ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner,
v.
NINGDE AMPEREX TECHNOLOGY LIMITED,
Patent Owner.

U.S. Patent No. 11,799,131
AIA Review No. IPR2025-00431

Patent Owner's Demonstratives
Under §42.70(b) for May 19, 2026, Oral Argument

ROADMAP

1. Zeng (Grounds 1-8)
   a) Zeng's disclosure cannot establish the claimed Y/Z ratio

2. Sunose (All Grounds)
   a) Sunose's density values cannot be relied upon

3. Matsuoka (Grounds 2, 4, 6, 8)
   a) Matsuoka is fundamentally incompatible with Zeng

4. Kim (Grounds 3, 4, 7, 8, 10, 12)
   a) A POSITA would not combine Kim with the other references

ROADMAP

5. Zhou (Grounds 9-12)
   a) A POSITA would not select or implement Zhou's Example 8
   b) A POSITA would not substitute PP for ethyl acetate

6. Su (Grounds 5-8, 11, 12)
   a) Petitioner's absence of argument

ROADMAP

1. Zeng (Grounds 1-8)
   a) Zeng's disclosure cannot establish the claimed Y/Z ratio

2. Sunose (All Grounds)
   a) Sunose's density values cannot be relied upon

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4. Kim (Grounds 3, 4, 7, 8, 10, 12)
   a) A POSITA would not combine Kim with the other references

Independent Claims 1, 14: Y/Z

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

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

Zeng: Relative Mass Ratio of PP in a Base Solvent Mixture

(19) State Intellectual Property Office of the People's Republic of China

(12) Invention Patent Application

(10) Publication No.: CN 106999187 A
(43) Publication Date: 2016.11.09

(21) Application No.: 201610555635.7
(22) Filing Date: 2016.07.15
(71) Applicant: Dongguan City Kaixin Battery Materials Co., Ltd.
Address: 523000 Guangdong Province, Dongguan City, Chashan Township, Ecological Industrial Park, Adjacent to Xingye Rd.
(72) Inventors: ZENG Qingpeng; YANG Yongjun; LV Jiabin; WAN Huaping; FAN Liming; ZHAN Xiaoyun
(74) Patent Agency: Guanchong Intellectual Property Agency Co., Ltd.
Agent: ZHANG Zuolin
(51) Int. Cl.
H01M 10/0567 (2010.01)
H01M 10/0569 (2010.01)

Claims 1 page Description 6 pages Drawings 1 page

(54) Title of Invention: Wide-temperature-range homogeneous non-aqueous electrolyte solution

(57) Abstract

Disclosed is a wide-temperature-range homogeneous non-aqueous electrolyte solution containing a non-aqueous organic solvent, electrolyte lithium salt, and additive combination, said non-aqueous organic solvent is an optimized and combined multi-component homogeneous mixed solvent; said additive combination can effectively protect the structural stability of positive and negative electrode materials, and has excellent solubility in the mixed solvent. The components of the non-aqueous electrolyte solution of the present invention have a suitable ratio and are highly soluble with each other, and the homogeneous and stable mixed solution state can be maintained even after storage for a long period of time in an environment below -30°C, solving the problem that conventional high-voltage non-aqueous electrolyte solutions tend to precipitate crystals at low temperatures and facilitating the transportation and long-term storage of the non-aqueous electrolyte solution in the north of China; the electrolyte solution is also highly wettable to the electrode material, has good electrode interfacial compatibility, ensuring good high-voltage performance of a lithium-ion battery

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Detailed Description of the Preferred Embodiments

[0036] Embodiment 1

[0037] Electrolyte solution preparation steps: in a glove box filled with argon gas, ethylene carbonate, propylene carbonate, diethyl carbonate, fluorobenzene, ethyl propionate, and propyl propionate are mixed at a mass ratio of EC:PC:DEC:FB:EP:PP = 25:10:30:5:10:20; then, lithium hexafluorophosphate of a concentration of 1.0 mol/L is slowly added to the mixed solution, finally, the following are added on the basis of the total weight of the electrolyte solution: 4wt% of fluoroethylene carbonate (FEC), 2wt% of adiponitrile (ADN), 1wt% of succinonitrile (SN), 0.5wt% of 1,2-bis(2-cyanoethoxy)ethane (DENE), 0.2wt% of vinylene carbonate (VC), and 4.0wt% of 1,3-propane sultone; after stirring well, the lithium-ion battery electrolyte solution of Embodiment 1 is obtained.

Embodiment 4	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 10: 20	4	2	T_4: 1 T_2: 0.5	VC: 0.2 PS: 4	91.0	No precipitation
Embodiment 6	EC: PC: DEC: FB: EP: PP =25: 10: 30: 5: 10: 20	4	2	T_4: 1 T_2: 0.5	DTD: 0.5 PS: 3.5	91.6	No precipitation

Paper 2 [Petition] at 20, Paper 28 [POR] at 7.
EX1006 [Zeng Translation] at ¶¶ [0037], [0046].

Zeng: Lithium Salt Solution

(19) State Intellectual Property Office of the People's Republic of China

(12) Invention Patent Application

(10) Publication No.: CN 106099187 A
(43) Publication Date: 2016.11.09

(21) Application No.: 201610555655.7
(22) Filing Date: 2016.07.15
(71) Applicant: Dongguan City Kaxin Battery Materials Co., Ltd.
Address: 523000 Guangdong Province, Dongguan City, Chashan Township, Ecological Industrial Park, Adjacent to Xingye Rd
(72) Inventors: ZENG Qingpeng; YANG Yongjun; LV Jobin; WAN Huaping; PAN Liming; ZHAN Xiaoyun
(74) Patent Agency: Guanzheng Intellectual Property Agency Co., Ltd.
Agent: ZHANG Zoolin
(51) Int. Cl.
H01M 10/0567 (2010.01)
H01M 10/0569 (2010.01)

Claims 1 page Description 6 pages Drawings 1 page

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(57) Abstract

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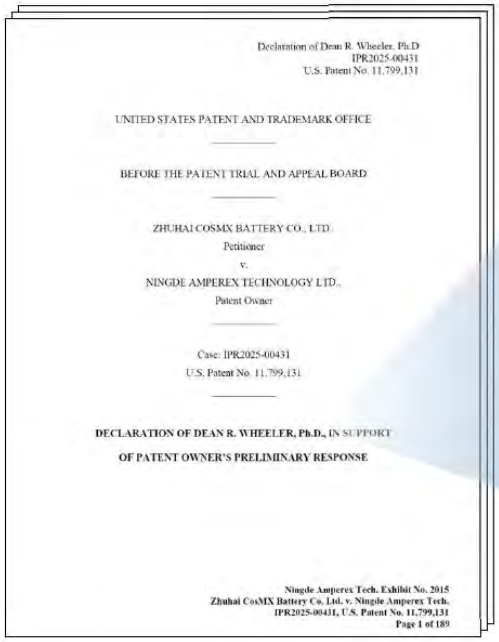
Paper 28 [POR] at 8, Paper 42 [Sur-Reply] at 1, 3, 5.
EX1006 [Zeng Translation] at ¶ [0037].

Zeng: Lithium Salt Solution



Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.
Petitioner
v.
NINGDE AMPEREX TECHNOLOGY LTD.,
Patent Owner

Case: IPR2025-00431
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DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S PRELIMINARY RESPONSE

Ningde Amperex Tech. Exhibit No. 2015
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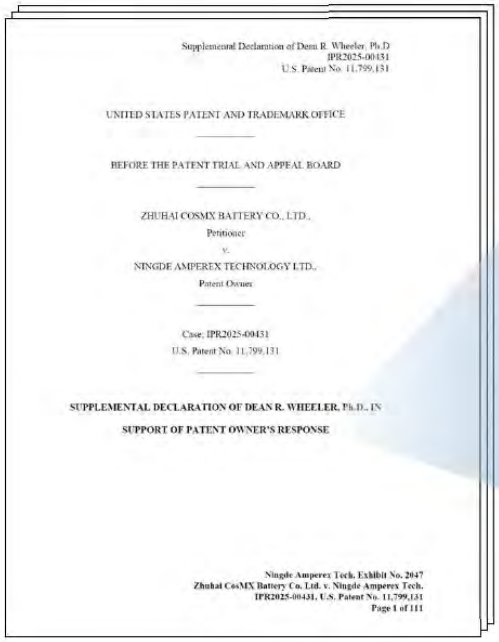
108. It is immediately apparent from the text of Paragraph [0037] that the inventors of Zeng make a clear distinction as to how certain components are to be added to the electrolyte composition. For example, with respect to the additive components (such as adiponitrile or succinonitrile), Zeng explicitly states that their addition is "on the basis of the total weight of the electrolyte solution." Ex. 1006 ¶ [0037]. And with respect to lithium hexafluorophosphate ($LiPF_6$), Zeng explicitly states that its addition is *at a certain concentration*, such that the POSITA would understand that the lithium hexafluorophosphate salt of Zeng is necessarily added in the form of a solution. That is, the terms "of a concentration" and "mol/L", which are indisputably present in the Zeng specification, necessarily require the existence of a solution with respect to the lithium hexafluorophosphate salt—not a solid. Specifically, Zeng recites that $LiPF_6$ "***of a concentration of 1.0 mol/L*** is slowly added to the mixed solution." *Id.* (emphasis added). Nowhere does Zeng state or imply, as Dr. Lucht suggests, that such "of a concentration of 1.0 mol/L" is an intended final concentration of the electrolyte solution or some specified concentration of the electrolyte solution ***before*** the subsequent addition of the additive combination). That is, for the addition of lithium hexafluorophosphate, no final concentration of the total electrolyte solution is specified by Zeng, only an addition of the lithium hexafluorophosphate salt solution that has a certain concentration.

Paper 28 [POR] at 9.
EX2015 [Wheeler Decl.] at ¶108.

Zeng: Lithium Salt Solution



Supplemental Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
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Patent Owner

Case: IPR2025-00431
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SUPPLEMENTAL DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S RESPONSE

Ningde Amperex Tech. Exhibit No. 2047
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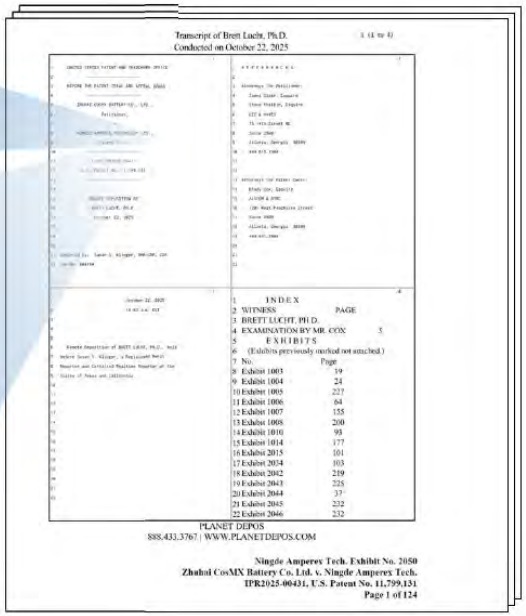
33. The language of Zeng speaks for itself - "lithium hexafluorophosphate [$LiPF_6$] of a concentration of 1.0 mol/L is slowly added to the mixed solution." Ex. 1006 ¶ [0037]. Paragraph [0037] of Zeng does NOT read that $LiPF_6$ is added *up to* a concentration of 1.0 mol/L. The terms "of a concentration" and "mol/L" are indisputably present in the wording which necessarily imply the existence of a solution. A POSITA would interpret Zeng as adding the lithium hexafluorophosphate in the form of a 1.0 mol/L $LiPF_6$ solution (i.e., a solid solute dissolved in a liquid solvent to form a liquid solution, such as a premixed "battery grade" 1.0 M $LiPF_6$ solution).[21,22] And without additional volume information, Zeng does not provide the POSITA with sufficient information to produce a mass fraction of the lithium salt in the total electrolyte solution. Therefore, a POSITA cannot determine the weight percentage (or mass fraction) of the non-additive constituents (i.e. salt and solvents) in the total electrolyte mixture. Additionally, with respect to Dr. Lucht's recitation of Zeng's "carefully-crafted solvent," while I do not agree that there is sufficient information from which to determine the exact composition of the total electrolyte solution, if there were sufficient information, it is my further opinion that the POSITA would not be motivated to alter the base solvent mixture of Zeng at least in view of the complexities and unpredictability of battery chemistry. Electrolyte components are subject to a complex matrix of requirements and tradeoffs and interactions such that successfully adding or removing components would require extensive experimentation.

Paper 42 [Sur-Reply] at 6.
EX2047 [Wheeler Suppl. Decl.] at ¶33.

Zeng: Lithium Salt Solution

12 **A Molarity is moles per liter.**
13 Q And is molarity a measurement for a liquid
14 or for a solid?
15 **A Molarity is a measurement of something**
16 **being dissolved into the liquid.**

6 Q What is concentration?
7 **A What is concentration?**
8 Q That's right.
9 **A Described here it is moles per liter.**
10 Q And concentration of 1 moles per liter is
11 a measurement that is used in the context of
12 liquid solutions, correct?
13 **A It is a context that is used in terms of**
14 **liquid solutions and liquid electrolytes for**
15 **lithium batteries, yes.**
16 Q A solid salt is not referred to as itself
17 having a molarity, correct?
18 **A A solid salt would not have a molarity,**
19 **that is a solid. Molarity specifically refers to**
20 **dissolving something into something else.**


Transcript of Brett Lucht, Ph.D.
Conducted on October 22, 2025

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(Exhibits previously marked not attached.)

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Exhibit 1010	93
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Ningde Amperex Tech. Exhibit No. 2050
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
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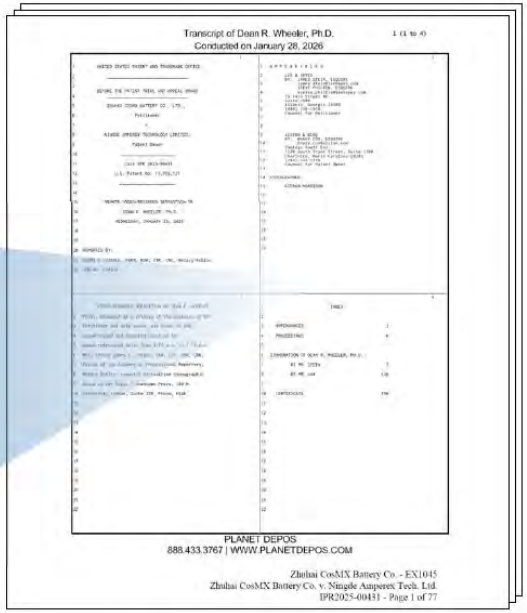
Paper 28 [POR] at 8.
EX2050 [Lucht Dep. Trans.] at 75:12-16, 83:6-20.

Zeng: Lithium Salt Solution

15 A. But when I look at Zeng and read the
16 plain English, there's only one interpretation.
17 Dr. Lucht's interpretation is basically coloring his
18 own practices or preferences on to what Zeng is
19 plainly saying, and in effect changing Zeng's
20 language for Zeng, which I believe is not an
21 appropriate way for a POSITA to read a reference.


Transcript of Dean R. Wheeler, Ph.D.
Conducted on January 28, 2026

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Zhuhai CosMX Battery Co. - EX1045
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
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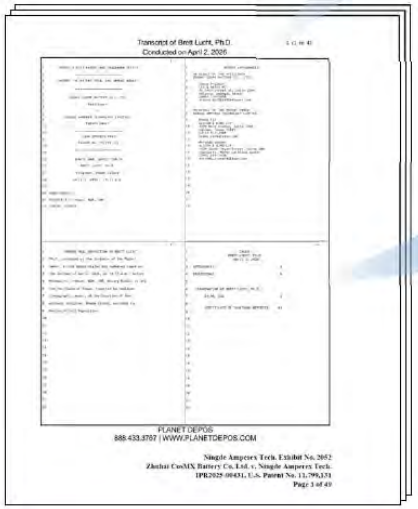
Paper 42 [Sur-Reply] at 1.
EX1045 [Wheeler Depo. Trans.] at 58:15-21.

Zeng: Lithium Salt Solution

21 A Zeng -- there is a typographical error in
22 Zeng. That's all I can say. It's obvious that --

38

1 as a POSITA, it's obvious you're making a 1 molar
2 solution. And I agree with the PTAB office, which
3 I believe in their statement when they responded
4 to the initial -- the initial declarations, that
5 they agreed with me.



17 Q My question is do you believe -- I
18 understand that you believe there's a
19 typographical error. My question is do you
20 believe the typographical error existed in the
21 original Chinese Zeng exhibit or if that error was
22 introduced in translation into English?

93

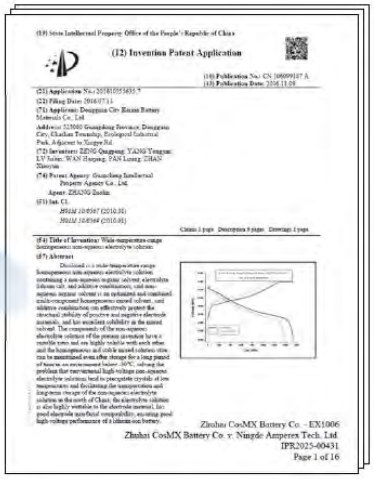
1 MR. PHILBIN: Objection, form and
2 relevance.
3 A Being that I can't read Chinese, I don't
4 know. I mean, it's possible that it's a
5 typographical error. It's possible that it's a
6 translation error. All I can tell you is that
7 clearly from a POSITA's perspective, you can't do
8 specifically what's described. And so it's
9 obvious that you would be dissolving the lithium
10 hexafluorophosphate salt into the solid mixture
11 that's listed there.

Paper 42 [Sur-Reply] at 1-2.
EX2052 [Lucht 2nd Dep. Trans.] at 37:21-38:5, 92:17-93:11.

