

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner

v.

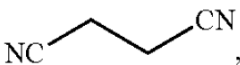
NINGDE AMPEREX TECHNOLOGY LIMITED,
Patent Owner

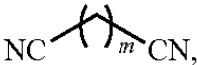
Case IPR2026-00402
U.S. Patent No. 12,334,494

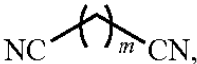
**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 12,334,494**

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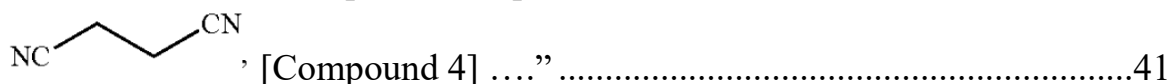
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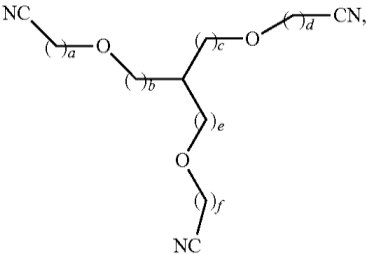
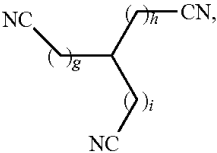
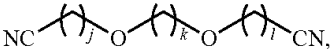
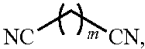
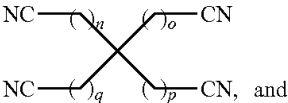
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<i>Perricone v. Medicis Pharm. Corp.</i> , 432 F.3d 1368 (Fed. Cir. 2005)	41
<i>Titanium Metals Corp. v. Banner</i> , 778 F.2d 775 (Fed. Cir. 1985)	41
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37 C.F.R. § 42.8	80, 82
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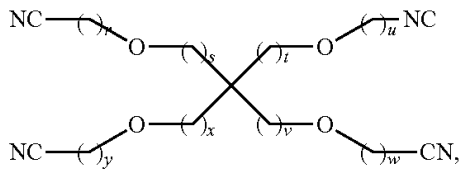
EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 12,334,494 (“the ’494 Patent”)
1002	File history of U.S. Patent No. 12,334,494
1003	Declaration of Yu Zhu, Ph.D.
1004	<i>Curriculum Vitae</i> of Yu Zhu, Ph.D.
1005	Chinese Patent Application Publication No. CN 105428720 A to Luo et al. (“Luo”)
1006	Certified English Translation of Luo
1007	Chinese Patent Application Publication No. CN 102208590 A to Zhang et al. (“Zhang”)
1008	Certified English Translation of Zhang
1009	Chinese Patent Application Publication No. CN 101714624 A to Li et al. (“Li”)
1010	Certified English Translation of Li
1011	Salomez et al., <i>Counteracting thermal degradation of LiPF₆-based electrolyte with additives or lithium salts: A gas analysis revealing the impact of NMC</i>
1012	PubChem Datasheets on Adiponitrile and Succinonitrile, downloaded from https://pubchem.ncbi.nlm.nih.gov/compound/8128 ; and https://pubchem.ncbi.nlm.nih.gov/compound/8062

Exhibit No.	Description
1013	Data Sheets for Lithium-ion Battery Copper Foil: downloaded from https://www.aotbattery.com/product/Electrodeposited-Copper-foil-for-lithium-ion-battery ; https://www.acemenergy.com/products/high-purity-copper-foils-for-lithium-anode-collectors.html ; and https://www.rolledcopperfoil.com/sale-9633162-99-95-high-purity-lithium-ion-battery-copper-foil-9-mic-with-none-pinholes.html
1014	Datasheet of Copper Properties
1015	Millipore-Sigma Datasheets
1016	U.S. Patent No. 7,304,453 B2 to Eaves (“Eaves”)
1017	China Patent Application Publication No. CN 106099187 A to Zeng et al. (“Zeng”)
1018	Certified English Translation of Zeng
1019	U.S. Patent Application Publication No. 2017/0288268 A1 to Kim et al. (“Kim-268”)
1020	U.S. Patent Application Publication No. 2020/0099098 A1 to Wang et al. (“Wang”)
1021	Japanese Unexamined Patent Application Publication No. 2018-6046 to Yamamoto (“Yamamoto”)
1022	Certified English Translation of Yamamoto
1023	U.S. Patent Application Publication No. 2015/0270578 A1 to Nakatsutsumi et al. (“Nakatsutsumi”)
1024	U.S. Patent Application Publication No. 2017/0069934 A1 to Kim et al. (“Kim-934”)
1025	U.S. Patent Application Publication No. 2015/0017542 A1 to Hirai et al. (“Hirai”)

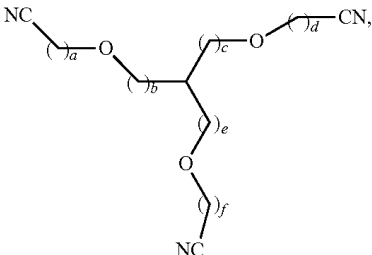
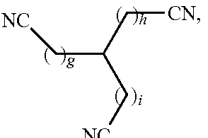
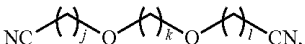
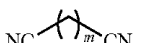
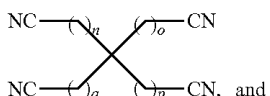
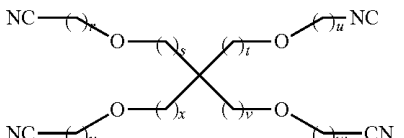
Exhibit No.	Description
1026	China Patent Application Publication No. CN 205376669 U to Tan et al. (“Tan”)
1027	English Translation of Tan
1028	U.S. Patent Application Publication No. 2006/0147803 A1 to Kim et al. (“Kim-803”)
1029	U.S. Patent Application Publication No. 2015/0288026 A1 to Yamamoto
1030	U.S. Patent Application Publication No. 2020/0153047 A1 to Kawai
1031	Complaint for Patent Infringement, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:26-cv-00139-JRG (E.D. Tex. Feb. 18, 2026), ECF 1.
1032	Order (granting Dismissal Without Prejudice), <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:26-cv-00139-JRG (E.D. Tex. June 16, 2026), ECF 17.

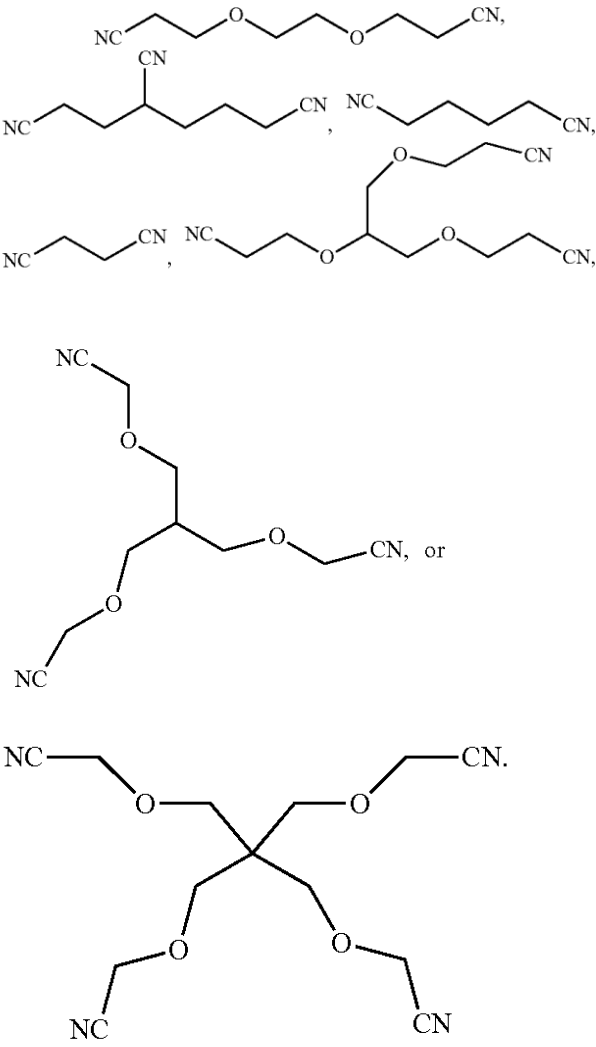
Claim Element	Language
[1.4]	<i>a negative electrode active substance layer is provided only in the first region;</i>
[1.5]	<i>an area of the second region, B %, is 0.4% to 54% of a surface area of the current collector; and</i>
[1.6]	<i>$A \times B < 600$.</i>
Claim 2	
[2.1]	<p><i>The electrochemical device according to claim 1, wherein the nitrile compound comprises at least one of a compound of Formula I, a compound of Formula II, a compound of Formula III, a compound of Formula IV, a compound of Formula V or a compound of Formula VI:</i></p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Formula I</p> </div> <div style="text-align: center;">  <p>Formula II</p> </div> <div style="text-align: center;">  <p>Formula III</p> </div> <div style="text-align: center;">  <p>Formula IV</p> </div> <div style="text-align: center;">  <p>Formula V</p> </div> </div>

Claim Element	Language
	<p style="text-align: right;">Formula VI</p>  <p>wherein each of a, d, f, j, k, l, m, r, u, w and y is an integer independently selected from 1 to 5, and each of b, c, e, g, h, i, n, o, p, q, s, t, v and x is an integer independently selected from 0 to 5.</p>
Claim 3	
[3.1]	<i>The electrochemical device according to claim 1, wherein the negative electrode comprises at least one tab, the tab is formed by being connected to the second region through welding, and</i>
[3.2]	$A \times B < 210$.
Claim 4	
[4.1]	<i>The electrochemical device according to claim 1, wherein the negative electrode comprises at least one tab, the tab is formed by cutting the current collector,</i>
[4.2]	<i>the tab comprises a region not coated with the negative electrode active substance layer, and</i>
[4.3]	$A \times B < 500$.
Claim 5	
[5.1]	<i>The electrochemical device according to claim 3, wherein at least one of the second region is positioned at an edge of the current collector, wherein a distance between a first tab from the at least one tab closest to an edge of the current collector and the edge of the current collector is C, and $0 \leq C/\text{tab width} \leq 50$.</i>
Claim 6	
[6.1]	<i>The electrochemical device according to claim 4, wherein at least one of the second region is positioned at an edge of the current collector,</i>

Claim Element	Language
[6.2]	<i>wherein a distance between a first tab from the at least one tab closest to the edge of the current collector and the edge of the current collector is C, and $0 \leq C/\text{tab width} \leq 50$.</i>
Claim 7	
[7.1]	<i>The electrochemical device according to claim 1, wherein at least one of the second region is positioned at the edge of the current collector, and</i>
[7.2]	<i>an edge of the second region positioned at the edge of the current collector is either folded or not folded,</i>
[7.3]	<i>wherein when the edge of the second region positioned at the edge of the current collector is folded, a width of the folded region is D, and $0.1 \leq D/\text{tab width} \leq 20$.</i>
Claim 8	
[8.1]	<i>The electrochemical device according to claim 1, wherein the current collector is a copper foil and the copper foil has one or more of the following properties:</i>
[8.2]	<i>a copper purity of $\geq 99.5\%$,</i>
[8.3]	<i>a thickness of 3 microns to 15 microns,</i>
[8.4]	<i>a weight per unit area of 30 g/m^2 to 150 g/m^2,</i>
[8.5]	<i>a tensile strength of $> 20 \text{ kg/mm}^2$, and</i>
[8.6]	<i>an elongation rate of $\geq 1.5\%$.</i>
Claim 9	
[9.1]	<i>The electrochemical device according to claim 1, wherein the second region is covered by a substance adhered onto the second region.</i>
Claim 10	
[10.1]	<i>The electrochemical device according to claim 3, wherein a position of the at least one tab is covered by a substance bond onto the position of the tab.</i>

Claim Element	Language
Claim 12	
[12.1]	<i>The electrochemical device according to claim 1, wherein the electrolyte further comprises an additive, and the additive comprises at least one of the following: 1,3-propane sultone, fluoroethylene carbonate, vinylene carbonate, 2,4-butane sultone, 1,4-butane sultone, methylene methanedisulfonate, ethylene sulfate, succinic anhydride, ethoxy (pentafluoro)cyclotriphosphazene, 1,3-dioxane, or propenyl-1,3-sultone.</i>
Claim 13	
[13.1]	<i>The electrochemical device according to claim 1, wherein the electrolyte further comprises an anion, the anion comprises at least one of Cl^-, Br^-, SO_4^{2-}, CO_3^{2-} or F, and the content of the anion in the electrolyte is less than or equal to 1000 ppm.</i>
Claim 14	
[14.pre]	<i>An electronic device, comprising an electrochemical device, wherein the electrochemical device comprises a positive electrode, a negative electrode, a separator, and an electrolyte; wherein</i>
[14.1]	<i>the electrolyte comprises a nitrile compound, and</i>
[14.2]	<i>a mass percentage of the nitrile compound in the electrolyte, A %, is 0.1% to 10%;</i>
[14.3]	<i>the negative electrode comprises a current collector, wherein the current collector comprises a first region and a second region;</i>
[14.4]	<i>a negative electrode active substance layer is provided only in the first region;</i>
[14.5]	<i>an area of the second region, B %, is 0.4% to 54% of a surface area of the current collector; and</i>
[14.6]	<i>$A \times B < 600$.</i>

Claim Element	Language
Claim 15	
[15.1]	<p><i>The electronic device according to claim 14, wherein the nitrile compound comprises at least one of a compound of Formula I, a compound of Formula II, a compound of Formula III, a compound of Formula IV, a compound of Formula V or a compound of Formula VI:</i></p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Formula I</p> </div> <div style="text-align: center;">  <p>Formula II</p> </div> <div style="text-align: center;">  <p>Formula III</p> </div> <div style="text-align: center;">  <p>Formula IV</p> </div> <div style="text-align: center;">  <p>Formula V</p> </div> <div style="text-align: center;">  <p>Formula VI</p> </div> </div> <p><i>wherein each of a, d, f, j, k, l, m, r, u, w and y is an integer independently selected from 1 to 5, and each of b, c, e, g, h, i, n, o, p, q, s, t, v and x is an integer independently selected from 0 to 5.</i></p>

Claim Element	Language
Claim 16	
[16.1]	<p><i>The electrochemical device according to claim 14, wherein the nitrile compound comprises at least one of:</i></p> 
Claim 17	
[17.1]	<p><i>The electrochemical device according to claim 14, wherein the negative electrode comprises a tab, the tab is formed by being connected to the second region through welding, and</i></p>

Claim Element	Language
[17.2]	$A \times B < 210$.
Claim 18	
[18.1]	<i>The electrochemical device according to claim 14, wherein the negative electrode comprises at least one tab, the tab is formed by cutting the current collector,</i>
[18.2]	<i>the tab comprises a region not coated with the negative electrode active substance layer, and</i>
[18.3]	$A \times B < 500$.
Claim 19	
[19.1]	<i>The electrochemical device according to claim 14, wherein the second region is covered by a substance adhered onto the second region.</i>

I. INTRODUCTION

Zhuhai CosMX Battery Co., Ltd. (“Petitioner”) requests *inter partes* review (IPR) to cancel claims 1-10 and 12-19 (“the Challenged Claims”) of U.S. Patent No. 12,334,494 (“the ’494 Patent,” EX1001), assigned to Ningde Amperex Technology Limited (“Patent Owner”). This Petition is supported by the declaration of Dr. Yu Zhu, Ph.D. (EX1003), an expert in the field of lithium-ion batteries.

The Challenged Claims cover essentially any lithium-ion battery whose electrolyte contains a nitrile (a compound having at least one –CN group) and whose negative electrode current collector is partly uncoated with active material. Both features, and their combination in a single battery, were known well before the ’494 Patent’s earliest claimed priority date. The Examiner allowed the claims because the purported closest prior art of record, while disclosing the nitrile, was silent as to the claimed area B% of the uncoated portion of that collector. Luo supplies that disclosure and, alone, or in combination with Zhang or Li renders the Challenged Claims unpatentable. Neither Luo, Zhang, nor Li was before the Examiner during prosecution. Accordingly, Petitioner requests institution of review and cancelation of the Challenged Claims.

II. TECHNOLOGY BACKGROUND

Because of their high energy density, lithium-ion batteries have become a widely-used power source for portable electronic devices, and demand for still

greater energy density continues to grow. But greater energy density typically requires raising the operating voltage, placing added stress on battery components. EX1003, ¶¶27-31. Specifically, “the oxidation activity of the positive electrode material increases, and the stability decreases, which makes the electrolyte decompose on the surface of the positive electrode easily or cause deterioration of the battery material, resulting in a decrease in battery capacity” and other problems. EX1020, ¶[0004].

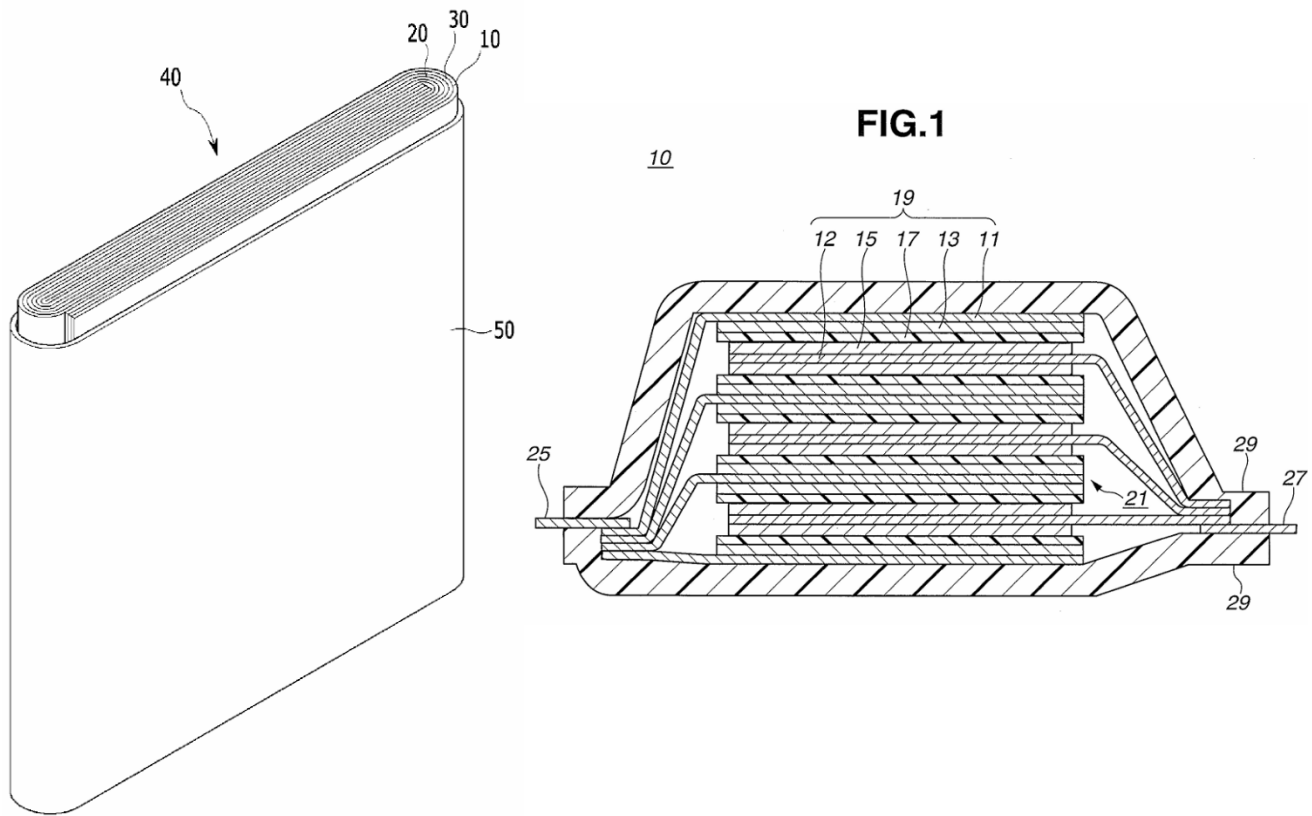
The prior art added nitriles (—CN-bearing) to the electrolyte, a practice now “common in the industry to stabilize the positive electrode structure” while promoting ionic conductivity EX1018, ¶[0006]; *see also* EX1006, ¶[0010]; EX1022, ¶[0067]. Mononitriles (single -CN group) were known to reduce interface resistance at the negative electrode by “form[ing] a low-resistance coating at the interface between the negative electrode and the nonaqueous electrolyte solution,” thereby improving high-rate characteristics. EX1023, ¶[0045]; *see also* EX1006, ¶[0011] (identifying exemplary mononitriles); EX1003, ¶32.

