

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 IPR2025-00431
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	5
IV.	THE '131 PATENT	5
A.	Specification.....	6
B.	Prosecution History	9
1.	The '910 Patent.....	9
2.	'131 Patent	10
3.	Petitioner's prior art and obviousness arguments undercut the Examiner's reasons for allowance	13
C.	IPR2023-00586 ('363 Patent IPR).....	16
V.	PERSON OF ORDINARY SKILL IN ART	16
VI.	CLAIM CONSTRUCTION	17
VII.	IDENTIFICATION OF CHALLENGES AND PRIOR ART	17
VIII.	GROUND 1A: ZENG AND SUNOSE RENDER OBVIOUS CLAIMS 1, 2, 4-7, 12, 14, 15, AND 17	20
A.	Overview of Zeng.....	20
B.	Independent Claim 1	28
1.	[1.pre].....	28
2.	[1.1].....	29

3.	[1.2]	29
4.	[1.3] “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; ”	29
5.	[1.4]	30
6.	Elements [1.5], [1.6]	30
7.	[1.7] “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;”	38
8.	[1.8]	40
C.	Claim 2	40
1.	[2.1]	40
D.	Claim 4	40
1.	[4.1]	40
E.	Claim 5	41
1.	[5.1]	41
F.	Claim 6	41
1.	[6.1]	41
G.	Claim 7	42
1.	[7.1]	42
H.	Claim 12	43
1.	[12.1]	43
I.	Claims 14, 15, and 17	43

IX.	GROUND 2A: ZENG AND SUNOSE, FURTHER IN VIEW OF SU, RENDER OBVIOUS CLAIMS 3 AND 16	44
A.	Claims 3 and 16.....	45
1.	Elements [3.1], [3.2], [16.1].....	45
X.	GROUND 1B, 2B: ZENG AND SUNOSE, FURTHER IN VIEW OF MATSUOKA, RENDER OBVIOUS CLAIMS 1, 2, 4-7, 12, 14, 15, AND 17; ZENG, SUNOSE, AND SU, FURTHER IN VIEW OF MATSUOKA, RENDER OBVIOUS CLAIMS 3 AND 16.....	49
A.	Overview of Matsuoka.....	49
B.	Elements [1.7], [14.7].....	50
1.	Matsuoka discloses “a weight percentage of the propyl propionate is Z”.....	50
2.	Rationale to Combine	51
3.	The Zeng/Sunose/Matsuoka combination teaches or suggests the claims.....	54
XI.	GROUND 1C, 2C: ZENG/SUNOSE, ZENG/SUNOSE/MATSUOKA—FURTHER IN VIEW OF KIM—RENDER OBVIOUS CLAIMS 1, 2, 4-7, 12, 14, 15, AND 17; ZENG/SUNOSE/SU, ZENG/SUNOSE/SU/MATSUOKA—FURTHER IN VIEW OF KIM—RENDER OBVIOUS CLAIMS 3 AND 16.....	55
XII.	GROUND 3A: ZHOU AND SUNOSE RENDER OBVIOUS CLAIMS 1, 2, 4-7, 12, 14, 15, AND 17	60
A.	Overview of Zhou	60
B.	Independent Claim 1	66
1.	[1.pre].....	66
2.	[1.1].....	66
3.	[1.2].....	66

4.	[1.3].....	70
5.	[1.4].....	71
6.	Elements [1.5], [1.6]	71
7.	[1.7].....	72
8.	[1.8].....	72
C.	Claim 2	73
1.	[2.1].....	73
D.	Claim 4.....	73
1.	[4.1].....	73
E.	Claim 5	73
1.	[5.1].....	73
F.	Claim 6	73
1.	[6.1].....	73
G.	Claim 7	74
1.	[7.1].....	74
H.	Claim 12	74
1.	[12.1].....	74
I.	Claims 14, 15 and 17.....	74
XIII.	GROUND 4A: ZHOU AND SUNOSE, FURTHER IN VIEW OF SU, RENDER OBVIOUS CLAIMS 3 AND 16	75
A.	Claims 3 and 16.....	75
1.	[3.1].....	75
2.	[3.2], [16.1]	76

XIV. GROUNDS 3C, 4C: ZHOU/SUNOSE, FURTHER IN VIEW OF KIM, RENDER OBVIOUS CLAIMS 1, 2, 4-7, 12, 14, 15, AND 17; ZHOU/SUNOSE/SU, FURTHER IN VIEW OF KIM, RENDER OBVIOUS CLAIMS 3 AND 16	76
XV. NO SECONDARY CONSIDERATIONS	77
XVI. INSTITUTION IS APPROPRIATE	77
XVII. GROUNDS FOR STANDING.....	79
XVIII. MANDATORY NOTICES (37 C.F.R. § 42.8(A)(1))	79
XIX. CONCLUSION	80

TABLE OF AUTHORITIES

	Page(s)
Cases	
<i>In re Baxter Travenol Labs.</i> , 952 F.2d 388 (Fed. Cir. 1991)	2
<i>Apple Inc. v. Fintiv, Inc.</i> , IPR2020-00019, Paper 11 (PTAB Mar. 20, 2020).....	78, 79
<i>KSR, Int’l Co. v. Teleflex Inc.</i> , 550 U.S. 398 (2007).....	36
<i>Osteomed LLC v. Stryker Eur. Operations Holdings LLC</i> , IPR2022-00487, Paper 8 (PTAB Aug. 12, 2022).....	78
<i>Sci. Design Co. v. Shell Oil Co.</i> , IPR2022-00158, Paper 7 (PTAB Apr. 4, 2022)	78
<i>Sotera Wireless, Inc. v. Masimo Corp.</i> , IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020)	79
<i>In re Stepan Co.</i> , 868 F.3d 1342 (Fed. Cir. 2017)	26, 64
Statutes	
35 U.S.C. § 282(b)	17
Other Authorities	
37 C.F.R. § 42.8	79, 80
37 C.F.R. § 42.100(b)	17
MPEP § 2143.I.(E).....	27, 69

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”)
1009	Japan Patent Application Publication No. 2009-252349 to Sunose et al. (“Sunose”)
1010	Certified English Translation of Japan Patent Application Publication No. 2009-252349 to Sunose et al. (“Sunose”)
1011	China Patent No. 108023117 to Su et al. (“Su”)
1012	Certified English Translation of China Patent No. 108023117 to Su et al. (“Su”)
1013	China Patent Application Publication No. CN 105552439 A to Zhou et al. (“Zhou”)
1014	Certified English Translation of China Patent Application 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 Ampere 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

CLAIMS APPENDIX

Claim Element	Language
Claim 1	
[1.pre]	<i>An electrochemical device, comprising:</i>
[1.1]	<i>an electrode; and</i>
[1.2]	<i>an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate;</i>
[1.3]	<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>
[1.4]	<i>wherein, the electrode comprises a current collector,</i>
[1.5]	<i>a single-sided coating and a double-sided coating; a first part of the current collector is provided with the single-sided coating and a second part of the current collector is provided with the double-sided coating; and</i>
[1.6]	<i>an electrode compaction density of the electrode corresponding to the first part with the single-sided coating is D1, and, an electrode compaction density of the electrode corresponding to the second part with the double-sided coating is D2, wherein, about 0.8 $\leq D1/D2 \leq$ about 1.2;</i>
[1.7]	<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>
[1.8]	<i>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.</i>

Claim Element	Language
Claim 2	
[2.1]	<i>The electrochemical device according to claim 1, wherein the electrode is a cathode, and $3.5 \text{ g/cm}^3 \leq D2 \leq 4.3 \text{ g/cm}^3$.</i>
Claim 3	
[3.1]	<i>The electrochemical device according to claim 1, wherein the electrode is an anode, and $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$.</i>
Claim 4	
[4.1]	<i>The electrochemical device according to claim 1, wherein the dinitrile compound further comprises a compound of Formula (4):</i> $\text{CN}-R_1-\text{CN} \quad (4);$ <i>where R_1 selected from an alkylene group having 1-5 carbon atoms or an alkenylene group having 2-5 carbon atoms.</i>

Claim Element	Language
Claim 5	
[5.1]	<i>The electrochemical device according to claim 1, 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-hexaoxaicosanoic 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>

Claim Element	Language
Claim 6	
[6.1]	<i>The electrochemical device according to claim 1, wherein the trinitrile compound comprises a compound of Formula (6)</i> $\text{CN}-(\text{CH}_2)_x-\text{CH}\{(\text{CH}_2)_y-\text{CN}\}-(\text{CH}_2)_z-\text{CN} \quad (6);$ Formula (7) $\begin{array}{c} \text{R}_5 \\ \\ \text{X}_4-\text{O}-\text{R}_6-\text{C}-\text{R}_7-\text{O}-\text{X}_5 \\ \\ \text{R}_8 \\ \\ \text{O} \\ \\ \text{X}_6 \end{array} \quad (7)$ <i>or a combination thereof,</i> <i>where in Formula (6), x, y, and z represent an integer from 0 to 5, and x, y, and z are not 0 at the same time; and</i> <i>in Formula (7), R₅ represents hydrogen or an alkyl group having 1-5 carbon atoms, R₆, R₇ and R₈ are each independently an alkylene group having 1-5 carbon atoms, and X₄, X₅ and X₆ are each independently —R₉—CN, in which R₉ represents an alkylene group having 1-5 carbon atoms.</i>
Claim 7	
[7.1]	<i>The electrochemical device according to claim 1, wherein X is about 0.01-10 wt %, Y is about 0.01-10 wt %, and a weight percentage Z of the propyl propionate is about 5-50 wt %.</i>

Claim Element	Language
Claim 12	
[12.1]	<i>The electrochemical device according to claim 1, wherein the electrolyte further comprising one selected from a group consisting of: a cyclic carbonate ester having a carbon-carbon double bond, a fluorinated chain carbonate ester, a fluorinated cyclic carbonate ester, a compound having a sulfur-oxygen double bond, and any combination thereof.</i>
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
[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* review to cancel claims 1-7, 12, and 14-17 (“the Challenged Claims”) of U.S. Patent No. 11,799,131 (“the ’131 Patent”) (EX1001), assigned to Ningde Amperex Technology Limited (“Patent Owner”).

I. INTRODUCTION

The ’131 Patent claims electrochemical devices having electrolyte compositions already known to deliver the purported benefits identified in the specification, and obvious variations thereof. For high-voltage (above 4.4V) lithium-ion batterie, the electrolytes purportedly improve electrode stability and battery performance. The 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 .

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 the applicant amended the limits of the claimed ranges to narrowly avoid prior art.

Petitioner presents prior electrolytes disclosing dinitrile (X), trinitrile (Y), and PP (Z) values satisfying or rendering obvious the claimed ranges. *See* EX1006 (Zeng); EX1014 (Zhou). 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 or similar parameters and delivering the same benefits. The Patent adds nothing to the art warranting the broad patent protection sought. Additionally, Petitioner's prior art teaches the claimed electrode structure purportedly lacking from prior art considered during prosecution. *See* EX1010 (Sunose); EX1012 (Su).

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. *See, e.g.,* EX1007 (Matsuoka); EX1008 (Kim). 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.").

