

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 IPR2025-00722
U.S. Patent No. 11,799,131

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 11,799,131**

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	TECHNOLOGY BACKGROUND	3
	A. Lithium-ion Batteries	3
	B. Electrolyte Components Improving SEI Layer Stability	5
III.	STATEMENT OF PRECISE RELIEF REQUESTED	6
IV.	THE '131 PATENT	6
	A. Specification.....	6
	B. Prosecution History	9
	1. The '910 Patent.....	9
	2. '131 Patent	10
	3. Petitioner's prior art, obviousness arguments undercut the Examiner's reasons for allowance	11
	C. IPR2023-00586 ('363 Patent IPR).....	14
V.	POSITA	15
VI.	CLAIM CONSTRUCTION	15
VII.	IDENTIFICATION OF CHALLENGES AND PRIOR ART	16
VIII.	GROUND 1A: ZENG AND HIRAI RENDER OBVIOUS CLAIMS 14-17	18
	A. Overview of Zeng.....	18
	B. Independent Claim 14	25
	1. [14.pre].....	25
	2. [14.1].....	25

3.	[14.2].....	25
4.	[14.3].....	26
5.	[14.4]-[14.6].....	26
6.	[14.7].....	43
7.	[14.8].....	44
C.	Claim 15	44
1.	[15.1].....	44
D.	Claim 16	45
1.	[16.1].....	45
E.	Claim 17	46
1.	[17.1].....	46
IX.	GROUND 2A: ZENG AND HIRAI, FURTHER IN VIEW OF HAN, RENDER OBVIOUS CLAIM 15	46
A.	Claim 15	47
1.	Han discloses element [15.1]	47
2.	Rationale to combine Zeng/Hirai with Han.....	47
X.	FOUNDATIONS 1B, 2B: ZENG/HIRAI, FURTHER IN VIEW OF MATSUOKA, RENDER OBVIOUS CLAIMS 14-17, ZENG/HIRAI/HAN, FURTHER IN VIEW OF MATSUOKA, RENDER OBVIOUS CLAIM 15	51
A.	Overview of Matsuoka.....	51
B.	[14.7]	52
1.	Matsuoka discloses “a weight percentage of the propyl propionate is Z”.....	52
2.	Rationale to Combine	53

3.	The Zeng/Hirai/Matsuoka combination teaches or suggests the claims.....	56
XI.	GROUND 1C, 2C: ZENG/HIRAI, ZENG/HIRAI/MATSUOKA—FURTHER IN VIEW OF KIM-’268—RENDER OBVIOUS CLAIMS 14-17; ZENG/HIRAI/HAN, ZENG/HIRAI/MATSUOKA/HAN—FURTHER IN VIEW OF KIM-’268—RENDER OBVIOUS CLAIM 15.....	57
XII.	GROUND 3A: ZHOU AND HIRAI RENDER OBVIOUS CLAIMS 14-17.....	62
A.	Overview of Zhou	62
B.	Independent Claim 14	67
1.	[14.pre].....	67
2.	[14.1].....	67
3.	[14.2].....	68
4.	[14.3].....	72
5.	[14.4]-[14.6].....	72
6.	[14.7].....	74
7.	[14.8].....	74
C.	Claim 15	74
1.	[15.1].....	74
D.	Claim 16	74
1.	[16.1].....	74
E.	Claim 17	75
1.	[17.1].....	75
XIII.	GROUND 4A: ZHOU AND HIRAI, FURTHER IN VIEW OF HAN, RENDER OBVIOUS CLAIM 15.....	75

XIV. GROUNDS 3C, 4C: ZHOU/HIRAI, FURTHER IN VIEW OF KIM- '268, RENDER OBVIOUS CLAIMS 14-17; ZHOU/HIRAI/HAN, FURTHER IN VIEW OF KIM-'268, RENDER OBVIOUS CLAIM 15	75
XV. NO SECONDARY CONSIDERATIONS	76
XVI. INSTITUTION IS APPROPRIATE	76
XVII. GROUNDS FOR STANDING.....	78
XVIII. MANDATORY NOTICES (37 C.F.R. §42.8(A)(1))	78
XIX. CONCLUSION	80

TABLE OF AUTHORITIES

Page(s)

Cases

<i>Apple Inc. v. Fintiv, Inc.</i> , IPR2020-00019, Paper 11 (PTAB Mar. 20, 2020).....	78
<i>In re Baxter Travenol Labs.</i> , 952 F.2d 388 (Fed. Cir. 1991)	2
<i>KSR Int’l Co. v. Teleflex Inc.</i> , 550 U.S. 398 (2007).....	38, 48
<i>Osteomed LLC v. Stryker Eur. Operations Holdings LLC</i> , IPR2022-00487, Paper 8 (PTAB Aug. 12, 2022).....	77
<i>In re Peterson</i> , 315 F.3d 1325 (Fed. Cir. 2003)	43, 45, 57
<i>Sci. Design Co. v. Shell Oil Co.</i> , IPR2022-00158, Paper 7 (PTAB Apr. 4, 2022)	77
<i>Sotera Wireless, Inc. v. Masimo Corp.</i> , IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020)	78
<i>In re Stepan Co.</i> , 868 F.3d 1342 (Fed. Cir. 2017)	22, 65
<i>Titanium Metals Corp. v. Banner</i> , 778 F.2d 775 (Fed. Cir. 1985)	44, 57, 72

Statutes

35 U.S.C. §282(b)	15
-------------------------	----

Other Authorities

37 C.F.R. §42.6	81, 82
37 C.F.R. §42.8	78, 79, 80
37 C.F.R. §42.24	81

37 C.F.R. §42.100	15
37 C.F.R. §42.105	82
MPEP §2143.I.....	<i>passim</i>

EXHIBIT LIST

<u>Exhibit No.</u>	<u>Description</u>
1001	U.S. Patent No. 11,799,131 (“the ’131 Patent”)
1002	Prosecution history of U.S. Patent No. 11,799,131 (“the ’131 Patent file history”)
1003	Declaration of Dr. Brett Lucht, Ph.D.
1004	<i>Curriculum Vitae</i> of Dr. Brett Lucht, Ph.D.
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 A1 to Kim et al. (“Kim-’268”)
1009	U.S. Patent Application Publication No. 2013/0302685 A1 to Kim et al. (“Kim-’685”)
1010	U.S. Patent Application Publication No. 2015/0017542 A1 to Hirai et al. (“Hirai”)
1011	Japan Patent Application No. JP 2018-78052 A to Han et al. (“Han”)
1012	Certified English Translation of Japan Patent Application No. JP 2018-78052 A to Han et al. (“Han”)
1013	China Patent Application Publication No. CN 105552439 A to Zhou et al. (“Zhou”)
1014	Certified English Translation of China Patent Application Publication 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 <i>Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.</i> , IPR2023-00586 (PTAB Feb. 23, 2023)

<u>Exhibit No.</u>	<u>Description</u>
1017	Decision Denying Institution (Paper 14) in <i>Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.</i> , IPR2023-00586 (PTAB Aug. 18, 2023)
1018	National Library of Medicine PubChem Pages
1019	Millipore Sigma data sheets for ethylene carbonate (EC), propylene carbonate (PC), ethyl propionate (EP), propyl propionate (PP), diethyl carbonate, and fluorobenzene
1020	TCI America page for 1,3,6-Hexanetricarbonitrile
1021	Complaint, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:24-cv-00728-JRG (E.D. Tex. Sept. 6, 2024), ECF 1.
1022	Reserved
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”)
1026	Prosecution history of U.S. Patent No. 11,769,910 (“the ’910 Patent file history”)
1027	Alleged Infringement Claim Chart for ’131 Patent
1028	Second Amended Complaint for Patent Infringement, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:24-cv-00728-JRG (E.D. Tex. Jan. 28, 2025), ECF 23.

CLAIMS APPENDIX

Claim Element	Language
Claim 14	
[14.pre]	<i>An electrochemical device, comprising:</i>
[14.1]	<i>electrodes; and</i>
[14.2]	<i>an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate;</i>
[14.3]	<i>wherein, based on a total weight of the electrolyte, a weight percentage of the dinitrile compound is X, and a weight percentage of the trinitrile compound is Y; wherein, about 2 wt %$\leq(X+Y)\leq$about 8 wt %, and about 0.1$\leq(X/Y)\leq$about 6;</i>
[14.4]	<i>wherein, the electrodes comprise a first electrode and a second electrode,</i>
[14.5]	<i>wherein the first electrode comprises a first current collector and a single-sided coating; the second electrode comprises a second current collector and a double-sided coating; and</i>
[14.6]	<i>an electrode compaction density of the first electrode comprising the single-sided coating is D1, and, an electrode compaction density of the second electrode comprising the double-sided coating is D2, wherein, about 0.8$\leq D1/D2\leq$about 1.2;</i>
[14.7]	<i>wherein based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z; wherein, about 0.01$\leq(Y/Z)\leq$about 0.3;</i>

Claim Element	Language
[14.8]	wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof.
Claim 15	
[15.1]	The electrochemical device according to claim 14, wherein the first electrode is a cathode, the second electrode is a cathode, and $3.5 \text{ g/cm}^3 \leq D_2 \leq 4.3 \text{ g/cm}^3$.
Claim 16	
[16.1]	The electrochemical device according to claim 14, wherein the first electrode is an anode, the second electrode is an anode, and $1.2 \text{ g/cm}^3 \leq D_2 \leq 1.8 \text{ g/cm}^3$.

Claim Element	Language
Claim 17	
[17.1]	<i>The electrochemical device according to claim 14, wherein the dinitrile compound is one selected from the group consisting of butanedinitrile, glutaronitrile, adiponitrile, 1,5-dicyanopentane, 1,6-dicyanohexane, 1,7-dicyanoheptane, 1,8-dicyanooctane, 1,9-dicyanononane, 1,10-dicyanodecane, 1,12-dicyanododecane, tetramethylbutanedinitrile, 2-methylglutaronitrile, 2,4-dimethylglutaronitrile, 2,2,4,4-tetramethylglutaronitrile, 1,4-dicyanopentane, 2,6-dicyanoheptane, 2,7-dicyanooctane, 2,8-dicyanononane, 1,6-dicyanodecane, 1,2-dicyanobenzene, 1,3-dicyanobenzene, 1,4-dicyanobenzene, 3,5-dioxa-pimelonitrile, 1,4-bis(cyanoethoxy)butane, ethylene glycol bis(2-cyanoethyl)ether, diethylene glycol bis(2-cyanoethyl)ether, triethylene glycol bis(2-cyanoethyl)ether, tetraethylene glycol bis(2-cyanoethyl)ether, 3,6,9,12,15,18-hexaoxaeicosanoic dinitrile, 1,3-bis(2-cyanoethoxy)propane, 1,4-bis(2-cyanoethoxy)butane, 1,5-bis(2-cyanoethoxy)pentane, ethylene glycol bis(4-cyanobutyl)ether, 1,4-dicyano-2-butene, 1,4-dicyano-2-methyl-2-butene, 1,4-dicyano-2-ethyl-2-butene, 1,4-dicyano-2,3-dimethyl-2-butene, 1,4-dicyano-2,3-diethyl-2-butene, 1,6-dicyano-3-hexene, 1,6-dicyano-2-methyl-3-hexene, 1,6-dicyano-2-methyl-5-methyl-3-hexene, and any combination thereof.</i>

Zhuhai CosMX Battery Co., Ltd (“Petitioner”) requests *inter partes* of claims 14-17 (“the Challenged Claims”) of U.S. Patent No. 11,799,131 (“the ’131 Patent”) (EX1001), assigned to Patent Owner Ningde Amperex Technology Limited (“PO”).

I. INTRODUCTION

The Challenged Claims¹ recite an electrochemical device (e.g., battery) having a known (1) electrolyte composition; and (2) electrode structure. But the electrolyte compositions (and similar electrolytes) were already known to deliver the purported benefits identified in the specification. For lithium-ion batteries, the ’131 Patent electrolytes purportedly improve electrode stability and battery performance. Those electrolytes contain: (1) a dinitrile (a compound having two nitrile, or cyano (-CN), groups); (2) trinitrile (a compound having three nitrile groups); and (3) propyl propionate (“PP”). The ’131 Patent claims recite broad ranges having as parameters weight percentage ranges for the dinitrile (X wt%), trinitrile (Y wt%), and propyl propionate (Z wt%) in the total electrolyte—specifically, ranges for $X+Y$, X/Y , and Y/Z .

¹ Petitioner filed a parallel Petition challenging claims 1-7, 12, and 14-17 of the ’131 Patent on January 28, 2025 (IPR2025-00431) and provides a ranking document for the two Petitions.

But all three were stock compounds of known electrolytes, as the prosecution history confirms. The Examiner rejected the claims over art disclosing the claimed ranges until Applicant amended the range limits to narrowly avoid prior art.

Petitioner presents prior electrolytes disclosing dinitrile (X), trinitrile (Y), and PP (Z) values satisfying the claimed ranges. EX1006; EX1014. The '131 Patent cites no criticality in its $X+Y$, X/Y , and Y/Z ranges to differentiate from prior art electrolytes with the same/similar parameters and delivering the same benefits. The Patent adds nothing to the art warranting the broad patent protection sought.

Long before the '131 Patent, prior art electrolytes achieved the '131 Patent's purported benefits of durable cathode films that improve storage/cycling performance. They also showed that adding trinitrile and PP to dinitrile-based electrolytes, and adjusting their relative proportions in the electrolyte, enhances performance. EX1007; EX1008. So, the known electrolytes had the same benefits claimed by the '131 Patent years before the priority date, confirming unpatentability of the Challenged Claims. *In re Baxter Travenol Labs.*, 952 F.2d 388, 392 (Fed. Cir. 1991) ("Mere recognition of latent properties in the prior art does not render nonobvious an otherwise known invention.").

Regarding electrode configuration, the Challenged Claims recite single- and double-sided coatings for respective first and second electrodes that have about the same compaction densities—the ratio of $D1/D2$ ranges from 0.8 to 1.2—which the

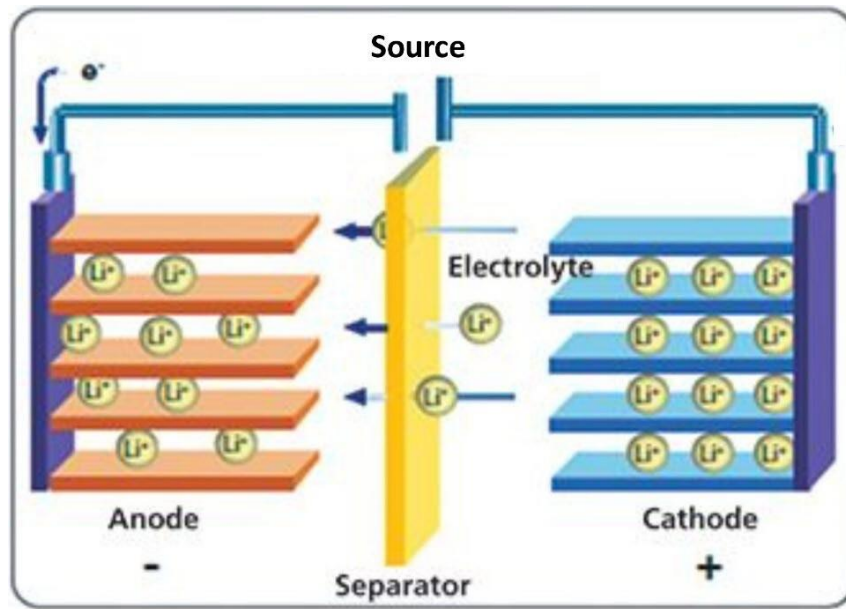
'131 Patent touts as inventive. But this was neither new nor innovative. Indeed, the electrode structure did not factor into the Examiner's reasons for allowance. For good reason: the prior art discloses the same structures and compaction density ratios in both cathodes and anodes. EX1010; EX1012; EX1009.

