions through various types of battery materials, including separator and electrode materials. I have also published papers on the subjects of electrode structures and compaction,

interactions of solids, binders, and electrolytes, interfaces between electrodes and electrolytes, and how all these factors relate to battery longevity.⁷

12. I have received more than \$7 million in government research grants to study batteries and related materials. Current research grants from NASA and the U.S. Army deal with understanding and improving electrolyte formulations and interactions with anode and cathode materials. My student assistants and I regularly fabricate and analyze battery materials in the laboratory, using techniques comparable to those described in the '910 Patent and cited prior art references. In particular, we routinely mix up custom-formulated electrolyte solutions, fabricate cathodes and anodes, and construct and test full lithium-based batteries. My research group is among the top users of electron microscopy at the university, which we use to analyze and understand battery electrode and separator structures. We also routinely measure the properties of battery materials and develop new diagnostic tools for making such measurements. Such training

⁷ See, e.g., Exs. 2028 (Amir-Sina Hamed, Fezzeh Pouraghajan, Fei Sun, Mojdeh Nikpour, & Dean R. Wheeler, *Interplay of Electrode Heterogeneity and Lithium Plating*, 169 020551 J. Electrochem. Soc. (2022)), 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 080502 J. Electrochem. Soc. (2023)), 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 229636 J. of Power Sources (2021)), 2031 (Amir-Sina Hamed, Edmund M. Shumway, & Dean R. Wheeler, *Electrode-Level Modeling of Silicon Anodes for Improved Cell Design*, 171 120539 J. Electrochem. Soc. (2024)).

in my laboratory has allowed the students graduating from my program to go on to employment at numerous battery manufacturers and battery-related startup companies across the United States.

13. In 2016, I led the Gordon Research Conference on Batteries,⁸ as conference chair, having been nominated and voted into that position at a previous conference. This biennial international conference is attended by around two hundred of the world's thought leaders in the field of batteries. Furthermore, on three occasions I was selected to be a member of the technical review team for an ongoing \$25 million/year "Battery Hub" program funded by the U.S. Department of Energy.⁹ I believe my experience in such positions of leadership and responsibility, among others, reflects the stature with which I am viewed by my peers in the academic, industrial, and government battery research communities.

B. Materials Considered

14. The opinions contained in this Declaration are based on the documents I reviewed, as well as my education, years of professional experience, and knowledge. In forming my opinions expressed in this Declaration, I further reviewed the Petition, all exhibits or other material cited therein, and any additional exhibits or other material cited in this Declaration.

⁸ See Ex. 2025 (*2016 Batteries Conference GRC*, <https://www.grc.org/batteries-conference/2016/> (last visited on May 12, 2025)).

⁹ See Ex. 2026 (*Hubs – Department of Energy*, <https://www.energy.gov/hubs> (last visited on May 12, 2025)); Ex. 2027 (*DOE Energy Innovation Hubs*, <https://science.osti.gov/bes/Research/DOE-Energy-Innovation-Hubs> (last visited on May 12, 2025)).

15. This 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 Declaration based on any new information that I may be asked to review.

16. As I discuss below, I disagree with Dr. Lucht's conclusions that the subject matter of any of claims 1-6 and 12-26 of the '910 patent would have been obvious in view of the Grounds he has identified.

III. LEGAL STANDARDS

17. In this section, I describe my understanding of certain legal standards. I have been informed of these legal standards by Patent Owner's legal counsel. I am not an attorney and I am relying only on instructions from Patent Owner's legal counsel for these legal standards.

A. Claim Construction

18. My opinions concern what I believe the person of ordinary skill in the art ("POSITA") would have understood the meaning of certain claim terms to be based on the patent documents.

19. I have been informed that assessing the validity of a patent claim requires a two-step analysis. The first step involves the proper interpretation or construction of the claim language in order to determine its scope and meaning. The second step requires comparing the claim, as properly construed, to the alleged prior art to determine whether the limitations of the claim are met by the prior art.

20. My methodology for determining the meaning of claim phrases was first to study the patent carefully. In particular, I studied the claims themselves, followed by the background, detailed specification, figures, and other patent content. Next, I reviewed the prosecution history

looking for any clarifications or limitations that might be attached to claim terms. In some circumstances, I looked at other documents, such as references applied by the patent office.

21. I understand that in an *inter partes* review, claim terms are to be given their ordinary and customary meaning as understood by a person of ordinary skill in the art in the context of the entire disclosure at the time of the invention. I understand that one must be careful not to read a specific embodiment appearing in the written description into the claim if the claim language is broader than the embodiment. I further understand that any special definition for a claim term must be set forth with reasonable clarity, deliberateness, and precision.

22. I have been informed that this standard is the same as that used in United States district courts, in which claim terms are given their ordinary and customary meaning as would be understood by a person of ordinary skill in the art at the time of the invention having taken into consideration the language of the claims, the specification, and the prosecution history of record under the *Phillips* claim construction standard.

B. Prior Art Status

23. I understand that the “priority date” of a patent is the date on which it is filed, or the date on which an earlier-filed patent application is filed if the patentee claims the benefit of priority to that earlier-filed patent application. I understand that a particular claim is entitled to claim the priority date of an earlier-filed application if the earlier-filed application provides written description of the subject matter of that particular claim.

24. I understand that a U.S. or foreign patent or patent application qualifies as prior art to an asserted patent if the date of issuance or publication of the patent or publication is prior to the priority date of the challenged patent.

25. I understand that a printed publication, such as an article published in a magazine or trade publication, qualifies as prior art to the challenged patent if the date of publication is prior to the priority date of the asserted patent.

26. I understand that to qualify as prior art, a reference must contain an enabling disclosure that allows one of ordinary skill to practice the reference's disclosure without undue experimentation.

C. Anticipation

27. I understand that, once the claims of a patent have been properly construed, determining anticipation of a patent claim requires a comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis.

28. I understand that in order for a claim to be anticipated, each and every requirement of the claim must be found, expressly or inherently, in a single prior art reference as recited in the claim.

29. I understand that a prior art reference "inherently" discloses a limitation if that limitation is necessarily present in the prior art reference.

30. I understand, however, that inherency may not be established by probabilities or possibilities, and the mere fact that a certain thing may result from a given set of circumstances is not sufficient to establish anticipation by inherency.

31. I understand that it is impermissible for anticipation to combine multiple, separate embodiments, even if they are described in a single prior art reference.

32. Understanding that there are not any issues with respect to anticipation in this *inter partes* review, I focus my attention on obviousness.

D. Obviousness

33. I understand that a claimed invention is not patentable if the claimed invention would have been obvious to a person of ordinary skill in the field of the invention at the time of the patent claim's effective filing date.

34. I have been informed and understand that the obviousness analysis requires evaluating the claim language as a whole, including comparing each and every limitation of the properly construed claim language to the prior art.

35. I understand that a person of ordinary skill in the art provides a reference point from which the prior art and claimed invention should be viewed. This reference point prevents one from using his or her own insight or hindsight in deciding whether a claim is obvious.

36. I have been informed and understand that an invention composed of several elements is not proved obvious merely by demonstrating that each of its elements was independently known or in the prior art, but that there must be an apparent reason or motivation to combine the known elements in the fashion claimed by the patents at issue.

37. I understand that in order to show obviousness based on a single reference or a combination of references, a particular motivation to modify the reference or combine the teachings in the references, and a reasonable expectation of success must be shown. I further understand that whether a proposed modification or combination of the prior art has a reasonable expectation of success is determined at the time the invention was made.

38. I understand that the obviousness inquiry includes consideration of various factors, such as the scope and content of the prior art, the differences between the prior art and the claims at issue, the knowledge of a person of ordinary skill in the pertinent art at the time of invention, and any objective factors indicating non-obviousness.

39. I am informed that objective factors indicating non-obviousness, also known as secondary considerations, may include (1) a long felt but unmet need in the prior art that was satisfied by the alleged invention of the patent; (2) commercial success or lack of commercial success of processes covered by the patent; (3) unexpected results achieved by the alleged invention; (4) praise of the alleged invention by others skilled in the art; (5) taking of licenses under the patent by others; and (6) deliberate copying of the alleged invention. I also understand that there must be a relationship or nexus between any such secondary indicia and the alleged invention.

40. I understand that in order to rely on a reference for obviousness, the reference must be analogous art. I also understand that to be analogous art, the reference must be either (1) from the same field of endeavor as the claimed subject matter, regardless of the problem addressed, or (2) if not in the same field of endeavor, reasonably pertinent to the particular problem with which the inventor is involved. I am also familiar with the premise that for a reference to be reasonably pertinent, it must have logically commended itself to an inventor's attention at the time of invention.

IV. TECHNOLOGY OVERVIEW

A. Solid Electrolyte Interphase in Lithium-Ion Batteries

41. In lithium-ion batteries, lithium ions shuttle back and forth between the negative and positive electrodes during cycling. During the first few cycles of the lithium-ion battery the electrolyte undergoes reduction at the negative electrode (or anode), and oxidation at the positive electrode (or cathode). This forms a passive protective layer on the anode and cathode called the solid electrolyte interphase (SEI), comprising a mixture of inorganic and organic compounds and

especially electrolyte decomposition or other reaction products. Battery performance, irreversible charge loss, rate capability, cyclability, and safety are highly dependent on the quality of the SEIs.

42. Many vital, interdependent factors contribute to properties of the SEI and there is no absolute parameter circumscribing the SEI. It is the combined effect of all these factors which affects the properties, quality, and efficiency of SEI. In particular, the specific type of solvent, organic additives, and lithium salt(s) added to the electrolyte solution, and the specific concentration of each such component, can play a crucial role in determining the performance of the SEI.

43. While anode SEIs have been studied for over two decades, cathode SEIs have not been studied as much, and constitute a relatively new and “hot” area of research today. In particular, cathode SEIs that do not decompose and perform well at voltages above 4.4V are an area of high interest in industry and academia.

44. The design rules for how to make a high-functioning SEI are still being discovered and explored, and the field remains highly empirical and Edisonian, in which researchers try many combinations to discover what works or does not work. To make an SEI that meets all objectives has never happened because the ultimate design goal is essentially a battery that lasts forever, meaning one has formed an SEI film on each electrode that perfectly protects the electrode and prevents any further degradation at operational conditions including temperature and voltage. The difficulty of the task is amplified by the vastness of the design space in which researchers may select any number and relative amounts of electrolyte solvents, additives, and lithium-containing salts.

B. The '910 Patent

45. The '910 Patent describes a novel lithium-ion battery electrolyte solution that can provide a firm protective SEI film on the surface of the cathode of an electrochemical device such as a lithium-ion battery that is not easily decomposed, effectively inhibits the increase in DC internal resistance of the lithium ion battery, and achieves high capacity density, and excellent cycle and storage performances. Ex. 1001, 1:56-63, 3:8-20. The '910 Patent achieves this by providing an electrolyte solution comprising a dinitrile compound, a trinitrile compound, and propyl propionate in specific weight percentage concentrations and mixing ratios. *Id.* 1:56-63, 27:48-60, 29:19-34.

46. The '910 Patent explains that a dinitrile compound can form a protective film (or SEI)¹⁰ on the cathode of the electrochemical device, so as to inhibit the decomposition of the electrolyte solvent in the electrochemical device. *Id.* 1:50-53. However, since the protective film itself is decomposed on the surface of the cathode at a high potential, the protective film's role of inhibiting decomposition of the solvent cannot be sustained for a long time. *Id.* 1:53-56.

47. The '910 Patent discusses the challenges with electrochemical devices working at voltages above 4.4V, noting that “[a]t 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.” *Id.* 22:57-62, 1:31-40; *see also* 1:33-38 (“at high voltages, the oxidation activity of the positive electrode material increases, and the stability decreases, which makes the electrolyte decompose on the surface of the positive

¹⁰ The “protective film” described in the '910 Patent is akin to the “SEI” described in Section IV.A.

electrode easily or cause deterioration of the battery material, resulting in a decrease in battery capacity.”). The ’910 Patent further explains that “[p]rior to the present application, the primary solution [was] to add a film-forming additive to the electrolyte [but] 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.” *Id.* 21:62-67.

48. The inventors of the ’910 Patent discovered that by using a mixture of a dinitrile compound, a trinitrile compound, and propyl propionate in specific concentration ranges and mixing ratios, a firm SEI protective film that is not easily decomposed at a high potential of 4.45V and inhibit a DC internal resistance in the electrochemical device, could be formed on the surface of the cathode. *Id.* 1:56-61 (“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.”), 29:26-29 (“The combination of [a dinitrile, a trinitrile, and propyl propionate as specified in Table 2] can form a cathode protection film so as to reduce the side reactions, thereby effectively controlling the polarization and side reactions of the battery.”), 29:29-34 (“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.”).

49. The ’910 Patent explains that such a protective film inhibits side reactions in the lithium ion battery and reduces a voltage drop during storage of the lithium ion battery, so as to

improve the long-term storage performance and reliability of the electrochemical device. *Id.* 2:39-52, 2:16-24, 29:19-34.

V. LEVEL OF ORDINARY SKILL IN THE ART

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

A person of ordinary skill in the art (“POSITA”) of the ’910 Patent would have had 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* EX1001, 1:19-21 (“the technical field of energy storage technologies, in particular to an electrolyte and an electrochemical device containing the electrolyte”); EX1003, ¶ 17. This level of skill is approximate, and more experience may compensate for less formal or different education, and vice versa.

Pet., p. 11.

51. For purposes of this Declaration in support of Patent Owner’s Preliminary Response, I offer no independent opinion of the level of ordinary skill in the art but have adopted the definition proposed by Petitioner. I reserve the right to further address the level of ordinary skill in the art if this proceeding is instituted.

52. Each of the arguments below should be considered from the perspective of a POSITA in the field of the ’910 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. THE BOARD SHOULD NOT INSTITUTE INTER PARTES REVIEW

53. I understand that in order for an *inter partes* review to be instituted, the Petition must establish that there is a reasonable likelihood that at least one challenged claim is unpatentable. For at least the reasons I explain below, it is my opinion that the Petition fails to do so.

A. Ground 1A: Zeng Does Not Render Obvious Claims 1-6, 12, and 16-26

54. Petitioner contends that Zeng renders obvious claims 1-6, 12, and 16-26 of the '910 Patent. These claims recite:

1. 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, a weight percentage of the trinitrile compound is Y, and a weight percentage of the propyl propionate is Z; wherein:

about $2.2 \text{ wt } \% \leq (X+Y) \leq$ about $8 \text{ wt } \%$,

about $0.1 \leq (X/Y) \leq$ about 2.3 ,

$5 \text{ wt } \% \leq Z \leq 20 \text{ wt } \%$ or $30 \text{ wt } \% \leq Z \leq 50 \text{ wt } \%$, and

about $0.02 \leq (Y/Z) \leq$ about 0.3 ;

wherein the dinitrile compound is one or more compounds selected from the group consisting of butanedinitrile, adiponitrile, ethylene glycol bis(2-cyanoethyl)ether, and 1,4-dicyano-2-butene; and the trinitrile compound is one or more compounds selected from the group consisting of 1,3,6-hexanetricarbonitrile, 1,2,6-hexanetricarbonitrile and 1,2,3-tris(2-cyanoethoxy)propane;

wherein the electrolyte further comprises a compound having a sulfur-oxygen double bond.

2. The electrolyte according to claim 1, wherein,

the dinitrile compound comprises adiponitrile, wherein,

$0.1 \leq$ a weight percentage of the adiponitrile \div a weight percentage of the trinitrile compound ≤ 2.3 ,

where the weight percent of the adiponitrile is based on the total weight of the electrolyte, and the weight percent of the trinitrile compound is based on the total weight of the electrolyte.

3. The electrolyte according to claim 1, wherein the compound having a sulfur-oxygen double bond comprises 1,3-propanesultone, based on the total weight of the electrolyte, a weight percentage of the 1,3-propanesultone is not less than 0.1 wt %, and not greater than 3 wt %.

4. The electrolyte according to claim 1, wherein $0.1 \leq X/Y \leq 2.0$.

5. The electrolyte according to claim 1, wherein $0.025 \leq Y/Z \leq 0.3$.

6. The electrolyte according to claim 1, wherein X is 0.01-10 wt %, Y is 0.01-10 wt %.

12. An electrochemical device, wherein the electrochemical device comprises electrodes and an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate, wherein, based on the total weight of the electrolyte, the weight percentage of the dinitrile compound is X, the weight percentage of the trinitrile compound is Y and a weight percentage of the propyl propionate is Z; wherein,

about $2.2 \text{ wt } \% \leq (X+Y) \leq \text{about } 8 \text{ wt } \%$,

about $0.1 \leq (X/Y) \leq \text{about } 2.3$,

about $5 \text{ wt } \% \leq Z \leq 20 \text{ wt } \%$ or $30 \text{ wt } \% \leq Z \leq 50 \text{ wt } \%$, and

about $0.02 \leq (Y/Z) \leq \text{about } 0.3$;

wherein the dinitrile compound is one or more compounds selected from the group consisting of butanedinitrile, adiponitrile, ethylene glycol bis(2-cyanoethyl) ether, and 1,4-dicyano-2-butene; and the trinitrile compound is one or more compounds selected from the group consisting of 1,3,6-hexanetricarbonitrile, 1,2,6-hexanetricarbonitrile and 1,2,3-tris(2-cyanoethoxy)propane;

wherein the electrolyte further comprises a compound having a sulfur-oxygen double bond.

16. The electrochemical device according to claim 12, wherein the dinitrile compound comprises adiponitrile, wherein,

$0.1 \leq a$ weight percentage of the adiponitrile \div a weight percentage of the trinitrile compound ≤ 2.3 ,

where the weight percent of the adiponitrile is based on the total weight of the electrolyte, and the weight percent of the trinitrile compound is based on the total weight of the electrolyte.

17. The electrochemical device according to claim 12, wherein, the compound having a sulfur-oxygen double bond comprises 1,3-propanesultone, based on the total weight of the electrolyte, a weight percentage of the 1,3-propanesultone is not less than 0.1 wt %, and not greater than 3 wt %.

18. The electrochemical device according to claim 12, wherein X is 0.01-10 wt %, Y is 0.01-10 wt %.

19. The electrochemical device according to claim 12, wherein $0.1 \leq X/Y \leq 2.0$.

20. 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, a weight percentage of the trinitrile compound is Y and a weight percentage of the propyl propionate is Z; wherein,

about $2.2 \text{ wt } \% \leq (X+Y) \leq$ about 8 wt %,

about $0.1 \leq (X/Y) \leq$ about 6,

5 wt % $\leq Z \leq$ 20 wt % or 30 wt % $\leq Z \leq$ 50 wt %, and

about $0.01 \leq (Y/Z) \leq$ about 0.3;

wherein the dinitrile compound comprises at least one selected from the group consisting of butanedinitrile, adiponitrile, ethylene glycol bis(2-cyanoethyl) ether, and 1,4-dicyano-2-butene; and the trinitrile compound is one or more compounds selected from the group consisting of 1,3,6-hexanetricarbonitrile, 1,2,6-hexanetricarbonitrile and 1,2,3-tris(2-cyanoethoxy)propane;

wherein the electrolyte further comprises 1,3-propanesultone and fluoroethylene carbonate; wherein,

based on the total weight of the electrolyte, a weight percentage of the 1,3-propanesultone is not less than 0.1 wt %, and not greater than 3 wt %.

21. The electrolyte according to claim 20, wherein,
the dinitrile compound comprises adiponitrile, wherein,

$0.1 \leq a$ weight percentage of the adiponitrile \div a weight percentage of the trinitrile compound ≤ 2.3 ,

where the weight percent of the adiponitrile is based on the total weight of the electrolyte, and the weight percent of the trinitrile compound is based on the total weight of the electrolyte.

22. The electrolyte according to claim 20, wherein X is 0.01-10 wt %, Y is 0.01-10 wt %.

23. The electrolyte according to claim 20, wherein $0.2 \leq X/Y \leq 5$.

24. The electrolyte according to claim 20, wherein $2.2 \text{ wt } \% \leq X+Y \leq 8 \text{ wt } \%$, and $0.1 \leq X/Y \leq 2.3$.