Zeng: Lithium Salt Solution

[0037] 电解液配制步骤：在充满氩气的手套箱中，将碳酸乙烯酯、碳酸丙烯酯、碳酸二乙酯、氟代苯、丙酸乙酯和丙酸正丙酯按质量比为EC:PC:DEC:FB:EP:PP＝25:10:30:5:10:20进行混合，然后向混合溶液缓慢加入浓度为1.0mol/L的六氟磷酸锂，最后加入基于电解液总重量4wt%的氟代碳酸乙烯酯(FEC)、2wt%己二腈(ADN)、1wt%丁二腈(SN)、0.5wt%1,2-二(2-氰乙氧基)乙烷(DENE)、0.2wt%碳酸亚乙烯酯(VC)、4.0wt%1,3-丙烷磺酸内酯，搅拌均匀后得到实施例1的锂离子电池电解液。

[0037] Electrolyte solution preparation steps: in a glove box filled with argon gas, ethylene carbonate, propylene carbonate, diethyl carbonate, fluorobenzene, ethyl propionate, and propyl propionate are mixed at a mass ratio of EC:PC:DEC:FB:EP:PP = 25:10:30:5:10:20; then, lithium hexafluorophosphate of a concentration of 1.0 mol/L is slowly added to the mixed solution, finally, the following are added on the basis of the total weight of the electrolyte solution: 4wt% of fluoroethylene carbonate (FEC), 2wt% of adiponitrile (ADN), 1wt% of succinonitrile (SN), 0.5wt% of 1,2-bis(2-cyanoethoxy)ethane (DENE), 0.2wt% of vinylene carbonate (VC), and 4.0wt% of 1,3-propane sultone; after stirring well, the lithium-ion battery electrolyte solution of Embodiment 1 is obtained.



Paper 42 [Sur-Reply] at 5, 6.
EX1005 [Zeng – Chinese Original] at ¶[0037].
EX1006 [Zeng – English Translation] at ¶[0037].

Zeng: Lithium Salt Solution

Transcript of Brett Lucht, Ph.D.
Conducted on October 22, 2025

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Ningde Amperex Tech. Exhibit No. 2050
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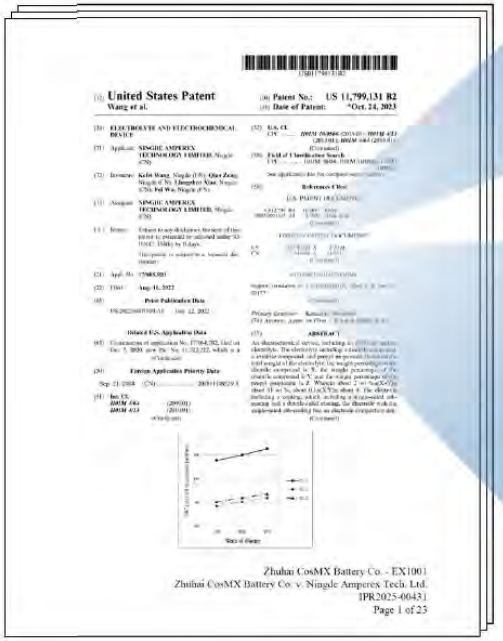
11 Q So as you recognize at the end of footnote
12 6, doing so would render the ultimate
13 concentration of lithium hexafluorophosphate
14 uncertain?
15 **A Yes.**
16 Q And you didn't provide any opinion or
17 calculation on what the propyl propionate weight
18 percentages would be for embodiments 4 and 6 of
19 Zeng if lithium hexafluorophosphate were
20 determined to instead have been added as a
21 solution?
22 MR. STEIN: Objection to the form.

81

1 Q Correct?
2 MR. STEIN: Asked and answered.
3 **A So I read the paragraph, which to me**
4 **clearly indicates to begin to dissolve the salt in**
5 **the -- in the pre-made specific ratios of**
6 **solvents. I did not do a calculation to determine**
7 **if lithium salt solution, the LiPS6 solution of**
8 **undetermined quantity and undetermined solvent was**
9 **added to the electrolyte because in my opinion as**
10 **a POSITA, it would make no sense to add an**
11 **undetermined amount of an electrolyte solution**
12 **dissolved in an undisclosed solvent to an**
13 **electrolyte formulation.**

Paper 28 [POR] at 12, fn. 4.
EX2050 [Lucht Dep. Trans.] at 80:11-81:13.

Criticality of Y/Z

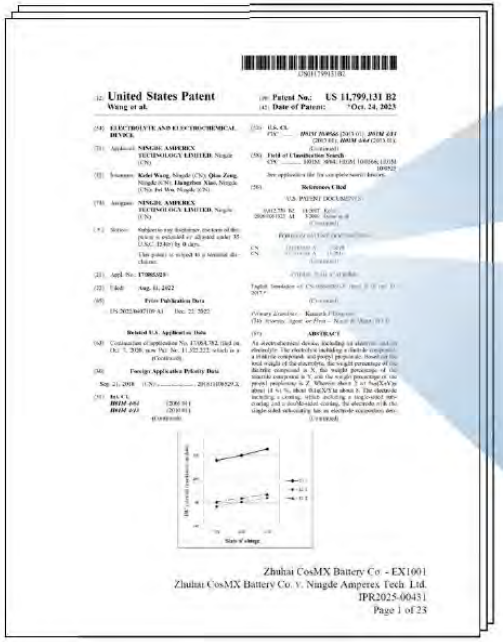


At a high voltage, the oxidizability of the cathode material is increased, and the stability is lowered, which makes the electrolyte easily decompose on the surface of the positive electrode or results in deterioration of the materials of the electrochemical device, so that the capacity of the electrochemical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

An embodiment of the present application provides an electrolyte and an electrochemical device containing the electrolyte, wherein the electrolyte comprises a compound comprising two cyano groups (herein also referred to as "a dinitrile compound"), a compound comprising three cyano groups (herein also referred to as "a trinitrile compound"), and propyl propionate. The dinitrile compound can form a protective film on the cathode of the electrochemical device, so as to inhibit the decomposition of the solvent in the electrochemical device. However, since the protective film itself is decomposed on the surface of the cathode at a high potential, the effect of inhibiting decomposition of the solvent cannot be sustained for a long time. The present inventors unexpectedly found that by using a mixture of a dinitrile compound, a trinitrile compound and propyl propionate, a firm protective film which is not easily decomposed on the surface of the cathode at a high potential can be formed. The electrolyte according to the embodiment of the present application can effectively inhibit the increase in DC internal resistance of the electrochemical device.

Paper 28 [POR] at 14, Paper 42 [Sur-Reply] at 7.
EX1001 [131 Patent] at 1:43-62, 22:24-34.

Criticality of Y/Z



ization and side reactions of the battery. The ratio of the content of the trinitrile compound to the content of propyl propionate has great effect on the change in DC internal resistance of the battery. When Y/Z is within the range of 0.01-0.3, a better inhibition effect on the increase in DC internal resistance is achieved.

TABLE 2

	C (Z wt %)	A_1 (X wt %)	B_1 (Y wt %)	Y/Z	DC internal resistance (mΩ) at 20% SOC: Fresh battery	After 200 cycles	After 400 cycles
S1-1	30	4	1	0.03	50.8	84.3	91.2
S2-1	5	4	1	0.2	68.7	85.2	97.6
S2-2	10	4	1	0.1	60.3	83.1	95.7
S2-3	20	4	1	0.05	56.1	81.6	93.9
S2-4	40	4	1	0.025	47.5	78.2	87.2
S2-5	50	4	1	0.02	56.3	82.6	98.3
S2-6	10	4	3	0.3	64.3	89.5	97.7
S2-7	50	4	0.5	0.01	53.2	84.3	94.1
D2-1	4	4	1	0.25	72.1	108.5	118.9
D2-2	60	4	1	0.017	42.0	100.1	113.9
D2-3	10	4	5	0.5	62.3	85.4	111.3
D2-4	50	4	0.1	0.0025	53.2	89.3	109.4

Paper 28 [POR] at 13, 14, Paper 42 [Sur-Reply] at 7, 8.
EX1001 [131 Patent] at Table 2, 28:59-64.

ROADMAP

1. Zeng (Grounds 1-8)
   a) Zeng's disclosure cannot establish the claimed Y/Z ratio

2. **Sunose (All Grounds)**
   a) **Sunose's density values cannot be relied upon**

3. Matsuoka (Grounds 2, 4, 6, 8)
   a) Matsuoka is fundamentally incompatible with Zeng

4. Kim (Grounds 3, 4, 7, 8, 10, 12)
   a) A POSITA would not combine Kim with the other references

Independent Claims 1, 14: D1/D2

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

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

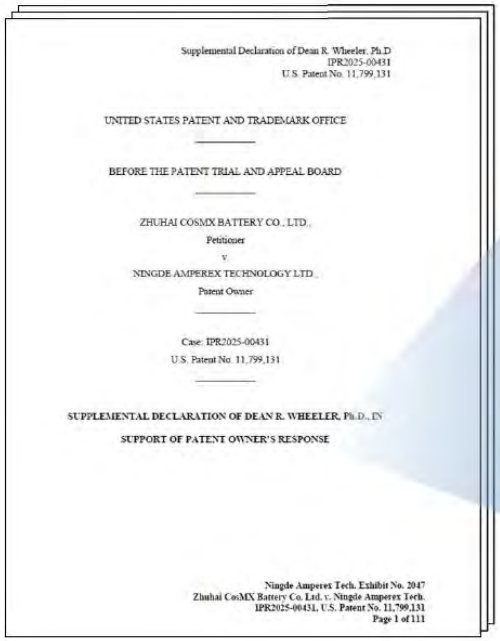
Sunose: Physically Impossible Densities

[Table 1]

	Active Material Density N of Two-Side Coated Portion g/cc	Active Material Density M of Single-Side Coated Portion g/cc	Active Material Density Ratio N/M	Crack Rate %
Embodiment 1	4	5.7	0.7	0
Embodiment 2	4	5	0.8	0
Embodiment 3	4	4.4	0.9	0
Embodiment 4	4	4	1	0
Comparative Example 1	4	2	2	62
Comparative Example 2	4	6.5	0.6	84
Comparative Example 3	4	8	0.5	Single-Side Coated Portion Breakage

Paper 28 [POR] at 15, Paper 42 [Sur-Reply] at 14.
EX1010 [Sunose] at ¶[0041].

Sunose: Physically Impossible Densities



Supplemental Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner
v.
NINGDE AMPEREX TECHNOLOGY LTD.,
Patent Owner

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

SUPPLEMENTAL DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S RESPONSE

Ningde Amperex Tech. Exhibit No. 2047
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
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48. As further explained in my original Declaration, each of the purported values of at least 5.7 g/cc, 6.5 g/cc, and 8.0 g/cc as electrode compaction density values of the single-sided coated portion of a cathode is *physically impossible* because each value exceeds the true or crystalline density of $LiCoO_2$ (LCO) active material, which is around 5.1 g/cm^3, not to mention that the presence of binder and carbon black additive would further lower the upper bound of possible electrode densities of an LCO active material. Ex. 2015 ¶¶ 71, 133. Indeed, as previously explained in my original Declaration, 4.5 g/cm^3 is the theoretical maximum compaction density of the active material composite of the embodiments and comparative examples of Sunose. *Id.* ¶¶ 71, 133, 137-143; Exs. 2034-2039. Accordingly, 5.7 g/cc, 5.0 g/cc, 6.5 g/cc, and 8.0 g/cc, corresponding to Embodiments 1 and 2 and Comparative Examples 2 and 3 of Sunose, respectively, each far exceed such theoretical maximum compaction density of the active material composite such that they are *physically impossible* electrode compaction density values. *Id.*

Paper 28 [POR] at 15.
EX2047 [Wheeler Suppl. Decl.] at ¶48.

Sunose: Physically Impossible Densities

JP 2009-252340 A 2009.10.29

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[0029]

(Embodiment 1)

To the positive electrode current collector 4 made of strip-shaped aluminum foil, 100 parts by weight of powder of LiCoO2 produced by Nichia Chemical, which is an active material, is mixed with 5 parts by weight of Denka Black, 4 parts by weight of a binder such as polyvinylidene fluoride (PVDF) is added thereto, and this was used as a thickening agent. This is then diluted with 7 parts by weight of a solvent of N-methyl-2-pyrrolidone produced by Mitsubishi Chemical, dispersion mixing was performed, and the prepared positive electrode coating is applied using a coating device at a speed of 15 m/min at a drying temperature of 200°C, and after applying a coating of 60 cm on the surface with an active material layer weight of 200 g/cm^2, the 10 cm coating is stopped. This process is repeated to create an electrode plate wherein portions that have the active material on the current collector and portions that have only the current collector intermittently exist.

Paper 28 [POR] at 16, Paper 42 [Sur-Reply] at 14.
EX1010 [Sunose] at ¶[0029].

Sunose: Physically Impossible Densities

Experimental

Composites of different composition were prepared by mixing and grinding the three components, $LiMn_2O_4$, polyvinylidenefluoride (PVDF), and carbon black (CB), in an agate mortar. Cylindrical and parallelepiped pellets of the composites as well as of the individual components were obtained by cold pressing at 170 MPa in conventional equipment. The dimensions of the pellets were 13 mm in diameter and *ca.* 1 mm in height for the pellets with cylindrical shape, and 10 × 3 mm surface and *ca.* 3 mm in height for those of parallelepiped shape. The force was applied in the direction perpendicular to the pellet surface. The cylindrical pellets were used for the electrochemical experiments. Both cylindrical and parallelepiped pellets were used for determining the electrical conductivity and analyzing the microstructure of the composite. $LiMn_2O_4$ was obtained from the solid-state reaction of Mn_2O_3 and $LiNO_3$ following the procedure described elsewhere.[23] The cubic cell parameter of $LiMn_2O_4$ was 8.2418(9) Å, and its Brunauer-Emmett-Teller (BET) surface area was 7.5 m^2/g^{-1}. PVDF (Mw ≈ 534,000) and CB (Super P carbon black) were commercial products supplied by Fluka and MMM Carbon, respectively. The BET surface area of CB was 60.7 m^2/g^{-1}. The density, determined by helium adsorption, was 1.80 g cm^{-3} for PVDF and 1.98 g cm^{-3} for CB. The calculated crystallographic density for $LiMn_2O_4$ was 4.28 g cm^{-3}.

One reason for the excellent cycling and rate performance of the binder-free $LiCoO_2$-SACNT cathodes is the well-developed porous structures of the composites. According to the rule of mixture, the volume fraction of pores was estimated to be 60%, given the actual density of the $LiCoO_2$-1 wt% SACNT at 1.94 g cm^{-3}, and the theoretical specific densities of $LiCoO_2$ and SACNT at 5.1 g cm^{-3} and 1.2 g cm^{-3}, respectively.[33] The pores in the composites are favorable for electrolyte infiltration and accommodation with the volume changes of the cathodes on

5/23/25, 3:29 PM Carbon Black - PubChem

Hawley, G.G. The Condensed Chemical Dictionary. 10th ed. New York: Van Nostrand Reinhold Co., 1981., p. 195

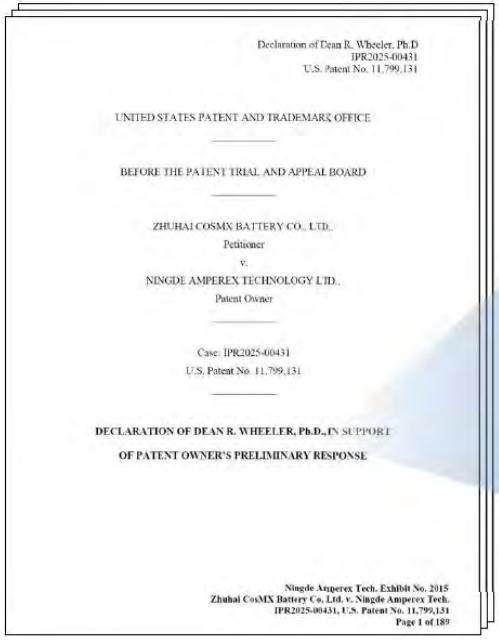
▸ Hazardous Substances Data Bank (HSDB); The National Institute for Occupational Safety and Hea···

Relative density (water = 1): 1.8-2.1

▸ ILO-WHO International Chemical Safety Cards (ICSCs)

Paper 28 [POR] at 16.
EX2039 (PVD, CB), EX2035 (LCO), EX2038 (CB).

Sunose: Physically Impossible Densities



Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

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Patent Owner

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U.S. Patent No. 11,799,131

DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S PRELIMINARY RESPONSE

Ningde Amperex Tech. Exhibit No. 2015
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
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140. Accordingly, to calculate the theoretical maximum compaction density of the active material composite of the embodiments and comparative examples of Sunose (using the highest possible crystalline density of each constituent for those that have a range of densities):

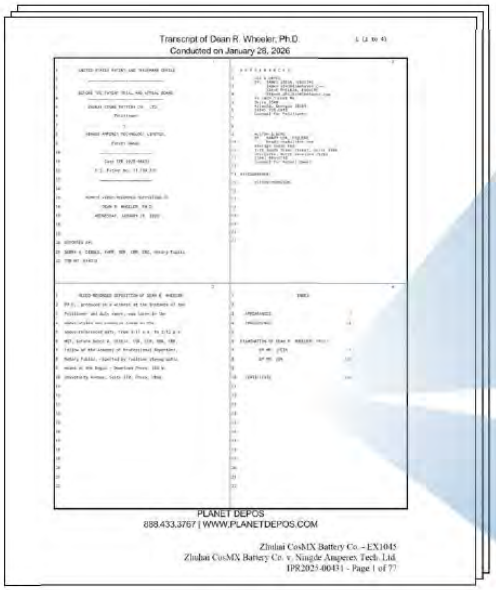
$$\rho_{max} = 1/\left[\left(\frac{100}{109}\Big/5.1\,\frac{g}{cm^3}\right) + \left(\frac{5}{109}\Big/2.1\,\frac{g}{cm^3}\right) + \left(\frac{4}{109}\Big/1.8\,\frac{g}{cm^3}\right)\right] = 4.5\,\frac{g}{cm^3}$$

141. Thus, 4.5 g/cm³ is the theoretical maximum compaction density of the active material composite of the embodiments and comparative examples of Sunose. However, this is based on a porosity of zero and an electrode with a porosity of zero is neither easy nor advisable to achieve. First, because it would require extremely high compaction pressures that would lead to cracking of particles, deforming of the current collector, and undesired severe damage to the electrode (i.e. even worse damage than what Sunose describes with respect to Comparative Example 3). Second, zero porosity would not lead to a desired electrode because sufficient porosity is needed for electrolyte-filled pathways for the ions in a functioning battery.

142. Accordingly, the actual compaction density of the active material composite of the embodiments and comparative examples of Sunose would necessarily be less than 4.5 g/cm³. At least inasmuch as the M values of

Paper 28 [POR] at 15, 16, Paper 42 [Sur-Reply] at 14.
EX2015[Wheeler Decl.] ¶¶140-142.

