

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner

v.

NINGDE AMPEREX TECHNOLOGY LIMITED,
Patent Owner

Case IPR2025-00524
U.S. Patent No. 12,015,118

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 12,015,118**

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PETITIONER'S EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 12,015,118
1002	File History of U.S. Patent No. 12,015,118
1003	Chinese Publication No. 202905885 with Certified English Language Translation (“Li”)
1004	Japanese Publication No. 2013-211096 with Certified English Language Translation (“Ishigaki”)
1005	U.S. Patent Publication No. 2011/0168550 (“Wang”)
1006	U.S. Patent Publication No. 2017/0256776 (“Saka”)
1007	Excel Spreadsheet of Saka Calculations
1008	U.S. Patent Publication No. 2016/0013480 (“Sikha”)
1009	U.S. Patent Publication No. 2013/0302685 (“Kim”)
1010	Declaration of Dr. Samuel Gido
1011	<i>Curriculum Vitae</i> of Dr. Samuel Gido
1012	Certified Translation of the File History of Chinese Patent No. 109004170
1013	“Lithium Ion Battery Nickel Manganese Cobalt Oxide Nmc Cathode Raw Material For Lab Battery Research,” Alibaba, accessed at https://www.alibaba.com/product-detail/Lithium-Ion-Battery-Nickel-Manganese-Cobalt_1600084022147.html
1014	<i>Intentionally Left Blank</i>
1015	File History of U.S. Patent No. 11,664,528
1016	File History of U.S. Patent No. 11,322,774
1017	File History of U.S. Patent No. 10,693,181
1018	ISO 13320-1 standard
1019	<i>Intentionally Left Blank</i>

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Exhibit No.	Description
1020	Kim, J., et al., “Structure Dependent Electrochemical Behaviors of Hard Carbon Anode Materials Derived from Natural Polymers for Next-Generation Sodium Ion Battery” <i>Polymers</i> , 15(22):4373 (Nov. 2023)
1021	Malvern Instruments Ltd., “A basic guide to particle characterization,” accessed at https://www.malvernpanalytical.com/en/learn/knowledge-center/whitepapers/wp120620basicguidepartchar
1022	“Battery Capacity,” accessed at https://www.pveducation.org/pvcdrom/battery-characteristics/battery-capacity
1023	“What is the difference between hard carbon black and soft carbon black?,” <i>Dery Chemical</i> , accessed at https://www.dr-carbonblack.com/what-is-the-difference-between-hard-carbon-black-and-soft-carbon-black
1024	“Overview of carbon black industry in China,” Henan Jinhe Industry Co., Ltd., accessed at https://www.jinhetec.com/blog/overview-of-carbon-black-industry-in-china-53773.html
1025	Abanades, A., et al., “Experimental analysis of direct thermal methane cracking,” <i>International Journal of Hydrogen Energy</i> , Vol. 36, pp. 12877-86 (Aug. 2011)
1026	Kim, M., et al., “Preparation of high-crystallinity synthetic graphite from hard carbon-based carbon black,” <i>Applied Physics</i> , Vol. 127:156 (Feb. 2021)
1027	Dick, J.S., et al., “Alternate Instrumental Methods of Measuring Scorch and Cure Characteristics,” <i>Polymer Testing</i> , Vol. 14, pp. 45-84 (April 1994)
1028	Schlögl, R., “Part A: 2.1.10 Carbons,” <i>Department of Inorganic Chemistry, Fritz-Haber-Institute of the MPG</i> (2008)

I. STATEMENT OF PRECISE RELIEF REQUESTED AND REASONS THEREFOR (37 C.F.R. §42.22(A))

Zhuhai CosMX Battery Co., Ltd. (“Petitioner”) petitions for *inter partes* review, seeking cancellation of claims 1-20 of U.S. Patent No 12,015,118 (“the ’118 patent”; EX1001), assigned to Ningde Amperex Technology Limited (“Patent Owner” or “PO”). The ’118 patent relates to Li-ion battery construction materials and properties. EX1010, ¶33. The challenged claims are unpatentable under 35 U.S.C. §§ 102(a)(1) and 103(a). This Petition is supported by the declaration of Dr. Samuel Gido (EX1010), an expert in polymer science and engineering with a focus in the compositions and structures of lithium-ion batteries.

II. BACKGROUND

High-capacity electrochemical devices like lithium-ion (“Li-ion”) batteries are used in a growing number of consumer electronics. EX1008, ¶4. They “typically include an anode electrode, a cathode electrode, a separator positioned between [them], and at least one current collector.” EX1008, ¶5. As the power and safety demands on these batteries increase, there is likewise an increase in the need for higher-capacity batteries that are also smaller, lighter, and more resistant to shorting. EX1008, ¶9. One way these needs are met is by manufacturing thicker electrodes containing more active materials. EX1010, ¶38; EX1008, ¶8. In other words, one can “pack” more materials into each battery cell to increase the

electrode loading (mAh/cm²) and thereby the energy density. EX1010, ¶39; EX1008, ¶22.

A well-known way of increasing active-material content of battery electrodes is to form a multi-layer structure. EX1010, ¶40; EX1008, ¶10. The typical process is to deposit a first slurry mixture of active material on the conductive substrate of the electrode. EX1010, ¶40. After that slurry dries, deposit a second slurry of another (or the same) material to form a second layer. *Id.* After the second layer dries, the resulting structure can be compacted to achieve a desired density or porosity. EX1008, ¶10, FIG. 3.

Physical and chemical attributes of the electrode layers like porosity, active material, particle size, and density have a well-understood influence on the resulting battery performance. EX1008, ¶23; EX1010, ¶41. Examples of popular cathode active materials are lithium-rich oxides or mixed-metal oxides. Anode materials are typically graphite-based. EX1008, ¶21. One of skill would know how to select materials with the properties for a desired application, balancing the various considerations of capacity, density, weight, cost, safety, ease of manufacturing, and the like. EX1010, ¶42.

III. THE CHALLENGED PATENT

The '118 patent issued June 18, 2024 from U.S. Application No. 17/707,137, and claims priority to February 26, 2018.

A. The Claims

The '118 patent independent claims recite an electronic device (claim 19), a battery (claim 10), and/or an electrode (claim 1). Each includes a current collector covered in two material layers. The layers have specified particle sizes and compaction densities. EX1010, ¶¶43-44. The dependent claims narrow the requirements for the layer thickness, particle sizes, compaction densities, or layer materials. All of these elements were known, and the prior art contains examples of lithium-ion battery electrodes made from the same materials with the recited properties. EX1010, ¶45.

B. Prosecution History

The '118 patent issued from U.S. Application No. 17/707,137 (“the '137 application”) filed on March 29, 2022, which is a continuation of U.S. Application No. 16/868,966 (“the '966 application”), which is a divisional of U.S. Application No. 16/000,597 (“the '597 application”). The '966 application has another continuation, U.S. Application No. 17/707,378 (“the '378 application”). The patents in this family all claim similar electrodes and have received double-patenting rejections. EX1002, 0097, 0099-102, 0112-13. Applicant filed terminal disclaimers without making substantive amendments. EX1002, 0118-23. Thus, the patented claims received minimal substantive examination.