25. The electrolyte according to claim 20, wherein $0.1 \leq X/Y \leq 2.0$.

26. The electrolyte according to claim 20, wherein $0.025 \leq Y/Z \leq 0.3$.

55. Zeng is directed to a wide-temperature range homogenous non-aqueous electrolyte solution to provide certain performance advantages for the lithium-ion battery, the electrolyte solution using an additive combination that can “effectively protect the structural stability of positive and negative electrode materials, and has excellent solubility in the mixed solvent.” Ex. 1006, Abstract. Indeed, it is important to Zeng that the electrolyte solution “can be maintained even after storage for a long period of time in an environment below -30°C ” such that it does not “precipitate crystals at low temperatures and facilitate[es] the transportation and long-term storage of the non-aqueous electrolyte solution in the north of China.” *Id.* Zeng describes 9 embodiments and 6 comparison examples of various electrolyte formulations conducts capacity retention rate performance and low-temperature storage (e.g., precipitation) testing on lithium-ion batteries made

with these electrolyte solutions to test the effect that the solvent systems and additive combinations have on performance and temperature range of the batteries:

Embodiment	Solvent composition	FEC (%)	ADN (%)	Structural formula I additives (%)	Other additives (%)	Retention rate (%) after 500 cycles at 1C rate for 4.40 V at ambient temperature	Precipitation of crystals after storage for 10 days at -30°C
Embodiment 1	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 10: 20	4	2	T ₁ : 1 T ₂ : 0.5	VC: 0.2 PS: 4	91.2	No precipitation
Embodiment 2	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 10: 20	4	1	T ₁ : 2 T ₂ : 0.5	VC: 0.2 PS: 4	91.9	No precipitation
Embodiment 3	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 10: 20	4	2	T ₃ : 1 T ₂ : 0.5	VC: 0.2 PS: 4	90.8	No precipitation

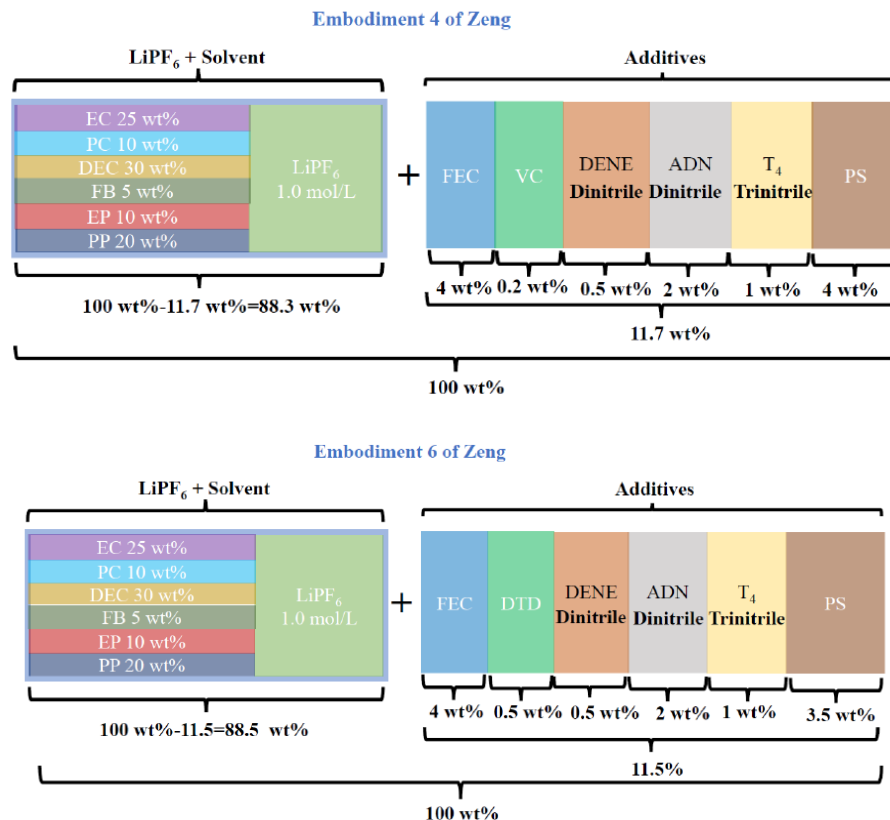
Embodiment 4	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 10: 20	4	2	T ₄ : 1 T ₂ : 0.5	VC: 0.2 PS: 4	91.0	No precipitation
Embodiment 5	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 10: 20	5	2	T ₂ : 2	VC: 0.2 PS: 4	92.2	No precipitation
Embodiment 6	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 10: 20	4	2	T ₄ : 1 T ₂ : 0.5	DTD: 0.5 PS: 3.5	91.6	No precipitation
Embodiment 7	EC: PC: DEC: FB: EP: PP =20: 15: 30: 5: 10: 20	4	2	T ₁ : 1 T ₂ : 0.5	VC: 0.2 PS: 4	90.3	No precipitation
Embodiment 8	EC: PC: DEC: FB: EP: PP =20: 10: 35: 5: 10: 20	4	2	T ₁ : 1 T ₂ : 0.5	VC: 0.2 PS: 4	91.5	No precipitation
Embodiment 9	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 15: 15	4	2	T ₁ : 1 T ₂ : 0.5	VC: 0.2 PS: 4	90.8	No precipitation
Comparison Example 1	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 10: 20	2.5	2	/	VC: 0.2 PS: 4	82.1	Small amount precipitated, main component ADN
Comparison Example 2	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 10: 20	4	2	/	VC: 0.2 PS: 4	84.3	Small amount precipitated, main component ADN
Comparison Example 3	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 10: 20	4	3.5	/	VC: 0.2 PS: 4	86.9	Large amount precipitated, main component ADN
Comparison Example 4	EC: DEC: FB: EP: PP=35: 30: 5: 10: 20	4	2	T ₁ : 1 T ₂ : 0.5	VC: 0.2 PS: 4	87.5	Precipitated, main components EC and ADN
Comparison Example 5	EC: PC: DEC=30: 20: 50	4	2	T ₁ : 1 T ₂ : 0.5	VC: 0.2 PS: 4	79.9	Precipitated, main components EC and ADN
Comparison Example 6	EC: PC: DEC: FB=30: 15: 50: 5	4	2	T ₁ : 1 T ₂ : 0.5	VC: 0.2 PS: 4	81.1	Precipitated, main components EC and ADN

Id. ¶¶ [0039]-[0043], Table 1.

56. Zeng is directed to a fundamentally different problem than the '910 Patent. Unlike Zeng, the '910 Patent's claims are directed to three components—a dinitrile compound, a trinitrile compound, and propyl propionate—combined in specific weight percentage ratio ranges that unexpectedly provided the benefit of forming a firm, protective SEI film on the surface of the cathode that was not easily decomposed, and which could provide performance improvements at a high potential of 4.45V and effectively reduce DC internal resistance of the battery. Ex. 1001 at 1:56-63 (“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”). Indeed, as set forth in the '910 Patent, “[t]he 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.” Ex. 1001, 29:29-34. Zeng is silent about this critical formula and how the specific interactions of these three compounds in the critical formulations can effectively inhibit the increase in DC internal resistance of the electrochemical device.

57. Instead of identifying any formula or a disclosure related to the critical nature of the ratio of the content of the trinitrile compound to the content of propyl propionate, it is my understanding that Petitioner points to the electrolyte compositions disclosed for Embodiments 4 and 6 in Table 1 of Zeng, and alleges that these electrolyte compositions render obvious the claimed electrolyte of claims 1, 12, and 20. *See* Pet., pp. 14-27. In particular, I understand that Dr. Lucht opines that a POSITA would have been motivated to implement Embodiments 4 and 6 of

Zeng, asserting that the electrolyte solutions of Embodiments 4 and 6 have the following compositions:



Ex. 1003 ¶ 73.

58. I understand that based on such alleged compositions set forth above, Dr. Lucht opines that Embodiments 4 and 6 contain a “*theoretical* upper limit weight percentage” of 17.66 wt% and 17.70 wt %, respectively, of propyl propionate in the final electrolyte solutions of Embodiments 4 and 6. Ex. 1003 ¶ 76.

59. To obtain such “*theoretical* upper limit weight percentages” of propyl propionate, I understand Dr. Lucht to have assumed (1) that propyl propionate forms 20 wt% of each solvent mixture, (2) that LiPF₆ is added in solid form to the solvent mixture, (3) that LiPF₆ and the solvent

mixture form 88.3 wt% and 88.5 wt%, respectively, of the total electrolyte solutions of Embodiments 4 and 6, and (4) that LiPF₆ has “zero weight”:

$$88.3\% * \left(\frac{20}{25 + 10 + 30 + 5 + 10 + 20} \right) = 17.66\% \quad \text{Embodiment 4}$$

$$88.5\% * \left(\frac{20}{25 + 10 + 30 + 5 + 10 + 20} \right) = 17.70\% \quad \text{Embodiment 6}$$

Ex. 1003 ¶ 76.

60. Based on the further assumption that LiPF₆ has a “non-zero weight” that “pushes down the weight percentages Z of [propyl propionate] in the total electrolyte solution,” it is also my understanding that Dr. Lucht opines that propyl propionate is <17.66 wt% in Embodiment 4 and <17.70 wt% in Embodiment 6, but that “the ultimate weight percentage of PP in the total electrolyte would also certainly be well above 5 wt%.” Ex. 1003 ¶ 77.

61. It is my further understanding that Dr. Lucht further opines, based on this tenuous calculation of the weight percentage of propyl propionate and a series of unsupported assumptions, that Embodiments 4 and 6 of Zeng disclose mixing ratios of trinitrile compound to propyl propionate (Y/Z) of >0.057 and >0.056, respectively. Ex. 1003 ¶¶ 95-97.

62. It is also my understanding that Dr. Lucht further asserts, with respect to claim limitations [1.2] and [12.2], that Embodiments 4 and 6 of Zeng both disclose a mixing ratio of dinitrile compound to trinitrile compound (X/Y) of “2.5, which, in [his] opinion, is ‘about 2.3’ as claimed” and that “a POSITA would consider Zeng’s X/Y ratio of 2.5 sufficiently close to the claimed range, particularly given that it falls within the ’910 patent’s express 10% tolerance.” Ex. 1003 ¶ 89; *see also*, ¶ 112 (incorporating by reference Dr. Lucht’s reasoning applied to element [1.2] to element [12.2] in summary table of “additional reasons”).

63. For the reasons below, it is my opinion that a POSITA would not have selected or implemented Embodiments 4 and/or 6 of Zeng.

64. It is also my opinion, for the reasons below, that the disclosure of Zeng does not provide sufficient detail that would allow the POSITA to determine that Zeng discloses or renders obvious the claimed weight percentages of propyl propionate (*Z*) or the claimed mixing ratio of trinitrile to propyl propionate (*Y/Z*) of independent claims 1, 12, or 20, as evidenced by at least the numerous unsupported and incorrect assumptions, calculations, and arguments made by Dr. Lucht. Nor does Zeng disclose, or Petitioner/Dr. Lucht identify disclosure, that overcomes the criticality of the claimed *Y/Z* ranges.

65. It is also my opinion, for the reasons below, that the disclosure of Zeng does not render obvious the claimed “about $0.1 \leq (X/Y) \leq 2.3$ ” limitation of limitations [1.2] and [12.2].

1. Petitioner Fails to Show that a POSITA Would Have Selected or Implemented Embodiments 4 or 6 of Zeng

66. Zeng provides an electrolyte solution that “ensure[s] that a lithium-ion battery has good high-voltage cycle performance.” Ex. 1006 ¶ [0008]. To that end, Zeng prepares and tests batteries using the electrolyte solutions of Embodiments 1-9 and Comparative Examples 1-6, determining the capacity retention rate at the 500th cycle for each prepared battery:

[0039] High-voltage battery electrical performance testing:

[0040] The lithium-ion battery electrolyte solution prepared in the steps described above is injected into a fully dried 4.40 V graphite/LiCoO₂ polymer battery; the battery is set aside at 45°C, and formed in a high-temperature fixture and sealed twice, then conventional classification of capacity is performed.

[0041] At 25°C, the capacity-classified battery is charged with constant current and voltage at 1C to 4.40 V, the cut-off current being 0.02C, and is then discharged at 1C constant current to 3.0 V. After 500 cycles of charging/discharging, the capacity retention rate at the 500th cycle is calculated. The calculation formula is as follows:

[0042] 500th cycle capacity retention rate (%) = (500th cycle discharge capacity / first cycle discharge capacity) × 100%

Ex. 1006 ¶¶ [0039]-[0042]

67. Dr Lucht opines that the selection of Embodiments 4 and 6 would have been obvious to a POSITA. Not so. Dr. Lucht cherry-picks Embodiments 4 and 6 from the 15 embodiments explicitly disclosed by Zeng and the thousands of embodiments which would fit within the ranges described in Zeng. In fact, Zeng is silent regarding why the two embodiments selected by Dr. Lucht provide benefits that would distinguish them from any of the remaining potential embodiments.

68. Regardless, Dr. Lucht asserts that “Zeng teaches, suggests, and motivates a POSITA to use the Embodiment 4 and 6 electrolytes” because the batteries of Embodiments 4 and 6 allegedly “significantly outperformed the Comparative Examples batteries on capacity retention...[a]nd, other than Embodiments 2 and 5, Embodiment 6 had the best capacity retention at 91.6%.” Ex. 1003 ¶ 81. I disagree that “Zeng teaches, suggests, and motivates a POSITA to use the Embodiment 4 and 6 electrolytes” at least because there is no unambiguous data of the embodiments of Zeng that would indicate to or encourage a POSITA to choose *any* particular embodiment of Zeng over another. *See e.g.*, Ex. 1006 ¶¶ [0045]-[0046] (each of Embodiments 1-

9 reflecting a similar capacity retention rate within a nominal 2% range (i.e., between 90.3-92.2%) and no precipitation of crystals after low-temperature storage for 30 days).

69. Moreover, Zeng offers no guidance to a POSITA as to why Embodiments 4 and 6 would be chosen. Indeed, in Dr. Lucht's attempts to parse the ambiguous data to try to manufacture some distinction or suggestion to use Embodiments 4 and 6 in Zeng, Dr. Lucht fails to appreciate that the POSITA would actually interpret the addition of a trinitrile compound in Zeng as *negatively* impacting the capacity retention rate. Embodiments 2 and 5, which had better capacity retention rates (91.9% and 92.2%, respectively) than both Embodiments 4 and 6 (91.0% and 91.6%, respectively), and Embodiment 8 which had a better capacity retention rate (91.5%) than Embodiment 4, contained dinitrile compound(s) but did not contain *any* trinitrile compound, and so a POSITA would interpret Zeng as teaching that the addition of a trinitrile compound is a factor that *lowers* capacity retention rate. Ex. 1006 ¶¶ [0045]-[0046]. Because capacity retention is an important aspect to Zeng in "the development of high-energy density lithium-ion batteries" (Ex. 1006 ¶ [0003]), such lower capacity retention rates relative to Embodiments 2, 5, and/or 8, would deter the POSITA from selecting Embodiments 4 and 6 in Zeng and teach away from selecting those embodiments.

70. Even if a POSITA were to select Embodiment 4 or 6 of Zeng (which it is my opinion that a POSITA would not make such selection), the negative impact of the trinitrile compound on the capacity retention rates of Embodiments 4 and 6 relative to Embodiments 2, 5, and/or 8 would also *teach away* from considering the relation or adjustment of a trinitrile compound to propyl propionate ratio (Y/Z) other than to eliminate the amount of trinitrile compound in Zeng's Embodiments 4 and 6 to zero, as in Embodiments 2, 5, and 8.

71. In support of his obviousness rationale related to Embodiments 4 and 6 of Zeng, Dr. Lucht also opines that “[e]ach example in Zeng is a self-contained, working embodiment providing a complete list of components, component amounts, and instructions needed to make Zeng’s electrolyte solution.” Ex. 1003 ¶ 80. I disagree at least because the components and component amounts present in Embodiments 2-9 and Comparison Examples 1-6 are ambiguous, deterring the POSITA from implementing any of such embodiments/examples of Zeng. For example, Paragraphs [0043] and [0044] of Zeng provide:

[0043] Embodiments 2-9 and Comparison Examples 1-6

[0044] In Embodiments 2-9 and Comparison Examples 1-6. Other than the electrolyte solution solvent and some additive composition and content *added as shown in Table 1*, all else is the same as in Embodiment 1. *Table 1 lists the electrolyte solution partial component content*, battery performance testing results, and low temperature storage of Embodiments 1-9 and Comparison Examples 1-6.

Ex. 1006 ¶¶ [0043]-[0044] (emphases added).

72. The phrases “**added as shown in Table 1**” and “**electrolyte solution partial component content**” in Paragraph [0044] indicate to a POSITA that Embodiments 2-9 and Comparison Examples 1-6, including Embodiments 4 and 6, contain the components identified in Table 1 *and* the components set forth in Embodiment 1 (i.e., at Paragraph [0037]), resulting in each Embodiment or Example constituting an amalgamation of indeterminable amounts of solvent compositions and additives.

73. In addition, as set forth in more detail below in Section VI.A.2.a., the instructions needed to make Zeng’s electrolyte solutions as set forth in Paragraph [0037] of Zeng fail to provide in which solvent the lithium hexafluorophosphate (LiPF₆) is dissolved or how much of such 1.0

mol/L salt solution is added to form Zeng's electrolyte solutions such that a POSITA would not be led to select or implement Embodiments 4 and 6 of Zeng.

74. Dr. Lucht provides his opinion that "it would have been obvious to try Embodiments 4 and 6 of Zeng". Ex. 1003 ¶ 82; *see also id.*, ¶¶ 83. I disagree with Dr. Lucht that it would have been obvious to try Embodiments 4 and 6 of Zeng in the manner proposed by Dr. Lucht.

75. As previously noted, Dr. Lucht alleges that "Zeng observes a market need for 'high-energy density lithium-ion batteries' driven by 'consumer terminals demand[ing] even-higher energy density from batteries'" and further asserts that Zeng "sought a well-rounded 'electrolyte solution that can remain homogenous and stable over a wide temperature range in order to ensure that a lithium-ion battery has good high-voltage cycle performance and can perform at high and low temperatures.'" Ex. 1003 ¶ 83 (citing Ex. 1006 ¶¶ [0003], [0008]). Such alleged "recognized need in the art" materially differs from the problem that the inventors of the '910 Patent faced. The '910 Patent is directed to solving the problem of how to address the decrease of battery capacity in the context of electrochemical devices with a working voltage above 4.4 V and effectively reduce DC internal resistance of the electrochemical device. Ex. 1001, 1:56-63. For example, "[a]t 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." Ex. 1001, 22:57-62.

76. Contrary to Dr. Lucht's further allegations of a "[f]inite number of identified, predictable solutions" and assertion that "Zeng only discloses nine electrolyte solutions (Examples 1-9) [that] all had better capacity retention over 500 cycles and low-temperature performance than

the comparative examples” (Ex. 1003 ¶ 84), a POSITA would have understood that there were many potential solutions to the problem faced by the inventors of the '910 Patent, not a finite number of identified, predictable solutions because the requirements in the battery art are so challenging and varied from application to application, the set of possible electrolyte compounds and combinations is effectively infinite, and the outcomes unpredictable.

77. To illustrate this complexity, I briefly outline the chemical and mechanical requirements for a solution to the high-voltage SEI problem. For example, multiple electrolyte components must oxidize on the cathode to form the SEI constituents but can be advantageous only if the combination of reactions are inherently self-limiting and therefore stop after a short period of time. Otherwise, an indefinitely ongoing reaction at the cathode will cause the cell to self-discharge, capacity to be lost, DC resistance to continually increase, or any combination of the same. Furthermore, the products of these oxidation reactions must be insoluble in the remaining electrolyte so as to form a solid film on the surface, the film must be mechanically stable in spite of volume changes in the underlying cathode material, and the film must allow the permeability of lithium ions but not the passage of electrons. Finally, any unreacted additives or other electrolyte components must function as a suitable electrolyte. Among other things, these components must, across a range of temperatures, be mutually soluble, function as a satisfactorily facile carrier of the lithium salt, and meet safety and price constraints.

78. While all the above requirements would be well known to a POSITA, simultaneously meeting these requirements requires extensive tradeoffs and careful balance of competing effects, with no guarantee of finding a satisfactory “sweet spot.” Therefore, generating a high-voltage passivated cathode surface having all these requirements is practically a miracle, leading to longstanding unmet need. Not to mention that the desired sweet spot could vary from

one practitioner to another depending on the envisioned application for their battery technology. A POSITA would have therefore understood that there are a very large number of potential solutions to the identified problem, each of which vary in terms of which characteristics are emphasized and which are “traded away” for other characteristics.

79. Similar to Dr. Lucht’s prior assertion that “Zeng teaches, suggests, and motivates a POSITA to use the Embodiment 4 and 6 electrolytes” because the batteries of Embodiments 4 and 6 “significantly outperformed the Comparative Examples” and “other than Embodiments 2 and 5, Embodiment 6 had the best capacity retention,” Dr. Lucht purports to support his opinion that it would have been “obvious to try” Embodiments 4 and 6 of Zeng with the idea that “[Embodiments] 4 and 6 [would be] a higher priority to try over other Examples [because] Example 6 performed better than average (91.6% vs. 91.2%) in capacity retention and Example 4 performed near the average (91.0%).” Ex. 1003 ¶¶ 82, 84. As I explained above in Paragraphs 69 and 70 of this Declaration, however, the lower capacity retention rates of Embodiments 4 and 6 relative to Embodiments 2, 5, and/or 8 would actually deter the POSITA from implementing Embodiments 4 and 6. *Supra*, ¶¶ 69-70. Indeed, far from an “obvious to try”, Zeng’s teachings about the comparatively negative impact of the trinitrile compound on the capacity retention rates of Embodiments 4 and 6 would teach the POSITA away from considering the relation or adjustment of a trinitrile compound to propyl propionate ratio (Y/Z) in Zeng’s embodiments. *Id.*

80. Dr. Lucht further purports to support his opinions with the idea that “Zeng also provides detailed instructions to make the Example electrolytes” (Ex. 1003 ¶ 85), however, as discussed in detail in Section VI.A.2.a., the instructions needed to make Zeng’s electrolyte solutions as set forth in Paragraph [0037] of Zeng fail to provide *which* solvent the lithium hexafluorophosphate (LiPF_6) is dissolved or *how much* of such 1.0 mol/L salt solution is added to

form Zeng's electrolyte solutions such that a POSITA would not be led to select or implement Embodiments 4 and 6 of Zeng, let alone any embodiment of Zeng.

81. Thus, I disagree with Dr. Lucht's suggestion that a POSITA reading the Zeng reference would have been motivated to select or implement Embodiments 4 and/or 6 of Zeng, let alone reach the same solution at which the inventors of the '910 Patent arrived.

2. Petitioner Fails to Show that Zeng Renders Obvious the Claimed Weight Percentages of Z and Mixing Ratio of Y/Z of Independent Claims 1, 12, and 20

82. Independent claim 1 requires, *inter alia*, “[a]n 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, a weight percentage of the trinitrile compound is Y, and a weight percentage of the propyl propionate is Z; wherein...**5 wt % ≤ Z ≤ 20 wt % or 30 wt % ≤ Z ≤ 50 wt %, and about 0.02 ≤ (Y/Z) ≤ about 0.3.**” Ex. 1001, 34:17-37 (emphasis added). Petitioner equates “5 wt % ≤ Z ≤ 20 wt % or 30 wt % ≤ Z ≤ 50 wt %” to claim element [1.3] and “about 0.02 ≤ (Y/Z) ≤ about 0.3” to claim element [1.4]. Pet. at viii (“Claims Appendix”).

83. Independent Claim 12 similarly requires, *inter alia*, “[a]n electrochemical device, wherein the electrochemical device comprises electrodes and an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate, wherein, based on the total weight of the electrolyte, the weight percentage of the dinitrile compound is X, the weight percentage of the trinitrile compound is Y and a weight percentage of the propyl propionate is Z; wherein...**about 5 wt % ≤ Z ≤ 20 wt % or 30 wt % ≤ Z ≤ 50 wt %, and about 0.02 ≤ (Y/Z) ≤ about 0.3.**” Ex. 1001, 35:40-63 (emphasis added). Petitioner equates “5 wt % ≤ Z ≤ 20 wt % or 30 wt % ≤ Z ≤ 50 wt %” to claim element [12.3] and “about 0.02 ≤ (Y/Z) ≤ about 0.3” to claim element [12.4]. Pet. at x (“Claims Appendix”).

