UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner

v.

NINGDE AMPEREX TECHNOLOGY LIMITED,
Patent Owner

Case IPR2025-00405
U.S. Patent No. 11,769,910

DECLARATION OF BRETT LUCHT, PH.D.

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I, Brett Lucht, Ph.D., declare as follows:

I. INTRODUCTION

1. I have been retained by Lee & Hayes, P.C. as a technical expert for Zhuhai CosMX Battery Co., Ltd. ("CosMX" or "Petitioner"), who is the Petitioner in an *Inter Partes* review before the United States Patent and Trademark Office involving U.S. Patent No. 11,769,910 ("the '910 Patent," EX1001).

2. Specifically, I have been retained as an independent expert consultant by Petitioner to provide my opinions on the technology claimed in, and the patentability of claims 1-6 and 12-26 ("the challenged claims") of the '910 Patent. Although I am being compensated at my usual rate of $600 per hour for the time I spend on this matter, no part of my compensation depends on the outcome of this proceeding, and I have no financial interest in any of the parties. I have no affiliation with either party in this case besides having been retained as an independent consultant in this matter.

3. I have personal knowledge of the facts and matters in this declaration and believe them to be true.

II. BACKGROUND AND QUALIFICATIONS

4. My *curriculum vitae*, which I understand has been attached as EX1004 in this proceeding, provides full description of my background and technical qualifications, as well as a list of publications that I have authored. In the following

paragraphs I provide a brief overview of my background and qualifications relevant to this matter.

5. I received a BS in Chemistry (1991) from the University of Puget Sound and Ph.D. in Chemistry (1996) from Cornell University and then moved to the University of California, Berkeley for post-doctoral research.

6. I am a Professor at the University of Rhode Island. I arrived at the University of Rhode Island in 1998, was promoted to Associate Professor with tenure in 2002 and Professor in 2006. I have many awards for research and intellectual property at the University of Rhode Island, including the 2016 URI Foundation Scholarly Excellence Award.

7. My research is focused on novel electrolytes and electrolyte electrode interfaces for lithium-ion battery applications which include extending the calendar life, improving low temperature properties, improving the performance of novel high-capacity anodes such as lithium metal or silicon, and improving the performance of high voltage cathode materials. I have received research grants and contracts in support of my research totaling over 14 million dollars. My research has been funded by several United States governmental agencies, including the Department of Energy, National Aeronautics and Space Administration, National Science Foundation, and Department of Defense. My research has also been funded by several companies, including BASF, Samsung, Duracell, and Volkswagen.

8. I have regularly conducted both basic science and applied research and have collaborated extensively with industrial partners. These collaborations have included the development of novel separators and commercial cell design.

9. I have mentored more than 100 students including over 40 graduate students, 30 undergraduate students, 20 postdoctoral fellows, along with several visiting students.

10. I became a Fellow of the Electrochemical Society in 2022 and am currently an Associate Editor for the Journal of Electrochemical Society and was the Chair of the Battery Division of the ECS from 2022-2024.

11. I have published over 190 manuscripts, and my manuscripts have been referenced over 15,000 times. I have also published two book chapters and hold nine patents. I have been an invited or keynote speaker at over 100 companies, universities, national laboratories, and international conferences. My invited and keynote lectures include the International Meeting for Lithium Batteries (Kyoto 2018, Sydney 2022), International Battery Association meeting (Barcelona 2013, France 2016, Korea 2018, Slovenia 2022), Japan Battery Symposium (Kyoto 2019), Munich Battery Discussions (2022), and the Advanced Automotive Battery Conference (Orlando 2012, Atlanta 2014, Detroit 2016, Germany 2018).

12. In the previous five years, I have testified as a witness in the following intellectual property legal matters:

- *Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.*, No. 2:22-cv-00232 (E.D. Tex) (filed Jun. 24, 2022);
- *Advanced Electrolyte Techs. LLC v. eSDi LLC*, No. 1:17-cv-00030 (W.D. Tex.) (filed Jan. 18, 2017);
- *Samsung SDI Co. v. UBE Indus.*, Ltd., No. IPR2018-00611 (PTAB) (filed Feb. 9, 2018),
- Ascend Performance Materials Operations LLC v. Samsung SDI Co., No. IPR2020-00349 (PTAB) (filed Dec. 24, 2019),
- *Maxell, Ltd. v. Amperex Tech. Ltd.*, Nos. 6:21-cv-347-ADA, 6:21-cv-1007-ADA (W.D. Tex.) (filed Apr. 8, 2021),
- *Amperex Tech. Ltd. v. Maxell, Ltd.*, No. IPR2021-01440 (PTAB) (filed Sept. 23, 2021),
- *Amperex Tech. Ltd. v. Maxell, Ltd.*, No. IPR2021-01441 (PTAB) (filed Sept. 23, 2021),
- *Amperex Tech. Ltd. v. Maxell, Ltd.*, No. IPR2021-01442 (PTAB) (filed Sept. 23, 2021),
- *Amperex Tech. Ltd. v. Maxell, Ltd.*, No. IPR2021-01443 (PTAB) (filed Sept. 23, 2021), and

- Amperex Tech. Ltd. v. Semiconductor Energy Lab. Co., No. 1:23-cv-272-PTG-LRV (E.D. Va).

III. MATERIALS CONSIDERED

13. In forming my opinions expressed in this declaration, I have considered, among other things, the following documents. I confirm that to the best of my knowledge the accompanying exhibits are true and accurate copies of what they purport to be, and that an expert in the field would reasonably rely on them to formulate opinions such as those set forth in this Declaration. I understand the documents have been given the following exhibit numbers in this proceeding:

Exhibit No.	Description
1001	U.S. Patent No. 11,769,910 (“the ’910 Patent”)
1002	Prosecution history of U.S. Patent No. 11,769,910 (“the ’910 Patent file history”)
1005	China Patent Application Publication No. CN 106099187A to Zeng et al. (“Zeng”)
1006	Certified English Translation of China Patent Application Publication No. CN 106099187A to Zeng et al. (“Zeng”)
1007	U.S. Patent Application Publication No. 2013/0224535 A1 to Matsuoka et al. (“Matsuoka”)
1008	U.S. Patent Application Publication No. 2017/0288268 to Kim et al. (“Kim”)
1009	Japan Patent Application Publication No. 2009-252349 to Sunose et al. (“Sunose”)
1010	Certified English Translation of Japan Patent Application No. 2009-252349 to Sunose et al. (“Sunose”)
1011	China Patent No. 108023117 to Su et al. (“Su”)

Exhibit No.	Description
1012	Certified English Translation of China Patent No. 108023117 to Su et al. ("Su")
1013	China Patent Application Publication No. CN 105552439 A to Zhou et al. ("Zhou")
1014	Certified English Translation of China Patent Application No. CN 105552439 A to Zhou et al. ("Zhou")
1015	Chinese Patent No. 106848381 ("Hong") and Certified Translation of Hong
1016	Petition (Paper 1) in *Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.*, No. IPR2023-00586 (PTAB Feb. 23, 2023)
1017	Decision Denying Institution (Paper 14) in *Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.*, IPR2023-00586 (PTAB Aug. 18, 2023)
1018	National Library of Medicine PubChem web pages for adiponitrile, 1,3,6-tricyanohexane, lithium hexafluorophosphate, 1,3-propane sultone, succinonitrile, 1,2-bis(2-cyanoethoxy)ethane
1019	Millipore Sigma data sheets for ethylene carbonate (EC), propylene carbonate (PC), ethyl propionate (EP), and propyl propionate (PP)
1020	TCI America page for 1,3,6-Hexanetricarbonitrile
1021	Complaint, *Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.*, No. 2:24-cv-00728-JRG (E.D. Tex. Sept. 6, 2024), ECF 1
1022	Unopposed Application for Extension of Time to Answer Complaint, *Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.*, No. 2:24-cv-00728-JRG (E.D. Tex. Dec. 4, 2023), ECF 16.
1023	U.S. Patent Application Publication No. 2017/0324116 A1 to Youichi Ohashi ("Ohashi")
1024	U.S. Patent Application Publication No. 2016/0294007 A1 to Wang Kefei ("Kefei")
1025	U.S. Patent Application Publication No. 2017/0069934 A1 to Yun-Hee Kim et al. ("Kim '934")

In forming my opinions, I have also relied on my education and experience.

IV. RELEVANT LEGAL STANDARDS

14. I am not an attorney. My analysis and opinions are based on my background and expertise in this technical field, as well as the instructions I have been given by counsel for the legal standards relating to patentability.

15. I have been informed by counsel for Petitioner that the following legal principles may apply to analysis of patentability based on 35 U.S.C. §§ 102 for anticipation and 103 for obviousness. I have also been informed that, in an *inter partes* review proceeding such as this one, a patent claim is unpatentable if it is shown by a preponderance of the evidence that the claim would have been anticipated by a prior art patent or publication, or obvious by one or more properly combined prior art patents or publications.

A. Level of Ordinary Skill in the Art

16. I have been instructed to consider patentability of the Challenged Claims through the lens of a person of ordinary skill in the art ("POSITA") at the time of the claimed priority date of the ’910 Patent—September 21, 2018. I am familiar with the level of ordinary skill in the subject matter of the ’910 Patent in 2018.

17. Based on my review of the technology, and drawing on my own experience in the field, my analysis below assumes that a POSITA 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. This level of skill is approximate, and more experience would compensate for less formal education, and vice versa. It is consistent with the field identified by the ’910 Patent: “the technical field of energy storage technologies, in particular to an electrolyte and an electrochemical device containing the electrolyte.” EX1001, 1:19-21.

18. Based on my qualifications discussed above, I qualified at least as a POSITA of the ’910 Patent by 2004.

19. My analysis below considers how a POSITA would have understood the references listed above with respect to the challenged claims of the ’910 Patent.

B. Anticipation

20. I have been informed a patent claim is unpatentable as anticipated under 35 U.S.C. § 102 if every limitation of the claimed invention is found in a single prior art reference--either expressly or required through inherency--as arranged in the claim.

C. Obviousness

21. I have been informed that, even if a single prior art reference does not disclose each and every element of a patent claim, the patent claim is still

unpatentable as obvious under 35 U.S.C. § 103. It is my understanding that a claimed invention is unpatentable as obvious over a combination of prior art references if the differences between the claimed invention and the prior art are such that a POSITA would have found the subject matter as a whole obvious.

22. I understand that obviousness is determined by evaluating: (1) the scope and content of the prior art, (2) the differences between the prior art and the claim, (3) the level of ordinary skill in the art, and (4) any secondary considerations of non-obviousness. To establish obviousness based on a combination of the elements disclosed in the prior art, it is my understanding that a challenger must provide a clear articulation of the reason(s) why the claimed invention would have been obvious. I understand this articulation may, but does not necessarily, require record evidence of an explicit teaching, suggestion, or motivation to combine the prior art in the way recited in a patent claim. Rather, prior art may be combined based on an express teaching, suggestion, or motivation from the prior art itself, or from a reasoned explanation of an expert witness or some other rationale.

23. For example, it is my understanding that this articulation can come from a number of rationales, which include but are not limited to (1) combining prior art elements according to known methods to yield predictable results; (2) simple substitution of one known element for another to obtain predictable results; (3) use of known technique to improve similar devices, methods, or products in the same

way; (4) applying a known technique to a known device, method, or product ready for improvement to yield predictable results; (5) choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success, e.g., the combination is "obvious to try"; (6) known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; and (7) some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed limitation.

24. I further understand that these rationales may be found explicitly or implicitly: (1) in the prior art; (2) in the knowledge of those of ordinary skill in the art that certain references, or disclosures in those references, are of special interest or importance in the field; and/or (3) from the nature of the problem to be solved.

25. Additionally, I understand that the legal determination of the motivation to combine references allows recourse to logic, judgment, and common sense. For example, in order to resist the temptation to read into prior art the teachings of the '910 Patent, the expert should avoid conflating "common sense" with what appears obvious in hindsight. I understand that if the teachings of a prior art would lead a POSITA to make a modification that would render another prior art device inoperable, then such a modification may not be obvious. I also understand

that if a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there may be no suggestion or motivation to make the proposed modification.

D. Claim Construction

26. Counsel has instructed me that, in this proceeding, the words of a claim are to be given their plain and ordinary meaning, which the meaning understood by a person of ordinary skill in the art after reading the entire patent. This analysis focuses on how the patentee used the claim term in the claims, specification, and prosecution history. Dictionaries or extrinsic sources may assist in determining the plain and ordinary meaning, but extrinsic evidence cannot override a meaning that is unambiguous from the intrinsic evidence. I have applied the plain and ordinary meaning in my analysis below.

V. TECHNOLOGY BACKGROUND

A. Lithium-Ion Battery Technology

27. Lithium-ion batteries have become a popular power source for portable and other electronic devices because of their high energy density. *See* EX1006, ¶¶ [0002]-[0006]. A typical lithium-ion battery has a positive electrode (cathode), a negative electrode (anode), a separator, and an electrolyte. The cathode typically comprises a current collector and a layered active material that in the discharged state contains lithium, while the anode typically comprises a current

collector with a layered active material capable of receiving lithium ions. The separator prevents physical contact between the cathode and anode, which would cause a short circuit. The electrolyte serves as the medium through which lithium ions travel between the cathode and the anode, and comprises lithium salt, solvent, and optional additives.

28. Lithium-ion batteries operate via a "rocking-chair" mechanism by which the lithium ions move or "rock" back and forth between the cathode and anode as the battery charges and discharges. As shown in Figure 1 below, charging the battery dislodges lithium from the cathode in the form of lithium ions. Those lithium ions enter the electrolyte, forcing lithium ions present in the electrolyte to move into the anode. The dislodging of the lithium ions from the cathode frees electrons in the cathode. Those free electrons cannot diffuse into the electrolyte but instead flow through an external circuit into the anode where they recombine with the lithium ions in the anode. This process creates an electrochemical potential between the anode and the cathode.

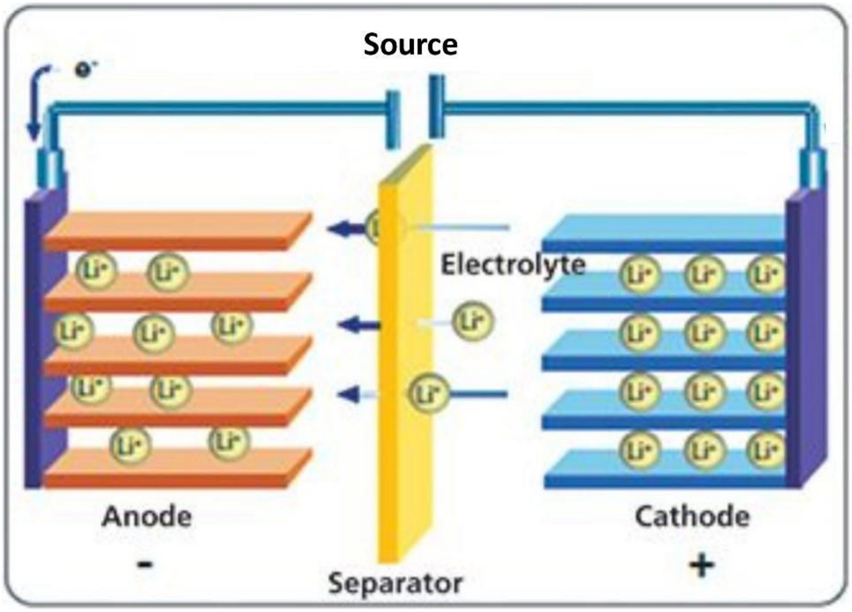

Figure 1: Charging Mechanism for a Lithium-Ion Battery

29. During discharge, the reverse electrochemical process occurs, as shown in Figure 2 below. A load, connected between the anode and cathode, creates a pathway for electrons to flow between the anode and the cathode. The difference in electrochemical potential drives electrons from the anode to the cathode through the load, powering the load. The release of electrons from the anode also dislodges lithium ions from the anode into the electrolyte, which causes lithium ions in the electrolyte to enter the cathode, where they recombine with electrons from the anode.

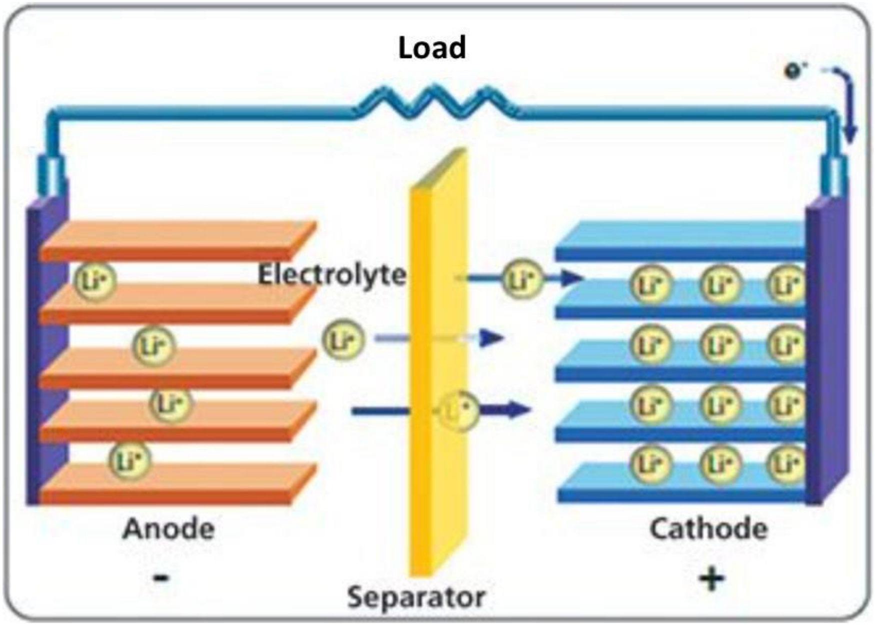

Figure 2: Discharge Mechanism for a Lithium-Ion Battery

30. One charge-discharge sequence is called a cycle.[1] In contrast with primary batteries like alkaline batteries, which cannot be recharged because they irreversibly consume chemical energy in the cathode, lithium-ion and other secondary (rechargeable) batteries can be cycled many times. The discharge reaction in lithium-ion batteries can be reversed by forcing a lithium ion to return to the anode, thereby returning the battery to its original, charged composition and structure for additional cycles.