II. TECHNOLOGY BACKGROUND

A. Lithium-ion Batteries

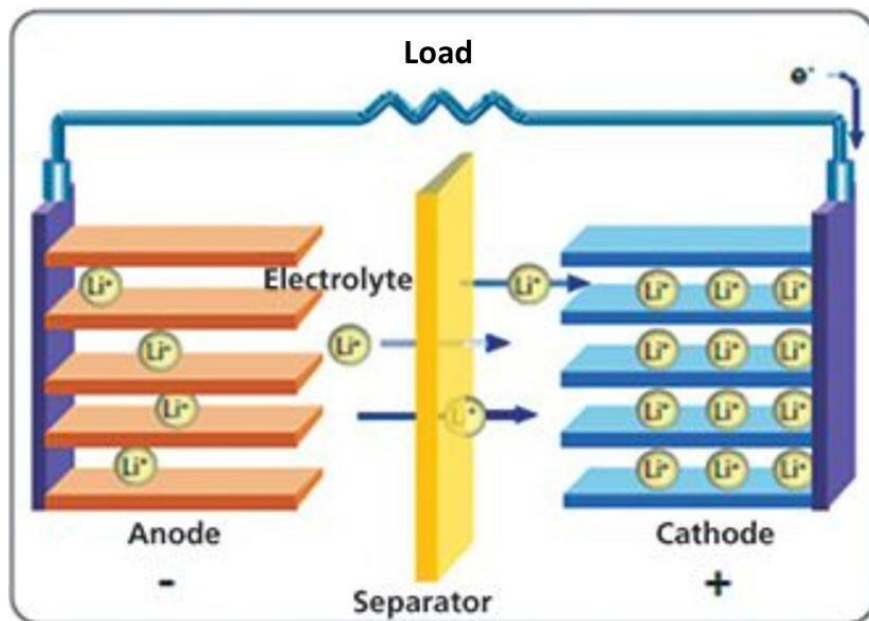
Lithium-ion batteries' high energy density makes them preferred power sources for electronic devices. EX1006, ¶¶[0002]-[0006]. They have cathode and anode electrodes—each with an active material coating on its current collector, a separator between the electrodes preventing shorts, and an electrolyte including lithium salt, solvents, and additives to enable ion transfer. EX1003, ¶28.

During charging, an external power source drives electrons from cathode to anode through an external circuit, causing cathode lithium ions to move to the anode through the electrolyte and combine with the electrons to store electrochemical potential between the electrodes. *Id.*, ¶29.



EX1003, ¶29

During discharge, the stored electrochemical potential drives electrons from anode to cathode through an external load, causing anode lithium ions to move through the electrolyte to the cathode where they recombine with the electrons. EX1003, ¶30.



EX1003, ¶30

One charge-discharge sequence is a “cycle.” Unlike primary batteries, rechargeable lithium-ion and other secondary batteries can cycle many times. EX1003, ¶31.

B. Electrolyte Components Improving SEI Layer Stability

The electrolyte must stay stable to support ion transport. The solid electrolyte interphase (SEI) layer, formed by initial electrolyte decomposition, prevents further decomposition in later cycles. It conducts ions but not electrons. EX1003, ¶32.

SEI layer stability is critical for higher-power lithium-ion batteries. EX1006, ¶¶[0003]-[0005]; EX1014, ¶¶[0001]-[0005], [0008]; EX1008, ¶¶[0001]-[0007]. Before the '131 Patent, electrolytes with dinitrile (X), trinitrile (Y), and PP (Z)

improved SEI stability. EX1006, ¶¶[0037], [0049]; EX1014, ¶¶[0058]-[0059]; EX1008, ¶¶[0014], [0040], [0090]-[0104] (Table 2), Claim 3; EX1003, ¶33.

III. STATEMENT OF PRECISE RELIEF REQUESTED

Petitioner requests IPR and cancellation of Challenged Claims 14-17 of the '131 Patent under §103.

IV. THE '131 PATENT

The '131 Patent issued October 24, 2023 from Application No. 17/885,920, claiming priority to China Application 201811108529.X filed September 21, 2018. EX1001.

A. Specification

The '131 Patent describes known lithium-ion battery electrolyte compositions and electrode structures. EX1003, ¶34.

- **Electrolyte**

The '131 Patent observes, “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, 1:32-37. It proposes a conventional solution: electrolyte compositions “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.*, 1:56-59; EX1003, ¶35.

The ’131 Patent discloses various weight percentages of dinitrile (X), trinitrile (Y), and PP (Z)—based on the electrolyte’s total weight—that purportedly form a durable SEI film. EX1001, 6:1-33. It provides Formulas in which $X+Y$, X/Y , Z , and Y/Z fall within broad ranges, mentioning different upper and lower limits for each throughout the description. *Id.*, Abstract, 6:1-55, 22:63-27:51. The ’131 Patent specifies no criticality to any particular set of upper/lower limits for these ranges. The ’131 Patent measured electrolyte performance based on inhibiting rise in internal resistance, reducing expansion rate, and maintaining voltage capacity during high-temperature storage and cycling (after 200 and 400 cycles). EX1001, 23:32-32:58; EX1003, ¶¶36-37.

- **Electrode Coatings**

“The electrode includes a current collector and a coating on the current collector” that “includes a single-sided coating, a double-sided coating, or a combination thereof.” EX1001, 20:17-20. Relevant to the Challenged Claims, the

embodiment of Figures 2 and 3 of the '131 Patent includes an electrode A with “coating 2...only present on one surface of the current collector” and an electrode B has “coating 2...present on two opposite surfaces of the current collector”. EX1001, 20:24-33, FIGS. 2-3 (reproduced at right)². This is for “a *laminated* electrochemical device,” where “the cathode and the anode are usually formed by laminating-shaped electrodes, and there is only a single-sided coating or a double-sided coating on the same electrode.” *Id.*, 20:44-48³; EX1003, ¶40.

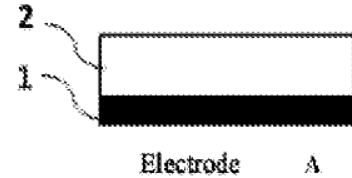


FIG. 2

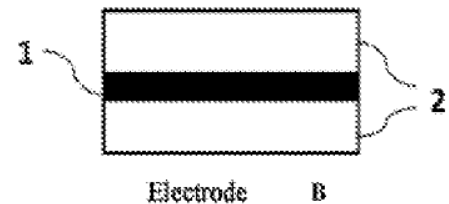


FIG. 3

The '131 Patent explains that “the electrode with a single-sided coating has an electrode compaction density D1,” the electrode “with a double-sided coating has an electrode compaction density D2,” and controlling the ratio D1/D2 results in good battery performance. *Id.*, 21:10-37. When D1 and D2 are about the same, i.e., “about

² The '131 Patent describes another embodiment where each electrode has a portion with a single-sided coating and a portion with a double-sided coating. EX1001, 20:34-41, FIG. 4.

³ Unless otherwise specified, all emphasis is added.

0.8≤D1/D2≤about 1.2” (the claimed range), “the electrode can obtain good electrical conductivity, which...control[s] the expansion of electrochemical devices” and delivers “high capacity density and excellent cycle and storage performances.” *Id.*, 21:10-20; EX1003, ¶39.

Claim 14 recites an electrochemical device incorporating an electrolyte adhering to broad ranges for $X+Y$, X/Y , and Y/Z . The device includes first and second electrodes with respective single- and double-sided coatings, where about 0.8≤D1/D2≤about 1. EX1001, 35:43-36:24; EX1003, ¶41.

B. Prosecution History

1. The '910 Patent

The '910 Patent claims recite dinitrile-, trinitrile- and PP-based electrolytes, but such compositions were known and cited against them during prosecution. EX1003, ¶43. In Application No. 18/076,882 (now the '910 Patent), Applicant overcame Hong prior art rejections by amending the independent claims to exclude 20-30 wt% from the original 5-50 wt% Z range⁴ to avoid Hong's (EX1015) disclosed electrolyte having 25% PP and otherwise satisfying the claim elements. EX1026, 27-30, 56-77, 194-209.

⁴ '131 Patent claim 7 recites the original claimed Z range of the '910 Patent—5 wt%-50 wt%.

2. '131 Patent

The '920 Application (now the '131 Patent) prosecution confirmed dinitrile-, trinitrile-, and PP-based electrolytes were unpatentable over prior art. In a first Action, the claims were rejected for double patenting and obviousness over Hong (EX1015) and Ohashi (EX1023), citing Hong for the electrolyte elements and Ohashi for the electrode details. EX1002, 97-112. Ohashi (EX1023) discloses electrode compaction densities ranging from 1 g/cm³-2.2 g/cm³, but Applicant argued Ohashi's electrode has a one-sided coating only. EX1002, 62-63; EX1023, ¶[0180]; EX1003, ¶45.

Following an Examiner Interview, EX1002, 50-66, 87, Applicant amended independent claims 1 and 16 (now 14) to:

- reduce the upper limit of the $X+Y$ range from 11 wt% to 8 wt%;
- reduce the upper limit of the X/Y range from 8 to 6;
- add a previously-unrecited range for Y/Z ;
- add a *Markush* group of permissible trinitriles; and
- clarify that $D1$ and $D2$ are compaction densities for the single- and a double-sided coatings, respectively.

Id., 73-95; EX1003, ¶46.

Regarding the electrolyte aspects, Applicant argued Hong’s Examples had trinitriles “not included within the Markush group specified in [the independent] claims[.]” EX1002, 91. Also, Hong purportedly did not expressly disclose the weight percentages of Y, Z, or the organic solvent based on the *electrolyte’s total weight*. *Id.*, 92; EX1003, ¶47.

And Applicant argued that neither Hong nor Ohashi disclosed electrodes having both single- and double-sided active material coatings. EX1002, 90. The Examiner allowed the claims, focusing on the amended electrolyte component ranges—not the electrode structure—in the reasons for allowance. *Id.*, 30 (“none disclose nor render obvious the electrolyte having the *specific* organic compounds at the *explicit* amounts and ratios as set forth in the claims”), 23-31. This matches the Examiner’s interview summary: “Applicant argues prior art does not disclose *amended ranges of materials & compounds* of proposed amendments,” which “appears persuasive.” *Id.*, 51; EX1003, ¶49.

3. Petitioner’s prior art, obviousness arguments undercut the Examiner’s reasons for allowance

• **Zeng**

Zeng discloses the specific compounds, amounts, and ratios recited in the Challenged Claims. Embodiments 4 and 6 disclose electrolytes including both a

dinitrile and a trinitrile (1,3,6-hexanetricarbonitrile) permitted by the recited Markush group, as well as PP. *Infra* Sections VIII.A, VIII.B; EX1003, ¶51.

Improving over Hong, Zeng discloses the weight percentage of the solvent plus LiPF_6 based on the electrolyte's total weight. Embodiments 4 and 6 specify the weight percentages of all remaining additives, including for the trinitrile (Y), based on the electrolyte's total weight. *Infra* Section VIII.A (11.7 wt% and 11.5 wt% respectively); EX1003, ¶52. Thus, the total weight of the solvent and LiPF_6 is simply $100\text{wt}\% - 11.7\text{ wt}\% = 88.3\text{ wt}\%$ and $100\text{wt}\% - 11.5\text{ wt}\% = 88.5\text{ wt}\%$ in Embodiments 4 and 6, respectively. *Id.*

Because PP is 20 wt% of the solvent before adding LiPF_6 and the remaining additives, Zeng suggests or renders obvious that PP constitutes less than $20\% \times 88.3\% = 17.66\text{ wt}\%$ and $20\% \times 88.5\% = 17.70\text{ wt}\%$ based on the total weight of the Embodiments 4 and 6 electrolytes, respectively. *Id.* Moreover, as explained below, diluting PP (i.e., reducing Z) to a value that pushes Y/Z outside the claimed range would create an atypical composition, inconsistent with Zeng's disclosure and lithium-ion batteries generally. *Infra* Section VIII.B.7; EX1003, ¶52.

- **Zhou**

Zhou's Example 8 electrolyte satisfies the Challenged Claims but has the carboxylic acid ester ethyl acetate (EA), instead of PP, at 16.56 wt% based on the electrolyte's total weight. Nevertheless, Zhou discloses PP is one of just a few well-

known and predictable substitutes for EA that would also facilitate ion-transport in the electrolyte. It would have been obvious to replace EA with PP in Example 8, arriving at the claimed subject matter. *Infra* Sections XII.A, XII.B.3; EX1003, ¶53.

- **Matsuoka and Kim-’268**

Matsuoka and Kim-’268 provide motivation to consider/modify the amount of PP (Z), and the trinitrile/PP ratio (Y/Z), to improve battery performance. *Infra* Sections X, XI; EX1003, ¶54. Matsuoka discloses preferred weight percentage ranges of the electrolyte’s total weight for non-nitrile electrolyte components—including PP, which Matsuoka touts to improve the SEI layer. *Id.* A person of ordinary skill in the art (“POSITA”) would simply select Matsuoka’s preferred PP weight as the weight percentage Z in Zeng’s or Zhou’s electrolytes. *Id.* Kim-’268 teaches that PP, combined with trinitrile, was a well-known electrolyte performance-enhancer. *Id.*

- **Hirai and Han**

Hirai’s and Han’s battery has the “laminated” electrode configuration purportedly absent in Hong and Ohashi. *Infra* Sections VIII.B.6; IX; EX1003, ¶55. The references describe different aspects of the same battery having the electrode configuration of Figures 2 and 3 of the ’131 Patent—an electrode stack including a first (outermost) electrode with a single-sided active layer coating and a second (inner) electrode with a double-sided active layer coating, where both electrodes

have about the same compaction density. Han also teaches the specific double-sided coating density D_2 recited in claim 15. A POSITA would have used Hirai's and Han's advantageous battery structure and compaction densities for Zeng's and Zhou's electrochemical devices—which are not limited by battery construction. *Id.*

- **Petitioner's references and arguments were not substantively evaluated**

Zeng and Zhou were not meaningfully evaluated or applied in rejection during prosecution. Applicant only provided English Abstracts of Zeng and Zhou in a long IDS during prosecution of the '882 Application. EX1002, 184-191. But the Abstracts alone lack sufficient information to determine patentability of the '131 Patent claims. Matsuoka, Hirai, and Han were not cited at all in original prosecution. EX1003, ¶56. Kim-'268 was only cited in an IDS and not substantively evaluated. EX1002, 186; EX1026, 383.

C. IPR2023-00586 ('363 Patent IPR)

The PTAB denied the '363 Patent IPR petition, rejecting three inherency assumptions in a Hong anticipation ground. EX1017, 10-12 (“(1) the total volume of the liquid components does not meaningfully change after mixing, (2) the solid components do not meaningfully contribute to the total volume of the electrolyte, and (3) [certain Hong] compounds are liquids at room temperature with a density of

0.60 g/cm³.”); EX1016. This Petition’s obviousness grounds require none of these assumptions. EX1003, ¶58.

V. POSITA

A POSITA of the ’131 Patent in September 2018 would have an advanced degree in chemistry, chemical engineering, materials science, or a related field, and two or more years of experience related to the design, research, evaluation, preparation, and/or manufacture of electrochemical energy storage devices. EX1003, ¶17; EX1001, 1:18-20. This skill level is approximate, and more experience could compensate for less formal education, and vice versa.