Dinitriles (two -CN groups) were known to “form a protective film on the cathode of the electrochemical device, so as to inhibit the decomposition of the solvent.” EX1020, ¶[0005]. For example, a representative dinitrile adiponitrile (ADN) was known to “effectively complex[] with the reactive metal ion reaction point in the positive electrode material, inhibiting the dissolution of the metal ions

and the decomposition of the electrolyte solution, stabilizing the structure of the positive electrode material.” EX1018, ¶[0029]; *see also* EX1003, ¶33.

Trinitriles (three -CN groups) were known to form “a stable and strong bonding with the metal ions” in the cathode material, creating “a protective layer having a strong bonding force on the surface of the positive active material layer” that prevents direct electrolyte contact, suppresses electrolyte decomposition, and “mitigate[s] battery expansion (swelling).” EX1019, ¶¶[0055]–[0056]. It was also well known to combine different types of nitriles in the same electrolyte formulation to achieve the benefits of each class. *See, e.g.*, EX1020, ¶¶[0006], [0167]; EX1019, ¶[0064]; EX1024, ¶[0015]–[0016], [0042]. EX1022, ¶[0085]; EX1003, ¶34.

A lithium-ion cell interleaves positive and negative electrode plates with a separator. EX1003, ¶35. The two main assembly architectures are wound and stacked. A wound cell rolls these components into a compact “jelly-roll.” A stacked cell alternates discrete electrode layers, interconnected in parallel. *See, e.g.*, EX1019, ¶[0070]; EX1020, ¶¶[0120]–[0123], FIGS. 2–4. Each involves well-known benefits and tradeoffs, and a skilled artisan selects between them based on target form factor and application. *See, e.g.*, EX1010, ¶[0002]; EX1025, ¶[0006]; EX1019, ¶[0069].

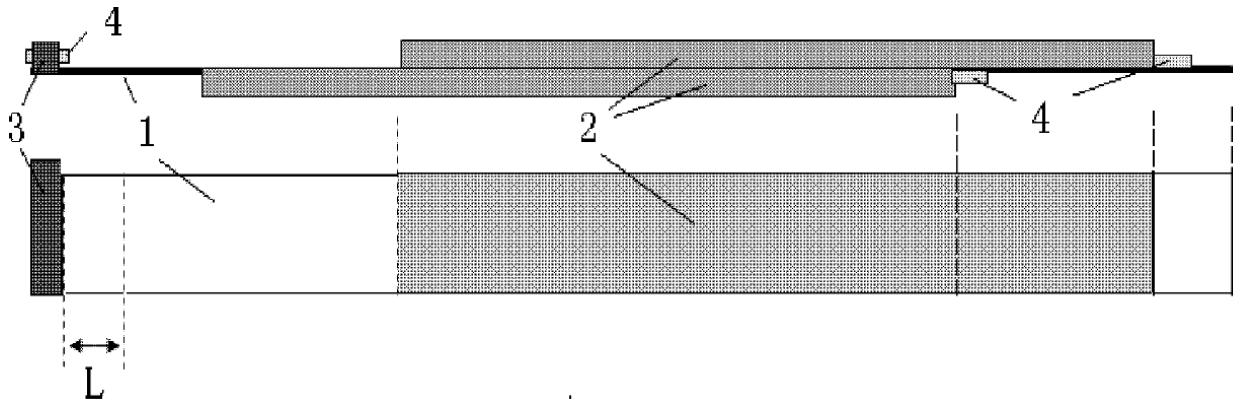


EX1024, FIG. 1 (wound)

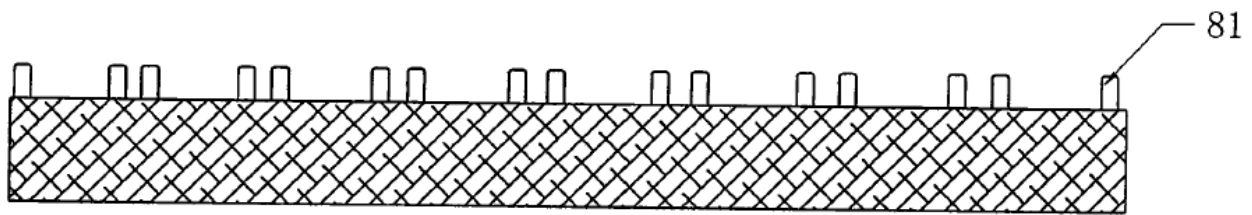
EX1025, FIG. 1 (stacked)

Electrode plates are fabricated by coating an active-material layer onto a conductive foil current collector. *See, e.g.*, EX1024, ¶¶[0091]-[0094]; EX1006, ¶¶[0115]-[0116]; EX1008, ¶[0009]. Electrode designs commonly reserve uncoated (bare) regions on the current collector, which serve several functions. EX1003, ¶36.

One reason is to provide bare metal for the tabs that connect the cell to the terminals of the battery packaging. EX1003, ¶¶37-38. Generally, tabs may be welded to the bare portions or cut from them. *Id.*; *see, e.g.*, EX1008, ¶[0009]; EX1010, ¶¶[0006], [0009]-[0010], [0037], [0049]-[0050].



Zhang, FIG. 1 (welded tab 3)



Li, FIG. 8 (cut tabs 81)

Another reason is short-circuit protection. EX1003, ¶39. One technique wraps the tab around the bare current collector, presses it flat, folds the leading current collector edge inward, and tapes the bare portions to prevent burrs from “piercing the separator and contacting the other electrode to form a short circuit.” EX1008, ¶¶[0011], [0014]. Another technique wraps bare current collector foil several times around the wound cell’s outer perimeter, forming a protective “vest area” against shorts. EX1027, 2.

III. STATEMENT OF PRECISE RELIEF REQUESTED

Petitioner requests IPR, seeking cancellation of the Challenged Claims of the '494 Patent as unpatentable.

IV. THE '494 PATENT

The '494 Patent issued on June 17, 2025, from U.S. Patent Application No. 18/607,737 filed March 18, 2024—a continuation of Application No. 16/970,864 filed as a national stage application on March 3, 2020 (now U.S. Patent No. 11,967,674). EX1001, 1.

A. Overview

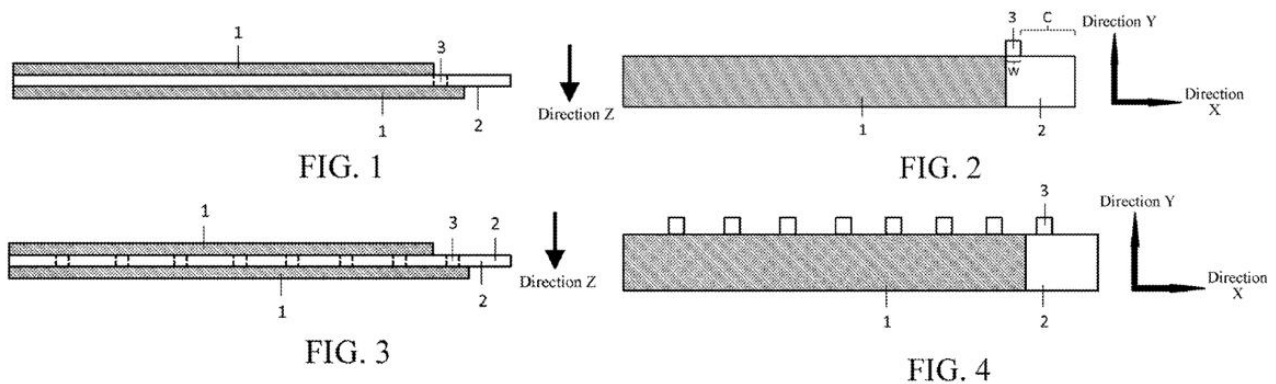
The '494 Patent purportedly addresses a problem caused by nitrile electrolyte additives. While nitrile compounds were known to improve positive electrode stability and cycle performance, the '494 Patent asserts they also “cause copper dissolution from current collector of negative electrode, thus influencing stability of negative electrode, and particularly, battery self-discharging or even safety problems may occur when copper ions are dissolved at welding position of tab.” EX1001, 1:41-51. Specifically, “[d]issolved copper ions can be slowly reduced into elemental copper and continuously deposited on the surface of the negative electrode during the charging and discharging..., which finally would cause a local short circuit and deteriorate the self-discharging of the battery.” *Id.*, 20:36-43.

The '494 Patent proposes “the value of A times B should be controlled within 600 to arrive at good battery performance,” where A% is the nitrile concentration in the electrolyte by mass and B% is the uncoated area of the negative electrode current collector as a fraction of its total surface area. *Id.*, 23:27-48; *see also id.*, Abstract, 9:28-44. The '494 Patent claims this helps reduce the copper dissolution and self-discharge problems described above. *Id.*, 1:43-51, 19:66-20:48.

The '494 Patent identifies seven potential nitrile compounds—Compounds 1-7—where Compounds 3 and 4 are respectively the dinitriles adiponitrile and succinonitrile commonly used in lithium-ion battery electrolytes. EX1001, 6:19-59; *see also* EX1003, ¶43; EX1012, 1, 86. The claimed A% range is “0.1% to 10%,” and the claimed B% is “0.4% to 54%.” EX1001, 28:51-60.

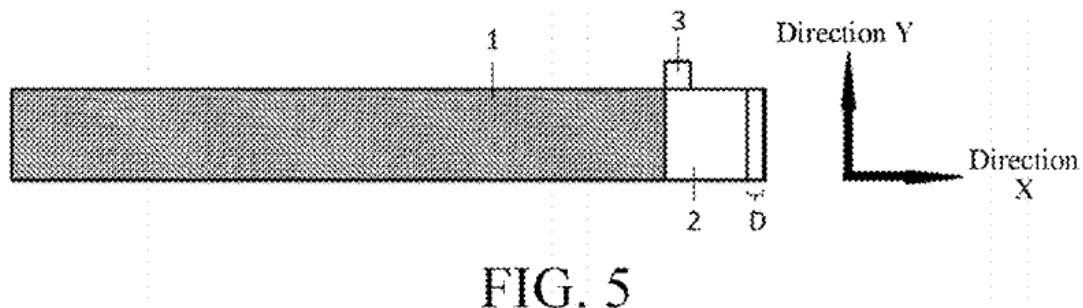
Because the Challenged Claims recite conventional nitrile concentrations (A%), a broad range of uncoated area (B%), and an illusory $A \times B$ cap of 600, they cover essentially any lithium-ion battery whose electrolyte contains a nitrile and whose negative electrode current collector is partly uncoated. *See, e.g.*, EX1006, ¶¶[0010]–[0011], [0116]; EX1018, ¶¶[0006], [0029]; EX1019, ¶¶[0017], [0086]; EX1020, ¶¶[0005]–[0006], [0143]; EX1022, ¶¶[0067], [0082]; EX1023, ¶¶[0045], [0064]; EX1024, ¶¶[0015]–[0016], [0085]; EX1003, ¶44.

The '494 Patent describes further features. For example, the negative electrode current collector may include one or more tabs, either welded to or cut from the uncoated region. EX1001, 9:45-10:12.



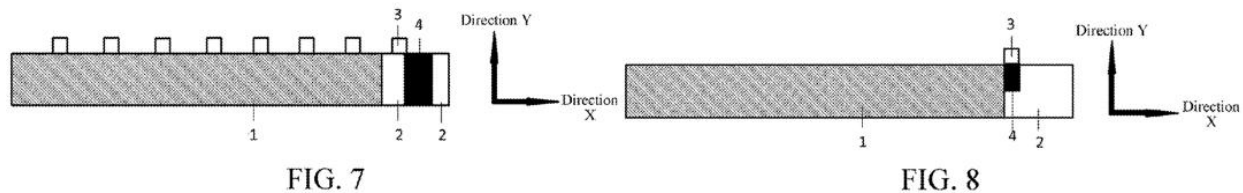
'494 Patent, FIGS. 1-4

The tab closest to the edge of the current collector may sit up to 50 tab-widths away from the edge (i.e., " $0 \leq C/\text{tab width} \leq 50$ "). *Id.*, 3:35-39; 9:61-67; FIG. 2. Additionally, the second region's edge "is either folded or not folded," and if folded, may be up to 20 tab-widths wide (i.e., " $0.1 \leq D/\text{tab width} \leq 20$ "). *Id.*, 3:40-46; 10:23-31.



'494 Patent, FIG. 5

Finally, the uncoated region and/or the tab welding position may optionally be covered with tape (or other adhesive “substance”) to reduce bare copper exposure. EX1001, 3:55–60; 10:38–50; FIGS. 7–8.



'494 Patent, FIGS. 7, 8

A. Prosecution History

The Challenged Claims issued after Applicant amended them to add numerical ranges for A% and B% and argued that Kim-803 (EX1028) failed to the B% range (and thus $A \times B$). The Examiner allowed the claims on that basis. Luo, Zhang, and Li appear nowhere in the prosecution history, let alone in any rejection. And unlike Kim-803, Luo discloses both the claimed electrolyte and the current collector and uncoated region dimensions from which B% is determined—supplying precisely what the Examiner found missing. Accordingly, the Examiner erred.

The Examiner rejected the pending claims as obvious over Kim-803. EX1002, 129–134. Those claims recited A% and B% as variable but without a numerical range for either. *See* EX1002, 63, 65-66. The Examiner acknowledged that Kim-803 was silent as to the area (B%) of the uncoated region but supplied that missing

limitation through a conclusory routine-optimization rationale. *Id.*, 130 (citing MPEP § 2144.05).

Applicant responded by amending the independent claims to recite, for the first time, numerical ranges for A% and B%. EX1002, 149. Applicant argued Kim-803 did not disclose the B% range and, thus, the A×B range. *Id.*, 158.

The Examiner withdrew the rejections “based on the amendments to the Claims and the arguments presented.” *Id.*, 180. The Examiner identified the missing features as the claimed B% range and AxB relationship, explaining the cited art did not “teach, fairly suggest or render obvious wherein an area of the second region, B%, is 0.4% to 54% of a surface area of the current collector; and $A \times B < 600$.” *Id.*, 181.

The prosecution history therefore confirms the Office erred by allowing the Challenged claims based on current-collector geometry that Kim-803 lacked but that unexamined prior art—including Luo—discloses in combination with the claimed nitrile content.

V. PERSON OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art (“POSITA”) of the ’494 Patent in March 2020 would have had an advanced degree in chemistry, chemical engineering, materials science, or a related field, and two or more years of experience related to the design, research, evaluation, preparation, and/or manufacture of electrochemical

energy storage devices. EX1003, ¶54. This skill level is approximate, and more experience could compensate for less formal education, and *vice versa*.

VI. CLAIM CONSTRUCTION

All claim terms receive their ordinary and customary meaning as understood by a POSITA at the time of the invention, in light of the specification and the prosecution history. *See* 37 C.F.R. § 42.100(b); 35 U.S.C. § 282(b). Petitioner applies that construction. No claim terms require express construction for purposes of evaluating the Petition, however, and the prior art renders the Challenged Claims unpatentable under any reasonable construction.

VII. IDENTIFICATION OF CHALLENGES AND PRIOR ART

Petitioner requests IPR and review of the Challenged Claims under 35 U.S.C. §§ 102 and 103 as follows:

Ground	Claims	Prior Art	Challenge
1A	1, 2, 7, 8, 13-16	• Chinese Patent Application Publication No. CN 105428720 A to Luo et al. (“Luo,” EX1005)	Anticipation
1B	1, 2, 7, 8, 12-16	• Luo	Obviousness
2A	3, 5, 7, 9, 10, 17, 19	• Luo • Chinese Patent Application Publication No. CN 102208590 A to Zhang et al. (“Zhang,” EX1007)	
2B			
3A	4, 6, 18	• Luo • Chinese Patent Application Publication No. CN 101714624 A to Li et al. (“Li,” EX1009)	
3B			

Luo, Zhang, and Li are foreign patent documents qualifying as prior art to the ’494 Patent under §102(a)(1) even if entitled to its earliest claimed priority date of March 3, 2020, because they were respectively published in March 2016, October 2011, and May 2010. EX1006, 1; EX1008, 1; EX1010, 1.

VIII. GROUND 1A: LUO ANTICIPATES CLAIMS 1, 2, 7, 8, AND 13-16

As explained below: (1) each Luo Example 57, 94, 118, and 178 (“the cited Examples”) anticipates claims 1, 2, 7, 8, and 13-16; and (2) each Example 58–61, 95–98, 119–120, and 179–180 (“the further cited Examples”) separately anticipate claim 14 and 15-16.

A. Overview of Luo

Luo discloses non-aqueous electrolytes for secondary batteries using lithium difluorophosphate¹ (LiPO_2F_2) as the electrolyte salt—either alone or in combination with lithium hexafluorophosphate (LiPF_6) and/or other fluorine-containing alkali metal salts—to improve the cycle retention rate of the battery. EX1006, Abstract, ¶¶[0013]-[0018]. Luo explains “lithium hexafluorophosphate is unstable and easily decomposes during use of the battery, thereby affecting the cycle retention rate of the lithium secondary battery prepared using the above non-aqueous electrolyte.” *Id.*, ¶[0003]. Luo addresses this by “provid[ing] a non-aqueous electrolyte, comprising a difluorophosphate and a non-aqueous solvent” that “uses difluorophosphate as an electrolyte salt.” EX1006, ¶¶[0005], [0017].

¹ Luo teaches using difluorophosphate salts generally—“preferably lithium difluorophosphate, sodium difluorophosphate, potassium difluorophosphate, ammonium difluorophosphate, or calcium difluorophosphate.” EX1006, ¶[0042]. But Luo focuses on lithium difluorophosphate, using it in 42 of 45 example electrolytes (Electrolytes 1–42). *Id.*, ¶¶[0107]-[0111]. Luo’s headline performance metrics of $256 \text{ mAh}\cdot\text{g}^{-1}$ and 89% cycle retention derive from lithium difluorophosphate example Electrolytes 19, 20, 21, 24, and 39 and Electrolyte 35, respectively. *Compare id.*, Abstract with *id.*, ¶¶[0155], [0171]-[0174], [0180].