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[1] An animation showing a charge-discharge cycle is available here: https://www.energy.gov/eere/articles/how-does-lithium-ion-battery-work.

B. Known Dinitrile-Based Electrolytes, Further Containing a Trinitrile Compound and Propyl Propionate, Improved Stability of the SEI Layer

31. As the medium through which lithium ions travel between the cathode and the anode, the electrolyte must remain stable. One feature that helps maintain the electrolyte stability is the solid electrolyte interphase ("SEI") layer. The SEI layer is a passivating layer formed on the electrode through partial decomposition of the electrolyte, predominantly during the first cycle, that inhibits further electrolyte decomposition from side reactions during later cycles. It is electronically insulating but conductive to lithium ions, allowing lithium ions to pass through it but not electrons.

32. As the demand for higher energy density pushed manufacturers to increase the voltage and capacity of lithium-ion batteries, that likewise put increased stress on the SEI layer, making its stability and durability more important. *See, e.g.*, EX1006, ¶¶ [0003]-[0005]; EX1014, ¶¶ [0001]-[0005], [0008]; EX1008, ¶¶ [0001]-[0007]. In my opinion, it was well known in the lithium-ion battery industry prior to the '910 patent that electrolytes that contain dinitrile compound (*X* wt%) and further contain a trinitrile compound (*Y* wt%) and PP (*Z* wt%) made the SEI layer more stable and durable. *See* EX1006, ¶¶ [0037], [0049]; EX1014, ¶¶ [0058], [0059]; EX1008, ¶¶ [0014], [0040], [0090]-[0104] (Table 2), Claim 3. Additionally, in my opinion, the prior art taught that adding a trinitrile compound and PP to dinitrile-

based electrolytes improved overall battery performance. *See*, *e.g.*, EX1008, ¶¶ [0090]-[0091] (Table 2), [0092]-[0104].

VI. THE ’910 PATENT

A. Overview

33. I understand the ’910 Patent issued on September 26, 2023 from U.S. Application No. 18/076,882 (“the ’882 Application”) and claims a priority to China Application No. 201811108529 filed September 21, 2018. EX1001, 1. For purposes of this declaration, I have been asked to assume that the ’910 Patent is entitled to its earliest claimed priority date.

34. Like the prior art, the ’910 Patent observes that, “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.” EX1001, 1:33-40. Also like the prior art, the ’910 Patent purports to address this issue with a conventional solution: an electrolyte composition “using a mixture of a dinitrile compound, a trinitrile compound and propyl propionate, [which forms] a firm protective film which is not easily decomposed on the surface of the cathode at a high potential ….” *Id.*, 1:57-63.

35. According to the ’910 Patent, an electrolyte having various weight percentages of dinitrile (X), trinitrile (Y), and PP (Z) (based on the total weight of the

electrolyte) that will purportedly form a durable SEI film on the cathode. EX1001, 6:1-34. The ’910 Patent provides four Formulas (1)-(4) in which $X+Y$, X/Y, Z, and Y/Z fall within respective ranges, mentioning different upper and lower ends for the ranges throughout the description and examples as exhibiting various levels of performance. *See id*., 6:1-67, 23:30-27:60. The ’910 Patent measured performance using three metrics, i.e., inhibiting rise in DC internal resistance, reducing expansion rate, and maintaining voltage capacity during high-temperature storage and cycling (after 200 and 400 cycles). *See* EX1001, 23:30-27:58.

36. The ’910 Patent specification discloses a broad range of about 5-50 wt% for Z, the wt% of propyl propionate (PP). Specifically, it teaches embodiments that incrementally narrow that broad Z range to “about 25-30%.” EX1001, 6:52-57 (“In some embodiments, the weight percentage (Z) of the propyl propionate is about 5-40 wt%, about 10-40 wt%, about 10-30 wt%, about 20-50 wt%, about 20-40 wt%, about 20-30 wt%, or about 25-30 wt%.”). The ’910 Patent specification does not criticize any particular Z range within the broader range of about 5-50 wt%; to the contrary, it merely suggests that Z values higher or lower than about 5-50 wt% diminish performance. EX1001, 29:23-26 (“[W]hen the content of the propyl propionate is less than 5 wt% or greater than 50 wt%, the DC internal resistance of the battery is greatly increased after 200 cycles and the performance is deteriorated.”).

37. Claim 1 of the ’910 Patent recites an electrolyte with representative ranges for Formulas (1)-(4):

> 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 wt%≤(X+Y)≤about 8 wt%, [Formula (1)]
> >
> > about 0.1≤(X/Y)≤about 2.3, [Formula (2)]
> >
> > 5 wt%≤Z≤20 wt% or 30 wt%≤Z≤50 wt%, and [Formula (3)]
> >
> > about 0.02≤(Y/Z)≤about 0.3; [Formula (4)]
>
> 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.

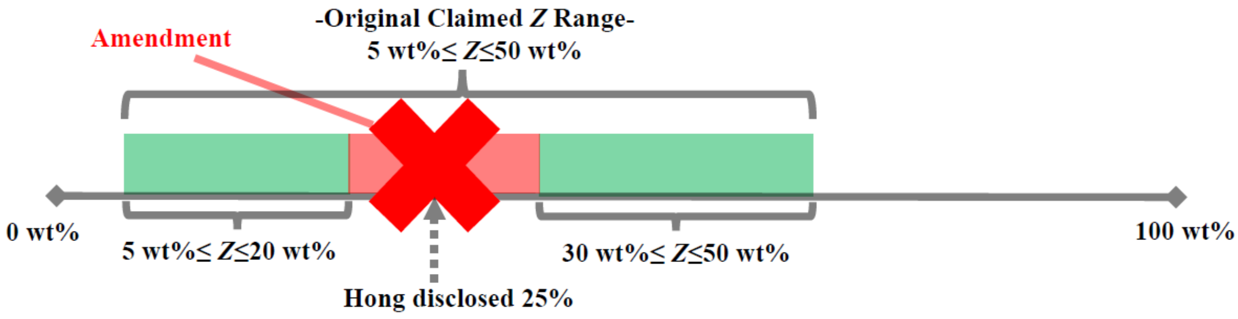
EX 1001, 34:17-38.

B. Prosecution History

38. Based on my review, and corroborating my opinion, prosecution of the ’882 Application that became the ’910 Patent confirms that electrolytes containing a dinitrile, a trinitrile, and PP were known in the art, including electrolytes with *X*, *Y*, and *Z* values that overlap or are very close to the claimed values. During

prosecution of the ’882 Application, the Examiner rejected claims to those kinds of electrolytes as not patentable over Chinese Patent No. 106848381 (“Hong”, EX1015), which disclosed electrolytes having a dinitrile, a trinitrile, and PP in certain amounts by weight. In fact, Hong was so close to the applicant’s claims that only one limitation was amended to secure allowance. Specifically, the Examiner only allowed the claims after the applicant amended the independent claims to carve out the mid-portion of the claimed range for *Z* (PP) taught by Hong—between 20 wt% and 30 wt%:

Claimed *Z* Range



39. In a first Non-final Office Action, I understand the Examiner rejected the pending claims based on double patenting over parent U.S. Patent No. 10,833,363 (“the ’363 Patent”) and over another patent and co-pending application in the same family. EX1002, 293-301. The Examiner found the claims were otherwise allowable for reciting “specific dinitriles, specific trinitriles, and propyl propionate in distinct ratios and amounts relative to one another as well as other organic compound additives in specific amounts.” *Id.*, 298.

40. I am aware that, shortly before the first Office Action, Petitioner had filed an IPR petition challenging the ’363 Patent with Hong as a primary reference. EX1016. The applicant responded to the first Office Action, disclosing Hong to the Examiner. EX1002, 269-292.

41. I understand the Examiner then issued a second Non-final Office Action rejecting the claims as anticipated and obvious over Hong. *See id.*, 194-209.

42. At the time, the rejected independent claims recited a continuous range of 5 wt% to about 50 wt%, without excluding he middle 20 wt% to 30 wt% portion. EX1002, 440-446.

43. In response to the second Non-final Office Action, I understand the applicant amended the independent claims to simply carve out the middle 20 wt% to 30 wt% portion of the previously claimed 5-50 wt% in Formula (3) for *Z* (PP). *See* EX1002, 64-72 (“5 wt%$\leq$Z$\leq$20 wt% or 30 wt%$\leq$Z$\leq$50 wt%.”). The applicant also argued that “Hong explicitly teaches an amount between the two instantly claimed ranges, i.e., propyl propionate of 25%,” and thus cannot anticipate or render obvious the pending claims. *Id.*, 75.[2] The Examiner then allowed the ’882

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[2] To my understanding, the applicant did not specify whether Hong’s 25% referred to a weight or volume percentage of propyl propionate, or whether this distinction was important.

Application citing the applicant's reasoning. *Id.*, 27-30. The applicant also filed terminal disclaimers to overcome the new double patenting rejections. *Id.*, 56-62.

44. As I explain below, Zeng Embodiments 4 and 6 (EX1006) disclose dinitrile-based electrolytes with a trinitrile compound and PP, where PP n the claimed *Z* range of 5 wt% to 20 wt%. Zeng Embodiments 4 and 6 also satisfy the remaining elements of the challenged claims, as well. Moreover, Zhou Example 8 discloses a dinitrile-based electrolyte having a trinitrile and ethyl acetate, which Zhou suggests replacing with PP as an obvious substitute carboxylic acid ester. Kim (EX1008, Ground 5) provides even more motivation to substitute PP for ethyl acetate in Zhou Example 8; Kim taught that dinitrile-based electrolytes having both PP and a trinitrile outperformed similar electrolytes lacking one or both of those compounds.

45. I understand that none of the references I rely upon in my opinions below were cited or considered by the Examiner during prosecution. EX1001, 1-2. In my opinion, had the Examiner considered these and other references relied upon in this Petition, the '910 Patent never would have been allowed.

C. IPR2023-00586 ('363 Patent IPR)

46. I understand that CosMX filed an *inter partes* review Petition challenging the '363 Patent using Hong as an anticipatory reference. EX1016.

47. Based on my review, the Patent Trial and Appeal Board denied institution of the ’363 Patent IPR petition because it relied on the Hong anticipation ground and made three assumptions for which the panel found insufficient evidentiary support:

> …[T]he total volume of the liquid components [of Hong’s electrolyte] does not meaningfully change after mixing [in all additives]; …
>
> [T]he solid components do not meaningfully contribute to the total volume of the electrolyte; and …
>
> [Two compounds in Hong’s solution] are liquids at room temperature…

See EX1017, 10-12; EX1016.

48. My positions regarding validity of the ’910 Patent, however, do not require any of the assumptions required by the Hong reference, in part, because I rely on obviousness rather than anticipation the ’363 Patent IPR Petition.

VII. CLAIM CONSTRUCTION

49. I have been informed that, in IPR, all claim terms must be given their ordinary and customary meaning as understood by a POSITA at the time of the invention.

50. I have been instructed that, for the purposes of this Petition, all claim terms should receive their plain and ordinary meaning in the context of the specification. It is my opinion that no claim terms require express construction for

purposes of granting the Petition. In my opinion, the prior art renders obvious the challenged claims under any reasonable interpretation of the claim language.

VIII. SUMMARY OF GROUNDS OF INVALIDITY

51. After analyzing the ’910 patent, prosecution history, prior art, and other documents identified above, it is my opinion that the challenged claims are rendered obvious as follows:

Ground		Claims	References
Zeng as Primary Reference			
1	A	1-6, 12, 16-26	• China Patent Application Publication No. CN 106099187A (“Zeng”). EX1005.
	B		• Zeng • U.S. Patent Application Publication No. 2013/0224535 (“Matsuoka”). EX1007.
	C		• Zeng • Matsuoka • U.S. Patent Application Publication No. 2017/0288268 (“Kim”). EX1008.
2	A	13, 14	• Zeng • Japan Patent Application No. 2009-252349 (“Sunose”). EX1009.
	B		• Zeng; Zeng and Matsuoka • Sunose
	C		• Zeng and Kim; Zeng, Matsuoka, Kim • Sunose

Ground		**Claims**	**References**
3	A	15	• Zeng • Sunose • China Patent No. 108023117 to Su et al. (“Su,” EX1011)
	B		• Zeng; Zeng and Matsuoka • Sunose • Su
	C		• Zeng and Kim; Zeng, Matsuoka, and Kim • Sunose • Su
Zhou as Primary Reference			
4	A	1-6, 12, 16-26	• China Patent Application Publication No. 105552439 A (“Zhou”). EX1013.
	C		• Zhou • Kim
5	A	13, 14	• Zhou • Sunose
	C		• Zhou; Zhou and Kim • Sunose
6	A	115	• Zhou • Sunose • Su
	C		• Zhou; Zhou and /Kim • Sunose • Su

A. Zeng

52. I understand that Zeng is a China Patent Application filed on July 13, 2016 and published November 9, 2016. EX1006, 1. I have been instructed that Zeng qualifies as prior art to the ’910 Patent.

53. Zeng discloses “a wide-temperature-range homogenous non-aqueous electrolyte solution” based on a dinitrile compound (adiponitrile) for lithium-ion batteries. EX 1006, Abstract. In addition to adiponitrile, Zeng Embodiments 4 and 6 further contain a trinitrile compound (1,3,6-hexane tricyanide (“HTCN”)) and PP. EX1006, ¶¶ [0045]-[0049]. These embodiments have 20 wt% PP before mixing the inorganic lithium salt. *Id.*

B. Matsuoka

54. Matsuoka is a U.S. Patent Application Publication filed in 2011 and published in 2013. EX1007, 1. I have been instructed that Matsuoka qualifies as prior art to the ’910 Patent.

55. Matsuoka discloses electrolytes for lithium-ion batteries that contain one or more nitrile additives and one or more non-nitrile additives—including PP—to improve the durability of the SEI layer formed on the electrode surface. EX1007, Abstract, ¶¶ [0015], [0022], [0035], [0036], [0038], [0040], [0044], [0056]-[0061]. Matsuoka observes that non-nitrile additives having LUMO (Lowest Unoccupied Molecular Orbital) and HOMO (Highest Occupied Molecular Orbital) energy levels

in certain ranges are particularly helpful for improving SEI layer durability. *Id.*, ¶¶ [0015], [0022], [0036], [0039].

56. PP, a component of Kim's electrolytes, has LUMO and HOMO energy levels falling within or near Matsuoka's most preferred ranges. *See id.*, ¶¶ [0036], [0039]. Matsuoka identifies preferred weight proportions in the total electrolyte for non-nitrile additives, like PP, to help form a stable SEI layer. *Id.*, ¶ [0041].

C. Kim

57. Kim is a U.S. Patent Application filed in 2016 and published October 5, 2017. EX1008, 1. I have been instructed that Kim is prior art to the '910 Patent.

58. Kim discloses electrolyte compositions for lithium-ion batteries. EX1008, Abstract. Kim Examples 1 and 2 contain a dinitrile (succinonitrile, SN), a trinitrile (1,3,6-hexane tricyanide, HTCN), and differing amounts of PP. *Id.*, ¶¶ [0090]-[0091] (Table 1). Batteries with Example 1 and 2 electrolytes—the electrolytes that included a dinitrile, a trinitrile, and PP—outperformed Kim's comparative examples that lacked either the trinitrile or PP in battery recovery capacity and reduction in thickness expansion during high temperature storage and cycling. *Id.*, ¶¶ [0090]-[0103], FIGS. 3-6. In my opinion, Kim highlights the combination of a dinitrile, a trinitrile and PP—and to varying the relative amounts of trinitrile and PP in the electrolyte—to improve battery performance.

D. Sunose

59. Sunose is a Japan Patent Application filed in 2008 and published in 2009. EX1010, 1. I have been instructed that Sunose is prior art to the ’910 Patent.

60. Sunose discloses a cathode configuration for rolled electrodes in which the active layer coating has a single-sided portion and a double-sided portion with respective compaction densities, falling in the scope of claims 13 and 14. *See, e.g.*, EX1010, ¶¶ [0005], [0007]-[0010], [0012], [0013], [0024], [0029]-[0033], [0040]. Sunose teaches that having a packing ration *M*/*N* of 0.7 to 1.0 between the single- and double-sided portions uniformly distributes pressure during the rolling process, improving adhesion of the electrode layers and reducing breakage. EX1010, ¶¶ [0016], [0017], [0027], [0028], [0042].

E. Su

61. Su is a China Patent Application filed November 30, 2017 and published May 11, 2018. EX1012, 1. I have been instructed that Su is prior art to the ’910 Patent.