VI. CLAIM CONSTRUCTION

In IPR, claim terms receive their ordinary and customary meaning as understood by a POSITA at the time of the invention, in light of the specification and the prosecution history. 37 C.F.R. §42.100(b); 35 U.S.C. §282(b). No claim terms require express construction for purposes of granting this Petition. Petitioner notes, however, that the electrode structure recited in claims 14-16—including first and second electrodes respectively having single- and double-sided coatings—corresponds to ’131 Patent Figures 2 and 3, discussed above. *Compare* EX1001, claim 14 *with id.*, 20:24-33, FIGS. 2-3; EX1003, ¶60.

VII. IDENTIFICATION OF CHALLENGES AND PRIOR ART

Petitioner requests cancellation of '131 Patent claims 14-17 as obvious under §103:

Ground ⁵		Claims	References
Zeng Grounds			
1	A	14-17	• China Patent Application Publication No. CN 106099187A (“Zeng”, EX1005) • U.S. Patent Application Publication No. 2015/0017542 to Hirai et al. (“Hirai”, EX1010)
	B		• Zeng • Hirai • U.S. Patent Application Publication No. 2013/0224535 A1 (“Matsuoka”, EX1007)
	C		• Zeng; Zeng/Matsuoka • Hirai • U.S. Patent Application Publication No. 2017/0288268 A1 (“Kim-’268”, EX1008)
2	A	15	• Zeng • Hirai • Japan Patent Application No. JP 2018-78052 A to Han et al. (“Han,” EX1012)

⁵ The A Grounds identify the base reference combinations: **Ground 1:** Zeng and Hirai; **Ground 2:** Zeng, Hirai, and Han; **Ground 3:** Zhou and Hirai; and **Ground 4:** Zhou, Hirai, and Han. The B Grounds add Matsuoka to the base combinations (for Zeng Grounds 1 and 2). The C Grounds further add Kim ’268 to the base combinations.

	B		• Zeng • Hirai • Matsuoka • Han
	C		• Zeng; Zeng/Matsuoka • Hirai • Kim-’268 • Han
Zhou Grounds			
3	A	14-17	• China Patent Application Publication No. CN 105552439 A (“Zhou”, EX1014) • Hirai
	C		• Zhou • Hirai • Kim-’268
4	A	15	• Zhou • Hirai • Han
	C		• Zhou • Hirai • Kim-’268 • Han

Petitioner’s references are U.S. and foreign patent documents qualifying as prior art under §§102(a)(1) and/or 102(a)(2) even if the ’131 Patent enjoys its earliest claimed priority date of September 21, 2018.

- **Zeng:** China patent application filed July 13, 2016 and published November 9, 2016. EX1006.

- **Hirai:** U.S. patent application filed in 2013 and published in 2015. EX1010.
- **Matsuoka:** U.S. patent application filed in 2011 and published in 2013. EX1007.
- **Kim-’268:** U.S. patent application filed in 2016 and published October 5, 2017. EX1008.
- **Zhou:** China patent application filed December 16, 2015; published May 4, 2016. EX1014.
- **Han:** Japan Patent Application published May 17, 2018. EX1012.

VIII. GROUND 1A: ZENG AND HIRAI RENDER OBVIOUS CLAIMS 14-17

A. Overview of Zeng

Zeng describes “a wide-temperature-range homogeneous non-aqueous electrolyte solution that has good lithium ion transport properties, electrode plate wettability, and interfacial compatibility.” EX1006, ¶[0009]. Zeng Embodiments 4 and 6 render obvious the Challenged Claims. EX1006, ¶¶[0045]-[0049]; EX1003, ¶¶62-80.

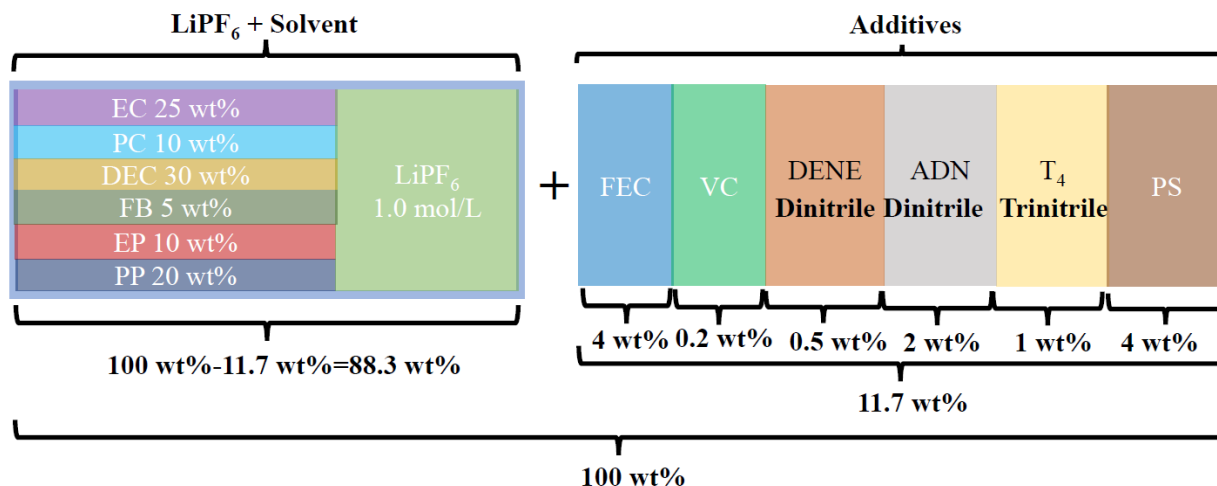
They have adiponitrile (ADN) and 1,2-bis(2-cyanoethoxy)ethane (DENE, “T2”) as the claimed *dinitrile* and 1,3,6-hexanetricarbonitrile (HTCN, “T4”) as the claimed *trinitrile*. EX1006, ¶¶[0037], [0044]-[0049] (Table). They also include 20 wt% PP in the solvent mixture *before* adding LiPF₆ and the remaining additives—in

specified weight percentages based on the *total weight of the electrolyte*.⁶ *Id.*; EX1003, ¶¶66-69. This suggests or renders obvious that Zeng Embodiments 4 and 6 have *less than 20 wt% PP* based on the total weight of the electrolyte after these remaining components are mixed in the solvent to form the final electrolyte. EX1003, ¶¶66-69.

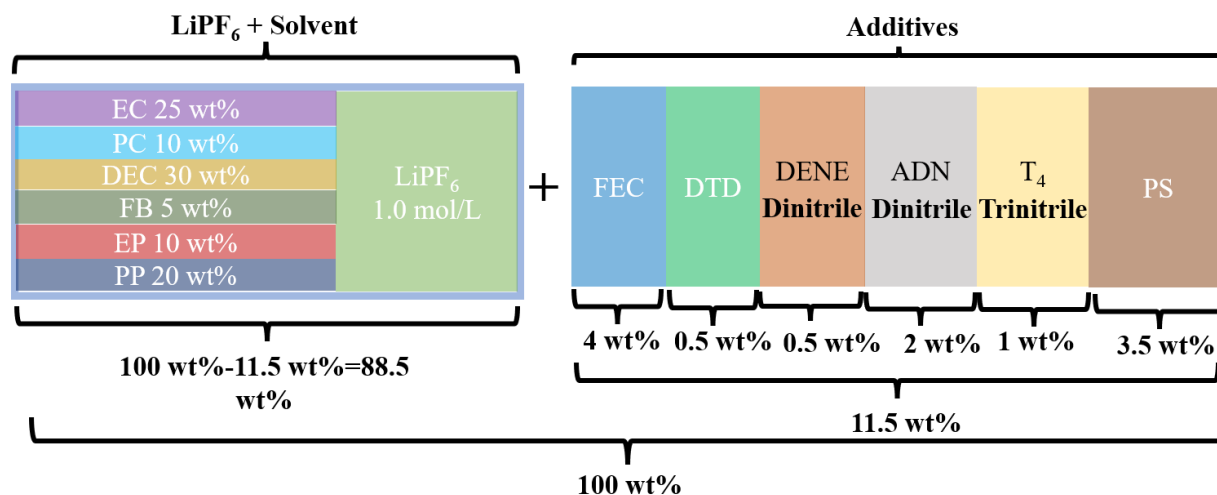
⁶ When describing the step of adding LiPF₆ to the solvent mixture, Zeng states that “then, lithium hexafluorophosphate of a concentration of 1.0 mol/L is slowly added to the mixed solution[.]” EX1006, ¶[0037]. As Dr. Lucht explains, a POSITA would understand this to mean adding (solid) LiPF₆ to the specified EC:PC:DEC:FB:EP:PP solvent mixture to reach a concentration of 1.0 mol/L LiPF₆. EX1003, ¶66, n.6. While LiPF₆ is commercially available premixed in different solvents to different concentrations, Zeng already discloses a solvent mixture for its electrolytes. In such cases, it is standard practice to mix LiPF₆ in the specified solvent mixture to a target concentration (usually around 1 mol/L)—not add LiPF₆, premixed in a second solvent mixture, to that solvent mixture. *See, e.g., id.*; EX1023, ¶¶[0237], [0245], [0255]; EX1024, ¶[0048], EX1025, ¶[0090]. Beyond rendering the ultimate concentration of LiPF₆ and amounts of the solvent components uncertain, this would disrupt the carefully-crafted solvent and additive weight percentages central to Zeng’s invention. EX1003, ¶66, n.6.

Zeng Embodiments 4 and 6 have the following compositions:

Embodiment 4 of Zeng



Embodiment 6 of Zeng



EX1003, ¶¶66-69; EX1006, ¶¶[0037], [0044]-[0049] (Table)⁷

⁷ EC: ethylene carbonate; PC: propylene carbonate; DEC: diethyl carbonate, FB: fluorobenzene; EP: ethyl propionate; FEC: fluoroethylene carbonate; DTD: ethylene sulfate; PS: propane sultone. EX1006, ¶¶[0037], [0049].

Weight percentage ADN, DENE (*dinitrile*) in the total electrolyte: ADN and DENE are *dinitriles* because they have two nitrile groups. EX1018, 1, 318. In both Embodiments, ADN and DENE have a combined weight percentage (the claimed X) of $2 \text{ wt\%} + 0.5 \text{ wt\%} = 2.5 \text{ wt\%}$ of the total electrolyte. EX1003, ¶71.

Weight percentage HTCEN (*trinitrile*) in the total electrolyte: HTCEN (T4) is a *trinitrile* because it has three nitrile groups. EX1018, 100; EX1020. HTCEN has a weight percentage (the claimed Y) of 1 wt% of the total electrolyte. EX1003, ¶72.

Weight percentage PP in the total electrolyte: Unlike Hong, Zeng explains the additives alone must total 11.7 wt% and 11.5 wt% based on the total weight of the Embodiments 4 and 6 electrolytes, respectively. Thus, a POSITA would know or find obvious that the solvent and LiPF_6 portion constitutes $100 \text{ wt\%} - 11.7 \text{ wt\%} = 88.3 \text{ wt\%}$ and $100 \text{ wt\%} - 11.5 \text{ wt\%} = 88.5 \text{ wt\%}$ based on the electrolyte's total weight in Embodiments 4 and 6, respectively. EX1003, ¶73.

Because PP is 20 wt% of the solvent, PP would therefore have a weight percentage in the total electrolyte of $88.3\% \times (20 / (25 + 10 + 30 + 5 + 10 + 20)) = 17.66 \text{ wt\%}$ in Embodiment 4 and $88.5\% \times (20 / (25 + 10 + 30 + 5 + 10 + 20)) = 17.70 \text{ wt\%}$ in Embodiment 6, assuming LiPF_6 has zero weight. Since LiPF_6 has some weight, however, a POSITA would know or find obvious that PP constitutes less than 17.66 wt% and less than 17.70 wt% based on the total weight of the Embodiments 4 and 6 electrolytes, respectively, with LiPF_6 added. *Id.*

Moreover, as explained below, PP could not be diluted (i.e., Z could not be reduced) to a value that removes Embodiments 4 and 6 from the scope of the Challenged Claims without producing an atypical solution inconsistent with Zeng’s disclosure and lithium-ion batteries generally. EX1003, ¶¶74-78; EX1019, 2, 12, 20, 29, 36, 45.

To summarize, the claimed X, Y, and Z have the following values in the total Zeng electrolytes.

Embodiment	X (ADN and DENE)	Y (HTCN)	Z (PP)
4	2.5 wt%	1 wt%	<17.66 wt%
6	2.5 wt%	1 wt%	<17.70 wt%

EX1003, ¶79.

Zeng Embodiments 4 and 6 improved high-voltage cycling performance of lithium-ion batteries, showing increased capacity retention over the Comparative Examples. *Id.*; EX1006, ¶¶[0045]-[0047].

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

Relying on Zeng Embodiments 4 and 6 does not involve “selecting from large lists of elements in a single reference” as a single embodiment rendering the Challenged Claims unpatentable. *Contra In re Stepan Co.*, 868 F.3d 1342, 1346 n.1 (Fed. Cir. 2017). Each Zeng Embodiment is a self-contained, working example

providing a complete list of compounds, amounts, and electrolyte preparation instructions. EX1003, ¶80.

Nonetheless, a POSITA would have been motivated to implement Zeng Embodiments 4 and 6 with a reasonable expectation of success. EX1003, ¶81. Embodiment 4 and 6 batteries significantly outperformed the Comparative Examples in capacity retention after 500 cycles. EX1006, ¶¶[0045]-[0047]. Except Embodiments 2 and 5, Embodiment 6 had the best capacity retention at 91.6% and Embodiment 4 had excellent capacity retention at 91.0%. *Id.* At a minimum, it would have been “obvious to try” Zeng Embodiments 4 and 6. MPEP §2143.I.E; EX1003, ¶¶81-82.

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 reduce electrolyte oxidation. *Id.*, ¶[0005]. But FEC decomposes at high temperatures, increasing battery expansion and internal resistance. *Id.* The industry then added organic nitriles to stabilize the electrode, but they have poor solubility in electrolyte solutions, limiting cycling 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...to ensure that a lithium-ion battery has good high-voltage cycle performance and can perform at high and low temperatures.” *Id.*, ¶[0008]; EX1003, ¶83.

Finite number of identified, predictable solutions: Zeng only discloses nine electrolyte solutions (Embodiments 1-9)—all demonstrating better capacity retention over 500 cycles and low-temperature performance than the Comparative Examples. EX1006, ¶¶[0044]-[0047] (Table 1). Embodiments 4 and 6 would have been considered strong options because they had excellent capacity retention at 91.6% and 91.0%, respectively. *Id.*; EX1003, ¶84.

Reasonable expectation of success: All Zeng Embodiments were tested successfully and outperformed the Comparative Examples. EX1006, ¶¶[0036]-[0053]; [0050] (Testing successfully showed “that the addition of FEC and ADN...improves the high-voltage cycling performance” and “capacity retention rate of the lithium-ion battery at 500 cycles of high voltage increases incrementally” with more FEC and ADN). Zeng provides detailed preparation instructions for the electrolytes. *Id.*, ¶¶[0036]-[0049]. The success of Zeng’s Embodiments and preparation instructions would have given a POSITA a reasonable expectation of success. EX1003, ¶85.