○ **Electrolyte**

Luo's Electrolytes 1-42 all had LiPO_2F_2 concentrations of 0.5M-2.5M. *Id.*, ¶¶[0107]-[0111], [0043] (most preferred concentration of 1.0–2.0M). They include “a functional additive ... selected from one or more of a nitrile compound and a sulfate compound.” *Id.*, ¶[0051]. Preferred nitriles include one or more of succinonitrile (BDN), glutaronitrile (PDN), adiponitrile (HDN), pimelonitrile (PLN), suberonitrile (SN), acetonitrile (AN), acrylonitrile (ACN), propionitrile (ECN) and derivatives of each.² *Id.* Succinonitrile (BDN, also known as butanedinitrile) and hexanedinitrile (HDN, also known as adiponitrile) respectively correspond to Compounds 4 and 3 of the '494 Patent. EX1012, 109, 1; EX1003, ¶¶59-60.

Electrolyte 35 contains 5 wt% succinonitrile. EX1006, ¶[0111] (Table 2) (“BDN...5”); EX1003, ¶61. Although Table 2 does not state units for the “Content

² Additional nitriles were well known and used in lithium-ion electrolytes before the claimed priority date, including DENE (1,2-bis(2-cyanoethoxy)ethane) (Compound 1) and HTCEN (1,3,6-hexanetricarbonitrile) (Compound 2). *See, e.g.*, EX1001, 6:19-59; EX1018 ¶¶[0024], [0049]; EX1019 ¶¶[0090]–[0091]; EX1020 ¶¶[0049], [0056], [0164], [0166]–[0170]; EX1022 ¶¶[0067], [0085], [0109]; EX1024 ¶¶[0015], [0090]; EX1003, ¶60 n.3.

%” of the additive, elsewhere Luo indicates additives are specified as weight percentages: “the addition amount of the functional additive is preferably 0 wt% to 10 wt%, preferably 1 wt% to 5 wt%.”³ EX1006, ¶[0054]. Thus, in Table 2, the succinonitrile “Content %” of “5” refers to 5 wt% succinonitrile. EX1003, ¶61. Accordingly, Electrolyte 35 contains a nitrile (e.g., Compound 4) at a mass⁴ percentage A% between 0.1 wt% and 10%. *Id.*

○ **Battery structure—negative electrode**

Luo discloses seven secondary battery configurations using a polyethylene separator—Batteries 1-3 and 5-7 constructed as 18650-type cylindrical cells and Battery 4 constructed as a “disk-shaped” cell. EX1006, ¶¶[0113]-[0129]. Luo paired combinations of Batteries 1-7 with Electrolytes 1-45 to produce Examples 23-204. EX1006, ¶¶[0117], [0150]–[0176] (Table 3); EX1003, ¶62.

Batteries 1–3 and 5–7 include a positive electrode having an aluminum-foil current collector coated with a cathode active material/charging voltage that varied

³ Unless otherwise specified, emphasis is added.

⁴ Weight percent (or fraction) and mass percent (or fraction) are the same because, in a uniform gravitational field, an object’s weight is directly proportional to its mass ($W=mg$). Thus, the gravitational acceleration constant g cancels from the numerator and denominator of the fraction. *Id.*, ¶61 n.3.

across the examples. EX1006, ¶¶[0115], [0119], [0121], [0125], [0127], [0129], [0134]-[0149]. The positive-electrode current collector dimensions were held constant: Battery 1 used positive electrode 1 having an active-material layer “with a width of 100 mm and a length of 100 mm” and “an uncoated portion with a width of 30 mm,” and Batteries 2, 3, and 6 were fabricated in the same manner as Battery 1 except for changes to the active material and/or charging voltage. *Id.*, ¶¶[0115], [0119], [0121], [0125], [0127], [0129].

For the negative electrode, Batteries 1-3 and 6 used a graphite slurry “coated on both sides of a copper foil having a thickness of 10 μm , dried, and rolled with a press machine to a thickness of 75 μm ,” and “then cut into a shape having an active material layer with a width of 104 mm and a length of 104 mm and an uncoated portion with a width of 30 mm.” EX1006, ¶¶[0116], [0119]-[0121], [0127].

A POSITA would have understood that Luo’s stated 104mm length is the total length of the cut copper-foil sheet—the common length of both its coated and uncoated regions. EX1003, ¶65. Luo teaches the copper foil is “cut into a shape having an active material layer with a width of 104 mm and a length of 104 mm and an uncoated portion with a width of 30mm to serve as a negative electrode.” EX1006, ¶[0116]; *see also id.*, ¶[0115] (parallel description of positive electrode

sheet)⁵. Luo states the 104mm length only once—for the entire cut shape—and distinguishes the uncoated portion solely by its different width (30mm). Repeating the length would have been redundant because the uncoated strip borders the coated area and shares the same 104mm dimension. *See, e.g.*, EX1010, ¶¶[0007], [0021], [0036], FIGS. 4–6; EX1008, ¶¶[0008]–[0009], FIG. 1; EX1027, FIGS. 5-6; EX1030, ¶¶[0023]–[0039], FIGS. 2A-3C (coated and uncoated regions sharing a common border dimension). Luo provides no reason to give the coated and uncoated regions different lengths. EX1003, ¶65.

Additionally, Luo intentionally makes the anode larger (104mm×134mm) than the cathode (100mm×130mm) so the anode overhangs the cathode—a well-known measure against lithium precipitation (e.g., plating and dendrite formation) at the electrode edges, which can lead to shorts or performance issues. *See, e.g.*, EX1006, ¶¶[0115]–[0116]; EX1029, ¶¶[0007], [0045], [0050], [0053], [0081]–[0085]; EX1030, ¶¶[0025]–[0039], Table 3, FIG. 2C (showing anode overhang D1 in the axial direction, including in overlapping uncoated regions); EX1003, ¶66.

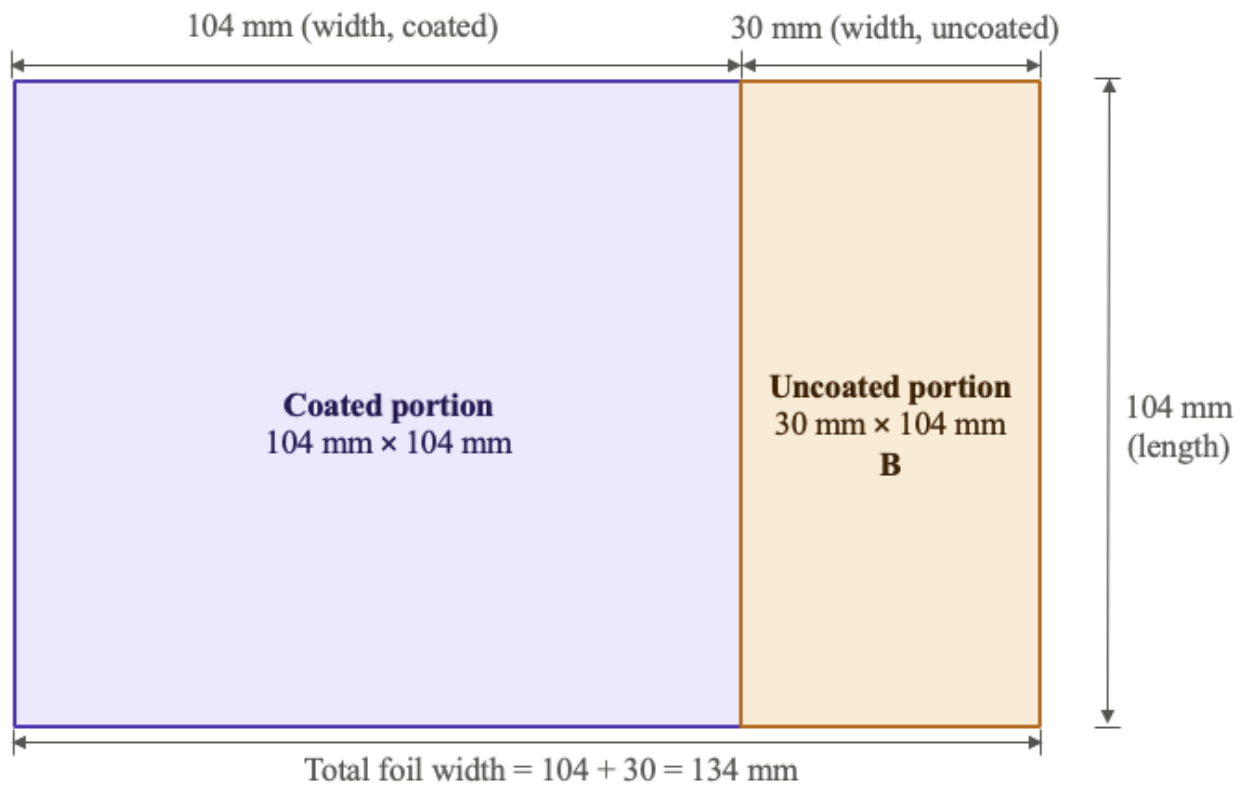
⁵ Because Luo differentiates the coated and uncoated regions in terms of their “width,” “width” corresponds to the direction in which the coating is applied, and “length” corresponds to the perpendicular direction. EX1006, ¶[0116]; EX1003, ¶65 n.6.

Decreasing the length below 104mm would reduce or eliminate the overhang, increasing the risk of precipitation at the edges. *Id.*, ¶67. And increasing the length beyond 104 mm would serve no stated purpose. EX1003, ¶67.

Indeed, changing the overhang in some areas (two sides of the 30 mm uncoated region) but not others (the remaining sides of coated and uncoated regions) make no technical sense unless done for a specific reason. *Id.* In that case, however, Luo would have described the relevant geometric parameters and special function of the irregular shape formed in the uncoated area. But Luo does not. *Id.* Arbitrarily changing the overhang in certain areas would require a pointless, non-standard notching step that introduces fabrication and uniformity problems. *Id.*

Accordingly, Batteries 1-3 and 6⁶ have an uncoated portion B% of the negative current collector of $(30 \times 104) / ((104 + 30) \times 104) = 30 / 134 = 22.4\%$ of the total current collector surface area:

⁶ Batteries 5 and 7 had the same 104mm×104mm coated region and 30-mm-wide uncoated portion on 10µm Cu foil but had a different active material coated on only on one side of the foil. EX1006, ¶¶[0125], [0129]. Because Batteries 5 and 7 left one entire side of the copper foil uncoated, their B%=50% (one entire side)+22.4%÷2=61.2%. EX1003, ¶68 n.7.



$$B\% = (30 \times 104) / ((104 + 30) \times 104) = 30 / 134 = \mathbf{22.4\%}$$

EX1003, ¶68

Accordingly, Batteries 1-3 and 6 each have a negative-electrode current collector with first (coated) and second (uncoated) regions, a negative electrode active substance provided in only the first (coated) region, and an area B% of the second (uncoated) region equal to 22.4%. EX1003, ¶69.

○ **Examples 57, 94, 118, and 178 (“the cited Examples”)**

Luo made Examples 23–204 and Comparative Examples 1–7 by injecting Electrolytes 1–45 into Secondary Batteries 1–7 and reported initial specific capacity

and 500-cycle retention for each pairing. EX1006, ¶¶[0117], [0150]–[0176] (Table 3), [0177]–[0189]. Each Example pairing Electrolyte 35 (5 wt% succinonitrile) with any of Batteries 1–3 or 6 (B%=22.4%) satisfies the elements of independent claims 1 and 14. These are the cited Examples:

Example	Electrolyte	Secondary Battery	A% (succinonitrile)	B%
57	Electrolyte 35	Battery 1	5 wt%	22.4%
94		Battery 2	5 wt%	22.4%
118		Battery 3	5 wt%	22.4%
178		Battery 6	5 wt%	22.4%

EX1006, ¶¶[0111], [0155], [0160], [0163], [0172]; EX1003, ¶70.

The cited Examples exhibited favorable performance. EX1003, ¶71. Example 57 (Electrolyte 35, Battery 1) achieved 89% capacity retention—the highest across all Examples, and the basis for Luo’s touting retention “up to 89%.” EX1006, ¶¶[0083], [0155]. That is a 24-percentage-point improvement (37% relative) over Comparative Example 1’s 65% that used the same LiCoO₂ cathode and a conventional 1M LiPF₆ baseline. *Compare* EX1006, ¶[0155] *with id.*, ¶[0151].

The other three examples likewise outperformed their comparative baselines. Example 94 recorded 83% retention versus Comparative Example 2’s 75%. *Compare* EX1006, ¶[0160] *with id.*, ¶[0161]; EX1003, ¶72. Example 118 recorded 61% retention versus Comparative Example 3’s 59%. *Compare id.*, ¶[0163] *with id.*, ¶[0164]. Example 178 recorded 77% retention versus Comparative Example 6’s

67% while achieving a $255 \text{ mAh} \cdot \text{g}^{-1}$ initial specific capacity—essentially matching Luo’s headline “as high as $256 \text{ mAh} \cdot \text{g}^{-1}$.” EX1006, ¶¶[0172], [0018], Abstract. Luo characterizes the example sets containing the cited Examples as showing “significant improvement”—or “slight improvement” for the Example 118 set—in cycle retention over their comparative examples. *Id.*, ¶¶[0179], [0183]-[0184], [0187]; *see also* EX1003, ¶72.

- **Examples 58–61, 95–98, 119–120, and 179–180 (“the further cited Examples”)**

The further cited Examples use the same Batteries 1, 2, 3, and 6, respectively, as the cited Examples, but pair them with Electrolytes 36–39 (each containing a different nitrile) instead of Electrolyte 35 (succinonitrile):

Example	Electrolyte	Secondary Battery	Nitrile	A%	B%	A×B
58	36	Battery 1	glutaronitrile (“PDN”)	5 wt%	22.4%	112
59	37		suberonitrile (“SN”)	5 wt%		
60	38		acetonitrile (“AN”)	2 wt%		44.8
61	39		acrylonitrile (“ACN”)	1 wt%		22.4
95	36	Battery 2	PDN	5 wt%		112
96	37		SN	5 wt%		
97	38		AN	2 wt%		44.8
98	39		ACN	1 wt%		22.4
119	38	Battery 3	AN	2 wt%		44.8
120	39		ACN	1 wt%		22.4
179	38	Battery 6	AN	2 wt%		44.8
180	39		ACN	1 wt%		22.4

EX1006, ¶¶[0111] (compositions of Electrolytes 36–39), [0155] (Examples 58–61 mappings), [0160] (Examples 95–98 mappings), [0164] (Examples 119–120 mappings), [0173] (Examples 179–180 mappings). Accordingly, each further cited Example satisfies independent claim 14—including the A%, B%, and A×B limitations—because that claim recites a generic nitrile. EX1003, ¶73.

B. Independent Claim 1

1. [1.pre] “An electrochemical device, comprising: a positive electrode, a negative electrode, a separator, and an electrolyte; wherein”⁷

Luo discloses this Element. EX1003, ¶¶74-79. Luo discloses *an electrochemical device* (the Cited Examples respectively using Batteries 1-3 and 6), *comprising: a positive electrode* (positive electrode 1-3, 6), *a negative electrode* (negative electrode 1), *a separator* (polyethylene separator), *and an electrolyte* (Electrolyte 35). *Supra* Section VIII.A; EX1006, ¶[0067].

Electrochemical device: The cited Examples respectively combine Batteries 1-3 and 6 and Electrolyte 35. *Supra* Section VIII.A; EX1006, ¶¶[0155], [0160], [0163], [0172]. Each Example is an electrochemical device, as claimed. EX1003, ¶75.

Positive electrode: Batteries 1-3 and 6 each include a positive electrode corresponding to the claimed positive electrode. EX1003, ¶76; *supra* Section VIII.A. Battery 1 contains “positive electrode 1” comprising “90% of lithium cobaltate (LiCoO₂) as the active material, 5% of acetylene black as a conductive material, and

⁷ The enclosed Claims Appendix includes the Challenged Claim language with bracketed reference numerals identifying respective Claim Elements referenced in the Petition.

5% of polyvinylidene fluoride (PVdF) as a binder....” EX1006, ¶[0115]. Remaining Batteries 2, 3, and 6 “w[ere] fabricated in the same manner as secondary battery 1” except for having different positive electrode active materials and/or charging voltages. *Id.*, ¶¶[0118]-[0121], [0126]-[0127]; EX1003, ¶76.

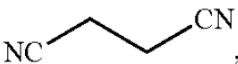
Negative electrode: Batteries 1-3 and 6 have respective negative electrodes corresponding to the claimed negative electrode. *Supra* Section VIII.A Battery 1 contains “negative electrode 1,” and remaining Batteries 2, 3, and 6 had the same negative electrode. EX1006, ¶¶[0116]-[0127]; EX1003, ¶77.

Separator: In Battery 1, “[t]he positive electrode and the negative electrode were overlapped and wound together with a polyethylene separator.” EX1006, ¶[0117]. The polyethylene separator corresponds to the claimed separator. EX1003, ¶78. Remaining Batteries 2, 3, and 6 used the same polyethylene separator. *Id.*; EX1006, ¶¶[0118]-[0127]; *supra* Section VIII.A.

Electrolyte: The cited Examples used Electrolyte 35, disclosing the claimed electrolyte. EX1006, ¶¶[0155], [0160], [0163], [0172]. Accordingly, the cited Examples each disclose Element [1.pre].

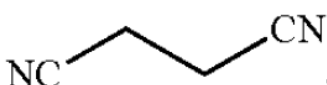
Electrochemical Device	Positive Electrode	Negative Electrode	Separator	Electrolyte
Example 57	1	1	Polyethylene separator	35
Example 94	2			
Example 118	3			
Example 178	6			

EX1003, ¶79.

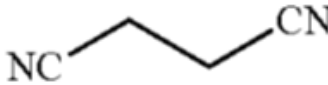
2. [1.1] “the electrolyte comprises a nitrile compound, wherein the nitrile compound comprises at least one of: ... , [Compound 4]....”

[1.2] “and a mass percentage of the nitrile compound in the electrolyte, A %, is 0.1% to 10%;

Luo discloses these Elements. EX1003, ¶¶80-82. Regarding Element [1.1], the cited Examples each contain *the electrolyte* (Electrolyte 35) *compris[ing] a nitrile compound* (succinonitrile), *wherein the nitrile compound comprises at least*

one of: ...  *, [Compound 4] (succinonitrile). Id.; supra Section VIII.A.*

The cited Examples use Electrolyte 35. *Supra* Section VIII.A; EX1006, ¶¶[0155], [0160], [0163], [0172]. Electrolyte 35 contains 5 wt% succinonitrile (BDN) as the claimed nitrile compound. *Supra* Section VIII.A; EX1006, ¶[0111]

(Table 2). Succinonitrile is '494 Patent Compound 4  and a

recited nitrile option in Element [1.1]. EX1012, 109; EX1003, ¶81. Luo's abbreviation BDN refers to butanedinitrile—a synonym for succinonitrile. *Id.* Thus, each of the cited Examples teaches Element [1.1].