62. Su describes a lithium-ion battery with high energy density in which the cathode and anode electrode plates having portions with single- and double-sided coatings. EX1012, Abstract, ¶¶ [0001], [0008]-[0013], [0027]. In multiple Su Examples, a ratio of the compaction density of the single sided portion to the

compaction density of the double-sided portion—which falls between 1.2 g/cc and 1.8 g/cc—is 1.0. EX1012, ¶¶ [0050]-[0067].

F. Zhou

63. Zhou is a China Patent Application filed on December 16, 2015 and published May 4, 2016. EX1014, 1. I have been instructed that Zhou qualifies as prior art to the ’910 Patent.

64. As I discuss below, Zhou describes “a fast-charging lithium-ion battery electrolyte, which is composed of a solvent, a lithium salt, and an additive, wherein the solvent includes a mixture of two or more of a low-boiling-point linear carbonate and a linear carboxylic acid ester[.]” EX1014, Abstract. Zhou Example 8 is an dinitrile-based (adiponitrile) electrolyte further containing a trinitrile compound (1,3,6-hexane trinitrile, HTCN) and ethyl acetate—a disclosed alternative linear carboxylic acid ester that can be substituted with PP. *Id.*, ¶¶ [0011], [0047].

IX. GROUND 1A: ZENG RENDERS OBVIOUS CLAIMS 1-6, 11, 12, AND 16-26

A. Overview of Zeng—Electrolyte Containing X, Y, and Z in the Claimed Amounts

65. Zeng discloses electrolytes containing *X*, *Y*, and *Z* in the claimed amounts. Zeng Embodiments 4 and 6 have 20 wt% PP *before* adding inorganic lithium salt and additives, suggesting or rendering obvious that the total electrolyte has less than 20 wt% PP (and certainly more than 5 wt%) consistent with the claimed

Z range. I rely on Zeng Embodiments 4 and 6 as rendering obvious the challenged claims. *See* EX1006, ¶¶ [0045]-[0049].

66. Zeng describes embodiments of "a wide-temperature-range homogenous non-aqueous electrolyte solution that has good lithium-ion transport properties, electrode plate wettability, and interfacial compatibility." EX1006, ¶ [0009]. Zeng's electrolytes have the following main components:

- a "multi-component homogenous mixed solvent" (including PP);
- fluoroethylene carbonate (FEC);
- dinitrile compounds, adiponitrile (ADN) and 1,2-bis(2-cyanoethoxy)ethane (DENE); and
- at least one second nitrile "compound having the structure shown in structural formula I" which can include trinitriles.

EX1006, ¶¶ [0011]-[0018], [0024].

67. FEC is used for its "good film-forming properties and resistance to oxidation[,]" which "ensures good high-voltage cycling performance of the battery without seriously affecting the high-temperature performance of the battery[.]" *Id.*, ¶ [0028].

68. The dinitrile compounds (i.e., the dinitriles ADN and DENE), and the trinitrile compounds according to formula I, have complementary effects. The dinitriles "stabilize the structure of the positive electrode material, compensating for

the high-temperature battery gas production problem caused by the FEC," *id.*, ¶ [0034], which "improv[es] the high-temperature performance of the battery," *id.*, ¶ [0029]. In complementary fashion, trinitrile "has better solubility in the electrolyte solution, without the problem of precipitation at low temperatures"—improving low-temperature performance. *Id.*, ¶ [0030]; *see also id.*, Abstract ("storage for a long period of time … below -30°C"), ¶¶ [0038], [0045] (Table 1).

69. Zeng Embodiments 4 and 6 contain PP as a solvent component, ADN and DENE as *dinitrile* compounds, and 1,3,6-hexanetricarbonitrile T4 (HTCN)—a *trinitrile*—as the formula I compound. EX1006, ¶¶ [0024], [0044]-[0049]. Specifically, in both Embodiments, "ethylene carbonate, propylene carbonate, diethyl carbonate, fluorobenzene, ethyl propionate, and PP are mixed at a *mass* ratio of EC:PC:DEC:FB:EP:PP = 25:10:30:5:10:20[.]" *Id.*, ¶ [0037][3]; *see also id.*, ¶ [0044]. "[T]hen, lithium hexafluorophosphate of a concentration of 1.0 mol/L is slowly added to the mixed solution,"[4] followed by further additives in certain weight percentages. EX1006, ¶ [0037].

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[3] Unless otherwise specified, emphasis is added.

[4] In my opinion, a POSITA would understand this to mean adding (solid) $LiPF_6$ to the specified EC:PC:DEC:FB:EP:PP solvent mixture to reach a

70. Thus, unlike Hong which disclosed 25% PP, Zeng Embodiments 4 and 6 both have less than 20 wt% PP in the total electrolyte. This is because the solvent-

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concentration of 1.0 mol/L. While $LiPF_6$ is commercially available premixed in different solvents to different concentrations, Zeng already discloses an EC:PC:DEC:FB:EP:PP solvent mixture for its electrolytes. In such cases, it is standard practice to mix $LiPF_6$ in the specified solvent mixture to a target concentration—usually around 1 mol/L—not add $LiPF_6$, premixed in some second solvent mixture, to the first solvent mixture. *See, e.g.*, EX1023, ¶¶ [0237], [0245], [0255] (Solvent components were mixed "to form a non-aqueous solvent, *into which was dissolved* $LiPF_6$*, so as to be 1.2 M,* and were added [various additives by wt%][.]"); EX1024, ¶ [0048] ("stir and mix homogeneously organic solvents according to certain ratios to obtain a solvent for electrolyte solutions" and then "*[s]lowly add a lithium salt, and when the lithium salt is dissolved,* add additives ..."); EX1025, ¶ [0090] ("An electrolyte was prepared by mixing ethylene carbonate and ethyl methyl carbonate ... to prepare a non-aqueous organic solvent and *dissolving 1.0 M* $LiPF_6$*,* hexane tricyanide (1,3,6 or 1,2,6-Hexanetricarbonitrile) (HTCN), ..."). Aside from rendering the ultimate concentration of $LiPF_6$ uncertain, adding some premixed solution of $LiPF_6$ would disrupt the carefully-crafted solvent and additive weight percentages central to Zeng's invention.

mixture has 20 wt% PP before $LiPF_6$ and the remaining components are added, reducing PP's weight proportion below 20 wt% in the total electrolyte.

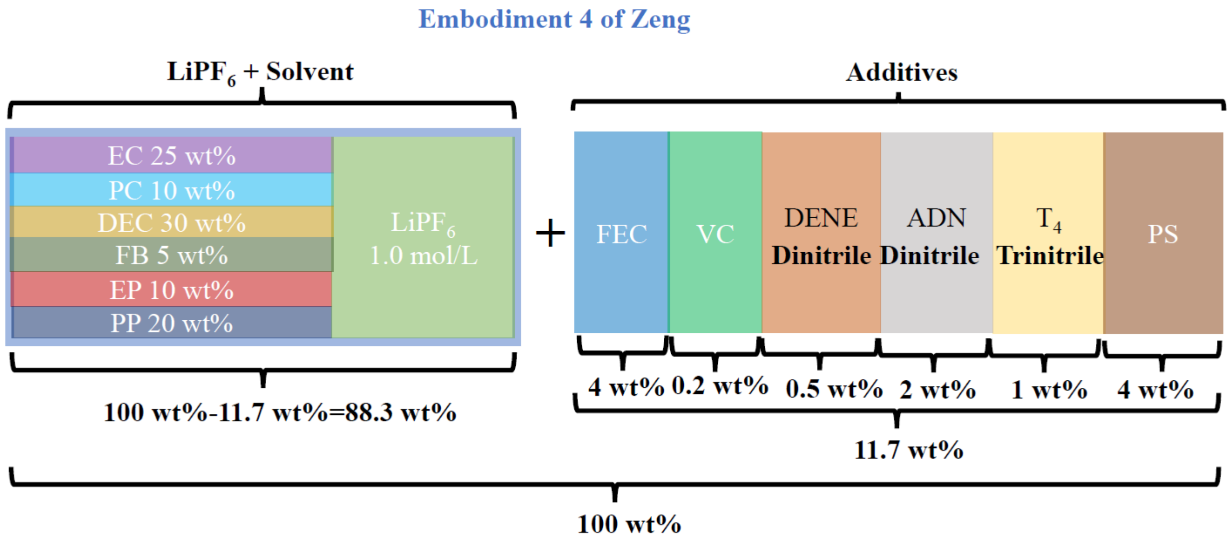
71. For Zeng Example 4, to this base electrolyte mixture,

> the following are added on the basis of the *total weight of the electrolyte solution*: 4 wt% of fluoroethylene carbonate (FEC), 2 wt% of adiponitrile (ADN) ... , 0.5 wt% of 1,2-bis(2-cyanoethoxy)ethane (DENE), 0.2 wt% of vinylene carbonate (VC), and 4.0 wt% of 1,3-propane sultone[.]

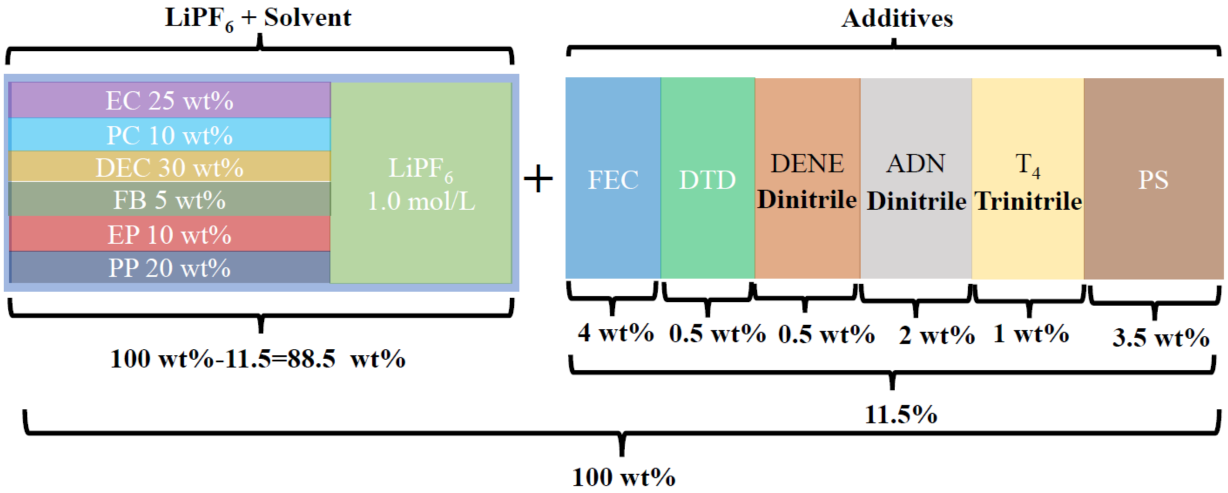
Id.; *see also id.*, ¶¶ [0044]-[0049].

72. Embodiment 4 also contained the *trinitrile* 1,3,6-hexanetricarbonitrile (HTCN, "T4") as the Formula I nitrile. *Id.*, ¶¶ [0044]-[0049] (Table 1). Embodiment 6 was identical to Embodiment 4 except that it swapped VC for 0.5 wt% ethylene sulfate (DTD) and had slightly less PS at 3.5 wt%. *Id.*, ¶ [0046].

73. Thus, Zeng Embodiments 4 and 6 have the following compositions:



Embodiment 6 of Zeng



74. **Weight percentage of ADN and DENE (*dinitrile*) in the total electrolyte:** ADN is a *dinitrile*, as claimed, because it has two nitrile (-CN) groups in its structure, with the molecular formula $NC\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CN$. EX1018, 1, 318. DENE is also a *dinitrile*, as claimed, with the molecular formula $NC\text{-}CH_2\text{-}CH_2\text{-}O\text{-}CH_2\text{-}CH_2\text{-}O\text{-}CH_2\text{-}CH_2\text{-}CN$. *Id.*, 318. As illustrated above, in both Embodiments 4 and 6, ADN and DENE have a combined weight ratio (the claimed *X*) of 2 wt%+0.5 wt%=2.5 wt% in the total electrolyte.

75. **Weight percentage HTCN (*trinitrile*) in the total electrolyte:** HTCN is a *trinitrile*, as claimed, because it has three -CN groups with the molecular formula $C_9H_{11}N_3$. EX1018, 100. As illustrated above, in both Embodiments 4 and 6, HTCN has a weight ratio (the claimed *Y*) of 1 wt% in the total electrolyte.

76. **Weight percentage PP in the total electrolyte:** As explained, Embodiments 4 and 6 had 20 wt% PP before adding lithium hexafluoride and the

remaining additives to the solvent mixture. Assuming zero weight $LiPF_6$, PP would have a theoretical upper limit weight percentage in the total electrolyte of 88.3%×(20/(25+10+30+5+10+20))=17.66% in Embodiment 4. Similarly, in Embodiment 6, PP would have an upper limit weight percentage of 88.5%×(20/(25+10+30+5+10+20))=17.70% in the total electrolyte.

77. However, $LiPF_6$ has a non-zero weight, and Zeng teaches it was mixed in the solvent solution to a concentration of 1.0M before mixing the remaining additives. EX1006, ¶ [0037]. This pushes down the weight percentages Z of PP in the total electrolyte solution to Z<17.66 wt% in Example 4 and Z< 17.70 wt% in Embodiment 6. In my opinion, the ultimate weight percentage of PP in the total electrolyte would also certainly be well above 5 wt%, because that amount would require $LiPF_6$ to comprise over 60 wt% of the total electrolyte. This corresponds to 4.0 mol/L solution of $LiPF_6$—much greater than the typical 1.0 mol/L taught by Zeng, and certainly atypical for lithium-ion batteries. *Id*.

78. In summary, the claimed *X*, *Y*, and *Z* have the following values in Zeng's Embodiments:

Embodiment	**X (Weight Percentage ADN and DENE in Total Electrolyte)**	**Y (Weight Percentage 1,3,6-hexanetricarbonitrile in Total Electrolyte)**	**Z (Weight Percentage PP in Total Electrolyte)**
4	2.5 wt%	1 wt%	< 17.66 wt%
6	2.5 wt%	1 wt%	< 17.70 wt%

Zeng found that Embodiments 4 and 6 improved high-voltage cycling performance of lithium-ion batteries, as shown in Table 1 of Zeng. In particular, the batteries using the Embodiment 4 and 6 electrolytes exhibited increased capacity retention rate than the comparative examples. EX1006, ¶¶ [0045]-[0047].

B. Independent Claim 1

1. [1.pre] "An electrolyte, comprising"[5]

79. As discussed, I rely on Embodiments 4 and 6 of Zeng's electrolytes as each rendering the challenged claims unpatentable. EX1006, ¶¶ [0046], [0049]; *see also* Section IX.A.

- **Rationale to Implement Embodiments 4 and 6 of Zeng**

80. Each 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.

81. In my opinion, Zeng teaches, suggests, and motivates a POSITA to use the Embodiment 4 and 6 electrolytes. First, the Embodiments 4 and 6 batteries significantly outperformed the Comparative Example batteries on capacity retention

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[5] In my declaration, I use bracketed reference numerals to identify respective Challenged Claim Elements of the '910 Patent.

after 500 cycles. *See* EX1006, ¶¶ [0045]-[0047]. And, other than Embodiments 2 and 5, Embodiment 6 had the best capacity retention at 91.6%. *Id.* In my opinion, this would have motivated the POSITA to implement at least Examples 4 and 6.

82. Moreover, in my opinion, it would have been obvious to try Embodiments 4 and 6 of Zeng.

83. **Recognized need in the art:** Zeng observes a market need for "high-energy density lithium-ion batteries" driven by "consumer terminals demand[ing] ever-higher energy density from batteries[.]" EX1006, ¶ [0003]. Conventionally, energy density was "improved primarily by selecting high-capacity, highly compact positive and negative electrode active materials and increasing the battery charge cut-off voltage." *Id.* This reduced stability of the positive electrode, so FEC was added to resist the resulting oxidation of the electrolyte. *Id.*, ¶ [0005]. But FEC is prone to decomposition at high temperatures, increasing battery expansion and internal resistance. *Id.* The industry then added organic nitriles to stabilize the electrode structure but, among other issues, organic nitriles have poor solubility in electrolyte solutions that limits cycling performance and low-temperature performance. *Id.*, ¶ [0006]. Zeng thus sought a well-rounded "electrolyte solution that can remain homogeneous 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." *Id.*, ¶ [0008].

84. **Finite number of identified, predictable solutions:** Zeng only discloses nine electrolyte solutions (Examples 1-9), and they all had better capacity retention over 500 cycles and low-temperature performance than the comparative examples. EX1006, ¶¶ [0044]-[0047] (Table 1). Making Examples 4 and 6 a higher priority to try over other Examples, Example 6 performed better than average (91.6% vs. 91.2%) in capacity retention and Example 4 performed near the average (91.0%). EX1006, ¶¶ [0044]-[0047] (Table 1). In my opinion, these performances would have motivated a POSITA to implement Examples 4 and 6.

85. **Reasonable expectation of success:** All of Zeng's Examples were successfully tested in batteries and had better performance than the comparative examples. EX1006, ¶¶ [0036]-[0053]. Zeng teaches that the Examples successfully showed "that the addition of FEC and ADN to the electrolyte solution improves the high-voltage cycling performance of the lithium-ion battery, and with the increase in added amounts of FEC and ADN, the capacity retention rate of the lithium-ion battery at 500 cycles of high voltage increases incrementally." *Id.*, ¶ [0050]. Zeng also provides detailed instructions to make the Example electrolytes. *See id.*, ¶¶ [0036]-[0049]. In my opinion, these teachings would have given a POSITA a reasonable expectation of success in implementing Examples 4 and 6.