84. Independent Claim 20¹¹ similarly requires, *inter alia*, “[a]n 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, a weight percentage of the trinitrile compound is Y and a weight percentage of the propyl propionate is Z; wherein... **5 wt % ≤ Z ≤ 20 wt % or 30 wt % ≤ Z ≤ 50 wt %, and about 0.01 ≤ (Y/Z) ≤ about 0.3.**” Ex. 1001, 36:39-37:7 (emphasis added). Petitioner equates “5 wt % ≤ Z ≤ 20 wt % or 30 wt % ≤ Z ≤ 50 wt %” to claim element [20.3] and “about 0.01 ≤ (Y/Z) ≤ about 0.3” to claim element [20.4]. Pet. at xii (“Claims Appendix”).

85. Embodiments 4 and 6 of Zeng are very different from the electrolyte solutions claimed in the '910 Patent, and each of Embodiments 4 and 6 of Zeng comprises numerous additional components, including organic solvents, additives, and electrolytes. Specifically, Zeng discloses that each of the electrolyte solutions of Embodiments 4 and 6 includes at least:

- A mixture of six organic solvents comprising ethylene carbonate (EC), propylene carbonate (PC), diethyl carbonate (DEC), ethyl propionate (EP), propyl propionate (PP), and fluorobenzene (FB). Ex. 1006 ¶¶ [0011]-[0016], [0036]-[0037], [0043]-[0047]. For these organic solvents, Zeng provides a relative mass ratio of each organic solvent based on the total mass of the organic solvents. *Id.*
- An “additive combination.” *Id.* ¶¶ [0036]-[0037], [0043]-[0049]. For each additive, Zeng provides a weight percentage concentration on the basis of the total weight of the electrolyte solution. *Id.*

¹¹ Notably, Petitioner has failed to address independent Claim 20. See Section VI.A.6. and VI.J.5.

- Lithium hexafluorophosphate (LiPF₆). *Id.* ¶¶ [0036]-[0037], [0043]-[0049].
 Zeng provides a molarity (mol/L) concentration of a LiPF₆ salt solution, which is equivalent to the number of moles of the LiPF₆ electrolyte salt divided by the total volume of the LiPF₆ salt solution. *Id.*

86. Table 1 below, excerpted from Zeng’s Table 1, presents the components and concentrations of the various electrolyte components that Zeng discloses for Embodiments 4 and 6, where the various **dinitrile compounds are highlighted in blue**, the various **trinitrile compounds are highlighted in green**, and the **propyl propionate component is highlighted in red**. In addition, “lithium hexafluorophosphate [LiPF₆] of a concentration of 1.0 mol/L is slowly added to the mixed solution.” Ex. 1006 ¶ [0037].

Embodiment	Solvent Composition	FEC (%)	ADN (%)	Structural formula I additives (%)	Other additives (%)	Retention rate (%) after 500 cycles at 1C rate for 4.40 V at ambient temperature	Precipitation of crystals after storage for 10 days at -30°C
Embodiment 4	EC:PC: DEC:FB:EP:PP =25:10:30:5:10:20	4	2	T ₄ : 1 T ₂ : 0.5	VC : 0.2 PS: 4	91.0	No precipitation
Embodiment 6	EC:PC: DEC:FB:EP:PP =25:10:30:5:10:20	4	2	T ₄ : 1 T ₂ : 0.5	DTD: 0.5 PS: 3.5	91.6	No precipitation

Table 1. Zeng’s Embodiments 4 and 6.

87. Zeng never explicitly discloses the weight percentage of propyl propionate or the mixing ratio of trinitrile compound to propyl propionate in the final electrolyte solutions of Embodiments 4 and 6. *Compare* Ex. 1006, Table 1, *with* Ex. 1001, Claim 1 (“wherein, ... 5 wt % ≤ Z ≤ 20 wt % or 30 wt % ≤ Z ≤ 50 wt %, and about 0.02 ≤ (Y/Z) ≤ about 0.3.”). Nor does Zeng provide

sufficient information from which to determine the weight percentage of propyl propionate or the mixing ratio of trinitrile compound to propyl propionate in the final electrolyte solutions of Embodiments 4 and 6 of Zeng. Indeed, Zeng does not teach, disclose, or suggest, in Table 1 or anywhere else, a *weight percentage* of propyl propionate *based on a total weight of the electrolyte solution* as claimed, but rather, discloses a relative *mass ratio* of each “electrolyte solvent partial component content” in the base solvent mixture based on the total mass of the solvent components. Ex. 1006 ¶¶ [0036]-[0037], [0043]-[0046]; *see also*, Ex. 1003 ¶ 69 (Dr. Lucht acknowledging the mass ratio disclosure of the solvent components of Zeng).

88. That is, despite Embodiments 4 and 6 of Zeng comprising various additional components and having three different types of concentration units—mass ratio of the organic solvents, weight % based on the final electrolyte solution weight, and molarity (mol/L) of the salt solution—which are respectively based on different measurements (total mass of the organic solvents, total weight of the electrolyte solution, and total volume of the LiPF₆ salt solution), Zeng does not provide such measurements (i.e., the total mass, total weight, or total volume), which would be necessary for a POSITA to even attempt to calculate a theoretical weight percentage of the propyl propionate component based on the total weight of the electrolyte solution or a mixing ratio of a trinitrile compound to the propyl propionate component. As explained in more detail below in Section VI.A.2.a., it is also not apparent from the disclosure of Zeng in which solvent its LiPF₆ is dissolved before being added to the solvent mixture.

89. Despite this lack of sufficient disclosure, Dr. Lucht makes numerous unsupported and speculative assumptions to theoretically calculate an alleged weight percentage of propyl propionate and mixing ratio of trinitrile compound to propyl propionate in the final electrolyte solutions of Embodiments 4 and 6 of Zeng. Indeed and as described in Section VI.A.2.a., at least

one assumption underlying Dr. Lucht's calculations is diametrically opposed to the actual wording and teachings of Zeng.

90. Without any disclosure related to the critical nature of the ratio of the content of the trinitrile compound to the content of propyl propionate and without any provision by Zeng of the information necessary for a calculation of the weight percentage of propyl propionate based on the total weight of the electrolyte (e.g., measurements of the total mass of the organic solvent, total weight of the final electrolyte solution, or total volume of the LiPF₆ salt solution), it is my opinion that Dr. Lucht cannot directly and accurately calculate a theoretical weight percentage of propyl propionate and it is improper for Dr. Lucht or anyone to conclude that a POSITA could determine that Zeng discloses the claimed weight percentage of propyl propionate or the claimed mixing ratio of the content of the trinitrile compound to the content of propyl propionate based on Zeng's disclosures.

a. Dr. Lucht's Assumption That LiPF₆ Is Added As A Solid Is Unjustified

91. In his calculation of the theoretical weight percentage of propyl propionate in Embodiments 4 and 6 of Zeng, Dr. Lucht relies on an unfounded and tenuous interpretation of the disclosure of Zeng that is diametrically opposed to the very wording and teaching of the document. Specifically, Paragraph [0037] of Zeng recites:

[0037] Electrolyte solution preparation steps: in a glove box filled with argon gas, ethylene carbonate, propylene carbonate, diethyl carbonate, fluorobenzene, ethyl propionate, and propyl propionate are mixed at a mass ratio of EC:PC:DEC:FB:EP:PP = 25:10:30:5:10:20; *then, lithium hexafluorophosphate of a concentration of 1.0 mol/L is slowly added to the mixed solution,* finally, the following are added on the basis of the total weight of

the electrolyte solution: 4wt% of fluoroethylene carbonate (FEC), 2wt% of adiponitrile (ADN), 1wt% of succinonitrile (SN), 0.5wt% of 1,2-bis(2-cyanoethoxy)ethane (DENE), 0.2wt% of vinylene carbonate (VC), and 4.0wt% of 1,3-propane sultone; after stirring well, the lithium-ion battery electrolyte solution of Embodiment 1 is obtained.

Ex. 1006 ¶ [0037] (emphasis added).

92. It is immediately apparent from the text of Paragraph [0037] that the inventors of Zeng make a clear distinction as to how certain components are to be added to the electrolyte composition. For example, with respect to the additive components, Zeng explicitly states that their addition is “on the basis of the total weight of the electrolyte solution.” Ex. 1006 ¶ [0037]. And with respect to lithium hexafluorophosphate (LiPF₆), Zeng explicitly states that its addition is *at a certain concentration*, such that the POSITA would understand that the lithium hexafluorophosphate salt of Zeng is necessarily added in the form of a solution. That is, the terms “of a concentration” and “mol/L”, which are indisputably present in the Zeng specification, necessarily imply the existence of a solution with respect to the lithium hexafluorophosphate salt. Specifically, Zeng recites that LiPF₆ “*of a concentration of 1.0 mol/L* is slowly added to the mixed solution.” *Id.* (emphasis added). Nowhere does Zeng state or imply that such “of a concentration of 1.0 mol/L” is an intended final concentration of the electrolyte solution or some specified concentration of the electrolyte solution *before* the subsequent addition of the additive combination). That is, 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.

93. Despite the actual text of Zeng, Dr. Lucht instead asserts, in a footnote, “a POSITA would understand [Zeng’s recitation of ‘then, lithium hexafluorophosphate of a concentration of 1.0 mol/L is slowly added to the mixed solution’] to mean adding (solid) LiPF₆ to the specified EC:PC:DEC:FB:EP:PP solvent mixture *to reach a concentration of 1.0 mol/L.*” Ex. 1003, 30-31, fn. 4 (emphasis added); *see also*, ¶ 77 (“Zeng teaches [LiPF₆] was mixed in the solvent solution to a concentration of 1.0M before mixing the remaining additives.”). Such assumptions—that (1) the lithium salt is in solid form, and (2) such solid lithium salt is added to or mixed in the solvent mixture to obtain the noted 1.0 mol/L concentration as a concentration of the electrolyte solution before adding the additive combination—necessarily contradict the literal text set forth in Zeng.

94. *First*, the commercial distribution of premixed “battery grade” 1.0 M LiPF₆ solution for use in batteries was well known at the time of the alleged invention of Zeng. *See, e.g.*, Exs. 2017 (“Lithium hexafluorophosphate solution in ethylene carbonate-d4 (99 atom % D) and ethyl-d5 methyl-d3 carbonate (98 atom % D), 1.0 M LiPF₆ in EC-d4/EMC-d8=3:7 (v/v), battery grade” Sigma-Aldrich Safety Data Sheet dated July 11, 2016), 2018 (“Lithium Hexafluorophosphate in EC/EMC 3:7” Safety Data Sheet dated September 2018), 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), 2020 (“Lithium hexafluorophosphate solution - in diethyl carbonate, 1.0M LiPF₆ in DEC, battery grade” Sigma-Aldrich Production Specification), 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). Indeed, even Dr. Lucht admits that “LiPF₆ is commercially available premixed in different solvent to different concentrations.” Ex. 1003, 30-31, fn. 4. Accordingly, adding the electrolyte salt LiPF₆ in the form of a salt solution having 1.0 mol/L

concentration to the solvent mixture would be well known to the POSITA experimenting with different electrolyte additives and an acceptable way to achieve a desired electrolyte mixture.

95. *Second*, Dr. Lucht's reliance on the language of example preparations of various electrolyte solutions set forth in three U.S. patent publications is misplaced and actually reinforces the clear meaning of the language set forth in Zeng that the LiPF₆ is added to the solvent mixture *as a salt solution having a certain concentration*. Dr. Lucht asserts that because "Zeng already discloses an EC:PC:DEC:DB:EP:PP solvent mixture for its electrolytes[*i*], in such cases, it is standard practice to mix LiPF₆ in the specified solvent mixture to a target concentration—usually around 1 mol/L—not add LiPF₆, premixed in some second solvent mixture, to the first solvent mixture." Ex. 1003, 30-31 at fn. 4 (citing Ex. 1023 ¶¶ [0237], [0245]; Ex. 1024 ¶ [0048]; Ex. 1025 ¶ [0090]). The cited portions of Exhibit 1023, however, simply identify sample language that Zeng could have used had the inventors actually intended for lithium salt to be added to a solvent mixture to obtain a specified or target electrolyte solution concentration before the addition of the additives. Ex. 1023 ¶ [0237] ("to form a non-aqueous solvent, *into which was dissolved LiPF₆, so as to be 1.2 M*") (emphasis added). Similarly, the paragraph in Exhibit 1024 on which Dr. Lucht relies actually identifies sample language that Zeng could have used had the inventors intended for lithium salt to be dissolved in a prepared solvent to obtain an electrolyte solution. Ex. 1024 ¶ 48 ("stir and mix homogeneously organic solvents according to certain ratios to *obtain a solvent for electrolyte solutions. Slowly add a lithium salt, and when the lithium salt is dissolved*, add additives, and stir homogeneously until there is no precipitate, suspended matter or stratification. Continue to stir for 1 hour and obtain the electrolyte solutions. The *obtained electrolyte solutions* are identified with electrolyte solutions numbers L1 to L18 depending on types and mixing ratios of organic solvents, *types of the lithium salt and concentrations thereof in the electrolyte*

solutions, and types of additives and concentrations thereof in the electrolyte solutions.”) (emphases added). Moreover, Exhibit 1025 on which Dr. Lucht relies, is simply another example like Zeng wherein a 1.0 M LiPF₆ salt solution is added to the prepared organic solvent mixture. Ex. 1025 ¶ [0090]. For example, Paragraph [0090] sets forth Example 1 wherein “[a]n electrolyte was prepared by mixing ethylene carbonate and ethyl methyl carbonate (3:7 volume ratio) to prepare a non-aqueous organic solvent and *dissolving 1.0 M LiPF₆, hexane tricyanide (1,3,6 or 1,2,6-Hexanetricarbonitrile) (HTCN), and γ-butyrolactone (GBL) thereto*. Herein, the hexane tricyanide and the γ-butyrolactone were used respectively in an amount of 2 wt % and 1.5 wt % based on 100 wt % of the non-aqueous organic solvent.” *Id.* (emphasis added). Similarly, Paragraph [0100] sets forth the preparation of Comparative Example 1 wherein “[a]n electrolyte was prepared by mixing ethylene carbonate and ethyl methyl carbonate (3:7 volume ratio) to prepare a non-aqueous organic solvent and *adding 1.0 M LiPF₆ thereto*.” *Id.* ¶ [0100].

96. Indeed, it is my opinion 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. *See e.g.*, Ex. 2022, claim 1 (“[a] non-aqueous electrolyte, comprising an organic solvent, a conductive lithium salt and an additive....”), claim 4 (“wherein the concentration of the conductive lithium salt in the organic solvent is between 0.8-1.5 mol/L....”), claim 9 (“(1) mixing the organic solvents in proportion...; (2) dissolving the conductive lithium salt in the organic solvents at room temperature, and stirring uniformly”), ¶¶ [0013] (“The concentration of the conductive lithium salt in the organic solvent is between 0.8 and 1.5 mol/L....”), [0019]-[0020] (“(1) Mix the organic solvents in the required proportions...; (2) At room temperature, dissolve the conductive lithium salt in the organic solvents, and stir uniformly”), [0030] (“The conductive lithium salt LiPF₆ has a

concentration of 1.0 mol/L in the organic solvent...”). Ex. 2022 is a 2014 Chinese patent application sharing the same applicant (Dongguan City Kaixin Battery Materials Co., Ltd.) and two of the same inventors (YANG Yongjun and WAN Huaping) with Zeng. *Id.*

97. Dr. Lucht appears to assert that there is some issue with interpreting the literal wording set forth in Zeng to mean a 1.0 mol/L solution of LiPF₆ is added to the solvent mixture because such interpretation “render[s] the ultimate concentration of LiPF₆ uncertain.” Ex. 1003, 30-31, fn. 4. However, such concern lacks credibility because even under Petitioner and Dr. Lucht’s erroneous solid salt form/target concentration interpretation of Zeng’s disclosure, the ultimate concentration of LiPF₆ would no longer be 1.0 mol/L and would necessarily also be “uncertain” once the various additives of the additive combination are added to the alleged 1.0 mol/L solution. *See, e.g.*, Ex. 1006 ¶ [0037].

98. Dr. Lucht further asserts that “adding some premixed solution of LiPF₆ would disrupt the carefully-crafted solvent and additive weight percentages central to Zeng’s invention.” Ex. 1003, 30-31, fn. 4. However, in the context of Zeng, the weight percentages of the solvent components in the final electrolyte solution is irrelevant and the additive weight percentages are explicitly described as being based on the total weight of the electrolyte solution (i.e., not affected by the form of the electrolyte salt). Zeng simply discloses preparation of an organic solvent mixture at an *initial* relative mass ratio, to which other components are added to form the electrolyte solution, such that any alleged “disrupt[ion] [to any alleged] carefully-crafted solvent...weight percentages” (Ex. 1003 ¶ 69, n. 4) is of no matter to Zeng. *See e.g.*, Ex. 1006 ¶ [0037]; *see also*, *e.g.*, Ex. 1006 ¶¶ [0012]-[0016] (“15% ≤ ethylene carbonate (EC) ≤ 35%; 5% ≤ propylene carbonate (PC) ≤ 15%; 20% ≤ diethyl carbonate (DEC) ≤ 40%; 10% ≤ ethyl propionate (EP) + propyl propionate (PP) ≤ 50; 3% ≤ fluorobenzene (FB) ≤ 10%”). To a POSITA, “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.

99. Moreover, Paragraph [0044] of Zeng further indicates that “Table 1 lists the electrolyte solution *partial* component content,” suggesting that there are other electrolyte solution components in the electrolyte solution, such as the unknown solvent components of the 1.0 mol/L LiPF₆ solution. *See* Ex. 1006 ¶ [0044].

100. Finally, there is no language or other exposition in Zeng indicating an intended final concentration of LiPF₆ in the electrolyte mixtures. Therefore, neither Dr. Lucht nor a POSITA can discern an intention in Zeng that would be disrupted by the addition of LiPF₆ in a pre-mixed and not solid state, which is what Zeng plainly describes.

101. Accordingly, in view of the very wording and teachings of Zeng, a POSITA skilled in the art of lithium-ion battery electrolyte preparation would not assume that the lithium salt of Zeng’s embodiments is added as a solid to reach some target concentration of the electrolyte solution of 1.0 mol/L before addition of the additives, and as such, Dr. Lucht’s assumption with respect to the addition of LiPF₆ in Zeng is improper and unjustified. In turn, the concentration of at least propyl propionate and the ratio of trinitrile compound to propyl propionate in the final electrolyte solutions of Embodiments 4 and 6 of Zeng cannot be determined.

102. That is, Dr. Lucht’s calculations of the alleged weight percentages of propyl propionate of “< 17.66 wt%” and “< 17.70 wt%” and the alleged mixing ratios of trinitrile to propyl propionate (*Y/Z*) of “>0.057” and “>0.056” in Embodiments 4 and 6, respectively, of Zeng cannot and do not account for the solvent component(s) or the amount of solvent component(s) added by the addition of the LiPF₆ salt solution to the base solvent mixtures of Zeng.

103. Dr. Lucht asserts that “both Zeng Embodiments [4 and 6] would have a practical floor above a Z value of 5 wt%” as “5 wt% PP would require LiPF_6 to make up over 60 wt% of the total electrolyte as the additives in Embodiments 4 and 6 are respectively 11.5 wt% and 11.7 wt%[, corresponding] to 4.0 mol/L LiPF_6 —much greater than the standard 1.0 mol/L taught by Zeng and atypical for lithium-ion batteries.” Ex. 1003 ¶ 92. However, Dr. Lucht fails to consider that propyl propionate is not even required to be present in Zeng. That is, as discussed in the following criticality section, the presence of propyl propionate is not considered necessary or even required in Zeng such that the amount of propyl propionate in an electrolyte solution of Zeng may be zero. *See e.g.*, Ex. 1006 ¶ 15 (“10% \leq ethyl propionate (EP) + propyl propionate (PP) \leq 50%”), ¶ 32 (“with the aid of the property of low viscosity of carboxylic acid ester”), claim 1. For example, an electrolyte solution of Zeng may contain 10%-50% EP and 0% PP. Indeed, Zeng identifies the carboxylic acid ester with respect to “the aid of the property of low viscosity of carboxylic acid ester.” Ex. 1006 ¶ [0032]. However, compared to EP, PP has a larger molecular mass and longer chain, which lead to a higher viscosity than EP, such that the POSITA would be motivated to decrease the amount of PP or completely replace PP with EP. Accordingly, Zeng Embodiments 4 and 6 do not have a practical floor above a Z value of 5 wt%.

104. Thus, a central assumption underlying Dr. Lucht’s calculations—that the lithium salt of Zeng’s Embodiments 4 and 6 is added in solid form—is, in my opinion, diametrically opposed to the actual wording and teachings of Zeng. Rather, the lithium salt of Zeng’s Embodiments 4 and 6 is plainly added in solution, without identification of the solvent(s) in which the lithium salt is dissolved or how much of such salt solution is added, such that the concentration of propyl propionate in the final electrolyte solution cannot be unambiguously determined from

the teachings of Zeng, by Dr. Lucht or by a POSITA. Accordingly, Dr. Lucht fails to show that Zeng discloses, teaches, or suggests at least limitations [1.3], [1.4], [12.3], [12.4], [20.3], or [20.4].

3. The '910 Patent's Claimed Y/Z Ranges are Critical

105. Even if one were to assume that Dr. Lucht's flawed assumptions and calculations are reasonable and justified, and that Zeng discloses a range of Y/Z values that fall within or overlap the claimed ranges of independent claims 1, 12, and 20, it is my opinion that the '910 Patent clearly establishes that the claimed ranges of Y/Z values in independent claims 1, 12, and 20 are critical to providing the advantages that the '910 Patent's invention provides, whereas Zeng does not.

106. Even if one were to adopt Dr. Lucht's unjustified assumptions and erroneous calculations, Zeng, as a whole, discloses, at best, electrolyte solutions with trinitrile and propyl propionate ratio concentration ranges that (Dr. Lucht claims) result in Y/Z ranges that are **broader** than the claimed range of Y/Z values in independent claims 1, 12, and 20. For example, the presence of propyl propionate is not even required in Zeng such that the amount of propyl propionate in an electrolyte solution of Zeng may be zero. *See e.g.*, Ex. 1006 ¶ 15 ("10% ≤ ethyl propionate (EP) + propyl propionate (PP) ≤ 50%"), ¶ 32 ("with the aid of the property of low viscosity of carboxylic acid ester"), claim 1. For example, an electrolyte solution of Zeng may contain 10%-50% EP and 0% PP. Applying such null propyl propionate value to some of the disclosed embodiments results in a Y/Z value of 0, which is broader than and necessarily outside of the claimed Y/Z range of 0.02-0.3 in claims 1 and 12, and of 0.01-0.3 in claim 20.