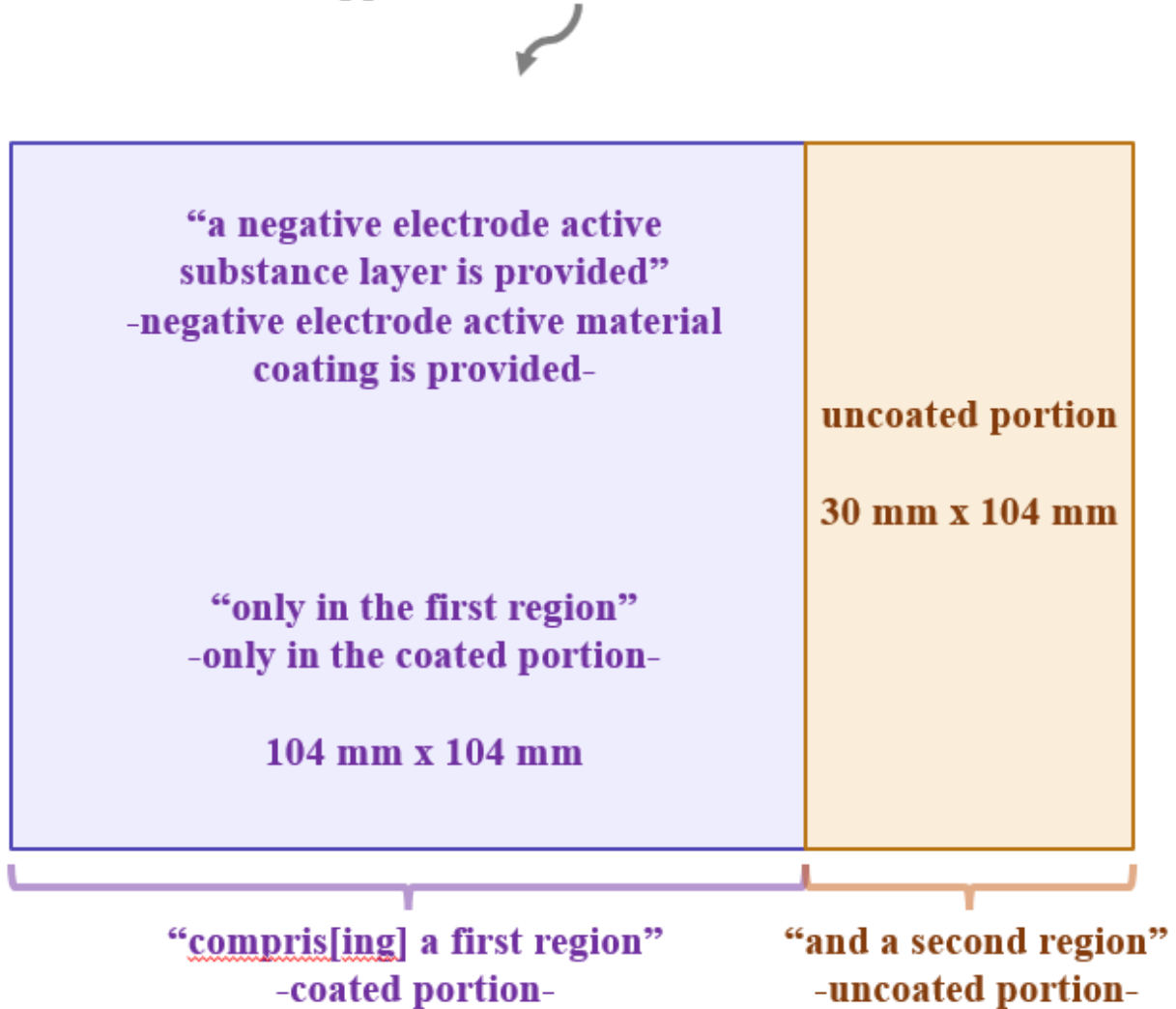
Regarding Element [1.2], the cited Examples disclose *a mass percentage of the nitrile compound (succinonitrile) in the electrolyte (Electrolyte 35), A %, is 0.1% to 10% (5 wt% succinonitrile)*, as claimed. Electrolyte 35—used in the cited Examples—contains 5 wt% succinonitrile. *Supra* Section VIII.A; EX1006, ¶¶[0054], [0107] (Table 2) (“Other additives...Content/%”), [0111] (Table 2) (“5...BDN”); EX1003, ¶82. This falls inside Element [1.2]’s recited A% range of 0.1% to 10%.

3. [1.3]: “the negative electrode comprises a current collector, wherein the current collector comprises a first region and a second region;”

[1.4] “a negative electrode active substance layer is provided only in the first region;”

Luo discloses these Elements. EX1003, ¶¶83-88. In the cited Examples, *the negative electrode (negative electrode 1 of Battery 1-3 and 6) comprises a current collector (copper foil), wherein the current collector (copper foil) comprises a first region (coated portion) and a second region (uncoated portion), and a negative electrode active substance layer (negative electrode active material coating) is provided only in the first region (coated portion)*, as claimed:

“the negative electrode comprises a current collector”
-negative electrode of each Luo Battery 1-3 and 6 comprises a
copper foil current collector-



Petitioner’s Figure Illustrating Luo’s Current Collector* (EX1003, ¶83)

Negative electrode comprises a current collector: Shown in the Figure above, Luo’s Batteries 1-3 and 6 have a negative electrode comprising a current collector. EX1003, ¶84; EX1006, ¶[0116]. Battery 1 includes “negative electrode 1” corresponding to the claimed negative electrode. *Id.* It comprises “a copper foil

having a thickness of 10 μm ” and “cut into a shape” to form the negative electrode current collector. *Id.* Luo’s cut copper foil corresponds to the claimed current collector. EX1003, ¶84.

The current collector comprises a first region and a second region: In Battery 1, the negative electrode copper foil (current collector) includes a portion “coated on both sides” with active material layer having “a width of 104 mm and a length of 104 mm.” EX1006, ¶[0116]. This coated portion corresponds to the claimed first region. Additionally, Luo’s copper foil has “an uncoated portion with a width of 30 mm” that corresponds to the claimed second region. *Id.*; EX1003, ¶85.

A negative electrode active substance layer is provided only in the first region: Battery 1’s negative electrode has an “active material layer” comprising graphite slurry “coated on both sides of [the] copper foil..., dried, and rolled with a press machine to a thickness of 75 μm , and then cut into a shape having an active material layer with a width of 104 mm and a length of 104 mm[.]” EX1006, ¶[0116]. Luo’s “active material layer” comprising graphite slurry corresponds to the claimed negative electrode active substance layer. EX1003, ¶86.

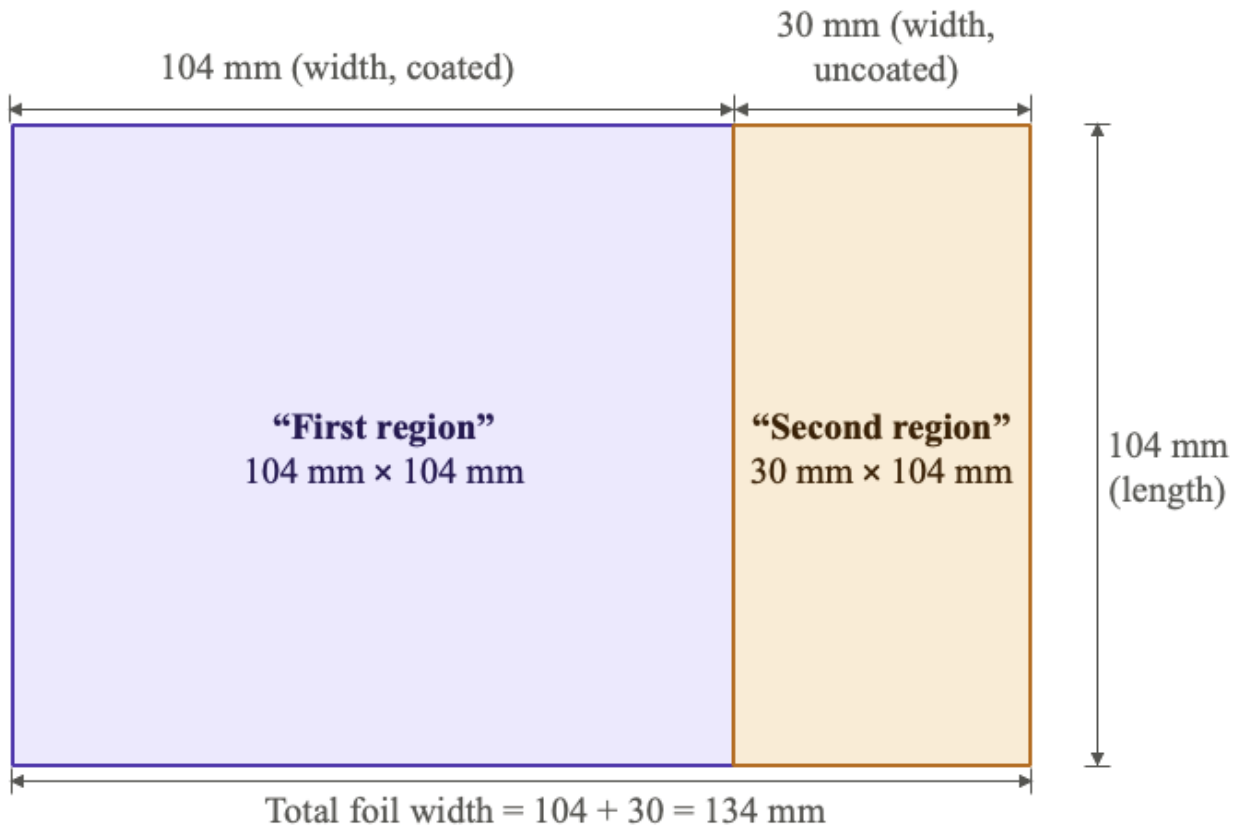
Luo forms the active material layer by “cut[ting] [the coated, dried, and pressed copper foil] into a shape having an active material layer with a width of 104 mm and a length of 104 mm.” EX1006, ¶[0116]. This resulting 104mm×104mm coated portion of the copper foil corresponds to the claimed first region. EX1003,

¶87. The coating appears only in the (104mm×104mm) first region, as claimed, because Luo cuts the copper foil to retain “an uncoated portion with a width of 30 mm.” EX1006, ¶[0116].

Because Luo Example 57 uses Battery 1, Example 57 satisfies Elements [1.3]-[1.4]. Remaining Batteries 2, 3, and 6 have the same negative electrode as Battery 1. *See* EX1006, ¶¶[0118]-[0127]. Thus, Examples 94, 118, and 178 independently satisfy elements [1.3]-[1.4] because they utilize Batteries 2, 3, and 6, respectively. EX1003, ¶88.

4. [1.5]: “an area of the second region, B %, is 0.4% to 54% of a surface area of the current collector; and”

Luo discloses this Element. EX1003, ¶¶89-91. In the cited Examples, *an area of the second region* (uncoated portion of copper foil), *B %, is 0.4% to 54% (22.4%) of a surface area of the current collector* (copper foil):



$$B\% = (30 \times 104) / ((104 + 30) \times 104) = 30 / 134 = \mathbf{22.4\%}$$

EX1003, ¶89.

Luo's negative electrode in the cited Examples has a 104mm×104mm coated first region and a 30mm×104mm uncoated second region on the copper foil current collector. *Supra* Section VIII.A; EX1006, ¶¶[0116]-[0127]; EX1003, ¶90. Thus, as shown in the Figure above, the total width of the current collector is 104mm+30mm=134mm, making the total surface area of each side 134mm×104mm=13,936mm². The uncoated second region has a surface area of 30mm×104mm=3,120mm². Accordingly, Luo's B%=3,120mm²÷13,936

$\text{mm}^2=22.4\%$, falling in the claimed B% range. *See id.*
($B\%=30\div(104+30)=30\div134=22.4\%$).

5. [1.6]: “A×B<600.”

Luo discloses this Element. EX1003, ¶92. In the cited Examples, A (5 wt% succinonitrile) × B (22.4%) < 600 (5 × 22.4 = 112):

A (wt% succinonitrile)	B (second region's percentage of total current collector surface area)	A x B
5	22.4	112

Id.; *supra* Sections VIII.A, VIII.B.3-4.

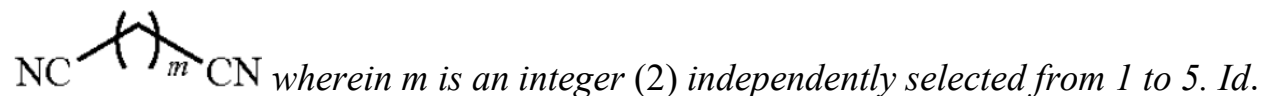
C. Dependent Claim 2

1. [2.1] “The electrochemical device according to claim 1, wherein the nitrile compound comprises at least one of ... a compound of Formula IV
Formula IV



...wherein...m...is an integer independently selected from 1 to 5....”

Luo discloses this Element. EX1003, ¶¶93-95. In the cited Examples, *the nitrile compound* (succinonitrile) *comprises a compound of Formula IV*:



The cited Examples have Electrolyte 35 containing succinonitrile as the claimed nitrile compound. *Supra* Section VIII.A; EX1006, ¶¶[0111], [0155], [0160],

[0163], [0172]. Succinonitrile is a compound of '494 Patent Formula IV where $m=2$, which is within the claimed range. EX1003, ¶¶94-95.

D. Dependent Claim 7

- 1. [7.1] “The electrochemical device according to claim 1, wherein at least one of the second region is positioned at the edge of the current collector, and”**

Luo discloses this Element. EX1003, ¶96. Luo discloses that *at least one of the second region* (uncoated portion) *is positioned at the edge* (one edge) *of the current collector* (copper foil). Luo's copper foil (current collector) has a 104mm×104mm coated portion bordering a 30mm×104mm uncoated portion. *Supra* Section VIII.A; EX1006, ¶[0116]. Thus, the coated portion is positioned at one edge (left) of the copper foil while the uncoated portion is positioned at the other edge (right) of the copper foil. EX1003, ¶96.

- 2. [7.2] “an edge of the second region positioned at the edge of the current collector is either folded or not folded,”**

[7.3] “wherein when the edge of the second region positioned at the edge of the current collector is folded, a width of the folded region is D , and $0.1 \leq D/\text{tab width} \leq 20$.”

Element [7.2] is satisfied because it expressly permits either alternative: the edge of the second region may be “folded or not folded.” EX1003, ¶97. Luo discloses an uncoated portion at the edge of the negative current collector but does not teach folding that edge. EX1006, ¶[0116]. Thus, Luo discloses or suggests the

“not folded” alternative. Element [7.3] imposes a dimensional requirement D/tab width only “when” the edge is folded. Because Luo’s uncoated edge is not folded, that requirement is not implicated. EX1003, ¶97.

E. Dependent Claim 8

1. [8.1] “The electrochemical device according to claim 1, wherein the current collector is a copper foil and the copper foil has one or more of the following properties:”

Luo discloses or suggests this Element. EX1003, ¶98. The cited Examples respectively use Batteries 1-3 and 6. *Supra* Section VIII.A; EX1006, ¶¶[0155], [0160], [0163], [0172]. Each has negative electrode 1 where *the current collector is a copper foil*. EX1006, ¶¶[0116]-[0127]; EX1003, ¶98.

2. [8.2] “a copper purity of $\geq 99.5\%$,”

Luo discloses or suggests this Element. EX1003, ¶¶99-101. Batteries 1-3 and 6, have copper foils as the negative electrode current collector. *Supra* Section VIII.A; EX1006, ¶¶[0116]-[0127], [0155]-[0172].

Element [8.2] simply covers industry-standard use of lithium-ion battery-grade copper foil as the negative electrode current collector. EX1003, ¶100. Commercial specifications for battery-grade electrolytic copper foil reflect copper purity uniformly $\geq 99.5\%$ and routinely higher. *See, e.g.*, EX1013, 2 (“Electrolytic Copper Foil Used for Li Ion Battery Anode Current Collector” having a “Purity(%)”

of “Cu $\geq 99.9\%$ ”), 11 (Normative purity values $\geq 99.8\%$ and typical purity value $\geq 99.98\%$), 13 (“99.95% High Purity Lithium Ion Battery Copper Foil”).

Luo expressly describes its negative electrode current collector as “a copper foil” for use in lithium-ion secondary batteries. EX1006, ¶[0116]; *see also id.*, ¶¶[0001]-[0002], [0117], [0067]. A POSITA would thus read Luo as referring to the battery-grade copper foil used throughout the industry—purity $\geq 99.5\%$ and routinely 99.8%-99.98%. EX1003, ¶101; EX1013, 2, 11, 13.

3. [8.3] “a thickness of 3 microns to 15 microns,”

Luo discloses or suggests this Element. EX1003, ¶102. Specifically, the copper foil used as the negative electrode current collector in the cited Examples has *a thickness of 3 microns to 15 microns* (10 μm), as claimed. *Supra* Section VIII.A.

Luo’s copper foil in Batteries 1-3 and 6 has a thickness of 10 μm . EX1006, ¶¶[0116]-[0127]. Because the cited Examples use Batteries 1-3 and 6 respectively, *supra* Section VIII.A; EX1006, ¶¶[0155]-[0172], each Example meets the claimed thickness range of 3-15 microns. EX1003, ¶103.

4. [8.4] “a weight per unit area of 30 g/m² to 150 g/m²,”

[8.5] “a tensile strength of >20 kg/mm², and”

[8.6] “an elongation rate of $\geq 1.5\%$.”

Luo discloses or suggests these Elements. Elements [8.4]-[8.6] recite inherent properties of room-temperature copper within roughly the same thickness range as

Element [8.3]—which the 10-um-thick copper foil of the cited Examples satisfies. EX1003, ¶¶104-110.

○ **Luo’s weight per unit area=89.6g/m²**

Copper has a density of 8.96g/cm³ at room temperature. EX1014. Multiplying that density by the 10 μm thickness of Luo’s copper foil yields an areal weight of 8.96g/cm³×0.001cm×10,000cm²/m²=89.6g/m², falling within the range of Element [8.4]. EX1014. Industry-published specifications for battery-grade copper foil of about the same thickness corroborate this, reporting a nominal areal weight of “85–90 g/m²” and a typical value of “88 g/m².” EX1013, 11; EX1003, ¶105.

Further, Element [8.4]’s 30–150g/m² weight range corresponds to a slightly broader pure-copper-thickness range (approximately 3.35–16.74μm) than the Element [8.3]’s 3-15μm range at room temperature:

Element [8.4] limit	Calculation	Equivalent copper thickness
30g/m ²	$30\text{g/m}^2 \div 10,000\text{cm}^2/\text{m}^2 \div 8.96\text{ g/cm}^3 = 0.000335\text{ cm}$	3.35μm
150g/m ²	$150\text{g/m}^2 \div 10,000\text{cm}^2/\text{m}^2 \div 8.96\text{g/cm}^3 = 0.001674\text{ cm}$	16.74μm

EX1003, ¶106. Thus, Luo’s 10-μm copper foil also falls within Element [8.4]’s weight-equivalent thickness range. *Id.*

○ **Luo’s tensile strength ≥~30kg/mm²**

Element [8.5]’s range covers the inherent tensile strength of battery-grade copper foil, which is about 30kg/mm². EX1013, 11 (datasheet specifying “Tensile strength...Kg/[m]m²... >30”). This falls inside the claimed range of Element [8.5] of >20kg/mm². EX1003, ¶¶107-108.

Another battery-grade copper foil datasheet specifies a tensile strength at room temperature of >280 MPa. EX1013, 14. Because 1MPa=1N/mm², and 1kgf=9.80665N (force exerted by 1 kg under standard gravity), 280 MPa=280N/mm²÷9.80665N/kgf=28.6kg/mm². This too falls inside the claimed range of >20 kg/mm². *Id.*

○ **Luo’s elongation rate ≥ 2.5%**

Regarding Element [8.6], the elongation of battery-grade copper foil is uniformly at least 2.5%. *See* EX1013, 2 (“Normal elongation(%)...2.5”), 11 (“Room temperature elongation” of “>3.5[%]”), 14 (“Elongation” at “R.T.(23°C)” of “>5”). Each figure falls inside the claimed range of ≥1.5%. EX1003, ¶¶109-110.