B. Independent Claim 14

1. [14.pre]⁸

Zeng's electrolytes were used in a lithium-ion secondary battery (*an electrochemical device*) as claimed. EX1006, Abstract, ¶¶[0028]-[0034], [0052]-[0053]; EX1003, ¶86. Zeng Embodiments 4 and 6 electrolytes, implemented in Zeng's lithium-ion battery, separately render the Challenged Claims unpatentable. EX1006, ¶¶[0046], [0049]; Section VIII.A.

2. [14.1]

Zeng teaches that its lithium-ion battery has a positive electrode (cathode) and a negative electrode (anode). EX1006, Abstract, ¶¶[0002]-[0009], [0028]-[0034], [0052]-[0053]. Indeed, by definition, all batteries, including lithium-ion batteries, have positive and negative *electrodes*, as claimed. Section II; EX1003, ¶87.

3. [14.2]

Zeng's Embodiments 4 and 6 electrolytes contain *a dinitrile compound* (ADN, DENE), *a trinitrile compound* (HTCN), *and PP*, as claimed. EX1018, 1, 318; EX1006, ¶¶[0037], [0044]-[0049] (Table 1); EX1003, ¶88; Section VIII.A.

⁸ The enclosed Claims Appendix includes the Challenged Claim language with bracketed reference numerals identifying respective Claim Elements referenced in this Petition.

4. [14.3]

X and Y and have the following values in Zeng's total electrolyte:

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

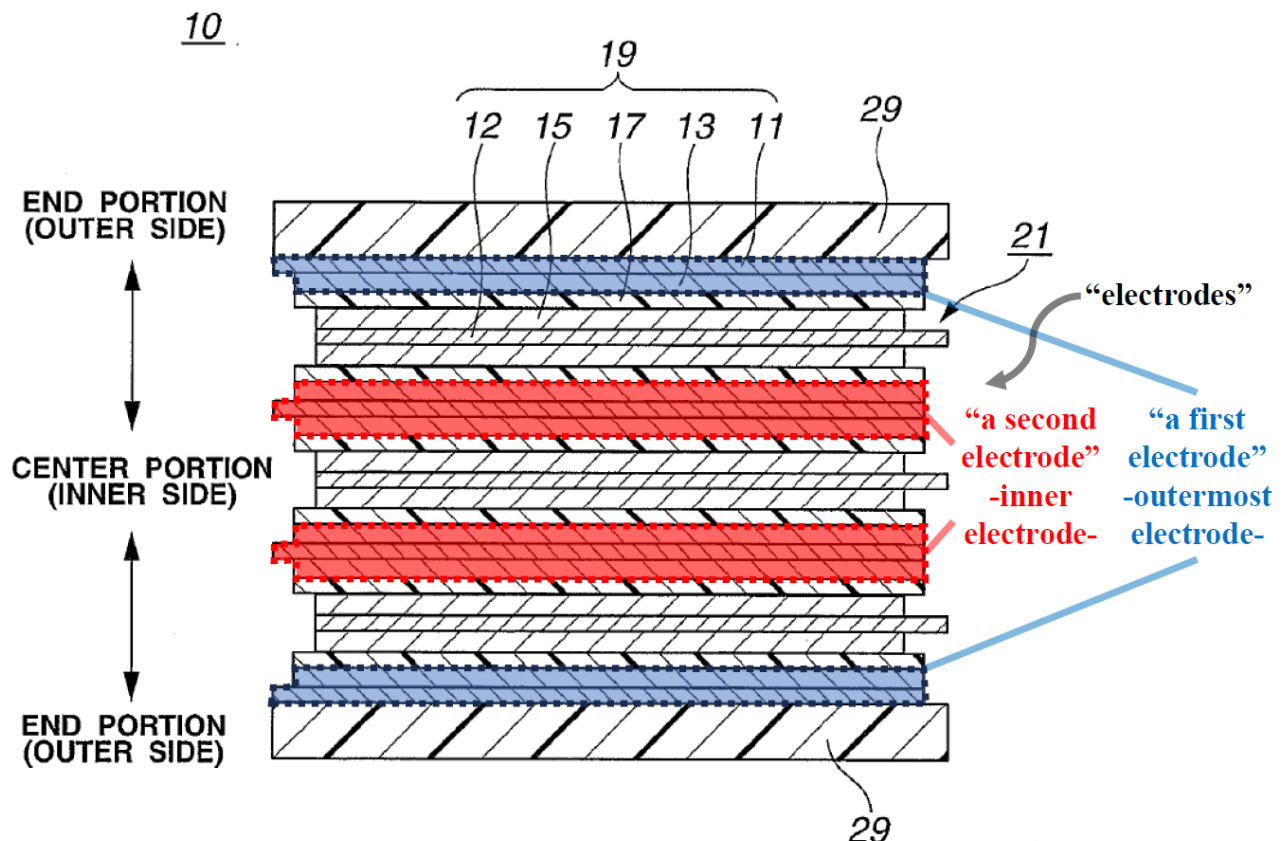
Section VIII.A. Thus, in both Embodiments, $X+Y=2.5\text{ wt\%}+1\text{ wt\%}=3.5\text{ wt\%}$, falling in the claimed range of about 2 wt% to about 8 wt%, and X/Y equals 2.5, falling in the claimed range of about 0.1 to about 6. EX1003, ¶89.

5. [14.4]-[14.6]

Zeng and Hirai render these elements obvious. EX1003, ¶90. Zeng's lithium-ion battery has *electrodes*—an anode and cathode. *Id.*, Sections II, VIII.B.2. But Zeng focuses on electrolyte compositions, not electrode structures, and thus does not describe the claimed electrode configuration having *a first electrode and a second electrode, wherein the first electrode comprises a first current collector and a single-sided coating and the second electrode comprises a second current collector and a double-sided coating*. But Hirai discloses the claimed electrode configuration, and it would have been obvious to combine Zeng and Hirai, with a reasonable expectation of success, to arrive at elements [14.4] and [14.5].

a. [14.4]

Hirai discloses a laminated-type lithium-ion battery 10 in which *electrodes* (rectangular power-generation electrode elements 21) comprise a *first electrode* (outermost electrode) and a *second electrode* (inner electrode). EX1003, ¶¶91-96.



Hirai, FIG. 2*

Hirai Figure 2 above shows a “laminated-type (flat-type) nonaqueous electrolyte lithium ion secondary battery.” EX1010, ¶[0024], Abstract. It “has at least a cathode, an anode, and an electrolyte layer...prepared by laminating at least three layers of single battery layers each prepared by opposing the cathode and the

anode to each other with an interposal of the electrolyte layer.” *Id.*, ¶[0019]. Specifically, the “laminated-structure battery 10...has a structure in which generally rectangular power generation elements 21, in which charge and discharge reactions...progress, are sealed up in the inside of battery cladding 29[.]” *Id.*, ¶[0024].

Hirai teaches electrode power output is temperature-dependent because the capacity of active material electrode coatings varies with temperature. *Id.*, ¶¶[0007], [0016], FIG. 3. Thus, and especially with larger batteries, the “large temperature difference between” the inner and outer portions of the battery causes uneven power output among the individual electrode elements. *Id.*, ¶¶[0006], [0007]. To offset this, Hirai configures the battery’s electrode elements 21 so the A/C ratio—the ratio of the charge/discharge capacity of the anode to the charge/discharge capacity of the cathode—is greater toward the center than toward the outer portion of the battery. *Id.*, ¶¶[0008]-[0013].

Electrodes: The stack of alternating cathodes and anodes (power generation elements 21) laminated within Hirai’s battery 10 correspond to the claimed *electrodes*. EX1010, ¶¶[0024]-[0028], FIG 2; EX1003, ¶94. Hirai teaches “power generation element 21 has a structure prepared by laminating a cathode, electrolyte layer 17, and an anode,” and the laminated-structure battery 10 includes multiple

power generation elements 21 stacked as individual battery layers or cells 19 and interconnected in parallel or in series. EX1010, ¶[0024].

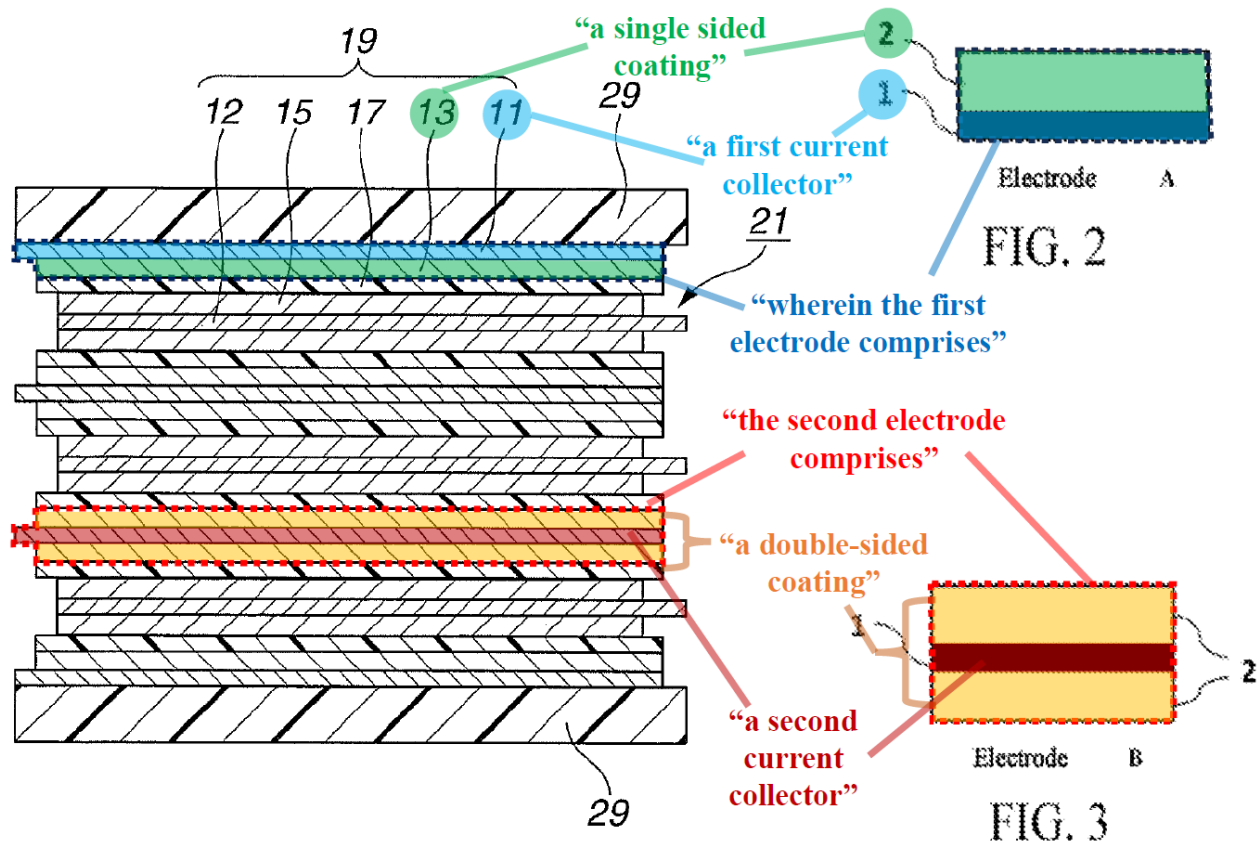
First electrode: Either of Hirai's outermost electrodes bordering battery cladding 29 (blue) corresponds to the claimed *first electrode*. EX1003, ¶95. Hirai explains the outermost electrodes can optionally be cathodes or anodes. EX1010, ¶[0025]. Thus, the stack of power generation elements 21 can be arranged such that either cathodes or anodes sit at the top and bottom (outermost) of the stack. EX1003, ¶95.

Second electrode: Any of Hirai's inner electrodes of the same type, cathode or anode, as the outermost electrodes (red) corresponds to the claimed *second electrode*. EX1010, ¶¶[0024]-[0025]; EX1003, ¶96. Referring to Hirai Figure 2 above, when the outermost electrodes (blue) are cathodes, the two inner electrodes (red) are cathodes and correspond to the claimed *second electrode*. Likewise, when the outermost electrodes (blue) are anodes, the two inner electrodes (red) are anodes and correspond to the claimed *second electrode*. EX1003, ¶96.

b. [14.5]

Hirai discloses that *the first electrode* (either of the outermost electrodes) comprises a *first current collector* (collector 11) and a *single-sided coating* (active material layer 13) and that *the second electrode* (either inner electrode of the same

type) comprises a second current collector (collector 13) and a double-sided coating (active material layers 15). EX1003, ¶97.



Hirai, FIG. 2*

'131 Patent, FIGS. 2-3*

First electrode: Hirai's outermost electrode corresponds to the claimed *first electrode*. EX1003, ¶98. Hirai's cathodes have a current collector 11 and one or more active material layers 13 coated on collector 11. EX1010, ¶[0024]. Regarding the outermost electrodes, and as illustrated above, Hirai explains that "cathode active material layers 13 are arranged on *only one surfaces of the outermost cathode collectors* positioned at both outermost layers of power generation element 21[.]"

Id., ¶[0025].⁹ Here, collector 11 (blue) of Hirai’s outermost electrode is the claimed *first current collector* and active material layer 13 (green), coated only on the bottom surface of collector 11, is the claimed *single-sided coating*. EX1003, ¶98.

Second electrode: Either of Hirai’s inner electrodes (red outline) of the same type as the outermost electrodes (blue outline) corresponds to the claimed *second electrode*. All Hirai’s inner electrodes have an active material layer (yellow) coated on *both* surfaces of the collector (red). Regarding the inner cathodes, “[t]he cathode has a structure in which cathode active material layers 13 have been arranged on *both surfaces* of cathode collector 11.” EX1010, ¶[0024]. Here, the collector of either inner cathode—including the one highlighted above—is the claimed *second current collector*, while its active material layer coating, on both surfaces of that collector, is the claimed *double-sided coating*. EX1003, ¶99.

⁹ In another Hirai embodiment, “it is optional to form the active material layers on both surfaces” of the outermost electrode. EX1010, ¶[0025]. “That is, it is optional to use a collector formed on its both surfaces with active material layers...[or] only one surface with an active material layer...for the outermost layer.” *Id.* As explained below, a POSITA would have used a *single-sided coating*, as claimed, on the outermost electrodes. EX1003, ¶98 n.8.

As mapped above, Hirai's battery has the same structure as the "laminating-shaped" electrode embodiment shown in Figures 2 and 3 of the '131 Patent. EX1001, 20:24-33, 44-53. EX1003, ¶100. Like Figure 2 of the '131 Patent, Hirai's outermost "electrode A includes a current collector 1 and a coating 2 on the current collector 1," and "the coating 2 is only present on one surface of the current collector, and...is a single-sided coating." EX1001, 20:24-28. And, like Figure 3 of the '131 Patent, Hirai's inner "electrode B includes a current collector 1 and a coating 2 on the current collector," and "the coating 2 is present on two opposite surfaces of the current collector,...and...is a double-sided coating." *Id.*, 20:29-33.

c. [14.6]

Hirai discloses two techniques for making the inner A/C ratio higher than the outer A/C ratio that involve selecting desired electrode densities (claimed *electrode compaction density*) of *about* $0.8 \leq D1/D2 \leq \text{about } 1.2$, as claimed: (1) the fifth means (e.g., Example 5); and (2) the sixth means (e.g., Example 6). EX1010, ¶¶[0066]-[0076]; EX1003, ¶101.