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On February 14, 2024, the Office issued a Notice of Allowance of '137 application claims 1-20. EX1002, 0139. The reasons for allowance indicated Sikha et al. (U.S. Pub. 2016/0013480) taught all of the limitations of the claims except the density of the cathode material being 3.2 g/cc or more. EX1002, 0139; EX1010, ¶¶49-50. The Office did not, however, consider the prior art applied herein, which discloses all claim limitations. On March 1, 2023, the Office issued a Notice of Allowance for the '378 (sibling) application. EX1015, 0103. The reasons for allowance were largely the same. EX1015, 0103; EX1010, ¶¶51-52. Again, the Office did not consider the prior art applied herein.

The '966 application (parent of the '378 and '137 applications) was allowed because the prior art considered (Imachi (U.S. Pub. 2007/0026316)) does not teach the average particle size of the first material being less than the second material. EX1016, 0117. That limitation is not included in the '118 patent claims, and therefore does nothing to distinguish the prior art applied herein. EX1010, ¶¶53-55. Regardless, the prior art applied herein (which was not considered by the Office) is closer to the claims than Imachi, Sikha, or Ijiri (U.S. Pub. 2014/0295284), the only three references discussed in the prosecution history of the entire family. EX1017, 0127-29, 0166; EX1010, ¶59.

The '137 application also has a corresponding application CN 202110531289 filed on February 26, 2018 in The China National Intellectual

Property Administration (CNIPA). On October 9, 2022, CNIPA rejected the claims for lack of inventive step in view of CN Pub. 105074967A to Sikha (the Chinese correspondence of the Sikha reference cited in the USPTO). EX1012, 0020-26. Following a request for reexamination, CNIPA affirmed the rejection. EX1012, 0027-39. The claims of the '118 patent do not recite any distinguishing features as compared to the Chinese counterpart that was finally rejected over Sikha. They are similarly unpatentable. While Petitioner does not rely on Sikha, it relies on references that are *even closer* to the patent claims and present an even stronger case of unpatentability.

IV. OVERVIEW OF PRIOR ART

Japanese Publication No. 2013-211096A (“Ishigaki”) was published October 10, 2013, is 35 U.S.C. § 102(a)(1) prior art. Ishigaki discloses a positive electrode for a lithium-ion battery used in common consumer portable electronic devices. EX1004, ¶4. Two layers of active material are applied to the electrode in order to improve the output and capacity of the battery, without compromising risk of internal short circuits. EX1004, ¶8. The electrode active materials contain lithium transition-metal oxides with particle sizes (90% cumulative diameter) of 5 µm or less. Ishigaki teaches increasing the capacity of the battery by “packing [the] electrode active material” “as densely as possible,” preferably at least 2.5 g/cc to 3.6 g/cc. EX1004, ¶¶7, 25. Ishigaki goes on to claim recesses in the current

collector to improve the binding between the active material and the foil. EX1004, Abstract. Disclosing the '118 features and claiming a different novel feature suggests the '118 limitations were not even novel as of Ishigaki.

U.S. Publication No. 2013/0302685 A1 (“Kim”) published November 14, 2013, is §102(a)(1) prior art. Kim discloses a composite cathode active material for a lithium-ion battery, and various desirable attributes. Kim’s electrode has a single active material layer. It teaches lithium-cobalt-nickel-manganese oxide as the active material, and an average particle size (Dv50) of 5 – 50 um. Kim teaches a cathode layer density of 3.31 g/cc or greater, and preferably 3.4 to 4.0 g/cc. EX1009, ¶36. Kim does not teach a two-layer structure, but does provide the numeric compaction density of the overall electrode structure (called “press density” in Kim), and the reason for choosing that density. Specifically, Kim explains that press densities below 3.31 g/cc “may be too small to obtain a high electrical capacity.” *Id.*

U.S. Publication No. 2011/0168550 A1 (“Wang”), published July 14, 2011, is §102(a)(1) prior art. Wang discloses methods of manufacture for improving the charging speed and energy capacity for a lithium-ion battery. EX1005, Abstract. Specifically, a layer of lithium transition-metal oxide is applied to the current collector of an electrode. EX1005, ¶11. The active material is subjected to a compression step, after which a second layer is applied, and compressed again. *Id.*

Wang teaches embodiments where the two layers are different materials, and others where they are the same. EX1005, ¶14. Wang teaches embodiments where the first layer has a lower density than the second layer, and vice versa. EX1005, ¶10. Wang describes the density of its layers in terms of porosity, and the effect of the compaction steps on decreasing the porosity of the active materials. EX1005, ¶¶56-58. Wang does not disclose values for the density of the layers, instead teaching that its method can be used to achieve a desired compaction density.

U.S. Publication No. 2017/0256776 A1 (“Saka”), published September 7, 2017, is §102(a)(1) prior art. Saka discloses numerous batteries made by a process similar to Wang’s. Specifically, Saka’s batteries have two layers of lithium transition-metal oxide applied to a positive electrode. EX1006, Abstract. Saka details the particle-size distributions, masses, porosities, and densities of the electrode layers. EX1006, FIGs. 7-11. Saka also provides performance data showing how different properties of the active material confer different characteristics to the resulting battery. *Id.* Some embodiments of Saka have a first layer containing lithium iron phosphate and a density of 2.9 g/cc, and a second layer containing lithium nickel cobalt manganese oxide and lithium iron phosphate and a density of more than 3.1 g/cc. Saka thus teaches compaction densities that one could achieve using Wang’s process.

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Chinese Publication No. 202905885 U (“Li”) published April 24, 2013, is §102(a)(1) prior art. Li discloses a lithium-ion battery for modern consumer electronic devices with a winding structure that reduces the deformation rate and increases the energy density. EX1003, ¶¶1, 2, 27. The cathode includes a current collector onto which two material layers are deposited. EX1003, ¶¶13, 14, 38. There are no special requirements for the active materials, and Li suggests various lithium transition metal compositions as examples. EX1003, ¶26. Li’s examples 2-13 specifically disclose “coating twice and compaction twice” with a resulting first compaction density of 3.8 g/cm³ for the first layer, and an average compaction density of 4.1 g/cm³ across the two-layer structure. EX1003, ¶44. Li therefore discloses compaction densities that one could achieve using Wang’s process.

V. IDENTIFICATION OF THE CHALLENGE (37 C.F.R. §42.104(B))

Petitioner requests IPR based on the Grounds summarized below.