F. Dependent Claim 13

- 1. [13.1] “The electrochemical device according to claim 1, wherein the electrolyte further comprises an anion, the anion comprises at least one of Cl^- , Br^- , SO_4^{2-} , CO_3^{2-} or F, and the content of the anion in the electrolyte is less than or equal to 1000 ppm.”**

Luo discloses or suggests this Element. EX1003, ¶¶111-114. Element [13.1] essentially specifies the electrolyte may contain trace amounts of one or more recited anions, and the cited Examples contain trace amounts of F^- .

The cited Examples use Electrolyte 35, which contains 1M lithium difluorophosphate. *Supra* Section VIII.A; EX1006, ¶¶[0111], [0155], [0160], [0163], [0172]. LiPO_2F_2 -based electrolytes contain trace fluoride anion (F^-) at low parts-per-million levels through two well-known mechanisms: (i) hydrolysis of LiPO_2F_2 by residual moisture, which liberates HF and ultimately F^- in solution ($\text{LiPO}_2\text{F}(\text{OH}) + \text{H}_2\text{O} \rightarrow \text{LiPO}_2\text{F}(\text{OH}) + \text{HF}$; $\text{HF} \rightarrow \text{H}^+ + \text{F}^-$), and (ii) slow thermal decomposition of LiPO_2F_2 , like other fluorine-containing salts, during storage and cell operation, which also liberates F^- . EX1003, ¶¶112-114; *see also* EX1011; EX1015, 3 (Commercial LiPO_2F_2 having ≤ 200 ppm of acid impurities); EX1006, ¶¶[0105] (electrolyte prepared in inert environment), [0111] (LiPO_2F_2 dissolved to 1M, reducing anion concentration).

G. Independent Claim 14

Independent claim 14 recites substantially the same subject matter as claim 1, with minor differences. Whereas claim 1 is directed to “an electrochemical device,” claim 14 recites “an electronic device, comprising an electrochemical device.” Claim 14’s electrochemical device is identical to claim 1’s except for reciting the nitrile generically. Thus, both the cited Examples (succinonitrile) and further cited Examples (different nitriles) of Luo meet claim 14. EX1003, ¶¶115-125; *supra* Section VIII.A.

1. [14.pre] “An electronic device, comprising an electrochemical device, wherein the electrochemical device comprises a positive electrode, a negative electrode, a separator, and an electrolyte; wherein”

○ An electronic device comprising an electrochemical device

Luo discloses this aspect of Element [14.pre]. EX1003, ¶¶116-119. First, Luo discloses or suggests an *electronic device* (electrical appliances powered by the cited Examples), *comprising an electrochemical device* (the cited Examples), as claimed. EX1006, ¶[0002].

A lithium-ion battery exists to power *an electronic device*. See EX1006; EX1003, ¶117. Because of their “high energy density,” Luo teaches using lithium-ion secondary batteries in “electrical appliances” undergoing “lightening and miniaturization.” EX1006, ¶[0002]. Luo packaged the cited Examples as an “18650-

type cylindrical battery.” *Id.*, ¶[0117]. Long before the claimed priority date, this form factor was widely used for “portable applications” of electronic devices, “such as...personal digital assistants, video cameras, and notebook computers.” EX1016, 1:60-2:3; EX1003, ¶117. The ’494 Patent admits lithium-ion batteries had been “widely applied” in such devices before the purported invention. EX1001, 1:22-39. Thus, Luo discloses or suggests using the cited Examples in an “electronic appliance,” disclosing the claimed *electronic device*. And once the Example battery is attached to that electronic appliance, the combination is *an electronic device, comprising an electrochemical device*, as claimed. EX1003, ¶117.

Second, Luo discloses *an electronic device* (equipment used to test the cited Examples), *comprising an electrochemical device* (the cited Examples), as claimed. *Id.*, ¶¶118-119. Luo performed a cycle-retention rate test on all Examples, comprising a five-cycle initial conditioning step to establish initial capacity, followed by a 500-cycle charge/discharge test. *See* EX1006, ¶¶[0132]–[0188]. The test equipment (e.g., battery cycler) connected to Luo’s batteries discloses *an electronic device comprising* those battery cells, thus disclosing Element [14.pre]. EX1003, ¶¶118-119.

- **Wherein the electrochemical device comprises a positive electrode, a negative electrode, a separator, and an electrolyte**

The cited and further cited Examples of Luo disclose this feature of Element [14.pre]. *Supra* Sections VIII.B.1, VIII.A; EX1003, ¶120.

2. [14.1] **“the electrolyte comprises a nitrile compound, and”**

[14.2] **“a mass percentage of the nitrile compound in the electrolyte, A %, is 0.1% to 10%;”**

The cited and further cited Examples of Luo disclose these Elements. *Supra* Sections VIII.B.2, VIII.A (table for the further cited Examples); EX1003, ¶121.

3. [14.3] **“the negative electrode comprises a current collector, wherein the current collector comprises a first region and a second region;”**

4. [14.4] **“a negative electrode active substance layer is provided only in the first region;”**

The cited and further cited Examples of Luo disclose these Elements. *Supra* Sections VIII.B.3, VIII.A; EX1003, ¶¶122-123.

5. [14.5] **“an area of the second region, B %, is 0.4% to 54% of a surface area of the current collector; and”**

The cited and further cited Examples of Luo disclose this Element. *Supra* Sections VIII.B.4, VIII.A (table for the further cited Examples); EX1003, ¶124.

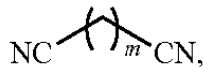
6. [14.6] **“ $A \times B < 600$.”**

The cited and further cited Examples of Luo disclose this Element. *Supra* Sections VIII.B.5, VIII.A (table for the further cited Examples); EX1003, ¶125.

H. Dependent Claim 15

1. [15.1] “The electronic device according to claim 14, wherein the nitrile compound comprises at least one of ... a compound of Formula IV ... :

Formula IV

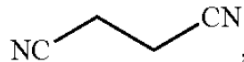


wherein ... m ... is an integer independently selected from 1 to 5
....”

Luo discloses this Element. *Supra* Section VIII.C; EX1003, ¶126.

I. Dependent Claim 16

1. [16.1] “The electrochemical device according to claim 14, wherein the nitrile compound comprises at least one of: ... [Compound 4]”



Luo discloses this Element. *Supra* Section VIII.B.2; EX1003, ¶127.

IX. GROUND 1B: LUO RENDERS OBVIOUS CLAIMS 1, 2, 7, 8, AND 12-16

No rationale to select any of the cited Examples or the further cited Examples of Luo is required to show anticipation. *See Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1371 (Fed. Cir. 2008); *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 782 (Fed. Cir. 1985) (“when...a claim covers several compositions, the claim is ‘anticipated’ if one of them is in the prior art”); *Perricone v. Medicis Pharm. Corp.*, 432 F.3d 1368, 1376 (Fed. Cir. 2005).

Regardless, Luo provides ample motivation to select any of the cited Examples or further cited Examples. EX1003, ¶¶128-134. First, Luo’s two headline performance metrics—256 mAh·g⁻¹ initial capacity and 89% cycle retention—trace directly to Compound-4-containing Examples 57 (89% retention) and 178 (255 mAh·g⁻¹). *Compare* EX1006, ¶[0083] *with id.*, ¶¶[0155], [0172]. By advertising these metrics, Luo expressly directs the POSITA to examples satisfying the ’494 Patent claims. EX1003, ¶128.

Second, Luo characterizes the example sets containing Examples 57, 94, and 178 as showing “a significant improvement in cycle retention rate” over the baseline. EX1006, ¶¶[0179], [0183], [0187]. A POSITA would thus have selected from these significantly improved sets. EX1003, ¶129. Each set contains a finite number of examples, and Luo’s further express teachings (discussed below) narrow the field to those containing Electrolyte 35. EX1006, ¶¶[0042]–[0043], [0053]–[0054]. Selecting Examples 57, 94, and 178 from this narrowed, finite set would therefore have been “obvious to try.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007); *see also* MPEP §2143.I.E; EX1003, ¶129. The same holds for remaining Example 118, in a set showing “a slight improvement in cycle retention.” EX1006, ¶[0184]; EX1003, ¶129.

Third, Luo expressly identifies succinonitrile as first among its “more preferr[ed]” functional additive subgroup. EX1006, ¶¶[0051]–[0053]. This directs

the POSITA to at least the cited Examples because Electrolyte 35 contains succinonitrile as its sole functional additive. EX1006, ¶¶[0111], [0155], [0160], [0163], [0172]; EX1003, ¶130.

Fourth, Electrolyte 35 falls within a subset of Luo's electrolytes satisfying multiple preferred criteria simultaneously: it (1) uses LiPO_2F_2 as the sole lithium salt at Luo's "particularly preferr[ed]" concentration of 1-2 molar, EX1006, ¶¶[0003], [0043], [0111]; and (2) contains a functional additive within Luo's preferred content range of 1-5wt%. *Id.*, ¶[0054]. Only eight of Luo's electrolytes (Electrolytes 35–42) meet both criteria. *See* EX1006, ¶¶[0107]-[0111]. This narrows the POSITA's selection to examples containing Electrolyte 35. EX1003, ¶131.

Finally, having selected Electrolyte 35, the POSITA would have deployed it across multiple battery configurations, as Luo teaches. *Id.*, ¶132. Luo holds the negative electrode constant across Batteries 1-3 and 6 while varying the cathode among mainstream configurations. EX1006, ¶¶[0116]-[0127]; EX1003, ¶132. Luo thus demonstrates that Electrolyte 35 works across common cathode chemistries, encouraging the POSITA to implement Examples using Electrolyte 35. EX1003, ¶132.

Similar logic applies to the further cited Examples, which pair nitrile Electrolytes 36-39 with Batteries 1-3 and 6 in groups showing improved cycle retention. EX1006, ¶¶[0179]-[0187]; EX1003, ¶133. Each of Electrolytes 36–39

shares Electrolyte 35's LiPO_2F_2 +DME:DDME backbone but substitutes a different preferred nitrile—PDN, SN, AN, or ACN in place of BDN—at 1, 2, or 5 wt%, within Luo's preferred 1–5 wt% content range. EX1006, ¶¶[0051]–[0054], [0107]–[0111]; EX1003, ¶133.

○ **Reasonable expectation of success**

A POSITA would have had a reasonable expectation of success in deploying Luo's Examples, because Luo expressly built and tested each one and documented how to reproduce it. EX1003, ¶134. Luo provides complete, reproducible preparation procedures for the electrolyte, including the composition of the Electrolytes used in the cited Examples and further cited Examples; the positive electrode for each battery configuration; the negative electrode; the separator and cell assembly; and the performance testing methodology. EX1006, ¶¶[0105], [0111], [0115]–[0121], [0127], [0132]–[0149]. Luo constructed each cited and further cited Example using these procedures—pairing Electrolytes 35–39 with Batteries 1–3 and 6—and reported the resulting initial specific capacity and 500-cycle retention for each. *Id.*, ¶¶[0155], [0160], [0163]–[0164], [0172]–[0173] (Table 3). A POSITA following Luo's procedures with routine skill would have arrived at the same operative batteries that Luo constructed and tested. EX1003, ¶134.

A. Current Collector Length: 104mm

Even if Patent Owner contends (incorrectly) that Luo does not disclose or suggest the length of the uncoated portion, it would have been obvious to make that portion the same 104mm length as the coated portion for the same reasons discussed above for why a POSITA would read the lengths as the same. Namely, Luo states the 104 mm length only once, for the entire copper foil. Luo gives no reason to make the uncoated length different from the coated length. If Luo intended a different length, Luo would have stated the value and described the purpose of the irregular shape (which Luo does not). Luo intentionally makes the anode larger than the cathode to provide a protective overhang. Arbitrarily changing the overhang in some areas but not others makes no technical sense and requires a non-standard fabrication step that introduces manufacturing issues. *Supra* Section VIII.A; EX1003, ¶135.

B. Claim 8

To the extent Patent Owner contends Luo does not expressly disclose the copper elements of claim 8, a POSITA would have found it obvious to use lithium-ion battery-grade copper foil as the negative electrode current collector in the cited Examples. EX1003, ¶¶136-138. Such copper foil, prepared as Luo specifies, results in the characteristics recited in Elements [8.1]-[8.6]. *Supra* Section VIII.E.

Luo teaches that the cited and further cited Examples were used “to prepare a 18650-type cylindrical battery.” EX1006, ¶[0117]. This form factor is widely used

in commercial lithium-ion battery applications, including notebook computers, power tools, e-bikes, electric vehicles, and large household storage batteries. EX1003, ¶137. In fact, lithium-ion-battery-grade copper foil is the *de facto* choice for the negative electrode current collector in all form factors and applications of lithium-ion batteries because it delivers lower internal resistance and better long-term cycle stability than lower-purity alternatives—properties essential to the capacity and cycle retention those applications demand. *See, e.g.*, EX1013, 13 (“99.5% High Purity Lithium Ion Battery” for “Application: ...notebook PC, ...Electric vehicle(EV)”); *see also* EX1003, ¶137. Accordingly, to the extent the POSITA did not already understand Luo to implicitly disclose or require using battery-grade copper foil in context—which Petitioner submits it would—using such foil would have been the natural and obvious. EX1003, ¶138.

C. Dependent Claim 12

1. [12.1] “The electrochemical device according to claim 1, wherein the electrolyte further comprises an additive, and the additive comprises at least one of the following: ... ethylene sulfate”

Luo renders obvious this Element. EX1003, ¶¶139-144. Each cited Example—combined with the remainder of Luo’s disclosure—renders obvious *the electrolyte (modified Electrolyte 35) further comprises an additive, and the additive comprises ethylene sulfate. Id.*

○ **Luo discloses Element [12.1]**

While Electrolyte 35 does not have one of the additives listed in claim 12, Luo discloses that its electrolytes may further contain *ethylene sulfate* as a functional additive. EX1006, ¶¶[0005]-[0012], [0051]-[0052].

○ **Rationale to add ethylene sulfate to Electrolyte 35**

A POSITA would have had reason to modify Electrolyte 35 to add *ethylene sulfate* and had a reasonable expectation of success. EX1003, ¶141.

First, Luo expressly teaches, suggests, and motivates the POSITA to add ethylene sulfate (DTD) to Electrolyte 35. EX1003, ¶142. Luo identifies “functional additives” as a category used in its electrolytes having improved cycle retention rate—the same performance metric driving Electrolyte 35’s succinonitrile (BDN) addition. EX1006, ¶¶[0017], [0051]-[0054]. Luo expressly teaches, “[p]referably, ...the functional additive is selected from one or more of a nitrile compound and a sulfate compound,” and identifies ethylene sulfate as one of a handful of sulfate-compound options. *Id.*, ¶¶[0051]-[0052]. Luo thus places both nitrile compounds and sulfate esters in the same preferred functional-additive class, deployed for the same cycle-retention purpose. EX1003, ¶142. The phrase “one or more” encourages the POSITA to combine additives from this class—i.e., to use a nitrile and a sulfate ester together in the same electrolyte. *Id.*; EX1006, ¶[0051].

A product data sheet confirms it was well-known that ethylene sulfate supports “[o]ne of the best-performing electrolyte formulations for graphite cells,” and is “primarily used as an electrolyte additive” to extend battery lifetime and improve formation of a stable solid electrolyte interphase (SEI) on the anode surface. EX1015, 11. A POSITA would thus have been motivated to use it as an additive in Luo’s Electrolyte 35 used with Batteries 1-3 and 6 of the cited Examples, which have graphite cells. EX1003, ¶143; EX1006, ¶[0116]; *supra* Section VIII.A

Second, it would have been “obvious to try” adding *ethylene sulfate* to Luo’s Electrolyte 35. *See KSR*, 550 U.S. at 421; MPEP §2143.I.E; EX1003, ¶¶144-147.

Recognized problem or need: Luo identifies a design/market need for lithium-ion battery electrolytes that “can improve the cycle retention rate of the lithium secondary battery.” EX1006, ¶¶[0017], [0002]-[0003], Abstract; EX1003, ¶145.

Finite number of identified, predictable potential solutions: Luo’s electrolytes contain: (1) difluorophosphate as the lithium salt; (2) a non-aqueous solvent; and (3) a functional additive “selected from one or more of a nitrile compound and a sulfate compound.” EX1006, ¶¶[0005]-[0010]. Electrolyte 35 already contains a nitrile (succinonitrile) but does not contain a sulfate compound. *Id.*, ¶[0111]. Luo only identifies only four sulfate compounds, one being ethylene

sulfate. *Id.*, ¶[0052]. Ethylene sulfate is thus one of a finite number (four) predictable additive options for improving cycle retention. EX1003, ¶146.

Reasonable expectation of success: A POSITA would have had a reasonable expectation of success in adding ethylene sulfate to Electrolyte 35. EX1003, ¶147. First, Luo teaches that its functional additive has two components—a nitrile and a sulfate compound—and identifies ethylene sulfate as one of four sulfate options. *Id.*; EX1006, ¶¶[0005]-[0010], [0052]. Second, as the data sheet discussed above confirms, a POSITA knew that ethylene sulfate extends battery life, works with other electrolyte additives, and performs well in graphite-cell formulations like the cited Examples using Electrolyte 35. *See* EX1006, ¶¶[0116], [0155]-[0172]; EX1015, 11; EX1003, ¶147. Both points support a reasonable expectation of success.

D. Independent Claim 14

1. [14.pre]

○ An electronic device comprising an electrochemical device

Luo also renders this element obvious. EX1003, ¶148. A lithium-ion battery exists to power an electronic device *an electronic device*. *Id.* Luo teaches using lithium-ion batteries in “electrical appliances” undergoing “lightening and miniaturization” for their “high energy density.” EX1006, ¶[0002]. Luo packaged the cited and further cited Examples as cylindrical batteries that were widely known and used for “portable applications” of electronic devices. EX1006, ¶[0117]; *see*

also EX1016, 1:60-2:3; EX1003, ¶148. Thus, if Patent Owner incorrectly contends that Luo does not expressly disclose or suggest using its batteries in *an electronic device*, Luo renders obvious doing so. EX1003, ¶148. Any of the cited Examples or further cited Examples electrically connected to such a device is *an electronic device, comprising an electrochemical device*, as claimed. *Id.*

- **Wherein the electrochemical device comprises a positive electrode, a negative electrode, a separator, and an electrolyte**

Luo discloses this feature. *Supra* Sections VIII.G.1, VIII.B.1; EX1003, ¶149.

2. [14.1]

Luo discloses this Element. *Supra* Sections VIII.G.2, VIII.B.2; EX1003, ¶150.

3. [14.2]

Luo discloses this Element. *Supra* Sections VIII.G.2, VIII.B.2; EX1003, ¶151.

4. [14.3]

Luo discloses this Element. *Supra* Sections VIII.G.3, VIII.B.3; EX1003, ¶152.

5. [14.4]

Luo discloses this Element. *Supra* Sections VIII.G.3, VIII.B.3; EX1003, ¶153.

6. [14.5]

Luo discloses this Element. *Supra* Sections VIII.G.4, VIII.B.4; EX1003, ¶154.

7. [14.6]

Luo discloses this Element. *Supra* Sections VIII.G.5, VIII.B.5; EX1003, ¶155.

X. Grounds 2A, 2B⁸: Luo and Zhang Render Obvious Claims 3, 5, 7, 9, 10, 17, and 19

To the extent Luo does not expressly disclose certain elements of claims 3, 5, 9, 10, 17, and 19, Zhang discloses them, and a POSITA would have combined Zhang with Luo to arrive at the claimed subject matter with a reasonable expectation of success. Luo and Zhang also render obvious the optional “folded” scenario of claim 7. EX1003, ¶¶156-162.