107. Similarly, the presence of a trinitrile is also not considered necessary or even required in Zeng (and, as I discussed above, a comparison of Zeng's embodiments teaches away from using a trinitrile in its electrolyte solutions) such that the amount of trinitrile in an electrolyte

solution of Zeng may also be zero. *See e.g.*, Ex. 1006 ¶¶ 17-19 (setting forth structural formula I and its various substituents that do not require a compound of structural formula I to be a trinitrile), ¶¶ 45-46 (none of Embodiments 1-3, 5, or 7-9 contain a trinitrile based on structural formula I). For example, an electrolyte solution of Zeng may contain 0% trinitrile. Applying such null trinitrile value to some of the disclosed embodiments, results in a Y/Z value of 0, which is broader than and outside of the claimed Y/Z range of 0.02-0.3 in claims 1 and 12, and of 0.01-0.3 in claim 20.

108. On the other hand, the '910 Patent explains that its specific weight percentage ratio ranges, including Y/Z values of 0.01-0.3, which equates to the claimed range of Y/Z values of 0.01-0.3 in independent claim 20 and subsumes the claimed range of Y/Z values of 0.02-0.3 in independent claims 1 and 12, were *unexpectedly found* to provide a firm, protective SEI film on the surface of the cathode that was not easily decomposed, and which could provide performance improvements by allowing a battery to operate at a high potential of 4.45V and more effectively reduce DC internal resistance of the battery. Ex. 1001, 1:56-61 (“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”) (emphasis added); 29:26-29 (“*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).

109. Zeng never mentions such criticality of the claimed Y/Z value ranges, nor the advantages of the '910 Patent that such narrow, specific Y/Z value ranges provide (indeed, Zeng

never mentions this ratio *at all*). Indeed, Dr. Lucht never purports that the POSITA would have known of the firm protective SEI film or the other unexpected benefits discovered by the inventors of the '910 Patent. In other words, Dr. Lucht does not suggest that the POSITA would have known that the electrolyte solutions in Embodiments 4 and 6 of Zeng would have led to the benefits of the '910 Patent, because the POSITA would not have been looking for them. Rather, the POSITA would have only been looking for capacity.

110. Dr. Lucht, however, asserts that “Embodiments 4 and 6 of Zeng disclose dinitrile-based electrolytes further containing a trinitrile and PP, and in different relative amounts” while “[t]he remaining examples lacked the combination of both a trinitrile and PP.” Ex. 1003 ¶ 165 (citing Ex. 1006 ¶¶ [0045]-[0049]). It is my understanding that Dr. Lucht opines that “this would have drawn the POSITA’s attention to the importance of the combination of these two compounds in improving performance of dinitrile-based electrolytes as well as their relative amounts that fall within and overlap the claimed *Y/Z* ranges.” Ex. 1003 ¶ 165.

111. I disagree at least because each of Embodiments 1-9 reflect a capacity retention rate between 90.3-92.2% and no precipitation of crystals after low-temperature storage for 30 days, such that a POSITA would discern no substantial difference between examples that included a trinitrile and PP and examples without a trinitrile and PP. *See e.g.*, Ex. 1006 ¶¶ [0045]-[0046]. Moreover, to the extent there is any attention drawn to such a combination of trinitrile and propyl propionate, the POSITA would have been drawn to the *lack of a trinitrile compound* in at least Embodiments 2 and 5, which had *better* capacity retention rates than both Embodiments 4 and 6, such that the POSITA could interpret the addition of a trinitrile compound as a factor in *lowering* capacity retention rate by comparing to other embodiments. Indeed, at least inasmuch as the addition of the trinitrile compound negatively impacts the capacity retention of Embodiments 4

and 6 compared to Embodiments 2 and 5, such negative impact would not further inspire (and would in fact deter) the POSITA to consider the relation or adjustment of trinitrile compound to propyl propionate ration (Y/Z).

112. In summary, it is my opinion that, based on Zeng, there is no reason for a POSITA to use a trinitrile compound as a component of an improved electrolyte composition, let alone provide a POSITA with any indication that certain ratios of dinitrile, trinitrile, and propyl propionate have advantageous properties.

4. Petitioner Fails to Show that Zeng Renders Obvious the Claimed Mixing Ratio of X/Y of Independent Claims 1 and 12

113. Independent claim 1 requires, *inter alia*, “[a]n 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 , a weight percentage of the trinitrile compound is Y , and a weight percentage of the propyl propionate is Z ; wherein...**about $0.1 \leq (X/Y) \leq$ about 2.3.**” Ex. 1001, 34:17-37 (emphasis added). Petitioner equates “about $0.1 \leq (X/Y) \leq$ about 2.3” to claim element [1.2]. Pet. at viii (“Claims Appendix”).

114. Independent Claim 12 similarly requires, *inter alia*, “[a]n electrochemical device, wherein the electrochemical device comprises electrodes and an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate, wherein, based on the total weight of the electrolyte, the weight percentage of the dinitrile compound is X , the weight percentage of the trinitrile compound is Y and a weight percentage of the propyl propionate is Z ; wherein...**about $0.1 \leq (X/Y) \leq$ about 2.3.**” Ex. 1001, 35:40-63 (emphasis added). Petitioner equates “about $0.1 \leq (X/Y) \leq$ about 2.3” to claim element [12.2]. Pet. at x (“Claims Appendix”).

115. It is my understanding that Dr. Lucht further asserts, with respect to claim limitations [1.2] and [12.2], that Embodiments 4 and 6 of Zeng both disclose a mixing ratio of dinitrile compound to trinitrile compound (X/Y) of “2.5, which, in [his] opinion, is ‘*about 2.3*’ as claimed” and that “[t]he ’910 Patent states that ‘about’ covers ‘minor variations’ including ‘less than or equal to $\pm 10\%$ of the stated value....’” Ex. 1003 ¶ 89 (citing Ex. 1001, 4:12-31); *see also*, ¶ 112 (incorporating by reference Dr. Lucht’s reasoning applied with respect to element [1.2] to element [12.2] in summary table of “additional reasons”). Dr. Lucht further purports to calculate 2.5 to be a “minor variation[]” within “8.7% of the upper end of the claimed range of 2.3,” and opines that “a POSITA would consider Zeng’s X/Y ratio of 2.5 sufficiently close to the claimed range, particularly given that it falls within the ’910 patent’s express 10% tolerance.” Ex. 1003 ¶ 89.

116. The ’910 Patent provides “[a]s used herein, the term ‘about’ is used to describe and depict minor variations. When used in connection with an event or circumstance, the term may refer to an example in which the event or circumstance occurs precisely, and an example in which the event or circumstance occurs approximately. *For example, when used in connection with a value, the term may refer to a range of variation less than or equal to $\pm 10\%$ of the stated value, such as less than or equal to $\pm 5\%$, less than or equal to $\pm 4\%$, less than or equal to $\pm 3\%$, less than or equal to $\pm 2\%$, less than or equal to $\pm 1\%$, less than or equal to $\pm 0.5\%$, less than or equal to $\pm 0.1\%$, or less than or equal to $\pm 0.05\%$.* In addition, amounts, ratios, and other values are sometimes presented in a range format in this application. It is to be understood that such a range format is provided for convenience and simplicity, and should be understood flexibly to include not only the numerical values that are explicitly defined in the range, but also all the individual

values or sub-ranges that are included in the range, as if each value and sub-range are explicitly specified.” Ex. 1001, 4:12-31 (emphasis added).

117. Dr. Lucht has not provided any reason or argument for why a POSITA would understand that “about 2.3” in the context of X/Y in the claim elements [1.2] and [12.2] would mean “about $2.3 \pm 10\%$ ” as opposed to any of the other exemplary tolerances described in the ’910 Patent that the term “about” may refer to, “such as less than or equal to $\pm 5\%$, less than or equal to $\pm 4\%$, less than or equal to $\pm 3\%$, less than or equal to $\pm 2\%$, less than or equal to $\pm 1\%$, less than or equal to $\pm 0.5\%$, less than or equal to $\pm 0.1\%$, or less than or equal to $\pm 0.05\%$.” Ex. 1001, 4:12-31 (emphasis added). I further understand that CosMX has not attempted to construe the meaning of the term “about 2.3” as used in the ’910 Patent in its Petition.

118. Accordingly, it is my opinion, that the disclosure of Zeng does not render obvious the claimed “ $0.1 \leq (X/Y) \leq 2.3$ ” of limitations [1.2] and [12.2].

5. Claims 2-6, 16-19, and 21-26 Are Not Unpatentable

119. Claims 2-6, 16-19, and 21-26 are not unpatentable for the same reasons as discussed above with respect to independent claims 1, 12, and 20. I reserve the right to address claims 2-6, 16-19, and 21-26 individually if this proceeding is instituted.

6. Petitioner Forfeits Any Challenge of Claims 20-26

120. In addressing claims 12 and 16-26, Dr. Lucht includes a summary table of “additional reasons” for why Zeng allegedly “discloses or suggests claims 12 and 16-26.” Ex. 1003 ¶ 112.

121. Independent Claim 20 recites, *inter alia*, “wherein the electrolyte further comprises 1,3-propanesultone and **fluoroethylene carbonate**; wherein, based on the total weight of the electrolyte, a weight percentage of the 1,3-propanesultone is not less than 0.1 wt %, and not greater

than 3 wt % ” Ex. 1001, 37:3-7 (emphasis added). Petitioner collectively refers to these limitations as claim element [20.7].

122. Because claims 21-26 each depend from independent claim 20, each of claims 21-26 also require claim element [20.7]. None of the other challenged claims recite “fluoroethylene carbonate”.

123. With respect to claim element [20.7], Dr. Lucht’s summary table identifies as his evidence *only* “Section IX.B.8 above regarding element [1.7]; Section IX.D.1 regarding element [3.1].” Ex. 1003, p. 49. Notably, elements [1.7] and [3.1] only recite “wherein the electrolyte further comprises a compound having a sulfur-oxygen double bond” and “[t]he electrolyte according to claim 1, wherein the compound having a sulfur-oxygen double bond comprises 1,3-propanesultone, based on the total weight of the electrolyte, a weight percentage of the 1,3-propanesultone is not less than 0.1 wt%, and not greater than 3 wt%”, respectively. Neither element [1.7] nor element [3.1], or the paragraphs 102-103 or 106-108 of Dr. Lucht’s declaration, address the requirement of “fluoroethylene carbonate” in element [20.7].

124. In addition, the Petition also includes a summary table of “additional reasons” at page 30 of the Petition for why Zeng allegedly “discloses or suggests claims 12 and 16-26.” Pet., p. 29 (citing Ex. 1003 ¶¶ 112-113). Notably, claim 20 and each of its claim elements are *missing* from the Petitioner’s table. *See id.*, p. 30.

125. Accordingly, I have not addressed at least claim element [20.7] of claim 20, as CosMX and Dr. Lucht have not presented any argument that this claim element is met. I reserve the right to address further failings with respect to claims 20-26 individually if this proceeding is instituted.

B. Ground 1B: Zeng and Matsuoka Do Not Render Obvious Claims 1-6, 12, and 16-26

126. It is my understanding that in Ground 1B, Petitioner asserts and Dr. Lucht opines that Zeng and Matsuoka render obvious Claims 1-6, 12, and 16-26 of the '910 Patent. Pet., pp. 42-49; Ex. 1003 ¶ 147. In particular, Dr. Lucht relies on Matsuoka's alleged "direct disclosure of an appropriate weight percentage Z of [propyl propionate] instead of a POSITA having to determine it from Zeng." *Id.* I disagree for at least the following reasons.

127. For the same reasons noted above with respect to Zeng in Ground 1A, it is my opinion that a POSITA would not have selected or implemented Embodiments 4 and/or 6 of Zeng, 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) or the claimed mixing ratio of trinitrile to propyl propionate (Y/Z) of independent claims 1, 12, or 20, and Zeng says nothing about the critical claimed mixing ratio formula of trinitrile to propyl propionate (Y/Z) of independent claims 1, 12, or 20. It is my further opinion that Matsuoka does not cure these failures of Zeng.

128. In addition, nothing in Zeng would instigate, prompt, or motivate the POSITA to "hav[e] to determine [an appropriate weight percentage Z of propyl propionate] from Zeng." Petitioner and Dr. Lucht are simply contriving some purpose in hindsight for why a POSITA would look beyond Zeng when no such reason exists. Contrary to Dr. Lucht's assertion, the POSITA would not be prompted to look beyond Zeng and "rely on Matsuoka's [alleged] direct disclosure" "for implementation details regarding appropriate amounts of PP to include in Zeng's electrolytes" because Zeng provides an amount of propyl propionate to include in relative mass ratio in the base

solvent mixture and the weight percentage of propyl propionate in the final electrolyte solution is simply not important to Zeng.

1. Petitioner Fails to Show that a POSITA would have Selected Propyl Propionate from Matsuoka's Teachings of Numerous "Non-Nitrile Additives"

129. Matsuoka proposes the addition of "non-nitrile additives" to a non-aqueous electrolyte solution, the electrolyte solution containing acetonitrile and a lithium salt. According to Matsuoka, "[t]he content of the non-nitrile additive is preferably 0.1-30 mass %, and more preferably 0.1 to 10 mass %, based on the total amount of the non-aqueous electrolyte solution." Ex. 1007 ¶ [0041].

130. According to Matsuoka, suitable non-nitrile additives include compounds having a Lowest Unoccupied Molecular Orbital (LUMO) energy and a Highest Occupied Molecular Orbital (HOMO) energy falling in specified ranges. Ex. 1007 ¶¶ [0036], [0038]-[0040]. Paragraphs [0038]-[0040] of Matsuoka list numerous compounds that have such advantageous LUMO and/or HOMO energies in the specified ranges. *Id.*

131. Although n-propyl propionate and isopropyl propionate are included in this large list of example non-nitrile additives, neither compound is given special significance in Matsuoka nor is the effect of such propyl propionate compounds clearly stated. *See e.g.*, Ex. 1007 ¶¶ [0038] ("n-propyl propionate (0.49 eV),...isopropyl propionate (0.49 eV)", [0040] ("n-propyl propionate (-7.10 eV),...isopropyl propionate (-7.07 eV)"). Indeed, each propyl propionate compound is merely listed as one of numerous possible compounds, but none are tested for actual functionality. *See e.g., id.* (listing the propyl propionate compounds among 76 possible LUMO compounds reiterating that Dr. Lucht's proposed selection is extremely broad, not the optimal choice, and would not necessarily be selected among numerous substances). Significantly, Table 2 of

Matsuoka lists 20 additives (A1 to A20) used in the Examples and Comparative Examples and neither propyl propionate compound is identified. Ex. 1007 ¶ [0108], Table 2. Moreover, Dr. Lucht's assertion that the PP isomers having such LUMO and HOMO energies "falling in or near the most-preferred ranges" is of no consequence as nearly all of the additives in the LUMO list fall within the most-preferred LUMO ranges and a majority of the additives in the HOMO list "fall[] in or near the most-preferred [HOMO] ranges." *Id.* ¶¶ [0038], [0040].

132. Thus, given Matsuoka's lack of disclosure as to any particular significance of propyl propionate, it is my opinion that a POSITA would have no reason to single out propyl propionate from Matsuoka's teachings of numerous "non-nitrile additives."

2. Petitioner Fails to Show Matsuoka Renders Obvious the Claimed Weight Percentages of Propyl Propionate

133. It is my understanding that Dr. Lucht opines that "a POSITA would have been motivated, with a reasonable expectation of success, to incorporate Matsuoka's preferred non-nitrile *weight percentages* as the *weight percentage of the PP Z* in Zeng's [Embodiments] 4 and 6." Ex. 1003 ¶ 153. However, without explanation, Dr. Lucht fails to consider that Matsuoka's preferred non-nitrile additive ranges are applicable to the sum of all non-nitrile additive components, not just a single non-nitrile additive. *See e.g.*, Ex. 1007 ¶¶ [0035] ("the non-nitrile additives includes substances that are not directly associated with electrochemical reactions, and they are used by a single use of one ingredient or by a combined use of two or more ingredients. From the viewpoint of the durability of SEI, the non-aqueous electrolyte solution of the present embodiment preferably contains two or more of the non-nitrile additives."), [0038] ("These compounds are used singly or in combination of two or more"). Significantly, in addition to n-propyl propionate and isopropyl propionate, Matsuoka identifies multiple components that overlap

with Zeng's Embodiments 4 and 6 as example non-nitrile additive compounds. Ex. 1007 ¶¶ [0038], [0040]. Accordingly, even if one were to assume that Dr. Lucht's application of Matsuoka's non-nitrile additive ranges to Zeng is reasonable and justified, it is my opinion that such non-nitrile additive ranges would apply to the sum of all overlapping components in Zeng's Embodiments 4 and 6. As such, there would be numerous variables for the POSITA to adjust such that there would be no "direct disclosure of an appropriate weight percentage Z of PP."

134. At least inasmuch as the non-nitrile additive ranges of Matsuoka apply to all such "non-nitrile additives" present in an electrolyte solution, and not just propyl propionate, the POSITA would not understand Matsuoka to suggest the criticality of the claimed Y/Z relationship. Indeed, Dr. Lucht's calculations of 0.1 and 0.033 as the Y/Z values based on Matsuoka's "preferred ranges" as (1) applying only to propyl propionate, and (2) using only the single highest points within such ranges (i.e., 10% and 30%) are unjustified. The inapplicability of Matsuoka's "preferred ranges" to just propyl propionate was already discussed hereinabove. Additionally, Dr. Lucht fails to account for the opposite, lower end points of such Matsuoka's "preferred ranges" (i.e., 0.1 wt%), which would result in a Y/Z value of 10 (i.e., Y = 1 wt% and Z = 0.1 wt%, and according to Dr. Lucht, Y = 1 wt% in Zeng's Embodiments 4 and 6), which far exceeds the claimed Y/Z ratio ranges. Moreover, Dr. Lucht's opinion that "Matsuoka highlights PP's ability to prevent a rise in internal resistance" necessarily fails for all the reasons discussed *supra* at VI.B.1 (e.g., Matsuoka's lack of disclosure as to any particular significance of propyl propionate) and because Dr. Lucht also fails to take into account the fact that Matsuoka's disclosure of "an increase in internal resistance caused by repeating charge-discharge cycles can be suppressed" is with respect to Matsuoka's non-nitrile additive having a certain LUMO energy *relative to acetonitrile* such that "the electrochemical reaction progresses more quickly than the reductive decomposition

of acetonitrile.” Ex. 1006 ¶ 161; Ex. 1003 ¶ [0036]. That is, as discussed below in Section VI.B.3, the electrolyte systems of Zeng and Matsuoka are fundamentally different such that the POSITA would not extend any such disclosure of Matsuoka to a non-acetonitrile based electrolyte solvent system nor would the POSITA “identify an optimum PP proportion for suppressing rise in internal resistance” (Ex. 1003 ¶ 161 (citing Ex. 1007 ¶ [0036])). Indeed, at least in view of Zeng’s teachings of low viscosity (Ex. 1006 ¶ [0032]) and the common knowledge of the POSITA that, as compared to EP, PP has a larger molecular mass and longer chain, which lead to a higher viscosity than EP, the POSITA would be motivated to decrease the amount of PP to the lowest point of such non-nitrile additive range in Matsuoka (i.e., 0.1 wt%).

135. As discussed below, although a few of the examples in Matsuoka include a dinitrile as an additive, none of the examples include a trinitrile as an additive such that Matsuoka did not and could not verify the effect of trinitrile compound(s) together with propyl propionate, let alone suggest the criticality of the claimed *Y/Z* relationship (which criticality I have discussed previously).

3. Petitioner Fails to Show That a POSITA Would have Combined Matsuoka with Zeng

136. Moreover, a POSITA would not be motivated to combine Matsuoka with Zeng.

137. The electrolyte component “buckets” of Zeng and Matsuoka are not comparable such that comparisons or applicability of amounts or ranges between the two references is comparing apples to oranges. Matsuoka identifies at least propyl propionate (PP), ethyl propionate (EP), and monofluorobenzene (FB) as “non-nitrile additives”. Ex. 1007 ¶¶ [0038], [0040]. Zeng considers and accounts for at least propyl propionate (PP), ethyl propionate (EP), and fluorobenzene (FB) as solvent components in the initial solvent mass ratio, not as additives. Ex.

1006 ¶ [0037]. Accordingly, a POSITA would not identify the teachings of Matsuoka as applicable to Zeng, and would have no reason to expect that any applicability of amounts or ranges of Matsuoka's additive components to the same components found in Zeng's solution as solvent components (especially in view of Zeng's solvents being in a defined solvent mass ratio in Embodiments 4 and 6) would have predictable results given the inherent unpredictability of the interactions of these components..

138. In addition, the electrolyte solutions of Zeng include dinitriles and in some instances, a trinitrile, as additive(s). *See e.g.*, Ex. 1006 ¶¶ [0045]-[0049]. Indeed, Embodiments 4 and 6 of Zeng include only adiponitrile (a dinitrile), 1,2-bis(2-cyanoethoxy)ethane (a dinitrile), and 1,3,6-hexanetricarbonitrile (a trinitrile) as minor *additives*. *Id.* Matsuoka considers a fundamentally different nitrile—acetonitrile (a mononitrile)—to not only be essential to its electrolyte solution, but as the solitary or main *solvent* component. *See e.g.*, Ex. 1007 ¶¶ [0043] (“The content of acetonitrile is preferably 10 to 100 vol %, more preferably 70 to 100 vol %, and further preferably 90 to 100 vol %, based on the total amount of ingredients contained in the non-aqueous electrolyte solution, other than the organic lithium salt, and 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.”), [109], and Tables 3-5 (setting forth numerous electrolyte solution examples with acetonitrile as the sole solvent component or the primary solvent component). Although a few of the examples in Matsuoka include a dinitrile as an additive, none of the examples include a trinitrile as an additive, and so a POSITA would consider the electrolyte systems of Zeng and Matsuoka to be fundamentally different.