Ground	35 U.S.C. §	Claims	References
1	§ 102(a)(1)	1-20	Ishigaki (EX1004)
2	§ 103(a)	1-20	Ishigaki and Kim (EX1009)
3	§ 103(a)	1-20	Wang (EX1005) and Saka (EX1006)
4	§ 103(a)	1-20	Wang and Li (EX1003)

VI. PERSON OF ORDINARY SKILL IN ART

A POSA at the claimed priority date would have had at least an undergraduate degree in chemistry, chemical engineering, polymer science and engineering, or materials science and engineering and two years of experience in the field of battery materials and construction. A higher level of education, such as a Master's Degree in one of these same fields, could substitute for work experience. EX1010, ¶36.

VII. CLAIM CONSTRUCTION

Claims must be given their ordinary and customary meaning in light of the specification—"the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention." *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-13 (Fed. Cir. 2005) (en banc). Petitioner has given all terms herein their plain meanings in view of the specification.

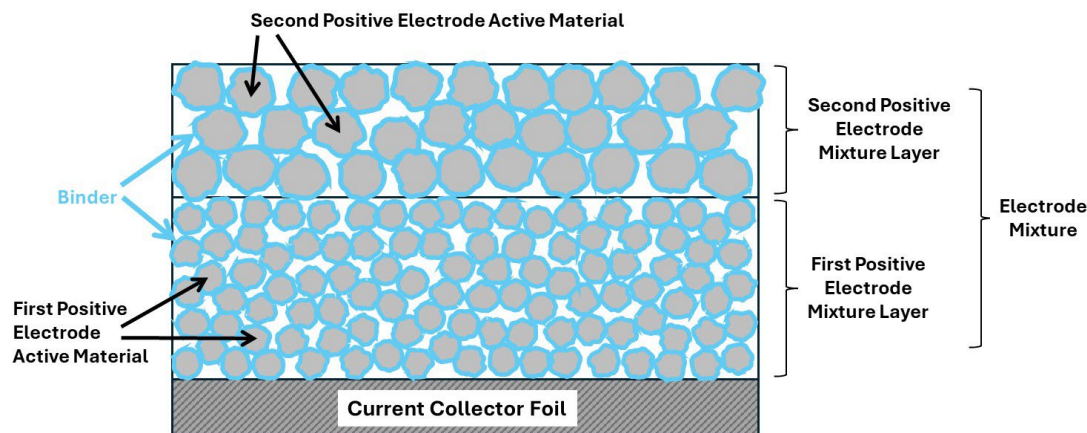
VIII. GROUND 1: CLAIMS 1-20 ARE ANTICIPATED BY ISHIGAKI.

Ishigaki expressly or inherently discloses all limitations of claims 1-20. EX1010, ¶72. First, Ishigaki discloses multiple points within the claimed ranges for particle size and compaction density, and therefore anticipates the claims that recite those ranges. *Ineos USA LLC v. Berry Plastics Corp.*, 783 F.3d 865, 869 (Fed. Cir. 2015); *Titanium Metals Corp. of America v. Banner*, 778 F.2d 775, 782 (Fed. Cir. 1985). Ishigaki also discloses overlapping ranges with sufficient specificity to show there is no reasonable difference in how the claimed invention

operates. *See Ineos*, 783 F.3d at 869; *Atofina v. Great Lakes Chem. Corp.*, 441 F.3d 991, 999 (Fed. Cir. 2006); *ClearValue, Inc. v. Pearl River Polymers, Inc.*, 668 F.3d 1340, 1345 (Fed. Cir. 2012). To the extent that PO attempts to overcome this *prima facie* case of anticipation by arguing criticality, Ishigaki overcomes that purported distinction. *Genentech, Inc. v. Hospira, Inc.*, 946 F.3d 1333, 1338 (Fed. Cir. 2020). Finally, several dependent claims recite Markush groups, for which Ishigaki discloses at least one member, thereby anticipating the group. *In re Slayter*, 276 F.2d 408, 411 (CCPA 1960); *In re Gosteli*, 872 F.2d 1008, 1010 (Fed. Cir. 1989).

A. 1.P

Ishigaki discloses an electrode. *See* EX1004, Abstract. Ishigaki further discloses “(1) A positive electrode for lithium rechargeable batteries on a current collecting foil, a mixture of an electrode” EX1004, ¶14. This is the same kind of electrode used in the same context for the same purpose as the ’118 patent. EX1010, ¶73.

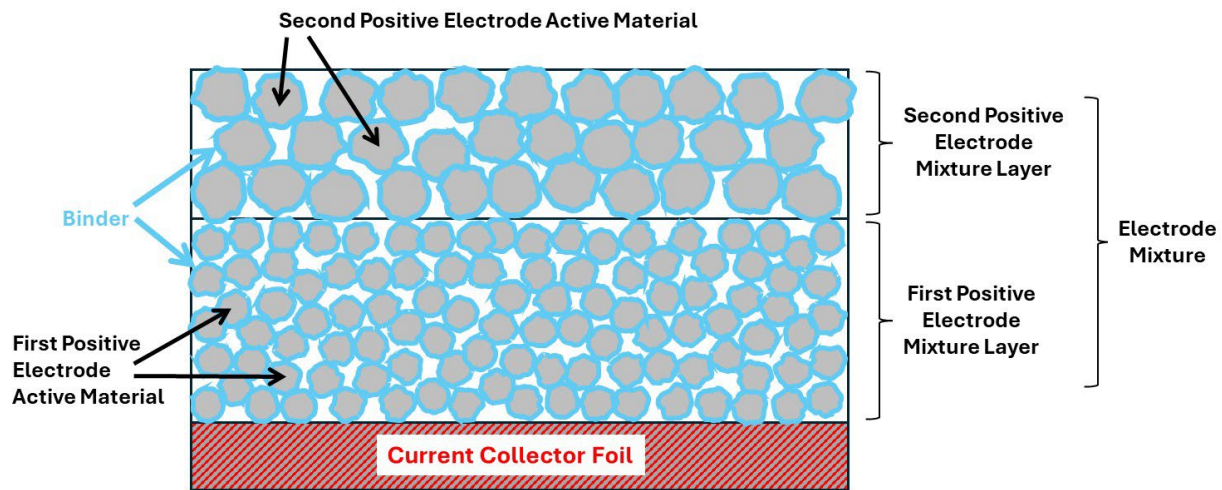


EX1010, Demonstrative 1.

1. 1.1

Ishigaki's electrode comprises a current collector foil. *See* EX1004, ¶14.

This is the same structure as the recited current collector of limitation 1.1. EX1010, ¶74.