2. [1.1] "a dinitrile compound, a trinitrile compound, and propyl propionate,"

86. In my opinion, Zeng discloses or suggests this element. As I explained in Section IX.A, Zeng's Embodiments 4 and 6 electrolytes both contain *a dinitrile compound* (ADN, DENE), *a trinitrile compound* (HTCN), *and PP*, as claimed. *See also* EX1018, 1, 318; EX1006, ¶¶ [0037], [0044]-[0049] (Table 1).

87. Accordingly, in my opinion, Zeng discloses or suggests element [1.1].

3. [1.2] "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 … ; wherein, about 2.2 wt%≤(X+Y)≤about 8 wt%, about 0.1≤(X/Y)≤about 2.3,"

88. In my opinion, Zeng discloses or suggests this element. As explained above, the claimed *X* and *Y* and have the following values in the total electrolytes of Zeng:

Embodiment	*X*	*Y*	*X* + *Y*	*X*/*Y*
4	2.5 wt%	1 wt%	**3.5 wt%**	**2.5**
6	2.5 wt%	1 wt%	**3.5 wt%**	**2.5**

Supra Section IX.A. In both Embodiments 4 and 6, $X + Y = 2.5$ wt%+1.0 wt%=3.5 wt%, which falls in the claimed range of about 2.2 wt% to about 8 wt%.

89. Additionally, *X*/*Y* in both Embodiments equals 2.5, which, in my opinion, is "*about 2.3*" as claimed. The '910 Patent states that "about" covers "minor variations" including "less than or equal to ±10% of the stated value ...." EX1001,

4:12-31. Based on this, it is my opinion that Zeng's *X/Y* values are "minor variations" within (2.5–2.3)/2.3 = 8.7% of the upper end of the claimed range of 2.3. Moreover, the '910 Patent teaches that the *X/Y* ratio may have an upper limit of less than or equal to about 6, 5, 4, or 1—without a preference for any one limit. *See* EX1001, 6:17-25. The specification of the '910 Patent does not even disclose the particular claimed range or an *X/Y* upper limit of 2.3. Thus, in my opinion, 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.

90. Accordingly, in my opinion, Zeng discloses or suggests element [1.2].

4. [1.3] "and a weight percentage of the propyl propionate is Z; wherein … 5 wt% ≤ Z ≤ 20 wt% or 30 wt% ≤ Z ≤ 50 wt%, and"

91. In my opinion, Zeng renders obvious this element. As I explained above, Zeng suggests or renders obvious that *Z* is less than 17.66 wt% and 17.70 wt% in Embodiments 4 and 6 because $LiPF_6$ has some nonzero weight:

Embodiment	***Z***
4	**<17.66 wt%**
6	**<17.70 wt%**

Supra Section IX.A. Each of these ranges substantially overlaps the lower portion of the claimed *Z* range.

92. Furthermore, both Zeng Embodiments would have a practical floor above a *Z* value of 5 wt%. To dilute PP to 5 wt% of the total electrolyte (from its

20 wt% proportion in the solvent mixture), the entire solvent mixture would need to be reduced to 25 wt% of the total electrolyte, requiring $LiPF_6$ plus the additives to make up the remaining 75 wt%. Even if such composition were operable, the $LiPF_6$ and "additives" would outweigh the "solvent" by a factor of three, contradicting the basic concept of a solvent-based electrolyte in which $LiPF_6$ and the additives are dissolved. Put differently, 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%. This corresponds 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.

93. Therefore, in my opinion, Embodiments 4 and 6 render obvious a weight proportion range for PP falling entirely within the lower portion of the claimed *Z* range—respectively less than 17.66 wt% and 17.70 wt%, and certainly greater than 5 wt%.

94. Accordingly, in my opinion, Zeng discloses or suggests element [1.3].

5. [1.4] "about 0.02 ≤ (Y / Z) ≤ about 0.3;"

95. In my opinion, Zeng discloses or suggests this element. As explained above, the claimed *Y* and *Z* have the following values in Zeng:

Embodiment	***Y***	***Z***	***Y/Z***
4	1 wt%	<17.66 wt%	**>0.057**
6	1 wt%	<17.70 wt%	**>0.056**

Supra Section IX.A. Thus, in Zeng Embodiments 4 and 6, *Y/Z* are respectively greater than 1/17.66 = 0.057 and 1/17.70 = 0.056, overlapping the claimed range of about 0.02 to about 0.3.

96. Furthermore, both Embodiments' *Y/Z* ratios would fall below the claimed upper limit of 0.3 for practical reasons. With *Y* = 1 wt%, achieving a *Y/Z* ratio of 0.3 or more would require *Z* to be 3.33 wt% or less. But diluting PP from 20 wt% in the base solvent to 3 wt% or less of the total electrolyte would require $LiPF_6$ and "additives" to comprise over 85% of the final mixture. In other words, the $LiPF_6$ and "additives" would cause the total weight of the electrolyte to exceed 667% of the weight of the base solvent, again contradicting the notion of a solvent-based electrolyte. Put another way, $LiPF_6$ and the "additives" would cause the total weight of the electrolyte to exceed 667% of the weight of the base solvent, contradicting the notion of a solvent-based electrolyte in which $LiPF_6$ and additives are dissolved.

97. Accordingly, in my opinion, Zeng Embodiments 4 and 6 render obvious a *Y/Z* range falling within the claimed range—greater than 0.05 and certainly less than 0.3.

6. [1.5] "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"

98. As discussed above, Embodiments 4 and 6 of Zeng have adiponitrile (ADN) and ethylene glycol bis(2-cyanoethyl) (DENE) as the claimed dinitrile compound. EX1006, ¶¶ [0029]-[0030].

99. Accordingly, in my opinion, Zeng discloses or suggests element [1.5].

7. [1.6] "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;"

100. As discussed, Embodiments 4 and 6 of Zeng both have 1,3,6-hexanetricarbonitrile (HTCN) as the claimed *trinitrile compound*. EX1006, ¶¶ [0046], [0049].

101. Accordingly, in my opinion, Zeng discloses or suggests element [1.6].

8. [1.7] "wherein the electrolyte further comprises a compound having a sulfur-oxygen double bond."

102. In Embodiments 4 and 6 of Zeng, *the electrolyte further comprises a compound having a sulfur-oxygen double bond*—1,3-propane sultone (PS)—as claimed. EX1006, ¶¶ [0037], [0049].

103. Accordingly, in my opinion, Zeng discloses or suggests element [1.7].

C. Claim 2

1. **[2.1] "The electrolyte according to claim 1, wherein, the dinitrile compound comprises adiponitrile, wherein, 0.1≤a weight percentage of the adiponitrile ÷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."**

104. In Embodiments 4 and 6, Zeng's *dinitrile compound* includes adiponitrile. EX1006, ¶¶ [0029]-[0030]. Moreover, as explained above for element [1.2], *X/Y = 2.5/1* = 2.5 in both Embodiments 4 and 6. In my opinion, this falls within the '910 Patent's 10% "about" tolerance. Also, *X/Y* of 2.5 is sufficiently close to 2.3 that a POSITA would have expected the same properties from both ratios.

105. Accordingly, in my opinion, Zeng discloses or suggests Claim 2.

D. Claim 3

1. **[3.1] "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%."**

106. As I explained above, Embodiments 4 and 6 of Zeng have 4 wt% and 3.5 wt% *1,3-propane sultone* (PS), respectively. EX1006, ¶¶ [0037], [0045]-[0047]. The '910 Patent specification states that PS (or other compound having a sulfur-oxygen double bond) can be up to 3 wt%, 4 wt%, or 5 wt% of the total electrolyte, without preference or criticality for any one option. EX1001, 16:12-28. This is

consistent with Zeng's statement that "[p]referably, … the mass percentage of [PS] in the electrolyte solution [can be] 0.1% to 5.0%," EX1006, ¶ [0025].

107. Thus, both the '910 Patent and Zeng agree that 4 wt% is close enough to the claimed range that one skilled in the art would expect them to have the same properties. Moreover, in my opinion, Zeng's statement separately renders obvious making Examples 4 and 6 up to 3 wt% or 4 wt% PS.

108. Accordingly, in my opinion, Zeng discloses or suggests Claim 3.

E. Claim 4

1. [4.1] "The electrolyte according to claim 1, wherein 0.1≤X/Y≤2.0."

109. In my opinion, Zeng discloses or suggests Claim 4. As I explained above, *X/Y* in both Zeng Embodiments 4 and 6 equals 2.5. While this is slightly above the claimed range, the '910 Patent teaches that the *X/Y* ratio may have an upper limit of less than or equal to about 6, 5, 4, or 1—without a preference or criticality for any one limit. *See* EX1001, 6:17-25. The '910 Patent does not even disclose the particular claimed range or an upper limit of 2.0. Thus, in my opinion, 2.5 is sufficiently close to 2.0 such that a POSITA would have expected the same properties.

F. Claim 5

1. [5.1] "The electrolyte according to claim 1, wherein $0.025 \le Y/Z \le 0.3$."

110. In my opinion, Zeng discloses or suggests Claim 5. As I explained above, in Embodiments 4 and 6 of Zeng, $Y/Z > 0.057$, $Y/Z > 0.056$ and would be practically limited well below 0.3. *Supra* Section IX.B.5.

G. Claim 6

1. [6.1] "The electrolyte according to claim 1, wherein X is 0.01-10 wt%, Y is 0.01-10 wt%."

111. In my opinion, Zeng discloses or suggests Claim 6. As explained above, *X* and *Y* have the following values in Zeng, falling within the claimed ranges for *X* and *Y*:

Embodiment	*X*	*Y*
4	2.5 wt%	1 wt%
6	2.5 wt%	1 wt%

Supra Section IX.B.3.

H. Claims 12 and 16-26

112. Claims 12 and 16-26 recite an electrolyte—substantively identical to or similar to that of claims discussed above—as part of an electrochemical device having electrodes. Accordingly, for the reasons discussed above and the additional reasons provided in the table below, Zeng discloses or suggests claims 12 and 16-26.

Claim 12		
Element	**Text**	**Reasoning**
[12.pre]	*An electrochemical device, wherein the electrochemical device comprises electrodes and an electrolyte comprising:*	*See* Section IX.B.1 above regarding element [1.pre].[6]
[12.1]	*a dinitrile compound, a trinitrile compound, and propyl propionate,*	*See* Section IX.B.2 above regarding element [1.1].
[12.2]	*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 … ; wherein, about 2.2 wt%≤(X+Y)≤about 8 wt%, about 0.1≤(X/Y)≤about 2.3,*	*See* Section IX.B.3 above regarding element [1.2].
[12.3]	*and a weight percentage of the propyl propionate is Z; wherein … about 5 wt%≤Z≤20 wt% or 30 wt%≤Z≤50 wt%, and*	*See* Section IX.B.4 above regarding element [1.3].
[12.4]	*about 0.02≤(Y/Z)≤about 0.3;*	*See* Section IX.B.5 above regarding element [1.4].
[12.5]	*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*	*See* Section IX.B.6 above regarding element [1.5].

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[6] Zeng discloses that its Embodiment 4 and 6 electrolytes were used in a lithium-ion secondary battery (an electrochemical device that comprises electrodes) as claimed. *See* EX1006, ¶¶ [0028]-[0034].

[12.6]	*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*	*See* Section IX.B.7 above regarding element [1.6].
[12.7]	*wherein the electrolyte further comprises a compound having a sulfur-oxygen double bond.*	*See* Section IX.B.8 above regarding element [1.7].
Claim 16		
Element	**Text**	**Reasoning**
[16.1]	*The electrochemical device according to claim 12, wherein the dinitrile compound comprises adiponitrile, wherein, 0.1≤a weight percentage of the adiponitrile ÷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.*	*See* Section IX.C.1 above regarding element [2.1].
Claim 17		
Element	**Text**	**Reasoning**
[17.1]	*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%.*	*See* Section IX.D.1 above regarding element [3.1].
Claim 18		
Element	**Text**	**Reasoning**
[18.1]	*The electrochemical device according to claim 12, wherein X is 0.01-10 wt%, Y is 0.01-10 wt%.*	*See* Section IX.G.1 above regarding element [6.1].

Claim 19		
Element	**Text**	**Reasoning**
[19.1]	*The electrochemical device according to claim 12, wherein 0.1≤X/Y≤2.0.*	*See* Section IX.E.1 above regarding element [4.1].

Claim 20		
Element	**Text**	**Reasoning**
[20.pre]	*An electrolyte, comprising*	*See* Section IX.B.1 above regarding element [1.pre].
[20.1]	*a dinitrile compound, a trinitrile compound, and propyl propionate,*	*See* Section IX.B.2 above regarding element [1.1].
[20.2]	*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 … ; wherein, about 2.2 wt%≤(X+Y)≤about 8 wt%, about 0.1≤(X/Y)≤about 6,*	*See* Section IX.B.3 above regarding element [1.2]. In Embodiments 4 and 6 of Zeng, *X*+*Y*= 3.5wt%, and *X/Y*= 2.5.
[20.3]	*and a weight percentage of the propyl propionate is Z; wherein … 5 wt%≤Z≤20 wt% or 30 wt%≤Z≤50 wt%, and*	*See* Section IX.B.4 above regarding element [1.3].

[20.4]	*about* $0.01 \leq (Y/Z) \leq$ *about* 0.3;	*See* Section IX.B.5 above regarding element [1.4]. In Embodiments 4 and 6 of Zeng, $Y/Z > 0.056$, $Y/Z > 0.057$, overlapping with the claimed range.
[20.5]	*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*	*See* Section IX.B.6 above regarding element [1.5].
[20.6]	*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;*	*See* Section IX.B.7 above regarding element [1.6].
[20.7]	*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%.*	*See* Section IX.B.8 above regarding element [1.7]; Section IX.D.1 regarding element [3.1].
Claim 21		
Element	**Text**	**Reasoning**
[21.1]	*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.*	*See* Section IX.C.1 above regarding element [2.1].

Claim 22		
Element	**Text**	**Reasoning**
[22.1]	*The electrolyte according to claim 20, wherein X is 0.01-10 wt%, Y is 0.01-10 wt%.*	*See* Section IX.G.1 above regarding element [6.1].
Claim 23		
Element	**Text**	**Reasoning**
[23.1]	*The electrolyte according to claim 20, wherein* $0.2 \leq X/Y \leq 5$.	*See* Section VIII.B.3 above regarding element [1.2]. In Embodiments 4 and 6 of Zeng, $X/Y= 2.5$.
Claim 24		
Element	**Text**	**Reasoning**
[24.1]	*The electrolyte according to claim 20, wherein* $2.2\ wt\% \leq X+Y \leq 8\ wt\%$, *and* $0.1 \leq X/Y \leq 2.3$.	*See* Section VIII.B.3 above regarding element [1.2]. In Example 8 of Zhou, $X+Y=$ 3.5 wt%, and $X/Y= 2.5$.
Claim 25		
Element	**Text**	**Reasoning**
[25.1]	*The electrolyte according to claim 20, wherein* $0.1 \leq X/Y \leq 2.0$	*See* Section IX.E.1 above regarding element [4.1].

Claim 26		
Element	**Text**	**Reasoning**
[26.1]	*The electrolyte according to claim 20, wherein* $0.025 \le Y/Z \le 0.3$	*See* Section VIII.B.5 above regarding element [1.4]. In Embodiments 4 and 6 of Zeng, $Y/Z > 0.057$, $Y/Z > 0.056$, overlapping the claimed range.

113. Accordingly, in my opinion, Zeng discloses or suggests claims 12 and 16-26.

X. GROUND 2A: ZENG AND SUNOSE RENDER OBVIOUS CLAIMS 13 AND 14

114. In my opinion, to the extent Zeng does not expressly disclose all elements of claim 13 and 14, as explained below, Sunose discloses a lithium-ion battery with a cathode having the single- and double-sided coatings of these claims. In my opinion, a POSITA would have found it obvious to modify Zeng's battery based on Sunose to arrive at the subject matter of these claims.