The '131 Patent claims also recite single- and double-sided coatings for electrodes that have about the same compaction densities—the ratio of $D1/D2$ ranges

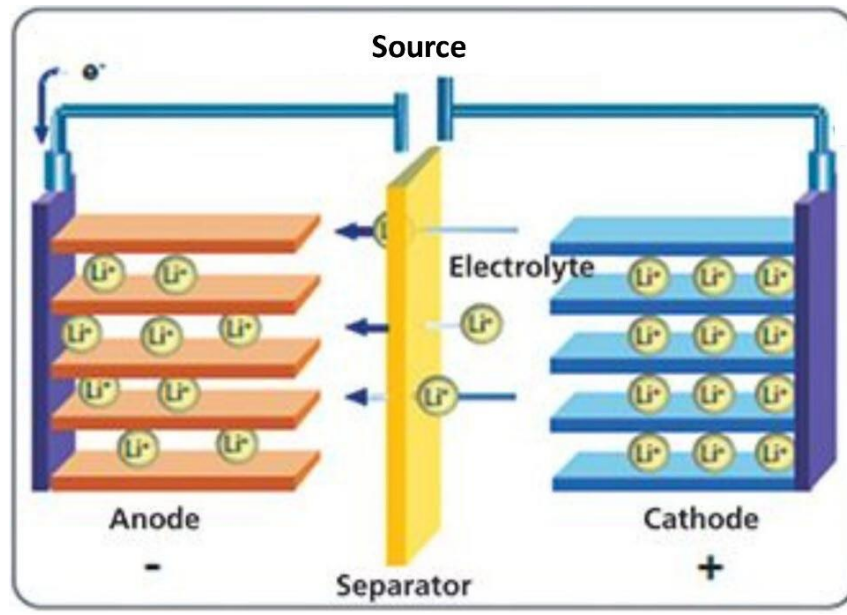
from 0.8 to 1.2—which the '131 Patent touts as inventive. But, here too, the prior art predates the '131 Patent, disclosing the same structures and compaction density ratios in both cathodes (EX1010 (Sunose)) and anodes (EX1012 (Su)). Indeed, the electrode structure did not factor into the Examiner's reasons for allowance.

II. TECHNOLOGY BACKGROUND

A. Lithium-ion Batteries

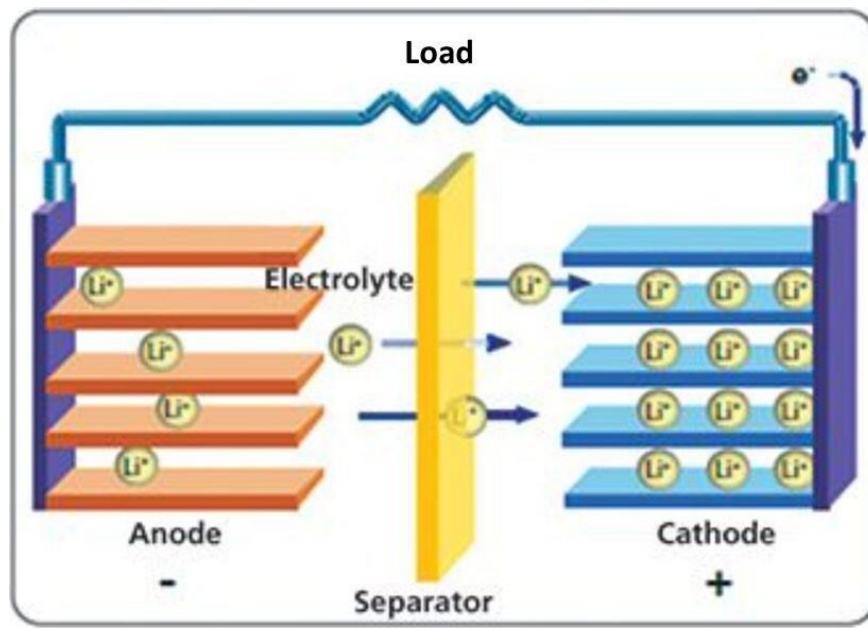
Lithium-ion batteries' high energy density makes them preferred power sources for electronic devices. *See, e.g.*, EX1006, ¶¶[0002]-[0006]. They contain cathode and anode electrodes—each with an active material coating on its current collector, a separator between the electrodes to prevent shorts, and an electrolyte including lithium salt, solvents, and optional 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, where they combine with the electrons to store an 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. *See, e.g.*, 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. *See* 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 1-7, 12, and 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 (“the ’920 Application”), claiming priority to Chinese 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**

Like the prior art, 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. *See id.*, Abstract, 6:1-55, 22:63-27:51. The '131 Patent does not express a preference for, or criticality to, any particular set of upper and lower limits for the $X+Y$, X/Y , Z , and Y/Z 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). *See* EX1001, 23:32-24:43; *see also id.*, 24:44-32:58; EX1003, ¶¶36-37.

- **Electrode Coatings**

The '131 Patent explains “[t]he 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. In Figure 4 below, electrode C has a single-sided coating 2 on one portion of the current collector 1 and a double-sided coating 2 on another portion of the current collector 1. *Id.*, 20:34-40.

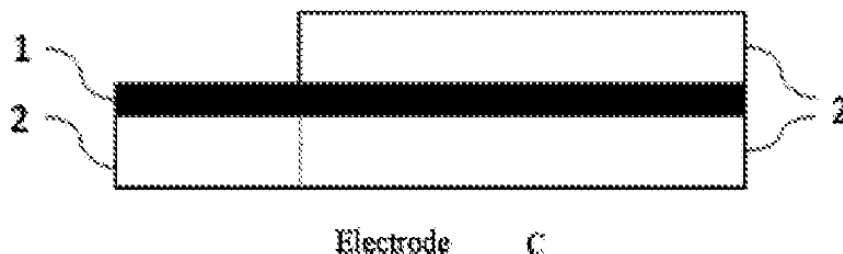


FIG. 4

This embodiment is for a “wound electrochemical device ... formed by winding an elongated electrode, so that both a single-sided coating and a double-sided coating are present on the elongated electrode.” EX1001, 20:41-44.

The '131 Patent explains the portion of “the electrode with a single-sided coating has an electrode compaction density D1,” the portion “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. Purportedly, when “about $0.8 \leq D1/D2 \leq \text{about } 1.2$ ” (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, ¶38-39.

In another embodiment, electrode A has “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” (FIG. 3). EX1001, 20:24-33, FIGS. 2, 3 (reproduced at right). 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.*, 20:44-48; EX1003, ¶40.

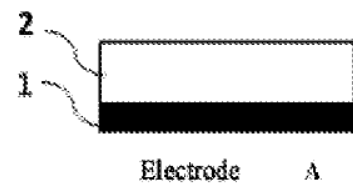


FIG. 2

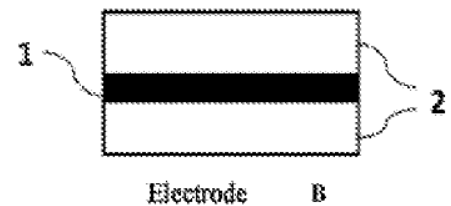


FIG. 3

Claim 1 recites an electrochemical device incorporating an electrolyte adhering to broad ranges for $X+Y$, X/Y , and Y/Z . The device includes an electrode

having a first and second parts with respective single- and double-sided coatings, and about $0.8 \leq D1/D2 \leq$ about 1. EX1001, 33:17-53; EX1003, ¶41.

B. Prosecution History

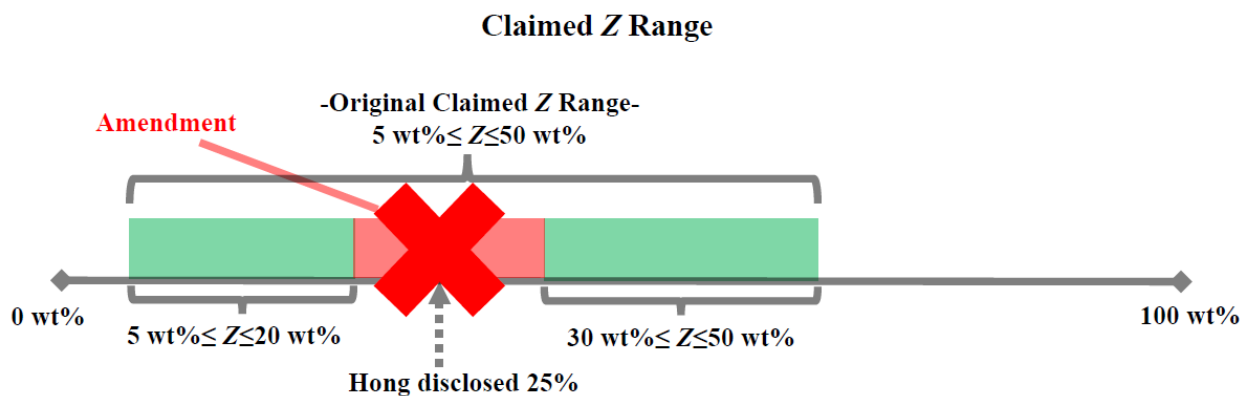
Prosecution of the '131 Patent and the '910 Patent (subject of IPR2025-00405)—related as continuations of U.S. Patent No. 10,833,363 (subject of IPR2023-00586)—demonstrates that electrolytes containing various weight percentages and relationships of dinitrile (*X*), trinitrile (*Y*), and PP (*Z*) were known and unpatentable over prior art. Additionally, the electrode configuration features (related to *D1*, *D2*) did not persuade the Examiner to allow the '131 Patent. Rather, both applications were allowed after selectively amending the electrolyte component ranges to avoid parameters taught by Hong (EX1015). EX1003, 42-49.

1. The '910 Patent

The '910 Patent claims focus on 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), the applicant overcame Hong anticipation and obviousness rejections by amending the independent claims to exclude 20-30 wt% from the original 5-50 wt% *Z* range¹ to

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

avoid Hong's (EX1015) disclosed electrolyte having 25% PP and otherwise satisfying the claim elements:



See EX1026, 27-30, 56-77, 194-209.

2. '131 Patent

Prosecution of the '920 Application (now the '131 Patent) confirmed dinitrile-, trinitrile-, and PP-based electrolytes were unpatentable over the 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/cm^3 - 2.2 g/cm^3 , but the applicant argued Ohashi's electrode has a one-sided coating only. See EX1002, 62-63; EX1023, ¶[0180]; EX1003, ¶45.

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

- reduce the upper limit of the claimed X+Y range from 11 wt% to 8 wt%;

- reduce the upper limit of the claimed 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 of the first and second parts of the electrode having single- and a double-sided coatings, respectively.

Id., 73-95; EX1003, ¶46.

Regarding the electrolyte aspects, the applicant argued the cited Hong 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 trinitrile (Y), PP (Z), or the organic solvent, based on the electrolyte’s total weight. *Id.*, 92; EX1003, ¶47.

Regarding the electrode features, the applicant argued “*neither Hong nor Ohashi disclose or suggest the configuration where a first part of the current collector is coated on a single side, while a second part of the current collector is coated on both sides.*” *Id.*, 90 (emphasis in original).² The applicant argued the claims were allowable because “Hong discloses electrodes formed by applying

² Unless otherwise specified, all emphasis is added.

active material coating to ***both sides*** of the current collector, while Ohashi discloses electrodes formed by applying active material coating to ***only one side*** of the current collector.” EX1002, 90 (emphasis in original); EX1003, ¶48.