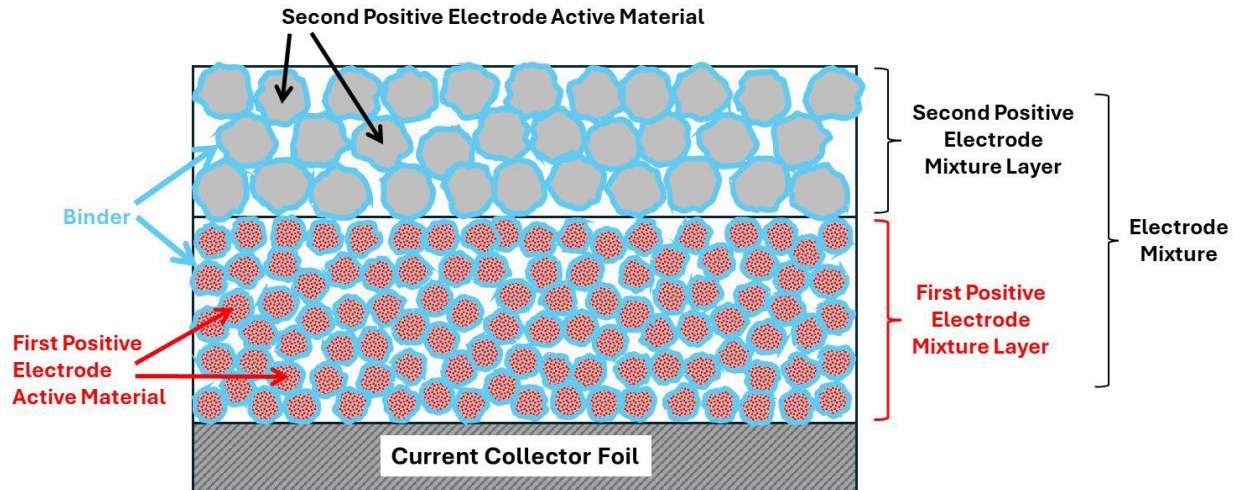


EX1010, Demonstrative 2.

2. 1.2

Ishigaki's electrode comprises an electrode mixture on a current collector.

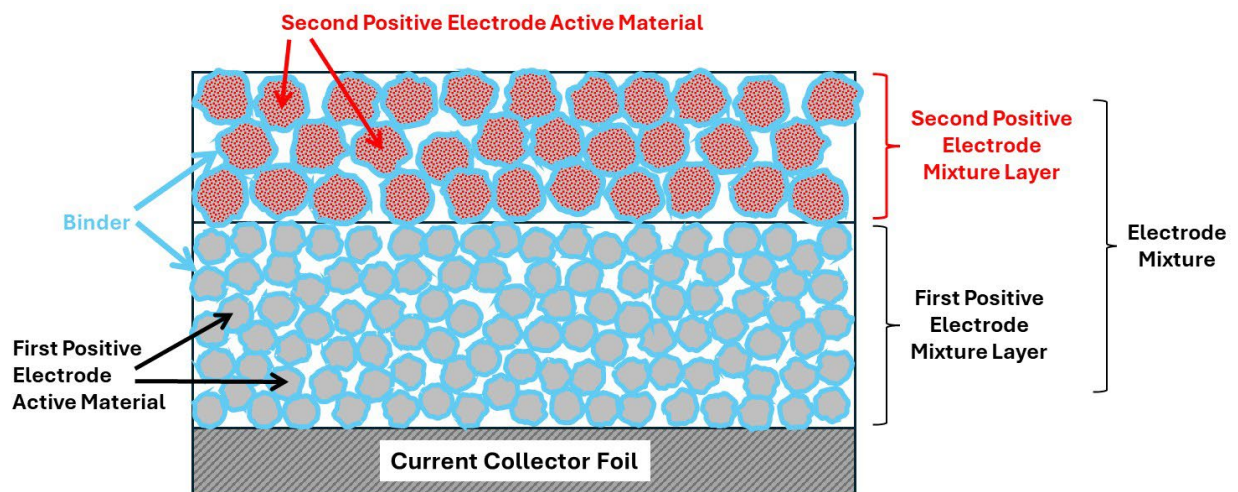
See EX1004, ¶14. The electrode mixture comprises a first positive electrode mixture layer, which is the first layer of claim 1.2. EX1010, ¶75; EX1004, ¶¶153, 347, 348. Ishigaki's first layer, in turn, comprises a first positive electrode active material, which is the first material of claim 1.2. EX1010, ¶75; EX1004, ¶153.



EX1010, Demonstrative 3.

3. 1.3

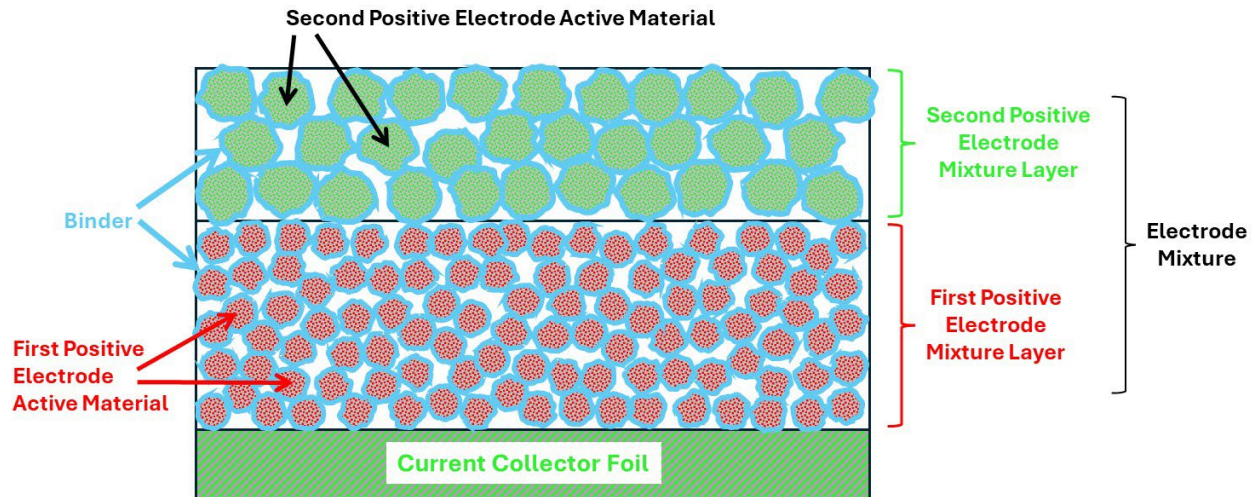
Ishigaki's electrode mixture comprises a second positive electrode mixture layer. EX1004, ¶153. This is the second layer of claim 1.3. EX1010, ¶76. Ishigaki further discloses “a second positive electrode mixture layer containing a second positive electrode active material.” EX1004, ¶14. This is the second material in the second layer of claim 1.3. EX1010, ¶76.



EX1010, Demonstrative 4.

4. 1.4.1

Ishigaki's first and second layers are "sequentially laminated and formed on the current collector" foil. EX1004, ¶¶14, 153, 366 (describing the first layer in between the current collector and second layer). Ishigaki's first layer is arranged between the current collector and the second layer. EX1010, ¶77.