Hirai's "electrode density" discloses the claimed *electrode compaction density*. EX1003, ¶[101]. First, Hirai teaches that the desired electrode densities were obtained by "using a *roll press machine*" to adjust electrode thickness—i.e., by *compaction*. *Id.*, ¶¶[0243]-[0245], [0254]-[0256]. Second, Hirai teaches "electrode density" is "mass of the [cathode/anode] *active material*/volume of the

[cathode/anode] *active material* in the [cathode/anode] *active material* layer.” *Id.*, ¶¶[0068]-[0073], [0243]-[0245], [0254]-[0256]. Likewise, the compaction density formula in the ’131 Patent specification respectively subtracts the current collector’s weight and thickness from the electrode’s weight and thickness, leaving the density of the *active material* layer only. EX1001, 20:54-64. Thus, Hirai calculates electrode compaction density in the same way as the ’131 Patent. EX1003, ¶[101].

- **Fifth Means**

Hirai’s fifth means expressly teaches the claimed $D1/D2$. *Id.*, ¶102. It involves making the anode compaction density higher in the inner portion of the battery than in the outer portion, while using the same cathode compaction density in all layers. EX1010, ¶¶[0067]-[0070]; EX1003, ¶102.

Hirai teaches that if the center anode compaction density is 100%, then the outer anode compaction densities should be 87-97%, and preferably 88-96%. EX1010, ¶[0068]. Thus, in Hirai’s typical laminated structure (Figures 1-2), when the outermost electrode (blue) and corresponding inner electrode (red) are anodes, $D1/D2=0.87$ to 0.97 , and preferably 0.88 to 0.96 —both falling inside the claimed range. EX1003, ¶103. And since all cathodes have the same compaction density in the fifth means, $D1/D2=1$ when the outermost electrode (blue) and corresponding inner electrode (red) are cathodes. EX1010, ¶[0067]; EX1003, ¶103.

- **Example 5**

Hirai Example 5 further discloses or suggests the claimed $D1/D2$. EX1003, ¶104. Example 5 includes five (odd number) cells stacked together, so one of the outermost electrodes is an anode and the other is a cathode. EX1010, ¶[0251]; *see also id.*, ¶¶[0037], [0041] (a “cell” is a single anode or cathode battery layer); EX1003, ¶104.

In Example 5, the compaction densities of the center anode (K) and outermost anode (I) are 1.6 g/cm³ and 1.4 g/cm³, respectively:

	Anode I	Anode J	Anode K
Mass per unit area (mg/cm ²)	8.5	9.0	9.5
Anode electrode density (g/cm ³)	1.4	1.5	1.6

Hirai, ¶[0245] (Table 9)*

See also EX1010, ¶[0249] (Table 10 showing Anode K as lamination 3, the middle of the electrode stack; Anode I as the outermost anodes in laminations 1, 5). Thus, the anode $D1/D2=1.4/1.6=0.875$, falling in the claimed range. EX1003, ¶105. And the cathode compaction densities are all 3.2 g/cm³ in Example 5. EX1010, ¶[0243]. Thus, the cathode $D1/D2=1/1=1$, also falling within the claimed range. EX1003, ¶105.

While all electrodes (including the outermost electrodes) in Example 5 had a double-sided coating, EX1010, ¶¶[0243], [0245], a POSITA would have found it

obvious to alternatively use single-sided coatings on the outermost electrodes in accordance with Hirai's typical Figures 1-2 structure, with comparable results. EX1003, ¶106. The compaction density in Example 5 was intentionally controlled, and a single-sided coating would have been equally controllable. *Id.* To achieve consistent energy density, a POSITA would have controlled the single-sided coating to the same compaction density. *Id.* And to achieve Hirai's benefits through the fifth means, with a single-sided coating on the outermost electrode, a POSITA would have followed Hirai's teachings to use a lower comparative anode compaction density for the outer anode and to do so in a ratio of 0.87-0.97, and preferably 0.88-0.96—both falling inside the claimed range. *Id.*

- **Sixth Means**

Hirai's sixth technique is the inverse of the fifth means: making the inner cathode compaction density lower than the outermost cathode compaction density while having the same anode compaction density in all layers. EX1010, ¶¶[0071]-[0076]. Thus, when the outermost electrode (blue) and corresponding inner electrodes (red) are cathodes, $D1/D2=0.87$ to 0.97 , and preferably 0.88 to 0.96 —inside the claimed range. EX1003, ¶107. And when the outermost (blue) and inner (red) electrodes are anodes, $D1/D2=1$ because all anodes have the same compaction density in the sixth means. EX1010, ¶[0072]; EX1003, ¶107.

- **Example 6**

Hirai Example 6 separately discloses or suggests the claimed $D1/D2$. EX1003, ¶108. The compaction densities of the outermost (J) and inner (L) cathodes were 3.1 and 3.3 g/cm³, respectively:

	Cathode J	Cathode K	Cathode L
Mass per unit area (mg/cm ²)	15	15.5	16
Cathode electrode density (g/cm ³)	3.1	3.2	3.3

Hirai, ¶[0254] (Table 11)*

See also EX1010, ¶[0260] (Table 12 showing Cathode L in lamination 3, the middle of the electrode stack; Cathode J as the outermost anodes in laminations 1, 5). Thus, the cathode $D1/D2=3.1/3.3=0.94$, falling in the claimed range. All anodes had a compaction density of 1.5 g/cm³, so the anode $D1/D2=1.5/1.5=1$. *Id.*, ¶[0256], ¶[0262] (Example 6 also has five cell layers, so one of the outermost electrodes is a cathode and the other is an anode). Like Example 5, Example 6 had double-sided coatings on all electrodes, *id.*, ¶¶[0254], [0256], but it would have been obvious to alternatively implement Example 6 with single-sided coatings on the outermost electrodes according to Hirai's typical Figures 1-2 structure. EX1003, ¶108.

Accordingly, Hirai's fifth and sixth means satisfy [14.6] as follows:

Embodiment	Cathode D1/D2	Anode D1/D2
Fifth Means	1	Range of 0.87-0.97; preferably 0.88-0.96
Example 5		0.875
Sixth Means	Range of 0.87-0.97; preferably 0.88-0.96	1
Example 6	0.94	

d. Rationale to combine Zeng and Hirai

A POSITA would have used Hirai's structure, including Examples 5 and/or 6, to control the A/C ratio based on electrode compaction density in Zeng's battery, with a reasonable expectation of success. EX1003, ¶109.

• **Analogous art**

Zeng and Hirai describe analogous art. *Id.*, ¶110. Zeng improves performance of lithium-ion batteries, which have electrode assemblies, through advantageous electrolyte compositions. EX1006, ¶¶[0001]-[0006]; EX1001, 20:41-53, 23:24-28. Hirai similarly improves the performance of lithium-ion batteries—through electrode configurations that smooth electrode output unevenness caused by temperature differences across the battery. EX1010, ¶[0010].

- **Teaching, suggestion, motivation (TSM)**

The references provide TSM for a POSITA to use Hirai's laminated battery configuration, including Examples 5 and/or 6, to control A/C ratio in Zeng. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417-418 (2007); MPEP §2143.I, EX1003, ¶111.

Battery configuration: Zeng describes advantageous electrolyte solutions for lithium-ion batteries but does not specify a particular physical embodiment for its batteries. *See generally* EX1006. Thus, a POSITA would have needed to choose a battery/electrode embodiment to implement Zeng's electrolyte solutions, and Hirai provides a suitable solution. EX1003, ¶112.

A POSITA would have selected Hirai's laminated battery structure, specifically, because Zeng identifies large-battery applications for its electrolytes, like in the “energy storage, power, and military aerospace fields[.]” EX1006, ¶[0002]. Fittingly, Hirai proposes its battery structure for such “large-size batteries like on-vehicle batteries in particular” that “us[e] a laminated-structure battery,” while adding improvements for “suppressing output unevenness of the single cells at a center portion and an end portion” that tends to occur in these batteries. EX1010, ¶¶[0006], [0010]. Zeng's silence on a physical battery embodiment would have prompted a POSITA to consider Hirai for large-battery implementation details. EX1003, ¶113.

Suppressing output unevenness: Hirai controls A/C ratio to smoothen power output of the laminated electrodes despite the temperature difference between the inner and outer portions of the battery 10. EX1010, ¶¶[0010]-[0012], [0019], [0029]-[0033], [0045]-[0076]. This would have further enticed a POSITA to use Hirai's structure for Zeng's battery. EX1003, ¶114.

A POSITA would have been motivated to use Hirai's fifth (Example 5) or sixth (Example 6) technique to control the A/C ratio and stabilize power output—both of which involve setting the compaction densities of the active materials of the individual electrodes in the laminated battery 10—in Zeng's battery. EX1003, ¶115. Hirai Table 17 shows Examples 5 and 6 both achieved 100% energy density—higher than Examples 1-4, which ranged from 91-93%. EX1010, ¶[0286].

High energy density did not require a significant tradeoff in capacity retention, as Examples 5 and 6 had comparable capacity retention after 500 cycles (82% and 80%, respectively) to Examples 1-4 (80% to 83%). *Id.* While Comparative Example 2 also had 100% energy density, it retained significantly less capacity (74%) after 500 cycles than Examples 5 and 6. *Id.* Praising these two Examples, Hirai states that “in Examples 5 and 6, it was possible to [keep] a high energy density...by having a gradation so that the center portion is higher than the end portion in terms of anode electrode density...or that the end portion is higher than the center portion in terms of cathode electrode density.” *Id.*, ¶[0288]. Thus, while Hirai teaches other

techniques to control the A/C ratio, a POSITA would have seen the fifth and sixth means—which do so through intentionally setting compaction densities of the electrodes in the lamination—as superior. EX1003, ¶116.

Separately, a POSITA would have found it “obvious to try” Hirai’s fifth and sixth means for Zeng’s battery structure. MPEP §2143.I.E; EX1003, ¶117. Hirai recognizes a market need for large lithium-ion batteries (e.g., EVs) that have multiple electrodes laminated in a stack but observes that temperature differences between the inner and outer portions of such a battery structure can destabilize power output of the individual electrodes in the stack. EX1010, ¶¶[0006]-[0009], [0021], [0179]. Hirai identifies a solution to smooth the power output of the individual electrodes despite the temperature difference—making the A/C ratio higher for inner electrodes than for outermost electrodes—and identifies six Example techniques to do so. *Id.*, ¶¶[0007]-[0013], [0019], [0029]-[0076]. With only six Examples, a POSITA would have tried at least the fifth and sixth techniques, especially given their superior performance discussed above. EX1003, ¶117.

Examples 5 and 6 would have worked predictably as the structure for Zeng’s battery because Hirai tested them with good results. Hirai also describes exemplary liquid electrolytes having some of the same electrolyte components as Zeng’s Embodiment 4 and 6 electrolytes, including ethylene carbonate (EC), propylene carbonate (PC), and diethyl carbonate (DEC), and the lithium salt LiPF_6 . *Compare*

EX1010, ¶[0139] with EX1006, ¶¶[0024], [0037], [0044]-[0049]. Thus, a POSITA would expect Hirai's fifth and sixth structure to work predictably as the battery structure for Zeng's electrolyte. EX1003, ¶118.

Heat dissipation: Hirai's acknowledgement that batteries retain too much heat would have motivated a POSITA to use Hirai's Figures 2 and 3 structure—i.e., where the outermost electrodes, adjacent cladding 29, have a single-sided active layer coating. EX1010, ¶¶[0006]-[0010], [0024]-[0025], FIGS. 2-3. While Hirai's techniques for increasing the inner A/C ratio help address the symptom—inconsistent power output across individual electrodes that hurts battery performance—they do not address the root cause—the battery's inability to adequately dissipate heat. Thus, a POSITA considering Hirai would have sought ways to reduce heat insulation of the battery and meet Hirai's goal of consistent power output through a balanced strategy—partly addressing both the root cause and the symptom. EX1003, ¶119.

The POSITA would have appreciated that Hirai's Figures 2 and 3 structure—with single-sided coatings on the outermost electrodes—should, in general, be less insulative than the alternative (not illustrated) structure having double-sided coatings on the outermost electrodes because it has two fewer total layers. EX1010, ¶¶[0024]-[0025]; EX1003, ¶120. Thus, to improve heat dissipation, the POSITA would have selected the former structure when implementing Zeng's battery based on Hirai's

teachings. As added benefits, fewer layers may reduce manufacturing cost. And, with better heat dissipation, Hirai's goal could be achieved with less manipulation of the A/C ratio, potentially allowing simplifying the construction of the various inner electrodes and further reducing cost. EX1003, ¶120. Separately, because Hirai discloses only two possible configurations for the outermost electrode coating (*single-sided* or *double-sided*), and only illustrates the former, a POSITA would have found it obvious to try the single-sided configuration for Zeng's battery. MPEP §2143.I.E.

- **Reasonable expectation of success**

Focusing on electrolyte composition, Zeng does not require any specific battery structure beyond identifying potential large-battery applications in the “energy storage, power, and military aerospace fields.” EX1006, ¶[0002]. The POSITA would have reasonably expected Hirai's battery structure to work in such “large-size batteries like on-vehicle batteries in particular.” EX1010, ¶[0021]; EX1003, ¶121.

Further, Hirai provides detailed description and figures showing the construction of battery 10, including how “tip portions of cathode collecting tab 25 and anode collecting tab 27 are guided to the outside of battery cladding 29 in a manner to be sandwiched between end portions of battery cladding 29.” *Id.*, ¶[0028], FIGS. 2-3; EX1003, ¶122. Hirai describes how to configure the active layer coatings

for the fifth and sixth means and to make the remaining parts of the battery. EX1010, ¶¶[0066]-[0190], [0242]-[0263]. And, as explained, Hirai's exemplary electrolyte shares common components with Zeng Embodiments 4 and 6. *Compare* EX1010, ¶[0139] *with* EX1006, ¶¶[0024], [0037], [0044]. Thus, a POSITA would have reasonably expected to succeed in combining Zeng and Hirai.

6. [14.7]

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

Section VIII.A. Thus, in Zeng Embodiments 4 and 6, Y/Z is respectively greater than $1/17.66=0.057$ and $1/17.70=0.056$, overlapping the claimed range of about 0.01 to about 0.3 and thus rendering it obvious. *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003); EX1003, ¶123.

Although not required to show obviousness of the claimed range, both Zeng Embodiments' Y/Z ratios fall below the claimed upper limit of 0.3. EX1003, ¶124. With $Y=1$ wt%, achieving a Y/Z ratio of 0.3 or more would require Z to be $1/0.3=3.33$ wt% or less. But, as Dr. Lucht explains, diluting PP (i.e., reducing Z) from 20 wt% of the solvent to 3.33 wt% in the total electrolyte would reduce the solvent to just 16.65 wt% of the total electrolyte and increase the concentration of

LiPF₆ to nearly *five times* the (typical) 1.0 mol/L specified by Zeng. *Id.* This reverses the notion of a solvent-based electrolyte in which “additives” and LiPF₆ are dissolved, creating an atypical composition inconsistent with Zeng’s disclosure and lithium-ion batteries generally. *See id.*; EX1019.

Accordingly, Zeng Embodiments 4 and 6 render obvious Y/Z falling within the claimed range—greater than 0.01 (0.057 and 0.056) and certainly less than 0.3. *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 782-783 (Fed. Cir. 1985); EX1003, ¶125.

7. [14.8]

Zeng Embodiments 4 and 6 both have 1,3,6-hexanetricarbonitrile (HTCN) as the claimed *trinitrile compound*. EX1006, ¶¶[0046], [0049]; Section VIII.A; EX1003, ¶126.