A. Claim 13

1. [13.1] "The electrochemical device according to claim 12, wherein the electrode comprises a cathode, the cathode comprises a current collector,"

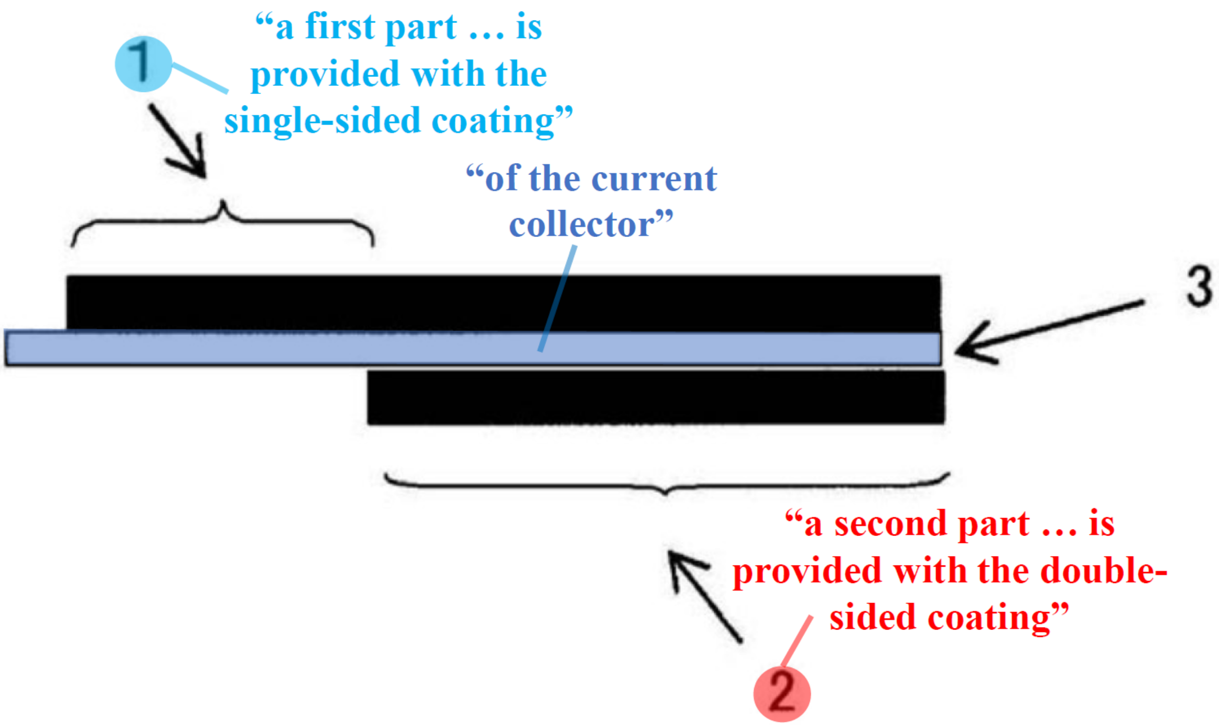
115. Zeng discloses electrolytes for "ensuring good high-voltage performance of a lithium-ion battery." EX1006, Abstract. Batteries using the Example 4 and 6 electrolytes were tested for performance. *Id.*, ¶¶ [0036]-[0053]. A lithium-ion battery, by definition, is an electrochemical device having a cathode that comprises a current collector. As claimed. EX1001, 34:58-35:9.

116. Accordingly, in my opinion, Zeng discloses or suggests element [13.1].

2. Sunose discloses elements [13.2]-[13.4].

a. [13.2] "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;"

117. As highlighted in Figure 2 below, Sunose discloses a positive electrode (cathode) with *a single-sided coating and a double-sided coating; a first part* (single-side coating part 1) *of the currents collector* (current collector 3) *is provided with the single-sided coating and a second part* (double-sided coated part 2) *of the current collector* (current collector 3) *is provided with the double-sided coating*, as claimed. EX1010, ¶¶ [0005], [0007]-[0010], [0012], [0013], [0024].



Sunose, FIG. 2*

118. As seen above, Sunose's electrode has "[a] single-sided active material layer portion [1], wherein the active material layer is formed only on a single side of the current collector [3]" and "[a] two-sided active material portion [2]" with an active material layer formed on both sides of the current collector 3. EX1010, ¶ [0007].

119. Accordingly, in my opinion, Sunose discloses or suggests element [13.2].

b. [13.3] "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≤D1/D2≤about 1.2; and,"

[13.4] "3.5 g/cm^3≤D2≤4.3 g/cm^3."

120. At least Sunose's electrode plates of Examples 2-4 satisfy elements [13.3] and [13.4], have single- and double-sided compaction densities *D1*, *D2* (packing densities) falling within the claimed ranges, as shown in the table below:

***Sunose* Example**	***D1*: Packing density of single-sided portion 1 (g/cm^3)**	***D2*: Packing density of double-sided portion 2 (g/cm^3)**	***D1/D2*: Packing density of 1 / packing density of 2**	**Citation**
2	5.0	4.0	1.25	EX1010, ¶¶ [0031], [0040], Table 1
3	4.4	4.0	1.1	EX1010, ¶¶ [0032], [0040], Table 1
4	4.0	4.0	1.0	EX1010, ¶¶ [0033], [0040], Table 1

121. As shown above, all Examples have a packing density *D2* of 4.0 g/cc for the double-sided portion 2, and Examples 2 through 4 respectively have packing densities *D1* of 5.0, 4.4, and 4.0 g/cm^3. EX1010, ¶¶ [0029]-[0033], [0040]. This results in a ratio *D1/D2* of 1.25, 1.1, and 1.0 for Examples 2-4 of Sunose, respectively. The ratios for Examples 3 and 4 fall within the claimed range.

Furthermore, in my opinion, a POSITA would reasonably consider Example 2's ratio 1.25, which falls in the '910 Patent's 10% tolerance, to be "*about 1.2*," as claimed. Furthermore, Sunose's packing density *D2* for the double-sided portion—4.0 in all three Examples—falls within Element [13.4]'s range of 3.5 g/cm^3 to 4.3 g/cm^3.

122. In my opinion, Sunose's "packing" densities listed in the above Table disclose the claimed *compaction densities* because Sunose explains that the densities were calculated after "rolling was performed using a roll press." EX1010, ¶ [0031]; *see also id.*, ¶¶ [0028], [0030]-[0034]. This refers to the "rolling process" that "*roll[s]* the electrodes that have been coated and dried in the manufacturing process at *high density*." EX1010, ¶ [0006]; *see also id.*, ¶¶ [0007], [0008], [0012]-[0016]. Thus, in my opinion, Sunose's "packing density" refers to density after *compaction*.

3. Rationale to combine Zeng and Sunose

123. In my opinion, a POSITA would have been motivated, with a reasonable expectation of success, to configure Zeng's cathode according to Sunose's Examples.

124. **Analogous art:** Sunose is analogous art to Zeng because it falls in the same field of endeavor—lithium-ion secondary batteries, including those employing non-aqueous electrolytes. *See* EX1010, Abstract, ¶¶ [0001]-[0011], [0043], [Claim 3]. Zeng seeks to improve performance of lithium-ion batteries, which have

electrode assemblies. EX1006, ¶¶ [0001]-[0006]; *see also* EX1001, 21:4-16, 23:66-24:3. Sunose also seeks to improve performance of lithium-ion batteries through its electrode assembly configuration. Specifically, Sunose's electrode plate configuration improves adhesion of the electrode layers while mitigating breakage of the electrode plate during rolling. *See, e.g.*, EX1010, ¶¶ [0010], [0012], [0017], [0018], [0021], [0024].

125. **Teaching, suggestion, motivation:** The teachings of Zeng and Sunose would have motivated a POSITA to use Sunose's electrode assembly configuration in Zeng Embodiment 4 and 6 batteries.

126. **Electrode assembly implementation details:** Zeng focuses on electrolyte compositions and thus omits details on configuration of the electrode assembly. Thus, a POSITA reading Zeng would have looked to other references for implementation and configuration details about electrode assemblies. Sunose provides a suitable example. The need to implement some electrode configuration in Zeng's batteries would have prompted a POSITA adopt Sunose's electrode configuration.

127. **Maximizing electrode area:** In my opinion, Sunose's electrode configuration, "wherein the positive electrode plate and a negative electrode plate are wound with a separator interposed therebetween," serves "to maximize the electrode area" in two ways. EX1010, ¶ [0004]. First, the spiral design permits more

electrode surface area within a given space, increasing capacity. EX1010, ¶ [0004]. Second, rolling the electrode assembly

> expos[es] the surface of the current collector of the positive electrode plate on a portion corresponding to the outermost and innermost circumferences positive electrode plate ... that does not oppose the positive electrode plate, ... increas[ing] the effective electrode area, thereby improving battery performance.

See EX1010, ¶ [0005]. In my opinion, industry pressure to increase battery capacity and performance would have motivated the POSITA to use Sunose's rolled design to increasing electrode surface area for a given form factor.

128. **Improving adhesion and reducing breakage:** In my opinion, the desire to reduce electrode breakage and adhesion during rolling would have enticed a POSITA to use Sunose's electrode configuration in Zeng. Sunose explains that the rolling setting required for the right compaction density and adhesion on the single-sided portion places an excessive load on the thicker double-sided portion, weakening the electrode and increasing crack rate and breakage. EX1010, ¶ [0010], [0012]. Sunose controls the packing ratios M/N between the single-sided M and double-sided N portions to fall between 0.7 and 1.0, so that the one-sided portion is thicker than the double-sided portion, as shown in Figure 1. *Id.*, ¶¶ [0016], [0017], [0027], [0028], [0042], FIG. 1. That way, the rolling process applies uniform pressure across both portions of the electrode, improving overall adhesion while

avoiding breakage. EX1010, ¶ [0042]. In my opinion, this would have further motivated the POSITA to combine Zeng and Sunose.

129. **Reasonable expectation of success:** In my opinion, a POSITA would have had a reasonable expectation of success in using Sunose's rolled electrode configuration in Zeng's example batteries. Zeng does not disclose any physical specifications or restrictions for its high-voltage (4.4V) lithium-ion batteries, broadly intended for "the digital, energy storage, power, and military aerospace fields." EX1006, ¶ [0002]; *see also id.*, ¶ [0035]. Sunose generally intends its rolled electrode configuration for "consumer electronic devices," so the POSITA would have reasonably expected Sunose's electrode configuration to work in Zeng's batteries. EX1010, ¶ [0002].

130. Accordingly, in my opinion, Zeng and Sunose render obvious claim 13.

B. Claim 14

1. [14.1] "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"

131. In my opinion, the above-described combination of Zeng and Sunose includes this element. In Sunose's electrode configuration, *both the single-sided coating* 1 *and the double-sided coating* 2 *are present on the same electrode* 3. *See* EX1010, Abstract, ¶ [0007], FIG. 1.

132. Accordingly, in my opinion, Zeng and Sunose render obvious claim 14.

XI. GROUND 3A: ZENG AND SUNOSE, FURTHER IN VIEW OF SU, RENDERS OBVIOUS CLAIM 15

133. To the extent Zeng and Sunose do not include all elements of claim 15, as explained below, Su discloses a lithium-ion battery with an anode configuration having the single- and double-sided coatings of claim 15. In my opinion, a POSITA would have found it obvious to modify the anode of the Zeng/Sunose battery based on Su to arrive at claim 15.

A. Claim 15

1. [15.1] "The electrochemical device according to claim 13, wherein the electrode comprises an anode, the anode comprises a current collector,"

134. In my opinion, Zeng discloses or suggests this element. *Supra* Section X.A.1.

2. Su discloses Elements [15.2] to [15.4]

a. [15.2] "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;"

135. In my opinion, Su discloses or suggests this element. Su describes a lithium-ion battery having high energy density and intended for a variety of applications, including mobile devices, as well as its preparation method. EX1012, Abstract, ¶¶ [0001]-[0003], [0005], [0006], [0036].

136. **Double-sided part of negative (anode) electrode current collector:** Su's method includes coating positive and negative electrode slurries on "*both sides* of ... a *negative electrode collector*" and "then drying and compacting to form ... *a double-sided negative electrode plate*[.]" EX1012, ¶ [0010]. Thus, in my opinion, Su discloses "*a double-sided coating*" where "*a second part of the current collector is provided with the double-sided coating,*" as claimed.

137. **Single-sided part of negative (anode) electrode current collector:** Additionally, Su "appl[ies] the negative electrode slurry on *one side* of the negative electrode current collector, and then drying and compacting to form a *single-sided negative electrode plate*[.]" EX1012, Claim 2(b), ¶¶ [0011], [0032]. Su then cuts both the single- and double-sided sheets "into required sizes respectively and assembl[es] them into a cell" with "the single-sided negative electrode plate is provided on the outermost layer, with the side without slurry facing outwards[.]" *Id.*, Claim 1(c), ¶¶ [0012], [0033], [0056], [0081]. Thus, in my opinion, Su also discloses that the anode has "*a single-sided coating*" and that "*a first part of the current collector is provided with the single-sided coating,*" as claimed.

b. [15.3] "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≤D1/D2≤about 1.2; and."

[15.4] "1.2 g/cm^3≤D2≤1.8 g/cm^3."

138. In my opinion, Su discloses these elements. Specifically, Su's Examples 2 and 3 had the following single- and double-sided coating compaction densities D1, D2 for the negative electrode (anode):

Example	D1	D2	Ratio D1/D2	Capacity (Ah)	Energy Density (Wh/kg)
2	1.8 g/cm^3	1.8 g/cm^3	1.0	31.48 Ah	189.92 Wh/kg
3	1.5 g/cm^3	1.5 g/cm^3		32.44 Ah	191.28 Wh/kg

See EX1012, ¶¶ [0059]-[0064]. As highlighted in the Table above, Examples 2 and 3 of Su satisfy the D1/D2 ratio of Element [15.3] and the D2 range of element [15.4].

c. Rationale to Combine

139. **Teaching, suggestion, motivation:** In my opinion, a POSITA would have found it obvious, with a reasonable expectation of success, to implement Examples 2 and 3 of Su for the negative electrode (anode) of Zeng/Sunose. First, Su is analogous art to the '910 Patent, Zeng, and Sunose because it also seeks to improve performance of lithium-ion batteries—using its anode (and cathode) configuration to increase energy density. *See* EX1012, Title, Abstract, ¶¶ [0005]-[0024].

140. **Lack of anode implementation details in Sunose:** Sunose describes a rolled electrode configuration and focuses primarily on the positive electrode (cathode), leaving out implementation anode implementation details. But, in my opinion, a POSITA would need anode implementation details, too, to implement the Zeng-Sunose battery. This, in my opinion, would have prompted a POSITA to look to Su—also describing a rolled electrode configuration—for anode implementation details, including appropriate compaction densities for the single- and double-sided coating portions of the current collector. EX1012, ¶¶ [0039]-[0040].

141. **Energy density:** Zeng and Sunose both express a market demand for high energy density, so in my opinion a POSITA considering these references would have been concerned with increasing energy density. *See, e.g.*, EX1006, ¶ [0003]; EX1010, ¶ [0002]. Su designed its electrode configuration—including the anode configuration—to improve energy density, and all Su's Example batteries had strong performance in capacity and energy density over more than 2000 cycles. EX1012, ¶¶ [0041], [0058], [0061], [0064], [0067], [0070], [0073], [0076]. Thus, the market need to improve energy density would have further enticed the POSITA to use Su's anode configuration in Zeng/Sunose.

142. **Obvious to try:** Moreover, in my opinion, a POSITA would have found it obvious to try Su's Example 2 and 3 anode configurations in Zeng/Sunose.

143. **Recognized need in the art:** Su observes a market need for high energy density lithium batteries for applications including mobile devices, electric vehicles, and electric tools. EX1012, ¶¶ [0001]-[0003]. Because of this market need "the performance of lithium ion batteries is facing higher development requirements, and high energy density has become one of the research directions of high-performance lithium-ion batteries." *Id*., ¶ [0003].

144. **Finite number of identified, predictable solutions:** Su only discloses seven Example batteries and one comparative Example, so in my opinion, a POSITA would have found it obvious to try all Examples. EX1012, ¶¶ [0050]-[0084]. Example 3 had the second best capacity (below Example 7) and above-average energy density—within 1 Wh/kg of Example 6. Example 2 had well-balanced performance above some other Examples (e.g., 1 and 5) when considering both capacity and energy density. In my opinion, this would have directed the POSITA to Examples 2 and 3 over some of Su's other Examples.

145. **Reasonable expectation of success:** In my opinion, a POSITA would have had a reasonable expectation of success because Sunose and Su both describe wound/rolled electrode configurations. EX1010, ¶¶ [0006]-[0008]; EX1012, Claims 3-5, ¶¶ [0014]-[0016], [0028], [0036]-[0040] The cathode and anode current collectors of Su both have single- and double-sided coating portions. EX1012, ¶¶ [0038]-[0040]. While Sunose only describes cathode configuration in detail,

Sunose's cathode collector has a similar single-sided and double-sided configuration to that described by Su. All of Su's Example batteries were successfully tested over more than 2000 cycles, with good results in capacity and energy density. EX1012, ¶¶ [0041], [0058], [0061], [0064], [0067], [0070], [0073], [0076]. Su provides instructions to prepare its lithium battery, including how to make the single- and double-sided coating parts of the anode. *See id*., Claims 2-10, ¶¶ [0008]-[0021], [0030]-[0040]. In my opinion, this would have given a POSITA a reasonable expectation of success in implementing Su's Examples for the anode in the Zeng/Su combination.

146. Accordingly, in my opinion, Zeng and Sunose, further in view of Su, render obvious claim 15.

XII. GROUNDS 1B, 2B, 3B: ZENG AND MATSUOKA RENDER OBVIOUS CLAIMS 1-6, 12, 16-26; ZENG/MATSUOKA AND SUNOSE RENDER OBVIOUS CLAIMS 13 AND 14; ZENG/MATSUOKA/SUNOSE AND SU RENDER OBVIOUS CLAIM 15

147. Grounds 1B-3B rely on Matsuoka's direct disclosure of an appropriate weight percentage Z of PP instead of a POSITA having to determine it from Zeng. Under this analysis, too, all challenged claim elements are rendered obvious. For the remaining claim elements not addressed below, I incorporate by reference my analysis above for those claim elements in Grounds 1A-1B. *See supra* Sections IX.B, XI.B.

A. Overview of Matsuoka—Electrolyte Specifying Non-nitrile Additives (e.g., PP) by Weight

148. Matsuoka describes a "non-aqueous electrolyte solution" that includes the nitrile additive "acetonitrile and a lithium salt," as well as a "non-nitrile additive," to improve the durability of the SEI layer formed on the electrode surface. EX1007, Abstract, ¶¶ [0015], [0035], [0044], [0056], [0057]. According to Matsuoka, a durable SEI layer better protects the electrodes, reducing side reactions and maintaining lower internal resistance which improves high-temperature storage and cycling performance. *Id.*, ¶¶ [0022], [0036], [0057].