Sunose: Physically Impossible Densities



16 The theoretical maximum is like what you
17 could achieve if you were just trying to put that
18 material in a press and press as much as it can be
19 pressed. But in an actual battery context, you
20 couldn't even get as high as that theoretical
21 maximum. Meaning that 4.5 is not realistically
22 achievable in any battery context. You would have
1 to have a value less than 4.5 by some significant
2 amount.

6 A. 4.5 corresponds to 0 porosity, meaning
7 you've compressed the electrode materials so much
8 that there are no pores left. And as I previously
9 stated, that does not make for a practical or
10 workable battery electrode, so a realistic upper
11 bound for density would necessarily be lower than
12 4.5.

Paper 42 [Sur-Reply] at 9.
EX1045 [Wheeler Dep. Trans.] at 76:16-77:2, 143:6-12.

Sunose: Physically Impossible Densities

10 Q Sure. Is it correct that the compaction
11 density of an LCO cathode cannot exceed the
12 theoretical maximum or crystalline density of LCO?
13 MR. STEIN: Objection, calls for
14 speculation.
15 A I would say in general it probably would
16 not exceed that. If you had binders or other
17 materials that you were putting in there that had
18 a greater density than LCO, then it would be
19 possible to.

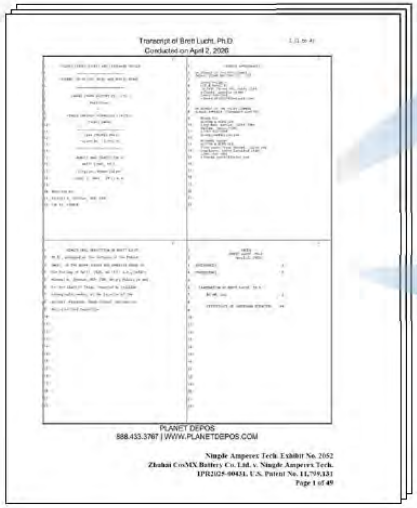
13 Q So you will agree that 4.5 is a reasonable
14 theoretical maximum compaction density for the
15 embodiments and comparative examples in Sunose?
16 MR. STEIN: Objection, asked and answered.
17 A I mean, I think the way that he did the
18 calculation looks reasonable. Like I said, I
19 haven't gone through the math myself, so assuming
20 that, I mean the number would appear to be
21 reasonable.

2 A I mean, as I've said I'm not -- I'm not
3 certain. I don't know if they're possible or not.
4 I think many of the embodiments in Sunose,
5 particularly embodiment 2 or embodiment 3, the
6 active material densities that are listed there
7 are very reasonable numbers and those are the
8 embodiments that I go to in my declaration.
9 Q Embodiment 2 states that the active
10 material density of the single-side coated portion
11 1 is 5 grams per cubic centimeter, correct?
12 A Yes, yes.
13 Q And that is higher than Dr. Wheeler's
14 calculated theoretical maximum compaction density
15 for the composite, correct?
16 A That is higher than that number that he
17 calculated, but it is also lower than the density
18 of lithium cobalt oxide.

12 A My expertise is in electrolytes and
13 electrolyte reactions with the surface of
14 electrode materials. I mean, I do have a fairly
15 good understanding of electrode materials and the
16 electrode process. That is not my primary area of
17 expertise.

Paper 28 [POR] at 15, 18.
EX2050 [Lucht Dep. Trans.] at 88:10-19, 111:13-21, 117:2-18, 231:12-17.

Sunose: Physically Impossible Densities



15 Q You say that the value of 4.4 is
16 reasonable?
17 A You certainly could have that utilizing
18 the value -- utilizing the calculation from
19 Dr. Wheeler, 4.4 is less than 5. I mean, it's
20 conceivable that you could get an electrode with
21 that density.
22 Q You've not calculated what level of
1 porosity that would represent, correct?
2 A No, I have not done that calculation.

11 Q Do you know what porosity levels for an
12 active layer a POSITA, at the time of the
13 invention of the '131 patent, would have believed
14 would have been typical or acceptable?
15 A I don't know.

Paper 42 [Sur-Reply] at 10.
EX2052 [Lucht 2nd Dep. Trans.] at 62:15-63:2, 80:11-15.

Sunose: Same Methodology in All Examples

Supplemental Declaration of Dean R. Wheeler, Ph.D.
IPR2025-00431
U.S. Patent No. 11,799,131

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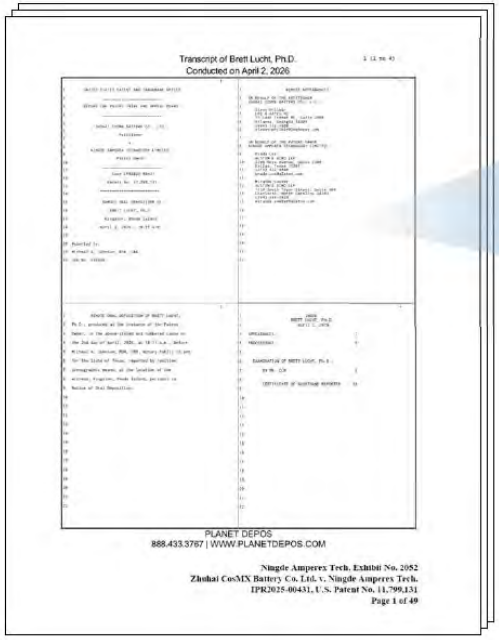
49. Sunose additionally does not disclose if or how the "prescribed densit[ies]," "packing densit[ies]," or "active material densit[ies]" were experimentally measured or somehow calculated. *See e.g.*, Ex. 1010 ¶ [0008] ("when rolling the coated and dried electrodes to a ***prescribed density***…"),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

Paper 28 [POR] at 17.
EX2047 [Wheeler Suppl. Decl.] at ¶49.

Sunose: Same Methodology in All Examples


Transcript of Brett Lucht, Ph.D.
Conducted on April 2, 2026

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22 Q Are you aware of any differences in how
1 this active material density M was calculated for
2 embodiments 3 and 4 compared to how any other
3 embodiment was calculated?
4 A **There's no -- I mean, from -- from the**
5 **Sunose document, I don't -- I don't see any**
6 **differences, no.**

Paper 42 [Sur-Reply] at 10.
EX2052 [Lucht 2nd Dep. Trans.] 66:22-67:6.

Sunose: Same Methodology in All Examples

2 Q Do you know if the same method of
3 calculating compaction density in Sunose was used
4 for every embodiment?
5 **A I don't recall Sunose specifically saying**
6 **how they measured the compaction density. It is**
7 **possible they measured it wrong.**

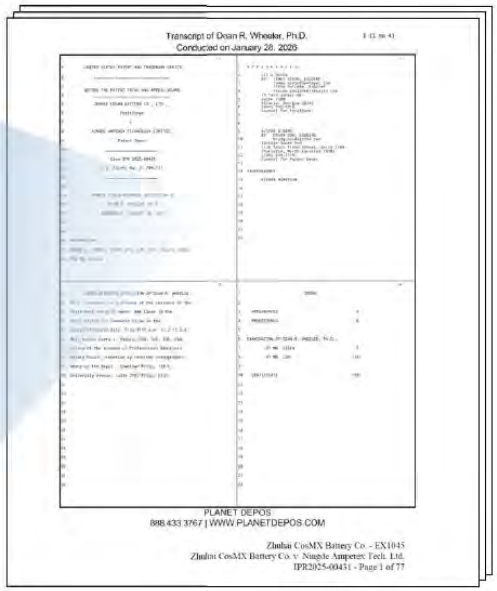
13 Q Is it possible that all of the
14 measurements listed in Table 1 are target
15 densities rather than actual measured densities?
16 MR. STEIN: Objection, calls for
17 speculation.
18 **A I would have to review the patent again**
19 **more thoroughly to really be able to answer that**
20 **question. I don't know. They don't specify how**
21 **they measure the compaction densities, but as I**
22 **said, the dense -- measuring densities for these**
1 **materials is well-known.**

10 **A I believe that is what is -- what is**
11 **stated in my declaration, yes, is that we -- that**
12 **Sunose did not measure the values after the**
13 **calendaring. And that what they used was the**
14 **volume based on the length and the thickness of**
15 **the coating and then how much was pressed to**
16 **the -- you know, to the thickness. Yeah, the**
17 **three values for volume, X times Y times Z.**

Paper 28 [POR] at 17, Paper 42 [Sur-Reply] at 12.
EX2050 [Lucht Dep. Trans.] at 119:2-7, 144:13-145:1, EX2052 [Lucht 2nd Dep. Trans.] at 56:10-17.

Sunose: Same Methodology in All Examples

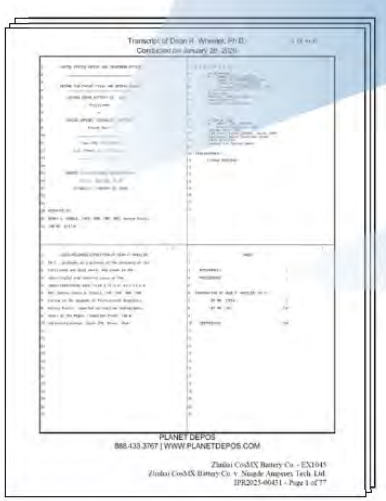
6 Q. Well, you would just be compacting the
7 same mass of material to the same volume. That's
8 the same density, right?
9 **A. Is that a question?**
10 Q. Yeah.
11 **A. Not necessarily.**
12 Q. So you don't agree that if you compact
13 the same amount of mass to the same density -- to
14 the same volume, you'd have equal densities?
15 **A. Your question has built in assumptions.**
16 **You said that it compacted to the same volume, and I**
17 **don't agree that it would necessarily compact to the**
18 **same volume.**
19 Q. The volume under the roll press is the
20 same for both -- for both -- for both portions as it
21 goes through, right?
22 MR. COX: Object to form.
1 **A. As previously stated, the distance**
2 **between the rollers is one factor, but not the only**
3 **factor in determining the final volume of the**
4 **material after it's passed through the rollers.**
5 **BY MR. STEIN:**
6 Q. And that's because the -- you're saying
7 the material might change density after you're
8 finished with the compaction process, right?
9 **A. Right. Because it's a -- there's a**
10 **partial elastic response. Materials are not simple**
11 **in the way that you might think, so it's difficult**
12 **to say what will happen between the time when it's**
13 **in -- between the rollers and when it's passed**
14 **through the rollers and has had a chance to relax.**



Paper 42 [Sur-Reply] at 12.
EX1045 [Wheeler Dep. Trans.] at 99:6-100:14.

Sunose: Same Methodology in All Examples

1 The roll press has a setting. You set
2 it. Is that distance between the rollers known?
3 They don't say. They don't specify -- they don't
4 give a value anywhere in the Sunose description.
5 They don't tell us how thick the layers were that
6 they put through. So it's hard to say what happened
7 in their experiment, but they clearly have a failure
8 of some kind, and it seems systematic because it's
9 occurring in multiple experiments.

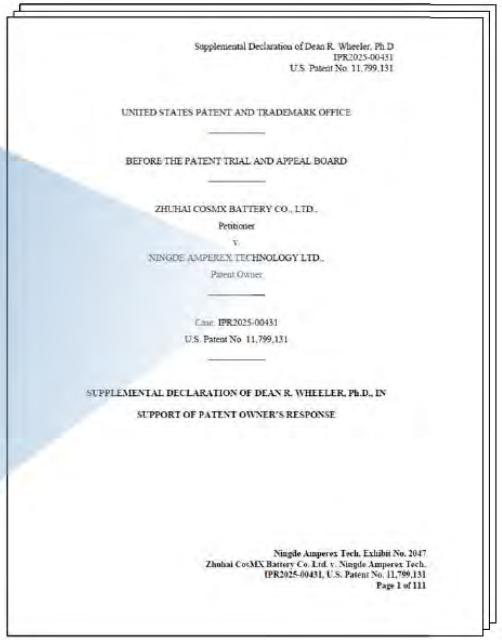


3 A. Again, as I've previously described, if
4 you know -- if you properly know a volume and a
5 mass, yes, you can get a density. The question is,
6 did you properly get that information?
7 I see no evidence in Sunose that they
8 properly got the thing that they reported, or think
9 that they got.
10 I don't know what went wrong. I don't
11 know how it -- but it's a fairly egregious case that
12 jumped out at me immediately, even without doing any
13 calculations. When I see a value of a density of --
14 a reported density of 8, it's like, that's -- that's
15 not just impossible, that's ridiculous. And so I --
16 I'm astonished that this got through any kind of
17 quality control process before it was turned into a
18 patent.

Paper 42 [Sur-Reply] at 12, 15.
EX1045 [Wheeler Dep. Trans.] at 89:3-18, 95:1-9.

Sunose: Same Methodology in All Examples

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


Supplemental Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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Patent Owner

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

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Ningde Amperex Tech. Exhibit No. 2047
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Paper 28 [POR] at 18.
EX2047 [Wheeler Suppl. Decl.] ¶52.

Sunose: Nonenablement

[0029]

(Embodiment 1)

To the positive electrode current collector 4 made of strip-shaped aluminum foil, 100 parts by weight of powder of LiCoO2 produced by Nichia Chemical, which is an active material, is mixed with 5 parts by weight of Denka Black, 4 parts by weight of a binder such as polyvinylidene fluoride (PVDF) is added thereto, and this was used as a thickening agent. This is then diluted with 7 parts by weight of a solvent of N-methyl-2-pyrrolidone produced by Mitsubishi Chemical, dispersion mixing was performed, and the prepared positive electrode coating is applied using a coating device at a speed of 15 m/min at a drying temperature of 200°C, and after applying a coating of 60 cm on the surface with an active material layer weight of 200 g/cm^2, the 10 cm coating is stopped. This process is repeated to create an electrode plate wherein portions that have the active material on the current collector and portions that have only the current collector intermittently exist.

[0030]

The coating on the rear side is the same as that of the front side, that is, 50 cm is applied at a drying temperature of 200°C, at a speed of 15 m/min, so that the weight of the active material layer on both sides of the applied portion reaches 400 g/cm^2, then the application is stopped at 20 cm. On the single-side coated portion 1, the coating device was used again to apply the positive electrode coating at a drying temperature of 200°C, at a speed of 15 m/min, so that the weight of the active material layer 120 g/cm^2.

[0031]

In relation to the obtained coated electrode plates, rolling was performed using a roll press machine to obtain a density of the active material layer on the two-side coated portion of 4.0 g/cc, and a density of the active material layer on the single-side coated portion of 5.7 g/cc, and cutting was then performed to the prescribed dimensions to produce a sheet-like positive electrode plate. This was used as the electrode plate in Embodiment 1.

Paper 28 [POR] at 19-20; Paper 42 [Sur-Reply] at 14.
EX1010 [Sunose] at ¶¶[0029]-[0031].

Sunose: Nonenablement

[0032]

(Embodiment 2)

Next, the positive electrode plate of embodiment 2 was created by rolling after changing the coating amount of the single-side coated portion 1 while keeping the same active material density of the two-side coated portion 2, and creating a positive electrode plate by changing so that the active material density of the single-side coated portion 1 is 5.0 g/cc.

[0033]

(Embodiment 3)

Next, the positive electrode plate of embodiment 3 was created by rolling after changing the coating amount of the single-side coated portion 1 while keeping the same active material density of the two-side coated portion 2, and creating a positive electrode plate by changing so that the active material density of the single-side coated portion 1 is 4.4 g/cc.

[0034]

(Embodiment 4)

Additionally, the positive electrode plate of embodiment 4 was created by rolling after changing the coating amount of the single-side coated portion 1 while keeping the same active material density of the two-side coated portion 2, and creating a positive electrode plate by changing so that the active material density of the single-side coated portion 1 is 4.0 g/cc.

[0035]

(Comparative Example 1)

The positive electrode plate of comparative example 1 was created by rolling without changing the coating amount of the single-side coated portion 1 while keeping the same active material density of the two-side coated portion 2, and creating a positive electrode plate by changing so that the active material density of the single-side coated portion 1 is 2.0 g/cc.

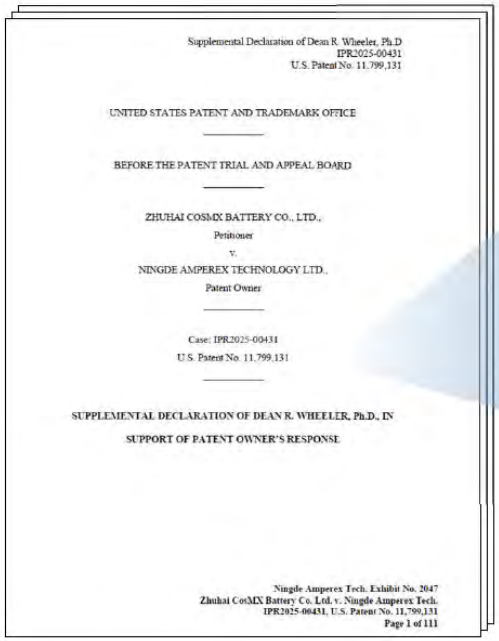
[0036]

(Comparative Example 2)

The positive electrode plate of comparative example 2 was created by rolling after changing the coating amount of the single-side coated portion 1 while keeping the same active material density of the two-side coated portion 2, and creating a positive electrode plate by changing so that the active material density of the single-side coated portion 1 is 6.5 g/cc.

Paper 28 [POR] at 19, 20, Paper 42 [Sur-Reply] at 14.
EX1010 [Sunose] at ¶¶[0032]-[0036].