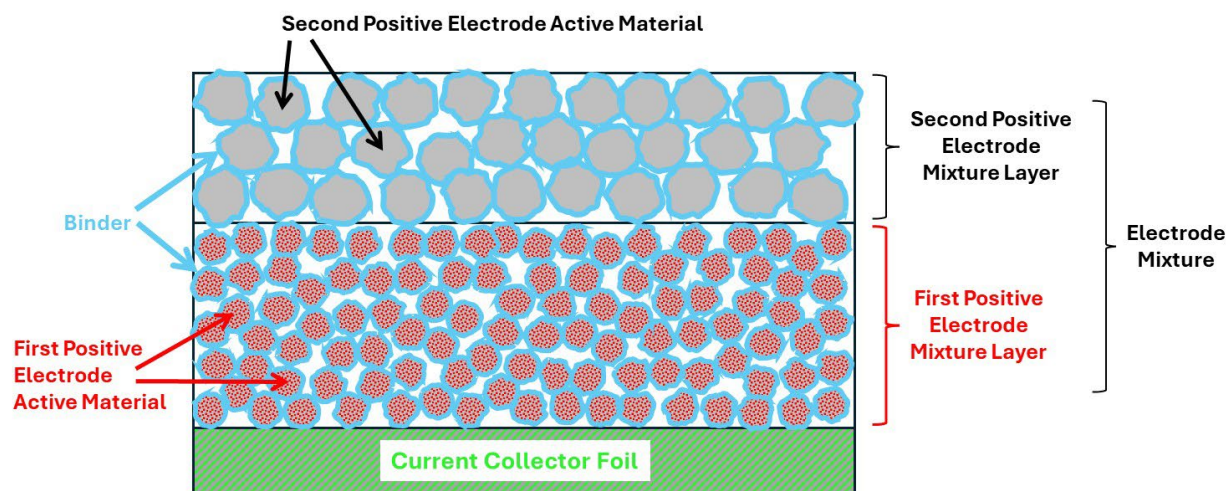
EX1010, Demonstrative 5.

Ishigaki explains that "slurry 1 was coated on one side and dried on an aluminum foil (thickness: 15 μm) as a collector foil with a doctor blade. Then the slurry 2 was applied on one side with a doctor blade and dried." EX1004, Example 2(confirming the first layer is arranged between the current collector and the second layer); EX1010, ¶78.

5. 1.4.2

Ishigaki's first layer is formed by applying a slurry of the first active material on a surface of the current collector. EX1004, ¶366; EX1010, ¶79.

Specifically, a uniform slurry of active material and binder is applied to one side of the current-collecting aluminum foil, and allowed to dry. EX1004, ¶366; EX1010, ¶80.



EX1010, Demonstrative 6.

6. 1.4.3

Ishigaki's first positive electrode material has particles with 90% cumulative diameter¹ less than 10 μm . EX1004, ¶38; *see also* EX1004, ¶39 (“[T]he 90% cumulative diameter (D90) are measured by a well-known laser diffraction/scattering particle size distribution measuring device ... and a particle diameter standard as a volume standard.”); EX1018 (explaining that laser

¹ A particle size of 90% accumulative volume is a standard metric in the art also known as D90 or Dv90. EX1010, ¶81. Ishigaki's particle size is measured by volume, which corresponds to Dv90 (the volume standard). *Id.*

diffraction is a standard volume-based measurement). Ten microns is less than 40 μm , which meets this limitation. EX1010, ¶81.

Ishigaki further discloses that “a 90% cumulative diameter (D90) of the secondary particles of the lithium transition metal compound powder of the present invention is normally 10 μm or less, preferably 8 μm or less, more preferably 6 μm or less, and most preferably 5 μm or less, and normally 0.5 μm or more, preferably 0.8 μm or more, more preferably 1 μm or more and, most preferably 1.5 μm or more.” EX1004, ¶38. This range falls completely within the ’118 patent claimed range of $< 40 \mu\text{m}$. *See also* EX1004, ¶¶14, 40, 346; EX1010, ¶¶83-84.

7. 1.5

Independent claim 1 (and claims 10 and 19) recites a total compaction density of the first layer and the second layer is greater than 3.2 g/cc. A POSA would understand the plain meaning of “compaction density” to refer to the density of the electrode-material layer after it has been subjected to the compression step of the electrode-formation process.² EX1010, ¶¶67-68.

The total compaction density of Ishigaki’s first layer is disclosed both inherently and expressly as the density of the electrode material layer after it has

² Petitioner may challenge the term “compaction density” as indefinite in other forums for other reasons. *Cf.* EX1010, ¶67.

been subjected to the compression step of the electrode formation process. The inherent disclosure comes from the density that a POSA could calculate from the densities of the layer components—the active material, conductive additive, and binder. EX1010, ¶85. The maximum density of Ishigaki's cathode layers has an upper limit of 4.4 g/cm³ (when porosity is zero), as derived from the weight ratios of the components in Ishigaki's Example 2. EX1010, ¶85. Specifically, the density of the active material is 4.8 g/cm³, and the densities of the conductive carbon and the binder are 1.8 g/cm³. EX1010, ¶¶89-92. Ishigaki emphasizes maximizing energy density, preferring compaction densities that approach the upper boundary. EX1010, ¶¶85, 93. This inherently discloses a range (< 4.4 g/cc) that overlaps the claimed range (> 3.2 g/cc).³

³ Even if one were to interpret the “electrode density” in Ishigaki to refer to the total density including the current collector (instead of just the active-material layers), Ishigaki at least teaches the total density of the entire electrode can be 3.2 g/cc and greater. EX1010, ¶94. The known density of the aluminum foil used as the current collector is 2.7 g/cc. Therefore, for the total average density of the entire electrode structure to be at least 3.2 g/cc, the layers containing active material must have a greater density than 3.2 g/cc.

But Ishigaki has more. Ishigaki expressly teaches a density range of 2.0 to 4.2 g/cm³. This range overlaps the claimed range, and expressly emphasizes densities towards the upper bound of this range. EX1010, ¶85. Ishigaki specifically discloses treating the electrode mixture with pressure to increase the packing density. EX1010, ¶86; EX1004, ¶24. The density that results from this treatment is compaction density. EX1010, ¶86.

Ishigaki also discloses “[t]he electrode density of the positive electrode after pressing has a lower limit of ... particularly preferably 2.6 g/cm³ or more, and an upper limit of normally 4.2 g/cm³ or less, preferably 4.0 g/cm³ or less, and particularly preferably 3.8 g/cm³ or less.” EX1004, ¶151; *see also* EX1004, ¶25. These numeric ranges overlap the range of the claims, and also call out specific values within the range (i.e. species within the claimed genus), such as 3.8 g/cc, 4.0 g/cc, and 4.2 g/cc. EX1010, ¶87.

Ishigaki further explains why the preferred boundaries are what they are. EX1010, ¶88. “[S]ince space is required in the positive electrode plate to hold the electrolyte in the electrode plate and to supply lithium ions, the upper limit is preferably 3.6 g/cm³ or less, more preferably 3.5 g/cm³ or less, and particularly preferably 3.4 g/cm³ or less.” EX1004, ¶25. Namely, Ishigaki instructs a POSA to choose the highest density possible in order to maximize energy capacity, constrained by the space needed to allow the flow of ions. EX1010, ¶¶88-89. The

result is numerous preferred embodiments all with compaction densities greater than 3.2 g/cc as claimed. These disclosures anticipate the claim limitation.