149. Matsuoka explains that compounds having LUMO (Lowest Unoccupied Molecular Orbital) and HOMO (Highest Occupied Molecular Orbital) energy levels falling in preferred ranges make suitable non-nitrile additives. *Id.*, ¶¶ [0015], [0036], [0039]. An ideal LUMO level improves reducibility of the non-nitrile additive, helping to form the SEI film on the negative electrode. *Id.*, ¶ [0036]. An ideal HOMO level distributes the protective effects of the SEI layer to other components of the battery, including the positive electrode. *Id.*, ¶ [0039]. Together, optimum LUMO and HOMO levels suppress side reactions, improving overall performance. *Id.*, ¶ [0022]. Matsuoka explains:

> By adjusting the LUMO energy of the specific additive in the above described range, it is not only effective for the formation of a protective film on a negative electrode, but it also suppresses nonelectrochemical side reactions caused by extremely high reducibility. Furthermore,

> differing from the case of an extremely low LUMO energy, the product generated as a result of the reductive reaction is not strongly fixed only on a negative electrode, but in some form, it provides good effects on members other than the negative electrode, such as a positive electrode and a separator. *As a result, an increase in internal resistance caused by repeating charge-discharge cycles can be suppressed*.

EX1007, ¶ [0036].

150. Matsuoka lists exemplary non-nitrile additives with LUMO and HOMO levels appropriate for use in its electrolytes. *Id*., ¶¶ [0036], [0038]-[0040]. Matsuoka lists n-propyl propionate and isopropyl propionate as suitable additives with LUMO and HOMO energies falling in or near the most-preferred ranges. *Id*., ¶¶ [0038], [0040].

B. Elements [1.4]/[12.4]/[20.4]

1. Matsuoka discloses Elements [1.4]/[12.4]/[20.4]

151. Matsuoka teaches two preferred weight proportion ranges for the non-nitrile additive (e.g., PP) in the total electrolyte:

	Amount of Non-nitrile Additive	**Citation**
Preferably	0.1 to 30 wt%	EX1007, ¶ [0041]
More preferably	0.1to 10 wt%	

152. Matsuoka's preferred range overlaps both the upper and lower portions of the claimed *Z* range, and Matsuoka's more preferred range overlaps the lower

portion of the claimed *Z* range. Thus, in my opinion, Matsuoka discloses or suggests the Elements [1.4]/[12.4]/[20.4].

2. Rationale to combine

153. In my opinion, 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 Examples 4 and 6.

- **Analogous art**

154. In my opinion, Matsuoka is analogous art to the '910 Patent, Zeng, Sunose, and/or Su because it also relates to the field of endeavor of lithium-ion batteries, including for mobile devices. EX1007, ¶¶ [0001]-[0005], [0212]. Additionally, the '910 Patent observes that, "at high voltages, the oxidation activity … increases, … 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." EX1001, 1:33-38. The '910 Patent thus seeks compositions that "inhibit[] the side reactions in the electrochemical device … to improve the long-term storage performance and reliability of the electrochemical device," EX1001, 2:48-52, highlighting reducing side reactions as "important to controlling the expansion of electrochemical devices." *Id.*, 3:15-20.

155. Addressing the same issue, Zeng uses the solvent "[f]luoroethylene carbonate (FEC), which has good film-forming properties and resistance to oxidation" and "ensures good high-voltage cycling performance of the battery without seriously affecting the high-temperature performance of the battery." EX1006, ¶ [0028]. Likewise, Matsuoka uses its non-nitrile additive such as PP to form a stable protective film on the negative electrode, suppressing side reactions that generate gas and rise in internal resistance that can damage the battery and/or hurt cycling performance. EX1007, ¶¶ [0011], [0022], [0036], [0042], [0057], [0104]. Thus, in my opinion, a POSITA would have considered Matsuoka in the proposed combinations.

- **Teaching, suggestion, motivation**

156. **Implementation details:** In my opinion, any hypothetical uncertainty in Zeng's preparation instructions would have prompted the POSITA to look to Matsuoka for implementation details regarding appropriate amounts of PP to include in Zeng's electrolytes. Looking for implementation details in Matsuoka, a POSITA would have identified Matsuoka's "off-the-shelf" preferred weight proportion ranges for the non-nitrile additive for use as the weight percentage Z for PP in Examples 4 and 6.

157. **Balanced performance:** Additionally, Matsuoka explains that its preferred weight proportion ranges for the non-nitrile additive balance the competing

interests of electrolyte stability and high-rate performance at low temperatures. EX1007, ¶ [0041]. Specifically, increasing the amount by weight of the non-nitrile additive improves electrolyte stability at the cost of low-temperature performance, and vice versa. *Id*. By using the non-nitrile additive in Matsuoka's preferred weight proportion ranges, however, "all of the cycling performance of the electrolyte solution, high-rate performance under a low temperature environment, and other battery characteristics can be further improved." *Id.* Apart from implementation details, the desire for balanced performance would have, in my opinion, motivated the POSITA to use Matsuoka's preferred weight proportion ranges as the amount of PP in Zeng's Example 4 and 6 electrolytes.

- **Reasonable expectation of success**

158. In my opinion, a POSITA would have had a reasonable expectation of success in using Matsuoka's preferred non-nitrile weight proportions for PP in Zeng's Example 4 and 6 electrolytes. First, in my opinion, the overlap in composition of Zeng's electrolytes and those of Matsuoka would have given a POSITA an expectation of success in the combination. Zeng's and Matsuoka's electrolytes both include the same carbonate-based solvents (EC, PC), ester compound (EP), $LiPF_6$ as the lithium salt, and VC as an additive. *Compare* EX1006, ¶¶ [0011]-[0019], [0037] *with* EX1007, ¶¶ [0029], [0030], [0034]. And Zeng and Matsuoka both use electrolyte components to improve the SEI film. *Compare*

EX1006, ¶¶ [0005], [0028], [0034] *with* EX1007, ¶¶ [0022], [0026], [0030]. Thus, in my opinion, a POSITA would have reasonably expected the preferred weight proportions of Matsuoka's non-nitrile additive to be suitable as the weight percentage *Z* of PP in Zeng's Example 4 and 6 electrolytes—particularly because Matsuoka describes non-nitrile additives as generally combinable, interchangeable, and "not particularly limited." EX1007, ¶ [0035]. In particular, in my opinion a POSITA would generally expect the resulting solution to have a blend of the performance characteristics of Zeng's and Matsuoka's electrolytes: (1) "a wide-temperature-range … [with] good lithium ion transport properties, electrode plate wettability, and interfacial compatibility," EX1006, ¶ [0009], and (2) "high-rate performance under a low temperature environment." EX1007, ¶ [0041].

a. The Zeng-Matsuoka combination teaches or suggests with the claims.

159. The proposed combination teaches or suggests the claimed *Y*/*Z* ranges:

Example	*Y* (Weight Percentage 1,3,6-hexanetricarbonitrile in Total Electrolyte)	*Z* (Matsuoka's preferred ranges)	*Y*/*Z*
4	1 wt%	10 wt%; 30 wt%	0.1; 0.033
6			

160. As shown above, using either of Matsuoka's preferred weight percentage ranges for PP in Examples 4 and 6 of Zeng results in *Y*/*Z* ranges

overlapping the claimed ranges of 0.02 to 0.3 (elements [1.5], [12.5]) and 0.025 to 0.3 (elements [5.1] and [20.5]). Similarly, using Matsuoka's preferred upper limit of 30 wt% results in Y/Z=1/30=0.033 wt%, also in the claimed range.

161. Alternatively, in my opinion, Matsuoka highlights PP's ability to prevent a rise in internal resistance. The '910 Patent acknowledges that known film-forming additives increase a battery's internal resistance due to the SEI layer they form, indicating a need for improvement. EX1001, 1:31-63. In my opinion, a POSITA, seeking enhancements based on Zeng, would recognize from Matsuoka that PP effectively suppresses rise in internal resistance. A POSITA would therefore be to adjust the PP content in Zeng's Embodiments 4 and 6, experimenting within Matsuoka's preferred ranges of 0.1-10 wt% and 0.1-30 wt% to identify an optimum PP proportion for suppressing rise in internal resistance. EX1007, ¶ [0036].

162. Accordingly, in my opinion, Zeng, Zeng/Sunose, and Zeng/Sunose/Su, further in view of Matsuoka render obvious the challenged claims.

XIII. GROUNDS 1C, 2C, AND 3C: ZENG, ZENG/MATSUOKA—FURTHER IN VIEW OF KIM—RENDER OBVIOUS CLAIMS 1-6, 12, 16-26; ZENG/SUNOSE, ZENG/MATSUOKA/SUNOSE—FURTHER IN VIEW OF KIM—RENDER OBVIOUS CLAIMS 13 AND 14; ZENG/SUNOSE/SU, ZENG/MATSUOKA/SUNOSE/SU—FURTHER IN VIEW OF KIM—RENDER OBVIOUS CLAIM 15

163. I have been asked to consider whether Elements [1.4]/[12.4]/[20.4] require paying particular attention to the ratio of trinitrile to PP, i.e., specifically

focusing on the quotient of *Y*/*Z* itself. In my opinion, it would be incorrect to conclude that Zeng does not render the challenged claims obvious on the grounds that Zeng does not highlight to importance of the ratio of HTCN (trinitrile) to PP specifically.

164. First, as discussed, Zeng discloses an electrolyte with *Y* and *Z* values falling within and overlapping the ranges and relationships for *Y* and *Z* recited in the ’910 Patent claims, which renders the ’910 Patent claims obvious. In my opinion, simply calling out the quotient *Y/Z* should not patentably distinguish the challenged claims from prior art that discloses or renders obvious *Y* and *Z* values that mathematically meet it.

165. Second, Embodiments 4 and 6 of Zeng disclose dinitrile-based electrolytes further containing a trinitrile and PP, and in different relative amounts. EX1006, ¶¶ [0045]-[0049]. The remaining examples lacked the combination of both a trinitrile and PP. *Id*. In my opinion, 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. In my opinion, Patent Owner would be wrong for at least the following additional reasons.

166. In my opinion, 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. Thus, in my opinion: (1) Zeng or Zeng/Matsuoka, further in view of Kim, renders obvious claims 1-6, 12, and 16-26; (2) Zeng or Zeng/Matsuoka and Sunose, further in view of Kim, renders obvious claims 13 and 14; and (3) Zeng or Zeng/Matsuoka and Sunose, further in view of Kim, renders obvious claim 15.[7]

167. Specifically, Kim discloses lithium-ion battery electrolytes that demonstrate superior capacity retention at high temperatures after battery charging cycles. According to Kim, "reactivity between an active material and an electrolyte solution is increased, thus a capacity retention is deteriorated during a cycle[.]" EX1008, ¶ [0005]. Kim experimented with electrolytes including a dinitrile, a trinitrile, and PP, finding the following advantageous characteristic: after storage at 60˚C for four weeks, and after 250 cycles, batteries using electrolytes that have both a trinitrile and PP exhibited improved capacity retention over batteries using electrolytes that lack at least one of these two components. EX1008, Tables 2-4.

168. Claim 1 of Kim introduces the concept of using trinitrile (depicted as Formula 1) with a C3 to C5 alkyl propionate (a category that includes PP) together.

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[7] For all remaining claim elements, I incorporate by reference my analysis above for those claim elements in Grounds 1A-3B. *See supra* Sections IX-XII.

The compound represented by Formula 1 features three or more nitrile (CN) groups and an asymmetric structure. *See* EX1008, ¶ [0055]. PP is explicitly identified in Claim 1 through the phrase "an organic solvent including C3 to C5 alkyl propionate," where "C3 alkyl propionate" directly corresponds to PP. *See* EX1008, Claim 1.

169. Kim thus, in my opinion, underscores the enhanced performance of electrolytes that incorporate both trinitrile and PP, compared to those missing either component or both. This is effectively demonstrated through Examples 1 and 2, as well as Comparative Examples 1-6. Of all Examples 1 and 2 and Comparative Examples 1-6 tested in Kim, only Examples 1 and 2 contained both a HTCN (trinitrile) and PP—and in different relative amounts. EX1008, ¶¶ [0090]-[0091]. The remaining Comparative Examples 1-6 lacked either HTCN (trinitrile), PP or both, as highlighted below:

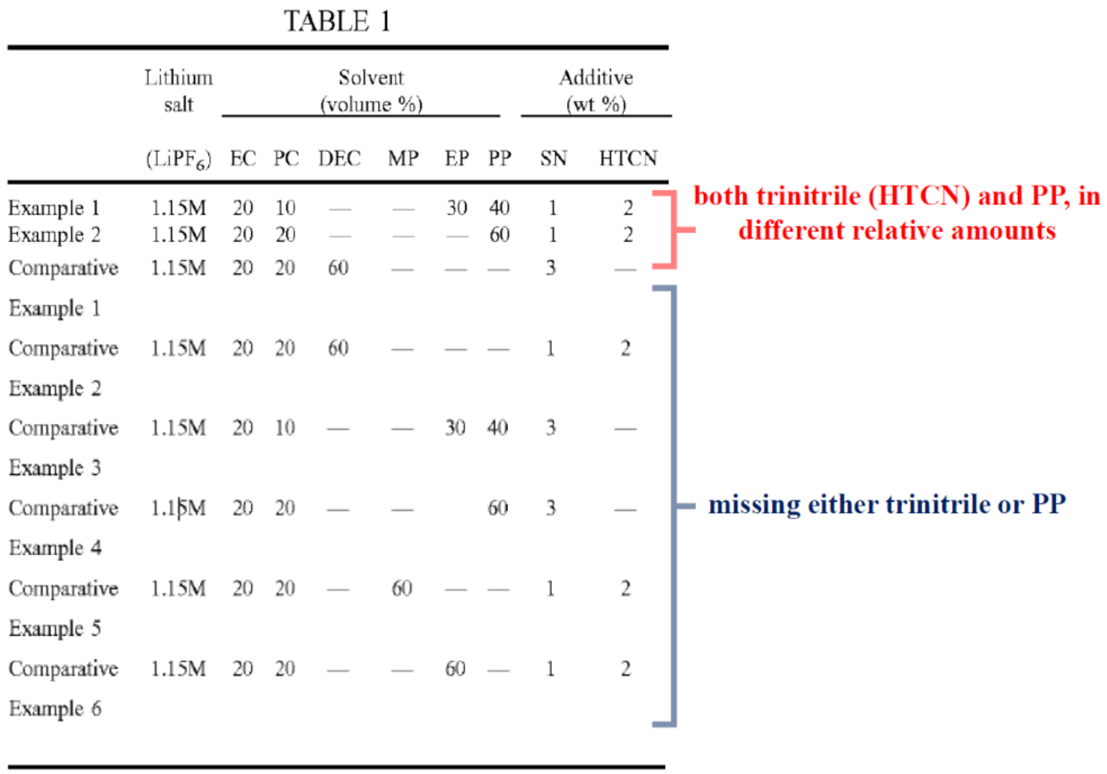


TABLE 1

	Lithium salt	Solvent (volume %)						Additive (wt %)	
	($LiPF_6$)	EC	PC	DEC	MP	EP	PP	SN	HTCN
Example 1	1.15M	20	10	—	—	30	40	1	2
Example 2	1.15M	20	20	—	—	—	60	1	2
Comparative Example 1	1.15M	20	20	60	—	—	—	3	—
Comparative Example 2	1.15M	20	20	60	—	—	—	1	2
Comparative Example 3	1.15M	20	10	—	—	30	40	3	—
Comparative Example 4	1.15M	20	20	—	—		60	3	—
Comparative Example 5	1.15M	20	20	—	60	—	—	1	2
Comparative Example 6	1.15M	20	20	—	—	60	—	1	2

both trinitrile (HTCN) and PP, in different relative amounts

missing either trinitrile or PP

Kim, Table 1*

Id., ¶ [0091].

170. In my opinion, 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*.

171. Moreover, Kim tested batteries using the example electrolytes, and Examples 1 and 2 (containing both trinitrile and PP) outperformed all Comparative Examples 1-6 (lacking trinitrile or PP) in resisting increase in battery thickness and capacity retention. *See* EX1008, ¶¶ [0097]-[0103] (Tables 3, 4), FIGS. 3-6. Evaluating the test results to determine the main driver of improved performance, in

my opinion the POSITA would have noted differences in electrolyte composition: Examples 1 and 2 contain both a trinitrile and a PP while the Comparative Examples lack one or the other. In my opinion, this would further focus the POSITA on the importance of having both components in an electrolyte solution.

172. Upon review, the only difference between Example 2 and Comparative Examples 5 and 6 is the substitution of PP in Example 2 with MP or EP in Comparative Examples 5 and 6, respectively. EX1008, ¶ [0090], Table 1. In all cases, the weight percentage of the substituted additive (PP, MP, or EP) is kept constant at 60%. *Id.* In my opinion, the superior performance of Example 2 shows that PP is better than its peers and cannot be replaced by MP or EP.

173. In Examples 1 and 2, the dinitrile and trinitrile contents are identical, but the PP weight percentage increases from 40% in Example 1 to 60% in Example 2. *Id.*, ¶ [0090], Table 1. Kim uses four evaluation methods to show that adjusting PP, while keeping trinitrile constant in Examples 1 and 2, significantly impacts battery performance. *Id.*, ¶¶ [0092]-[0103]. In my opinion, 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.