C. Claim 15

1. [15.1]

The Zeng-Hirai combination renders obvious this element. EX1003, ¶127. As explained, when the outermost electrode (*first electrode*) is a cathode and the corresponding inner electrode (*second electrode*) is a cathode, as claimed, Hirai discloses:

Embodiment	D2
Example 5	3.2 g/cm ³
Example 6	3.3 g/cm ³

Section VIII.B.5.c; EX1010, ¶¶[0068], [0073], [0245], [0260]. Hirai's *D2* values fall slightly below 3.5, but they are "close enough such that one skilled in the art would have expected them to have the same properties." *Peterson*, 315 F.3d at 1329; EX1003, ¶127. Moreover, it was well-known that higher cathode active material compaction densities provide higher electrical capacity, so a POSITA would have found it obvious to experiment with increasing Hirai's *D2* into the claimed range to improve battery capacity. *See, e.g.*, EX1009, ¶[0036] (compaction densities of 3.31-4.0 g/cm³ provide sufficiently high capacity without risking breakage); EX1003, ¶127.

D. Claim 16

1. [16.1]

When the outermost electrode (*first electrode*) is an anode and the corresponding inner electrode (*second electrode*) is an anode, as claimed, Hirai Examples 5 and 6 have the following characteristics:

Embodiment	D2
Example 5	1.6 g/cm ³
Example 6	1.5 g/cm ³

Section VIII.B.5.c; EX1010, ¶¶[0068], [0073], [0245], [0260]. Hirai's *D2* values of 1.6 and 1.5 in Examples 5 and 6, respectively, fall inside the claimed range. EX1003, ¶128.

E. Claim 17

1. [17.1]

Zeng's *dinitrile compound* includes *adiponitrile*. EX1006, ¶¶[0029]-[0030]; Section VIII.A. The formula for adiponitrile is $\text{CN}(\text{CH}_2)_4\text{CN}$, so the alkylene group R_1 (i.e., $(\text{CH}_2)_4$) has four carbon atoms. EX1003, ¶129; EX1018, 1; EX1001, 7:13-19 (identifying adiponitrile specifically as a Formula [4] compound).

IX. GROUND 2A: ZENG AND HIRAI, FURTHER IN VIEW OF HAN, RENDER OBVIOUS CLAIM 15

Claim 15 of the '131 Patent recites that both electrodes are cathodes and that the compaction density *D2* of the second electrode having the double-side coating falls between 3.5 g/cm³ and 4.3 g/cm³. PO may argue that Hirai's compaction density *D2* range of 3.1-3.3 g/cm³, though adjacent the claimed range, nonetheless fails to render the claimed range obvious. Such an argument would lack merit for the reasons discussed above in Ground 1A. Section VIII.C. Nonetheless, Han discloses the

subject matter of claim 15, and a POSITA would have combined Zeng/Hirai and Han to arrive at claim 15 with a reasonable expectation of success. EX1003, ¶130.

A. Claim 15

1. Han discloses element [15.1]

Han discloses a non-aqueous electrolyte secondary battery where “the density of the positive electrode active material layer is preferably 2.5 to 3.8 g/cm³, and more preferably 2.6 to 3.7 g/cm³.” EX1012, ¶[0058]. Because Han teaches that the density of the cathode active material (*D2*) may be from about 2.5 to 3.8 g/cm³—a range substantially overlapping the claimed range—Han discloses or suggests this claim element. EX1003, ¶131.

2. Rationale to combine Zeng/Hirai with Han

A POSITA would have found it obvious to combine the Zeng/Hirai battery structure with Han’s cathode density. EX1003, ¶132.

• **Analogous art**

Han is analogous art because it also falls in the same field of endeavor—lithium-ion secondary batteries as the other references. EX1012, Abstract, ¶¶[0002]-[0007]; EX1006, Abstract; EX1010, Abstract. Indeed, Han and Hirai are both assigned to Nissan Motors and describe different aspects of the same laminated battery 10 for large applications, like EVs. *Compare* EX1010, 1, ¶¶[0024]-[0029], FIGS. 1-2 *with* EX1012, 1, ¶¶[0028]-[0031], FIGS. 1-2. Hirai improves the

performance of lithium-ion batteries by increasing the A/C ratio toward the inner portion of the battery to provide consistent performance of the individual electrodes in the lamination despite the temperature difference between the inner and outer portions of the battery. EX1010, ¶¶[0006]-[0010]. Han addresses this same problem in laminated batteries that use a mixture of silicon and carbon materials as the negative electrode active material. EX1012, Abstract, ¶¶[0009]-[0016], [0032]-[0033], [0037]-[0038]. Thus, a POSITA considering the Zeng-Hirai battery would have looked to Han for further improvements. EX1003, ¶133.

- **TSM**

The references provide TSM to use Han's cathode density $D2$ in the Zeng-Hirai battery. *KSR*, 550 U.S. at 417-418; MPEP §2143.I. For example, Han teaches that "it is preferable that the density of the positive electrode active material layer be 2.5 to 3.8 g/cm³, and more preferable that it be 2.6 to 3.7 g/cm³." EX1012, ¶[0058]. Because neither Zeng nor Hirai explicitly recommends which cathode densities are appropriate or advantageous, a POSITA considering Zang and Hirai would have looked to a reference like Han to select and try appropriate cathode densities in the Zeng-Han battery. EX1003, ¶134. As Kim-'685 shows, cathode active material were known to have optimal performance with a press density between 3.31 g/cm³ and 4.0 g/cm³, as lower densities reduce electrical capacity, while higher densities risk

material breakage. EX1009, ¶[0036]. Thus, a POSITA would have been motivated to use Han's cathode press density in the Zeng-Hirai battery. EX1003, ¶134.

- **Reasonable expectation of success**

Han and Hirai are references by the same assignee (Nissan) that describe the same laminated battery structure 10, include common figures, and address the same problem of inconsistent performance of the inner and outer electrodes due to temperature difference. *Compare* EX1010, ¶¶[0006]-[0010], [0024]-[0029], FIGS. 1-2 *with* EX1012, ¶¶[0009]-[0019], [0024]-[0033], [0037]-[0038], FIGS. 1(A)-2. Additionally, Han discloses the same exemplary electrolyte as Hirai having common components with Zeng's electrolyte. *Compare* EX1010, ¶[0139] *with* EX1012, ¶[0135]; Section VIII.B.5.c. Thus, the POSITA would have reasonably expected Han's cathode compaction density to work with Hirai's battery EX1003, ¶135.

- **Known technique to improve a similar device or method**

Using Han's cathode density in the Zeng/Hirai combination merely would have involved using a known technique to improve a similar device or method in the same way. MPEP § 2143.I.C; EX1003, ¶136.

Prior art “base device”: Here, the base device is a lithium-ion battery with Zeng's electrolytic composition and Hirai's electrode structure. Han improves upon the Zeng/Hirai combination by expressly disclosing suitable cathode densities. EX1012, ¶[0058]; EX1003, ¶137.

Improved “comparable” device: Here, Han demonstrates that Hirai/Han’s laminated battery can be improved by adjusting the density of the cathode active material to be from about 2.5 to 3.8 g/cm³, and more preferably 2.6 to 3.7 g/cm³. EX1012, ¶[0058].

Predictable results: As explained, a POSITA would have predictably improved the Zeng/Hirai lithium-ion battery by adjusting the cathode density as taught by Han. Han discloses that cathode densities exhibit superior properties at 2.5 to 3.8 g/cm³, and more preferably 2.6 to 3.7 g/cm³. EX1012, ¶[0058]. Zeng and Hirai disclose electrolytic compositions and electrode structure for improving battery performance. EX1006, Abstract; EX1010, Abstract, ¶¶[0007]-[0010]. All three references prioritize energy density and stability of lithium-ion batteries, with Hirai and Han discussing applications for electric vehicles specifically. EX1006, ¶¶[0001]-[0009]; EX1010, ¶¶[0006]-[0007], [0021], [0109], [0149], [0179]; EX1012, ¶¶[0001]-[0004], [0009]-[0010], [0017], [0092]. And Hirai and Han have the same applicant, describe different aspects of the same laminated battery, and address the same issue of inconsistent performance of electrodes due to temperature differences. Compare EX1010, ¶¶[0024]-[0029], FIGS. 1-2 with EX1012, ¶¶[0019], [0028]-[0031], FIGS. 1-2. Accordingly, combining Han’s cathode density with the Zeng/Hirai device would have yielded predictable results.

X. GROUNDS 1B, 2B: ZENG/HIRAI, FURTHER IN VIEW OF MATSUOKA, RENDER OBVIOUS CLAIMS 14-17, ZENG/HIRAI/HAN, FURTHER IN VIEW OF MATSUOKA, RENDER OBVIOUS CLAIM 15

PO may argue Zeng is ambiguous about adding LiPF_6 , making the weight proportion of the solvent components in the electrolyte is unclear. This argument, if raised, lacks merit for the reasons above.

But for the sake of completeness, any potential ambiguity can be dispelled by Matsuoka, which explicitly discloses an appropriate amount of PP (Z). Alternate Grounds 1B, 2B rely on Matsuoka for independent claim 14 element [14.7]. For the remaining claim elements, Petitioner incorporates by reference its analysis from Grounds 1A and 2A. Sections VIII-IX; EX1003, ¶¶140-141.

A. Overview of Matsuoka

Matsuoka's "non-aqueous electrolyte solution" combines "acetonitrile and a lithium salt" with a "non-nitrile additive" to increase durability of the SEI layer. EX1007, Abstract, ¶¶[0015], [0035], [0044], [0056]-[0057]. A durable SEI protects the electrodes, reducing side reactions and maintaining low internal resistance for better high-temperature storage/cycling. *Id.*, ¶¶[0022], [0036], [0057]; EX1003, ¶142.

Like Kim-'268, Matsuoka identifies benefits of PP as an electrolyte additive. Matsuoka lists PP isomers as having LUMO (Lowest Unoccupied Molecular

Orbital) and HOMO (Highest Occupied Molecular Orbital) energies falling in or near most-preferred ranges, which improves SEI film durability. EX1007, ¶¶[0015], [0036]-[0040]. An ideal LUMO improves SEI formation on the negative electrode while “provid[ing] good effects on...a positive electrode and a separator” and suppressing “increase in internal resistance caused by repeating charge-discharge cycles[.]” EX1007, ¶[0036]. An ideal HOMO extends SEI protection to at least the positive electrode. *Id.*, ¶[0039]. Together, optimum LUMO and HOMO suppress side reactions, improving performance. *Id.*, ¶[0022]; EX1003, ¶143.

B. [14.7]

1. Matsuoka discloses “a weight percentage of the propyl propionate is Z”

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

Matsuoka Range	Non-nitrile Additive (wt%)	Citation
Preferably	0.1 to 30	EX1007, ¶[0041]
More preferably	0.1 to 10	

Thus, to the extent a POSITA sought to use an advantageous amount of PP in Zeng’s electrolyte, Matsuoka provides, and explains the benefits of, such an amount. Matsuoka therefore discloses *a weight percentage of the PP is Z*. And, as explained

below, when used in Zeng's electrolytes, Matsuoka's amount of PP results a Y/Z ratio overlapping that range recited in elements [1.7] and [14.7]. EX1003, ¶144.

2. Rationale to Combine

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 is Z* in Zeng's Embodiments 4 and 6. EX1003, ¶145.

- **Analogous art**

Matsuoka is analogous art because it also relates to the field of endeavor of lithium-ion batteries, including for mobile devices. EX1007, ¶¶[0001]-[0005], [0212]. Zeng and Matsuoka strive to improve long-term battery performance, just like the '131 Patent. 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 stabilize the 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]; EX1003, ¶146. And, as explained, Hirai and Han also seek to improve performance of lithium-ion batteries, and disclose example electrolytes consistent with Zeng's. Sections VIII.B.5.c, IX.

Like Zeng and Matsuoka, the '131 Patent focuses on long-term battery performance, explaining 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, 1:32-37. The '131 Patent seeks compositions that “inhibit[] the side reactions ... to improve the long-term storage performance and reliability of the electrochemical device,” *id.*, 2:48-52, highlighting reducing side reactions as “important to controlling the expansion of electrochemical devices.” *Id.*, 3:15-20. Thus, a POSITA would have combined the teachings of Zeng and Matsuoka for the same reasons to achieve the same purported benefits. EX1003, ¶147.

- **TSM**

Implementation details: To the extent Zeng’s recipe is hypothetically unclear about how much PP to use, that would have prompted the POSITA to consider Matsuoka’s teachings about appropriate amounts of PP to include in Zeng’s electrolytes. The POSITA would have noted Matsuoka’s “off-the-shelf” preferred weight proportion ranges for PP, a non-nitrile additive, to fine-tune the weight percentage Z of PP in Zeng Embodiments 4 and 6. EX1003, ¶148.

Balanced performance: Matsuoka explains that its preferred weight proportion ranges for non-nitrile additives like PP balance the competing advantages of electrolyte stability and high-rate performance at low temperatures. EX1007,

¶[0041]. Specifically, increasing the amount of the non-nitrile additive improves electrolyte stability, which comes at the cost of low-temperature performance, and vice versa. *Id.* By calibrating the non-nitrile additive in Matsuoka's preferred weight proportion ranges, however, "all of the cycling performance of the electrolyte solution, high-rate performance under a low temperature environment, and other battery characteristics can be further improved." *Id.* So, the desire for balanced performance, as taught by Matsuoka, would have motivated the POSITA to use Matsuoka's preferred weight proportion ranges as the amount of PP in Zeng's Embodiment 4 and 6 electrolytes. EX1003, ¶149.

- **Reasonable expectation of success**

A POSITA would have reasonably expected success in using Matsuoka's preferred non-nitrile weight proportions for PP in Zeng's electrolytes. EX1003, ¶150. First, Zeng's and Matsuoka's electrolytes compositions are substantially similar, which would have reasonably ensured success. *Id.* Indeed, Zeng's and Matsuoka's electrolytes share the same carbonate-based solvents (EC, PC), the same ester compound (EP), the same lithium salt (LiPF₆), and the same additive (VC). *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, a POSITA would have reasonably expected the preferred weight proportions of Matsuoka's additive (here, PP) to be especially suitable to use as the weight percentage Z of PP in Zeng's electrolytes—particularly because Matsuoka describes non-nitrile additives as generally combinable, interchangeable, and “not particularly limited.” EX1007, ¶[0035]. Moreover, a POSITA would expect the resulting electrolyte combination to have significant benefits described in both references: (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]. EX1003, ¶151.

3. The Zeng/Hirai/Matsuoka combination teaches or suggests the claims

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

Y (Zeng)	Z (Matsuoka)	Y/Z
1 wt%	0.1-10 wt%	0.1-10
	0.1-30 wt%	0.033-10

As shown above, selecting Matsuoka's more preferred range for PP (0.1-10 wt%) in Embodiments 4 and 6 of Zeng results in a Y/Z range from 0.1 to 10, overlapping the claimed range 0.01 to 0.3 of Elements [1.7] and [14.7]. EX1003, ¶152. Similarly, selecting Matsuoka's preferred range (0.1-30 wt%) results in Y/Z a range from 0.033 to 10, again overlapping the claimed range. *Id.*

Matsuoka also directs the POSITA to PP, specifically, by highlighting PP's ability to keep the battery's internal resistance low. The '131 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, 1:30-62. A POSITA would have applied Matsuoka's teaching that PP effectively keeps internal resistance low to optimize PP content in Zeng's Embodiments 4 and 6, experimenting within Matsuoka's ranges of 0.1-10 wt% and 0.1-30 wt%. EX1007, ¶[0036]; EX1003, ¶153.