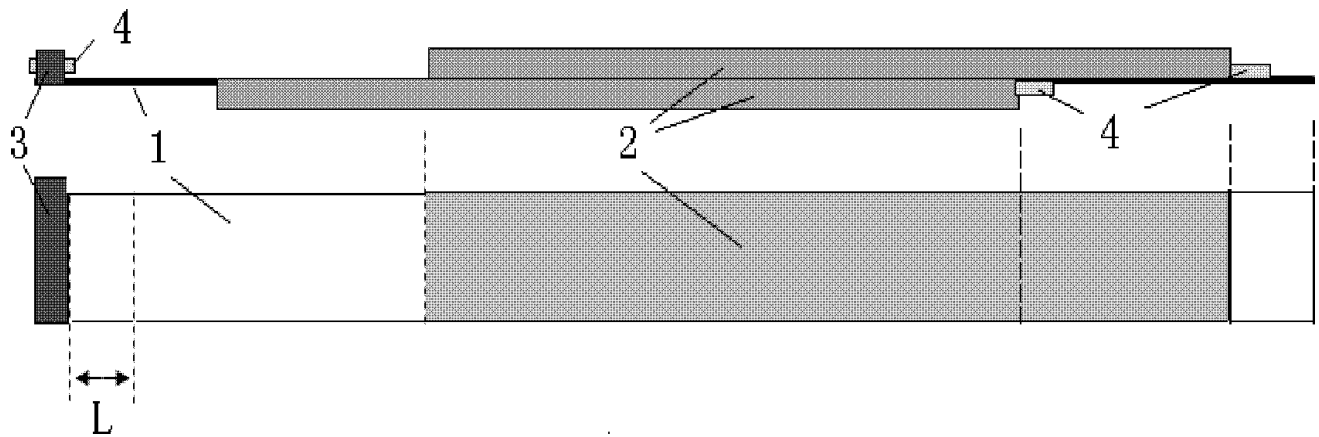
A. Overview of Zhang

Zhang “discloses a method for controlling burrs at leading and trailing ends of battery electrode sheets” to reduce internal short circuits and improve safety.

⁸ Ground 2A combines Ground 1A (Luo anticipates) with Zhang, rendering obvious claims 3, 9, 10, 17, and 19; and Ground 2B combines Ground 1B (Luo renders obvious) with Zhang, also rendering obvious these same claims.

EX1008, Abstract; *see also id.*, ¶[0005]. Zhang explains, “[t]raditional current collector edge burrs easily pierce through the separator and contact the other electrode of the battery, forming a short circuit and causing danger.” *Id.*, ¶[0014].

Zhang’s electrode sheet includes a current collector 1, coating 2, tab 3, and tape 4. EX1008, ¶¶[0015]-[0016].



Zhang, Fig. 1

Zhang’s Figure 1 depicts a generic “battery electrode sheet”—for either a negative or positive electrode—because Zhang states that burrs on “the positive or negative current collectors” can cause internal shorts. *Id.*, ¶¶[0004], [0015]; EX1003, ¶¶159-160.

On the leading (left) end, Zhang discloses “[p]roviding a bare current collector area on both sides of one end of the electrode sheet, welding a tab to the bare current collector area,” and “bending and wrapping the tab 360 degrees around the current collector, and then pressing it flat.” EX1008, ¶[0009]. Then, “the edge of the current

collector is folded inward.” *Id.*, ¶[0011]. And “the length L [of the folded portion] is twice the tab width.” *Id.*, ¶[0017]. Zhang also applies “tape 4...to the current collector and the inner surface of the tab at the trailing end of the double-sided coating area.” *Id.*

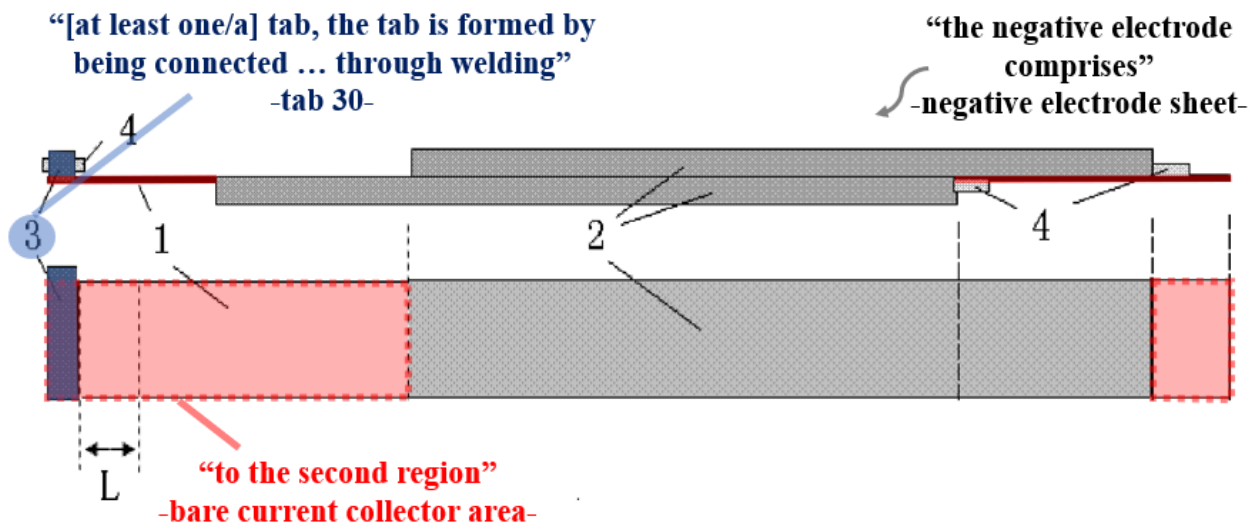
Zhang’s leading-edge configuration keeps burrs from piercing the separator and shorting the other electrode “[b]ecause the leading end utilizes a tab wrapped 360 degrees around the current collector and pressed flat, and the edge of the current collector is folded inward.” *Id.*, ¶[0014]. Without these features, “current collector edge burrs easily pierce through the separator and contact the other electrode of the battery, forming a short circuit and causing danger.” *Id.*

Zhang also applies “tape 4...to the current collector and the inner surface of the tab at the trailing end of the double-sided coating area on the electrode sheet.” *Id.*, ¶[0017]; *see also id.*, ¶[[0010], Abstract. This taping likewise prevents trailing-end burrs from piercing the separator and contacting the other electrode to form a short circuit. *Id.*, ¶[0014].

B. Claims 3 and 17

1. [3.1]/[17.1] “The electrochemical device according to claim [1/14], wherein the negative electrode comprises [at least one/a] tab, the tab is formed by being connected to the second region through welding, and”

Zhang discloses these Elements. EX1003, ¶¶163-164. Zhang discloses *the negative electrode* (electrode sheet) *comprises [at least one/a] tab* (tab 3) *formed by being connected to the second region* (bare current collector region) *through welding*:



Zhang, FIG. 1*⁹

Zhang explains “[o]ne end of the electrode sheet is provided with a bare current collector area, and a tab 3 is welded to this bare current collector area[.]” EX1008,

⁹ An “*” indicates a figure from a cited reference that has been annotated or otherwise modified for illustrative purposes.

¶[0017]; *see also id.*, Abstract, Claim 1, ¶[0009]. Zhang’s electrode sheet—either a negative or positive electrode as discussed above—discloses the claimed negative electrode. *Id.*, ¶¶[0004], [0015]; EX1003, ¶164. Zhang’s tab 3 welded to the bare current collector area discloses the *claimed tab that is formed by being connected to the second region through welding*. EX1003, ¶164.

2. [3.2]/[17.2] “ $A \times B < 210$.”

Luo discloses this Element. Specifically, $A \times B = 112$. *Supra* Sections VIII.A, VIII.B.5. Welding Zhang’s tab 3 to Luo’s bare current-collector portion would not materially increase the uncoated-area percentage B—certainly not enough to push $A \times B$ outside the claimed range. EX1003, ¶165. To reach 210, Luo’s B value would have to increase by 87.5% (nearly double), from 22.4% to 42%. This would require the single added tab to occupy an implausibly large share of Luo’s current collector, contrary to Zhang’s disclosure and figures. *Id.*

C. Claim 5

1. [5.1] “The electrochemical device according to claim 3, wherein at least one of the second region is positioned at an edge of the current collector,”

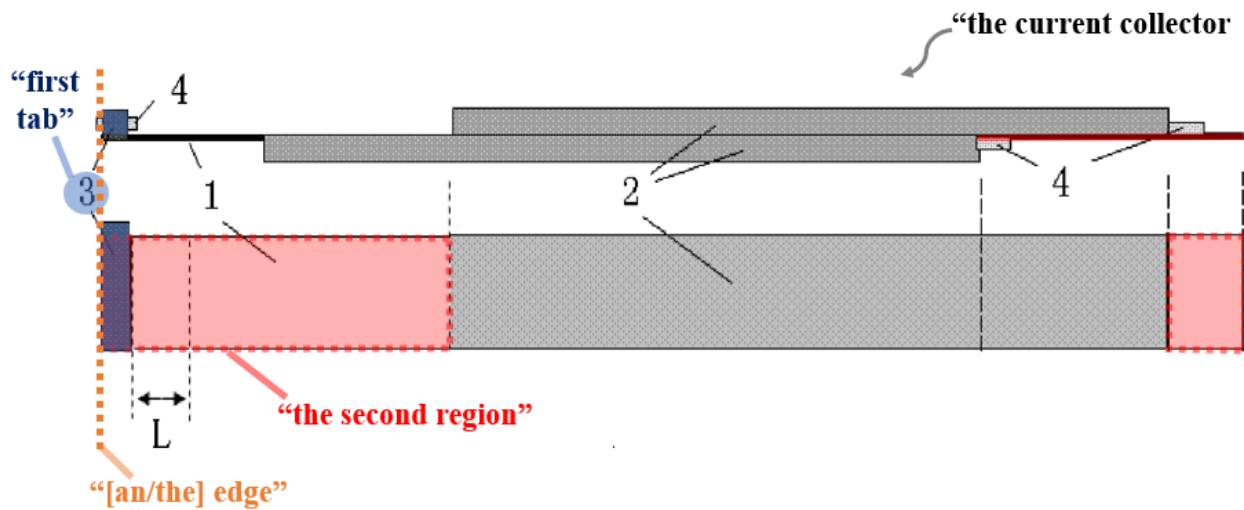
Luo discloses this Element. EX1003, ¶166; *supra* Section VIII.D.1. Zhang also discloses this element because *at least one of the second region* (bare current collector region) *is positioned at an edge* (leading end and trailing end) *of the current*

collector (current collector 1). Thus, the combination of Luo and Zhang discussed below includes this element. *Id.*

2. [5.1] “wherein a distance between a first tab from the at least one tab closest to an edge of the current collector and the edge of the current collector is C, and $0 \leq C/\text{tab width} \leq 50$.”

Zhang discloses this Element. Specifically, Zhang discloses *a distance* (zero or near zero) *between a first tab* (tab 3) *from the at least one tab* (tab 3) *closest to an edge* (leading end) *of the current collector* (current collector 1) *and the edge of the current collector is C, and $0 \leq C/\text{tab width} \leq 50$* (zero or near zero). EX1003, ¶¶167-170.

Solving the inequality for C, Element [5.1] recites that first tab can be located anywhere from at the edge (zero distance) of the current collector to 50 times its width away from the edge of the current collector: $0 \leq C \leq 50 \text{ tab}$. EX1003, ¶168. Zhang’s tab 3 sits at the edge (zero distance) of current collector 1:



Zhang, FIG. 1*

Claim 5 does not require multiple tabs. It depends from claim 3, which recites “at least one tab” and “a first tab from the at least one tab closest to an edge of the current collector.” EX1001, claims 3, 5. When only one tab is present, that tab is the claimed “first tab” and is necessarily closest to the edge. EX1003, ¶169. This is consistent with the ’494 Patent’s Figures 1 and 2, which show a single tab 3 at second region 2 near the current-collector edge. *Id.*; EX1001, FIGS. 1–2; 9:51–67.

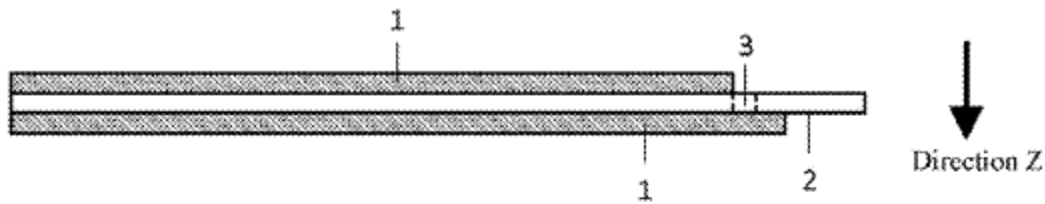


FIG. 1

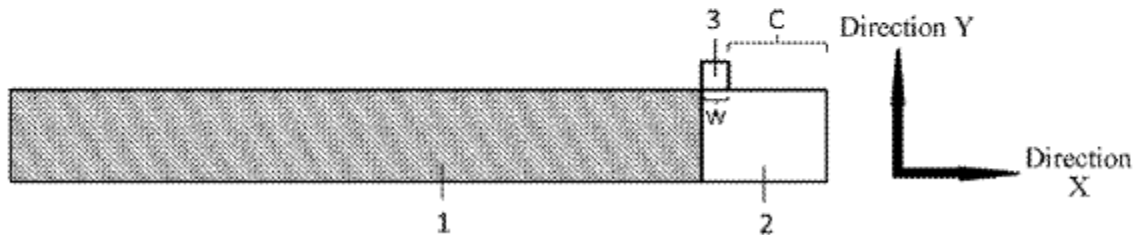


FIG. 2

'494 Patent, FIGS. 1, 2

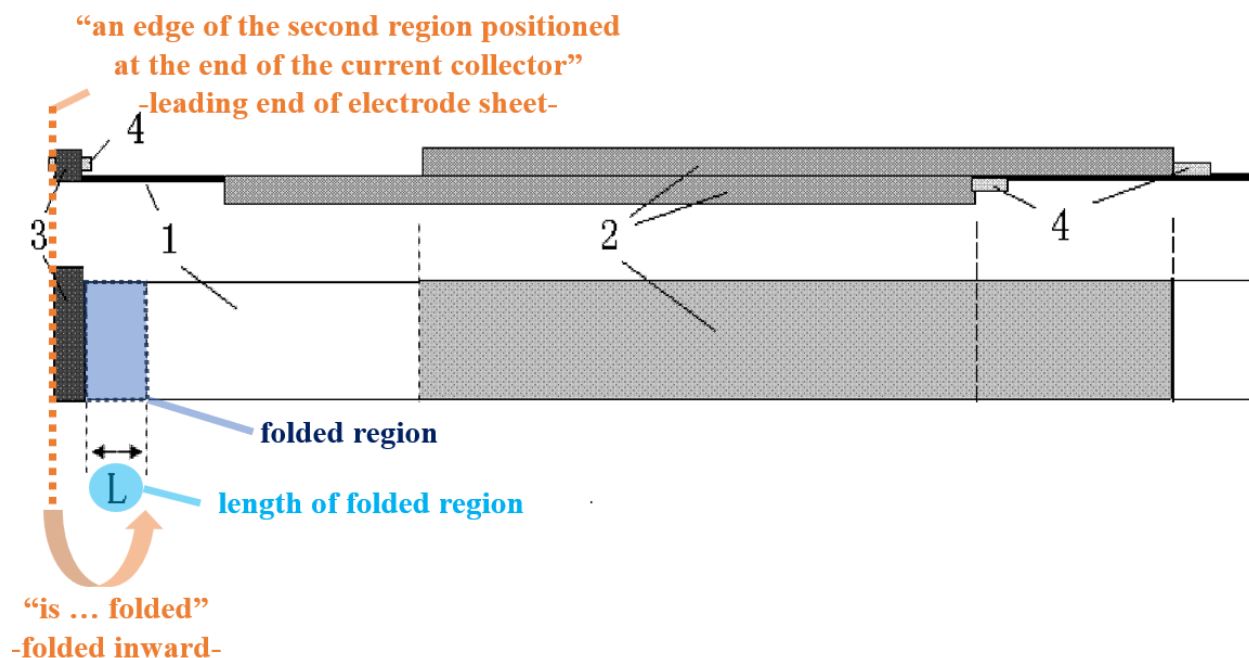
D. Claim 7

1. [7.1] “The electrochemical device according to claim 1, wherein at least one of the second region is positioned at the edge of the current collector, and”

Luo discloses this Element. EX1003, ¶171; *supra* Section VIII.D.1. Zhang also discloses this element because *at least one of the second region* (bare current collector region) *is positioned at an edge* (leading end and trailing end) *of the current collector* (current collector 1). Thus, the combination of Luo and Zhang discussed below includes this element. EX1003, ¶171.

2. [7.2] “an edge of the second region positioned at the edge of the current collector is either folded or not folded,”

Zhang discloses this Element. EX1003, ¶172. Specifically, Zhang discloses *an edge of the second region (bare current collector region) positioned at the edge (leading end) of the current collector (current collector 1) is either folded (folded inward a distance L) or not folded:*



Zhang, FIG. 1*

Zhang discloses this Element because the edge of bare current collector region bearing tab 3 sits at the leading end of the electrode sheet, and that edge is folded inward. EX1003, ¶¶173-174; *supra* Section X.A; EX1008, ¶¶[0009], [0011], [0014], [0017].

3. [7.3] “wherein when the edge of the second region positioned at the edge of the current collector is folded, a width of the folded region is D, and $0.1 \leq D/\text{tab width} \leq 20$.”

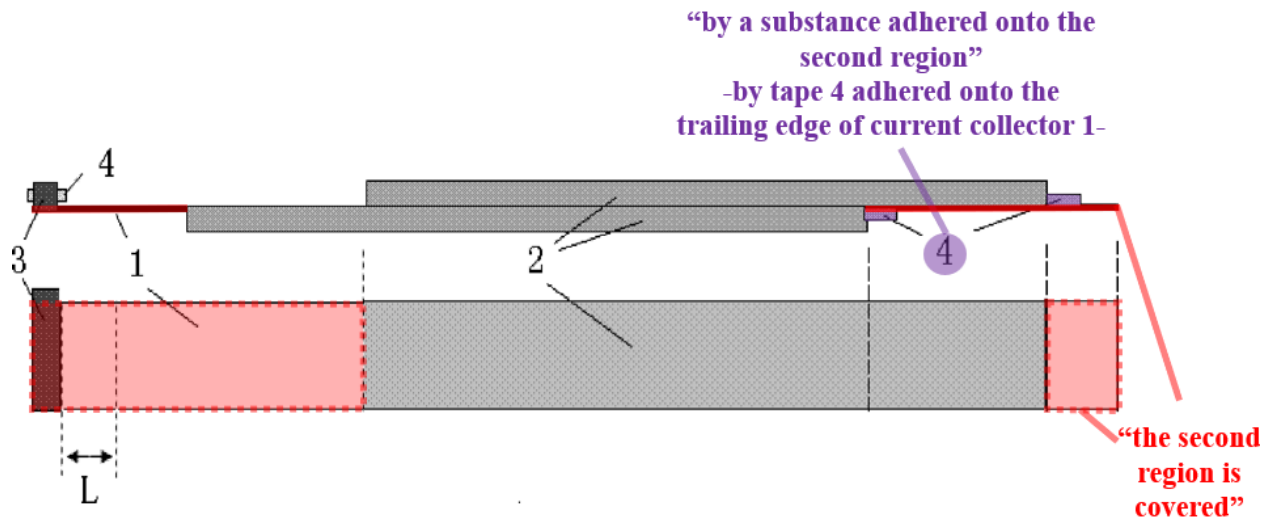
Zhang discloses this Element. EX1003, ¶¶175-176. Specifically, Zhang discloses that, *when the edge (leading end) of the second region (bare current collector region) positioned at the edge of the current collector (current collector 1) is folded, a width of the folded region is D (length L), and $0.1 \leq D/\text{tab width} \leq 20$ (L=twice the width of tab 3).*

This Element means the folded region D is 10% to 20 times the width of the tab. EX1003, ¶176. Zhang discloses the folded-region “length L is twice the tab width.” EX1008, ¶[0017]; *see also id.*, ¶¶[0011], [0014], Abstract, Claim 2. Because D corresponds to Zhang’s length L, Zhang discloses a D/tab width ratio of 2, falling within the claimed range of 0.1-20. EX1003, ¶176.