8. Claim 2

The combined thickness of Ishigaki's first and second layers is between 10 and 200 microns. EX1004, ¶25; EX1010, ¶95. This combined thickness is divided in a ratio of "normally 60:40 ... preferably 70:30, more preferably 80:20, and particularly preferably 90:10." EX1004, ¶216. Therefore, Ishigaki teaches that at a minimum, the thickness of the first active material layer is 60% of the total active material thickness, which is 60% of 10 to 200 μm , or 6 to 120 μm . EX1010, ¶¶96-97. Ishigaki's preferred embodiment has a first layer thickness of 90% of 10 to 200 μm , or 9 to 180 μm . EX1010, ¶98.

Meanwhile, Ishigaki's "volume ratio of the positive electrode active material having a particle diameter of 5 μm or more is 10 vol% or less," teaches that Dv90 of the active material particles is 5 μm or less. EX1004, Claim 4, ¶14; EX1010, ¶99. Thus, Ishigaki's Dv90 of the first material particles (consistent with claim 1) is smaller than the smallest possible first layer thickness (6 μm), and smaller than the most preferable smallest first layer thickness (9 μm). EX1010, ¶100. Ishigaki therefore anticipates claim 2. EX1010, ¶101.

9. Claim 3

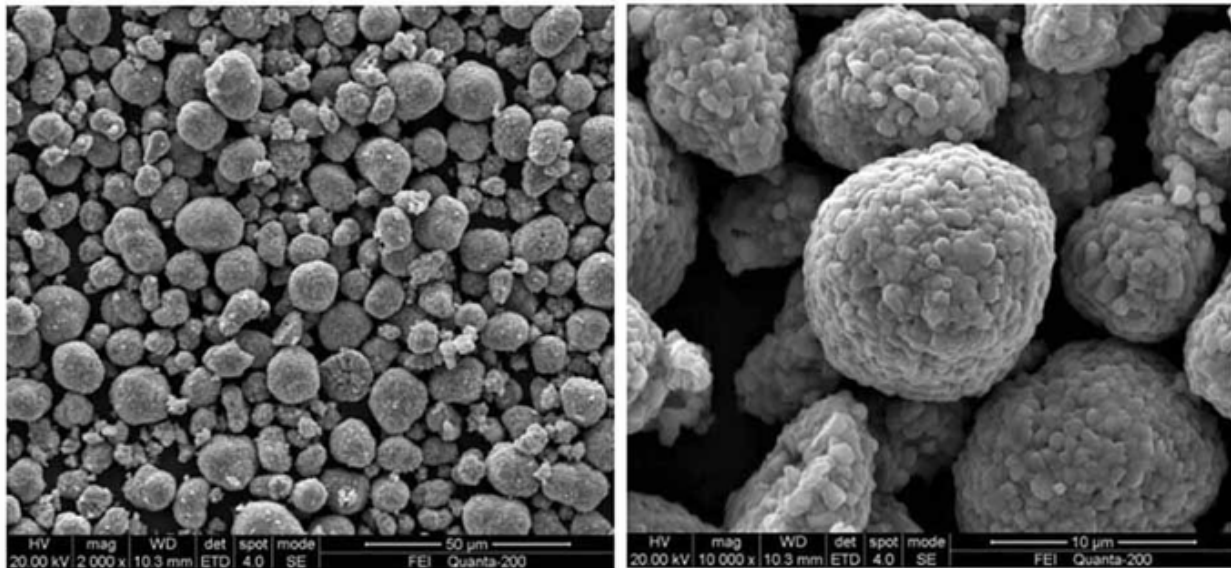
Claim 3 (and claims 4, 12, and 13) uses the term **“average particle size.”**

This term is ambiguous because there are different mathematical ways to determine averages, and different concepts in physics and chemistry of how to define the size of a particle. EX1010, ¶¶69-70. The '118 patent makes clear that by “average particle size” the claim means Dv50. *See* EX1001, 1:60-64; EX1010, ¶102. Dv50 is a standard metric in this art (along with Dv10 and Dv90). EX1010, ¶69. Dv50 denotes the maximum particle diameter below which 50% of the sample volume exists. *See, e.g.*, EX1021. Dv50 is also known as the median particle size by volume. *Id.* Accordingly, the PTAB should construe the term “average particle size” to mean Dv50.

Ishigaki discloses the average particle sizes of the layers have a ratio that falls within the range of claim 3. Ishigaki uses “median diameter” rather than average when describing the general size of its particles. *See* EX1004, Claim 8, ¶14. A POSA would equate “median” with the middle value of a distribution, which could be weighted by number, volume, or mass. EX1010, ¶¶103-104. Ishigaki’s “median diameter, as the average particle diameter, and the 90% cumulative diameter (D₉₀) are measured by a well-known laser diffraction/scattering particle size distribution measuring device.” EX1004, ¶¶39, 184, 342. Laser diffraction is sensitive to the volume of the particles, and gives

volume-based cumulative averages such as Dv50 and Dv90. EX1010, ¶105. A median diameter measured by laser diffraction is Dv50. EX1010, ¶106.

Ishigaki also refers to an “average diameter” of *primary* particles based on the number of individual particles seen in electron microscope (SEM) images. EX1004, ¶¶41, 185. Ishigaki talks about two different size distributions because the active materials relevant to these kinds of battery electrodes form primary and secondary particles when viewed at different scales. EX1010, ¶¶107-109. For example, SEM images of lithium nickel manganese cobalt oxide show both nano-scale and micro-scale particles:



EX1013 (showing secondary particles at 2000x magnification (left), and that the secondary particles are aggregates of primary particles at 10,000x (right)).

Unlike SEM, laser diffraction only detects the secondary particles. EX1010, ¶¶109-110. Ishigaki’s laser-light measurements of secondary particles give

cumulative average values (Dv50 and Dv90) that correspond to the values claimed in the '118 patent. EX1004, ¶39; EX1010, ¶¶112-114. These secondary particles are the aggregates of the primary particles, which correspond to the '118 patent particle sizes. EX1010, ¶111. A POSA could readily determine the ratio of Ishigaki's average particle size of the second material to the first material from the Dv50 and Dv90 data in Ishigaki. EX1010, ¶115.

For instance, Ishigaki claim 3 recites the median diameter of the first positive electrode active material is 0.1-5 μm . EX1004, ¶¶14, 37. Ishigaki claim 7 recites the first positive electrode mixture layer comprises the positive electrode active material, and has a smaller particle diameter than the second active material in the second layer. *See* EX1004, Claim 7. Ishigaki claim 8 recites the median particle diameter of the second positive electrode active material is between 6 and 20 μm . *See* EX1004, ¶¶14, 182. The ratios of the second material to the first material are therefore 6:5 (or 1.2:1) to 20:0.1 (or 200:1). EX1010, ¶116.