Following the response, the Examiner allowed the claims, focusing on the amended electrolyte component ranges—not the electrode structure—in the reasons for allowance:

[W]hile the applied references disclose a battery electrolyte having a number of organic compound constituents at various combinations and ratios with the electrode structure as set forth in the claims, none disclose nor render obvious the electrolyte having the *specific* organic compounds at the *explicit* amounts and ratios as set forth in the claims and electrode structure as set forth in the claim.

EX1002, 30; *see also id.*, 23-31. This matches the Examiner’s interview summary—omitting the electrode structure and highlighting that “Applicant argues prior art does not disclose *amended ranges of materials & compounds* of proposed amendments and compares this to what the prior art reference(s) show,” which “appears persuasive.” *Id.*, 51; EX1003, ¶49.

3. Petitioner's prior art and 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. *Infra* Sections VIII.A, VIII.B; EX1003, ¶51. Zeng also discloses PP in such an electrolyte.

Addressing the applicant's Hong critique, Zeng discloses the weight percentage of the solvent plus LiPF_6 based on the electrolyte's total weight. Embodiments 4 and 6 provide the weight percentages of all remaining additives, including that of 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 starts at 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 discloses or renders obvious the specific compounds, ranges, and relationships recited in the Challenged Claims. Example 8 teaches an electrolyte that satisfies the 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 that 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,

- **Matsuoka and Kim**

Although PP was a well-known electrolyte performance enhancer, Matsuoka and Kim provide specific motivation to consider and modify the amount of PP, and the trinitrile/pp ratio (Y/Z), to improve lithium-ion 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.* It would have been obvious to simply select Matsuoka's preferred weight for PP as the weight percentage Z in Zeng's or Zhou's electrolytes. *Id.*

- **Sunose and Su**

Sunose's and Su's electrodes have the configuration purportedly absent in Hong and Ohashi. *Infra* Sections VIII.B.6; IX; EX1003, ¶55. Sunose describes single- and double-side-coated cathodes having the claimed compaction density ratios that exhibited good adhesion and reduced electrode breakage during rolling/compaction. A POSITA would have used Sunose's advantageous cathodes in Zeng's and Zhou's electrochemical devices—which are broad regarding electrode construction. *Id.* Su discloses anodes with single- and double-sided coating portions having the claimed compaction density ratios, teaching this configuration increases energy density of the battery. *Id.*

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

Zeng, Zhou, and Su were not meaningfully evaluated or applied in rejection during prosecution. The applicant only provided English Abstracts of Zeng and Zhou in a long IDS during prosecution of the '882 Application. *See* EX1002, 184-191. Su was not cited in the '882 Application, and the applicant only cited an English Abstract of Su during prosecution of the '910 Patent. EX1026, 83, 384. But the Abstracts alone lack sufficient information to determine patentability of the '131 Patent claims. Likewise, Kim was only cited in an IDS and not substantively

evaluated. EX1002, 186; EX1026, 383. Matsuoka and Sunose were not cited at all in original prosecution. EX1003, ¶56.

C. IPR2023-00586 ('363 Patent IPR)

The PTAB denied the '363 Patent IPR petition, rejecting three inherency assumptions in a Hong anticipation ground. *See* 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, ¶¶57-58.

V. PERSON OF ORDINARY SKILL IN ART

A person of ordinary skill in the art (“POSITA”) of the '131 Patent in September 2018 would have an advanced degree in chemistry, chemical engineering, materials science, or a related field, and two or more years of experience related to the design, research, evaluation, preparation, and/or manufacture of electrochemical energy storage devices. *See* EX1003, ¶17; EX1001, 1:18-20. This level of skill is approximate, and more experience could compensate for less formal 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. *See* 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, however, and solely for purposes of this Petition, Petitioner applies Patent Owner's positions that both claims 1 and 14 read on the same subject matter. On January 7, 2025, Patent Owner served contentions in related litigation, including a claim chart alleging infringement of the '131 Patent that equated the elements of claim 14 with claim 1. EX1027, 12-14. Patent Owner contended an electrode having a current collector with both single- and double-sided coating portions satisfied all limitations of claims '131 Patent claims 1 and 14, without separate analysis of claim 14. *Id.*, 1-4 (claim 1 analysis), 12-14 (referring to claim 1 for all claim 14 limitations without more). Under Patent Owner's positions, Petitioner's art renders obvious the Challenged Claims.

VII. IDENTIFICATION OF CHALLENGES AND PRIOR ART

Petitioner requests cancellation of '131 Patent claims 1-7, 12, and 14-17 as obvious under § 103 as follows:

Ground ³		Claims	References
Zeng Grounds			
1	A	1, 2, 4-7, 12, 14, 15, 17	• China Patent Application Publication No. CN 106099187A (“Zeng”, EX1005) • Japan Patent Application No. 2009-252349 (“Sunose”, EX1009)
	B		• Zeng • Sunose • U.S. Patent Application Publication No. 2013/0224535 A1 (“Matsuoka”, EX1007)
	C		• Zeng; Zeng/Matsuoka • Sunose • U.S. Patent Application Publication No. 2017/0288268 A1 (“Kim”, EX1008)
2	A	3, 16	• Zeng • Sunose • China Patent No. 108023117 (“Su”, EX1011)
	B		• Zeng • Sunose • Matsuoka • Su

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

	C		• Zeng; Zeng/Matsuoka • Sunose • Su • Kim
3	A	1, 2, 4-7, 12, 14, 15, 17	• China Patent Application Publication No. CN 105552439 A (“Zhou”, EX1014) • Sunose
	C		• Zhou • Sunose • Kim
4	A	3, 16	• Zhou • Sunose • Su
	C		• Zhou • Sunose • Su • Kim

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

- **Zeng:** filed July 13, 2016; published November 9, 2016. EX1006.
- **Sunose:** filed in 2008; published in 2009. EX1010.
- **Su:** filed November 30, 2017; published May 11, 2018. EX1012.
- **Matsuoka:** filed in 2011; published in 2013. EX1007.
- **Kim:** filed in 2016; published October 5, 2017. EX1008.
- **Zhou:** filed December 16, 2015; published May 4, 2016. EX1014.

VIII. GROUND 1A: ZENG AND SUNOSE RENDER OBVIOUS CLAIMS 1, 2, 4-7, 12, 14, 15, AND 17

A. Overview of Zeng

Zeng discloses dinitrile- and trinitrile-based electrolytes containing *X* and *Y* in the claimed amounts. Embodiments 4 and 6 have 20 wt% PP *before* adding LiPF₆ and additives, suggesting or rendering obvious that the total electrolyte has less than 20 wt% PP. EX1003, ¶¶64-65, 76; EX1001, claim 7. The Challenged Claims would have been obvious over Zeng Embodiments 4 and 6. *See* EX1006, ¶¶[0045]-[0049].

Zeng describes “a wide-temperature-range homogeneous non-aqueous electrolyte solution that has good lithium ion transport properties, electrode plate wettability, and interfacial compatibility.” *Id.*, ¶[0009]. Zeng’s electrolytes have:

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

Id., ¶¶[0011]-[0018], [0024]; EX1003, ¶77.

Zeng teaches the roles of each electrolyte component. FEC has “good film-forming properties and resistance to oxidation[,]” which “ensures good high-voltage

cycling performance of the battery without seriously affecting the high-temperature performance of the battery[.]” EX1006, ¶[0028]. The dinitrile and trinitrile complement each other at different temperatures. Dinitriles “stabilize the structure of the positive electrode material, compensating for the high-temperature battery gas production problem caused by the FEC,” *id.*, ¶[0034], which “improv[es] the high-temperature performance of the battery,” *id.*, ¶[0029]. The trinitrile “has better solubility in the electrolyte solution, without the problem of precipitation at low temperatures”—improving low-temperature performance. *Id.*, ¶[0030]; *see also id.*, Abstract, ¶¶[0038], [0045] (Table 1); EX1003, ¶¶78-79.

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

⁴ As Dr. Lucht explains, a POSITA would understand this to mean adding

additives in certain weight percentages. EX1006, ¶[0037]. Thus, the base electrolyte of both Embodiments has 20 wt% PP before adding LiPF₆ and additives. EX1003, ¶¶80-81.

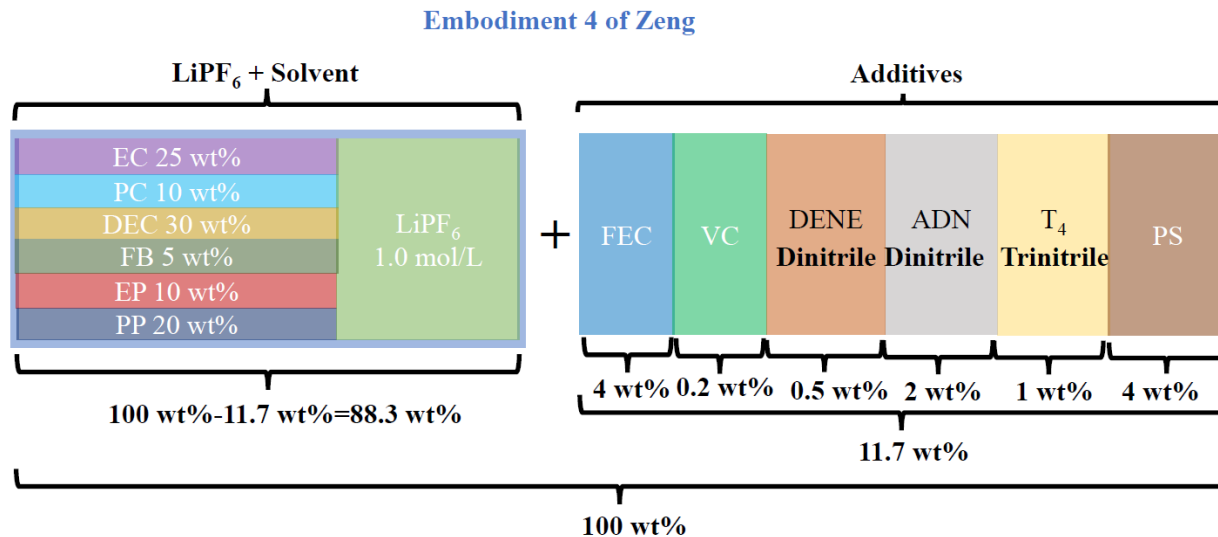
To this base electrolyte of Zeng Embodiments 4 and 6:

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

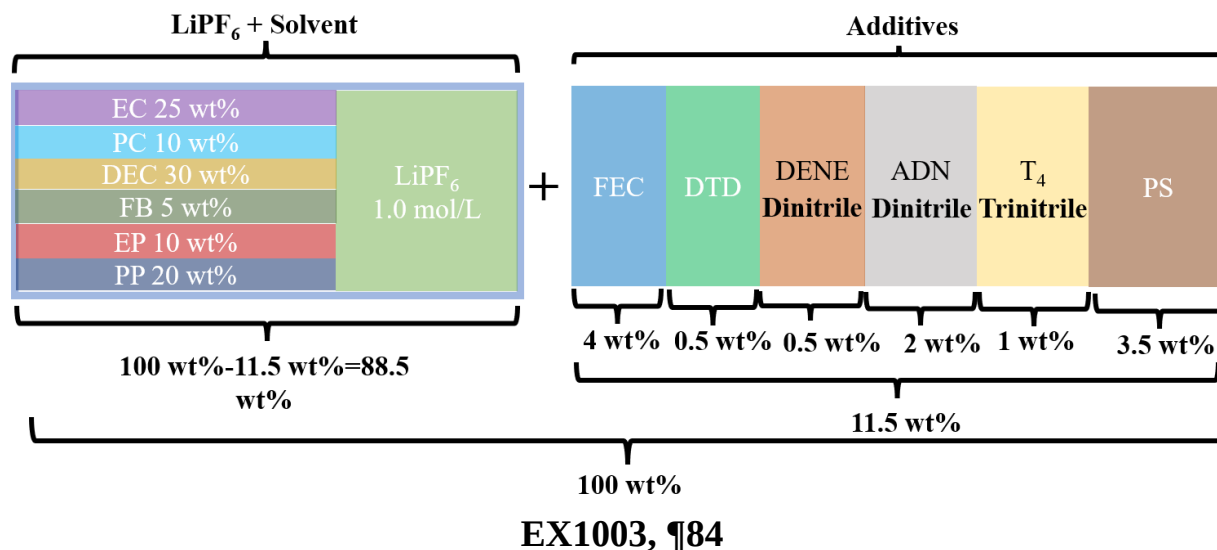
(solid) LiPF₆ to the specified EC:PC:DEC:FB:EP:PP solvent mixture to reach a concentration of 1.0 mol/L LiPF₆. EX1003, ¶80, n.6. While LiPF₆ is commercially available premixed in different solvents to different concentrations, Zeng already discloses a solvent mixture for its electrolytes. In such cases, 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, ¶80, n.6.

EX1006, ¶[0037]; *see also id.*, ¶¶[0044]-[0049]. Embodiment 4 also contained the *trinitrile* 1,3,6-hexanetricarbonitrile (HTCN, “T4”) as the Formula I nitrile. *Id.*, ¶¶[0044]-[0049] (Table 1). Embodiment 6 was identical to Embodiment 4 except for swapping VC for 0.5 wt% ethylene sulfate (“DTD”) and having slightly less PS at 3.5 wt%. *Id.*, ¶[0046]. EX1003, ¶¶82-83.

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



Embodiment 6 of Zeng



Weight percentage of ADN, DENE (*dinitrile*) in the total electrolyte: ADN and DENE are *dinitriles* because they have two nitrile groups. EX1018, 1, 318. As illustrated above, in both Embodiments, ADN and DENE have a combined weight percentage (the claimed X) of 2 wt%+0.5 wt%=2.5 wt% of the total electrolyte. EX1003, ¶85.

Weight percentage HTCEN (*trinitrile*) in the total electrolyte: HTCEN is a *trinitrile* because it has three nitrile groups. EX1018, 100; EX1020. In Embodiments 4 and 6, HTCEN has a weight percentage (the claimed Y) of 1 wt% of the total electrolyte. EX1003, ¶86.

Weight percentage PP in the total electrolyte: Embodiments 4 and 6 had 20 wt% PP *before* adding LiPF₆ and the remaining additives to the solvents. Unlike Hong, and as illustrated above, 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, ¶87.

Thus, PP would 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. But since any amount of LiPF_6 has weight, 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. Moreover, as explained in Ground 1A 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. See EX1003, ¶¶87-92; EX1019, 2, 12, 20, 29, 36, 45.

Thus, 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%

Id., ¶93.

Zeng Embodiments 4 and 6 improved high-voltage cycling performance of lithium-ion batteries, showing increased capacity retention rate 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, ¶94.

Nonetheless, a POSITA would have been motivated to implement Zeng Embodiments 4 and 6 with a reasonable expectation of success. EX1003, ¶95. Embodiment 4 and 6 batteries significantly outperformed the Comparative Examples in capacity retention after 500 cycles. *See* EX1006, ¶¶[0045]-[0047]. Other than 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. *See* MPEP § 2143.I.(E); EX1003, ¶¶95-96.

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, ¶97.

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, ¶98.

Reasonable expectation of success: All Zeng Embodiments were tested successfully and outperformed the Comparative Examples. *See* 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, ¶99.

B. Independent Claim 1

1. [1.pre]⁵

Zeng Embodiments 4 and 6 electrolytes separately render the Challenged Claims unpatentable. EX1006, ¶¶[0046], [0049]. Zeng’s electrolytes were used in a

⁵ The enclosed Claims Appendix includes the Challenged Claim language with bracketed reference numerals identifying respective Claim Elements referenced in this Petition.

lithium-ion secondary battery (*an electrochemical device*) as claimed. *See id.*, ¶¶[0028]-[0034]; EX1003, ¶¶100-101; *supra* Section VIII.A.

2. [1.1]

Zeng's Embodiment 4 and 6 electrolytes were used in a lithium-ion secondary battery, which by definition has electrodes. *See* EX1006, Abstract, ¶¶[0028]-[0034], [0052]-[0053]; EX1003, ¶¶102-103; *supra* Section VIII.A

3. [1.2]

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, ¶¶104-105; *supra* Section VIII.A.

4. [1.3] “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 %≤(X+Y)≤about 8 wt %, and about 0.1≤(X/Y)≤about 6; ”

As explained above, 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

Supra 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, ¶¶106-107.

5. [1.4]

Zeng discloses electrolytes, including Embodiments 4 and 6, for lithium-ion batteries. EX1006, ¶¶[0036]-[0053]. All lithium-ion batteries, by definition, have a positive *electrode* and a negative *electrode* that each *comprises a current collector*, as claimed. See EX1003, ¶¶108-109; EX1010, Abstract, ¶[0021].

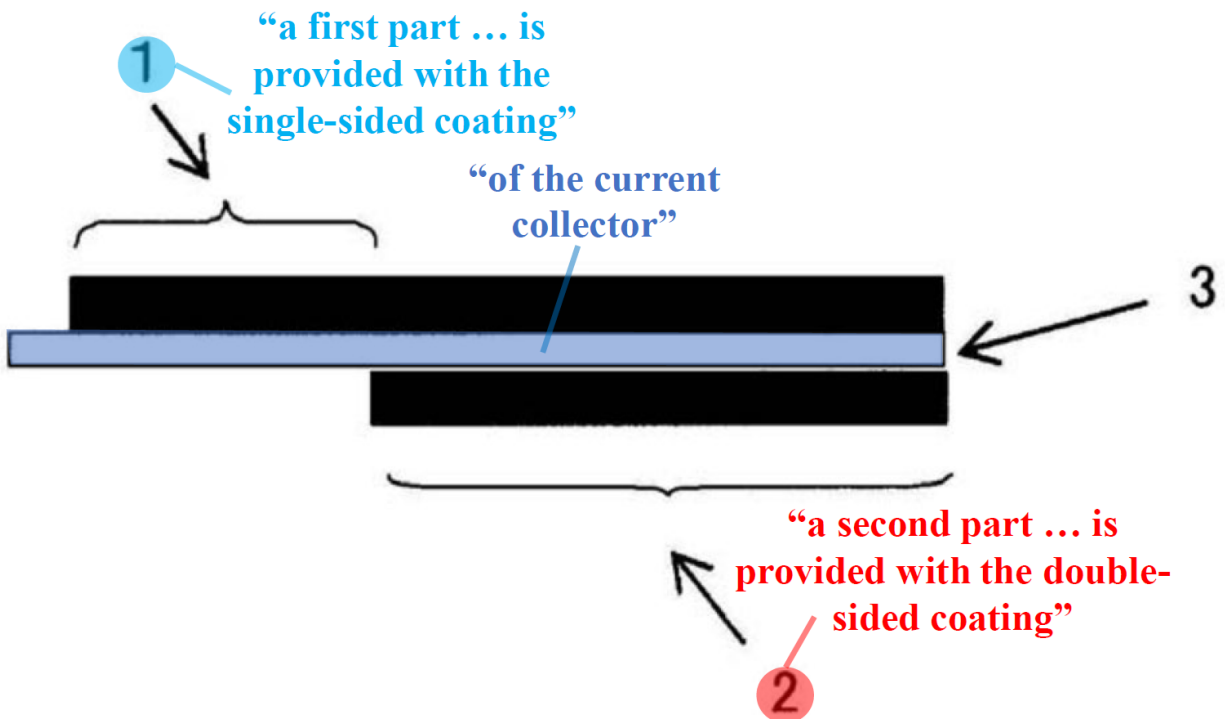
6. Elements [1.5], [1.6]

Zeng focuses on electrolyte compositions, not electrode structures. But Sunose discloses a lithium-ion battery with a cathode having single- and double-sided coating portions on its current collector, as claimed. A POSITA would have found it obvious to modify Zeng's battery based on Sunose to arrive at the claimed subject matter. EX1003, ¶110.

- a. [1.5]: “a single-sided coating and a double-sided coating; a first part of the current collector is provided with the single-sided coating and a second part of the current collector is provided with the double-sided coating; and”**

As highlighted below, Sunose discloses a positive electrode (cathode) with *a single-sided coating and a double-sided coating; a first part (single-side coating part 1) of the current collector (current collector 3) is provided with the single-sided*

coating and a second part (double-sided coated part 2) of the current collector (current collector 3) is provided with the double-sided coating, as claimed. EX1010, ¶¶[0005], [0007]-[0010], [0012], [0013], [0024]; EX1003, ¶111.



Sunose, FIG. 2*⁶

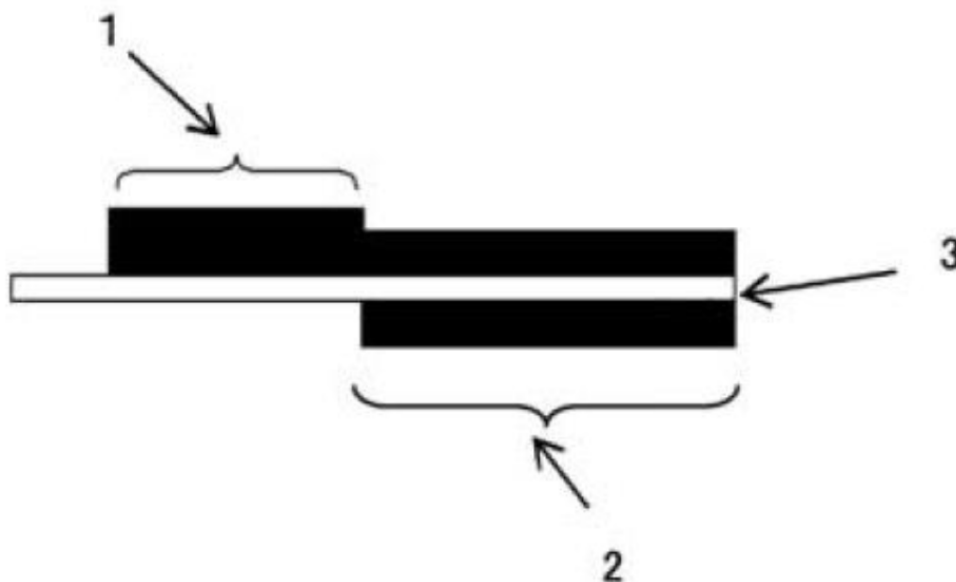
As shown, Sunose’s electrode has “[a] single-sided active material layer portion [1], wherein the active material layer is formed only on a single side of the current collector [3]” and “[a] two-sided active material portion [2]” with an active material

⁶ Petitioner identifies annotated or otherwise modified figures from the Exhibits with an “*”.

layer formed on both sides of the current collector 3. EX1010, ¶[0007]; *See also* EX1003, ¶112.