E. Claims 9 and 19

1. [9.1]/[19.1] “The electrochemical device according to claim [1/14], wherein the second region is covered by a substance adhered onto the second region.”

Zhang discloses these Elements. EX1003, ¶177-179. Specifically. Zhang discloses *the second region (bare current collector area) is covered by a substance (tape 4 on trailing end of current collector 1) adhered onto the second region (bare current collector area)*



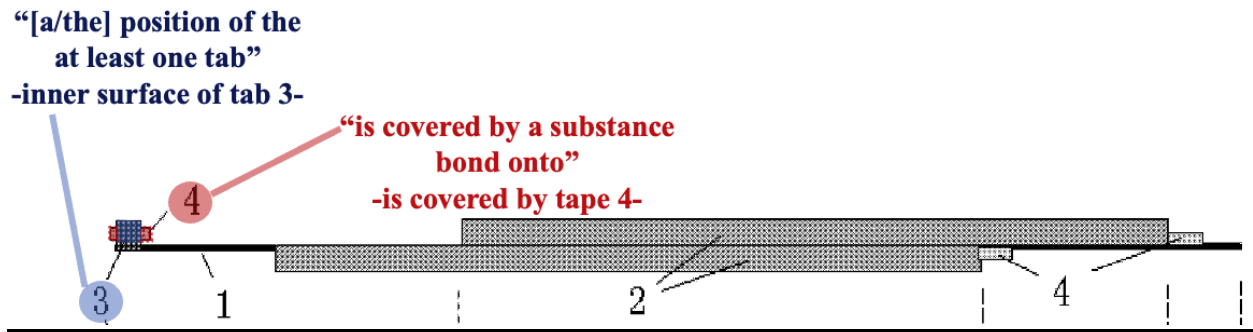
Zhang, FIG. 1*

Zhang's bare current collector area (claimed second region) is covered by tape 4 adhered onto the current collector 1. EX1003, ¶178. Specifically, "tape 4 is applied to [both] the current collector and the inner surface of the tab..." EX1008, ¶[0017]. The pieces of tape 4 adhered to the bare trailing-end portions of current collector 1, highlighted in Figure 1 above, disclose the claimed substance adhered onto the second region. EX1003, ¶178. The claim language does not require the uncoated region to be completely covered with the substance, but it would have been obvious to do so prevent burrs from penetrating the separator. *Id.*, ¶179.

F. Claim 10

- 1. [10.1] “The electrochemical device according to claim 3, wherein a position of the at least one tab is covered by a substance bond onto the position of the tab.”**

Zhang discloses this Element. EX1003, ¶¶180-181. Specifically, Zhang discloses that *position (inner surface) of the at least one tab (tab 3) is covered by a substance bond (tape) onto the position (inner surface) of the tab*, as claimed:



Zhang, FIG. 1*

Zhang discloses this Element because “tape 4 is applied to...the inner surface of the tab [3],” and “[t]he tape can be high-temperature tape or green tape.” EX1008, ¶¶[0017]; *see also id.*, ¶[0010], Abstract; EX1003, ¶181. Thus, Zhang’s tape 4 is the claimed substance, and it is bonded/attached onto the position of tab 3. EX1003, ¶181.

G. Proposed Combination of Luo and Zhang

1. Combination

The proposed combination applies Zhang's electrode-end features to Luo's negative electrode current collectors of the cited and further cited Examples before winding. EX1003, ¶182. Specifically:

- Zhang's tab 3 is welded to Luo's uncoated portion, wrapped 360 degrees around the current collector, and pressed flat, and "the edge of the current collector is folded inward." EX1008, ¶¶[0009], [0011], [0014], [0017]; EX1003, ¶182.
- "Tape 4 is applied to the current collector and the inner surface of the tab at the trailing end of the double-sided coating area on the electrode sheet" and to "the inner surface of the tab [3]" as illustrated in Figure 1 of Zhang. EX1008, ¶¶[0017], [0010], [0012], Abstract; EX1003, ¶182.

2. Rationale to combine

- **Analogous art**

Luo and Zhang are in the same field of endeavor as the challenged claims: lithium secondary batteries and their electrodes. EX1003, ¶183; EX1006, ¶¶[0001], [0115]–[0117]; EX1008, ¶¶[0001], [0008]–[0010]. Luo and Zhang are also reasonably pertinent to problems the '494 Patent addresses. EX1003, ¶184. The '494 Patent seeks to improve lithium-ion battery performance and safety by reducing

“copper dissolution from current collector of negative electrode” that can cause “battery self-discharging or even safety problems” at the tab region. EX1001, 1:32-51. Luo addresses performance, and Zhang addresses safety by preventing current-collector burrs from piercing the separator and causing an internal short circuit. *Compare* EX1006, ¶[0003] *with* EX1008, ¶¶[0003]-[0005], [0014].

- **Teaching, suggestion, motivation**

A POSITA would have been motivated to apply Zhang’s technique to Luo’s cylindrical batteries of the cited Examples, with a reasonable expectation of success. EX1003, ¶¶185-189.

First, Luo focuses on electrolyte chemistry and battery performance, not the implementation of electrode tabs or burr control at the current-collector ends. EX1006, Abstract. Luo nonetheless implements the cited Examples as cylindrical cells in which “[t]he terminals of the positive electrode and the negative electrode were housed in a battery can such that they were exposed to the outside.” *Id.*, ¶¶[0117]-[0121], [0127]; EX1003, ¶186. Because Luo does not describe the tab mechanism used to expose those terminals, a POSITA would have looked to references like Zhang for implementation details. Luo invites this, stating that undiscussed electrode details “are not particularly limited,” and that any “known to those skilled in the art can be used.” EX1006, ¶[0068]; EX1003, ¶186.

A POSITA understood that tabs are commonly added to a bare current collector in two ways: welding a discrete tab to the bare current-collector region, as Zhang teaches, or cutting a tab from that region, as Li teaches (Grounds 3A, 3B below). *Supra* Section II; EX1003, ¶187. Either would have been obvious to apply to Luo. EX1003, ¶187. Zhang teaches a welding approach and supplies a suitable tab structure for Luo’s cylindrical cells, so a POSITA would have used it. *Id.*

Moreover, a POSITA would have wanted Zhang’s technique, specifically, in Luo’s batteries to prevent internal battery short circuits and reduce probability of cell explosion. *See* EX1008, Abstract, ¶¶[0003], [0014]; EX1003, ¶188. Zhang explains that because electrolytes composed of esters and ethers typical of lithium-ion batteries are flammable and decompose at high temperature, such cells “inevitably face the risk of cell ignition and explosion” from external or internal short circuits. EX1008, ¶[0003]. A principal cause of those shorts, Zhang teaches, is current-collector edge burrs that exceed the separator thickness, pierce the separator, and create internal micro-short circuits that can lead to ignition and explosion. *Id.*, ¶[0004].

Zhang’s technique reduces this risk at both electrode ends. EX1003, ¶189. At the leading end, wrapping the tab around the current collector, pressing it flat, and folding the edge inward prevents burrs from piercing the separator and reaching the opposing electrode—a failure common in traditional designs. EX1008, ¶[0014]. At

the trailing end, tape over the bare current collector and the inner tab surface likewise keeps trailing-end burrs from piercing the separator and contacting the other electrode *Id.*, ¶¶[0010], [0014], [0017]. These advantages would have motivated a POSITA to use Zhang’s design in Luo’s batteries. EX1003, ¶189.

- **Applying a Known Technique to a Known Device Ready for Improvement to Yield Predictable Results**

Moreover, the proposed combination merely applies a known technique (Zhang’s tab-wrapping/folding/taping technique) to a known device (Luo’s cylindrical cells) ready for improvement (reduced risk of shorts caused by burrs on the current collector) to yield predictable results (working, safer batteries). *KSR*, 550 U.S. at 415, 417-18; MPEP § 2143.I.D; *see also* EX1003, ¶¶190-194.

Base device: Luo discloses a cylindrical lithium secondary battery in which positive and negative electrodes are wound “together with a polyethylene separator” and their “terminals...housed in a battery can such that they were exposed to the outside.” EX1006, ¶[0117]. Each electrode includes a bare current-collector region—“an uncoated portion with a width of 30 mm”—able to accommodate a tab structure—but Luo says nothing about the tab structure beyond the existence of those terminals. *Id.*, ¶¶[0115]-[0116]; EX1003, ¶191. Luo instead invites the POSITA to consider other references for those details. EX1006, ¶[0068] Thus, Luo’s Examples stand ready for improvement by Zhang’s technique. EX1003, ¶191.

Known technique: Zhang teaches a discrete tab-finishing technique to avoid burr-caused shorts. EX1008, ¶¶[0009]-[0011], [0017]. The technique operates on a “bare current collector area,” *id.*, ¶[0009]—which Luo already provides on both electrodes, EX1006, ¶¶[0115]-[0116]. Zhang’s technique thus applies to Luo without substantial structural modification. EX1003, ¶192.

Predictable results: Zhang states the result of its technique: At the leading end, wrapping and folding the collector edge inward means “the corresponding position remains the current collector” rather than the separator, so burrs cannot pierce the separator and short the other electrode. The trailing-end taping method prevents the same failure. EX1008, ¶[0014]; EX1003, ¶193. That result applies directly to Luo’s wound cells, which present the same conventional structure susceptible to burr piercing. EX1006, ¶¶[0115]-[0117]. The combination would therefore have predictably yielded a safer cell. EX1003, ¶193.

- **Reasonable expectation of success**

For similar reasons, a POSITA would also have had a reasonable expectation of success in making the combination. EX1003, ¶194. Zhang’s technique requires only the “bare current collector area” that Luo’s electrodes already provide, and the welding, wrap, inward fold, and taping are electrode-finishing operations requiring no substantial change to Luo’s electrolyte chemistry or winding-and-canning assembly. EX1006, ¶¶[0115]-[0117]; EX1008, ¶[0017]. Zhang also articulates the

expected outcome—preventing burrs from piercing the separator and shorting the other electrode—leaving no material uncertainty whether the combination would work. EX1008, ¶[0014]; EX1003, ¶194.

XI. Grounds 3A, 3B¹⁰: Luo and Li Render Obvious Claims 4, 6, and 18

Luo does not expressly disclose certain elements of claims 4, 6, and 18 discussed below, but Li does, and a POSITA would have combined Zhang and Li and arrived at the claimed subject matter with a reasonable expectation of success. EX1003, ¶¶195-227.

A. Overview of Li

Li discloses a spiral-line multi-tab lithium-ion battery addressing problems in both wound and stacked cells. In wound cells, Li explains “the electrode plates are long, the internal resistance is high,” making wound cells “unfavorable for high-current charging and discharging” and resulting in “low” specific power. EX1010, ¶[0002]. Additionally, conventional wound and stacked cells both “have drawbacks and are unfavorable for fast charging and high-current discharging.” *Id.* Li also explains that unsound electrode structure and cell design cause non-uniform current

¹⁰ Ground 3A combines Ground 1A (Luo anticipates) with Li, rendering obvious claims 4, 6, and 18; and Ground 3B combines Ground 1B (Luo renders obvious) with Zhang, also rendering obvious these same claims.

density during high-current cycling, compromising the cell's safety, fast-charging, and cycle-life performance. *Id.*

Li addresses this through a single-piece, multi-tab wound structure. Li's negative electrode¹¹ begins as a current-collector sheet reserving: “a blank region [41] ... on the front surface along one longitudinal edge of the negative electrode plate”; “a blank region [51] ... on the back surface along one longitudinal edge of the negative electrode plate”; “a band of blank region [53] ... on the back surface of the positive electrode”; and the remainder coated with active material paste. *Id.*, ¶[0009]. Figures 4 and 5 respectively show front and back views of the negative electrode before tab cutting, with blank region 41 (front), 51 (back), 53 (back) and active material paste 42 (front), 52 (back) coated on the remainder. *Id.*, ¶[0036].

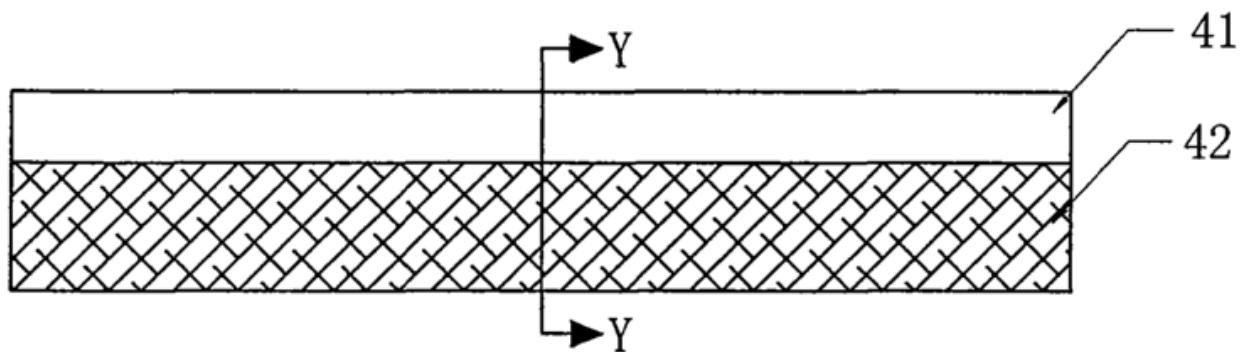


图 4

¹¹ The positive electrode is made in a similar fashion. EX1010, ¶[0009], [0035], [0037], FIGS. 1-3, 7.

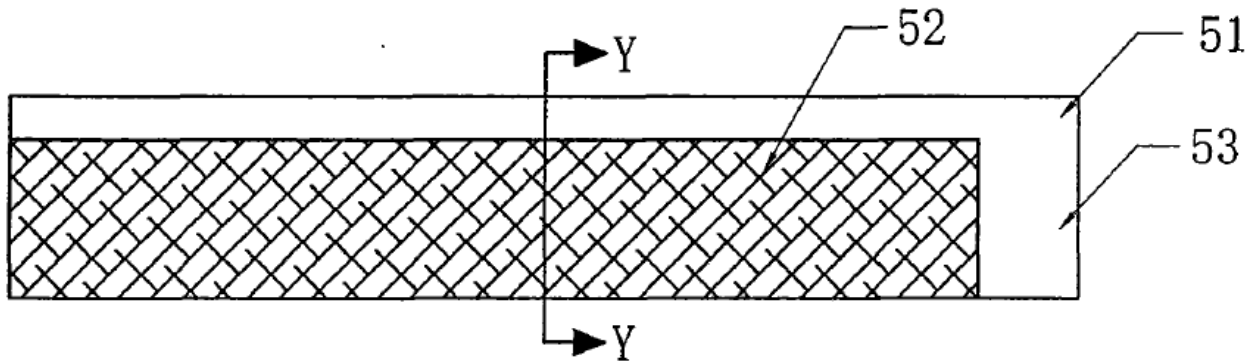


图 5

Li, FIGS. 4 (front view), 5 (back view)

As shown in Figure 8, Li then cuts multiple spaced negative-electrode tabs 81 from the reserved blank regions 41, 51 of the negative electrode plate. EX1010, ¶¶[0009], [0039].

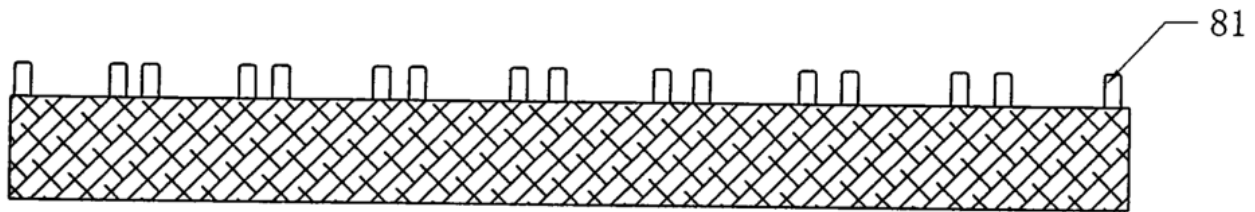
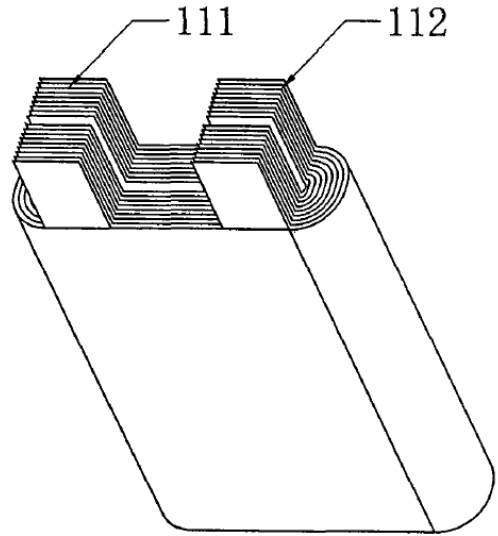


图 8

Li, FIG. 8 (front)

Li spaces tabs 81 so same-polarity tabs align after winding. *See* EX1010, ¶¶[0010]-[0017], [0039]. For the negative electrode shown in Figure 8, “[t]he tab width ... in this example is 6.5 mm,” with the first tab located “1.5 mm” from the edge. *Id.*, ¶[0039]. This yields a spacing-to-width ratio of $1.5/6.5=0.23$. EX1003, ¶201. As Figure 11 (right) shows, this produces “a neat stack of negative electrode tabs 111 and a neat stack of positive electrode tabs 112 ... formed at the top of the cell.” EX1010, ¶[0049]; *see also id.*, ¶¶[0009]-[0010], [0050].