Sunose: Nonenablement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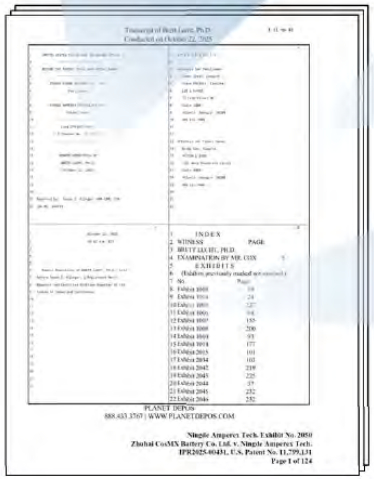
58. Sunose purportedly sets forth the steps for forming an electrode plate in Embodiment 1. Ex. 1010 ¶¶ [0029]-[0030]. Each of Embodiments 2-4 and Comparative Examples 1-3 necessarily rely on the disclosure of Embodiment 1 as each Embodiment or Comparative Example refers to creating each respective positive electrode plate "by rolling after changing the coating amount of the single-sided coated portion 1" or "by rolling without changing the coating amount of the single-sided coated portion 1" and only the description of Embodiment 1 sets forth purported "coating amounts" or "active material layer weights" that would be necessary for creating each respective single-sided coated portion 1 of a positive electrode plate. Ex. 1010 ¶¶ [0029]-[0037]. Indeed, none of Embodiments 2-4 or Comparative Examples 2-3 identify to even what "coating amount" the single-side coated portion is purportedly changed nor does Sunose provide thicknesses of such single-side coated portions.[25] Ex. 1010 ¶¶ [0032]-[0037]. Even Dr. Lucht admits that the active material weights or "coating amounts" are not disclosed in Sunose. Ex. 2050, 123:10-126:14 ("They don't specify how much material was layered on additionally or less for the – for the single layer.").[26] As such, the POSITA would not be able to create the positive electrode plates of Embodiments 2-4 or Comparative Examples 2-3.[27]

Paper 28 [POR] at 20.
EX2047 [Wheeler Suppl. Decl.] at ¶58.

Sunose: Nonenablement

4 What is the active material layer weight
5 of the single-side coated portion of embodiment 2?
6 **A They didn't – they did not show that in**
7 **the description. They just show what the density**
8 **is at least from where I am.**

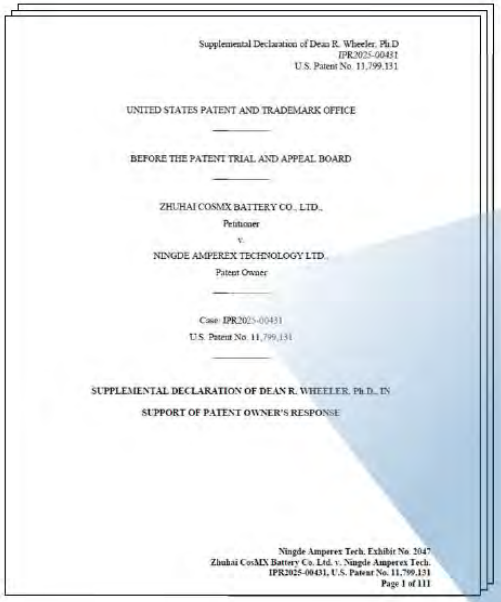
21 Q Embodiment 2, the coating amount is not
22 specified, right?
1 **A It is not listed there. What is listed is**
2 **the active material density of the -- of the**
3 **single-side portion.**



3 Q So where comparative example 1 says
4 without changing the coating amount of the
5 single-side coated portion 1, does that mean that
6 no separate layers were added to the single-sided
7 portion basically corresponding to not performing
8 the last sentence of paragraph 30 or does it mean
9 the single-side was coated with 200 grams per
10 centimeter square?
11 MR. STEIN: Objection to the form.
12 **A I don't know. It says what is created by**
13 **rolling without change in the coating amount of**
14 **the single-side coated portion 1, so I'm not**
15 **certain in regards to the comparative example 1,**
16 **which is not an example that I utilize in my**
17 **declaration.**
18 Q But embodiments 2 and 3 and 4 are all
19 built on the context of varying the embodiments
20 that is in embodiment 1, correct?
21 **A That is – yes, that is what is indicated,**
22 **yes.**

Paper 28 [POR] at 20.
EX2050 [Lucht Dep. Trans.] at 122:4-8, 123:21-124:3, 130:3-22.

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

Paper 28 [POR] at 20; Paper 42 [Sur-Reply] at 14.
EX2047 [Wheeler Suppl. Decl.] at ¶58, fn26.

Sunose: N/M Incommensurable D1/D2

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

21 Q If Sunose's measurement of compaction
22 density was wrong, would that affect your

120

1 calculations?
2 **A I'm not -- I don't know if their method of**
3 **calculating the active material density ratio is**
4 **wrong or not. I said that I don't know of that,**
5 **but if any value in any published or patented**
6 **thing is wrong, then if you try and calculate**
7 **something from that number, then the number might**
8 **not be correct either.**

Transcript of Brett Lucht, Ph.D.
Conducted on October 22, 2025

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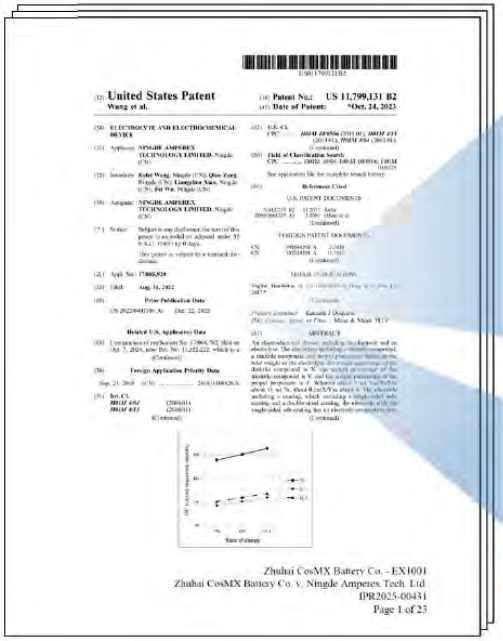
Paper 28 [POR] at 23.
EX2047 [Wheeler Suppl. Decl.] at ¶61, EX2050 [Lucht Dep. Trans.] at 119:21-120:8.

Criticality of D1/D2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Wang et al.
Patent No.: US 11,799,131 B2
Date of Patent: *Oct. 24, 2023

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TABLE 7

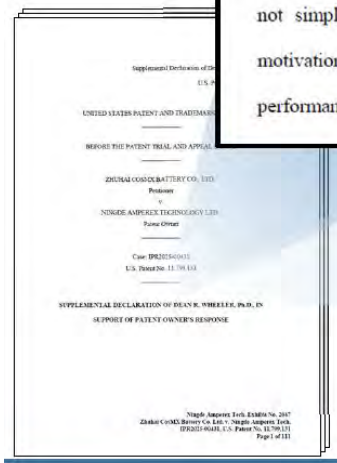
	Compaction density ratio (D1/D2)	Capacity retention rate: Fresh battery	After 200 cycles	After 400 cycles
S7-1	0.8	100%	93.8%	89.3%
S7-2	0.9	100%	95.3%	90.1%
S7-3	0.95	100%	95.9%	90.8%
S7-4	1.0	100%	96.8%	91.4%
S7-5	1.05	100%	95.8%	90.7%
S7-6	1.1	100%	95.2%	90.2%
S7-7	1.2	100%	93.7%	88.8%
D7-1	1.3	100%	91.2%	83.6%
D7-1	0.7	100%	90.5%	82.7%

cycle performance of lithium-ion batteries. It can be seen that when D1/D2 is within the range of 0.8-1.2, a better cycle performance is obtained, possibly because the combined additives facilitate the reduction of the electrode interface resistance and the reduction of the cell polarization.

Paper 28 [POR] at 24; Paper 42 [Sur-Reply] at 15.
EX1001 [131 Patent] at Table 7, 31:53-57.

No Motivation to Combine

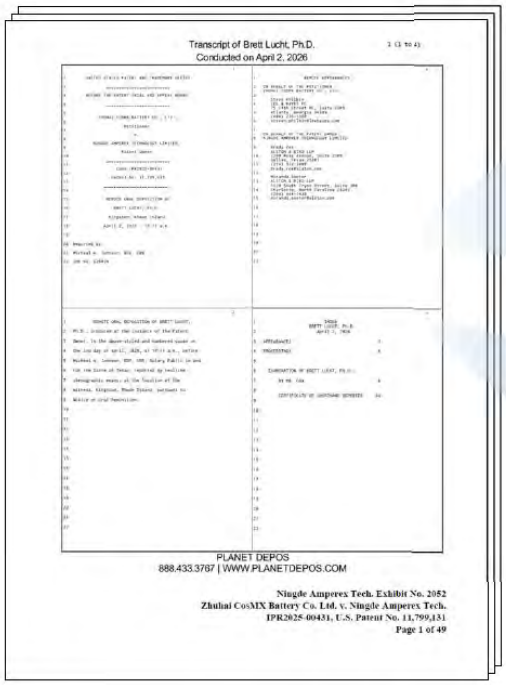
44. Once again, Petitioner's and Dr. Lucht's argument that Zeng omits essential implementation details boils down to the argument that Zeng's disclosure is fundamentally flawed. The purported "need" for a POSITA to find implementation as alleged by Petitioner is unfounded as Zeng managed to generate results for its electrolyte formulations with commercially accessible cell materials. Ex. 1006 ¶ [0040]. Moreover, ensuring compatibility between electrode and electrolyte designs requires extensive testing and even minor changes to one may result in large changes to the other. *See e.g.*, Ex. 2050, 62:18-64:5 (Dr. Lucht testifying that "typically you would do a whole bunch of testing" and that both small and large changes can result in large differences). Indeed, the surface chemistry and the design of compatibility of electrodes and electrolyte is so complex, one would not simply combine Zeng and Sunose without a contrived, hindsight-driven motivation. Indeed, the combination of Sunose's electrodes may deteriorate the performance in Zeng.



139. For at least the reasons discussed above in Paragraphs 45-61, which I incorporate here, Sunose is replete with values that are either based on a fundamentally flawed density methodology such that all purported density values are completely erroneous or which otherwise must correspond to some physical characteristic other than electrode compaction density, Sunose lacks enablement such that a POSITA would be deterred from its teachings, and Sunose's N/M ratios are incommensurable with the claimed D1/D2 ratio. Indeed, the compatibility between electrode and electrolyte designs, including interactions on surfaces, requires extensive testing and any changes thereto may result in large performance differences. *See e.g.*, Ex. 2050, 62:18-64:5 (Dr. Lucht testifying that "typically you would do a whole bunch of testing" and that both small and large changes can result in large differences). Given the complexity, one would not simply combine Zhou and Sunose without a contrived, hindsight-driven motivation. Indeed, the combination of Sunose's electrodes may deteriorate the performance in Zhou.

Paper 28 [POR] at 25, 59.
EX2047 [Wheeler Suppl. Decl.] at ¶¶44, 139.

No Motivation to Combine


Transcript of Brett Lucht, Ph.D.
Conducted on April 2, 2026

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10 Q Do you know if the level of porosity that
11 would correspond to a compaction density of 4.4
12 would work with any of the electrolyte solutions
13 that you proposed to combine with Sunose?
14 A So in terms of how well it would work,
15 once again, I'm not – I'm not sure. The
16 compaction density of 4.4 is, as you said,
17 relatively going to have relatively low porosity.
18 Which I'll point out that the maximum density that
19 is utilized in the '131 patent is up to 4.3, which
20 is just slightly lower than 4.4. And certainly
21 that's what ATL claimed, making electrodes up to
22 4.3 is an important – is an important aspect of

64

1 the patent. So 4.4 is slightly higher than that,
2 but ATL, yeah, utilizes 4.3.

11 Q Do you know what porosity levels for an
12 active layer a POSITA, at the time of the
13 invention of the '131 patent, would have believed
14 would have been typical or acceptable?
15 A I don't know.

Paper 42 [Sur-Reply] at 16.
EX2052 [Lucht 2nd Dep. Trans.] at 63:10-64:2, 80:11-15.

ROADMAP

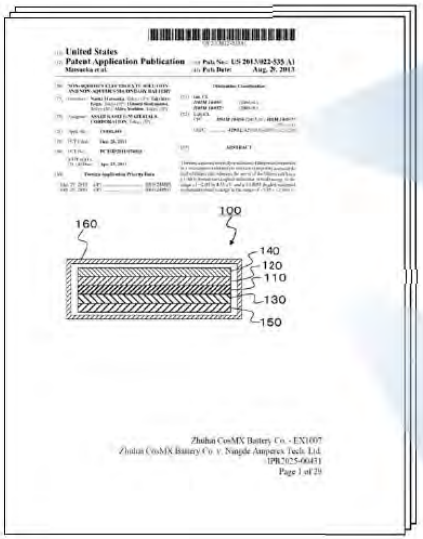
1. Zeng (Grounds 1-8)
   a) Zeng's disclosure cannot establish the claimed Y/Z ratio

2. Sunose (All Grounds)
   a) Sunose's density values cannot be relied upon

3. **Matsuoka (Grounds 2, 4, 6, 8)**
   a) **Matsuoka is fundamentally incompatible with Zeng**

4. Kim (Grounds 3, 4, 7, 8, 10, 12)
   a) A POSITA would not combine Kim with the other references

Matsuoka: Essential Requirements



[0014] As a result of intensive studies directed towards achieving the above-mentioned object, the present inventors have found that a non-aqueous electrolyte solution containing at least acetonitrile and a specific lithium salt can realize a non-aqueous secondary battery having high-rate performance, thereby completing the present invention. Specifically, the present invention is as follows.

[1] A non-aqueous electrolyte solution containing acetonitrile and an organic lithium salt, wherein an anion of the organic lithium salt has a LUMO (lowest unoccupied molecular orbital) energy in the range of −2.00 to 4.35 eV, and a HOMO (highest occupied molecular orbital) energy in the range of −5.35 to −2.90 eV.

[0043] The content of acetonitrile in the non-aqueous electrolyte solution of the present embodiment is not particularly limited. The content of acetonitrile is preferably 10 to 100 vol %, more preferably 70 to 100 vol %, and further preferably 90 to 100 vol %, based on the total amount of ingredients contained in the non-aqueous electrolyte solution, other than the organic lithium salt, and in a case in which the non-aqueous electrolyte solution contains an inorganic lithium salt, based on the total amount of ingredients contained in the non-aqueous electrolyte solution, other than the organic lithium salt or the inorganic lithium salt. By adjusting the content of acetonitrile in the above described range, the excellent performance of acetonitrile can be sufficiently exhibited without impairing a basic function as a non-aqueous secondary battery. As a result, 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.

Paper 28 [POR] at 35, 37.
EX1007 [Matsuoka] at ¶¶[0014], [0043].

Matsuoka: Essential Requirements

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

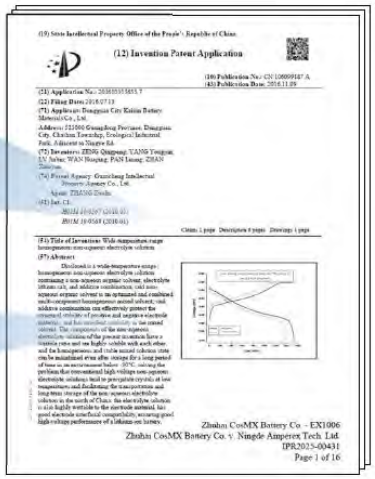
Paper 28 [POR] at 38; Paper 42 [Sur-Reply] at 17.
EX2047 [Wheeler Supp. Decl.] ¶90.

Matsuoka: Incompatibility With Zeng

[0037] Electrolyte solution preparation steps: in a glove box filled with argon gas, ethylene carbonate, propylene carbonate, diethyl carbonate, fluorobenzene, ethyl propionate, and propyl propionate are mixed at a mass ratio of EC:PC:DEC:FB:EP:PP = 25:10:30:5:10:20; then, lithium hexafluorophosphate of a concentration of 1.0 mol/L is slowly added to the mixed solution, finally, the following are added on the basis of the total weight of the electrolyte solution: 4wt% of fluoroethylene carbonate (FEC), 2wt% of adiponitrile (ADN), 1wt% of succinonitrile (SN), 0.5wt% of 1,2-bis(2-cyanoethoxy)ethane (DENE), 0.2wt% of vinylene carbonate (VC), and 4.0wt% of 1,3-propane sultone; after stirring well, the lithium-ion battery electrolyte solution of Embodiment 1 is obtained.

[0048] In Table 1 above, the abbreviated names of the chemical substances correspond as follows:

[0049] EC (ethylene carbonate); PC (propylene carbonate); DEC (diethyl carbonate); FB (fluorobenzene); EP (ethyl propionate); PP (propyl propionate); FEC (fluoroethylene carbonate); ADN (adiponitrile); T1 (succinonitrile); T2 (1,2-bis(2-cyanoethoxy)ethane); T3 (1,4-dicyano-2-butene); T4 (1,3,6-hexanetricarbonitrile); VC (vinylene carbonate); PS (1,3-propane sultone); DTD (ethylene sulfate).


(12) Invention Patent Application

Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
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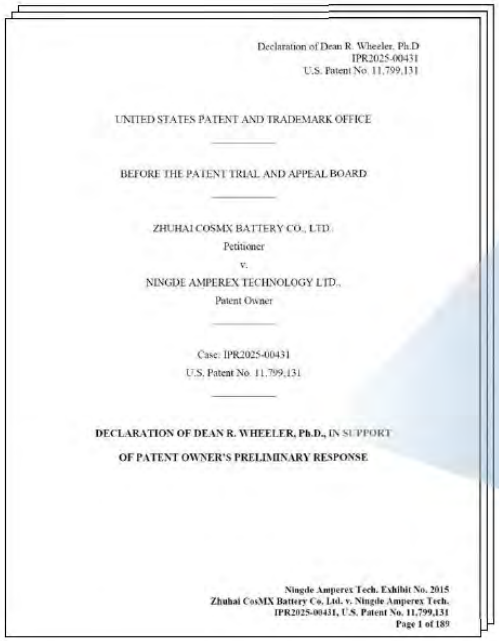
Embodiment 4	EC：PC：DEC：FB：EP：PP =25：10：30：5：10：20	4	2	T_4：1 T_2：0.5	VC：0.2 PS：4	91.0	No precipitation
Embodiment 6	EC：PC：DEC：FB：EP：PP =25：10：30：5：10：20	4	2	T_4：1 T_2：0.5	DTD：0.5 PS：3.5	91.6	No precipitation

Paper 28 [POR] at 34, 35.
EX1006 [Zeng] at ¶¶[0037], [0046], [0048], [0049].