174. Kim highlights the same technique to improve electrolyte performance as the '910 Patent (adjusting *Y/Z*) and describes the same underlying mechanism causing the improved performance. The '910 Patent observes that "[a] dinitrile

compound can form a protective film on the cathode of the electrochemical device … to inhibit the decomposition of the solvent[,]" EX1001, 1:50-53, but that the high working voltages (above 4.4V) required by conventional electronic devices tend to decompose the protective film. *Id.*, 1:31-40, 1:53-56. The '910 Patent states that the addition of trinitrile forms a durable, protective SEI film on the cathode surface, which resists decomposition. *Id.*, 1:56-63. However, film-forming additives such as dinitrile and trinitrile have an inherent limitation: the protective SEI film they create increases the battery's DC internal resistance and thickness expansion rate, ultimately compromising storage and cycling performance. *Id.*, 22:63-67. The '910 Patent does not explain why the protective SEI film leads to an increase in DC internal resistance. Instead, it highlights that the SEI film formed by a dinitrile and/or trinitrile requires further optimization to address the issue of DC internal resistance.

175. Kim observes that an additive, such as dinitrile succinonitrile (SN), "may help formation of a film on a negative electrode as well as a positive electrode" that "suppress[es] gas generation … when stored at a high temperature" or operated at high voltage (above 4.4V). EX1008, ¶ [0064]; *see also id.*, ¶ [0104]. Gas generation increases thickness and internal resistance of the battery, hurting storage and cycle performance. *Id.*, ¶¶ [0039], [0063]-[0066]. Like the '910 Patent, Kim also observes that adding to the electrolyte a trinitrile, like HTCN, "represented by Chemical Formula 1," gives the protective layer a "stable and strong bonding" force

that reduces battery swelling typically caused by high temperature storage and cycling. *Id.*, ¶¶ [0055]-[0056]. And, as discussed, Kim's Examples and claims demonstrate that further adding PP further improves high temperature storage and cycling performance. *Id.*, ¶¶ [0014], [0040], [0090], [0091], claim 3.

176. Thus, in my opinion, the only difference between the teachings of the '910 Patent and Kim lies in their focus on the role of PP. The '910 Patent explicitly states that adding PP to dinitrile and trinitrile helps suppress DC internal resistance, thereby enhancing battery performance. In contrast, Kim broadly mentions that the combination of PP with dinitrile and trinitrile improves cycling performance but does not specifically address the suppression of DC internal resistance. Testing DC internal resistance, however, was a routine procedure for evaluating electrolyte performance. 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.), introducing DC internal resistance as an additional evaluation approach is merely a standard technical measure. In my opinion, it does not constitute an inventive step, nor does it result in any surprising or unexpected performance improvements.

177. Accordingly, in my opinion, Kim's disclosure would further motivate a POSITA to consider the ratio of trinitrile to PP in Zeng's electrolytes and/or

incorporate Matsuoka's disclosed preferred non-nitrile additive weight percentage ranges in Zeng.

XIV. GROUND 4A: ZHOU RENDERS OBVIOUS CLAIMS 1-6, 11, 12, AND 16-26

A. Overview of Zhou—Electrolyte Containing X, Y, and Z in the Claimed Amounts

178. Zhou's Example 8 discloses an adiponitrile-based (ADN) dinitrile electrolyte further containing 1,3,6-hexane trinitrile (HTCN) and the linear carboxylic acid ester ethyl acetate (EA). Example 8 does not contain PP. However, Zhou lists only eight alternative suitable linear carboxyl acid esters—two being EA and PP. In my opinion, it would have been obvious for a POSITA to try the replacement of EA with PP. Example 8 has 20 wt% EA in the solvent mixture, which gets reduced to 16.56 wt% after adding $LiPF_6$ and the additives. Replacing EA with PP would thus result in the total electrolyte having between 5 wt% and 20 wt% PP. I rely on Example 8 of Zhou as rendering obvious the challenged claims.

179. Zhou describes embodiments of "a fast charging lithium-ion battery electrolyte [having] a high potential and a high compaction density, and ... good cycle performance and high and low temperature performance." EX1014, ¶ [0006]. Zhou's electrolytes have the following main components:

- a solvent which "accounts for 70%-88% of the total mass of the lithium-ion battery electrolyte" and "includes a mixture of two or more of a low-boiling-point linear carbonate and a linear carboxylic acid ester, fluorobenzene and hydrofluoroether";

- a lithium salt;
- an additive package including "[a] third additive [that] is a nitrile compound containing 2 or 3 nitrile functional groups" and that "accounts for 0.5%-5% of the total mass of the lithium-ion battery electrolyte[.]"

EX1014, ¶¶ [0008], [0009], [0016], [0018].

180. The solvent "adjust[s] the wetting effect and mass transfer resistance of the electrolyte system [so that] a good channel is provided for the lithium-ion deintercalation process[.]" *Id.*, ¶ [0020]. But "the low-boiling-point linear carbonate and carboxylate introduced into the above-mentioned solvent" has the side effects of "incompatibility with graphite, poor battery cycle performance, and high temperature resistance[.]" *Id.*

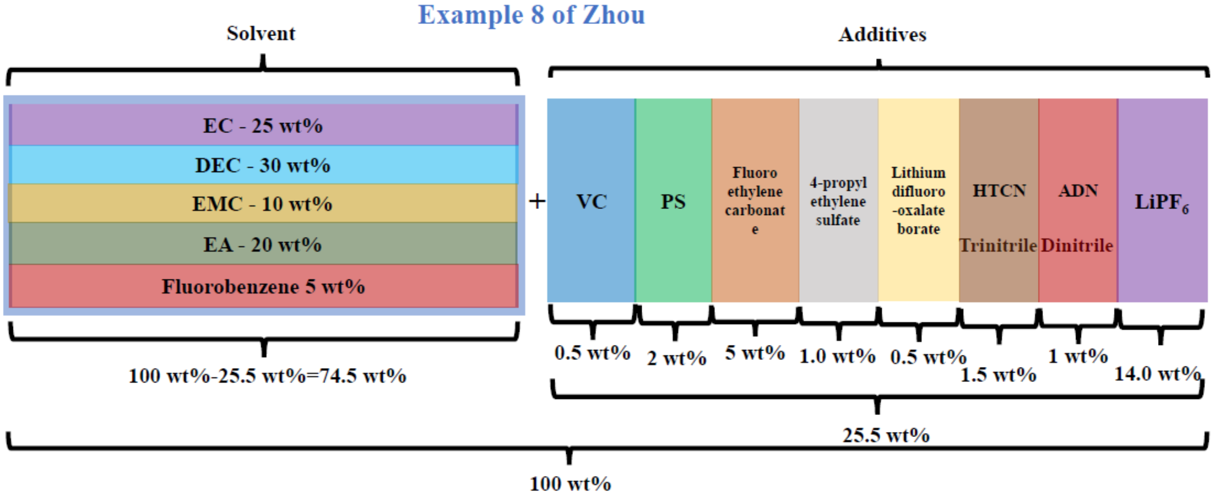
181. The additives, including the nitrile compound(s), "solve the problem of incompatibility with graphite" and "eliminate the deterioration of high-temperature performance caused by the above-mentioned low-boiling-point organic solvent." *Id.* Zhou prefers "nitrile compounds containing 2 or 3 nitrile functional groups … to improve the high temperature performance of the battery[.]" EX1014, ¶ [0059]. "1,3,6-hexane trinitrile is particularly preferred" because it is "[an] efficient high

temperature additive" with "better compatibility with the negative electrode and is easier to protect the positive electrode." *Id.*

182. In the solvent, Zhou prefers "non-methyl carboxylates … in large quantities" because they are "more conducive to the fast charging of the system under high voltage and high compaction conditions." *Id.*, ¶ [0058]. Zhou identifies a handful of suitable linear carboxylic acid esters: "[PP], ethyl propionate, propyl acetate, butyl propionate, ethyl acetate, isopropyl propionate, ethyl butyrate, and methyl acetate." *Id.*, ¶ [0011].

183. When Zhou describes electrolyte composition, Zhou refers to all additives based on "the total mass of the lithium-ion battery electrolyte." EX1014, ¶¶ [0009], [0013]-[0016], [0018]. Example 8 of Zhou contains EA (PP substitute) as a solvent, the *dinitrile* adiponitrile (ADN), and the *trinitrile* 1,3,6-hexane trinitrile (HTCN). *Id.*, ¶ [0047]. Specifically, "ethylene carbonate, dimethyl carbonate, ethyl methyl carbonate, ethyl acetate, and fluorobenzene are mixed uniformly in a *mass ratio* of 25:30:10:20:5." *Id*. Then, "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 $LiPF_6$ is slowly added and stirred until it is completely dissolved." *Id.*

184. Example 8 of Zhou has the following composition, with the combined mixture totaling 100 wt%:



185. **Weight percentage of ADN (dinitrile) in the total electrolyte:** ADN is a dinitrile, as claimed, because it has two nitrile (-CN) groups in its structure, with the molecular formula NC-CH$_2$-CH$_2$-CH$_2$-CH$_2$-CN. EX1018, 1. As illustrated above, in the total Example 8 electrolyte after mixing the additives with the solvent mixture, ADN has a weight ratio (the claimed *X*) of 1 wt%.

186. **Weight percentage of HTCN (trinitrile) in the total electrolyte:** HTCN is a *trinitrile*, as claimed, because it has three -CN groups with the molecular formula C$_9$H$_{11}$N$_3$. EX1018, 100. As illustrated above, in the total electrolyte of Example 4 and after mixing the additives with the lithium salt and solvent, HTCN has a weight ratio (the claimed *Y*) of 1.5 wt%.

187. **Weight percentage of EA in the total electrolyte:** As illustrated above, in the total electrolyte of Example 4 and after mixing the additives with the lithium salt and solvent, EA has a weight ratio (denoted as Z') of （1-25.5%）×(20%/（25%+30%+10%+20%+5%）)=16.56%.

188. In summary, the claimed X, Y, and Z' have the following values in Zhou’s Example 8:

X (Weight Percentage ADN in Total Electrolyte)	**Y (Weight Percentage HTCN in Total Electrolyte)**	**Z' (Weight Percentage PP in Total Electrolyte)**
1 wt%	1.5 wt%	16.56 wt%

189. In Example 8, Zhou found improved discharge capacity of lithium-ion batteries, as shown in Figure 1. In particular, the battery using the Example 8 electrolyte showed improved discharge capacity over not only Comparative Example 3, but also Examples 3-6. EX1014, ¶ [0061], FIG. 1. Zhou also found that Example 8 exhibit lower internal impedance of lithium-ion batteries than Comparative Examples 1-3 and Examples 1, 2, 4, and 6 as shown in Figure 4. *Id.*, ¶¶ [0057]-[0058], FIG. 4.

B. Independent Claim 1

1. [1.pre] “An electrolyte, comprising”

190. As I discussed, I rely on Example 8 of Zhou’s electrolyte as rendering the challenged claims unpatentable. EX1014, ¶ [0047]; *see* Section XIV.A.

- **Rationale to Implement Zhou Example 8**

191. Each Example in Zhou is a self-contained, working embodiment that provides a complete list of components, amounts, and preparation instructions. And in my opinion, a POSITA would have been motivated to implement the electrolyte of Zhou's Example 8 with a reasonable expectation of success. The Example 8 battery not only significantly outperformed 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. *See* EX1014, ¶¶ [0057], [0061], FIGS. 1, 4. This would have motivated the POSITA to implement Example 8 over other Examples.

192. Furthermore, in my opinion, it would have been obvious to try Example 8 of Zhou. For example:

193. **Recognized need in the art:** In my opinion, Zhou observes a market need for "the development of fast charging technology" driven by "the popularization of smart digital products [and] the application of new energy vehicles[.]" EX1014, ¶¶ [0002]-[0003]. Conventionally, "low-boiling-point organic solvents are commonly used to improve the kinetic properties of the electrolyte," such as "better wettability [and] lower viscosity[.]" *Id.*, ¶¶ [0003]-[0004]. "However, the use of these solvents will cause the high temperature performance of the battery to be challenged" and "poor compatibility of carboxylic acid ester organic solvents

with the negative electrode graphite of the battery will cause the battery cycle performance to deteriorate." *Id.*, ¶ [0004]. Zhou thus sought "a combination of solvents and additives that matches the fast charging electrolyte" and thereby "[i]improv[es] battery kinetics, high temperature performance, and cycle performance[.]" *Id.*, ¶ [0005].

194. **Finite number of identified, predictable solutions:** Zhou only discloses eight electrolyte solutions (Examples 1-8), which had better discharge capacity and lower impedance than the Comparative Examples. *Id.*, ¶¶ [0032]-[0048]. Making Example 8 a higher priority to try over others, Example 8 outperformed Examples 3-6 in discharge capacity and outperformed Examples 1, 2, 4, and 6 in internal impedance. EX1014, ¶¶ [0057], [0058], [0061], FIGS. 1, 4.

195. **Reasonable expectation of success:** All Zhou's Examples were successfully tested in batteries and had better performance than the Comparative Examples. EX1014, ¶¶ [0057]-[0063]. According to Zhou, the Examples successfully showed that "[a]n efficient high temperature additive" such as "[n]itrile compounds containing 2 or 3 nitrile functional groups," overcomes the fact that "[t]he high temperature performance is often challenged when using the solvent system of the present invention." *Id.*, ¶ [0059]. Zhou also provides detailed instructions to make the Example electrolyte. *See id.*, ¶ [0047]. In my opinion, this

would have given a POSITA a reasonable expectation of success in implementing Example 8.

2. [1.1] "a dinitrile compound, a trinitrile compound, and propyl propionate,"

196. As discussed in Section XIV.A, Zhou's Example 8 electrolyte contains *a dinitrile compound* (ADN) and *a trinitrile compound* (HTCN), as claimed. *See* EX1014, ¶ [0047]; EX1018, 1 (describing ADN), 100 (describing HTCN). In my opinion, while Example 8 does not contain PP, Zhou's broader disclosure would have rendered obvious to a POSITA to substitute PP in Example 8 for EA, with a reasonable expectation of success.

b. Zhou discloses "*propyl propionate*"

197. As discussed, Zhou's solvent "includes a mixture of two or more of a low-boiling-point linear carbonate and a linear carboxylic acid ester, fluorobenzene and hydrofluoroether." EX1014, ¶ [0008]. And Zhou expressly discloses that PP and EA are two of eight suitable linear carboxylic acid esters: "[t]he linear carboxylic acid ester is at least one of PP, ethyl propionate, propyl acetate, butyl propionate, ethyl acetate, isopropyl propionate, ethyl butyrate, and methyl acetate." EX1014, ¶ [0011]. Therefore, Zhou discloses that its electrolytes can include "propyl propionate," as claimed.

c. Rationale to substitute propyl propionate for ethyl acetate in Example 8

- **Obvious to try**

198. In my opinion, a POSITA would have found it obvious to try substituting PP for EA in Example 8 of Zhou.

199. **Recognized problem/need:** Zhou observes that, in the lithium-ion battery market, "people's demand for fast charging has become more urgent" due to "the popularization of smart digital product[.]" EX1014, ¶ [0002]. Fast charging demands "rapid migration of a large number of lithium-ions" which, in turn, "requires the electrolyte to have higher kinetic properties and smaller mass transfer resistance[.]" *Id.*, ¶ [0003]. Zhou explains that "low-boiling-point organic solvents are commonly used to improve the kinetic properties of the electrolyte[.]" *Id.*, ¶ [0004]. Thus, Zhou discloses that popular demand for fast charging requires organic solvents that improve kinetic properties of lithium-ion battery electrolytes.

200. **Finite number of identified, predictable solutions:** Zhou identifies a solution to the problem of improving kinetic performance of the electrolyte: "a mixture of two or more of a low-boiling-point linear carbonate and a linear carboxylic acid ester[.]" EX1014, ¶ [0008]. As Zhou found, "the melting and boiling points of the linear carbonate and carboxylate solvents … are both low, providing a more suitable channel for lithium-ion transmission and reducing the impedance of

the battery system.” *Id.*, ¶ [0055]; *see also id.*, ¶ [0020] (selecting linear carbonates and linear carboxylates “improves the battery kinetic performance by changing the solvent system” because they “are easy to diffuse, have good wettability, low viscosity and low melting and boiling points as solvents in the solvent system[.]”). Zhou identifies eight potential linear carboxyl acid esters—one of which (EA) is used in Example 8 and another of which is PP. EX1014, ¶ [0011]. Therefore, PP is one of only a handful of solutions to increase kinetic performance suggested by Zhou.

201. **Reasonable expectation of success**: In my opinion, a POSITA would have had a reasonable expectation of success in replacing one linear carboxyl acid ester (EA) for another (PP) in Zhou’s Example 8 electrolyte. Zhou lists PP alongside EA as a suitable linear carboxylic acid ester, EX1014, ¶ [0011], so, in my opinion, the POSITA would likewise expect PP to have a low melting point and provide a good channel for ion conductivity. *Id.*, ¶ [0057].

202. Zhou also teaches the benefits of including large quantities, and different types, of carboxylic acid esters in its electrolyte solutions; for example:

> As for the selection of the above-mentioned carboxylic acid esters, … the applicant believes that non-methyl carboxylates at the end can be used in large quantities (accounting for up to 30% of the solvent system), ... which is more conducive to the fast charging of the system under high voltage and high compaction conditions.

Id., ¶ [0058]. Therefore, in my opinion, a POSITA would not expect replacing EA with PP in Example 8 to render the electrolyte inoperable or harm performance. Instead, a POSITA would expect the resulting electrolyte to work as Zhou describes.