**XI. GROUNDS 1C, 2C: ZENG/HIRAI, ZENG/HIRAI/MATSUOKA—
FURTHER IN VIEW OF KIM-'268—RENDER OBVIOUS CLAIMS
14-17; ZENG/HIRAI/HAN, ZENG/HIRAI/MATSUOKA/HAN—
FURTHER IN VIEW OF KIM-'268—RENDER OBVIOUS CLAIM 15**

PO may argue that Element [14.7] requires specific focus on Y/Z (the ratio of trinitrile to PP) and criticize Zeng and Matsuoka for not highlighting the ratio of HTCN to PP, specifically. This argument lacks merit.

First, as established, Zeng discloses Y and Z values that, when expressed as a ratio (Y/Z), fall within the range claimed in the '131 Patent. EX1003, ¶¶154-155. Mere recitation of this mathematical relationship—expressing known values as a ratio—does not create a patentable distinction over prior art that discloses or renders obvious the underlying Y and Z values. *Peterson*, 315 F.3d at 1329; *Titanium Metals*, 778 F.2d at 782-783.

Second, Zeng Embodiments 4 and 6 disclose dinitrile-based electrolytes containing a trinitrile and PP—in different relative amounts. EX1006, ¶¶[0045]-[0049]. The remaining examples lacked both a trinitrile and PP. *Id.* Given that Zeng Embodiments 4 and 6 were advantageous, this would have drawn attention to the importance of Zeng’s *Y* and *Z* proportions (satisfying the claims) in improving performance of dinitrile-based electrolytes. EX1003, ¶156.

Third, it was known that the relative proportions of *Y* and *Z* were beneficial, thanks to Kim-’268. Kim-’268 further focuses the POSITA on including both a trinitrile and PP in a dinitrile-based electrolyte and motivates adjusting relative amounts of these two components (i.e., *Y/Z*) to improve performance. Thus, Zeng/Hirai or Zeng/Hirai/Matsuoka, further in view of Kim-’268, render obvious claims 14-17 (Ground 1C). Likewise, Zeng/Hirai/Han or Zeng/Hirai/Matsuoka/Han further in view of Kim-’268, render obvious claim 15 (Ground 2C).¹⁰ EX1003, ¶157.

Kim-’268 discloses lithium-ion battery electrolytes with superior capacity retention at high temperatures after many charging cycles. EX1008, ¶[0005]. Kim-’268 even claimed trinitrile- and PP-based electrolytes, with claim 1 reciting a

¹⁰ For the remaining claim elements except [14.7], Petitioner incorporates by reference its analysis for those claim elements in Grounds 1A-2B. *Supra* Sections VIII-X.

trinitrile (Formula 1) with a C3-to-C5 alkyl propionate (e.g., PP, a C3 alkyl propionate). EX1008, ¶[0055] (Formula 1 compounds feature three or more nitrile (CN) groups and an asymmetric structure), Claim 1; EX1003, ¶158.

Kim-'268's experiments show electrolytes having both trinitrile and PP had better capacity retention—after storage at 60°C for four weeks, and after 250 cycles—versus similar electrolytes missing either or both components. EX1008, Tables 2-4; *Id.* Only Kim-'268 Examples 1 and 2 contained both a HTC� (trinitrile) and PP—and in different relative amounts. EX1008, ¶¶[0090]-[0091] (Table 1). The Comparative Examples lacked either HTC� (trinitrile), PP (or both). *Id.*; EX1003, ¶159.

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	both trinitrile (HTCN) and PP, in different relative amounts
Example 2	1.15M	20	20	—	—	—	60	1	2	
Comparative	1.15M	20	20	60	—	—	—	3	—	
Example 1										missing either trinitrile or PP
Comparative	1.15M	20	20	60	—	—	—	1	2	
Example 2										
Comparative	1.15M	20	10	—	—	30	40	3	—	
Example 3										
Comparative	1.15M	20	20	—	—	—	60	3	—	
Example 4										
Comparative	1.15M	20	20	—	60	—	—	1	2	
Example 5										
Comparative	1.15M	20	20	—	—	60	—	1	2	
Example 6										

Kim-'268, Table 1*

Kim-'268 Examples 1 and 2 showed better thickness stability and capacity retention than Comparative Examples 1-6 (lacking one or both). EX1008, ¶¶[0097]-[0103] (Tables 3, 4), FIGS. 3-6. A POSITA would recognize this superior performance stemmed from combining trinitrile and PP, focusing the POSITA on the importance of trinitrile- and PP-based electrolytes. EX1003, ¶160.

Kim-'268's Examples also highlight the superiority of PP, specifically. Example 2 (with PP) outperformed Comparative Examples 5-6 (with MP or EP at same wt%) when substituting these alkyl propionates. EX1008, ¶[0090], Table 1.

This shows PP performs better than similar alkyl propionates like MP or EP. EX1003, ¶161.

Kim-'268 also shows optimizing the trinitrile (Y)/PP (Z) ratio affects performance: Examples 1 and 2 used identical dinitrile/trinitrile but varied PP (40 wt% versus 60 wt%), demonstrating PP's impact on battery performance. EX1008, ¶[0090], Table 1, ¶¶[0092]-[0103]; EX1003, ¶162. Kim-'268 explains how Y/Z improves performance, explaining that dinitrile “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” operated or above 4.4V. EX1008, ¶[0064], *see also id.*, ¶[0104]. But gas increases battery thickness and resistance, harming performance. EX1008, ¶¶[0039], [0063]-[0066]. Kim-'268 explains that adding trinitrile gives the protective layer “stable and strong bonding” to reduce swelling, while adding PP further improves high-temperature storage/cycling. *Id.*, ¶¶[0014], [0040], [0055]-[0056], [0090]-[0091], claim 3; EX1003, ¶163.

The '131 Patent echoes Kim-'268: “[a] dinitrile compound can form a protective film on the cathode of the electrochemical device...to inhibit the decomposition of the solvent[,]” EX1001, 1:49-51, but notes that high operating voltages degrade the protective film. *Id.*, 1:30-39, 1:52-55. Kim-'268 explains that while adding trinitrile creates a durable cathode SEI film, such film-forming additives increase battery internal resistance and thickness expansion, hurting

performance. *Id.*, 1:55-62, 22:31-34. The '131 Patent does not explain why the nitrile-based SEI film increases internal resistance, instead suggesting further optimization as a solution. EX1003, ¶164.

The '131 Patent and Kim-'268 differ in their focus on PP's effects. The '131 Patent claims combining PP with nitriles reduces DC resistance, while Kim-'268 shows combining PP with nitriles improves cycling but does not specifically mention DC resistance. EX1008, ¶¶[0090]-[0104]. Since DC resistance testing was routine, evaluating Kim-'268's electrolytes for PP's internal resistance effects would have been standard practice, to the extent that matters. EX1003, ¶165.

Accordingly, Kim-'268 would have further motivated a POSITA to consider and adjust the proportions of trinitrile and PP in Zeng's electrolytes and/or use Matsuoka's PP amounts in Zeng's electrolytes. EX1003, ¶166.

XII. GROUND 3A: ZHOU AND HIRAI RENDER OBVIOUS CLAIMS 14-17

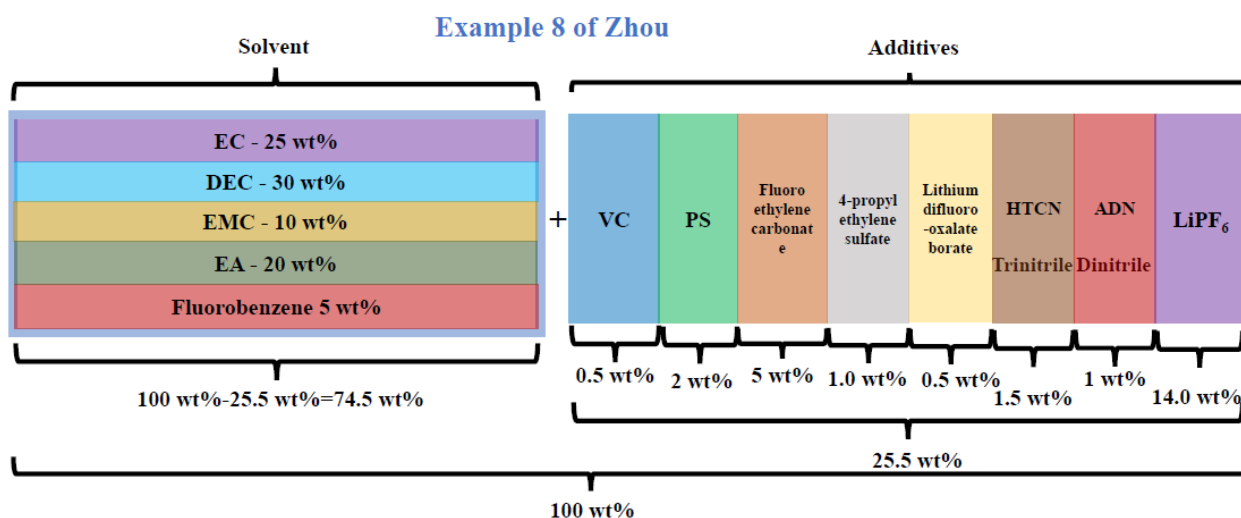
A. Overview of Zhou

Zhou describes “a fast charging lithium-ion battery electrolyte [having] a high potential and a high compaction density” with “good cycle performance and high and low temperature performance.” EX1014, ¶[0006]. Zhou electrolyte Example 8 has adiponitrile (ADN) as the claimed *dinitrile*, 1,3,6-hexanetrinitrile (HTCN) as the

claimed *trinitrile*, and the linear carboxylic acid ester ethyl acetate (EA) at 20 wt% of the solvent. *Id.*, ¶[0047]; EX1003, ¶¶167-178.

Zhou teaches that esters—including EA and PP—have low boiling points and strong lithium-ion conductivity, which decreases internal impedance and improves kinetic performance of the battery. EX1014, Abstract, ¶¶[0004], [0008], [0020], [0052]-[0055]. Although Example 8 lacks PP, Zhou lists only eight esters that are suitable replacements for EA, one being PP. EX1014, ¶[0011]. It would have been obvious to substitute EA with PP—an ester with a similar structure but having two additional methyl groups—particularly given that PP was a known electrolyte-enhancer, for example, as evidenced by Kim-’268. EX1003, ¶167. This would have resulted in the claimed subject matter. *Id.*, ¶168.

Zhou specifies the weight percentages of additives to the solvent, including LiPF₆, based on “the *total mass* of the lithium-ion battery electrolyte.” EX1014, ¶¶[0009]-[0018]; EX1003, ¶173. Zhou Example 8 has the following composition:



EX1003, ¶¶173-178; EX1014, ¶[0047]¹¹

Weight percentage ADN (*dinitrile*) in the total electrolyte: ADN has two nitrile groups, so it is a *dinitrile*. EX1018, 1. In Example 8, ADN has a weight percentage (the claimed *X*) of 1 wt% of the total electrolyte. EX1003, ¶174.

Weight percentage HTC N (*trinitrile*) in the total electrolyte: HTC N has three nitrile groups, so it is a *trinitrile*. EX1018, 100; EX1020. In the total electrolyte, HTC N has a weight ratio (the claimed *Y*) of 1.5 wt%. EX1003, ¶175.

Weight percentage EA in the total electrolyte: In the total electrolyte of Example 8, EA—interchangeable with PP—has a weight ratio of $(1 - 25.5\%) \times (20\% / (25\% + 30\% + 10\% + 20\% + 5\%)) = 16.56\%$, which Petitioner denotes as

¹¹ EC: ethylene carbonate; DEC: dimethyl carbonate; EMC: ethyl methyl carbonate; EA: ethyl acetate; VC: vinylene carbonate; PS: propane sultone. EX1014, ¶[0047].

Z'. EX1003, ¶176. Substituting EA with PP results in the claimed PP and Z, where Z is 16.56% and falls within claim 7's range of 5-50 wt%. *Id.*, ¶168. Thus, this simple ester substitution in Example 8 results in the claimed subject matter.

To summarize, X, Y, and Z' (EA) have the following values in Zhou's Example 8:

X	Y	Z' (EA)
1 wt%	1.5 wt%	16.56 wt%

EX1003, ¶177.

Example 8 improved battery discharge capacity over Comparative Example 3 and Examples 3-6. EX1014, ¶[0061], FIG. 1. It also had lower internal impedance than Comparative Examples 1-3 and Examples 1, 2, 4, and 6. *Id.*, ¶¶[0057]-[0058], FIG. 4; EX1003, ¶208.

- **Rationale to Implement Zhou Example 8**

Relying on Zhou Example 8 does not involve “selecting from large lists of elements in a single reference” as a single embodiment. *Contra Stepan*, 868 F.3d at 1346 n.1. Each of Zhou's Example electrolytes is a self-contained, working embodiment providing a complete list of compounds, amounts, and preparation instructions. EX1003, ¶179.

Nonetheless, a POSITA would have selected and implemented Zhou Example 8 with a reasonable expectation of success. *Id.*, ¶180. Example 8 significantly

outperformed the Comparative Example batteries in discharge capacity and low impedance and outperformed other Examples in low impedance. EX1014, ¶¶[0057], [0061], FIGS. 1, 4. At minimum, it also would have been “obvious to try” Zhou Example 8. EX1003, ¶180.

Recognized need in the art: Zhou cites a market need for “[t]he development of fast charging technology” driven by “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]. But these solvents hinder high-temperature performance and ester organic solvents, specifically, are incompatible “with the negative electrode graphite...caus[ing] the battery cycle performance to deteriorate.” *Id.*, ¶[0004]. Zhou thus sought “a combination of solvents and additives that matches the fast charging electrolyte” and “[i]mprov[es] battery kinetics, high temperature performance, and cycle performance[.]” *Id.*, ¶[0005]. Since Zhou Example 8 achieved these goals, a POSITA would have appreciated that it met recognized needs in the art. EX1003, ¶181.

Finite number of predictable solutions: Zhou only discloses eight electrolyte solutions to address this need, Examples 1-8, which had better performance than the Comparative Examples. *Id.*, ¶¶[0032]-[0048]. Notably,

Example 8 outperformed Examples 3-6 in discharge capacity and outperformed Examples 1, 2, 4, and 6 in internal impedance. EX1014, ¶¶[0057]-[0061], FIGS. 1, 4; EX1003, ¶182.

Reasonable expectation of success: All Zhou's Examples were successfully tested in batteries and outperformed the Comparative Examples. EX1014, ¶¶[0057]-[0063]. The tests showed "[a]n efficient high temperature additive," such as "[n]itrile compounds containing 2 or 3 nitrile functional groups," compensates for the fact that "[t]he high temperature performance is often challenged when using [a fast-charging] solvent system[.]" *Id.*, ¶[0059]. Zhou provides detailed instructions to make its Example electrolytes. *Id.*, ¶[0047]. Thus, a POSITA would have reasonably expected to succeed with Example 8. EX1003, ¶183.

B. Independent Claim 14

1. [14.pre]

Zhou discloses electrolytes for lithium-ion battery—an *electrochemical device*. EX1014, Abstract, ¶¶[0001]-[0020]; EX1003, ¶184. Zhou's Example electrolytes were tested in lithium-ion batteries. EX1014, ¶¶[0032]-[0064]; Section XII.A.

2. [14.1]

Zhou's lithium-ion battery has positive and negative *electrodes*. EX1014, Abstract, ¶¶[0002]-[0008], [0020], [0048], [0058]-[0064]; EX1003, ¶185.

3. [14.2]

As explained, Example 8 of Zhou's *electrolyte*, implemented in Zhou's lithium-ion battery, renders the Challenged Claims unpatentable. EX1014, ¶[0047]; Section XII.A; EX1003, ¶186.