Sunose notes that one rolling setting might provide the right compaction density and adhesion for the single-sided portion but may excessively load the thicker double-sided portion, weakening the electrode and increasing crack rate and breakage. EX1010, ¶¶[0010], [0012]. Sunose addressed this problem by making the pre-compaction thickness of the single-sided coating greater than that of each coating of the double-sided coating portion, as seen in Figure 1 below. *Id.*, Abstract, [0011]-[0017], [0022]-[0029]. EX1003, ¶113.

[FIG. 1]



Sunose, FIG. 1

Then, Sunose rolls the electrode, while controlling the resulting ratio N/M of the packing density N ($D2$) of the double-sided coating portion to the packing density M ($D1$) of the single-sided coating portion M , to fall between 0.7 and 1.0. *See, e.g.*, EX1010, ¶¶[0012]-[0017], [0021]-[0023], [0041]-[0043]. Accordingly, the rolling process applies uniform pressure across both electrode portions, improving overall adhesion while avoiding breakage (peeling and/or cracking). *See, e.g., id.*, ¶¶[0018], [0021]-[0022], [0028], [0042], [0044]; EX1003, ¶114.

- b. [1.6] “an electrode compaction density of the electrode corresponding to the first part with the single-sided coating is $D1$, and, an electrode compaction density of the electrode corresponding to the second part with the double-sided coating is $D2$, wherein, about $0.8 \leq D1/D2 \leq \text{about } 1.2$;”

At least Sunose’s Examples 2-4 electrode plates satisfy this element, having single- and double-sided electrode compaction densities $D1$, $D2$ (packing densities) falling within the claimed range, as shown in the table below. EX1003, ¶115.

Example	$D1$ (g/cm ³) (M)	$D2$ (g/cm ³) (N) ⁷	$D1/D2$
2	5.0	4.0	1.25
3	4.4	4.0	1.1
4	4.0	4.0	1.0

⁷ Sunose’s N , M respectively correspond to claimed $D2$, $D1$ because the

EX1010, ¶¶[0031]-[0033], [0040], Table 1.

Sunose's densities are the claimed *compaction densities of the electrode* because they are “the packing density of the active material layer on which coating has been applied.” EX1010, ¶[0021]. This matches the density calculation in the '131 Patent specification, which excludes the weight and thickness of the of the current collector to target the active layer compaction density. See EX1001, 20:54-64; EX1003, ¶116.

For the density N, “*rolling was performed using a roll press machine* to obtain a density of the active material layer on the two-side coated portion,” resulting in the density values N in the Examples. EX1010, ¶[0031]. Likewise, for the density M, “a density of the active material layer on the single-side coated portion,” resulting in the density values M of the Examples. *Id.*; see also *id.*, ¶¶[0032]-[0037], [0041]-[0044] (“active material density”); EX1003, ¶117. Compacting the electrodes, the rolling process “*roll[s]* the electrodes that have been coated and dried in the

former is density for the double-sided coated portion of the electrode and the latter is the packing density for the single-sided coating portion. See, e.g., EX1010, ¶¶[0014], [0021], [0041], Table 1. That is, $D1/D2$ in the '131 Patent is the same as M/N in Sunose. EX1003, ¶115, n.9.

manufacturing process *at high density*.” EX1010, ¶[0006]; *see also id.*, ¶¶[0007]-[0008], [0012]-[0016].

All Sunose Examples have a “packing” density $D2$ of 4.0 g/cm³ for the double-sided portion 2, and Examples 2 through 4 respectively have packing densities $D1$ of 5.0, 4.4, and 4.0 g/cm³. EX1010, ¶¶[0029]-[0033], [0040]; EX1003, ¶118. This results in a ratio $D1/D2$ of 1.25, 1.1, and 1.0 for Examples 2-4 of Sunose, respectively. The Examples 3 and 4 ratios fall within the claimed range, and a POSITA would reasonably consider Example 2’s ratio 1.25 to be “*about 1.2*,” as claimed. EX1003, ¶118. Indeed, the ’131 Patent states that “about” covers “minor variations” including “less than or equal to $\pm 10\%$ of the stated value[.]” EX1001, 4:12-31. Thus, Sunose Example 2’s ratio of 1.25 constitutes less than a 10% “minor variation”—within $(1.25-1.2)/1.2=4.2\%$ of the claimed range. EX1003, ¶118.

c. Rationale to combine Zeng and Sunose

A POSITA would have been motivated, with a reasonable expectation of success, to configure Zeng’s cathode according to Sunose, resulting in Elements [1.5] and [1.6]. That is, it would have been obvious to make the pre-rolling thickness of the single-sided coating greater than the pre-rolling thickness of each layer forming the double-sided layer—like Figure 1 of Sunose—and roll the electrode to achieve the resulting compaction density ratio N/M taught by Sunose. EX1003, ¶120.

- **Analogous art**

Sunose is analogous art because it falls in the same field of endeavor—lithium-ion secondary batteries, including those employing non-aqueous electrolytes. *See* EX1010, Abstract, ¶¶[0001]-[0011], [0043], [Claim 3]; EX1003, ¶121. Zeng seeks to improve performance of lithium-ion batteries, which have electrode assemblies, by describing advantageous electrolyte compositions. EX1006, ¶¶[0001]-[0006]; *see also* EX1001, 20:41-53, 23:24-28. Sunose's electrode assembly, including its pre-rolling structure and compaction density properties, improves battery performance by increasing adhesion of the electrode layers while mitigating breakage of the electrode plate during rolling. EX1010, ¶¶[0010], [0012], [0017]-[0018], [0021], [0024].

- **Teaching, suggestion, motivation**

Zeng and Sunose would have motivated using Sunose's electrode configuration in Zeng's Embodiment 4 and 6 batteries—i.e., making the pre-rolling single-sided coating thicker than the pre-rolling thicknesses of each double-sided coating portion (Figure 1) and rolling the electrode to Sunose's disclosed compaction density ratio N/M. EX1003, ¶122; *KSR, Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417-418 (2007).

Electrode details: Zeng focuses on electrolyte compositions, not electrode structures. Thus, a POSITA reading Zeng would have looked to other references,

like Sunose, for electrode structure and implementation details. EX1003, ¶123. The need to use some rolled electrode configuration in Zeng's batteries would have prompted a POSITA to adopt Sunose's electrode configuration. *Id.*

Maximizing electrode area: Sunose teaches a particularly advantageous electrode configuration that maximizes electrode area, increasing battery capacity and performance. EX1010, ¶[0004]. First, Sunose's spiral design permits more electrode surface area within a given space, increasing capacity. *Id.* Second, rolling the electrode exposes surfaces of the innermost and outermost ends of the rolled current collector, "increas[ing] the effective electrode area, thereby improving battery performance." EX1010, ¶[0005]. Industry pressure, noted by Zeng and Sunose, to increase battery capacity and performance would have motivated the POSITA to use Sunose's electrode design to increase electrode surface area. EX1003, ¶124.

Improving adhesion; reducing breakage: Sunose teaches that arranging the single- and double-sided electrode coating thicknesses according to Figure 1, and rolling the electrode to Sunose's disclosed compaction density ratios N/M, reduce electrode breakage and improve adhesion. This further reason would have prompted a POSITA to use Sunose's electrode configuration in Zeng. EX1003, ¶¶125-126. Sunose explains that one rolling setting might provide the right compaction density and adhesion for the single-sided portion but excessively load the thicker double-

sided portion, weakening the electrode and increasing crack rate and breakage. EX1010, ¶¶[0010], [0012]. Thus, Sunose discloses making the pre-rolling thickness of the single-sided coating greater than that of each coating of the double-sided portion and rolling the electrode to control the ratio N/M to fall between 0.7 and 1.0. *Id.*, ¶¶[0016]-[0017], [0027]-[0028], [0042], [0043], FIG. 1. This way, Sunose's rolling process applies uniform pressure across both portions of the electrode, improving overall adhesion while avoiding breakage. *Id.*, ¶¶[0042], [0044].

- **Reasonable expectation of success**

A POSITA would have had a reasonable expectation of success using Sunose's electrode configuration in Zeng's batteries. Zeng does not disclose any physical requirements for its high-voltage (4.4V) lithium-ion batteries, broadly intended for "the digital, energy storage, power, and military aerospace fields." EX1006, ¶[0002]; *see also id.*, ¶[0035]. Sunose also generally intends its electrode configuration for batteries of "consumer electronic devices," so the POSITA would have reasonably expected Sunose's electrode configuration to work in Zeng's batteries. EX1010, ¶[0002]; EX1003, ¶127.

7. **[1.7] "wherein based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z; wherein, about $0.01 \leq (Y/Z) \leq \text{about } 0.3$;"**

As explained, the claimed Y and Z have the following values in Zeng:

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

Supra Section 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. *Peterson*, 315 F.3d at 1329; EX1003, ¶128.

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, ¶¶129-132. With Y=1 wt%, achieving a Y/Z ratio of 0.3 or more would require Z to be 3.33 wt% or less. But, as explained by Dr. Lucht, 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 a Y/Z range falling within the claimed range—greater than 0.01 (0.057 and 0.056) and certainly less than 0.3. *Titanium Metals*, 778 F.2d at 782-783; EX1003, ¶¶133-134.

8. [1.8]

As explained, Zeng Embodiments 4 and 6 both have 1,3,6-hexanetricarbonitrile (HTCN) as the claimed *trinitrile compound*. EX1006, ¶¶[0046], [0049]; *supra* Section VIII.A; EX1003, ¶135.

C. Claim 2

1. [2.1]

The Zeng-Sunose combination includes this element. EX1003, ¶¶136-138. As explained, Zeng's lithium-ion battery includes electrodes—a *cathode* and an anode. Section VIII.B.2; EX1006, Abstract, ¶¶[0028]-[0034], [0052]-[0053]. Sunose focuses *cathode* (positive electrode) configuration. *See, e.g.*, EX1001, ¶¶[0011]; [0029]-[0040]. Moreover, as explained in Section VIII.B.6, all four Sunose Examples had a packing density $N(D2)$ of 4 g/cm^3 for the double-sided coating portion, falling in the claimed range of $3.5 \text{ g/cm}^3 \leq D2 \leq 4.3 \text{ g/cm}^3$. EX1010, ¶¶[0031]-[0033], [0040]; EX1003, ¶137. Thus, a POSITA would have incorporated Sunose's electrode configuration for the *cathode* of Zeng's Embodiments. EX1003, ¶138.