- **Simple substitution**

203. In my opinion, 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.

204. **Prior art electrolyte:** Zhou's Example 8 electrolyte differs from the claimed electrolyte by substitution of the carboxylic acid ester EA for another carboxylic acid ester PP.

205. **Function of substituted components known in the art:** Zhou lists PP and EA as two of a handful of alternative carboxylic acid esters. EX1014, ¶ [0011]. Zhou explains that carboxylic acid esters have a low melting point and provide a good channel for ion conductivity in lithium-ion battery electrolytes, reducing internal impedance and improving kinetic performance of the electrolyte. *Id.*, ¶¶ [0009], [0057], [0058].

206. **Predictable results:** In my opinion, a POSITA could have substituted PP for EA in Example 8 of Zhou with only routine skill in the art. Zhou instructs mixing the electrolyte components, including 20 wt% EA, in argon glove box and

then slowly add and dissolve 14 wt% $LiPF_6$ to form the total electrolyte. EX1014, ¶ [0047]. In this process, a POSITA could have simply added 20 wt% PP instead of 20 wt% EA. In my opinion, the result of this substitution would have been predictable because Zhou identifies EA and PP as fungible carboxylic acid esters that provide a good channel for ion conductivity. EX1014, ¶ [0009], [0011], [0057], [0058].

207. Accordingly, in my opinion, Zhou discloses or suggests element [1.1].

3. [1.2] "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 … ; wherein, about 2.2 wt%≤(X+Y)≤about 8 wt%, about 0.1≤(X/Y)≤about 2.3, and"

208. As explained above, the claimed *X* and *Y* and have the following values in Zhou's Example 8:

X	***Y***	***X* + *Y***	***X/Y***
1 wt%	1.5 wt%	**2.5 wt%**	**0.67**

See supra Section XIV.A. Therefore, in Example 8, *X* + *Y* = 1 wt% + 1.5 wt% = 2.5 wt%, which in my opinion is "about 2.2 wt%" as claimed and within the '910 Patent's 10% tolerance. Moreover, in my opinion, 2.5 wt% is sufficiently close to 2.2 wt% that a POSITA would expect the same properties.

209. Accordingly, in my opinion, Zhou discloses or suggests element [1.2].

4. [1.3] "a weight percentage of the propyl propionate is Z; wherein … 5 wt% ≤ Z ≤ 20 wt% or 30 wt% ≤ Z ≤ 50 wt%, and"

210. As explained above, in my opinion, Zhou suggests or renders obvious that Z' is 16.56 wt% in Example 8 and further renders obvious substituting PP for EA in Example 8. *Supra* Section XIV.A. Thus, Z is 16.56 wt%, which falls in the lower end of the recited Z range.

211. Accordingly, in my opinion, Zhou discloses or suggests element [1.3].

5. [1.4] "about 0.02 ≤ (Y / Z) ≤ about 0.3;"

212. As explained above, the claimed Y and Z have the following values in the modification to Example 8 of Zhou:

Y	***Z***	***Y/Z***
1.5 wt%	16.56 wt%	**0.091**

See supra Section XIV.A. Therefore, in modified Example 8 of Zhou, Y/Z is 0.091, which falls in the claimed range of about 0.02 to about 0.3.

213. Accordingly, in my opinion, Zhou discloses or suggests element [1.4].

6. [1.5] "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"

214. As discussed above, Example 8 of Zhou has adiponitrile (ADN) as the claimed *dinitrile compound*. EX1014, ¶[0047]; *supra* Section XIV.A. Accordingly, in my opinion, Zhou discloses or suggests element [1.6].

7. [1.6] "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;"

215. As discussed, Example 8 of Zhou has 1,3,6-hexanetricarbonitrile (HTCN) as the claimed *trinitrile compound*. EX1014, ¶ [0047]; *supra* Section XIV.A. Accordingly, in my opinion, Zhou discloses or suggests element [1.7].

8. [1.7] "wherein the electrolyte further comprises a compound having a sulfur-oxygen double bond."

216. In Zhou's Example 8, *the electrolyte further comprises a compound having a sulfur-oxygen double bond*—1,3-propanesultone (PS)—as claimed. EX1014, ¶ [0047]. Accordingly, in my opinion, Zhou discloses or suggests element [1.8].

C. Claim 2

1. [2.1] "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%."

217. In Zhou's Example 8, the *dinitrile compound* is *adiponitrile*. EX1014, ¶ [0047]. Moreover, as explained above, *X/Y* = 0.67 in Example 8 of Zhou, which falls in the claimed range of 0.1 to 2.3 recited in element [2.1]. *Supra* Section XIV.B.3.

218. Accordingly, in my opinion, Zhou discloses or suggests claim 2.

D. Claim 3

1. [3.1] "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%."

219. Example 8 of Zhou has 2 wt% *1,3-propanesultone* (PS), falling in the claimed range of 0.1 wt% to 3 wt% for this compound recited in element [3.1]. EX1014, ¶ [0047]; *supra* Section XIV.B.8.

220. Accordingly, in my opinion, Zhou discloses or suggests claim 3.

E. Claim 4

1. [4.1] "The electrolyte according to claim 1, wherein 0.1≤X/Y≤2.0."

221. As explained above, *X/Y* in Zhou's Example 8 equals 0.67, falling within the claimed range of 0.1 to 2.0. *Supra* Section XIV.B.3.

222. Accordingly, in my opinion, Zhou discloses or suggests claim 4.

F. Claim 5

1. [5.1] "The electrolyte according to claim 1, wherein 0.025≤Y/Z≤0.3."

223. As explained above, *Y/Z′* in Zhou's Example 8 equals 0.091, falling within the claimed range of 0.025 to 0.3. *Supra* Section XIV.B.5.

224. Accordingly, in my opinion, Zhou discloses or suggests claim 5.

G. Claim 6

1. [6.1] "The electrolyte according to claim 1, wherein X is 0.01-10 wt%, Y is 0.01-10 wt%."

225. As explained above, *X* and *Y* have the following values in Zhou's Example 8, falling within the claimed ranges for *X* and *Y*:

X	***Y***
1 wt%	1.5 wt%

Supra Section XIV.A.

226. Accordingly, in my opinion, Zhou discloses or suggests claim 6.

H. Claims 12 and 16-19

227. Zhou discloses or suggests the elements of claims 12 and 16-26:

Claim 12		
Element	**Text**	**Reasoning**
[12.pre]	*An electrochemical device, wherein the electrochemical device comprises electrodes and an electrolyte comprising:*	*See* Section XIV.B.1 above regarding element [1.pre].[8]

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[8] Zhou discloses that its Example 8 electrolyte was used in a lithium-ion battery (an electrochemical device that comprises electrodes) as claimed. *See* EX1014, ¶ [0048].

[12.1]	*a dinitrile compound, a trinitrile compound, and propyl propionate,*	*See* Section XIV.B.2 above regarding element [1.1].
[12.2]	*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 … ; wherein, about 2.2 wt%≤(X+Y)≤about 8 wt%, about 0.1≤(X/Y)≤about 2.3,*	*See* Section XIV.B.3 above regarding element [1.2].
[12.3]	*and a weight percentage of the propyl propionate is Z; wherein … about 5 wt%≤Z≤20 wt% or 30 wt%≤Z≤50 wt%, and*	*See* Section XIV.B.4 above regarding element [1.3].
[12.4]	*about 0.02≤(Y/Z)≤about 0.3;*	*See* Section XIV.B.5 above regarding element [1.4].
[12.5]	*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*	*See* Section XIV.B.6 above regarding element [1.5].
[12.6]	*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*	*See* Section XIV.B.7 above regarding element [1.6].
[12.7]	*wherein the electrolyte further comprises a compound having a sulfur-oxygen double bond.*	*See* Section XIV.B.8 above regarding element [1.7].

Claim 16		
Element	**Text**	**Reasoning**
[16.1]	*The electrochemical device according to claim 12, wherein the dinitrile compound comprises adiponitrile, wherein,* $0.1 \leq$ *a weight percentage of the adiponitrile ÷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.*	*See* Section XIV.C.1 above regarding element [2.1].
Claim 17		
Element	**Text**	**Reasoning**
[17.1]	*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%.*	*See* Section XIV.D.1 above regarding element [3.1].
Claim 18		
Element	**Text**	**Reasoning**
[18.1]	*The electrochemical device according to claim 12, wherein* X *is 0.01-10 wt%,* Y *is 0.01-10 wt%.*	*See* Section XIV.G.1 above regarding element [6.1].
Claim 19		
Element	**Text**	**Reasoning**
[19.1]	*The electrochemical device according to claim 12, wherein* $0.1 \leq X/Y \leq 2.0$*.*	*See* Section XIV.E.1 above regarding element [4.1].

Claim 20

Element	**Text**	**Reasoning**
[20.pre]	*An electrochemical device, wherein the electrochemical device comprises electrodes and an electrolyte comprising:*	*See* Section XIV.B.1 above regarding element [1.pre].
[20.1]	*a dinitrile compound, a trinitrile compound, and propyl propionate,*	*See* Section XIV.B.2 above regarding element [1.1].
[20.2]	*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 … ; wherein, about 2.2 wt%$\leq(X+Y)\leq$about 8 wt%, about $0.1\leq(X/Y)\leq$about 6,*	*See* Section XIV.B.3 above regarding element [1.2]. In Example 8 of Zhou, $X+Y$= 2.5 wt%, and X/Y= 0.67 (both in claimed range).
[20.3]	*and a weight percentage of the propyl propionate is Z; wherein … 5 wt%$\leq Z\leq$20 wt% or 30 wt%$\leq Z\leq$50 wt%, and*	*See* Section XIV.B.4 above regarding element [1.3].
[20.4]	*about $0.01\leq(Y/Z)\leq$about 0.3;*	*See* Section XIV.B.5 above regarding element [1.4]. In Example 8 of Zhou, $Y/Z' > 0.091$, falling within the claimed range.

[20.5]	*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*	*See* Section XIV.B.6 above regarding element [1.5].
[20.6]	*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;*	*See* Section XIV.B.7 above regarding element [1.6].
[20.7]	*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%.*	*See* Section XIV.B.8 above regarding element [1.7]; Section XIV.D.1 regarding element [3.1].
Claim 21		
Element	**Text**	**Reasoning**
[21.1]	*The electrolyte according to claim 20, wherein, the dinitrile compound comprises adiponitrile, wherein, 0.1≤a weight percentage of the adiponitrile ÷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.*	*See* Section XIV.C.1 above regarding element [2.1].
Claim 22		
Element	**Text**	**Reasoning**
[22.1]	*The electrolyte according to claim 20, wherein X is 0.01-10 wt%, Y is 0.01-10 wt%.*	*See* Section XIV.G.1 above regarding element [6.1].
Claim 23		

[23.1]	*The electrolyte according to claim 20, wherein* $0.2 \le X/Y \le 5$.	*See* Section XIV.B.3 above regarding element [1.2]. In Example 8 of Zhou, $X/Y = 0.67$.
Claim 24		
[24.1]	*The electrolyte according to claim 20, wherein* $2.2\ wt\% \le X+Y \le 8\ wt\%$, *and* $0.1 \le X/Y \le 2.3$.	*See* Section XIV.B.3 above regarding element [1.2]. In Example 8 of Zhou, $X+Y = 2.5$ wt%, and $X/Y = 0.67$.
Claim 25		
Element	**Text**	**Reasoning**
[25.1]	*The electrolyte according to claim 20, wherein* $0.1 \le X/Y \le 2.0$	*See* Section XIV.E.1 above regarding element [4.1].
Claim 26		
[26.1]	*The electrolyte according to claim 20, wherein* $0.025 \le Y/Z \le 0.3$	*See* Section XIV.B.5 above regarding element [1.4]. In Example 8 of Zhou, $Y/Z > 0.091$, overlapping the claimed range.

228. Accordingly, in my opinion, Zhou discloses or suggests claims 12 and 16-26.

XV. GROUND 5A: ZHOU AND SUNOSE RENDER OBVIOUS CLAIMS 13 AND 14

229. In my opinion, to the extent Zhou does not expressly disclose all elements of claims 13 and 14, as explained below, a POSITA would have found it obvious to modify Zhou's battery based on Sunose to arrive at the subject matter of these claims.

A. Claim 13

1. [13.1] "The electrochemical device according to claim 12, wherein the electrode comprises a cathode, the cathode comprises a current collector,"

230. In my opinion, Zhou discloses or suggests this element. Specifically, Zhou discloses electrolytes that "can meet the requirements of fast charging requirements of a fast-charging system battery above 2C with voltage of 4.35V, a negative electrode compaction density of 1.6g/cm^3 or more, a high potential and a high compaction density, and has good cycle performance and high and low temperature performance." EX1014, ¶ [0008]. A battery using the Example 8 electrolyte was tested for performance. *Id.*, ¶¶ [0057], [0061]. A lithium-ion battery, by definition, is an electrochemical device having a cathode that comprises a current collector, as claimed.

2. Sunose discloses Elements [13.2] to [13.4]

a. [13.2] "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;"

231. As discussed above, in my opinion, Sunose discloses or suggests this element. *Supra* Section X.A.2.a.

a. [13.3] "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≤D1/D2≤about 1.2; and,"

[13.4] "3.5 g/cm^3≤D2≤4.3 g/cm^3."

232. As discussed above, in my opinion, Sunose discloses this element. *Supra* Section X.A.2.b. For the reasons discussed above in Ground 2A and the additional reasons below, a POSITA would have been motivated, with a reasonable expectation of success, to configure Zhou's cathode according to Sunose's Examples.

233. Sunose is analogous art to the '910 Patent and Zhou because it falls in the same field of endeavor—lithium-ion secondary batteries, including those employing non-aqueous electrolytes. *See* EX1010, Abstract, ¶¶ [0001]-[0011], [Claim 3]; EX1014, ¶¶ [0001]-[0008]; EX1001, 1:19-3:26. Because Zhou focuses on electrolytes rather than the physical configuration of the battery itself, in my opinion a POSITA would have looked to Sunose for implementation details for its

improved electrode. *Supra* Sections X.A.2.c, XIV.A. In my opinion, a POSITA would have had a reasonable expectation of success in using Sunose's rolled electrode configuration in Zhou's example batteries because Zhou does not describe any physical specifications or restrictions for its battery or electrode configuration.

234. Accordingly, in my opinion, Zhou and Sunose disclose or suggest claim 13.

B. Claim 14

1. [14.1] "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."

235. As discussed above, in my opinion, Zhou and Sunose disclose or suggest claim 14. *Supra* Section X.B.

XVI. GROUND 6A: ZHOU AND SUNOSE, FURTHER IN VIEW OF SU, RENDERS OBVIOUS CLAIM 15

236. To the extent the Zhou/Sunose combination does not disclose all elements of claim 15, in my opinion Zhou/Sunose further in view of Su renders claim 15 obvious.

A. Claim 15

1. [15.1] "The electrochemical device according to claim 13, wherein the electrode comprises an anode, the anode comprises a current collector,"

237. In my opinion, Zhou discloses or suggests this element. *Supra* Section XIV.A.1.

2. Su discloses Elements [15.2] to [15.4]

a. [15.2] "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,"

238. In my opinion, Su discloses or suggests this element. *Supra* Section XI.A.2.a.

b. [15.3] "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≤D1/D2≤about 1.2; and,"

[15.4] ***"$1.2\ g/cm^3 \leq D2 \leq 1.8\ g/cm^3$."***

239. In my opinion, Su discloses these elements. *Supra* Section XI.A.2.b. For the reasons discussed above in Ground 3A, in my opinion a POSITA would have found it obvious to configure Zhou's cathode according to Su's Examples with a reasonable expectation of success. *Supra* Section XI.A.2.c. Zhou, Sunose, and Su are directed to analogous art—lithium-ion batteries, including those using non-aqueous electrolytes. *See* EX1014, ¶ [0006]; EX1010, Abstract, ¶¶ [0001]-[0011],

[0043], [Claim 3]; EX1012, Abstract, ¶¶ [0001]-[0003]. Like Zeng, Zhou also expresses a market demand for batteries with high energy density. EX1014, ¶¶ [0002]-[0005].

XVII. GROUNDS 4C, 5C, 6C: ZHOU AND KIM RENDER OBVIOUS CLAIMS 1-6, 12, 16-26; ZHOU/KIM AND SUNOSE RENDER OBVIOUS CLAIMS 13 AND 14; ZHOU/KIM AND SU RENDERS OBVIOUS CLAIM 15

240. For the reasons discussed above in Grounds 1C-3C, 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. *Supra* Section XIII.A.[9] Moreover, Zhou draws further attention to the advantage of the trinitrile HTCN:

> 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.

EX1014, ¶ [0059].

241. Zhou also discloses that EA can be substituted for PP in its examples. *Id.*, ¶ [0011]. 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

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[9] For all challenged claim elements other than Elements [1.4]/[12.4]/[20.4], I incorporate by reference my analysis for those claim elements in Grounds 1C-3C into corresponding Grounds 4C-6C.

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." EX1014, ¶ [0059].

242. For these additional reasons, in my opinion, Zhou/Kim, Zhou/Kim and Sunose, and Zhou/Kim and Su, render obvious the challenged claims.

XVIII. CONCLUSION

For these reasons, it is my opinion that the challenged claims of the ’910 Patent are unpatentable.

I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I could testify to the matters in this declaration competently if called upon to do so. I further declare 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 the Title 18 of the United States Code.

Date: January 3, 2025

Respectfully Submitted,

Brett Lucht

Brett Lucht, Ph.D.