139. Indeed, Matsuoka teaches that “by adjusting the content of the non-nitrile additive in the above described [0.1 to 30 mass %] range, **the excellent performance of acetonitrile can be sufficiently exhibited without impairing a basic function as a non-aqueous secondary battery.**” Ex. 1007 ¶ [0043] (emphasis added). Because Embodiments 4 and 6 of Zeng do not contain acetonitrile, a POSITA would not be given the slightest indication as to whether the preferred range of non-nitrile additives described in Matsuoka as advantageous for an acetonitrile solvent-based electrolyte would have any positive effect on other electrolyte solutions which do not contain acetonitrile as a solvent component, such as Zeng. In other words, a POSITA would not consider turning to or using Matsuoka at least because the electrolyte systems are fundamentally different.

140. Not only are the electrolyte systems of Zeng and Matsuoka fundamentally different, but a POSITA would not have “a reasonable expectation of success in using Matsuoka’s non-nitrile weight proportions for PP in Zeng’s [Embodiment] 4 and 6 electrolytes” at least because Matsuoka teaches away from the mixed solvent electrolyte systems of Zeng due to its lower discharge capacity at low temperatures (a focus of Zeng) such that a POSITA would not consider Matsuoka’s teachings applicable to Zeng’s mixed solvent electrolyte systems. For example, Table 3 of Matsuoka (reproduced below), sets forth the solvent(s) in each electrolyte solution S1-S23:

TABLE 3

		Electrolyte solution (d)							
		Mother electrolyte solution (D)							
		Organic		Inorganic		Additive			
		lithium salt		lithium salt		Additive 1		Additive 2	
No.	Solvent	No.	Conc. [mol/L]	No.	Conc. [mol/L]	No.	Conc. [mass %]	No.	Conc. [mass %]
S1	Acetonitrile	L1	1	—	—	—	—	—	—
S2	Acetonitrile	—	—	L7	1	—	—	—	—
S3	Acetonitrile	L1	1	—	—	A1	10	—	—
S4	Acetonitrile	L2	1	—	—	—	—	—	—
S5	Acetonitrile	—	—	L8	1	—	—	—	—
S6	Acetonitrile	L3	1	—	—	—	—	—	—
S7	Acetonitrile	L1	1	—	—	A2	5	—	—
S8	Acetonitrile	L1	1	—	—	A3	10	—	—
S9	Acetonitrile	L1	1	—	—	A3	1	—	—
S10	Acetonitrile	L1	1	—	—	A4	30	—	—
S11	Acetonitrile	L1	1	—	—	A5	5	—	—
S12	Acetonitrile	L1	1	—	—	A6	5	A7	20
S13	Acetonitrile	L1	1	—	—	A8	5	A9	5
S14	Acetonitrile	L4	1	—	—	A3	3	—	—
S15	Acetonitrile	L2	1	—	—	A1	10	—	—
S16	Acetonitrile	L4	1	—	—	—	—	—	—
S17	Acetonitrile	L1	1	—	—	A10	5	—	—
S18	Acetonitrile	L1	1	—	—	A1	30	—	—
S19	Acetonitrile/ethylene carbonate/methyl ethyl carbonate (mass ratio = 30/21/49)	L1	1	—	—	A3	5	—	—
S20	Acetonitrile/ethylene carbonate/methyl ethyl carbonate (mass ratio = 13/29/58)	L1	1	—	—	A4	5	—	—
S21	Ethylene carbonate/methyl ethyl carbonate (volume ratio = 3/7)	—	—	L7	1	—	—	—	—
S22	Ethylene carbonate/methyl ethyl carbonate (volume ratio = 1/2)	—	—	L7	1	A1	10	—	—

Ex. 1007, Table 3.

141. Table 9 of Matsuoka (reproduced below) sets forth the measurement results for discharge capacity at low temperatures 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.

142. A POSITA would 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 low temperature discharge capacity of the corresponding battery is higher than that of the mixed solvent systems. As another example, the electrolyte solution of Example 23 contains acetonitrile, ethylene carbonate, and methyl ethyl carbonate in a 30/21/49 mass ratio, the electrolyte solution of Example 24 contains acetonitrile, ethylene carbonate, and methyl ethyl carbonate in a 13/29/58 mass ratio, and the electrolyte solution of Comparative Example 8 contains ethylene carbonate and methyl ethyl carbonate in a 3/7 volume ratio. Ex. 1007, Table 3, Table 9. Notably, the acetonitrile single solvent-based electrolyte solution of Example 21 has low-temperature discharge capacities of 5.37 mAh (-30°C) and 7.36 mAh (-20°C) and the acetonitrile single solvent-based electrolyte solution of Example 22 has discharge capacities of 4.73 mAh (-30°C) and 7.21 mAh (-20°C), which are higher than the low-temperature discharge capacities of Example 23 (3.61 mAh (-30°C) and 6.73 mAh (-20°C)), Example 24 (2.80 mAh (-30°C) and 6.45 mAh (-20°C)), and Comparative Example 8 (1.32 mAh (-30°C) and 6.33 mAh (-20°C)).

143. Similarly, in Example 25 of the prepared small battery (SC1), acetonitrile is used as the only solvent and the electrolyte solution of Comparative Example 9 contains ethylene carbonate and methyl ethyl carbonate in a 1:2 volume ratio. Ex. 1007, Table 3, Table 9. Notably, the acetonitrile single solvent-based electrolyte solution of Example 25 has low-temperature discharge capacities of 2.11 mAh (-30°C) and 2.34 mAh (-20°C), which are higher than the low-temperature discharge capacities of Comparative Example 9 (1.53 mAh (-30°C) and 2.08 mAh (-20°C)).

144. Accordingly, a POSITA would interpret Matsuoka as teaching away from mixed solvent electrolyte systems because Matsuoka's single solvent acetonitrile electrolyte systems outperformed such mixed solvent electrolyte systems in low-temperature discharge capacity measurements.

145. Not only are the solvents of the electrolyte systems of Matsuoka and Zeng materially different, but the lithium salts used in the electrolyte systems are also different and a POSITA would understand Matsuoka to teach away from the single inorganic lithium salt of Zeng. That is, the only lithium salt used in Embodiments 4 and 6 of Zeng or disclosed generally by Zeng, is hexafluorophosphate (LiPF₆). *See e.g.*, Ex. 1006 ¶ [0037]. The non-aqueous electrolyte solution of Matsuoka, however, requires, in addition to acetonitrile, “an organic lithium salt, wherein an anion of the organic lithium salt has a LUMO [] energy in the range of -2.00 to 4.35 eV, and a HOMO [] energy in the range of -5.35 to -2.90 eV.” Ex. 1007 ¶ [0014]. According to Matsuoka, an organic lithium salt “is soluble in acetonitrile” and “contain[s] a carbon atom in the anion thereof”, wherein the anion satisfying such LUMO and HOMO energy requirements is “able to suppress the reductive composition of acetonitrile and an increase in internal resistance.” Ex. 1007 ¶ [0020].

146. LiPF_6 is an inorganic lithium salt having a LUMO of 4.05 eV and a HOMO of -5.39 eV. Ex. 1007 ¶ [0029] and Table 1 (LiPF_6 is identified as lithium salt L7). Accordingly, although Matsuoka identifies LiPF_6 as preferable when used in combination with the required organic lithium salt (Ex. 1007 ¶ [0030]), LiPF_6 does not meet the organic lithium salt requirements or the HOMO requirements (-5.39 eV falls outside the HOMO range) of the required organic lithium salt of Matsuoka.

147. In addition, a POSITA would understand an electrolyte solution using only the inorganic lithium salt LiPF_6 (like Zeng) to be fundamentally different from, and to have a much lower discharge capacity than, an electrolyte solution using an organic lithium salt as required by Matsuoka. For example, Example 1 of Matsuoka is a monolayer laminate type battery (SL1) prepared using a 1 mol/L LiBOB (organic lithium salt) electrolyte solution containing acetonitrile and Comparative Example 1 is a monolayer laminate type battery (SL1) prepared using a 1 mol/L LiPF_6 (inorganic lithium salt used in Zeng) electrolyte solution containing acetonitrile. See Ex. 1007, Table 1 (identifying lithium salts L1-L9), Table 3 (identifying solvent(s), organic lithium salt(s), inorganic lithium salt(s), and additive(s) of electrolyte solutions S1-S22). As demonstrated in Table 6 of Zeng (reproduced below), it can be seen that the discharge capacity of Comparative Example 1 (0.07 mAh with only LiPF_6) is much lower than Example 1 (7.86 mAh with the required organic lithium salt of Matsuoka):

TABLE 6

	Electrolyte solution	Battery	Battery evaluation	Discharge capacity [mAh]
Example 1	S1	SL1	1-1	7.86
Comparative Example 1	S2	SL1	1-1	0.07
Example 2	S3	SL1	1-1	8.73
Example 3	S4	SL1	1-1	7.79
Comparative Example 2	S5	SL1	1-1	0.01

TABLE 6-continued

	Electrolyte solution	Battery	Battery evaluation	Discharge capacity [mAh]
Comparative Example 3	S6	SL1	1-1	0.03
Example 4	S3	SL1	1-2	8.44
Example 5	S7	SL1	1-2	8.49
Example 6	S8	SL1	1-2	8.30
Example 7	S9	SL1	1-2	8.21
Example 8	S10	SL1	1-2	8.36
Example 9	S11	SL1	1-2	8.54
Example 10	S12	SL1	1-2	8.25
Example 11	S13	SL1	1-2	8.33
Example 12	S14	SL1	1-2	8.99
Comparative Example 4	S2	SL1	1-2	0.07
Comparative Example 5	S5	SL1	1-2	0.01
Example 13	S3	SC1	1-4	3.10
Example 14	S15	SC1	1-4	3.11
Comparative Example 6	S6	SC1	1-4	0.01

Ex. 1007, Table 6.

148. Thus, I disagree with Dr. Lucht’s suggestion that a POSITA reading the Zeng and Matsuoka references would have been motivated to reach the same solution that the inventors of the ’910 Patent arrived at. Claims 2-6, 16-19, and 21-26 are not unpatentable over Zeng and Matsuoka for at least the reasons discussed above with respect to claims 1, 12, and 20. I reserve the right to address claims 2-6, 16-19, and 21-26 individually if this proceeding is instituted.

C. Ground 1C: Zeng and Kim, with or without Matsuoka, Do Not Render Obvious Claims 1-6, 12, and 16-26

149. It is my understanding that in Ground 1C, Petitioner asserts and Dr. Lucht opines that Zeng and Kim, with or without Matsuoka, render obvious Claims 1-6, 12, and 16-26 of the ’910 Patent. Pet., pp. 49-55; Ex. 1003 ¶¶ 163-177. In particular, Dr. Lucht opines that “Kim further focuses the POSITA on the notion of including both a trinitrile and PP in a dinitrile-based electrolyte solution and provides more motivation to adjust the relative amounts of these two components (i.e., Y/Z) to improve performance.” Ex. 1003 ¶ 166. It is my opinion that Kim does

not cure the failures of Zeng alone or of Zeng and Matsuoka together, such that I disagree with Dr. Lucht for at least the following reasons.

150. For the same reasons noted above with respect to Zeng in Ground 1A, it is my opinion that a POSITA would not have selected or implemented Embodiments 4 and/or 6 of Zeng; 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*) or the claimed mixing ratio of trinitrile to propyl propionate (*Y/Z*) of independent claims 1, 12, or 20; Zeng says nothing about the critical claimed mixing ratio formula of trinitrile to propyl propionate (*Y/Z*) of independent claims 1, 12, or 20; and a POSITA would interpret Zeng as actually teaching away from use of a trinitrile compound as the addition of a trinitrile compound is a factor in *lowering* the capacity retention rate in Zeng's Embodiments 4 and 6 (which contain a trinitrile) as compared to Embodiments 2 and 5 (which do not contain a trinitrile). Indeed, the POSITA would be deterred from Kim's use of a trinitrile compound at least because of Zeng's teachings.

151. For the same reasons noted above with respect to Zeng and Matsuoka in Ground 1B, it is my further opinion that a POSITA would not turn to Matsuoka to cure the failures of Zeng. For example, nothing in Zeng would prompt a POSITA to look beyond Zeng to Matsuoka "for implementation details regarding appropriate amounts of PP to include in Zeng's electrolytes", Matsuoka does not employ propyl propionate in any of its examples let alone identify any special significance or effect of propyl propionate among a list of 75+ possible compounds, Matsuoka's preferred non-nitrile additive ranges are applicable to the sum of all non-nitrile additive components, not just a single non-nitrile additive such as propyl propionate, the electrolyte component "buckets" of Zeng and Matsuoka are not comparable such that comparisons or

applicability of amounts or ranges between the two references is unsupported, and the solvents and the lithium salt of the electrolyte systems of Zeng and Matsuoka are fundamentally different.

152. With reference to Table 1 of Kim, Dr. Lucht argues that “by disclosing one set of dinitrile-based electrolytes (Examples 1 and 2) containing both a trinitrile and PP in different relative amounts and another set of electrolytes (Comparative Examples 1-6) lacking either the trinitrile or PP, Kim draws the POSITA’s attention to *Y/Z*.” Ex. 1003 ¶ 170. In particular, Dr. Lucht opines that “Examples 1 and 2 contain both a trinitrile and a PP while the Comparative Examples lack one or other [which] would further focus the POSITA on the importance of having both components in an electrolyte solution.” Ex. 1003 ¶ 171. Dr. Lucht further opines that “the superior performance of Example 2 [as compared to Comparative Examples 5 and 6] shows that PP is better than its peers and cannot be replaced by MP or EP” and because “Kim uses four evaluation methods to show that adjusting PP, while keeping trinitrile constant in Examples 1 and 2, significantly impacts battery performance” such that “a POSITA would recognize that fine-tuning the ratio of trinitrile (*Y*) to PP (*Z*) can optimize battery performance, emphasizing the importance of balancing these components.” Ex. 1003 ¶¶ 172-173.

153. To better understand what a POSITA would be taught by Kim, we must examine with some detail Kim’s experiments. This is difficult because Kim’s experimental procedures are not articulated in any meaningful way—they are simply named, e.g. “thickness increase” (Ex. 1008, FIG. 3, FIG. 5, FIG. 7), “recovery capacity” (Ex. 1008, Table 2, FIG. 4, FIG. 6), “thickness variation ratio” (Ex. 1008, Table 2, Table 3, FIG. 4, FIG. 6), and “DC capa. to ini. capacity” (Ex. 1008, FIG. 7). Even though they are not defined, a POSITA might, with some effort, deduce from Table 2 what is meant by “recovery capacity” and “thickness variation” and how they might be calculated from underlying capacity and thickness measurements, respectively. However, the

POSITA is still dependent on Kim for how to understand and therefore interpret the underlying capacity and thickness measurements.

154. Kim does not specify how its “capacity” values are measured. To evaluate the applicability of these data to a goal the POSITA might have, a POSITA would need to know additional details such as at what charge or discharge rate and between what voltage limits capacity was measured. When it comes to cycling data (*see* Ex. 1008, Table 4 and Figure 7), a POSITA would need to know details of at what rate the cycling is performed, which is an independent rate that does not necessarily match the rate at which capacity is measured. Different tests may be used to measure capacity and cycling, depending on the intended application. Likewise, Kim does not specify how “thickness” values are measured. It is not clear whether the thickness corresponds to the total thickness of the cell at a particular location or from an ensemble of locations, how multiple values are treated, whether the thickness is measured under a particular state of charge/voltage and stack pressure, among other conceivable interpretations of “thickness”. In all cases, the measurements are not clear and, thus, would not be usable by the POSITA.

155. Nor does Kim give any teachings as to why thickness has particular relevance to a particular battery performance outcome a POSITA might seek. Kim mentions undesired gas generation (Ex. 1008 ¶¶ [0039], [0063]-[0064], [0104]-[0106]), for instance that “The electrolyte for a rechargeable lithium battery may exhibit low viscosity, excellent ion conductivity, and an excellent suppression effect on gas generation under a high voltage and a high temperature condition, and thus may effectively mitigate cell swelling at high temperature, and may improve cycle life characteristics, for example, in a high voltage battery of greater than or equal to about 4.4 V.” (Ex. 1008 ¶ [0039]). Notwithstanding that single oblique use of the word “swelling,” Kim never directly connects thickness measurements to possible suppression (or not) of gas generation,

and especially not to internal resistance, saying only that possible gas suppression provides generic benefits: “the electrolyte according to an embodiment may help suppress gas generation in a high voltage battery and thus help improve cycle life characteristics of the battery.” (Kim paragraph [0066]). This is not because gas generation cannot be measured or otherwise observed in cell testing, if desired, only that Kim chose not to perform any such measurements despite seeming to care about that property. In spite of all this, Dr. Lucht attempts to make a connection between gas generation, thickness and internal resistance by citing the above paragraphs of Kim, even though Kim itself does not make the connection: “Gas generation increases thickness and internal resistance of the battery, hurting storage and cycle performance, *Id.* ¶¶ [0039], [0063]-[0066].” (Ex. 1003 ¶ 175).

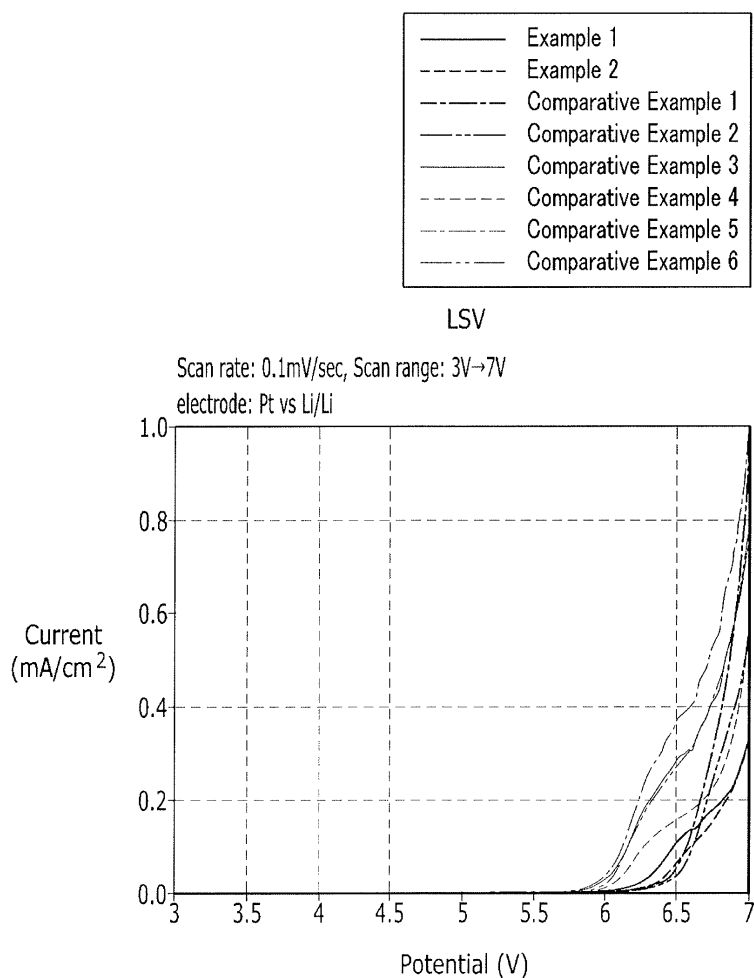
156. Kim’s data show, but Kim does not discuss, that its results are highly dependent on cell format. For example, Kim at Paragraph [0095] describes that Examples 1 and 2 and Comparative Examples 1 to 6 are embodied in prismatic cells. However, at Paragraph [0099], Kim describes embodiments of same Examples 1 and 2 and Comparative Examples 1 to 6 as pouch cells. No description is given as to how the respective prismatic and pouch cells are manufactured or are otherwise distinct from each other, nor are there teachings as to how they should be comparatively judged. For instance, a POSITA comparing “recovery capacity” results from the prismatic Example 1 (Ex. 1008, Table 2) would see 89.4% and from the pouch Example 1 (Ex. 1008, Table 3) would see 93.9%. This notable capacity difference or uncertainty of 4.5% for two embodiments of Example 1 exceeds the capacity differences between Example 1 and Comparative Examples 2, 3, 4, and 6 in Table 2. A POSITA cannot reliably judge that Example 1 is superior in recovery capacity to these supposedly dissimilar cases.

157. Similar divergence between Table 2 and Table 3 results for other properties and examples are manifest. The POSITA would then infer that there is a comparatively wide band of statistical uncertainty in the measurements made for each Example and Comparative Example in the two cell formats. First, this would lead a POSITA to have less confidence in the individual measurements due to their manifest differences by cell format. Second, this would lead a POSITA to not 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 according to established statistical principles.

158. Kim at Paragraphs [0099] and [0100] states that the thermal aging measurements on pouch cells were made after being “allowed to stand at 60°C. for *3 weeks*,” whereas Table 3 indicates the measurements were made after being “allowed to stand at 60°C. for *4 weeks*.” Ex. 1008 ¶¶ [0099]-[0100] and Table 3 (emphasis added). It is not clear which of these contradictory statements is correct.

159. FIG. 2 of Kim provides “linear sweep voltammetry” data, purporting to show that Examples 1 and 2 are more electrochemically stable electrolytes than Comparative Examples 1 to 6 would be at a particular electrode potential, meaning the smaller the current (vertical axis) at a particular potential (horizontal axis), the more stable the electrolyte. Ex. 1008, FIG. 2. First, a POSITA would note that one does not necessarily always want a more stable electrolyte. As discussed in Paragraph 77 above, one wants an electrolyte to react on the electrode and then passivate the electrode, so that an initial reaction is a desired trait as long as it subsequently ceases after a suitable break-in period. Second, it is obvious from FIG. 2 that those potentials far exceed (i.e. up to 7 V) potentials anticipated on a high-voltage cathode (i.e. around 4.4V). Because of the vertical scale used, a POSITA cannot determine from the plot the stability/currents for Examples

and Comparative Examples at more realistic potentials, i.e. around 4.4 V. Third, contrary to Kim’s assertion that Examples 1 and 2 are the most stable (Ex. 1008 ¶ [0094] (“Examples 1 and 2 showed a lower oxidation current at a higher voltage as compared with Comparative Examples”), Comparative Examples 1 and 2 actually have lower oxidation currents than Examples 1 and 2 at potential 6.5V, which is certainly a “higher voltage.” To summarize, Kim’s limited teachings as to the value of the “linear sweep voltammetry” data are not borne out, or are otherwise outright contradicted, by Kim’s own data.