D. Claim 4

1. [4.1]

As explained, in Embodiments 4 and 6, Zeng's *dinitrile compound* includes *adiponitrile*. EX1006, ¶¶[0029]-[0030]. The structural formula for adiponitrile is $\text{CN}(\text{CH}_2)_4\text{CN}$, so the alkylene group R_1 (i.e., $(\text{CH}_2)_4$ or $\text{CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2$) has four

carbon atoms. See EX1003, ¶139; EX1018, 1; EX1001, 7:13-19 (identifying adiponitrile specifically as a Formula [4] compound).

E. Claim 5

1. [5.1]

As explained, Zeng Embodiments 4 and 6 have *adiponitrile* (ADN) and *ethylene glycol bis(2-cyanoethyl)* (DENE) as the claimed *dinitrile compound*. EX1006, ¶¶[0029]-[0030]; *supra* Section VIII.A; EX1003, ¶140.

F. Claim 6

1. [6.1]

As discussed, Zeng Embodiments 4 and 6 both have 1,3,6-hexanetricarbonitrile (HTCN)—both recited in claim 5— as the claimed *trinitrile compound*. EX1006, ¶¶[0046], [0049]; *supra* Section VIII.A. As Dr. Lucht explains, HTCN has the structural formula $\text{NC-CH}_2\text{-CH(CN)-CH}_2\text{-CH}_2\text{-CH}_2\text{-CN}$ and thus satisfies claimed Formula (6) where $x=1$, $y=0$, $z=3$, so “ x , y , and z represent an integer from 0 to 5, and x , y , and z are not 0 at the same time,” as claimed. See EX1003, ¶141; EX1018, 100-103; EX1020. Moreover, after introducing Formula (6), the ’131 Patent provides a list of compliant trinitriles including HTCN. EX1001, 7:41-8:27.

G. Claim 7

1. [7.1]

As explained, X, Y, and Z have the following values in Zeng, falling within the claimed ranges for X, Y, and Z:

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%

Supra Section VIII.A; *see also* EX1003, ¶142.

Although not required to show obviousness of the claimed Z range, both Zeng Embodiments have Z values above 5 wt% (low end of claimed Z range) of the total electrolyte. EX1003, ¶¶143-147. As Dr. Lucht explains, diluting PP (i.e., reducing Z) from 20 wt% of the solvent to 5 wt% in the total electrolyte would reduce the solvent to just 25 wt% of the total electrolyte and increase the concentration of LiPF₆ to nearly *four times* the (typical) 1.0 mol/L specified by Zeng. *Id.* This flips the notion of a solvent-based electrolyte in which “additives” and LiPF₆ are dissolved, resulting in an atypical composition inconsistent with Zeng’s disclosure and lithium-ion batteries generally. *See id.*; EX1019.

H. Claim 12

1. [12.1]

In Zeng Embodiments 4 and 6, *the electrolyte further comprises a compound having a sulfur-oxygen double bond—1,3-propanesultone (PS)—as claimed. See* EX1006, ¶¶[0037], [0049]; EX1003, ¶148.

I. Claims 14, 15, and 17

The Zeng-Sunose combination renders obvious claims 14, 15, and 17 for reasons discussed above for elements of claims 1, 2, and 5, as indicated in the table below. EX1003, ¶¶149-150. As explained, Patent Owner has equated claim 14 and claim 1 in litigation, contending claim 14 reads on an electrode with single- and double-sided portions for the same reasons claim 1 does. Specifically, Patent Owner asserted that the same accused electrode infringed both claims 1 and 14 and Patent Owner’s entire explanation for elements of claim 14 were citations to elements of claim 1. Applying Patent Owner’s position here, the elements of claim 14 are taught by the prior art for the same reasons as the elements of claim 1 addressed above:

Element	Previously-discussed Element	Reasoning
[14.pre]	[1.pre]	See Section VIII.B.1.
[14.1]	[1.1]	See Section VIII.B.2. As explained, Zeng’s lithium-ion batteries have two electrodes—a cathode and an anode.
[14.2]	[1.2]	See Section VIII.B.3.

[14.3]	[1.3]	See Section VIII.B.4.
[14.4]	[1.1], [1.4]	See Sections VIII.B.2, VIII.B.5.
[14.5]	[1.1], [1.4], [1.5]	See Section VIII.B.2, VIII.B.5, VIII.B.6.
[14.6]	[1.6]	See Section VIII.B.6.
[14.7]	[1.7]	See Section VIII.B.7.
[14.8]	[1.8]	See Section VIII.B.8.
[15.1]	[2.1]	See Section VIII.C. As explained above, Sunose's electrode configuration, incorporated into Zeng's lithium-ion battery, pertains to the cathode (positive electrode). Thus, in the combination, the single- (left side) and double-sided (right-side) coating portions of Sunose's current collector 3 in Figure 1 respectively correspond to the claimed first electrode and second electrode—both of which are “a cathode”, as claimed. EX1003, ¶149.
[17.1]	[5.1]	See Section VIII.E.

IX. GROUND 2A: ZENG AND SUNOSE, FURTHER IN VIEW OF SU, RENDER OBVIOUS CLAIMS 3 AND 16

'131 Patent claims 3 and 16 relate to anodes with compaction density *D2*. While Zeng and Sunose focus on electrolytes and cathodes, respectively, a POSITA would have also understood that any lithium-ion battery also needs an anode. This need, plus the need for a high-performing anode configuration, would have led a POSITA to Su, which discloses anodes having the double-sided compaction density *D2* of claims 3 and 16. A POSITA would, therefore, have found it obvious to use Su's anode in the Zeng/Sunose battery to arrive at claims 3 and 16. EX1003, ¶151.

A. Claims 3 and 16

1. Elements [3.1], [3.2], [16.1]

a. [3.1]

Zeng discloses or suggests this claim element. EX1003, ¶152; *supra* Sections VIII.B.2; VIII.C; VIII.I.

b. [3.2] “1.2 g/cm³ ≤ D2 ≤ 1.8 g/cm³”

[16.1] “wherein the first electrode is an anode, the second electrode is an anode, and 1.2 g/cm³ ≤ D2 ≤ 1.8 g/cm³.”

By definition, a lithium-ion battery requires a cathode and an anode (among other things). While Zeng and Sunose do not focus on anodes, Su does. EX1003, ¶¶153-155. Specifically, Su’s Examples 2 and 3 batteries had the following single- and double-sided coating compaction densities *D1*, *D2* for the negative electrode (anode).

Example	D2
2	1.8 g/cm ³
3	1.5 g/cm ³

See id.; EX1012, ¶¶[0059]-[0064]. As shown in the Table, Su Examples 2 and 3 have *D2* values falling in the claimed range.

c. Rationale to Combine

- **Teaching, suggestion, motivation**

Su is analogous art to Zeng and Sunose because it also seeks to improve performance of lithium-ion batteries—using electrode configuration to increase energy density. *See* EX1012, Title, Abstract, ¶¶[0005]-[0024]. A POSITA would have found it obvious to use Su’s Examples 2 and 3 configurations for the negative electrode (anode) of Zeng/Sunose and had a reasonable expectation of success in doing so. EX1003, ¶156.

Anode implementation details: Sunose describes a rolled electrode configuration and focuses primarily on the positive electrode (cathode), leaving out anode implementation details. But a POSITA would also recognize the need to provide an anode in the Zeng-Sunose battery. EX1003, ¶157. And Su, which, like Sunose, describes a rolled electrode configuration, would have commended itself to a POSITA looking for such anode implementation details, including appropriate compaction densities for the single- and double-sided coating portions of the current collector. *Id.*, EX1012, ¶¶[0039]-[0040].

Energy density: Zeng and Sunose both emphasize market demand for high energy density, so a POSITA would have been on the lookout for ways to boost energy density. *See, e.g.*, EX1006, ¶[0003]; EX1010, ¶[0002]. That would have led the POSITA to Su’s anode configuration specifically designed to improve energy

density; indeed, all Su’s Example batteries had strong performance in capacity and energy density over more than 2000 cycles. EX1012, ¶¶[0041], [0058], [0061], [0064], [0067], [0070], [0073], [0076]. Thus, the need for anode implementation details in the Zeng-Sunose battery—plus the market need to improve energy density recognized in Zeng, Sunose, and Su—would have further prompted the POSITA to use Su’s anode in Zeng/Sunose. EX1003, ¶158.

- **Obvious to try**

A POSITA would have found it “obvious to try” Su’s Examples 2 and 3 anode configurations in Zeng/Sunose. EX1003, ¶159.

Recognized need in the art: Like Zeng and Sunose, Su observes an underlying market need for high-energy-density lithium batteries for applications including mobile devices, electric vehicles, and electric tools. EX1012, Abstract, ¶¶[0001]-[0003]. With this market demand, “the performance of lithium ion batteries is facing higher development requirements, and high energy density has become one of the research directions of high-performance lithium-ion batteries.” *Id.*, ¶[0003]; EX1003, ¶160.

Finite number of identified, predictable solutions: Su only discloses seven Example batteries and one comparative Example, so a POSITA would have found it obvious to try all Examples. EX1012, ¶¶[0050]-[0084]. Examples 2 and 3 had well-balanced capacity and energy density compared to the other Examples, including

above-average performance. EX1003, ¶161. This blend of balanced characteristics would have directed the POSITA to Examples 2 and 3.

- **Reasonable expectation of success**

Because Sunose and Su both describe wound/rolled electrode configurations, a POSITA would have reasonably expected success in combining the two. EX1010, ¶¶[0006]-[0008]; EX1012, Claims 3-5, ¶¶[0014]-[0016], [0028], [0036]-[0040]. Both electrode current collectors of Su have single- and double-sided coating portions. EX1012, ¶¶[0038]-[0040]. While Sunose focuses on cathode details, Sunose's cathode and Su's anode share similar single-sided and double-sided configurations. All Su's Example batteries were successfully tested over more than 2000 cycles, with good results in capacity and energy density. EX1012, ¶¶[0041], [0058]-[0076]. Su provides instructions to prepare its lithium battery, including the single- and double-sided coating parts of the anode. *See id.*, Claims 2-10, ¶¶[0008]-[0021], [0030]-[0040]. This would have given a POSITA a reasonable expectation of success in implementing Su's Examples as the anode in the Zeng/Sunose battery. EX1003, ¶¶162-163.

X. GROUND 1B, 2B: ZENG AND SUNOSE, FURTHER IN VIEW OF MATSUOKA, RENDER OBVIOUS CLAIMS 1, 2, 4-7, 12, 14, 15, AND 17; ZENG, SUNOSE, AND SU, FURTHER IN VIEW OF MATSUOKA, RENDER OBVIOUS CLAIMS 3 AND 16

Patent Owner 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 reasons set forth 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 elements [1.7] and [14.7] of the independent claims. For the remaining claim elements, Petitioner incorporates by reference its analysis above in Grounds 1A and 2A. *Supra* Sections VIII-IX; EX1003, ¶¶164-165.

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, ¶166.

Like Kim, 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. See EX1007, ¶¶[0038], [0040], [0015], [0036], [0039]. 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, ¶167.

B. Elements [1.7], [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, ¶¶168-169.

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, ¶170.

- **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, ¶¶171-172.

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, ¶173.

- **Teaching, suggestion, motivation**

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, ¶174.