Matsuoka: Incompatibility With Zeng



Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner
v.
NINGDE AMPEREX TECHNOLOGY LTD.,
Patent Owner

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

DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S PRELIMINARY RESPONSE

Ningde Amperex Tech. Exhibit No. 2015
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
IPR2025-00431, U.S. Patent No. 11,799,131
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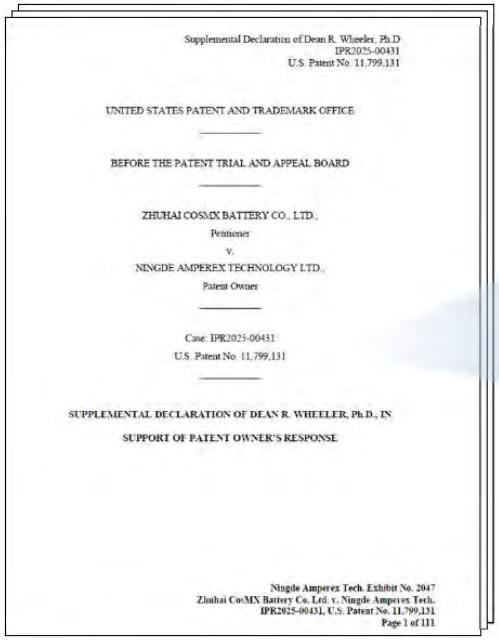
180. In addition, the electrolyte solutions of Zeng include dinitriles and in some instances, a trinitrile, as additive(s). *See e.g.*, Ex. 1006 ¶¶ [0045]-[0049]. Indeed, Embodiments 4 and 6 of Zeng include only adiponitrile (a dinitrile), 1,2-bis(2-cyanoethoxy)ethane (a dinitrile), and 1,3,6-hexanetricarbonitrile (a trinitrile) as minor *additives*. *Id.* Matsuoka considers a fundamentally different nitrile—acetonitrile (a mononitrile)—to not only be essential to its electrolyte solution, but as the solitary or main *solvent* component. *See e.g.*, Ex. 1007 ¶ [0043] ("The content of acetonitrile is preferably 10 to 100 vol %, more preferably 70 to 100 vol %, and further preferably 90 to 100 vol %, based on the total amount of ingredients contained in the non-aqueous electrolyte solution, other than the organic lithium salt, and in a case in which the non-aqueous electrolyte solution contains an inorganic lithium salt, based on the total amount of ingredients contained in the non-aqueous electrolyte solution, other than the organic lithium salt or the inorganic lithium salt."), ¶ [0109], and Tables 3-5 (setting forth numerous electrolyte solution examples with acetonitrile as the sole solvent component or the primary solvent component). Although a few of the examples in Matsuoka include a dinitrile as an additive, none of the examples include a trinitrile as an additive, and so a POSITA would consider the electrolyte systems of Zeng and Matsuoka to be fundamentally different.

Paper 28 [POR] at 35.
EX2015[Wheeler Decl.] at ¶180.

Matsuoka: Incompatibility With Zeng



Supplemental Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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Patent Owner

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

SUPPLEMENTAL DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S RESPONSE

Ningde Amperex Tech. Exhibit No. 2047
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
IPR2025-00431, U.S. Patent No. 11,799,131
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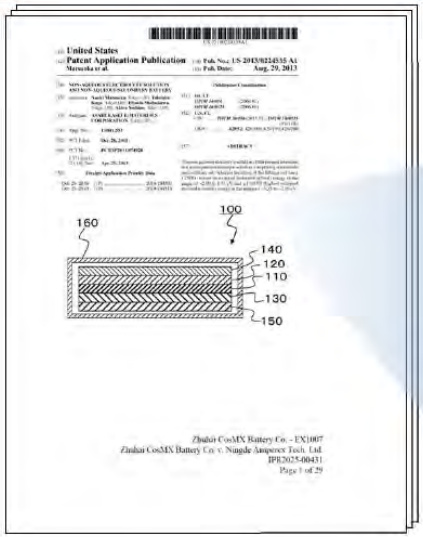
temperature and low temperatures." Paper 15, 47. Although Zeng is not drawn to low-temperature non-aqueous electrolyte solutions only, the Board overlooked the fact that stability of electrolyte solutions at -30°C is one focus of Zeng, including a specific storage test conducted by Zeng at -30°C with respect to its wide-temperature range homogenous non-aqueous electrolyte solution. Ex. 1006 ¶ [0038]. Indeed, in my opinion, the performance or stability at low temperatures better distinguishes electrolyte options in Zeng's established framework, especially solubility. In other words, for Zeng, if an electrolyte solution fails or does not perform as well at low temperature due to some components freezing or crystalizing out, then that is sufficient evidence to remove that electrolyte from further consideration, as reflected in Zeng's choice of which experiments are labeled as "Embodiments" vs. "Comparison Examples". Ex. 1006 ¶¶ [0045]-[0047]. In my opinion, the variation in results corresponding to the testing of the examples conducted at -30°C in Table 9 of Matsuoka would be more significant to a POSITA than the non-discriminating results corresponding to the testing conducted at 25°C.

Paper 28 [POR] at 37.
EX2047 [Wheeler Suppl. Decl.] at ¶86.

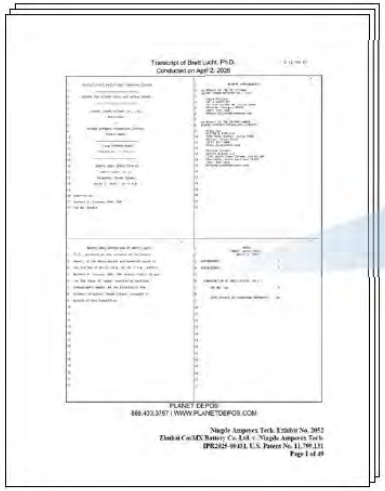
Matsuoka: Energies Relative to Acetonitrile



[0036] The non-nitrile additive preferably contains a compound having a LUMO energy that is in the range of −3.00 to 0.90 eV (hereinafter also referred to as a "specific additive"). The LUMO energy is more preferably from −2.10 to 0.80 eV, and further preferably from −2.00 to 0.60 eV. Since the reaction in which electrons enter the LUMO is a reductive reaction, the LUMO energy correlates with the reducibility of an additive. Thus, the lower the LUMO energy, the higher the reduction potential that can be obtained, and it means easy reducibility. Since the LUMO energy of acetonitrile calculated by the DFT calculation is 0.98 eV, the specific additive of the present embodiment is a compound that is reduced more sufficiently than acetonitrile, and this suggests that the electrochemical reaction progresses more quickly than the reductive decomposition of acetonitrile. By adjusting the LUMO energy of the specific additive in the above described range, it is not only effective for the formation of a protective film on a negative electrode, but it also suppresses nonelectrochemical side reactions caused by extremely high reducibility. Furthermore, differing from the case of an extremely low LUMO energy, the product generated as a result of the reductive reaction is not strongly fixed only on a negative electrode, but in some form, it provides good effects on members other than the negative electrode, such as a positive electrode and a separator. As a result, an increase in internal resistance caused by repeating charge-discharge cycles can be suppressed.

Paper 28 [POR] at 36.
EX1007 [Matsuoka] at ¶[0036].

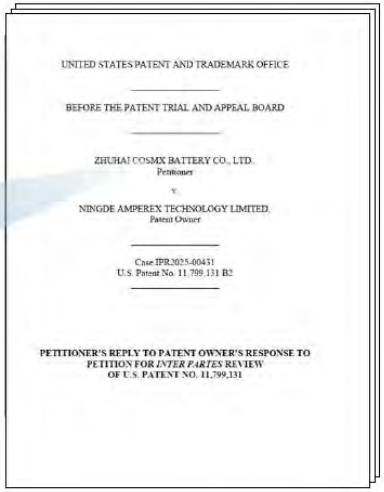
Matsuoka: Hindsight



21 percentage in Matsuoka. **The only reason I'm**
22 **relying upon Matsuoka is it specifically refers to**

82

1 **propyl propionate as a total weight percentage**
2 **versus the total electrolyte, which Zeng did not.**



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Patent Owner

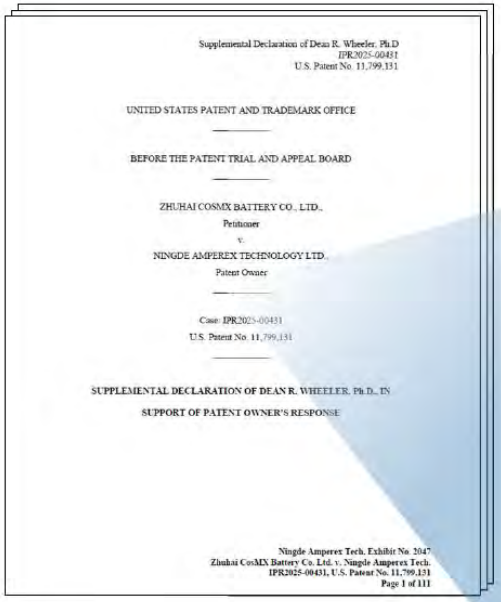
Case IPR2025-00431
U.S. Patent No. 11,799,131 B2

PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE TO PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 11,799,131

appropriate amount of PP." Decision, 44.[5] Petitioner cites Matsuoka solely for an express disclosure of an appropriate *weight* for PP—a compound Zeng's electrolytes already have—in the total electrolyte. Pet., 50-52.

Paper 42 [Sur-Reply] at 19.
Paper 32 [Reply] at 18; EX2052 [Lucht 2nd Dep. Trans.] 81:21-82:2.

Matsuoka: Hindsight


Supplemental Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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SUPPLEMENTAL DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S RESPONSE

Ningde Amperex Tech. Exhibit No. 2047
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IPR2025-00431, U.S. Patent No. 11,799,131
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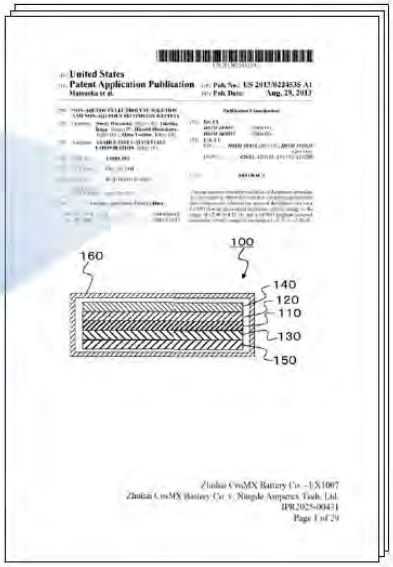
69. First, the fact that Zeng does not disclose its amount of propyl propionate in terms of the weight percentage of propyl propionate *based on a total weight of the electrolyte* (nor can such weight percentage of propyl propionate *based on a total weight of the electrolyte* be calculated from Zeng) does not mean that "Zeng's recipe is hypothetically unclear about how much PP to use" or "prompt[] the POSITA to consider Matsuoka's teachings about appropriate amounts of PP to include in Zeng's electrolytes," as alleged by Dr. Lucht. Ex. 1003 ¶ 174. Rather, Zeng's "recipe" is very clear about much propyl propionate to use in its base solvent mixture – a specified mass ratio to other solvents. After making its base solvent mixture, however, Zeng is not concerned with nor is Zeng motivated to even identify the weight percentage of propyl propionate *based on a total weight of the electrolyte, i.e.,* after adding lithium salt and various additives. Absent using the '131 Patent as a guide or otherwise contriving some purpose in hindsight, there is no reason why a POSITA would look beyond Zeng for "appropriate amounts of PP to include in Zeng's electrolytes." Ex. 1003 ¶ 174.

Paper 28 [POR] at 33.
EX2047 [Wheeler Suppl. Decl.] at ¶69.

Matsuoka: Hindsight

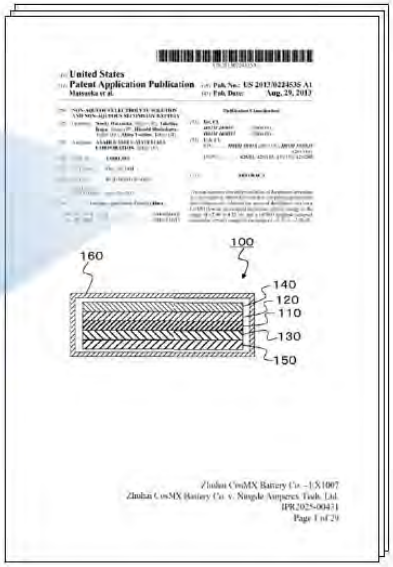
[0038] Specific examples of the compound having a LUMO energy that is in the range of −3.00 to 0.90 eV (hereafter, in this paragraph, the numerical value in the parentheses indicates a LUMO energy) include: fluoroethylene carbonates including, as typical examples, 4-fluoro-1,3-dioxolan-2-one (0.52 eV), 4,4-difluoro-1,3-dioxolan-2-one (0.22 eV), cis-4,5-difluoro-1,3-dioxolan-2-one (0.08 eV), trans-4,5-difluoro-1,3-dioxolan-2-one (0.00 eV), 4,4,5-trifluoro-1,3-dioxolan-2-one (−0.27 eV), 4,4,5,5-tetrafluoro-1,3-dioxolan-2-one (−0.52 eV), and 4,4,5-trifluoro-5-methyl-1,3-dioxolan-2-one (−0.11 eV); unsaturated bond-containing cyclic carbonates including, as typical examples, vinylene carbonate (0.00 eV), 4,5-dimethylvinylene carbonate (0.44 eV), and vinyl ethylene carbonate (−0.52 eV); lactones including, as typical examples, γ-butyrolactone (0.33 eV), γ-valerolactone (0.38 eV), γ-caprolactone (0.38 eV), δ-valerolactone (0.30 eV), δ-caprolactone (0.35 eV), and ϵ-caprolactone (0.38 eV); cyclic ethers including 1,2-dioxane (0.84 eV) as a typical example; carboxylic esters including, as typical examples, methyl formate (0.14 eV), methyl acetate (0.35 eV), methyl propionate (0.41 eV), methyl butyrate (0.41 eV), ethyl formate (0.16 eV), ethyl acetate (0.41 eV), ethyl propionate (0.46 eV), ethyl butyrate (0.46 eV), n-propyl formate (0.19 eV), n-propyl acetate (0.44 eV), n-propyl propionate (0.49 eV), n-propyl butyrate (0.49 eV), isopropyl formate (0.24 eV), isopropyl acetate (0.44 eV), isopropyl propionate (0.49 eV), isopropyl butyrate (0.49 eV), n-butyl formate (0.19 eV), n-butyl acetate (0.44 eV), n-butyl propionate (0.49 eV), n-butyl butyrate (0.49 eV), isobutyl formate (0.22 eV), isobutyl acetate (0.41 eV), isobutyl propionate (0.46 eV), isobutyl butyrate (0.49 eV), sec-butyl formate (0.24 eV), sec-butyl acetate (0.46 eV), sec-butyl propionate (0.49 eV), sec-butyl butyrate (0.52 eV), tert-butyl formate (0.27 eV), tert-butyl acetate (0.46 eV), tert-butyl propionate (0.44 eV), tert-butyl butyrate (0.44 eV), methyl pivalate (0.41 eV), n-butyl pivalate (0.49 eV), n-hexyl pivalate (0.49 eV), n-octyl pivalate (0.49 eV), dimethyl oxalate (−1.58 eV), ethylmethyl oxalate (−1.52 eV), diethyl oxalate (−1.47 eV), diphenyl oxalate (−1.99 eV), malonic ester, fumaric ester, and maleic ester; amides including, as typical examples, N-methylformamide (0.90 eV), N,N-dimethylformamide (0.87 eV), and N,N-dimethylacetamide (0.90 eV); cyclic sulfur compounds including, as typical examples, ethylene sulfite (−0.60 eV), propylene sulfite (0.00 eV), butylene sulfite (−0.16 eV), pentene sulfite (0.14 eV), sulfolane (−0.30 eV), 3-methyl sulfolane (−0.33 eV), 3-sulfolene (−0.33 eV), 1,3-propane sultone (−0.33 eV), 1,4-butane sultone (−0.35 eV), 1,3-propanediol sulfate (0.68 eV), tetramethylene sulfoxide (−0.14 eV), and thiophene 1-oxide (−2.37 eV); aromatic compounds including, as typical examples, monofluorobenzene (−0.22 eV), biphenyl (−0.90 eV), and biphenyl fluoride (−2.07 eV); nitro compounds including nitromethane (−1.88 eV) as a typical example; Schiff bases; Schiff base complexes; and oxalato complexes. These compounds are used singly or in combination of two or more.



Paper 28 [POR] at 29.
EX1007 [Matsuoka] at ¶[0038].

Matsuoka: Hindsight

[0040] Specific examples of the non-nitrile additive having a HOMO energy that is in the range of −9.55 to −6.00 eV (hereafter, in this paragraph, the numerical value in the parentheses indicates a HOMO energy) include: fluoroethylene carbonates including, as typical examples, 4-fluoro-1,3-dioxolan-2-one (−8.44 eV), 4,4-difluoro-1,3-dioxolan-2-one (−8.82 eV), cis-4,5-difluoro-1,3-dioxolan-2-one (−8.82 eV), trans-4,5-difluoro-1,3-dioxolan-2-one (−8.87 eV), 4,4,5-trifluoro-1,3-dioxolan-2-one (−9.17 eV), 4,4,5,5-tetrafluoro-1,3-dioxolan-2-one (−9.52 eV), and 4,4,5-trifluoro-5-methyl-1,3-dioxolan-2-one (−8.98 eV); unsaturated bond-containing cyclic carbonates including, as typical examples, vinylene carbonate (−6.91 eV), 4,5-dimethylvinylene carbonate (−6.34 eV), and vinylethylene carbonate (−7.73 eV); lactones including, as typical examples, γ-butyrolactone (−7.21 eV), γ-valerolactone (−7.13 eV), γ-caprolactone (−7.13 eV), δ-valerolactone (−7.02 eV), δ-caprolactone (−6.97 eV), and ϵ-caprolactone (−6.99 eV); cyclic ethers including 1,2-dioxane (−6.99 eV) as a typical example; carboxylic esters including, as typical examples, methyl formate (−7.70 eV), methyl acetate (−7.21 eV), methyl propionate (−7.18 eV), methyl butyrate (−7.18 eV), ethyl formate (−7.56 eV), ethyl acetate (−7.13 eV), ethyl propionate (−7.13 eV), ethyl butyrate (−7.10 eV), n-propyl formate (−7.54 eV), n-propyl acetate (−7.10 eV), n-propyl propionate (−7.10 eV), n-propyl butyrate (−7.10 eV), isopropyl formate (−7.48 eV), isopropyl acetate (−7.07 eV), isopropyl propionate (−7.07 eV), isopropyl butyrate (−7.05 eV), n-butyl formate (−7.54 eV), n-butyl acetate (−7.10 eV), n-butyl propionate (−7.10 eV), n-butyl butyrate (−7.07 eV), isobutyl formate (−7.54 eV), isobutyl acetate (−7.13 eV), isobutyl propionate (−7.13 eV), isobutyl butyrate (−7.10 eV), sec-butyl formate (−7.46 eV), sec-butyl acetate (−7.05 eV), sec-butyl propionate (−7.05 eV), sec-butyl butyrate (−7.05 eV), tert-butyl formate (−7.27 eV), tert-butyl acetate (−7.05 eV), tert-butyl propionate (−6.97 eV), tert-butyl butyrate (−6.94 eV), methyl pivalate (−7.16 eV), n-butyl pivalate (−7.05 eV), n-hexyl pivalate (−7.05 eV), n-octyl pivalate (−7.05 eV), dimethyl oxalate (−7.29 eV), ethylmethyl oxalate (−7.62 eV), diethyl oxalate (−7.16 eV), diphenyl oxalate (−6.69 eV), malonic ester, fumaric ester, and maleic ester; amides including, as typical examples, N-methylformamide (−6.80 eV), N,N-dimethylformamide (−6.59 eV), and N,N-dimethylacetamide (−6.34 eV); cyclic sulfur compounds including, as typical examples, ethylene sulfite (−7.73 eV), propylene sulfite (−7.29 eV), butylene sulfite (−7.10 eV), pentene sulfite (−7.07 eV), sulfolane (−7.84 eV), 3-methyl sulfolane (−7.78 eV), 3-sulfolene (−7.67 eV), 1,3-propane sultone (−8.30 eV), 1,4-butane sultone (−8.54 eV), 1,3-propanediol sulfate (−8.49 eV), tetramethylene sulfoxide (−6.26 eV), and thiophene 1-oxide (−6.64 eV); aromatic compounds including, as typical examples, monofluorobenzene (−6.61 eV) and biphenyl fluoride (−7.02 eV); and nitro compounds including nitromethane (−8.00 eV) as a typical example.