Ishigaki's most-preferred ranges, i.e., 1.2 μm to 2.5 μm (first material) and 9 μm to 15 μm (second material), EX1004, ¶¶37, 182, yield ratios ranging from a maximum of 12.5:1 (15 μm / 1.2 μm) to a minimum of 3.6:1 (9 μm / 2.5 μm), both of which fall within the claimed range of 1:1 to 40:1. EX1010, ¶117. Ishigaki's ratio almost entirely overlaps the claimed range and therefore anticipates it.

10. Claim 4

Ishigaki's first active material has a median diameter (Dv50) of 0.1 to 5 μm . See EX1004, ¶¶14, 37; *see also* Section VIII.A.9 (analysis of Ishigaki's disclosure of median particle size for claim 3); EX1010, ¶118. At least some of Ishigaki's compositions with a Dv50 of 0.1 to 5 μm will necessarily have an average particle size in a range of 0.2 to 15 μm . EX1010, ¶119. For example, an Ishigaki composition with a first active material "median diameter" (Dv50) of 2 μm corresponds to the '118 patent first material "average particle size" (also Dv50) of 2 μm , and will necessarily have an average particle size in a range of 0.2 μm to 15 μm . EX1010, ¶¶119-120. Ishigaki therefore inherently anticipates claim 4.

11. Claim 5

Ishigaki's electrode mixture has a compaction density (density after pressing) between 2.0 g/cm^3 and 4.2 g/cm^3 . EX1004, ¶¶25, 151. As discussed above, this leads to a range of combinations for the individual densities of layers 1 and 2, many of which have compaction densities for the first layer greater than 2.8 g/cc and the second layer greater than 3.3 g/cc . EX1010, ¶121. Ishigaki even directs a POSA to increase energy capacity⁴ by increasing layer densities. EX1004,

⁴ Ishigaki's quoted reason for using compaction densities above a lower limit is "increasing capacitance density." EX1004, ¶25. Capacitance is another property of

¶25; EX1010, ¶122. Ishigaki therefore not only discloses an overlapping range, but it specifically calls out the advantage of the higher end of that range—i.e. the part that overlaps the claimed range. EX1010, ¶123.

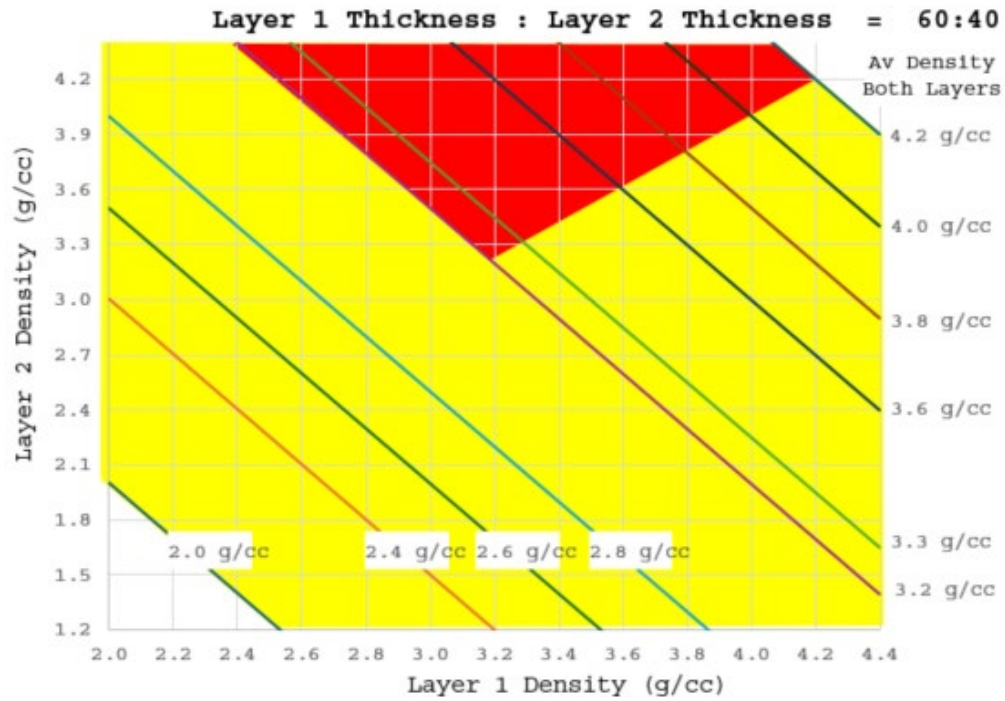
12. Claim 6

Ishigaki's second "active material has a higher bulk density than the first active material." EX1004, ¶216. The bulk densities of the first and second materials are proxies for the compaction densities of the first and second layers. EX1010, ¶124. Ishigaki discloses the bulk density ratios as a means for obtaining a high energy density in the final product, and teaches that corresponding compaction densities achieve Ishigaki's goal of high energy density. *Id.*

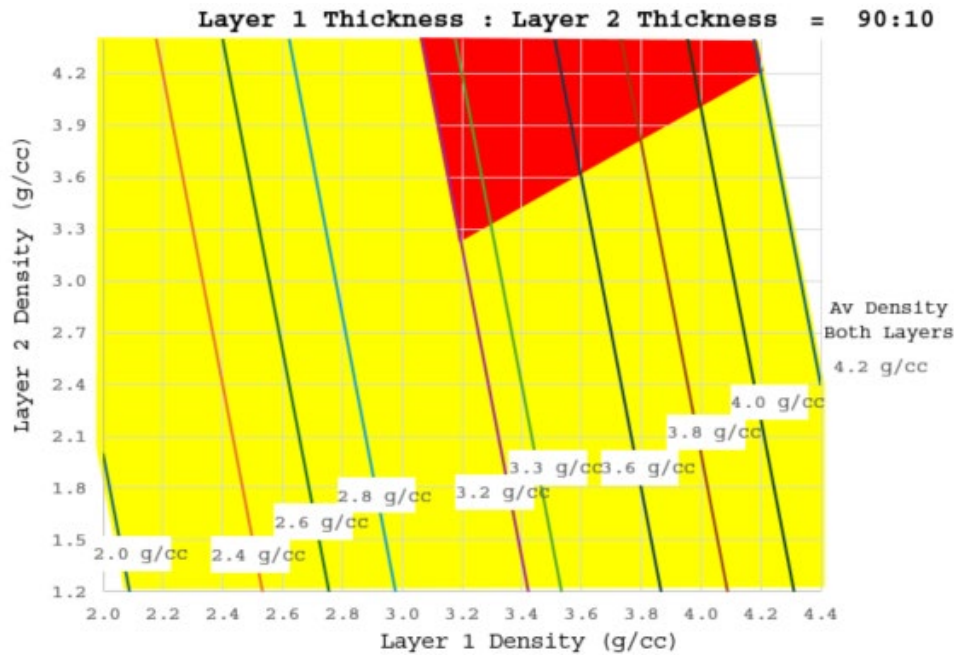
Additionally, a POSA would recognize multiple embodiments of Ishigaki in which the average density over both layers is greater than 3.2 g/cc per claim 5, EX1004, ¶216, and the second layer density is greater than the first per claim 6. EX1010, ¶¶125-126. Those embodiments are illustrated below, showing embodiments that anticipate in red:

some electrical devices, particularly capacitors, but that is not what Ishigaki means here. This is likely a result from the translation from the original Japanese. What Ishigaki means here is "increasing capacity density," or "increasing energy density."