Ex. 1008, FIG. 2.

160. Although I disagree as to the relevance or application of Kim to the problems faced by the inventors of the '910 patent, even if a POSITA were to try to apply Kim, in my opinion, only Kim's measurement of cycle life would be of possible relevance to considerations made in the '910 patent, meaning that a POSITA interested in extending the cycle life of cells in the manner of the '910 patent would assign more relevance to that measurement than other of Kim's measurements. However, Kim lacks any information on how the battery cell was cycled, which would prevent a POSITA from combining the teachings of Kim and Zeng with a reasonable expectation of success. Indeed, key information for assessing the performance of Kim's batteries is missing, such as the voltage limit to which the battery is charged or discharged and at what rate the cycling is performed. Given Kim's focus on increasing the thermal stability of a battery, (*see* Ex. 1008 ¶¶ [0055] and [0056]), information on how the battery was cycled is particularly relevant as a 0.1 V higher charging voltage shortens the battery life by 50%. Moreover, even if Kim provided information regarding how the battery cell was cycled, Kim's summary of cycle life in Table 4 is inconsistent with the data presented in FIG. 7, removing any confidence that a POSITA would have with respect to Kim's presentation of data.

161. Although not explicitly stated by Kim, a POSITA would conclude using test calculations that the "Capacity retention" values in Table 4 of Kim (reproduced below) are computed as the ratio of "Capacity after 250 cycles" to "Initial capacity" in Table 4. Thus, "Capacity retention" in Table 4 corresponds directly to "DC capa. to ini. capacity" in Figure 7 of Kim (also reproduced below). And indeed, this correspondence is precisely confirmed by reading Example 1, Example 2, Comparative Example 1, and Comparative Example 2 values from Figure 7 at 250 cycles and comparing these values to the values in Table 4. Furthermore, Kim invites the

reader to make this comparison: “Referring to Table 4 and FIG. 7, the Examples showed much higher capacity retention after 250 cycles....” Ex. 1008 ¶ [0103].

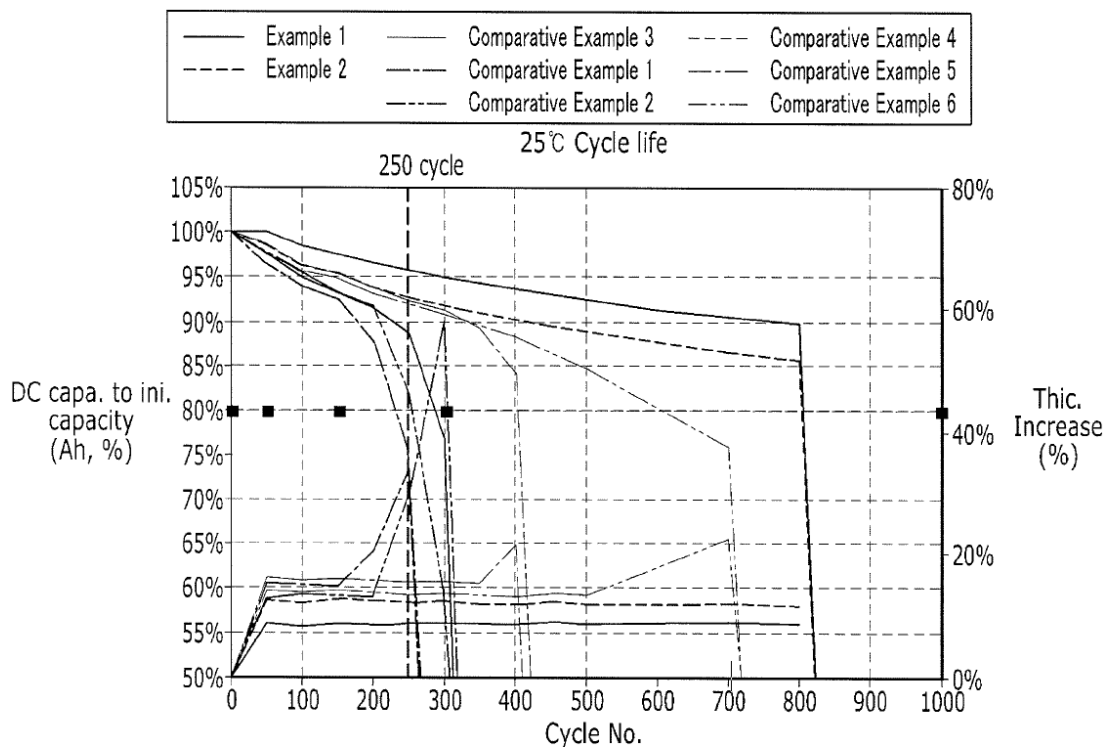
162. However, a problem arises when comparing the capacity retention values for the remaining Comparative Examples, namely Comparative Examples 3, 4, 5, and 6. In Figure 7, for example, Comparative Examples 5 and 6 have a 250-cycle capacity retention of around 92.5% and 92.3%, respectively. However, in Table 4, these capacity retentions are reported at much lower values of 75.8% and 75.3%, respectively. Similarly, in Figure 7, the 250-cycle capacity retention of Comparative Example 3 is around 88.9%, whereas in Table 4 the 250-cycle capacity retention of Comparative Example 3 is 92.0%. Meanwhile, there is no capacity retention curve for Comparative Example 4 in Figure 7 by which to make a comparison with Table 4. To summarize, there are notable unexplained discrepancies between Figure 7 and Table 4 capacity retention values, which ultimately would deter a POSITA, who is presumably to receive teachings from Kim, from applying Kim.

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%

Ex. 1008, Table 4.

FIG. 7



Ex. 1008, FIG. 7.

163. I disagree with Dr. Lucht's suggestion that Examples 1 and 2 of Kim motivate adjusting relative amounts of propyl propionate and a trinitrile. Ex. 1003 ¶¶ 166-177. This suggestion by Dr. Lucht appears to hinge on his analysis that Examples 1 and 2 are superior to Comparative Examples 5 and 6 in Kim. Ex. 1003 ¶ 172. Even if a POSITA were to retain confidence in Kim's data, which is suspect in multiple respects as discussed above, a POSITA would note that Example 1 is superior to Example 2 in Kim's data on cell cycle life, as shown in Table 4 and FIG. 7. Therefore, a POSITA seeking to maximize cycle life would be taught by Kim, if anything, to consider Example 1's composition as superior to Example 2's composition. In particular, this requires substitution of a portion of the PP and PC solvent fractions used in Example

2 with a substantial EP solvent fraction used in Example 1. This would teach the POSITA away from using an even higher fraction of PP than is used in Example 1, which is 40 vol% of the base solvent (i.e. not including salt or additives) and would draw the POSITA's attention, if any, to the ratio of PP to EP (rather than PP to HTCN as Dr. Lucht opined, *see* Ex. 1003 ¶ 170. Still further, to the extent Dr. Lucht argues that Example 2 as compared to Comparative Examples 5 and 6 indicates "PP is better than its peers and cannot be replaced by MP or EP" (Ex. 1003 ¶ 172), these arguments (if true) would actually lead a POSITA to use PP in place of EP in Zeng's Embodiments 4 and 6. That is, both of Embodiments 4 and 6 of Zeng include EP (ethyl propionate) in addition to PP. Ex. 1006 ¶ [0046] ("EC: PC: DEC: FB: **EP: PP** = 25: 10: 30: 5: **10: 20**") (emphases added). Based on Petitioner's own (still-erroneous) estimations, this would result in, based on a total weight of the electrolyte, a Z value of 26.49 wt% and 26.55 wt%, respectively, neither of which falls in the claimed Z range. That is, the amount of EP in the solvent mixture of each of Embodiments 4 and 6 (i.e., 10) would be replaced with PP such that the total amount of PP in the solvent mixture (prior to the addition of additives and lithium salt) would be 30 (10 + 20). For Embodiment 4, Dr. Lucht's calculations would correspond to $88.3\% \times (30/(25 + 10 + 30 + 5 + 10 + 20)) = 26.49\%$ and for Embodiment 6, Dr. Lucht's calculations would correspond to $88.5\% \times (30/(25 + 10 + 30 + 5 + 10 + 20)) = 26.55\%$. *See* Ex. 1003 ¶ 76.

164. Moreover, the teachings of Kim also do not mandate the presence of PP (propyl propionate) and other alkyl propionates, such as variations of butyl (C4) or pentyl (C5) propionate are disclosed. Ex. 1008 ¶¶ [0013]-[0014] ("C3 to C5 alkyl propionate"). For example, as stated in Kim, propyl propionate is one example of a C3 to C5 alkyl propionate which may be included individually, or in combination with other C3 to C5 alkyl propionates, in an amount of 10 volume percent to 80 volume percent based on the total amount of the organic solvent. Ex. 1008 ¶¶ [0040]-

[0041]. Despite no experiments being performed on C4 or C5 alkyl propionate compounds, Kim describes the C3 to C5 alkyl propionate as being not particularly limited (*see e.g.*, Ex. 1008 ¶ [0088] and claim 3) and no preference is given to propyl propionate. Indeed, Kim provides no direct comparison between different C3-C5-alkyl propionates that would motivate selection of propyl propionate over another C3-C5-alkyl propionate discussed in Kim. Thus, the POSITA would not make any inference about the efficacy of various alkyl propionates and at best would see a suggestion from Example 1 that substituting C3 alkyl propionate (PP) for C2 alkyl propionate (EP) is beneficial. Accordingly, I disagree with Dr. Lucht that a POSITA would be taught by Kim to use propyl propionate as the most efficacious alkyl propionate compound, especially when used exclusively (to the exclusion of other compounds). To wit, the presence of propyl propionate is not mandatory from the teaching of Kim and other alkyl propionates, such as variations of butyl (C4) or pentyl (C5) propionate are disclosed. Ex. 1008 ¶¶ [0013]-[0014] (“C3 to C5 alkyl propionate”).

165. Moreover, Kim fails to provide a POSITA with any guidance with respect to a mixing ratio of a *weight percentage* of a trinitrile compound to a *weight percentage* of propyl propionate *based on a total weight of the electrolyte*. That is, the solvents of Kim are only disclosed in *volume percentages, based on the total amount of the organic solvent* (Ex. 1008 ¶ [0013], Table 1). Thus, Kim does not contain an *explicit* disclosure of the amount of propyl propionate in the unit of weight percentage “based on a total weight of the electrolyte,” as is required in independent claims 1, 12, and 20 of the '910 Patent. Kim also does not contain an *implicit* disclosure of the amount of propyl propionate in the unit of weight percentage based on a total weight of the electrolyte. That is, no information can be taken from Kim that would allow a POSITA to convert the volume percentages mentioned therein into weight percentages. For example, Kim provides no

information regarding experimental parameters, such as the temperature under which the volume percentages of propyl propionate mentioned therein were determined. Thus, Kim fails to provide a POSITA with any guidance as to a mixing ratio based on weight percentages of components, let alone weight percentages of the components based on a total weight of the electrolyte. Indeed, a POSITA would not be motivated to turn to Kim from Zeng at least because the solvents of Zeng are set forth in a relative mass ratio and Kim only discloses its solvents in *volume percentages*.

166. Additionally, Kim's Examples 1 and 2 and Comparative Examples 1 to 6 use dinitrile amounts of 3 wt% or 1 wt% and use trinitrile amounts of 0 or 2 wt%. In all cases, dinitrile plus trinitrile amounts uniformly sum to 3 wt%. In the language of the '910 patent, all of Kim's embodiments are $X+Y = 3 \text{ wt\%}$ and X/Y is either 0.5 or infinity (i.e. divide by zero). Thus, despite Dr. Lucht's suggestion otherwise, there is little variation and no experimentation in Kim to suggest to a POSITA that there should be preferred or critical range of values for the combination of dinitrile (X) and trinitrile (Y) compounds.

167. Dr. Lucht further attempts to justify a POSITA's reliance on Kim on the basis that "Kim uses **four evaluation methods** to show that adjusting PP, while keeping trinitrile constant in Examples 1 and 2, significantly impacts battery performance" (Ex. 1003 ¶ 173, emphasis added). Likewise, "Since Kim already teaches that adding PP to dinitrile and trinitrile improves battery performance across **four evaluation approaches** (e.g., linear sweep voltammetry (LSV) evaluation of cell, thickness change and capacity evaluation, cycle life characteristics, etc.)..." Ex. 1003 ¶ 176 (emphasis added). Kim's evaluation methods are discussed above in some detail. In my opinion, the mere assertion by Dr. Lucht does not establish that Kim's purported four measurements have any particular value to the POSITA seeking to provide a firm protective SEI film on the surface of the cathode of an electrochemical device such as a lithium-ion battery that

is not easily decomposed, effectively inhibits the increase in DC internal resistance of the lithium ion battery, and achieves high capacity density, and excellent cycle and storage performances. See e.g., Ex. 1001, 1:56-63, 3:8-20. And as shown above, all of the measurements are inadequately described by Kim, scientifically problematic, and/or have no explicated connection to such objectives.

168. In my opinion, a POSITA would not be motivated to combine Kim and Zeng. Kim does not contain any teaching to prevent increases in the internal DC resistance of a battery, which is a main objective of the '910 Patent (*see supra* Section IV (B)). Nor would a POSITA be led to introduce DC internal resistance as a “routine procedure for evaluating electrolyte performance” or as an additional “evaluation approach” to the four evaluation approaches of Kim as alleged by Dr. Lucht. Ex. 1003 ¶ 176. Battery performance can be measured in numerous ways and which test(s) a POSITA would choose is dependent on a number of factors (including the battery’s intended application) such that no one test is “routine” or “merely a standard technical measure” as asserted by Dr. Lucht.

169. In my opinion, even a cursory examination of the battery development literature over the last 200 years or even last decade would show a practically unlimited list of possible experiments one could perform, and there is certainly no consensus on which battery tests are routine. For instance, cells have been adapted for measurements by instruments or techniques such as mass spectrometry, optical microscopy, electron microscopy, x-ray diffraction, neutron diffraction, nuclear magnetic resonance, stress and strain, and gas pressure, among many other

analytic techniques. *See e.g.*, Ex. 2032.¹² This is not to mention the multiplicity of electrochemical interrogation techniques such as determining cell responses to transient, scanning, and steady-state electrical perturbations. *See e.g.*, Ex. 2033.¹³ Individual cell components and electrolytes may similarly be evaluated chemically and mechanically. And of course, any of the properties recovered are functions of temperature, state of charge of the cell, and thermal and cycling history of the cell. Moreover, if the DC internal resistance measurement as taught in the '910 Patent is a “routine procedure,” as Dr. Lucht asserts, then Dr. Lucht would be able to point to numerous examples in the Petitioner’s exhibits, including Kim, wherein this measurement was performed, which he has not done.

170. Moreover, in addition to not containing any teaching to prevent increases in the internal DC resistance of a battery, Kim also does not contain any teachings to improve electrode plate wettability and interfacial compatibility, which are main objectives of Zeng. *See e.g.*, Ex. 1006, Abstract. Instead, Kim aims to increase the thermal stability of a battery through the use of “an electrolyte additive including greater than or equal to about three nitrile groups.” Ex. 1008 ¶¶ [0055]-[0056]. Kim describes that this purpose may be further served by the optional addition of an additive, which is intended to suppress the generation of gas in the electrodes during storage at high temperatures. Ex. 1008 ¶ [0064]. The additive may be selected from a variety of classes of compounds and may be present in a wide range of concentrations from about 0.01 to 20% by

¹² Jerome Workman, *A Comprehensive Review of Spectroscopic Techniques for Lithium-Ion Battery Analysis*, (Dec. 4, 2024), <https://doi.org/10.56530/spectroscopy.ii3689u3>.

¹³ Anup Barai et al., *A Comparison of Methodologies for the Non-Invasive Characterisation of Commercial Li-Ion Cells*, 72 *Progress in Energy and Combustion Science* 1-31 (2019).

weight of the total weight of the electrolyte composition. Ex. 1008 ¶¶ [0064]-[0065]. Examples 1 and 2 include succinonitrile (the only dinitrile compound mentioned at all in Kim) as an example of this additive, but Kim provides no single comparative example investigating whether succinonitrile has a beneficial effect on the electrolyte compositions.

171. A POSITA would also not be motivated to combine Kim and Matsuoka. As discussed above in Section VI.B.3. with respect to Zeng and Matsuoka, the electrolyte systems of Matsuoka and Kim are fundamentally different. Examples 1 and 2 of Kim each use a single inorganic lithium salt (LiPF₆) and are not acetonitrile solvent-based electrolytes. A POSITA would have understood that Matsuoka teaches away from such solvent electrolyte systems that are not acetonitrile solvent-based electrolytes, as well as the use of the single inorganic lithium salt LiPF₆. As such, a POSITA would not be motivated combine Matsuoka with Kim. Claims 2-6, 16-19, and 21-26 are not unpatentable over Zeng and Kim, with or without Matsuoka, for at least the reasons discussed above with respect to claims 1, 12, and 20. I reserve the right to address claims 2-6, 16-19, and 21-26 individually if this proceeding is instituted.

D. Ground 2A: Zeng and Sunose Do Not Render Obvious Claims 13-14

172. Petitioner contends that Zeng and Sunose render obvious claims 13-14 of the '910 Patent. These claims recite:

13. The electrochemical device according to claim 12, wherein the electrode comprises a cathode,

the cathode 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;

an electrode compaction density of the single-sided coating is D1, and, an electrode compaction density of the double-sided

coating is D2, wherein, about $0.8 \leq D1/D2 \leq$ about 1.2; and, $3.5 \text{ g/cm}^3 \leq D2 \leq 4.3 \text{ g/cm}^3$.

14. The electrochemical device according to claim 13, wherein,

both the single-sided coating and the double-sided coating are present on the same electrode; or,

only a single-sided coating or a double-sided coating present on the same electrode.

173. For at least the reasons discussed above with respect to Ground 1A, claims 13 and 14 are also not unpatentable. It is my further opinion that Sunose does not and cannot cure the deficiencies of Zeng. I reserve the right to further address additional issues with Sunose and claims 13 and 14 individually if this proceeding is instituted.

E. Ground 2B: Zeng, Matsuoka, and Sunose Do Not Render Obvious Claims 13-14

174. For at least the reasons discussed above with respect to Grounds 1A, 1B, and 2A, claims 13 and 14 are also not unpatentable. It is my opinion that Sunose and Matsuoka do not and cannot cure the deficiencies of Zeng. I reserve the right to address additional issues with Sunose and Matsuoka and claims 13 and 14 individually if this proceeding is instituted.

F. Ground 2C: Zeng, Sunose, and Kim, with or without Matsuoka, Do Not Render Obvious Claims 13-14

175. For at least the reasons discussed above with respect to Grounds 1A, 1B, 1C, 2A, and 2B, claims 13 and 14 are also not unpatentable. It is my opinion that Matsuoka, Kim, and Sunose do not and cannot cure the deficiencies of Zeng. I reserve the right to address additional issues with Matsuoka, Kim, and Sunose and claims 13 and 14 individually if this proceeding is instituted.

G. Ground 3A: Zeng, Sunose, and Su Do Not Render Obvious Claim 15

176. Petitioner contends that Zeng, Sunose, and Su render obvious claim 15 of the '910

Patent. This claim recites:

15. The electrochemical device according to claim 13, wherein the electrode comprises an anode,

the anode 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;

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

177. For at least the reasons discussed above with respect to Grounds 1A and 2A, claim 15 is also not unpatentable. It is my opinion that Su does not and cannot cure the deficiencies of Zeng and Sunose. I reserve the right to address additional issues with Su and claim 15 individually if this proceeding is instituted.

H. Ground 3B: Zeng, Matsuoka, Sunose, and Su Do Not Render Obvious Claim 15

178. For at least the reasons discussed above with respect to Grounds 1A, 1B, 2A, 2B, and 3A, claim 15 is also not unpatentable. It is my opinion that Matsuoka, Sunose, and Su do not and cannot cure the deficiencies of Zeng. I reserve the right to address additional issues with Matsuoka, Sunose, and Su and claim 15 individually if this proceeding is instituted.

I. Ground 3C: Zeng, Sunose, Su, and Kim, with or without Matsuoka, Do Not Render Obvious Claim 15

179. For at least the reasons discussed above with respect to Grounds 1A, 1B, 1C, 2A, 2B, 2C, 3A, and 3B, claim 15 is also not unpatentable. It is my opinion that Matsuoka, Kim,

Sunose, and Su do not and cannot cure the deficiencies of Zeng. I reserve the right to address additional issues with Matsuoka, Kim, Sunose, and Su and claim 15 individually if this proceeding is instituted.

J. Ground 4A: Zhou Does Not Render Obvious Claims 1-6, 12, and 16-26

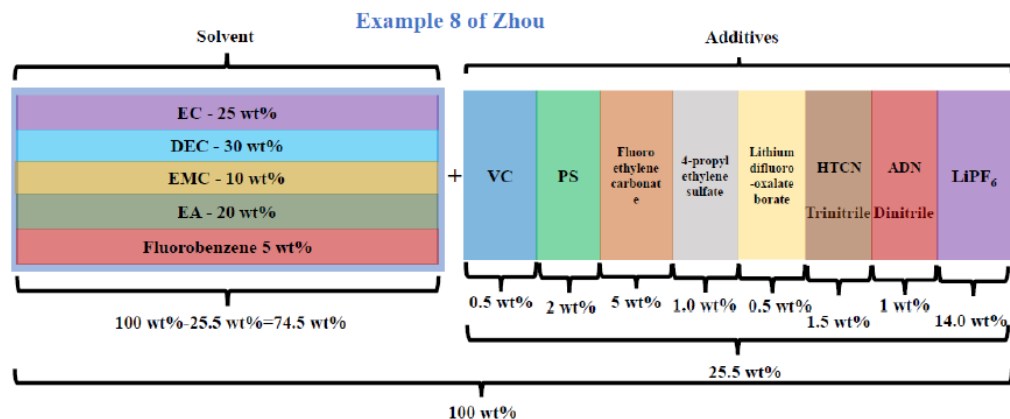
180. Petitioner contends that Zhou renders obvious claims 1-6, 12, and 16-26 of the '910 Patent.