Paper 28 [POR] at 29.
EX1007 [Matsuoka] at ¶[0040].

ROADMAP

1. Zeng (Grounds 1-8)
   a) Zeng's disclosure cannot establish the claimed Y/Z ratio

2. Sunose (All Grounds)
   a) Sunose's density values cannot be relied upon

3. Matsuoka (Grounds 2, 4, 6, 8)
   a) Matsuoka is fundamentally incompatible with Zeng

4. **Kim (Grounds 3, 4, 7, 8, 10, 12)**
   a) **A POSITA would not combine Kim with the other references**

Petition Identifies No Motivation to Combine Kim

Zeng Embodiments 4 + 6

- **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, a
instructions. EX1003, ¶94.

Nonetheless, a POSITA would have
Embodiments 4 and 6 with a reasonable e

Zeng Embodiments 4 + 6 and Sunose

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
of the single-sided coating greater than the pre-
forming the double-sided layer—like Figure 1 of S
achieve the resulting compaction density ratio N
¶120.

Zeng Embodiments 4 + 6, Sunose, and Su

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
D2 of claims 3 and 16. A POSITA would, the
Su's anode in the Zeng/Sunose battery to arriv

Zeng Embodiments 4 + 6, Sunose, Su, and Matsuoka

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*

??

Zeng Embodiments 4 + 6, Sunose, Su, Matsuoka, **AND** Kim?

Paper 2 [Petition] at 26, 35, 51.
Paper 28 [POR] at 39-40, Paper 42 [Sur-Reply] at 20.

Kim: Addition of DEC

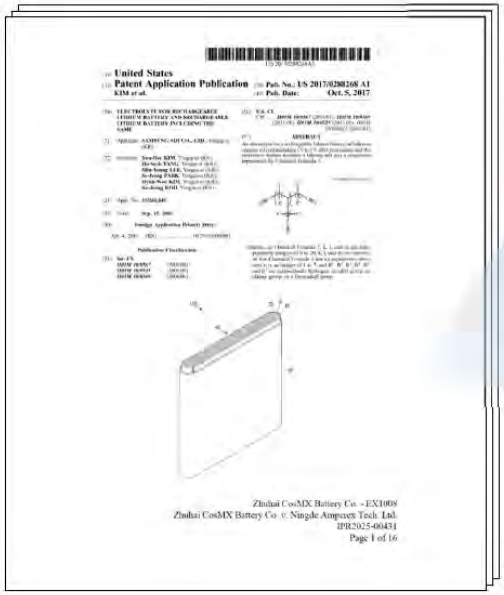
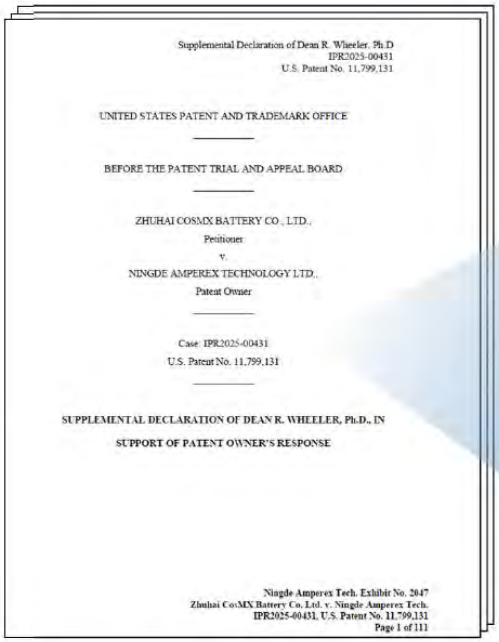


TABLE 1

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

Paper 28 [POR] at 45.
EX1008 [Kim] at Table 1.

Kim: Addition of DEC



Supplemental Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner
v.
NINGDE AMPEREX TECHNOLOGY LTD.,
Patent Owner

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

SUPPLEMENTAL DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S RESPONSE

Ningde Amperex Tech. Exhibit No. 2047
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96. I note that Dr. Lucht's reliance on Examples 1 and 2 of Kim is misguided and fails to address the fact that Examples 1 and 2 do not contain diethyl carbonate (DEC). Ex. 1008 ¶ [0090], Table 1; Ex. 1003 ¶¶ 182-196. For example, in addition to removing HTCN from Comparative Example 1 and removing PP and EP from Comparative Examples 1 and 2, Comparative Examples 1 and 2 also *add* DEC to the solvent mixture. Kim does not disclose, nor does Dr. Lucht address, the effect DEC has on the examples of Kim. For example, the presence of DEC in such a large volume % in Comparative Examples 1 and 2 may also be affecting the performance thereof. Accordingly, Kim teaches a POSITA to remove DEC from Zeng's solvent mixture, which would affect the carefully-crafted solvent ratio.

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

Paper 28 [POR] at 45, Paper 42 [Sur-Reply] at 20.
EX2047 [Wheeler Suppl. Decl.] at ¶¶96-97.

Kim: Addition of DEC

REVIEW ARTICLE

Review on Low-Temperature Electrolytes for Lithium-Ion and Lithium Metal Batteries

Ningde Amperex Tech. Exhibit No. 2046
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
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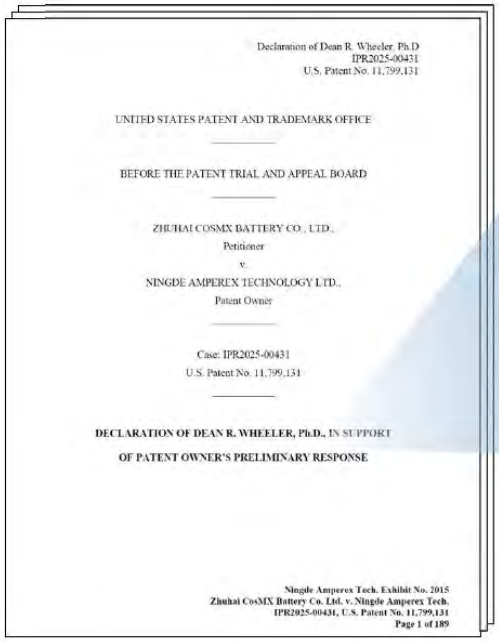
In addition to ion transport properties, SEI properties vary with the type of linear carbonates introduced. It was reported by Ein-Eli et al. [23] that in asymmetric carbonates a methyl group is required for stable graphite

Paper 28 [POR] at 45.
EX2046 [Lucht paper] at 7.

Kim: Life Cycle/Capacity Retention Measurements



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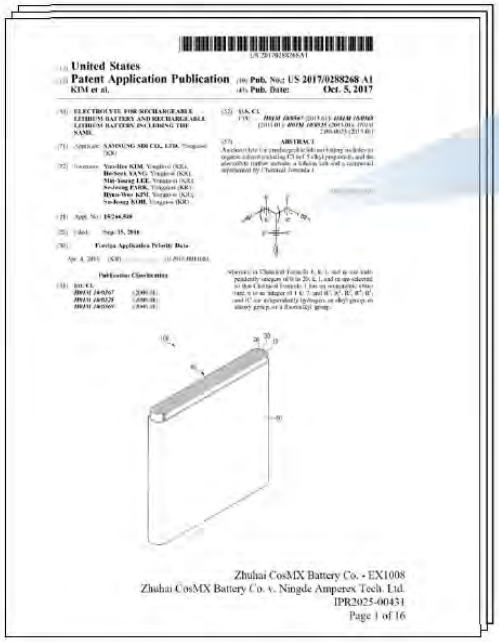
203. Although I disagree as to the relevance or application of Kim to the problems faced by the inventors of the '131 patent, even if a POSITA were to try to apply Kim, in my opinion, only Kim's measurement of cycle life would be of possible relevance to considerations made in the '131 patent, meaning that a POSITA interested in extending the cycle life of cells in the manner of the '131 patent would assign more relevance to that measurement than other of Kim's measurements. However, Kim lacks any information on how the battery cell was cycled, which would prevent a POSITA from combining the teachings of Kim and Zeng (with or without Matsuoka) and Sunose with a reasonable expectation of success. Indeed, key information for assessing the performance of Kim's batteries is missing, such as the voltage limit to which the battery is charged or discharged and at what rate the cycling is performed. Given Kim's focus on increasing the thermal stability of a battery, (*see* Ex. 1008 ¶¶ [0055] and [0056]), information on how the battery was cycled is particularly relevant as even small differences in operating voltages, such as during charging, can have significant effects on battery life.

Paper 28 [POR] at 42.
EX2015 [Wheeler Decl.] ¶203.

Kim: Life Cycle/Capacity Retention Measurements



[0055] The compound represented by Chemical Formula 1 may be an electrolyte additive including greater than or equal to about three nitrile groups (—CN) and having an asymmetric structure. The compound represented by Chemical Formula 1 may have a very low bonding energy with metal ions in a battery, and thus may form a stable and strong bonding with the metal ions, and significantly reduce a thickness change of the battery by a high temperature storage and a thermal impact.

[0056] The compound represented by Chemical Formula 1 may have a very strong bond with the surface of the positive active material and thus may form a protective layer having a strong bonding force on the surface of the positive active material layer. Accordingly, the compound may help to effectively prevent the electrolyte from directly contacting a positive electrode, suppress the electrolyte from being decomposed in the positive electrode even though a battery is stored at a high temperature or continuously charged and discharged, and thus help mitigate battery expansion (swelling). In addition, the compound represented by Chemical Formula 1 may help suppress a battery thickness change when a thermal impact is applied to the battery and thus improve thermal impact durability of the battery.

Paper 28 [POR] at 42.
EX1008 [Kim] at ¶¶[0055]-[0056].

Kim: Life Cycle/Capacity Retention Measurements

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98. Moreover, Kim's summary of cycle life in Table 4 is inconsistent with the cycle life data presented in FIG. 7. For example, a POSITA would conclude using test calculations that the "Capacity retention" values in Table 4 of Kim were computed as the ratio of "Capacity after 250 cycles" to "Initial capacity" in Table 4. Thus, "Capacity retention" in Kim's Table 4 corresponds directly to "DC capa. to ini. capacity" in Figure 7 of Kim. Ex. 2015 ¶ 204. This correspondence between Table 4 and Figure 7 is consistent for Examples 1 and 2 and Comparative Examples 1 and 2, which are shown as being 95.7%, 92.7%, 75.1%, and 82.0%, respectively, in both Table 4 and Figure 7. Ex. 1008, Table 4, Figure 7. However, when comparing the capacity retention values for the remaining Comparative Examples, including Comparative Examples 3-6, a POSITA would note significant discrepancies. In Figure 7, for example, Comparative Examples 5 and 6 are shown as having a 250-cycle capacity retention of around 92.5% and 92.3%, respectively, as reflected in the annotated Figure 7[36]:

Paper 28 [POR] at 44, Paper 42 [Sur-Reply] at 21.
EX2047 [Wheeler Suppl. Decl.] at ¶98.

Kim: Life Cycle/Capacity Retention Measurements

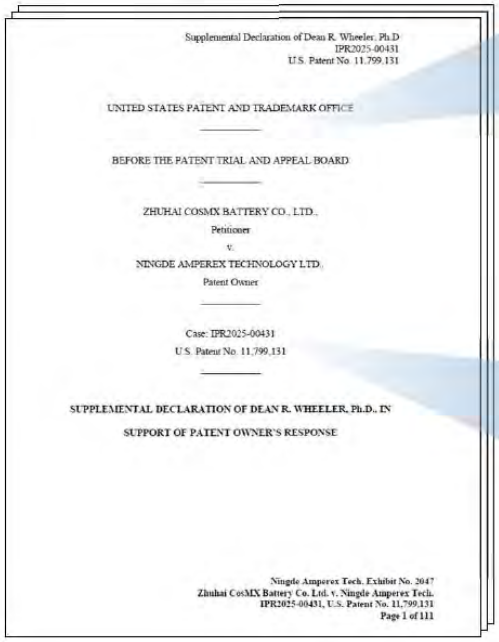

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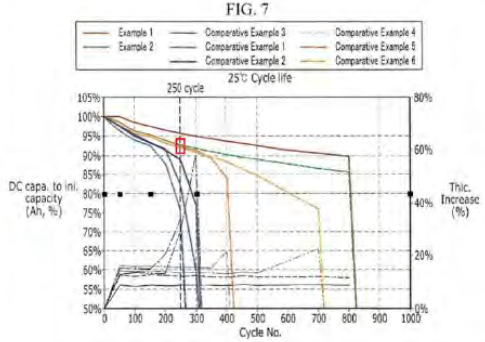
TABLE 4

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

FIG. 7



Paper 28 [POR] at 43-44, Paper 42 [Sur-Reply] at 21.
EX1008 [Kim] at Table 4, Figure 7.

ROADMAP

5. Zhou (Grounds 9-12)
   a) A POSITA would not select or implement Zhou's Example 8
   b) A POSITA would not substitute PP for ethyl acetate

6. Su (Grounds 5-8, 11, 12)
   a) Petitioner's absence of argument with respect to Su and the D1/D2 limitation

Zhou: Example 8

(19) State Intellectual Property Office of the People's Republic of China

(12) Invention Patent Application

(21) Application number: 201510954110.X
(22) Application date: Dec 16, 2015
(71) Applicant: Dongguan Shanshan Battery Materials Co., Ltd.
Address: Dongguan Shanshan Battery Materials Co., Ltd. Fifth Factory Area, Shizhongzhuqiang Industrial Zone, Nancheng District, Dongguan City, Guangdong Province 523085
(72) Inventor: Zhou Wanshan; Zhu Xiaojun; Li Zhiqiang
(74) Patent agency: Dongguan Huanna Patent and Trademark Office Co., Ltd. 44215
Agent: Liu Kaixue
(51) Int. Cl.
[0016] (0095872/2019.01)
[0016] (0095862/2019.01)

Claims 1 page, Specification 6 pages, Drawings 2 pages

(54) Invention Name
Fast charging lithium-ion battery electrolyte

(57) Abstract
The present invention relates to the field of lithium-ion battery technology, and specifically, to a fast charging lithium-ion battery electrolyte, which is composed of a solvent, a lithium salt and an additive, wherein the solvent includes a mixture of two or more of a low-boiling-point linear carbonate and a linear carboxylic acid ester, fluorobenzene and hydrofluoroether, the additive includes a first additive for negative electrode film formation, a second additive for improving battery cycle performance and a third additive for improving battery high temperature performance. Compared with the prior art, the combined use of the organic solvent and the three additives of the present invention produces a synergistic effect which can meet the fast charging requirements of a fast charging system, battery of above 2C with voltage of 4.35V, a negative electrode compaction density of 1.6g/cm³ or more, a high potential and a high compaction density, and has good cycle performance and high and low temperature performance.

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[0046] Example 8

[0047] In a glove box filled with argon (water content <10ppm, oxygen content <1ppm), ethylene carbonate, dimethyl carbonate, ethyl methyl carbonate, ethyl acetate, and fluorobenzene are mixed uniformly in a mass ratio of 25:30:10:20:5, 0.5% by mass of vinylene carbonate, 2% by mass of 1,3-propane sultone, 5% by mass of fluoroethylene carbonate, 1.0% by mass of 4-propyl ethylene sulfate, 0.5% by mass of lithium difluorooxalate borate, 1.5% by mass of 1,3,6-hexane trinitrile and 1% by mass of adiponitrile are added to the mixed solution, and then 14.0% by mass of $LiPF_6$ is slowly added and stirred until it is completely dissolved to obtain the lithium-ion battery electrolyte of Comparative Example 8.

Paper 2 [Petition] at 63, Paper 28 [POR] at 49, 54.
EX1014 [Zhou] at Example 8, ¶¶[0046]-[0047].

Zhou: AC Impedance

(12) Invention Patent Application

Zhuhai CosMX Battery Co. - EX1014
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
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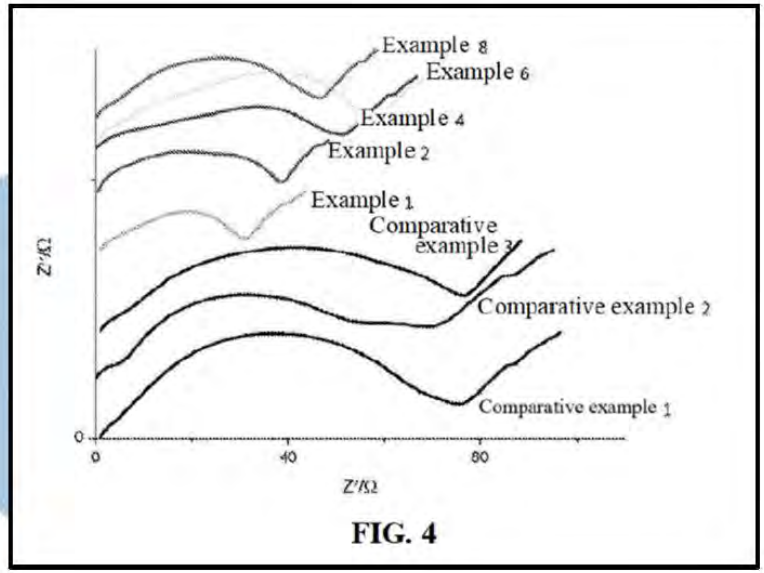

FIG. 4

Paper 28 [POR] at 50.
EX1014 [Zhou] at FIG. 4.