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, ¶175.

- **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, ¶176. 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, ¶177.

3. The Zeng/Sunose/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 to 10
	0.1-30 wt%	0.033 to 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, ¶¶178-179. 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%. See EX1007, ¶[0036]; EX1003, ¶¶180-181.

XI. GROUND 1C, 2C: ZENG/SUNOSE, ZENG/SUNOSE/MATSUOKA—FURTHER IN VIEW OF KIM—RENDER OBVIOUS CLAIMS 1, 2, 4-7, 12, 14, 15, AND 17; ZENG/SUNOSE/SU, ZENG/SUNOSE/SU/MATSUOKA—FURTHER IN VIEW OF KIM—RENDER OBVIOUS CLAIMS 3 AND 16

Patent Owner may argue Elements [1.7] and [14.7] require specific focus on Y/Z (the ratio of trinitrile to PP) and criticize Zeng and Matsuoka for not highlighting the ratio of HTC� 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, ¶¶182-183. 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, ¶184.

Third, it was known that the relative proportions of *Y* and *Z* were beneficial, thanks to Kim. Kim 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/Sunose or Zeng/Sunose/Matsuoka, further in view of Kim, render obvious claims 1, 2, 4-7, 12, 14, 15, and 17 (Ground 1C). Likewise, Zeng/Sunose/Su or Zeng/Sunose/Su/Matsuoka, further in view of Kim, render obvious claims 3 and 16 (Ground 2C).⁸ EX1003, ¶185.

Kim discloses lithium-ion battery electrolytes with superior capacity retention at high temperatures after many charging cycles. EX1008, ¶[0005]. Kim even

⁸ For the remaining claim elements other than [1.7] and [14.7], Petitioner incorporates by reference its analysis above for those claim elements in Grounds 1A-2B. *Supra* Sections VIII-X.

claimed trinitrile- and PP-based electrolytes, with claim 1 reciting a trinitrile (Formula 1) with a C3-to-C5 alkyl propionate (e.g., PP, a C3 alkyl propionate). See EX1008, ¶[0055] (Formula 1 compounds feature three or more nitrile (CN) groups and an asymmetric structure), Claim 1; EX1003, ¶186.

Kim'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 Examples 1 and 2 contained both a HTC� (trinitrile) and PP—and in different relative amounts. EX1008, ¶¶[0090]-[0091]. The Comparative Examples lacked either HTC� (trinitrile), PP (or both). *Id.*; EX1003, ¶187.

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, Table 1*

Kim's Examples 1 and 2 (with trinitrile + PP) showed better thickness stability and capacity retention than Comparative Examples 1-6 (lacking one or both). See 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, ¶¶188-189.

Kim'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 that PP performs better than similar alkyl propionates like MP or EP. EX1003, ¶190.

Kim 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, ¶191.

Kim explains how Y/Z improves performance, explaining that a dinitrile like SN “may help formation of a film on a negative electrode as well as a positive electrode” that “suppress[es] gas generation ... when stored at a high temperature” 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 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.*, ¶¶[0055]-[0056], [0014], [0040], [0090]-[0091], claim 3; EX1003, ¶¶192, 194.

The '131 Patent echoes Kim: “[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 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 suggest why the nitrile-based SEI film increases DC internal resistance, instead suggesting further optimization as a solution. EX1003, ¶¶193-194.

The '131 Patent and Kim differ in their focus on the effect of PP. The '131 Patent claims combining PP with nitriles reduces DC resistance, while Kim shows combining PP with nitriles improves cycling but does not specifically mention DC resistance. EX1008, ¶¶[0090]-[0104]. Since DC resistance testing was routine and Kim taught PP's benefits, evaluating Kim's electrolytes for internal resistance effects would have been standard practice, to the extent that matters. EX1003, ¶195.

Accordingly, Kim 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, ¶196.

XII. GROUND 3A: ZHOU AND SUNOSE RENDER OBVIOUS CLAIMS 1, 2, 4-7, 12, 14, 15, AND 17

A. Overview of Zhou

Zhou Example 8 discloses an adiponitrile-based (ADN, *dinitrile*) electrolyte containing the *trinitrile* HTC� and the linear carboxylic acid ester ethyl acetate (EA). Although Example 8 lacks PP, Zhou lists eight esters that are suitable replacements for EA, one being PP. It would have been obvious to replace EA with

PP—an ester with a similar structure but having two additional methyl groups—particularly given that Kim had already shown PP to be an electrolyte-enhancer. EX1003, ¶197.

Doing so would have resulted in the claimed subject matter. Example 8 has 16.56 wt% EA, so substituting EA with PP results in PP falling within claim 7’s Z range of 5-50 wt%. *Id.*

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’s electrolytes have:

- a solvent which “accounts for 70%-88% of the total mass of the lithium-ion battery electrolyte” and “includes a mixture of two or more of a low-boiling-point linear carbonate and a linear carboxylic acid ester”;
- a lithium salt;
- an additive package including “[a] third additive [that] is a nitrile compound containing 2 or 3 nitrile functional groups” and “accounts for 0.5%-5% of the total mass of the lithium-ion battery electrolyte[.]”

Id., ¶¶[0008], [0009], [0016], [0018]; EX1003, ¶198.

The solvent “adjust[s] the wetting effect and mass transfer resistance of the electrolyte system [so that] a good channel is provided for the lithium-ion

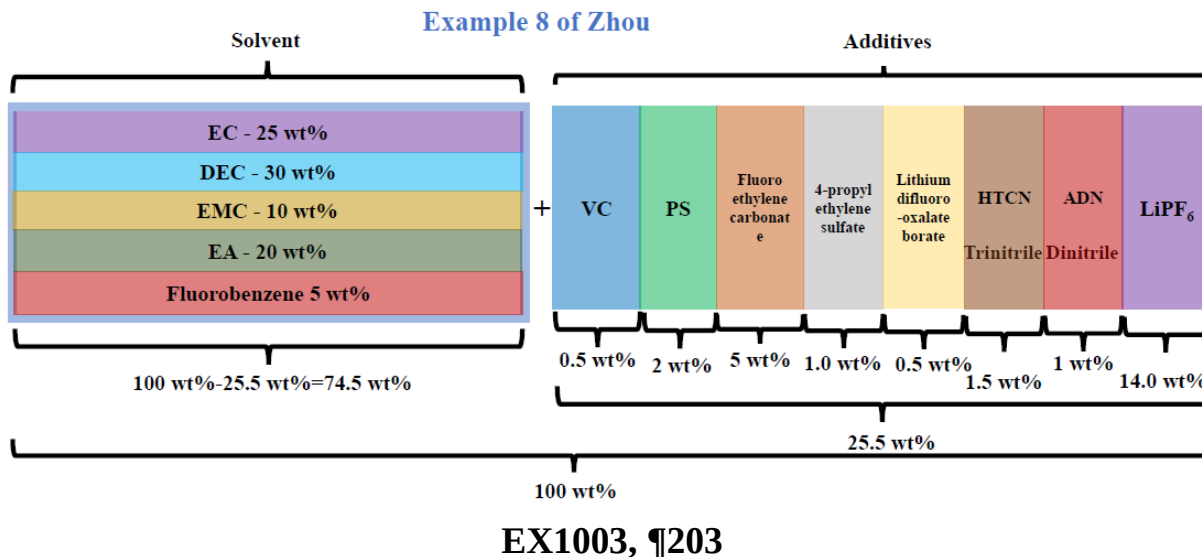
deintercalation process[.]” EX1014, ¶[0020]. But “the low-boiling-point linear carbonate and carboxylate” causes “incompatibility with graphite, poor battery cycle performance, and high temperature resistance[.]” *Id.*; EX1003, ¶199.

The additives, including the nitriles, “solve the problem of incompatibility with graphite” and “eliminate the deterioration of high-temperature performance caused by the above-mentioned low-boiling-point organic solvent.” EX1014, ¶[0020]. Zhou prefers dinitriles and trinitriles as they “improve the high temperature performance of the battery[.]” *Id.*, ¶[0059]. “1,3,6-hexane trinitrile is particularly preferred” because it is “[an] efficient high temperature additive” having “better compatibility with the negative electrode and ... protect[ing] the positive electrode.” *Id.*; EX1003, ¶200.

In the solvent, Zhou prefers “non-methyl carboxylates ... in large quantities” because they are “more conducive to the fast charging of the system under high voltage and high compaction conditions.” EX1014, ¶[0058]. Zhou identifies a few suitable esters: “[PP], ethyl propionate, propyl acetate, butyl propionate, [EA], isopropyl propionate, ethyl butyrate, and methyl acetate.” *Id.*, ¶[0011]; EX1003, ¶201.

When describing electrolyte compositions, Zhou specifies the weight percentage of additives based on “the total mass of the lithium-ion battery electrolyte.” EX1014, ¶¶[0009], [0013]-[0016], [0018]; *see also* EX1003, ¶202.

Example 8 contains EA (PP substitute) as a solvent, the *dinitrile* adiponitrile (ADN), and the *trinitrile* HTCEN, with the overall composition shown below. EX1014, ¶[0047].



Weight percentage of ADN (*dinitrile*) in the total electrolyte: ADN has two nitrile groups, so it is a *dinitrile*. EX1018, 1. In the total Example 8 electrolyte, ADN has a weight percentage (the claimed X) of 1 wt%. EX1003, ¶204.

Weight percentage of HTCEN (*trinitrile*) in the total electrolyte: HTCEN has three nitrile groups, so it is a *trinitrile*. EX1018, 100; EX1020. In the total electrolyte, HTCEN has a weight ratio (the claimed Y) of 1.5 wt%. EX1003, ¶205.

Weight percentage of EA in the total electrolyte: In the total electrolyte 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 Z'. EX1003, ¶206.

Thus, 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, ¶207.

Example 8 performed well, improving battery discharge capacity over Comparative Example 3 and Examples 3-6. See 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 Co.*, 868 F.3d 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, ¶¶209-210.

Nonetheless, a POSITA would have selected and implemented Zhou Example 8 with a reasonable expectation of success. *Id.* The Example 8 battery significantly outperformed the Comparative Example batteries in discharge capacity and low impedance and outperformed other Examples in low impedance. See EX1014, ¶¶[0057], [0061], FIGS. 1, 4. At minimum, it also would have been “obvious to try” Zhou Example 8. EX1003, ¶210.

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, ¶211.

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], [0058], [0061], FIGS. 1, 4; EX1003, ¶212.

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. *See id.*, ¶[0047]. Thus, a POSITA would have reasonably expected to succeed with Example 8. EX1003, ¶213.

B. Independent Claim 1

1. [1.pre]

Zhou discloses electrolytes for lithium-ion battery—an *electrochemical device*. EX1014, Abstract, ¶¶[0001]-[0020]; EX1003, ¶¶214-215.

2. [1.1]

Zhou’s lithium-ion battery has positive and negative *electrodes*. *See* EX1014, Abstract, ¶¶[0002]-[0005]; EX1003, ¶¶216-217.

3. [1.2]

Example 8 of Zhou’s *electrolyte*, implemented in Zhou’s lithium-ion battery, renders the Challenged Claims unpatentable. EX1014, ¶[0047]; *supra* Section XII.A; EX1003, ¶218.