Zhou's Example 8 contains *a dinitrile compound* (ADN) and *a trinitrile compound* (HTCN), as claimed. EX1014, ¶[0047]; EX1018, 1, 100; Section XII.A. While Example 8 lacks PP, PP is structurally similar to EA and has two additional methyl groups. EX1003, ¶187. Zhou specifically identifies PP as one of but a few suitable alternatives to EA, which renders obvious substituting PP for EA in Example 8, with a reasonable expectation of success. *Id.*

a. Zhou discloses PP

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]. Zhou identifies PP and EA as two of nine suitable, alternative esters. *Id.*, ¶[0011]. Thus, Zhou discloses that its electrolytes can include PP, as claimed. EX1003, ¶188.

b. Rationale to substitute PP for EA in Zhou Example 8

- **Obvious to try**

A POSITA would have found it "obvious to try" substituting PP for EA in Zhou Example 8. EX1003, ¶189.

Recognized problem/need: Zhou observes that “demand for fast charging has become more urgent” due to “the popularization of smart digital products[.]” 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 fast-charging batteries need organic solvents that improve kinetic properties of electrolytes. EX1003, ¶190.

Finite number of identified, predictable solutions: Zhou identifies a solution for improving kinetic performance of the electrolyte: “a mixture of...a low-boiling-point linear carbonate and a linear carboxylic acid ester[.]” EX1014, ¶[0008]. As Zhou found, both types of compounds “provid[e] a more suitable channel for lithium-ion transmission and reducing the impedance of the battery system.” *Id.*, ¶[0055]; *see also id.*, ¶[0020] (discussing benefits of linear carbonates carboxylic acid esters). Zhou identifies nine potential esters—one of which (EA) is used in Example 8, and another of which is PP. EX1014, ¶[0011]. Thus, Zhou proposes a handful of solutions to increase kinetic performance, and PP is one of them. Kim-’268 had also identified PP as a known electrolyte performance-enhancer, and EA and PP have similar structures except for PP’s two additional

methyl groups. EX1003, ¶191; Section XI. Thus, a POSITA would expect Zhou's Example 8 electrolyte—with PP substituted for EA—to work predictably and as Zhou describes. *Id.*

Reasonable expectation of success: A POSITA would have reasonably expected to succeed in replacing one ester (EA) with another (PP) in Zhou Example 8. EX1003, ¶192. Zhou lists PP alongside EA in a short list of suitable esters, EX1014, ¶[0011], so the POSITA would likewise expect PP to have the properties necessary to succeed in Zhou's electrolytes. *Id.*, ¶[0057]. Zhou shows esters have favorable low boiling points that promote electrolyte conductivity, consistent with Kim-'268's touting PP as improving electrolyte performance. While PP has a higher boiling point than EA, this would improve battery safety without compromising performance. EX1003, ¶192.

Zhou teaches that using large quantities, and different types, of esters in electrolyte solutions “is more conducive to the fast charging of the system under high voltage and high compaction conditions.” EX1014, ¶[0058]. Thus, a POSITA would not expect replacing EA with PP in Example 8 to hurt performance. Rather, a POSITA would expect the resulting electrolyte to provide good ion conductivity for fast charging as Zhou teaches. EX1003, ¶193.

- **Simple substitution**

Replacing EA with PP in Zhou Example 8 constitutes mere simple substitution of one known element (the ester EA) for another (the ester PP) to obtain predictable results. MPEP § 2143.I.E; EX1003, ¶194.

Prior art electrolyte: Zhou's Example 8 electrolyte differs from the claimed electrolyte by substitution of one well-known ester, EA, for another, PP. EX1003, ¶195.

Function of substituted components known in the art: Zhou lists PP and EA as two of a handful of alternative esters. EX1014, ¶[0011]. Zhou explains that esters have low melting points and strong ion conductivity in lithium-ion battery electrolytes, reducing internal impedance and improving kinetic performance. *Id.*, ¶¶[0009], [0057]-[0058]; EX1003, ¶196.

Predictable results: A POSITA could have substituted PP for EA in Zhou Example 8 with predictable results. EX1003, ¶197. Zhou instructs mixing the electrolyte components, including 20 wt% EA, and slowly adding and dissolving 14 wt% LiPF₆ to form the total electrolyte. EX1014, ¶[0047]. With this guidance, a POSITA could have simply added 20 wt% PP instead of 20 wt% EA during this process. The result of this substitution would have been predictable because Zhou presents EA and PP as fungible esters that support lithium-ion conductivity. EX1014, ¶¶[0009]-[0011], [0057]-[0058]; EX1003, ¶197.

4. [14.3]

The claimed X and Y 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

Section XII.A. Thus, in Example 8, $X+Y=1\text{ wt\%}+1.5\text{ wt\%}=2.5\text{ wt\%}$ —within the claimed $X+Y$ range. Additionally, in Example 8, X/Y in Example 8 is $1/1.5=0.67$, within the claimed X/Y range. *Titanium Metals*, 778 F.2d at 782-783; EX1003, ¶198.

5. [14.4]-[14.6]

Zhou and Hirai render these elements obvious. EX1003, ¶199. Zhou's battery has *electrodes*—anode and cathode. *Id.*; Sections II, XII.B.2. Zhou focuses on electrolyte compositions, not electrode structures, and thus does not disclose *a first electrode and a second electrode, wherein the first electrode comprises a first current collector and a single-sided coating and the second electrode comprises a second current collector and a double-sided coating*. But Hirai discloses the claimed electrode configuration, and it would have been obvious to combine Zhou and Hirai, with a reasonable expectation of success, to arrive at elements [14.4] and [14.5].

a. [14.4]-[14.6]

Hirai discloses these elements. Section VIII.B.5; EX1003, ¶200.

b. Rationale to Combine

For the reasons discussed in Ground 1A, a POSITA would have found it obvious use Hirai's electrode structure with Zhou's lithium-ion battery. *Id.*, ¶201. Zhou and Hirai are analogous art because both relate to lithium-ion batteries, including those employing non-aqueous electrolytes. EX1014, ¶¶[0001]-[0020], [0032]-[0048]; EX1010, Abstract, ¶¶[0004]-[0006], [0014]-[0015], [0019]-[0024]; EX1001, 1:19-3:26; EX1003, ¶201. Like Zeng, Zhou focuses on electrolytes rather than battery structures, so a POSITA would have looked to Hirai for details to implement its improved electrode structure. Sections VIII.B.5.d, XII.A.

Indeed, Zhou specifically teaches that its lithium-ion batteries are used in “electric vehicles, military, aerospace and other fields,” EX1014, ¶[0002], and Hirai states that “[i]t is preferable to apply [Hirai's] laminated (laminated structure) lithium ion secondary battery of the present embodiment to large-size batteries like on-vehicle batteries in particular.” EX1010, ¶[0021]; *see also id.*, ¶¶[0006]-[0109] (explaining that Hirai's battery structure is particularly advantageous for large-battery applications like EVs). Thus, Hirai and Zhou motivate the POSITA to use Hirai's large-battery electrode structure in Zhou's battery, and the POSITA would have had a reasonable expectation of success in doing so. EX1003, ¶202.

6. [14.7]

As discussed, Y and Z have the following values in the obvious modification to Zhou Example 8:

Y	Z (PP substituted for EA)	Y/Z
1.5 wt%	16.56 wt%	0.091

Sections XII.A, XII.B.3. Thus, in modified Zhou Example 8, $Y/Z=0.091$, falling in the claimed range of about 0.01 to about 0.3 and rendering it obvious. EX1003, ¶203.

7. [14.8]

Zhou Example 8 has 1,3,6-hexanetricarbonitrile (HTCN) as the claimed *trinitrile compound*. EX1014, ¶[0047]; Section XII.A; EX1003, ¶204.

C. Claim 15

1. [15.1]

Hirai discloses or suggests this element, and it would have been obvious to combine Zhou and Hirai for the reasons discussed in Ground 1A. Section VIII.C; EX1003, ¶205.

D. Claim 16

1. [16.1]

As explained, Hirai's D_2 values in the fifth and sixth means fall within the claimed range. Section VIII.D; EX1003, ¶206.

E. Claim 17

1. [17.1]

In Example 8, Zhou's *dinitrile compound* is *adiponitrile*. Sections XII.A, XII.B.3; EX1014, ¶[0047]; EX1018, 1; EX1001, 7:13-19; EX1003, ¶207.

XIII. GROUND 4A: ZHOU AND HIRAI, FURTHER IN VIEW OF HAN, RENDER OBVIOUS CLAIM 15

For the reasons in Ground 2A, a POSITA would have successfully configured Zhou's cathode to have Han's cathode compaction density *D2*. EX1003, ¶208. Section IX. Zhou, Hirai, and Han relate to analogous art—lithium-ion batteries, including those using non-aqueous electrolytes. EX1014, ¶¶[0001]-[0020], [0032]-[0048]; EX1010, Abstract, ¶¶[0004]-[0024]; EX1012, Abstract, ¶¶[0001]-[0017]; EX1001, 1:19-3:26; EX1003, ¶208. Like Zeng, Zhou cites market demand for batteries with high energy density. EX1014, ¶¶[0002]-[0005]; EX1003, ¶208. Thus, Zhou, Hirai, and Hirai render claim 15 obvious.

XIV. GROUNDS 3C, 4C: ZHOU/HIRAI, FURTHER IN VIEW OF KIM-'268, RENDER OBVIOUS CLAIMS 14-17; ZHOU/HIRAI/HAN, FURTHER IN VIEW OF KIM-'268, RENDER OBVIOUS CLAIM 15

For the reasons discussed in Grounds 1C, 2C, Kim-'268 motivates considering the ratio of trinitrile to PP in Zhou and substituting EA for PP in Zhou

Example 8. Section XI.¹² Zhou highlights the advantage of trinitrile (HTCN) by explaining that it has “[a high] density of nitrile groups per unit volume” and “better compatibility with the negative electrode and is easier to protect the positive electrode.” EX1014, ¶[0059]. Zhou discloses substituting EA with PP, drawing attention to PP. *Id.*, ¶[0011]. Zhou also cautions the POSITA against using an “excessive” amount of PP for its “a negative effect on the cycle performance,” focusing attention on Y/Z. EX1014, ¶[0059]; EX1003, ¶209.

XV. NO SECONDARY CONSIDERATIONS

Petitioner is unaware of evidence of alleged secondary considerations of non-obviousness having nexus to the Challenged Claims, but reserves the right to address any evidence PO presents.

XVI. INSTITUTION IS APPROPRIATE

As explained in Sections IV.B.3 and IV.C, unlike the ’363 Patent IPR Petition, Petitioner raises obviousness, not anticipation. Zeng and Zhou were merely cited in a long IDS providing English Abstracts only and not substantively evaluated or applied in rejection. Zeng discloses the weight of the solvent portion based on the

¹² For all Challenged Claim elements except Element [14.7], Petitioner incorporates by reference its analysis for those claim elements in Grounds 3A and 4A.

electrolyte's total weight, rendering obvious the weight percentage Z of PP in the total electrolyte. Zhou discloses the claimed subject matter except Example 8 uses EA instead of PP, but a POSITA would have substituted one ester (EA) for the other (EA). Zeng and Zhou undercut the reason the Examiner allowed the '131 Patent and do not require the assumptions of the Hong anticipation ground.

Zeng's and Zhou's Abstracts alone lack disclosure sufficient to show the unpatentability of the claims, so they were effectively not considered during prosecution. *Osteomed LLC v. Stryker Eur. Operations Holdings LLC*, IPR2022-00487, Paper 8 at 9 (PTAB Aug. 12, 2022) (Regarding *Advanced Bionics* factor 1, the "Examiner may not have been able to consider the portions of [the reference] on which Petitioner's challenges are based" because an "English language translation of Abstract only" was provided). Alternatively, the Office materially erred allowing the claims over omitted disclosures of Zeng and Zhou. *Sci. Design Co. v. Shell Oil Co.*, IPR2022-00158, Paper 7 at 25 (PTAB Apr. 4, 2022) (Regarding *Advanced Bionics* factor 2, the "Examiner, apart from initialing the asserted art in an IDS, did not indicate a substantive evaluation of the asserted art[.]").

Matsuoka was not cited and Kim-'268 was only cited in an IDS but not substantively evaluated. Matsuoka renders obvious using its preferred weight percentage of PP in Zeng, if further guidance is needed. Kim-'268 motivates adjusting Y/Z in Zeng and substituting PP for EA in Zhou. Hirai and Han, also not

cited, disclose the electrode configuration purportedly lacking from Hong and Ohashi.

PO asserts the '131 Patent against Petitioner in related litigation. EX1028. IPR should be instituted under *Fintiv. Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (PTAB Mar. 20, 2020). Having answered on January 20, 2025, the parties have invested little resources and timing remains uncertain. IPR will help resolve the parties' dispute. Petitioner presents compelling patentability challenges. If IPR is instituted, Petitioner stipulates not to pursue in the related litigation the Grounds in this Petition or any other ground Petitioner reasonably could have raised here for the Challenged Claims. *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020).

XVII. GROUNDS FOR STANDING

Petitioner certifies the '131 Patent is available for IPR and Petitioner is not barred or estopped from requesting IPR of the Challenged Claims.

XVIII. MANDATORY NOTICES (37 C.F.R. §42.8(A)(1))

Real Party-in-Interest (37 C.F.R. §42.8(b)(1)): The real party-in-interest is Petitioner Zhuhai CosMX Battery Co., Ltd.

Related Matters (37 C.F.R. §42.8(b)(2)): The '131 patent is currently asserted against Petitioner in *Ningde Amperex Technology Limited v. Zhuhai CosMX Battery Co.*, No. 2:24-cv-00728 (E.D. Tex.).

The '131 patent is a continuation of U.S. Patent No. 10,833,363, the subject of IPR2023-00586. The '131 Patent is related to the U.S. Patent No. 11,769,910, currently at issue in IPR2025-00405. On January 28, 2025, Petitioner filed a parallel Petition challenging claims 1-7, 12, and 14-17 of the '131 Patent in IPR2025-00431. Petitioner provides a separate ranking document explaining why both Petitions should be instituted.

Lead and Back-up Counsel (37 C.F.R. §42.8(b)(3)):

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Service Information (37 C.F.R. §42.8(b)(4)): Please direct all correspondence regarding this Petition to counsel at the above addresses, COSMX-PTAB@leehayes.com and PTAB@sternekessler.com. Petitioner consents to service by email at the addresses above.

XIX. CONCLUSION

Petitioner respectfully requests institution of IPR and cancellation of the Challenged Claims.

Respectfully submitted,

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Date: April 1, 2025

CERTIFICATE OF WORD COUNT (37 C.F.R. §42.24(d))

This Petition for *Inter Partes* Review complies with the type-volume limitation of 14,000 words, comprising 13,998 words, excluding the parts exempted by 37 C.F.R. §42.24(a)(1).

This Petition for *Inter Partes* Review complies with the general format requirements of 37 C.F.R. §42.6(a) and has been prepared using Microsoft® Word in 14-point Times New Roman font.

Respectfully submitted,

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CERTIFICATE OF SERVICE (37 C.F.R. §§42.6(e)), 42.105(a))

I certify that the above-captioned PETITION FOR *INTER PARTES* REVIEW FOR U.S. PATENT NO. 11,799,131, PETITIONER'S POWER OF ATTORNEY, and associated Exhibits 1001-1028 were served in their entireties upon the Patent Owner on April 1, 2025, via FedEx® Express as follows:

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