Zhou: AC Impedance

(19) State Intellectual Property Office of the People's Republic of China

(12) Invention Patent Application

(10) Application publication number: CN[illegible]
(43) Application publication date: May 6, 2015

(21) Application number: 2015[illegible]
(22) Application date: Dec 16, 2015
(71) Applicant: Dongguan Shanshan Battery Materials Co., Ltd.
Address: Dongguan Shanshan Battery Materials Co., Ltd., Fifth Factory Area, Shiellongpeng Industrial Zone, Nanchang District, Dongguan City, Guangdong Province 523085
(72) Inventor: Zhou Wenshan, Zhu Xiaoyuan, Li Zhiqiang
(74) Patent agency: Dongguan Huanan Patent and Trademark Office Co., Ltd. 44215
Agent: Lili Kekuan
(51) Int. Cl.
[illegible]
[illegible]

Claims 1 page. Specification 6 pages. Drawings 2 pages.

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Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
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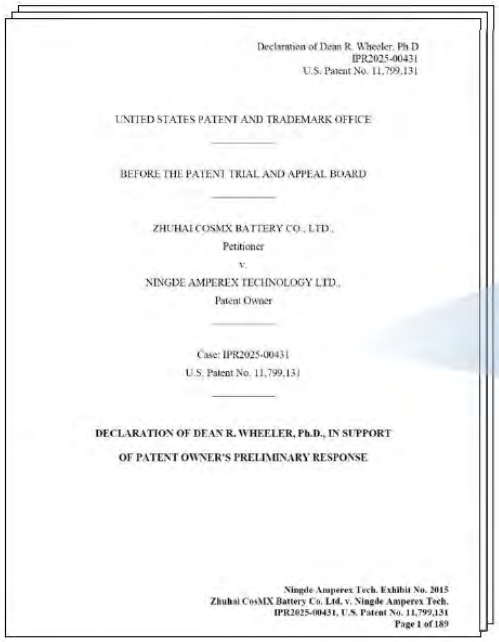
[0058] The present invention systematically adjusts the battery solvent system and the additive composition, and the overall impedance of the electrolyte is reduced to a certain extent. The impedance sources of lithium-ions in the battery process have three components: the migration impedance of lithium-ions in the electrolyte, the impedance of lithium-ions passing through the SEI film, and the impedance of lithium-ions passing through the positive and negative electrodes, separating film and other materials. Usually, the impedance of lithium-ions passing through the SEI film is one of the characterization bases for studying the kinetic performance of lithium-ions in the battery system transmission process. From Figure 4, it can be found that the corresponding semicircle in the AC impedance curve can characterize the impedance behavior of lithium-ions in the SEI film. The larger the radius of the arc, the worse the kinetic performance, and the smaller the radius, the better the kinetic performance of the battery. The carboxylic acid esters, fluorobenzenes and fluoroether are used in the present invention have this property. First, these components often do not participate in the formation of the SEI film, and mainly provide a better channel for the transmission of lithium-ions. When using the carboxylic acid esters, fluorobenzenes and fluoroethers of the present invention, SEI film-forming additives are particularly important for the performance of the battery. On the one hand, the cycle performance of fast charging must be guaranteed, and on the other hand, other performance of the battery must not be affected. As for the selection of the above-mentioned carboxylic acid esters, fluorobenzene and fluoroethers, the applicant believes that non-methyl carboxylates at the end can be used in large quantities (accounting for up to 30% of the solvent system), while the amount of fluorobenzene and fluoroether compounds is relatively low, which is more conducive to the fast charging of the system under high voltage and high compaction conditions. This is largely related to the viscosity of fluorobenzene and fluoroethers; In addition, the boiling point of carboxylates is lower and the molecular weight is smaller, while the groups in fluorobenzene or fluoroethers are often larger, which is not conducive to the improvement of the kinetic performance of the electrolyte. The addition of fluorobenzene and fluoroether as auxiliary solvents can improve the comprehensive performance of the present invention.

Paper 28 [POR] at 51.
EX1014 [Zhou] at ¶[0058].

Zhou: AC Impedance



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

Paper 28 [POR] at 51.
EX2015[Wheeler Decl.] at ¶253.

Zhou: Cycle Performance at High Temperatures

(12) Invention Patent Application

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[0059] In the above solvent system, the present invention improves the battery cycle performance with the help of certain special film-forming additives to make up for the incompatibility of the other negative electrodes. For the second additive for improving the battery cycle performance, lithium difluorooxalate borate, ethylene sulfate (DTD) and substituted ethylene sulfate have the best cycle stability. For the improvement of high temperature performance under high voltage of the fast charging system, among the nitrile compounds containing 2 or 3 nitrile functional groups in the third additive used in the present invention to improve the high temperature performance of the battery, 1,3,6-hexane trinitrile is particularly preferred. This is related to the poor compatibility of nitrile compounds with the negative electrode. The high temperature performance is often challenged when using the solvent system of the present invention. An efficient high temperature additive is the best choice. Nitrile compounds containing 2 or 3 nitrile functional groups, such as 1,3,6-hexane trinitrile, contain three nitrile groups, and the density of nitrile groups per unit volume is higher. It has better compatibility with the negative electrode and is easier to protect the positive electrode. The high temperature improvement effect of other dinitrile compounds or mononitrile compounds is relatively poor. This requires more nitrile to compensate. However, excessive addition of nitrile has a negative effect on the cycle performance, especially in the case of fast charging, this phenomenon is more obvious, and the cycle performance will drop rapidly.

Paper 28 [POR] at 51.
EX1014 [Zhou] at ¶[0059].

Zhou: Cycle Performance at High Temperatures

(12) Invention Patent Application

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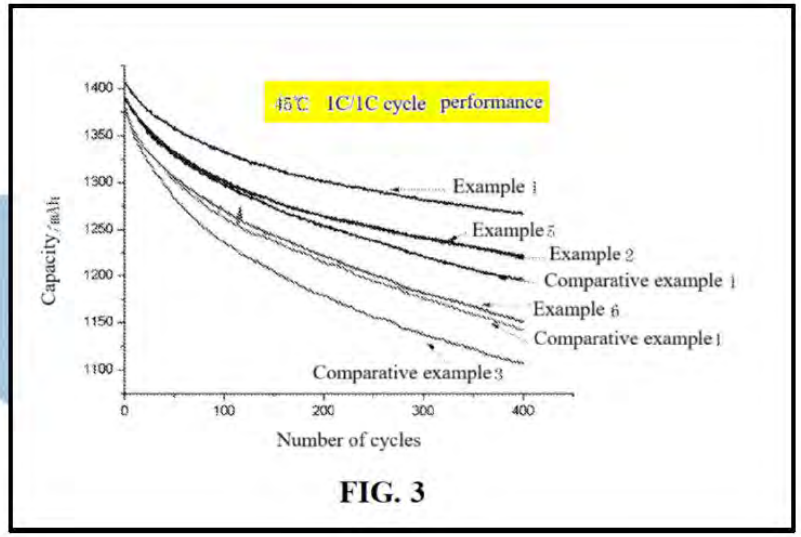

FIG. 3

Paper 28 [POR] at 51-52, Paper 42 [Sur-Reply] at 22-23.
EX1014 [Zhou] at FIG. 3.

Zhou: Cycle Performance at High Temperatures

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

257. The electrolyte solutions of Examples 4 and 8 of Zhou are the only examples that include a trinitrile, specifically, 1,3,6-hexane trinitrile. Ex. 1014 ¶¶ [0038]-[0039] ("1.5% by mass of 1,3,6-hexane trinitrile"), [0046]-[0047] ("1.5% by mass of 1,3,6-hexane trinitrile"). Significantly, neither Example 4 nor Example 8 are depicted in FIG. 3 such that a POSITA would not be able to draw any conclusions therefrom. Accordingly, it is my opinion that a POSITA would not have selected or implemented Example 8 over any of the other Examples of Zhou.

Paper 28 [POR] at 51.
EX2015[Wheeler Decl.] at ¶¶254, 257.

Zhou: SEI Formation

(19) State Intellectual Property Office of the People's Republic of China

(12) Invention Patent Application

(21) Application number: 201510561110.X
(22) Application date: Dec 16, 2015
(71) Applicant: Dongguan Shanshan Battery Materials Co., Ltd.
Address: Dongguan Shanshan Battery Materials Co., Ltd. Fifth Factory Area, Shizhongzhuqiang Industrial Zone, Nanchang District, Dongguan City, Guangdong Province 523085
(72) Inventor: Zhou Wanshun; Zhu Xiangqian; Li Zhiqiang
(74) Patent agency: Dongguan Huanna Patent and Trademark Office Co., Ltd. 44215
Agent: Li Kaiyou
(51) Int. Cl.
H01M 10/0567(2010.01)
H01M 10/0568(2010.01)

Claims: 1 page. Specification: 6 pages. Drawings: 2 pages.

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[0058] The present invention systematically adjusts the battery solvent system and the additive composition, and the overall impedance of the electrolyte is reduced to a certain extent. The impedance sources of lithium-ions in the battery process have three components: the migration impedance of lithium-ions in the electrolyte, the impedance of lithium-ions passing through the SEI film, and the impedance of lithium-ions passing through the positive and negative electrodes, separating film and other materials. Usually, the impedance of lithium-ions passing through the SEI film is one of the characterization bases for studying the kinetic performance of lithium-ions in the battery system transmission process. From Figure 4, it can be found that the corresponding semicircle in the AC impedance curve can characterize the impedance behavior of lithium-ions in the SEI film. The larger the radius of the arc, the worse the kinetic performance, and the smaller the radius, the better the kinetic performance of the battery. The carboxylic acid esters, fluorobenzenes and fluoroether are used in the present invention have this property. First, these components often do not participate in the formation of the SEI film, and mainly provide a better channel for the transmission of lithium-ions. When using the carboxylic acid esters, fluorobenzenes and fluoroethers of the present invention, SEI film-forming additives are particularly important for the performance of the battery. On the one hand, the cycle performance of fast charging must be guaranteed, and on the other hand, other performance of the battery must not be affected. As for the selection of the above-mentioned carboxylic acid esters, fluorobenzene and fluoroethers, the applicant believes that non-methyl carboxylates at the end can be used in large quantities (accounting for up to 30% of the solvent system), while the amount of fluorobenzene and fluoroether compounds is relatively low, which is more conducive to the fast charging of the system under high voltage and high compaction conditions. This is largely related to the viscosity of fluorobenzene and fluoroethers; In addition, the boiling point of carboxylates is lower and the molecular weight is smaller, while the groups in fluorobenzene or fluoroethers are often larger, which is not conducive to the improvement of the kinetic performance of the electrolyte. The addition of fluorobenzene and fluoroether as auxiliary solvents can improve the comprehensive performance of the present invention.

Paper 28 [POR] at 51, Paper 42 [Sur-Reply] at 22.
EX1014 [Zhou] at ¶[0058].

ROADMAP

5. Zhou (Grounds 9-12)
   a) A POSITA would not select or implement Zhou's Example 8
   b) A POSITA would not substitute PP for ethyl acetate

6. Su (Grounds 5-8, 11, 12)
   a) Petitioner's absence of argument with respect to Su and the D1/D2 limitation

Zhou: Example 8

(19) State Intellectual Property Office of the People's Republic of China

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Agent: Liu Kaixun
(51) Int. Cl.
[illegible]
[illegible]

Claims 1 page, Specification 6 pages, Drawings 2 pages

(54) Invention Name
Fast charging lithium-ion battery electrolyte
(57) Abstract
The present invention relates to the field of lithium-ion battery technology, and specifically, to a fast charging lithium-ion battery electrolyte, which is composed of a solvent, a lithium salt and an additive, whereas the solvent includes a mixture of two or more of a low-boiling-point linear carbonate and a linear carboxylic acid ester, fluorobenzene and hydrofluoroether, the additive includes a first additive for negative electrode film formation, a second additive for improving battery cycle performance, and a third additive for improving battery high temperature performance. Compared with the prior art, the combined use of the organic solvent and the three additives of the present invention produces a synergistic effect which can meet the fast charging requirements of a fast charging system battery of above 2C with voltage of 4.35V, a negative electrode compaction density of 1 kg/cm² or more, a high potential and a high compaction density, and has good cycle performance and high and low temperature performance.

Zhuhai CosMX Battery Co. - EX1014
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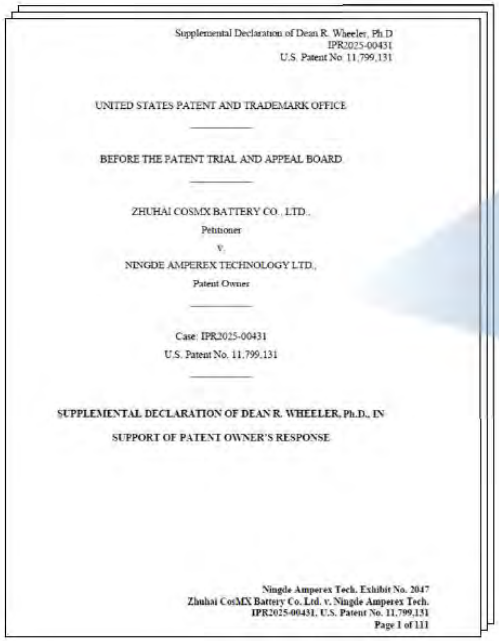
[0046] Example 8

[0047] In a glove box filled with argon (water content <10ppm, oxygen content <1ppm), ethylene carbonate, dimethyl carbonate, ethyl methyl carbonate, ethyl acetate, and fluorobenzene are mixed uniformly in a mass ratio of 25:30:10:20:5, 0.5% by mass of vinylene carbonate, 2% by mass of 1,3-propane sultone, 5% by mass of fluoroethylene carbonate, 1.0% by mass of 4-propyl ethylene sulfate, 0.5% by mass of lithium difluorooxalate borate, 1.5% by mass of 1,3,6-hexane trinitrile and 1% by mass of adiponitrile are added to the mixed solution, and then 14.0% by mass of $LiPF_6$ is slowly added and stirred until it is completely dissolved to obtain the lithium-ion battery electrolyte of Comparative Example 8.

Paper 2 [Petition] at 63, Paper 28 [POR] at 49, 54.
EX1014 [Zhou] at Example 8, ¶¶[0046]-[0047].

Zhou: EA and PP



Supplemental Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

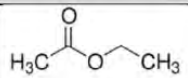
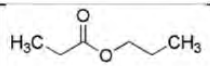
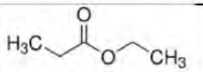
BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner
v.
NINGDE AMPEREX TECHNOLOGY LTD.,
Patent Owner

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

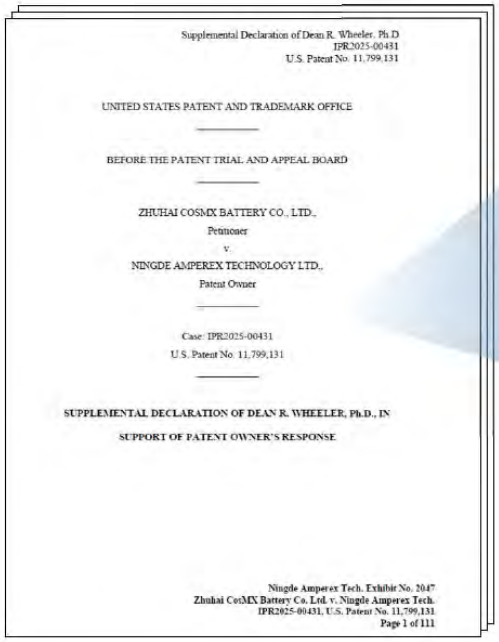
SUPPLEMENTAL DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S RESPONSE

Ningde Amperex Tech. Exhibit No. 2047
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
IPR2025-00431, U.S. Patent No. 11,799,131
Page 1 of 111

Molecule	Formula	Structure	Molar Mass (g/mol)	Melting Point	Boiling Point
Ethyl Acetate	C4H8O2		88.106	-84°C	77.1°C
Propyl Propionate	C6H12O2		116.16	-75.9°C	122.5°C
Ethyl Propionate	C5H10O2		102.13	-73°C	99°C

Paper 28 [POR] at 55.
EX2047 [Wheeler Suppl. Decl.] at ¶130.

Zhou: EA and PP


Supplemental Declaration of Dean R. Wheeler, Ph.D
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Ningde Amperex Tech. Exhibit No. 2047
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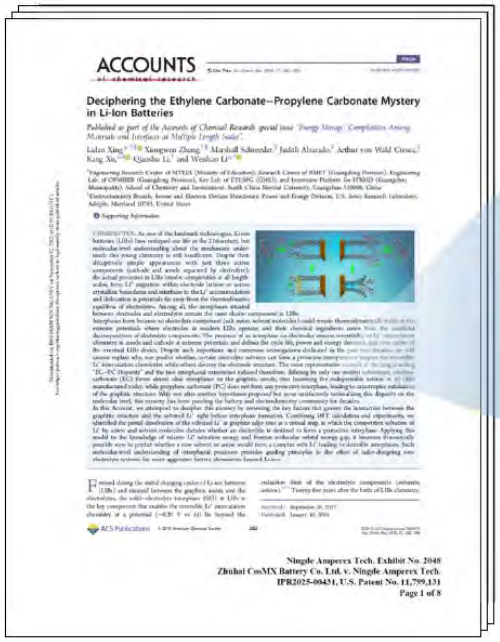
127. However, a POSITA grasping the complexities and unpredictable nature of battery chemistry, and specifically SEI chemistry, would understand that, just because two molecules share a functional group, does not mean that they can be used interchangeably without impacting performance. One well known example of small differences in chemical structure causing large differences in battery performance is the so-called "EC-PC disparity." Ex. 2048.[43] Although ethylene carbonate (EC) and propylene carbonate (PC) differ by only one methyl substituent, EC is well-known to contribute positively to SEI formation, while PC is found to not form any protective interphase and indeed to contribute to the exfoliation (flaking off) of graphite anodes. *Id.*

Paper 28 [POR] at 56, Paper 42 [Sur-Reply] at 24.
EX2047 [Wheeler Suppl. Decl.] at ¶127.