As discussed in Section IX.A, Zhou’s Example 8 electrolyte contains *a dinitrile compound* (ADN) and *a trinitrile compound* (HTCN), as claimed. See EX1014, ¶[0047]; EX1018, 1, 100. While Example 8 lacks PP, PP is structurally similar to EA, having two additional methyl groups. EX1003, ¶¶219-220. 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 expressly 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, ¶221.

b. Rationale to substitute PP for EA in Example 8

• **Obvious to try**

A POSITA would have found it “obvious to try” substituting PP for EA in Zhou Example 8. EX1003, ¶222.

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, ¶223.

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 also identified PP as a known performance-enhancer, and EA and PP have similar structures except for PP’s two additional methyl groups, so a POSITA would expect replacing EA with PP in Zhou’s electrolyte to work predictably and as Zhou describes. EX1003, ¶224.

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, ¶225. 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'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, ¶225.

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, one could expect the resulting electrolyte to provide good ion conductivity for fast charging. EX1003, ¶226.

- **Simple substitution**

Replacing EA with PP in Zhou Example 8 amounts to simple substitution of one known element (the ester EA) for another (the ester PP) to obtain predictable results. MPEP § 2143.I.(E); EX1003, ¶227.

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, ¶228.

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, ¶229.

Predictable results: A POSITA could have substituted PP for EA in Zhou Example 8 with predictable results. EX1003, ¶230. 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]. In this process, a POSITA could have simply added 20 wt% PP instead of 20 wt% EA. 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, ¶230.

4. [1.3]

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

Supra 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. EX1003, ¶¶231-232. 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; *see also* EX1003, ¶__.

5. [1.4]

Zhou discloses or suggests this element. Zhou discloses electrolytes, including Example 8, for lithium-ion batteries. *See* EX1014, Abstract, ¶¶[0002]-[0006], [0020], [0047], [0057], [0061]. A lithium-ion batteries, by definition, have positive and negative electrodes that each comprise *a current collector*, as claimed. *See* EX1003, ¶¶233-234; EX1010, Abstract, ¶¶[0021], [0047].

6. Elements [1.5], [1.6]

Zhou does not disclose these elements, but Sunose does. *Supra* Section VIII.B.6; EX1003, ¶235. For the reasons discussed above in Ground 1A, a POSITA would have found it obvious use Sunose's cathode with Zhou's electrolyte. *Id.* Sunose is analogous art because Sunose also relates to lithium-ion batteries, including those employing non-aqueous electrolytes. *See* EX1010, Abstract, ¶¶[0001]-[0011], [Claim 3]; EX1014, ¶¶[0001]-[0008]; EX1001, 1:19-3:26. Because Zhou focuses on electrolytes rather than physical configuration of battery elements, a POSITA would have looked to Sunose for details implement its

improved electrode. *Supra* Sections VIII.B.6.c, XII.A. A POSITA would have had a reasonable expectation of success using Sunose's rolled electrode configuration in Zhou's example batteries because Zhou does not describe any physical specifications or restrictions for its battery or electrode configuration. Also, the proposed combination with Sunose already uses a rolled electrode configuration. EX1003, ¶235.

7. [1.7]

The claimed 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

Supra 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, ¶¶236-237.

8. [1.8]

Zhou Example 8 has 1,3,6-hexanetricarbonitrile (HTCN) as the claimed *trinitrile compound*. EX1014, ¶[0047]; *supra* Section XII.A; EX1003, ¶238.

C. Claim 2

1. [2.1]

Zhou's lithium-ion battery is an electrochemical device that, by definition, has a cathode. See EX1014, Abstract, ¶¶[0002]-[0005]. Sunose's packing density D_2 for the double-sided portion—4.0 in all four Examples—falls within Element [2.1]'s range of 3.5 g/cm³ to 4.3 g/cm³. *Supra* Section VIII.C; EX1003, ¶239.

D. Claim 4

1. [4.1]

In Example 8, Zhou's *dinitrile compound* is adiponitrile which, as explained above in Section VIII.D, satisfies claimed Formula 4. See EX1014, ¶[0047]; EX1018, 1; EX1001, 7:13-19; EX1003, ¶240.

E. Claim 5

1. [5.1]

As discussed, Example 8 of Zhou has adiponitrile (ADN) as the claimed *dinitrile compound*. EX1014, ¶[0047]; *supra* Section XII.A; EX1003, ¶241.

F. Claim 6

1. [6.1]

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

explained above in Section VIII.F, HTC� satisfies claimed Formula. See EX1018, 100-103; EX1001, 7:41-8:27; EX1003, ¶242.

G. Claim 7

1. [7.1]

As explained, the obvious modification to Zhou Example 8—replacing EA with PP—has the following X, Y, and Z values falling in the claimed ranges:

X	Y	Z (PP, substituted for EA)
1 wt%	1.5 wt%	16.56 wt%

Supra Section XII.A; EX1003, ¶243.

H. Claim 12

1. [12.1]

In Zhou Example 8, *the electrolyte further comprises a compound having a sulfur-oxygen double bond*—1,3-propane sultone (PS)—as claimed. EX1014, ¶[0047]; EX1003, ¶244.

I. Claims 14, 15 and 17

Zhou and Sunose render obvious claims 14, 15, and 17 for reasons discussed above for claims 1, 2, and 5 in this Ground and reasons discussed above regarding claims 14, 15, and 17 in Ground 1A. *Supra* Sections VIII.I, XII.B, XII.C, XII.E; EX1003, ¶¶245-246.

Claim 14		
Element	Previously Discussed Element	Reasoning
[14.pre]	[1.pre]	See Section XII.B.1.
[14.1]	[1.1]	See Section XII.B.2.
[14.2]	[1.2]	See Section XII.B.3.
[14.3]	[1.3]	See Section XII.B.4.
[14.4]	[1.1], [1.4], [14.4]	See Sections XII.B.2, XII.B.5, VIII.I (Ground 1A).
[14.5]	[1.1], [1.4], [1.5], [14.5]	See Sections XII.B.2, XII.B.5, XII.B.6, VIII.I (Ground 1A).
[14.6]	[1.6]	See Section XII.B.6.
[14.7]	[1.7]	See Section XII.B.7.
[14.8]	[1.8]	See Section XII.B.8.
[15.1]	[2.1]	See Section XII.C.
[17.1]	[5.1]	See Section XII.E.

XIII. GROUND 4A: ZHOU AND SUNOSE, FURTHER IN VIEW OF SU, RENDER OBVIOUS CLAIMS 3 AND 16

Zhou and Sunose, further in view of Su, render obvious claims 3 and 16.

EX1003, ¶247.

A. Claims 3 and 16

1. [3.1]

Zhou discloses or suggests this claim element. *Supra* Section XII.B.2;

EX1003, ¶248.

2. [3.2], [16.1]

Zhou/Sunose do not disclose these elements, but Su does. *Supra* Section IX.A.1.b. For the reasons in Ground 2A, a POSITA would have successfully configured Zhou’s anode according to Su’s Examples. Zhou, Sunose, and Su relate to analogous art—lithium-ion batteries, including those using non-aqueous electrolytes. See EX1014, ¶[0006]; EX1010, Abstract, ¶¶[0001]-[0011], [0043], [Claim 3]; EX1012, Abstract, ¶¶[0001]-[0003]. Like Zeng, Zhou cites market demand for batteries with high energy density. EX1014, ¶¶[0002]-[0005]; EX1003, ¶249. Thus, Zhou, Sunose, and Su render claims 3 and 16 obvious.

XIV. GROUNDS 3C, 4C: ZHOU/SUNOSE, FURTHER IN VIEW OF KIM, RENDER OBVIOUS CLAIMS 1, 2, 4-7, 12, 14, 15, AND 17; ZHOU/SUNOSE/SU, FURTHER IN VIEW OF KIM, RENDER OBVIOUS CLAIMS 3 AND 16

For the reasons discussed in Grounds 1C, 2C, Kim motivates considering the ratio of trinitrile to PP in Zhou and substituting EA for PP in Zhou Example 8. *Supra* Section XI.⁹ Zhou highlights the advantage of trinitrile (HTCN) by explaining that it has “[a high] density of nitrile groups per unit volume” and “better compatibility

⁹ For all Challenged Claim elements other than Elements [1.7] and [14.7], Petitioner incorporates by reference its analysis for those claim elements in Grounds 3A and 4A.

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]; *see also* EX1003, ¶¶250-251.

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 Patent Owner 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 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 it would have been obvious to substitute 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, relied on above, 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 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 motivates adjusting Y/Z in Zeng and substituting PP for EA in Zhou. Sunose (not cited) and Su (English Abstract only provided in an IDS) disclose the electrode configuration purportedly lacking from Hong and Ohashi.

Patent Owner asserts the '131 Patent against Petitioner in related litigation. EX1021. IPR should be instituted under *Fintiv. Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (PTAB Mar. 20, 2020). Having just 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, overriding any *Fintiv* concerns. Vidal 06.21.24 Memo, 2-3. 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. *Id.*, 3; *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020).

XVII. GROUNDS FOR STANDING

Petitioner certifies that the '131 patent is available for IPR and Petitioner is not barred or estopped from requesting IPR of any '131 Patent claim.

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.

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

Lead Counsel	Backup Counsel
James D. Stein (Reg. No. 63,782) Lee & Hayes, P.C. 75 14th Street NE, Suite 2500 Atlanta, Georgia 30309 404-736-1918 james.stein@leehayes.com	Kevin Yao (Limited Recognition No. L0790) Lee & Hayes, P.C. 701 Pike Street, Suite 1600 Seattle, WA 98101 206.876.6020 kevin.yao@leehayes.com
	Jason D. Eisenberg (Reg. No. 43,447) Sterne, Kessler, Goldstein & Fox PLLC 1101 K Street, NW, 10th Floor Washington, DC 20005 202-772-8645 jasone-PTAB@sternekessler.com.
	Jason A. Fitzsimmons (Reg. No. 65,367) Sterne, Kessler, Goldstein & Fox PLLC 1101 K Street, NW, 10th Floor Washington, DC 20005 202-772-8701 jfitzsimmons-PTAB@sternekessler.com.

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 cancelation of the Challenged Claims.

Respectfully submitted,

LEE & HAYES, P.C.

/James Stein/

James D. Stein
Registration No. 63,782
Lead Counsel for Petitioner

Date: January 28, 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 13,995 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,

LEE & HAYES, P.C.

/James Stein/

James D. Stein
Registration No. 63,782
Lead Counsel for Petitioner

Date: January 28, 2025

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 1001-1027 were served in their entireties upon the Patent Owner on January 28, 2025, via FedEx® Express at the following addresses:

MAIER & MAIER, PLLC
345 South Patrick Street
Alexandria, VA 22314
*Patent Owner's Correspondence Address of Record for
U.S. Patent No. 11,799,131*

QUINN EMANUEL URQUHART & SULLIVAN LLP
Michael D. Powell
50 California Street, 22nd Floor
San Francisco, California 94111
Additional Address Known to Petitioner as Likely to Effect Service

Respectfully submitted,

LEE & HAYES, P.C.

/James Stein/

James D. Stein
Registration No. 63,782
Lead Counsel for Petitioner

Date: January 28, 2025