181. Zhou is directed to a fast-charging lithium-ion battery electrolyte solution to provide certain fast charging requirements and battery cycling performance with a voltage of 4.35V, the electrolyte solution using a solvent including a mixture of two or more of low-boiling point linear carbonate and a linear carboxylic acid ester, fluorobenzene, and hydrofluoroether, a lithium salt, and three additives including “a first additive for negative electrode film formation, a second additive for improving battery cycle performance, and a third additive for improving battery high temperature performance.” Ex. 1014, Abstract. Zhou conducts battery cycling performance and AC impedance testing on lithium-ion batteries made with these electrolyte solutions to test the effect that the electrolyte systems have on performance and AC impedance of the batteries. *Id.* ¶¶ [0021]-[0024], [0048]-[0051], [0056]-[0057], [0060]-[0064].

182. Unlike Zhou, the claims of the '910 Patent are directed to three components—a dinitrile compound, a trinitrile compound, and propyl propionate—mixed in specific weight percentage ratio ranges that were unexpectedly found to result in a firm, protective SEI film on the surface of the cathode that was not easily decomposed, and which could provide performance improvements at a high potential of 4.45V and effectively reduce DC internal resistance of the battery. Ex. 1001, 1:56-63 (“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”). Indeed, as set forth in the ’910 Patent, “[t]he 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 [which subsumes the claimed range of 0.02-0.3], a better inhibition effect on the increase in DC internal resistance is achieved.” Ex. 1001, 29:29-34. Zhou says nothing about this critical ratio or that its electrolyte solutions can effectively inhibit the increase in DC internal resistance of the electrochemical device.

183. Instead of identifying the formula or a disclosure related to the critical nature of the ratio of the content of the trinitrile compound to the content of propyl propionate, it is my understanding that Petitioner points to the electrolyte composition disclosed for Example 8 of Zhou, and alleges that this electrolyte composition, as would allegedly be modified by the POSITA to substitute propyl propionate (PP) for ethyl acetate (EA), renders obvious the claimed electrolyte of claim 1. *See* Pet., pp. 55-69. In particular, I understand that Dr. Lucht opines that a POSITA would have been motivated to implement Example 8 of Zeng, asserting that the original electrolyte solution of Example 8 has the following composition:



Ex. 1003 ¶ 184.

184. It is my understanding that Dr. Lucht opines that a POSITA would have substituted propyl propionate (PP) for the ethyl acetate (EA) in Example 8 of Zhou. Ex. 1003 ¶¶ 197-207, 210-211.

185. I understand that Dr. Lucht opines that Example 8 of Zhou, as modified with propyl propionate, contains a “weight percentage PP in total electrolyte” of 16.56 wt%. Ex. 1003 ¶¶ 187-188, 210-212.

186. To obtain such “weight percentage PP in total electrolyte” in Example 8 of Zhou, I understand Dr. Lucht to have assumed that ethyl acetate (EA) forms 20 wt% of the solvent mixture, that the solvent mixture forms 74.5 wt% (1-25.5%) of the total electrolyte solution of Example 8, and that propyl propionate (PP) was substituted for ethyl acetate (EA) at a 1:1 ratio:¹⁴

¹⁴ The Equation is presented in the same form as Dr. Lucht depicted it in Paragraph 187 of Ex. 1003 with respect to Zhou, which is different from how Dr. Lucht depicted the Equation in Paragraph 76 of Ex. 1003 with respect to Zeng.

$$(1 - 25.5\%) * \left(\frac{20}{25\% + 30\% + 10\% + 20\% + 5\%} \right) = 16.56\% \quad \text{Example 8}$$

Ex. 1003 ¶¶ 187-188, 210-212.

187. It is my further understanding that Dr. Lucht further opined, based on this tenuous calculation of the weight percentage of propyl propionate, that modified Example 8 of Zhou discloses a mixing ratio of trinitrile to propyl propionate (Y/Z) of 0.091. Ex. 1003 ¶¶ 212-213.

188. For the reasons below, it is my opinion that a POSITA would not have selected or implemented Zhou in general or Example 8 of Zhou in particular.

189. It is also my opinion that Dr. Lucht relies on numerous improper assumptions with respect to his analysis of Example 8.

190. It is also my opinion, for the reasons below, that a POSITA would not substitute propyl propionate (PP) for ethyl acetate (EA) in Example 8 of Zhou, as evidenced by at least the numerous unsupported and incorrect assumptions, calculations, and arguments made by Dr. Lucht.

1. Petitioner Fails to Show that a POSITA Would Have Selected or Implemented Zhou in general or Example 8 of Zhou in particular

191. It is my opinion a POSITA would not have selected or implemented Zhou as its electrolyte formulation purposes are not aligned with the objective task underlying the '910 Patent.

192. The '910 Patent achieves a novel lithium-ion battery electrolyte solution that can provide a firm protective SEI film on the surface of the cathode of an electrochemical device that is not easily decomposed, effectively inhibits the increase in DC internal resistance of the lithium ion battery, and achieves high capacity density, and excellent cycle and storage performances. Ex. 1001, 1:56-63, 3:8-20. That is, as discussed in the Technology Overview section of this Declaration, during the first charge of a lithium-ion battery, the electrolyte reacts with the

respective electrode materials, undergoing reduction at the negative electrode (or anode), and oxidation at the positive electrode (or cathode). The reaction of the electrolyte causes a passive protective layer (the SEI), to form on the surfaces of the electrodes. The SEI contains a mixture of organic and inorganic electrolyte decomposition products and is very important to the function of the battery. Stable cathode SEI films, which can perform well at working voltages above 4.4V were of particular interest. At such “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” with an increasing number of charging cycles. *Id.* 22:57-62, 1:31-40; *see also* 1:33-38 (“at high voltages, the oxidation activity of the positive electrode material increases, and the stability decreases, which makes the electrolyte decompose on the surface of the positive electrode easily or cause deterioration of the battery material, resulting in a decrease in battery capacity.”).

193. Accordingly, faced with such premature degradation of the electrolyte and thus deterioration of the battery material with reduced battery capacity, it was an objective task of the '910 Patent to provide electrolyte compositions which prevent such prior art problems, especially for electrochemical devices working at voltages above 4.4V, such as 4.45V.

194. In contrast, Zhou does not mention cathode SEI film formation or high-voltage operation. The objective of Zhou is a fast-charging electrolyte, which emphasizes better wettability, lower viscosity, and lower lithium-ion transmission resistance. Ex. 1014 ¶ [0003].

195. Moreover, Zhou is directed to batteries with a lower charging voltage of only 4.35V, which is much lower than the high working voltages of the objective task of the '910 Patent. While it might seem to one new to the battery field that 4.35V in Zhou is close to the 4.45V level

of the '910 Patent, they are, in fact, substantially different. First, a POSITA trained in electrochemistry would understand that a small voltage difference can lead to substantial differences in rates of reaction—in this case, reactions that would lead to electrolyte or electrode degradation—because, in general, electrochemical reactions scale exponentially in voltage. Second, 4.35V is considered the extreme upper voltage limit for commercially produced cells employing LiCoO₂ (also known as LCO) cathodes, meaning that any operation over short or long periods of time above this voltage limit would substantially impair the life of the battery. In my opinion, Zhou did not choose 4.35V arbitrarily, but rather to show that fast charging could be enabled for the at-the-time cutting-edge battery standard. A POSITA would understand that the 4.45V disclosed in the '910 Patent would be well outside the conventional operating limit for both cell safety and longevity.

196. Prior to the '910 Patent, the primary solution to such above-described decomposition and premature degradation was to add a film-forming additive to the electrolyte. “However, doing so [caused] 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, 22:58-67. Accordingly, faced with such problem, a POSITA would find Zhou’s AC impedance testing/focus to be insufficient. That is, the DC internal resistance of the '910 Patent is different from the AC impedance studied in Zhou. While the two methods do both measure some common phenomena, they are not the same. *See, e.g.*, Ex. 2033. For example, DC internal resistance represents the resistance when the battery is in working condition and produces a weighted average of multiple operationally relevant resistances. DC internal resistance is particularly relevant to the power performance of the battery and its performance when under load, and is of great significance to the battery’s discharge capacity and charging efficiency. This

parameter can be measured by an instrument designed for controlling and measuring current and voltage of the test cell, such as a potentiostat.

197. The determination of AC impedance, however, involves injecting a sinusoidal current signal of a specific frequency into the cell, and synchronously detecting a sinusoidal voltage across the cell, thereby deriving the AC impedance of the battery. AC impedance is used in battery research and development, quality control, and electrochemical analysis because it is designed to give a linear response that can be better understood. However, the linear response means the AC measurement does not generally incorporate “polarization,” which happens when a cell in operation experiences large potential and concentration variations. In contrast, DC internal resistance captures polarization effects and better provides real-world operational assessment.

198. It is my further opinion that a POSITA would not have selected or implemented Zhou at least because there are multiple erroneous references to different or non-existent comparative examples in nearly every Example and Comparative Example set forth in Zhou. That is, the final sentence of each of the descriptions of Comparative Examples 2 and 3 and Examples 1-8 refers to a different or non-existent Comparative Example, thereby introducing uncertainty in the intention of Zhou with respect to the Examples. *See e.g.*, ¶¶ [0028]-[0029] (“**Comparative Example 2**...and then 14.0% by mass of LiPF₆ is slowly added and stirred until it is completely dissolved to obtain the lithium-ion battery electrolyte of **Comparative Example 1**.”), ¶¶ [0038]-[0039] (“**Example 4**...and then 14.0% by mass of LiPF₆ is slowly added and stirred until it is completely dissolved to obtain the lithium-ion battery electrolyte of **Comparative Example 6**.”), ¶¶ [0046]-[0047] (“**Example 8**...and then 14.0% by mass of LiPF₆ is slowly added and stirred until it is completely dissolved to obtain the lithium-ion battery electrolyte of **Comparative Example 8**.”) (emphases added).

199. In support of his rationale to implement Example 8 of Zhou, Dr. Lucht opines that the POSITA would have been motivated “to implement Example 8 over other Examples” because “Example 8 battery not only significantly performed the Comparative Example batteries on discharge capacity and low impedance, but also outperformed four other Examples on discharge capacity, and **outperformed four other Examples on low impedance.**” Ex. 1003 ¶ 191 (citing Ex. 1014 ¶¶ [0057], [0061], FIGS. 1-4); *see also*, Ex. 1003 ¶ 194 (Dr. Lucht asserting that “Example 8 outperformed Examples 3-6 in discharge capacity and **outperformed Examples 1, 2, 4, and 6 in internal impedance.**”) (emphases added). Dr. Lucht’s interpretations of FIG. 4 of Zhou are wrong.

200. FIG. 4 of Zhou provides:

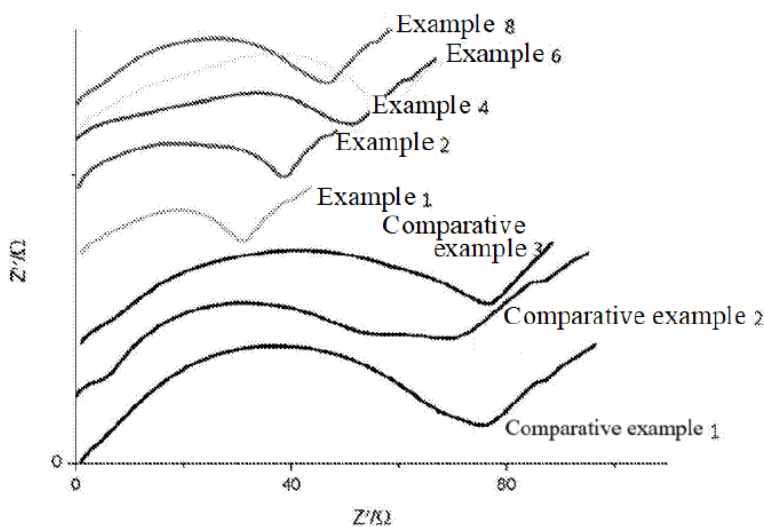


FIG. 4

Ex. 1014, FIG. 4.

201. FIG. 4 is known as a Nyquist plot, a way of presenting AC impedance data. It appears that Dr. Lucht assumed that Example 8 outperformed all of the other batteries depicted in

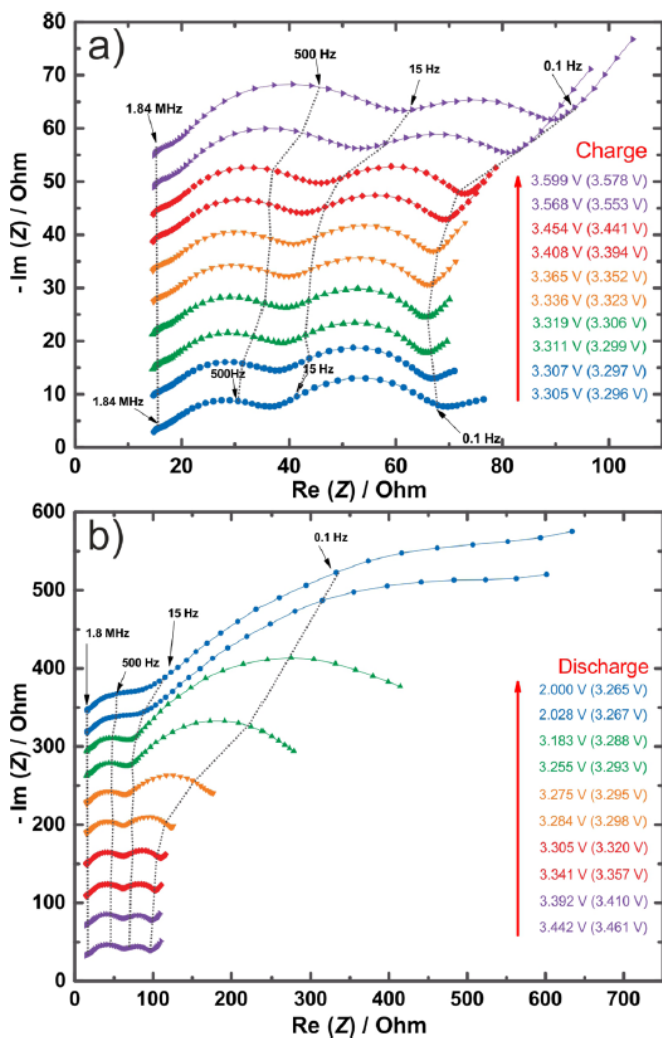
FIG. 4 simply because it is positioned at the top of the figure. However, this is a misinterpretation of the data reflected in FIG. 4. Rather, the results for each of the different Examples 1, 2, 4, 6, and 8 and Comparative Examples 1, 2, and 3 are stacked so that the depicted spectra do not overlap for easier viewing by the reader. Paragraph [0058] of Zhou provides, in relevant part,:

From Figure 4, it can be found that the corresponding semicircle in the AC impedance curve can characterize the impedance behavior of lithium-ions in the SEI film. **The larger the radius of the arc, the worse the kinetic performance, and the smaller the radius, the better the kinetic performance of the battery.**

Ex. 1014 ¶ [0058] (emphasis added).

202. Zhou's choice to present vertically offset or stacked curves in FIG. 4 is less common in Nyquist-type battery impedance plots, however, is common in some kinds of chemical spectroscopy; nevertheless, another example of vertically offset or stacked curves in a Nyquist-

type battery impedance plot may be found in FIG. 4 of Ex. 2023¹⁵ (reproduced below).



Ex. 2023, FIG. 4 (reflecting “[s]tacked Nyquist plots of [solid-state batteries] with LNTO-coated LiCoO₂ as active material during (a) the charge and (b) the discharge process”).

¹⁵ 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, 17835–17845 (2017).

203. Accordingly, the key value is not the vertical placement of a spectrum, but rather the horizontal position of the elbow or sharp dip of the spectrum, with the elbow or sharp dip located further to the left being preferable as it indicates lower “real” impedance for the electrode interface. The radius of each of Example 1 and 2 is smaller (i.e., the elbow or sharp dip is positioned further left) than the radius of Example 8 (i.e., the elbow or sharp dip is positioned further right). As such, Dr. Lucht misinterprets the results depicted in FIG. 4 at least inasmuch as Examples 1 and 2 both outperformed Example 8 with respect to AC internal impedance. Significantly, neither the electrolyte solution of Example 1 nor the electrolyte solution of Example 2 contain a trinitrile. Ex. 1014 ¶¶ [0032]-[0035]. It is my opinion that a POSITA would not have selected or implemented Example 8 over any of the other Examples of Zhou, and that Zhou teaches away from the electrolyte solution of Example 8 at least because Examples 1 and 2 both outperformed Example 8 with respect to AC internal impedance.

204. Moreover, FIG. 3 of Zhou is the only figure that depicts battery cycle performance at high temperatures. Ex. 1014 ¶¶ [0023] (“Figure 3 is a 1C/1C cycle performance test diagram of a battery prepared by the electrolytes of Comparative Examples 1, 2, 3 and Examples 1, 2, 5, and 6 at 45°C”), [0063] (“In order to further investigate the cycle performance of the battery at high temperature, a 1C/1C cycle performance test was conducted at 45°C”). The remaining figures depict testing results at room temperature or low temperature. Ex. 1014 ¶¶ [0024] (“Figure 4 is the AC impedance spectrum...at a low temperature of 10°C”), [0049] (“Room temperature 2C/1C cycle experiment...and the results are shown in Figure 1”), [0050] (“Room temperature 3C/1C cycle experiment...and the results are shown in Figure 2”).

205. FIG. 3 of Zhou provides:

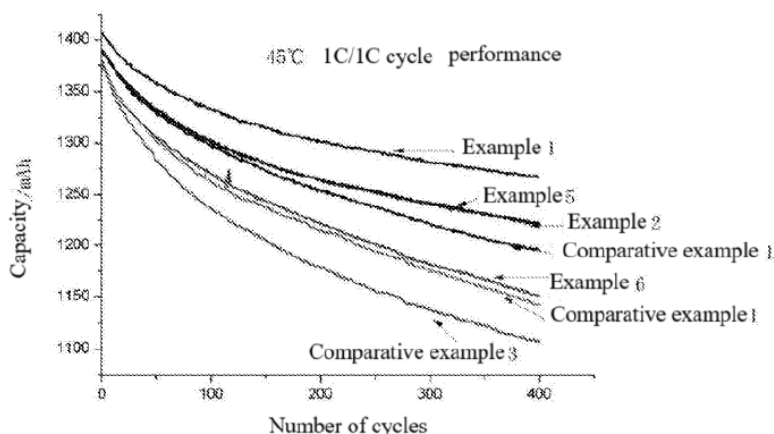


FIG. 3

Ex. 1014, FIG. 3.

206. Paragraph [0059] of Zhou provides, in relevant part,:

For the improvement of high temperature performance under high voltage of the fast charging system, among the nitrile compounds containing 2 or 3 nitrile functional groups in the third additive used in the present invention **to improve the high temperature performance of the battery, 1,3,6-hexane trinitrile is particularly preferred.** This is related to the poor compatibility of nitrile compounds with the negative electrode. **The high temperature performance is often challenged when using the solvent system of the present invention.**

Ex. 1014 ¶ [0059] (emphasis added).

207. The electrolyte solutions of Examples 4 and 8 of Zhou are the only examples that include a trinitrile, specifically, 1,3,6-hexane trinitrile. Ex. 1014 ¶¶ [0038]-[0039] (“1.5% by mass of 1,3,6-hexane trinitrile”), [0046]-[0047] (“1.5% by mass of 1,3,6-hexane trinitrile”). Significantly, neither Example 4 nor Example 8 are depicted in FIG. 3 such that a POSITA would

not be able to draw any conclusions therefrom. Accordingly, it is my opinion that a POSITA would not have selected or implemented Example 8 over any of the other Examples of Zhou.

208. It is my further opinion that Zhou teaches away from the combination of a dinitrile compound and a trinitrile compound in its electrolyte solutions because the dinitrile contains less nitrile groups for the same volume, such that a POSITA would not have selected or implemented Example 8 because it contains both a dinitrile compound and a trinitrile compound. Ex. 1014 ¶ [0059], ¶ [0046]-[0047] (identifying “1.5% by mass of 1,3,6-hexane trinitrile and 1% by mass of adiponitrile” in Example 8). According to Zhou, “[a]n efficient high temperature additive is the best choice. Nitrile compounds containing 2 or 3 nitrile functional groups, **such as 1,3,6-hexane trinitrile, contain three nitrile groups, and the density of nitrile groups per unit volume is higher. It 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. This requires more nitrile to compensate. 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.**” Ex. 1014 ¶ [0059] (emphasis added). Zhou, accordingly, teaches away from using both dinitrile and trinitrile compounds in the same solution.

209. It is my further opinion that a POSITA would not have selected or implemented Example 8 over any of the other Examples of Zhou at least because there is no unambiguous data that would indicate to or encourage a POSITA to choose any particular embodiment of Zhou over another. For example, in FIGS. 1-4 of Zhou, none of the figures contain all of the Examples, no one Example is set forth in each figure, and no one Example consistently outperforms the other Examples or even all the Comparative Examples. *See e.g.*, Ex. 1014, FIG. 1 (Examples 1 and 2 are

absent), FIG. 2 (Examples 3 and 6-8 are absent), FIG. 3 (Examples 3, 4, 7, and 8 are absent and Comparative Example 1 is depicted as having two distinct curves), and FIG. 4 (Examples 3, 5, and 7 are absent), ¶¶ [0060]-[0063].

210. It is my further opinion that a POSITA would not have selected or implemented Example 8 over any of the other Examples of Zhou based on a discrepancy in the solvent composition of Example 8. Dr. Lucht asserts that “[e]ach Example in Zhou is a self-contained, working embodiment that provides a complete list of components, amounts, and preparation instructions.” Ex. 1003 ¶ 191. However, the sum of the mass ratio of the solvent components in Example 8 **only adds up to 90**, while the mass ratios of all other Examples and Comparative Examples **add up to 100**. Compare Ex. 1014 ¶¶ [0046]-[0047] (“Example 8...mass ratio of 25:30:10:20:5) with Ex. 1014 ¶¶ [0032]-[0033] (“Example 1...mass ratio of 25:35:20:20”). Dr. Lucht never addresses this discrepancy and such discrepancy is only exacerbated by Dr. Lucht’s assumption that such mass ratio directly corresponds to *weight percentages* of the identified solvent components. See e.g., Ex. 1003 ¶ 184 (equating each solvent component relative mass ratio of 25:30:10:20:5 in Example 8 to weight percentages of 25 wt%, 30 wt%, 10 wt%, 20 wt%, and 5 wt%). It is unknown if there is an additional, different solvent component present at 10 wt% or if there is an additional 10 wt% of one or more of the identified solvent components. A POSITA would have disregarded Example 8 at least based on this weight discrepancy. I reserve the right to address this discrepancy in further detail if this *inter partes* review is instituted.