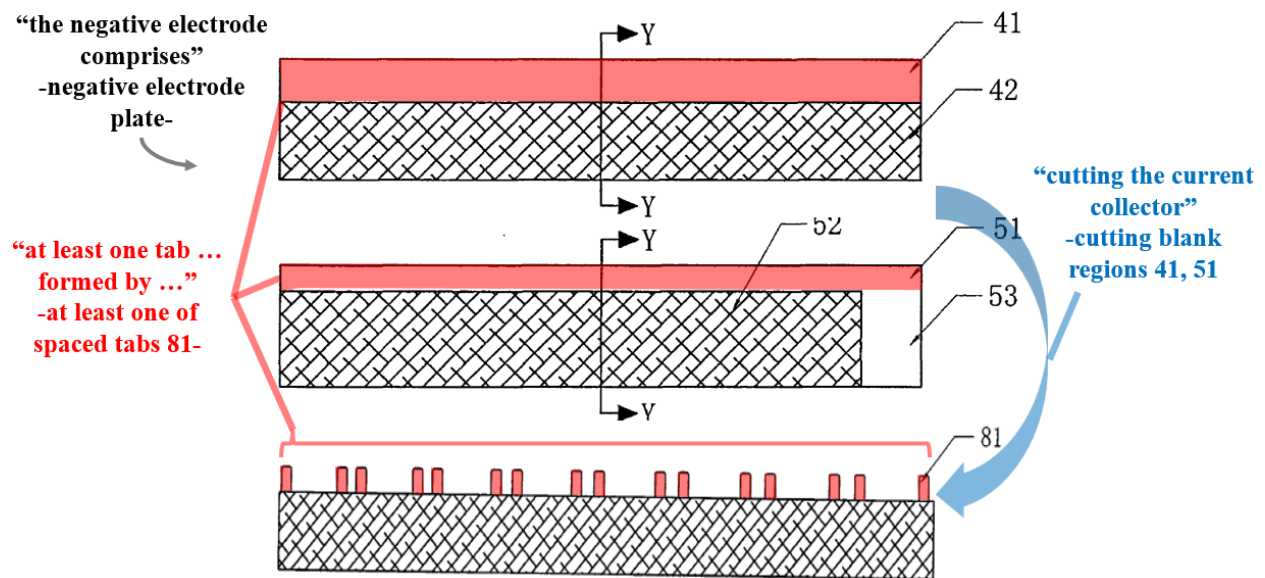


Advantageously, Li’s design “shortens the distance from the electrode plate to the electrode terminal, reduces internal resistance, and decreases heat generation during discharge, thereby improving safety,” and further “reduces the voltage drop caused by internal resistance, thereby raising the discharge plateau. *Id.*, ¶ [0021]. The tab stack also reduces the risk that breakage of one tab disables an entire electrode plate and makes the invention “suitable for high-rate discharge, with uniform charge-discharge current distribution so that lithium plating is unlikely...during high-current” cycling, giving long cycle life and high safety. *Id.*, ¶[0021].

B. Claims 4 and 18

1. [4.1]/[18.1] “The electrochemical device according to claim [1/14], wherein the negative electrode comprises at least one tab, the tab is formed by cutting the current collector,”

Li discloses these Elements. EX1003, ¶¶202-203. Li discloses *the negative electrode* (negative electrode plate of Figure 8) *comprises at least one tab* (at least one of spaced tabs 81), *the tab is formed by cutting* (roll cutting, die cutting, laser cutting, etc.) *the current collector* (at blank regions 41, 51 of the plate):



Li, FIGS. 4 (front view), 5 (back view), 8 (front view)*

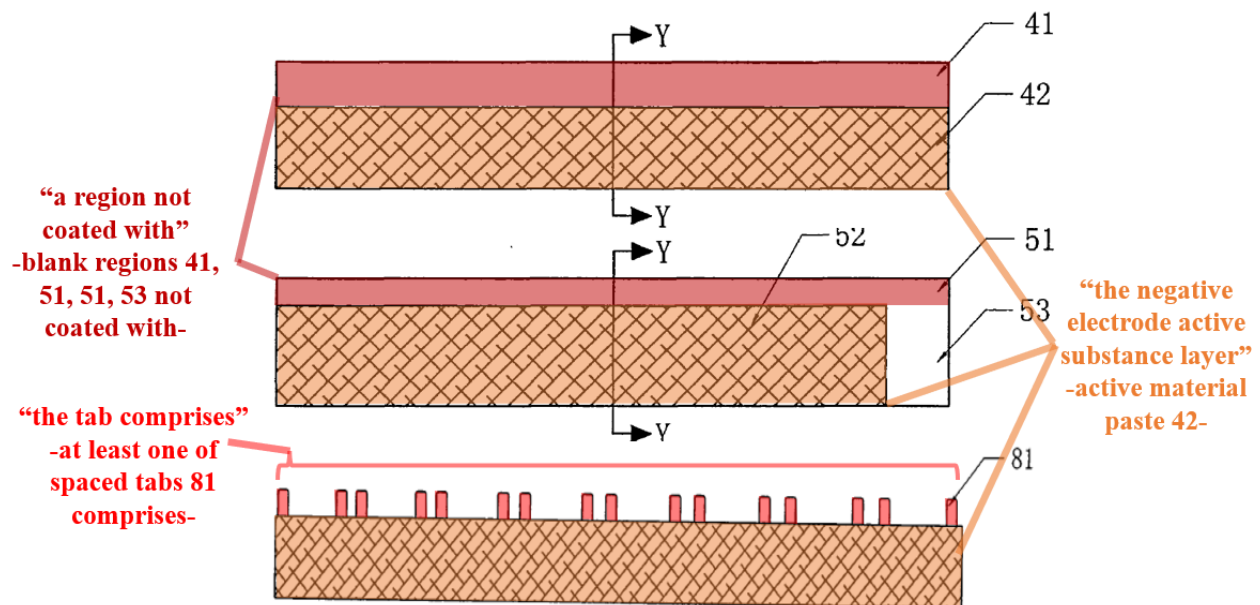
As shown in Figures 4 and 5 above, Li’s negative electrode initially has three blank regions 41 (front), 51 (back), 53 (back). EX1010, ¶[0036]. Then, as shown in Figure 8, “spaced tabs 81 are provided on the reserved blank region of the negative electrode plate,” with “the spaced tabs being formed by rotary cutting, die cutting, or laser cutting” the blank regions 41, 51. *Id.*, ¶[0039], FIG. 8. Li’s spaced tabs 81

correspond to the claimed at least one tab formed by cutting the current collector.

EX1003, ¶203.

2. [4.2], [18.2] “the tab comprises a region not coated with the negative electrode active substance layer, and”

Li discloses these Elements. EX1003, ¶¶204-205. Specifically, Li discloses *the tab* (at least one spaced tab 81) *comprises a region not coated* (blank regions 41, 51) *with the negative electrode active substance layer* (with the active material paste 42, 52):



Li, FIGS. 4 (front), 5, (back), 8 (front)*

Li’s spaced tabs 81 comprise blank regions 41 (front), 51 (back) that are uncoated with active material paste 42 (front), 52 (back), respectively. EX1010, ¶[0036], FIGS. 4, 5; EX1003, ¶205. This is, spaced tabs 81 are cut from those blank regions, as shown in Figure 8. *Id.*, ¶[0039], FIG. 8. Because Li forms tabs 81 from

the reserved blank regions 41, 51—not “the remainder” of the negative electrode current collector coated with active material paste—the tabs comprise the claimed *region not coated with the negative electrode active substance layer*. EX1003, ¶205.

3. [4.3], [18.3] “ $A \times B < 500$.”

Luo discloses or suggests this Element. EX1003, ¶206. Specifically, $A \times B = 112$ in the cited Examples. *Supra* Section VIII.A. Adding Li’s tab(s) to Luo’s bare portion would not increase B enough to push $A \times B$ outside the claimed range. *Id.* To reach 500, Luo’s B value of 22.4% would have to increase by about 346%—to nearly 100% of the total current-collector area. That would require tabs to consume virtually the entire current collector area, which is not plausible. *Id.*, ¶¶206-211.

C. Claim 6

- 1. [6.1] “The electrochemical device according to claim 4, wherein at least one of the second region is positioned at an edge of the current collector,”**

Luo discloses this Element. EX1003, ¶212; *supra* Section VIII.D.1.

- 2. [6.2] “wherein a distance between a first tab from the at least one tab closest to the edge of the current collector and the edge of the current collector is C, and $0 \leq C/\text{tab width} \leq 50$.”**

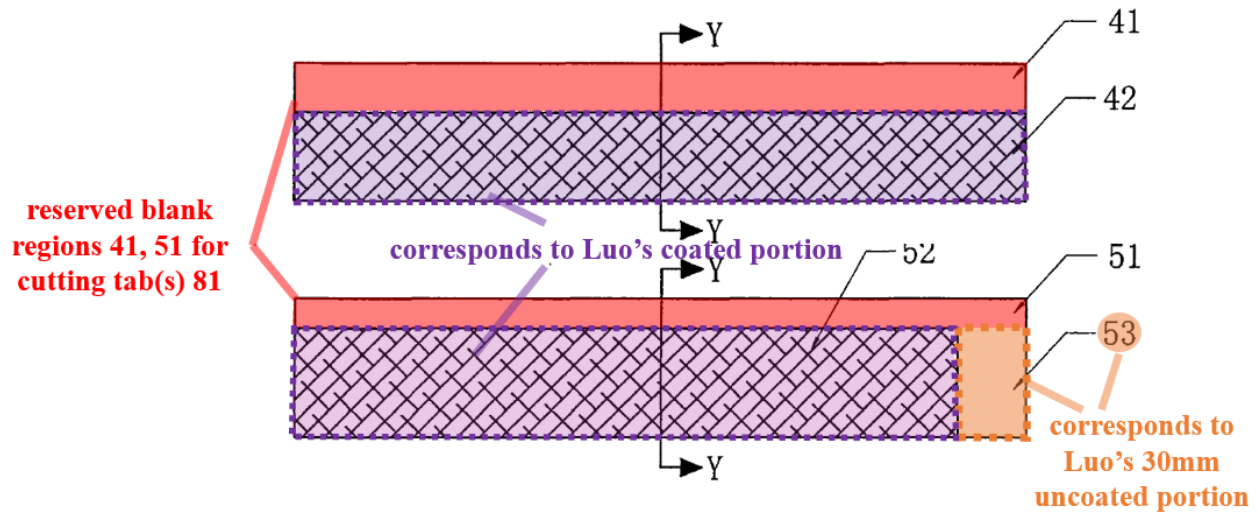
Li discloses this Element. Specifically, Li discloses *a distance* (1.5mm) *between a first tab* (the first tab) *from the at least one tab* (from among spaced tabs 81) *closest to an edge* (right edge in Figure 8) of the current collector (negative

electrode sheet in Figure 8) *and the edge of the current collector is C, and $0 \leq C/\text{tab width} \leq 50$* ($1.5\text{mm} \div 6.5\text{mm} = 0.23$). EX1003, ¶¶213-214. As explained, Li's tab spacing-to-width ratio for the first tab—corresponding to the claimed $C/\text{tab width}$ —is $1.5\text{mm}/6.5\text{mm} = 0.23$. *Supra* Section IX.A. This falls in the claimed range.

D. Proposed Combination of Luo and Li

1. Combination

The proposed combination applies Li's tab-forming technique to Luo's negative electrode in the cited and further cited Examples. EX1003, ¶¶215-217. Luo's final negative electrode is 104mm long, with a 104mm-wide coated portion and 30mm-wide uncoated portion. EX1006, ¶[0116]; *supra* Section VIII.A. Applying Li's disclosure, a POSITA would have increased the 104mm length of Luo's copper foil sheet by at least the desired length of tab(s) 81 (i.e., $104\text{mm} + \text{tab length}$), reserving blank regions 41, 51 from which tab(s) 81 may be cut. EX1003, ¶215. This results in a negative current collector sheet like that shown in Li Figures 4 and 5, with blank regions 41, 51 for cutting tab(s) 81, a region coated with active material paste 42, 52 corresponding to Luo's coated region, and blank region 53 corresponding to Luo's 30mm-wide uncoated portion. *Id.*, EX1010, ¶[0036].



Li, FIGS. 4 (front), 5, (back)*

Then, one or more “spaced tabs [81] [are] formed by rotary cutting, die cutting, or laser cutting” blank regions 41, 51. EX1010, ¶[0039]. Any foil remaining in blank regions 41, 51 not used for tabs is trimmed away. EX1003, ¶216. Where multiple tabs are formed, they are spaced so that same-polarity tabs “overlap upon winding” and form “a neat stack of tabs” for electrical connection to Luo’s cylindrical battery can negative terminal. *Id.*, EX1010, ¶¶[0010]–[0017], [0021], [0047]–[0050]; *see also* EX1006, ¶[0117].

2. Rationale to combine

- Analogous art**

Luo and Li fall in the same field of lithium secondary batteries and their electrode assemblies. EX1003, ¶218; EX1006, ¶¶[0001], [0115]–[0117]; EX1010, ¶¶[0001], [0036], [0039], FIGS. 4, 8. Luo and Li are also reasonably pertinent to

problems addressed by the '494 Patent. EX1003, ¶219. The '494 Patent addresses lithium-ion battery performance and safety, including the need to improve energy density at higher charging voltage while avoiding “battery self-discharging or even safety problems” caused by copper dissolution from the negative-electrode current collector, particularly at the tab welding position. EX1001, 1:32-55. Luo similarly seeks to improve lithium secondary battery performance. EX1006, ¶[0003]. And Li addresses related wound-cell performance and safety issues. EX1010, ¶¶[0002], [0021].

- **Teaching, suggestion, motivation**

A POSITA would have been motivated to apply Li's tab-forming technique to Luo's wound batteries. EX1003, ¶220. First, Luo does not describe the tab structure for connecting the positive and negative electrodes to the battery can, EX1006, ¶[0117], leading the POSITA to consider other references to implement such peripheral details, *id.*, ¶¶[0068], [0081]; EX1003, ¶220. The POSITA would have needed disclosure of a suitable tab structure to implement Luo's battery. EX1003, ¶220. As explained, a POSITA understood that tabs are generally added to a bare current collector in two ways—welding or cutting the tabs—and either would have been obvious to use here. *Id.*; *supra* Section II. Li supplies a suitable cutting approach: it forms spaced tabs by rotary, die, or laser cutting them from reserved blank region(s), so a POSITA would have used it. EX1010, ¶[0009]; EX1003, ¶220.

Second, a POSITA would have wanted Li's tab structure both to improve redundancy against individual tab failure and to shorten the electrode-to-terminal distance—lowering internal resistance, discharge heat, and voltage drop, thereby improving safety and raising the discharge plateau. EX1010, ¶¶[0021]; EX1003, ¶221; *supra* Section XI.A.

- **Applying a Known Technique to a Known Device Ready for Improvement to Yield Predictable Results**

Moreover, this combination merely applies a known technique to a known device ready for improvement to yield predictable results. EX1003, ¶¶222-226.

Base device: Luo provides a base device—cylindrical batteries including a 104 mm-long copper foil with a 104-mm coated portion and a 30-mm uncoated portion serving as the negative current-collector sheet. *Supra* Section VIII.A; *see, e.g.*, EX1006, ¶¶[0116]-[0117], [0155]-[0173]; EX1003, ¶223. But Luo does not describe a mechanism to connect the electrodes to the battery can, which is necessary to make a working cell. EX1006, ¶¶[0117], [0068], [0081]; EX1003, ¶223.

Known technique: Li's known technique applies to Luo's base device: forming one or more spaced tabs in reserved blank regions of the copper foil by cutting, with the tabs spaced to overlap upon winding and form a neat stack for connection to the battery terminal. EX1010, ¶¶[0017], [0036]-[0049], FIGS. 4, 8. Beyond allowing the necessary connection of the electrode terminals to Luo's

battery package, this technique improves redundancy against individual tab failure and shortens the current path from the negative electrode plate to the battery terminal, thereby improving performance and safety. *Id.*, ¶[0021]; EX1003, ¶224.

Predictable results: The combination would have predictably permitted connection of Luo’s electrode terminals to the battery can while achieving Li’s taught benefits: tab redundancy and a shortened current path, thereby improving performance and safety. EX1010, ¶¶[0010]-[0017], [0021]; EX1003, ¶225. That result would have been predictable because Li expressly teaches its technique may be “fabricated as an oval or cylindrical battery” and in cells where “the tabs...extend from the two opposite ends of the cell”—like Luo’s cylindrical form factor. EX1010, ¶[0052]; EX1003, ¶225.

- **Reasonable expectation of success**

A POSITA would have had a reasonable expectation of success in applying Li’s tab-forming technique to Luo’s batteries. EX1003, ¶226. Luo already discloses the battery architecture to which that technique would be applied, including a partially-coated copper foil. EX1006, ¶¶[0116]-[0117]; EX1010, ¶¶[0017], [0036], [0039], FIGS. 4, 8. The main change is lengthening Luo’s copper foil by the desired tab length to provide material from which the tabs are cut as Li teaches and trimming any excess not used for tabs—a change requiring no more than routine skill.

EX1003, ¶226; *supra* Section XI.D1. Li confirms its technique may be used in cylindrical/wound batteries like Luo's. EX1010, ¶¶[0003], [0052].

XII. GROUNDS FOR STANDING

Petitioner certifies that the '494 Patent is available for IPR and Petitioner is not barred or estopped from requesting IPR of any '494 Patent claim.

XIII. MANDATORY NOTICES

Real Party-in-Interest (37 C.F.R. § 42.8(b)(1)): The real parties-in-interest are Petitioner Zhuhai CosMX Battery Co., Ltd., Chongqing CosMX Battery Co., Ltd., Chongqing CosMX Power Battery Co., Ltd., Zhejiang CosMX Battery Co., Ltd., Zhejiang CosMX Power Supply Co., Ltd., Zhuhai CosMX Power Battery Co., Ltd., Zhuhai CosMX Power Jinwan Subsidiary Co., Ltd., and Zhuhai CosMX Power Supply Co., Ltd.

Related Matters (37 C.F.R. § 42.8(b)(2)):

Matter	Status
<i>Ningde Ampere Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:26-cv-00139-JRG (E.D. Tex. Feb. 18, 2026), ECF 1. EX1031.	Dismissed <u>WITHOUT</u> prejudice on June 16, 2026. EX1032.
<i>Zhuhai CosMX Battery Co. v. Ningde Ampere Tech. Ltd.</i> , No. IPR2026-00398 (PTAB) for U.S. Pat. No. 10,916,769	Filed July 21, 2026.

Matter	Status
<i>Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.</i> , No. IPR2026-00399 (PTAB) for U.S. Pat. No. 12,374,686	Filed July 21, 2026.
<i>Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.</i> , No. IPR2026-00401 (PTAB) for U.S. Pat. No. 12,294,082	Filed July 22, 2026.
<i>Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.</i> , No. IPR2026-00408 (PTAB) for U.S. Pat. No. 11,699,808	Filed July 28, 2026.
<i>Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.</i> , No. IPR2026-00409 (PTAB) for U.S. Pat. No. 12,278,330	Filed July 28, 2026.

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

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

XIV. CONCLUSION

Petitioner respectfully requests that the Board institute review and cancel the challenged claims as unpatentable.

Respectfully submitted,

LEE & HAYES, P.C.

/ James D. Stein /

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

Date: July 30, 2026

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

This Petition for *Inter Partes* Review complies with the type-volume limitation of 14,000 words, comprising 13,990 words, excluding the parts exempted by 37 C.F.R. § 42.24(a)(1).

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

Respectfully submitted,

LEE & HAYES, P.C.

/ *James D. Stein* /

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

Date: July 30, 2026

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

I certify that the above-captioned **PETITION FOR *INTER PARTES* REVIEW FOR U.S. PATENT NO. 12,334,494** and associated Exhibits 1001-1032 were served in their entireties upon the Patent Owner on July 30, 2026, via FedEx® Express at the following address:

Timothy J. Maier
MAIER & MAIER, PLLC
345 South Patrick Street
Alexandria, VA 22314

*Patent Owner's Correspondence Address of Record
for U.S. Patent No. 12,334,494*

In addition, a courtesy copy of these filings has been provided by email to the following counsel of record for Patent Owner: Christopher TL Douglas (christopher.douglas@alston.com) and Brady Cox (brady.cox@alston.com).

Respectfully submitted,

/ James D. Stein /

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Lead Counsel for Petitioner

Date: July 30, 2026