Zhou: EA and PP



ACCOUNTS of chemical research

Deciphering the Ethylene Carbonate–Propylene Carbonate Mystery in Li-Ion Batteries

Published as part of the Accounts of Chemical Research special issue "Energy Storage: Complexities Among Materials and Interfaces at Multiple Length Scales".

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Supporting Information

CONSPECTUS: As one of the landmark technologies, Li-ion batteries (LIBs) have reshaped our life in the 21stcentury, but molecular-level understanding about the mechanism underneath this young chemistry is still insufficient. Despite their deceptively simple appearances with just three active components (cathode and anode separated by electrolyte), the actual processes in LIBs involve complexities at all length-scales, from Li^+ migration within electrode lattices or across crystalline boundaries and interfaces to the Li^+ accommodation and dislocation at potentials far away from the thermodynamic equilibria of electrolytes. Among all, the interphases situated between electrodes and electrolytes remain the most elusive component in LIBs. Interphases form because no electrolyte component (salt anion, solvent molecules) could remain thermodynamically stable at the extreme potentials where electrodes in modern LIBs operate, and their chemical ingredients come from the sacrificial decompositions of electrolyte components. The presence of an interphase on electrodes ensures reversibility of Li^+ intercalation chemistry in anode and cathode at extreme potentials and defines the cycle life, power and energy densities, and even safety of the eventual LIBs device. Despite such importance and numerous investigations dedicated in the past two decades, we still cannot explain why, nor predict whether, certain electrolyte solvents can form a protective interphase to support the reversible Li^+ intercalation chemistries while others destroy the electrode structure. The most representative example is the long-standing "EC−PC Disparity" and the two interphasial extremities induced therefrom: differing by only one methyl substituent, ethylene carbonate (EC) forms almost ideal interphases on the graphitic anode, thus becoming the indispensable solvent in all LIBs manufactured today, while propylene carbonate (PC) does not form any protective interphase, leading to catastrophic exfoliation of the graphitic structure. With one after another hypotheses proposed but none satisfactorily rationalizing this disparity on the molecular level, this mystery has been puzzling the battery and electrochemistry community for decades.

In this Account, we attempted to decipher this mystery by reviewing the key factors that govern the interaction between the graphitic structure and the solvated Li^+ right before interphase formation. Combining DFT calculation and experiments, we identified the partial desolvation of the solvated Li^+ at graphite edge sites as a critical step, in which the competitive solvation of Li^+ by anion and solvent molecules dictates whether an electrolyte is destined to form a protective interphase. Applying this model to the knowledge of relative Li^+ solvation energy and frontier molecular orbital energy gap, it becomes theoretically possible now to predict whether a new solvent or anion would form a complex with Li^+ leading to desirable interphases. Such molecular-level understanding of interphasial processes provides guiding principles to the effort of tailor-designing new electrolyte systems for more aggressive battery chemistries beyond Li-ion.

Reprinted during the initial charging cycles (1 Li ion) batteries (LIBs) and situated between the graphite anode and the electrolytes, the solid−electrolyte interphase (SEI) in LIBs is the key component that enables the reversible Li^+ intercalation chemistry at a potential (~0.20 V vs Li) far beyond the reduction limit of the electrolyte components (solvents, anions).[1−7] Twenty-five years after the birth of LIBs chemistry,

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ACS Publications

Ningde Amperex Tech. Exhibit No. 2048
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
IPR2025-00431, U.S. Patent No. 11,799,131
Page 1 of 8

CONSPECTUS: As one of the landmark technologies, Li-ion batteries (LIBs) have reshaped our life in the 21stcentury, but molecular-level understanding about the mechanism underneath this young chemistry is still insufficient. Despite their deceptively simple appearances with just three active components (cathode and anode separated by electrolyte), the actual processes in LIBs involve complexities at all length-scales, from Li^+ migration within electrode lattices or across crystalline boundaries and interfaces to the Li^+ accommodation and dislocation at potentials far away from the thermodynamic equilibria of electrolytes. Among all, the interphases situated between electrodes and electrolytes remain the most elusive component in LIBs. Interphases form because no electrolyte component (salt anion, solvent molecules) could remain thermodynamically stable at the extreme potentials where electrodes in modern LIBs operate, and their chemical ingredients come from the sacrificial decompositions of electrolyte components. The presence of an interphase on electrodes ensures reversibility of Li^+ intercalation chemistry in anode and cathode at extreme potentials and defines the cycle life, power and energy densities, and even safety of the eventual LIBs device. Despite such importance and numerous investigations dedicated in the past two decades, we still cannot explain why, nor predict whether, certain electrolyte solvents can form a protective interphase to support the reversible Li^+ intercalation chemistries while others destroy the electrode structure. The most representative example is the long-standing "EC−PC Disparity" and the two interphasial extremities induced therefrom: differing by only one methyl substituent, ethylene carbonate (EC) forms almost ideal interphases on the graphitic anode, thus becoming the indispensable solvent in all LIBs manufactured today, while propylene carbonate (PC) does not form any protective interphase, leading to catastrophic exfoliation of the graphitic structure. With one after another hypotheses proposed but none satisfactorily rationalizing this disparity on the molecular level, this mystery has been puzzling the battery and electrochemistry community for decades.

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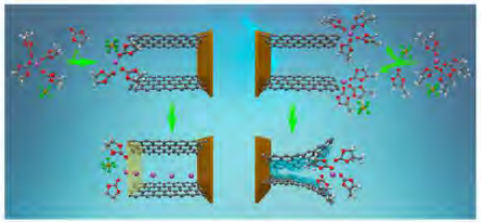
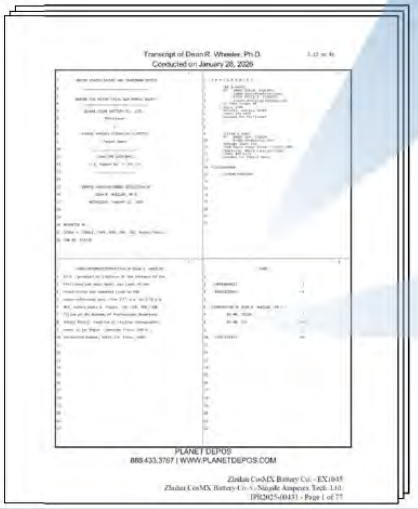


Paper 28 [POR] at 56-57.
EX2048 [Xing et al.] at 1.

Zhou: EA and PP

6 Q. And what do the differences in these
7 physical properties tell you about the substitution
8 or proposed substitution of propyl propionate for
9 ethyl acetate?
10 **A. So this is a limited picture. It's --**
11 **this table is looking -- lists molar mass, melting**
12 **point, and boiling point.**
13 **Those are convenient and easy to measure**
14 **for pure components.**
15 **In just those measures, there's a**
16 **significant difference between ethyl acetate and**
17 **propyl propionate. For instance, the boiling point**
18 **is -- for ethyl acetate it's 77.1 degrees Celsius,**
19 **and the boiling point for propyl propionate it's**
20 **122.5 degrees Celsius. And so there's a fairly**
21 **noticeable difference there.**
22 **And there's a -- but again, that's --**


Transcript of Dean R. Wheeler, Ph.D.
Conducted on January 28, 2026
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Zhuhai CosMX Battery Co. - EX1045
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
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1 **that's not a complete picture. Even -- and I do**
2 **cite from Dr. Lucht's own writings on the topic of**
3 **electrolytes, that there are many properties you**
4 **need to look at for electrolytes, and melting point,**
5 **boiling point wouldn't be the only ones you would**
6 **consider.**
7 **Furthermore, even when you know all of**
8 **these single-moleculed properties, it's not**
9 **predictable what will happen when you mix them**
10 **altogether with some bunch of other molecules with**
11 **their own sets of properties and how they're all**
12 **going to interact.**
13 **Some things you can know better than**
14 **others. You know, there's lots of science over the**
15 **years on these things, but ultimately you have to do**
16 **experiments to find out what a mixture -- how a**
17 **mixture is going to behave.**

Paper 42 [Sur-Reply] at 24.
EX1045 [Wheeler Dep. Trans.] at 145:6-146:17.

Zhou: EA and PP

REVIEW ARTICLE

Review on Low-Temperature Electrolytes for Lithium-Ion and Lithium Metal Batteries

Ningde Amperex Tech. Exhibit No. 2046
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
IPR2025-00431, U.S. Patent No. 11,799,131
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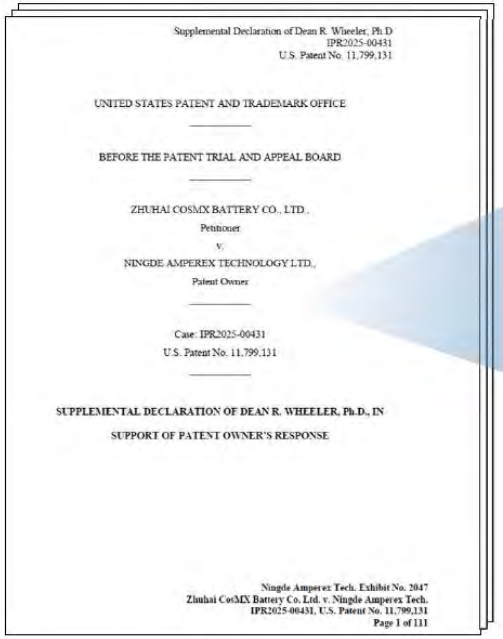
Linear carbonates and carboxylic esters are always desirable for LT electrolytes, owing to their low viscosity and low melting points (Fig. 3). We would like to point out that Fig. 3 only uses two parameters, i.e., the viscosity and the melting point. However, other properties, such as good electrochemical and chemical stability, miscibility with other cosolvents, and a wide liquidus range should also be considered for LT electrolyte solvents. In addition, some solvents

atically explored by Smart et al. [39–41]. It was concluded that esters with shorter alkyl chains have the advantage in getting better ionic conductivity for the bulk electrolyte, but the disadvantage in forming more resistive and less protective SEIs as compared to longer chain counterparts. Among

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

Paper 28 [POR] at 54, 56.
EX2046 [Lucht paper] at 5-6, 9-10

Zhou: EA and PP


Supplemental Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner
v.
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Patent Owner

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

SUPPLEMENTAL DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S RESPONSE

Ningde Amperex Tech. Exhibit No. 2047
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
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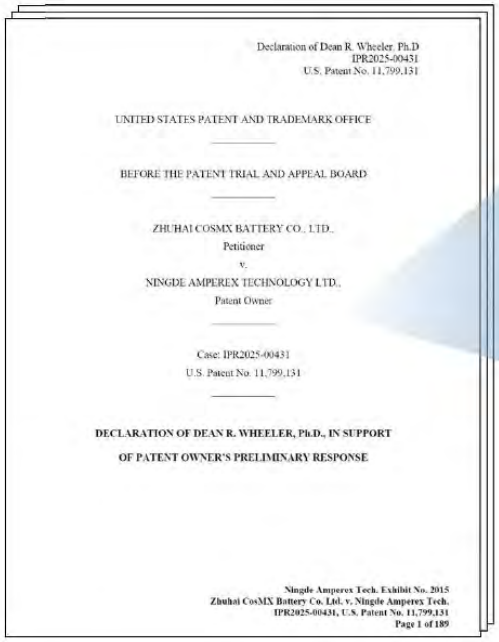
129. In other words, a POSITA would have the same understanding as summarized in Dr. Lucht's article and would understand that swapping one molecule out for another, even if they are both linear carboxylic acid esters, cannot be done without impacting performance. Moreover, even if a POSITA were to swap one linear carboxylic acid ester out for another, a POSITA would not assume that the optimal amount of one linear carboxylic acid ester would also be the optimal amount of another linear carboxylic acid ester.

Paper 28 [POR] at 56.
EX2047 [Wheeler Suppl. Decl.] at ¶129.

Zhou: EA and PP


Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
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v.
NINGDE AMPEREX TECHNOLOGY LTD.,
Patent Owner

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

DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S PRELIMINARY RESPONSE

Ningde Amperex Tech. Exhibit No. 2015
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
IPR2025-00431, U.S. Patent No. 11,799,131
Page 1 of 189

275. Electrolyte components are subject to a complex matrix of requirements and tradeoffs and there is no obvious choice of such components for every application and objective That is, there is no component that is universally beneficial, which makes it a complex decision on whether to include a component and how much to include of such component. Indeed, Dr. Lucht assumes that the propyl propionate would be substituted at a 1:1 weight percentage ratio, without accounting for such varying parameters (e.g., boiling point, viscosity, molecule size, molar mass, etc.) that defeat Zhou's identified purpose. *See e.g.*, Ex. 1003 ¶ 230 (Dr. Lucht asserting that "a POSITA could have simply added 20 wt% PP instead of 20 wt% EA.")

Paper 28 [POR] at 55.
EX2015[Wheeler Decl.] at ¶275.

Zhou: EA and PP

13 Q You agree that the substitution of propyl
14 propionate for ethyl acetate will change the
15 performance of the electrolyte solution in
16 example 8, right?
17 **A It might change it somewhat. And in terms**
18 of what the applications are, I mean, I don't --
19 it might, it might not. It probably would change
20 it some. Certainly, like you say, it's going to
21 change the melting point and the freezing point of
22 the electrolyte in terms of the performance. You
1 know, it depends on what the performance criteria
2 you're looking for is.

Paper 42 [Sur-Reply] at 25.
EX2052 [Lucht 2nd Dep. Trans.] at 88:13-89:2.

Zhou: EA and PP

18 Q. Do you believe that a POSITA reviewing
19 Zhou would assume that propyl propionate could be
20 substituted for an equal weight amount of ethyl
21 acetate without impacting the performance of the
22 resulting battery?

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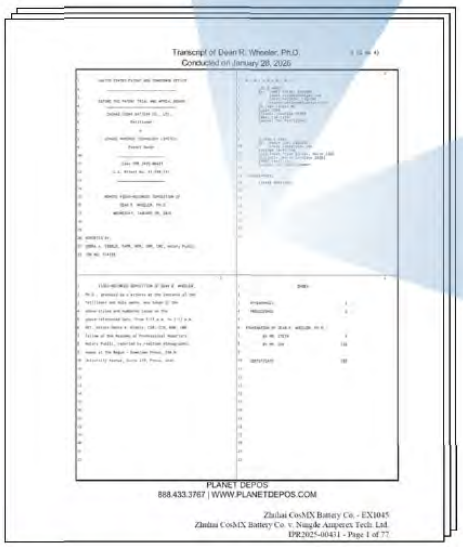
1 A. No, there would be no expectation that an
2 equal weight of those two molecules would be a
3 substitution that you could predict the outcome of
4 the electrolyte behavior.



17 Q. Do you believe that a similar weight of a
18 given linear carboxylic acid ester will lead to the
19 same effects of adding a similar weight of a
20 different linear carboxylic acid ester to an
21 electrolyte solution?
22 A. So even if one believed that the two

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1 materials had -- would have similar behavior or
2 predictable behavior, mass is not necessarily the
3 best way to compare two different molecules.
4 Another common way in chemistry is by
5 moles, or another common way is by volume. And it
6 depends on the property that you are thinking about
7 or targeting. Some are more sensitive to molar
8 ratios, some are more sensitive to mass ratios, some
9 are more sensitive to volume ratios.
10 So there's no clean answer for whether --
11 should you substitute by weight or some other
12 method. If you substitute by some other method,
13 then you would obviously have to account for the
14 property of the molecule, in this case like its
15 molecular weight or its density, when you make the
16 substitution.

Paper 42 [Sur-Reply] at 24.
EX1045 [Wheeler Dep. Trans.] at 143:17-144:22, 146:18-147:4.

ROADMAP

5. Zhou (Grounds 9-12)
   a) A POSITA would not select or implement Zhou's Example 8
   b) A POSITA would not substitute PP for ethyl acetate

6. Su (Grounds 5-8, 11, 12)
   a) Petitioner's absence of argument with respect to Su and the D1/D2 limitation

Dependent Claims 3, 16

3. The electrochemical device according to claim **1**, wherein the electrode is an anode, and 1.2 g/cm^3≤D2≤1.8 g/cm^3.

16. The electrochemical device according to claim **14**, wherein the first electrode is an anode, the second electrode is an anode, and 1.2 g/cm^3≤D2≤1.8 g/cm^3.

The Electrode = Anode, D2, and D1/D2

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

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

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

106. Accordingly, "the electrode" of Claim 3 is "the electrode" of Claim 1, such that "the electrode" of Claim 3 must meet both claimed formulas of "the electrode": "1.2 g/cm^3≤D2≤1.8 g/cm^3" and "about 0.8≤D1/D2≤about 1.2". Because Claim 3 requires "the electrode" of Claim 1 to be "an anode", the "anode" must meet both claimed formulas of "the electrode": "1.2 g/cm^3≤D2≤1.8 g/cm^3" and "about 0.8≤D1/D2≤about 1.2".

Paper 28 [POR] at 47.
EX2047 [Wheeler Suppl. Decl.] at ¶¶ 105, 106.

The Electrode = Anode, D2, and D1/D2

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

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

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

Supplemental Declaration of Dean R. Wheeler, Ph.D
IPR2025-00431
U.S. Patent No. 11,799,131

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner
v.
NINGDE AMPEREX TECHNOLOGY LTD.,
Patent Owner

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

SUPPLEMENTAL DECLARATION OF DEAN R. WHEELER, Ph.D., IN SUPPORT OF PATENT OWNER'S RESPONSE

Ningde Amperex Tech. Exhibit No. 2047
Zhuhai CosMX Battery Co. Ltd. v. Ningde Amperex Tech.
IPR2025-00431, U.S. Patent No. 11,799,131
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Paper 28 [POR] at 48.
EX2047 [Wheeler Suppl. Decl.] at ¶ 113.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Petition Never Argued Su's Anode Meets D1/D2

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

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/cm^3≤D2≤1.8 g/cm^3"

[16.1] "wherein the first electrode is an anode, the second electrode is an anode, and 1.2 g/cm^3≤D2≤1.8 g/cm^3."

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.

Paper 28 [POR] at 47.
Paper 2 [Petition] at 45.