211. Accordingly, in my opinion, a POSITA would not have selected or implemented Zhou in general or Example 8 of Zhou in particular.

2. Dr. Lucht's Assumptions With Respect to His Analysis of Example 8 of Zhou are Improper

212. Dr. Lucht also relies on numerous improper assumptions with respect to his analysis of Example 8. For example, Example 8 of Zhou provides:

[0046] Example 8

[0047] In a glove box filled with argon (water content <10pm, oxygen content <1ppm), ethylene carbonate, dimethyl carbonate, ethyl methyl carbonate, ethyl acetate, and fluorobenzene are mixed uniformly in mass ratio of 25:30:10:20:5, 0.5% by mass of vinylene carbonate, 2% by mass of 1,3-propane sultone, 5% by mass of fluoroethylene carbonate, 1.0% by mass of 4-propyl ethylene sulfate, 0.5% by mass of lithium difluorooxalate borate, 1.5% by mass of 1,3,6-hexane trinitrile and 1% by mass of adiponitrile are added to the mixed solution, and then 14.0% by mass of LiPF₆ is slowly added and stirred until it is completely dissolved to obtain the lithium-ion battery electrolyte of Comparative Example 8.

Ex. 1014 ¶ [0046]-[0047].

213. In performing each of his calculations with respect to the alleged weight percentages of dinitrile, trinitrile, and propyl propionate, as well as the corresponding claimed sums and mixing ratios, Dr. Lucht, without explanation, erroneously relies on a central assumption that the mass percentages provided by Zhou in Example 8 for various additives (including ADN and HTCN) and for lithium salt are all based on the total mass of the final electrolyte solution. Ex. 1003 ¶ [0183] (“When Zhou describes electrolyte composition, Zhou refers to all additives based on ‘the total mass of the lithium-ion battery electrolyte’”) (citing Ex. 1014 ¶¶ [0009], [0013]-[0016], [0018]); *see also*, ¶¶ [0184]-[0189]. That is, Dr. Lucht assumes that the denominator for

determining the identified “% by mass” of each of the additives and the lithium salt is the total mass of the final electrolyte solution.

214. However, Example 8 of Zhou is silent as to what the identified mass percentages are relative to. For example and in view of the silence regarding identified mass percentages, a POSITA would interpret Example 8 of Zhou such that the identified mass percentages of the additives and the lithium salt are relative only to the mass of the solvents, not the total mass of the electrolyte. In this interpretation, the denominator for determining the identified “% by mass” of each of the additives and the lithium salt is the mass of the solvents. Alternatively, the POSITA could interpret the identified mass percentages of the additives and salt differently, according to their respective placements in the sequence of mixing steps. In this interpretation, the denominator for determining the identified “% by mass” of each of the additives is the mass of the solvents and the denominator for determining the identified “% by mass” of the lithium salt is the combined mass of the solvents and the additives. For example, in such interpretation, the POSITA understands Example 8 of Zhou to describe three steps: (1) mix solvents in mass ratio, (2) add the additives to the mixed solvents such that the identified mass percentages are based on the mass of the mixed solvents formed in Step 1, and (3) add the lithium salt such that the mass percentage is based on the combined mass of the solvent and additives mixture formed in Step 2. Based on the silence of Example 8 with respect to the relative measurement of the mass percentages, the POSITA logically understands that the mass percentages are calculated based on the mass of the mixture formed in the prior step.

215. The two interpretations in Paragraph 214 are based on a plain reading of the language found in Example 8, which describes a sequential mixing process in which solvent is mixed first and then all other constituents are treated as perturbations to this base mixture. Example

8, as do the other Examples, uses the language that additives “are added to the mixed solution” implying that the solvent mixture has distinct status as a base mixture. In view of the silence in Example 8 with respect to the determination of the mass percentages, Petitioner and Dr. Lucht have failed to address at least these interpretations of the relative denominator of the mass percentages identified in Example 8 of Zhou. Dr. Lucht’s flawed assumption that the mass percentages provided by Zhou in Example 8 for the various additives and for lithium salt are necessarily based on the total mass of the final electrolyte solution is erroneous and permeates each of his resulting calculations of the alleged weight percentages of dinitrile, trinitrile, and propyl propionate, as well as the corresponding claimed sums and mixing ratios.

3. Petitioner Fails to Show that a POSITA Would Have Substituted Propyl Propionate for Ethyl Acetate in Example 8 of Zhou

216. It is my understanding that Dr. Lucht opines that “a POSITA would have found it obvious to try substituting PP for EA in Example 8 of Zhou” and “replacing EA for PP in Example 8 of Zhou is merely a simple substitution of one known element (the carboxylic acid ester EA) for another (the carboxylic acid ester PP) which a POSITA could use to obtain predictable results.” Ex. 1003 ¶¶ [0198], [0203]. For the reasons set forth below, I disagree and it is my opinion that a POSITA would not have substituted propyl propionate (PP) for ethyl acetate (EA) in Example 8 of Zhou, as evidenced by at least the numerous unsupported and incorrect assumptions, calculations, and arguments made by Dr. Lucht.

217. Observing that Example 8 of Zhou contains “the linear carboxylic acid ester ethyl acetate (EA)”, Dr. Lucht concedes that “Example 8 does not contain PP.” Ex. 1003 ¶ 178. However, Dr. Lucht asserts that “Zhou lists only eight alternative suitable linear carboxylic acid esters”, “one of which (EA) is used in Example 8 and another of which is PP.” Ex. 1003 ¶¶ 178,

200 (citing Ex. 1014 ¶ [0011]). Dr. Lucht assumes that because “Zhou lists PP alongside EA as a suitable linear carboxylic acid ester,” “the POSITA would likewise expect PP to have a low melting point and provide a good channel for ion conductivity.” Ex. 1003 ¶ 201 (citing Ex. 1014 ¶ [0057]). I disagree at least because although propyl propionate is identified as a potential linear carboxylic acid ester, there is no preference, special significance, or even the slightest indication for the POSITA to select propyl propionate for use in Zhou as propyl propionate is not used in any of the Comparative Examples or Examples of Zhou or otherwise tested for its actual functionality. *See* Ex. 1014 ¶¶ [0026]-[0048], [0052]-[0055]. As such, it would be impossible to predict the effect of propyl propionate in Zhou’s Example 8. The chemical interactions and effects of complex combinations of various compounds in electrolyte solutions are extremely complex and unpredictable, and a POSITA would not expect predictable results from adding propyl propionate in the place of EA.

218. Moreover, the POSITA would not “likewise expect PP to have a low melting point and provide a good channel for ion conductivity” simply because Zhou lists PP alongside EA as a suitable linear carboxylic acid ester, as assumed by Dr. Lucht. Ex. 1006 ¶ 201. For example, Table 1 of Zhou provides the melting and boiling point data of some solvents used in Examples 1-8:

[0053] Table 1. Melting and boiling point data of solvents used in Examples 1-8

[0054]

Solvent	Melting Point/°C	Boiling Point/°C
Dimethyl carbonate	4.6	90
Ethyl methyl carbonate	-55	108
Ethyl acetate	-84	77.1
Ethyl propionate	-73.8	99
Butyl butyrate	-98	121.6
Fluorobenzene	-42	85

Ex. 1014 ¶¶ [0053]-[0054], Table 1.

219. Paragraph [0055] of Zhou further provides:

[0055] From the melting and boiling point data of some solvents in Examples 1-8 listed in Table 1, **it can be seen that the melting and boiling points of the linear carbonate and carboxylate solvents used in the present invention are both low**, providing a more suitable channel for lithium-ion transmission and reducing the impedance of the battery system.

Ex. 1014 ¶ [0055].

220. A POSITA would understand that having both a low melting point and a low boiling point correlates to lower viscosity, which allows the lithium ions to move more quickly, i.e., “providing a more suitable channel for lithium-ion transmission and reducing the impedance of the battery system.” Notably, propyl propionate has a melting point of -75.9°C, a boiling point of 122.5°C, and viscosity of 0.69 mPa/s at 20°C. Ex. 2024 (BYU DIPPR® (Design Institute for Physical Properties) Thermophysical Properties Laboratory Data Information Sheet for n-Propyl Propionate). Propyl propionate’s boiling point is nearly 50°C higher than the boiling point of ethyl acetate (77.1°C) and more than 20°C higher than ethyl propionate (99°C), the linear carboxylic acid esters used in Examples 1, 4, 6, and 8 and Examples 2, 3, 5, and 7, respectively. Indeed, propyl propionate’s boiling point is considerably higher than any other solvent in Table 1 that is used in Examples 1-8.¹⁶ In the event Petitioner or Dr. Lucht attempt to argue that the increased boiling

¹⁶ Although “Butyl butyrate” is listed in Table 1 of Zhou, it is not used in any of Examples 1-8 or Comparative Examples 1-3. *See* Ex. 1014 ¶¶ [0026]-[0048]. Indeed, “butyl butyrate” is not identified as a linear carboxylic acid ester in Zhou (Ex. 1014 ¶ [0011]) nor are the identified melting point and boiling point correct for “butyl butyrate”. Ex. 1014, Table 1. Rather, the noted

point of propyl propionate would improve battery safety, I note that any such change would necessarily make such electrolyte inferior for viscosity and conductivity, which is the focus of Zhou. Propyl propionate's melting point (-75.9°C) is also nearly 10°C higher than the melting point of ethyl acetate (-84°C). Propyl propionate's viscosity (0.69 mPa/s at 20°C) is also 53% higher than the viscosity of ethyl acetate (0.45 mPa/s at 20°C).

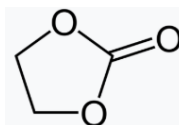
221. Moreover, propyl propionate is a much larger molecule and has a larger molar mass of 116.16 g/mol compared to the smaller molecule and molar mass of 88.106 g/mol of ethyl acetate. Compared to ethyl acetate, propyl propionate has a longer chain, with two additional methylene groups, such that propyl propionate has greater mutual intermolecular attractive forces, with the liquid molecules of propyl propionate moving more slowly and being impeded by neighboring molecules and thereby increasing viscosity.

222. Accordingly, a POSITA seeking higher electrolyte conductivity as Zhou is would not have had a reasonable expectation of success in replacing propyl propionate for ethyl acetate in Example 8 of Zhou nor would the POSITA obtain predictable results in such a substitution. For example, propyl propionate is a larger molecule and such substitution would increase both the melting point and the boiling point relative to the smaller ethyl acetate molecule, which defeats Zhou's identified purpose of using this solvent component.

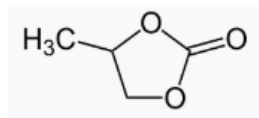
melting point of -98°C and boiling point of 121.6°C appear to correspond more closely to the literature melting point and boiling point of "ethyl butyrate", which although is identified as a linear carboxylic acid ester in Zhou (Ex. 1014 ¶ [0011]), is also not used in any of Examples 1-8 or Comparative Examples 1-3. *See* Ex. 1014 ¶¶ [0026]-[0048].

223. Moreover, the chemical reactions in a battery are unpredictable. The POSITA would understand that all of the components of an electrolyte are important and interact in complex and unexpected ways and substituting one component for another, even if apparently chemically similar, can cause substantial changes to properties of interest. Indeed, a component may promote one desirable property and simultaneously inhibit another desirable property. For example, ethylene carbonate (EC) and propylene carbonate (PC) have similar structures, but PC has one additional carbon atom:

Ethylene Carbonate (EC)



Propylene Carbonate (PC)



Their performances are very different, however. For example, EC can form a good SEI film on the surface of the carbon negative electrode, but PC cannot. This led to PC being rejected for use in Li-ion battery electrolytes for nearly 30 years, despite it having other desirable electrolyte properties.

224. 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. 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. Indeed, Dr. Lucht assumes that the propyl propionate would be substituted at a 1:1 weight percentage ratio, without

accounting for such varying parameters (e.g., boiling point, viscosity, molecule size, molar mass, etc.) that defeat Zhou's identified purpose.

4. Claims 2-6, 16-19, and 21-26 Are Not Unpatentable

225. Claims 2-6, 16-19, and 21-26 are not unpatentable for the same reasons as discussed above with respect to claims 1, 12, and 20. I reserve the right to address claims 2-6, 16-19, and 21-26 individually if this proceeding is instituted.

5. Petitioner Forfeits Any Challenge of Claims 20-26

226. In addressing claims 12 and 16-26, Dr. Lucht includes a summary table of "additional reasons" for why Zhou allegedly "discloses or suggests claims 12 and 16-26." Ex. 1003 ¶ 227.

227. As I discussed above, independent Claim 20 recites, *inter alia*, "wherein the electrolyte further comprises 1,3-propanesultone and **fluoroethylene carbonate**; wherein, based on the total weight of the electrolyte, a weight percentage of the 1,3-propanesultone is not less than 0.1 wt %, and not greater than 3 wt %" Ex. 1001, 37:3-7 (emphasis added). Petitioner collectively refers to these limitations as claim element [20.7].

228. Because claims 21-26 each depend from independent claim 20, each of claims 21-26 also require claim element [20.7]. None of the other challenged claims recite "fluoroethylene carbonate".

229. As I also discussed above with respect to Zeng, with respect to claim element [20.7], Dr. Lucht's summary table identifies only "Section XIV.B.8 above regarding element [1.7]; Section XIV.D.1 regarding element [3.1]." Ex. 1003, p. 98. Notably, elements [1.7] and [3.1] only recite "wherein the electrolyte further comprises a compound having a sulfur-oxygen double bond" and "[t]he electrolyte according to claim 1, wherein the compound having a sulfur-oxygen double

bond comprises 1,3-propanesultone, based on the total weight of the electrolyte, a weight percentage of the 1,3-propanesultone is not less than 0.1 wt%, and not greater than 3 wt%”, respectively. Neither element [1.7] nor element [3.1], or the paragraphs 216 or 219-220 of Dr. Lucht’s declaration, address the requirement of “fluoroethylene carbonate” in element [20.7].

230. In addition, the Petition also includes a summary table of “additional reasons” at pages 68-69 of the Petition for why Zhou allegedly “discloses or suggests claims 12 and 16-26.” Pet., p. 68 (citing Ex. 1003 ¶¶ 227-228). With respect to element [20.7], the summary table recites “Sections XIII.B.8 ([1.7]), XIII.D.1 ([3.1])” as alleged “reasoning.” *See id.*, p. 69. I have reviewed such cited sections of the Petition and they do not address the claimed “fluoroethylene carbonate.”

231. Accordingly, I have not addressed at least claim element [20.7] of claim 20, as CosMX and Dr. Lucht have not presented any argument that this claim element is met. I reserve the right to address the Petition’s further failings as to claims 20-26 individually if this proceeding is instituted.

K. Ground 4C¹⁷: Zhou and Kim Do Not Render Obvious Claims 1-6, 12, and 16-26

232. It is my understanding that in Ground 4C, Petitioner asserts and Dr. Lucht opines that Zhou and Kim render obvious Claims 1-6, 12, and 16 -26 of the ’910 Patent. Pet., pp. 72-73; Ex. 1003 ¶¶ 240-242. In particular, Dr. Lucht asserts that “Kim provides further motivation for a POSITA to consider the ratio of trinitrile to PP in Zhou and substitute EA for PP in Example 8 of Zhou” as “Zhou draws further attention to the advantage of the trinitrile HTC�”, “Zhou [] discloses that EA can be substituted for PP”, and “Zhou also cautions the POSITA against using an excessive

¹⁷ I note that Petitioner does not assert a “Ground 4B.”

amount of PP, at least indirectly focusing attention on the ration of Y/Z.” Ex. 1003 ¶¶ 240-241. I disagree for at least the following reasons.

233. For at least the reasons discussed above with respect to Zhou in Ground 4A, claims 1-16, 12, and 16-26 are not unpatentable.

234. It is my opinion that Kim does not and cannot cure the deficiencies of Zhou.

235. First, Dr. Lucht refers to “Section XIII.A” of his declaration for alleged support of Kim providing “further motivation for a POSITA to consider the ratio of trinitrile to PP in Zhou and substitute EA for PP in Example 8 of Zhou.” Ex. 1003 ¶ 240 (citing Section XIII.A). However, there is no “Section XIII.A” in Dr. Lucht’s declaration.

236. Moreover, as similarly discussed with respect to Grounds 1C, 2C, and 3C hereinabove, Kim is replete with internally contradicting data, statistical uncertainty, and woefully inadequate experimental procedure details from which a POSITA could draw any conclusions. For example, Kim does not specify how “capacity” or “thickness values” are measured. To evaluate the applicability of these data to a goal the POSITA might have, a POSITA would need to know additional details such as at what charge or discharge rate and between what voltage limits capacity was measured. When it comes to cycling data (*see* Ex. 1008, Table 4 and Figure 7), a POSITA would need to know details of at what rate the cycling is performed, which is an independent rate that does not necessarily match the rate at which capacity is measured. With respect to thickness, it is not clear whether the thickness corresponds to the total thickness of the cell at a particular location or from an ensemble of locations, how multiple values are treated, whether the thickness is measured under a particular stack pressure, among other conceivable interpretations of “thickness”. In all cases, the measurements are not clear.

237. Moreover, Kim fails to provide a POSITA with any guidance with respect to a mixing ratio of a *weight percentage* of a trinitrile compound to a *weight percentage* of propyl propionate *based on a total weight of the electrolyte*. That is, the solvents of Kim are only disclosed in *volume percentages, based on the total amount of the organic solvent* (Ex. 1008 ¶¶ [0013], Table 1). Thus, Kim does not contain an *explicit* disclosure of the amount of propyl propionate in the unit of weight percentage “based on a total weight of the electrolyte,” as is required in independent claims 1, 12, and 20 of the '910 Patent. Kim also does not contain an *implicit* disclosure of the amount of propyl propionate in the unit of weight percentage based on a total weight of the electrolyte. That is, no information can be taken from Kim that would allow a POSITA to convert the volume percentages mentioned therein into weight percentages. For example, Kim provides no information regarding experimental parameters, such as the temperature under which the volume percentages of propyl propionate mentioned therein were determined. Indeed, the density of at least all of the solvents would be necessary for such conversion and the density is not disclosed as a parameter in Kim. Notably, density changes with temperature which also was not provided in Kim. Moreover, the volume would not be conserved when mixing the various components, especially in view of the polar molecules. Thus, Kim fails to provide a POSITA with any guidance as to a ratio based on weight percentages of components, let alone weight percentages of the components based on a total weight of the electrolyte. Indeed, a POSITA would not be motivated to turn to Kim from Zhou at least because the solvents of Zhou are set forth in a relative mass ratio and Kim only discloses its solvents in *volume percentages*.

238. Additionally, Dr. Lucht’s assertion that “Zhou also cautions the POSITA against using an excessive amount of PP, at least indirectly focusing attention on the ratio of Y/Z: ‘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” (Ex. 1003 ¶ 241 (citing Ex. 1014 ¶ [0059])) is clearly wrong as the cited portion of Zhou has nothing to do with “excessive PP” as suggested by Dr. Lucht.

239. Accordingly, it is my opinion, that the Zhou and Kim do not render obvious claims 1-6, 12, and 16-26. I reserve the right to address additional issues with Kim and claims 1-6, 12, and 16-26 individually if this proceeding is instituted.

L. Ground 5A: Zhou and Sunose Do Not Render Obvious Claims 13-14

240. Petitioner contends that Zhou and Sunose render obvious claims 13-14 of the '910 Patent. For at least the reasons discussed above with respect to Ground 4A, claims 13 and 14 are also not unpatentable. It is my opinion that Sunose does not and cannot cure the deficiencies of Zhou. I reserve the right to address additional issues with Sunose and claims 13 and 14 individually if this proceeding is instituted.

M. Ground 5C¹⁸: Zhou, Kim, and Sunose Do Not Render Obvious Claims 13-14

241. Petitioner contends that Zhou, Kim, and Sunose render obvious claims 13-14 of the '910 Patent. For at least the reasons discussed above with respect to Grounds 4A, 4C, and 5A, claims 13 and 14 are also not unpatentable. It is my opinion that Sunose and Kim do not and cannot cure the deficiencies of Zhou. I reserve the right to address additional issues with Sunose and Kim and claims 13 and 14 individually if this proceeding is instituted.

N. Ground 6A: Zhou, Sunose, and Su Do Not Render Obvious Claim 15

242. Petitioner contends that Zhou, Sunose, and Su render obvious claim 15 of the '910 Patent. For at least the reasons discussed above with respect to Grounds 4A, and 5A, claim 15 is

¹⁸ I note that Petitioner does not assert a “Ground 5B.”

also not unpatentable. It is my opinion that Sunose and Su do not and cannot cure the deficiencies of Zhou. I reserve the right to address additional issues with Sunose and Su and claim 15 individually if this proceeding is instituted.

O. Ground 6C¹⁹: Zhou, Kim, Sunose, and Su Do Not Render Obvious Claim 15

243. Petitioner contends that Zhou, Kim, Sunose, and Su render obvious claim 15 of the '910 Patent. For at least the reasons discussed above with respect to Grounds 4A, 4C, 5A, 5C, and 6A, claim 15 is also not unpatentable. It is my opinion that Kim, Sunose, and Su do not and cannot cure the deficiencies of Zhou. I reserve the right to address additional issues with Kim, Sunose, and Su and claim 15 individually if this proceeding is instituted.

VII. CONCLUSION

244. In sum, it is my opinion that Grounds 1A, 1B, 1C, 2A, 2B, 2C, 3A, 3B, 3C, 4A, 4C, 5A, 5C, 6A, and 6C of the Petition do not render Claims 1-6 and 12-26 of the '910 Patent unpatentable as obvious for the reasons I discuss above.

¹⁹ I note that Petitioner does not assert a "Ground 6B."

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 May 14, 2025 in Provo, Utah.

A handwritten signature in cursive script that reads "Dean R. Wheeler". The signature is written in black ink and is positioned above a horizontal line.

Dean R. Wheeler