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EX1010, Demonstrative 11.



EX1010, Demonstrative 12.

13. Claim 7

Ishigaki's first material in the first layer is lithium nickel cobalt manganese oxide (LiNiMnCoO_2). EX1004, ¶27; *see also* EX1004, Claims 5, 9. Ishigaki therefore discloses a composition selected from the recited group, which anticipates the Markush group. EX1010, ¶¶128-129.

14. Claim 8

Ishigaki's second material in the second layer is also lithium nickel cobalt manganese oxide (LiNiMnCoO_2). EX1004, Claim 9, ¶27; *see also* EX1004, Claim 5. Ishigaki therefore discloses a composition selected from the recited group, which anticipates the Markush group. EX1010, ¶¶129-130.

15. Claim 9

Ishigaki's first material alternatively comprises natural graphite, artificial graphite, soft carbon and/or hard carbon. *See* EX1004, Claim 6, ¶110. Ishigaki therefore anticipates claim 9. EX1010, ¶¶131-132; *see also* EX1020 (showing hard carbon and soft carbon as different grades of carbon black). Ishigaki therefore discloses multiple compositions selected from the Markush group and anticipates claim 9.

B. 10.P-10.5

Ishigaki discloses an electrochemical device (a Li-ion battery) that comprises an electrode. *See* EX1004, Abstract. Ishigaki further discloses "(1) A positive electrode for a lithium secondary battery comprising, on a current

collector foil, an electrode mixture” EX1004, ¶14. This is the same electrochemical device in the same context for the same purpose as the ’118 patent. EX1010, ¶133.

Claim elements 10.1-10.5 duplicate the limitations of claim 1, and are therefore anticipated by Ishigaki. Sections VIII.A.1-7; EX1010, ¶¶134-155.

1. Claims 11-18

Claims 11-18 duplicate claims 2-9. Ishigaki therefore anticipates them for the same reasons. Sections VIII.A.8-15; EX1010, ¶¶156-180.

C. 19.P-19.5

Ishigaki discloses “electronic devices,” and “lithium rechargeable batteries for use in these devices.” EX1004, ¶2. Ishigaki gives examples of “notebook computers, mobile phones, and handheld video cameras, as well as hybrid electric vehicles.” EX1004, ¶4. Ishigaki further discloses “(1) A positive electrode for a lithium secondary battery comprising, on a current collector foil, an electrode mixture” EX1004, ¶14. This is the same kind of electronic device, electrochemical device, and electrode used in the same context for the same purpose as the ’118 patent. EX1010, ¶181.

Claim elements 19.1-19.5 duplicate the limitations of claim 1 and are therefore anticipated by Ishikagi. Sections VIII.A.1-7; EX1010, ¶¶182-204.

1. Claim 20

Dependent claim 20 duplicates the limitations of claim 6, and is therefore anticipated by Ishigaki. Section VIII.A.12; EX1010, ¶¶205-207.

IX. GROUND 2: CLAIMS 1-20 ARE OBVIOUS OVER ISHIGAKI AND KIM

A. Motivation to Combine

Like Ishigaki and the '118 patent, Kim discloses a “composite cathode active material” for a lithium-ion battery, and various attributes. EX1009, Abstract. Also like Ishigaki, Kim teaches lithium cobalt nickel manganese oxide as the active material, and discloses an average particle size (Dv50) from 5 – 50 µm. Kim’s materials and attributes are therefore compatible with Ishigaki’s electrode and applications. EX1010, ¶208.

1. Ishigaki

As discussed in Ground 1, Ishigaki discloses all limitations of the '118 patent claims and therefore anticipates claims 1-20. For certain limitations, however, PO may argue the overlapping ranges disclosed or numeric values that require some standard derivation to calculate do not fully anticipate the claims. To the extent the Board finds any failure of express or inherent anticipation, Ishigaki nonetheless renders these limitations obvious.

As discussed above in Ground 1, Ishigaki’s own teachings encourage a POSA to choose particle sizes, compaction densities, layer thicknesses, and ratios

within the claimed ranges, even where the ranges Ishigaki discloses are broader than (or do not completely overlap) the claimed ranges. In the case where claimed ranges “overlap or lie inside ranges disclosed by the prior art” a prima facie case of obviousness exists. *In re Wertheim*, 541 F.2d 257 (CCPA 1976); *In re Woodruff*, 919 F.2d 1575 (Fed. Cir. 1990).

For the compaction density limitation, for example, Ishigaki discloses a range (>2 g/cc) that subsumes the claimed range (>3.2 g/cc total or 2.8 g/cc first layer and 3.3 g/cc second layer). EX1010, ¶209. Ishigaki teaches the upper limit of mixture densities for preferred embodiments is 3.6 g/cc, more preferably 3.5 g/cc, and most preferably 3.4 g/cc. EX1004, ¶25. That alone renders the claimed compaction densities obvious. To the extent PO argues there is a criticality to the claimed range—despite no such criticality being supported in the specification—PO may contend that Ishigaki does not explicitly teach a POSA of any criticality (only preference). In the event that PO attempts to distinguish Ishigaki based on an alleged criticality of the claimed numeric range, Kim discloses that range and criticality. EX1010, ¶210.

2. Kim

Kim teaches a cathode layer density of 3.31 g/cc or greater, and of 3.4 to 4.0 g/cc. EX1009, ¶36. Kim explains that compaction densities below 3.31 g/cc “may be too small to obtain a high electrical capacity.” EX1009, ¶36. Ishigaki discloses

the pursuit of “high energy density,” EX1004, ¶216, and “high capacity,” EX1004, Abstract, ¶¶7, 13, 14, 16, 18, as one of its objectives. High energy density is also an objective of the ’118 patent, EX1001, 1:36-41, 4:18-24, 6:7-12, 6:20-27, and a near-universal objective in the art. EX1010, ¶211.

3. KSR

Kim’s compaction density ranges are compatible with the teachings of Ishigaki, and encourage a POSA to pursue compaction densities towards the higher values of the range taught by Ishigaki. *Id.* Accordingly, combining the teachings of Ishigaki and Kim does not even require any modification to either device, as Ishigaki teaches compaction densities greater than 2 g/cc and further specifies 2.5 to 3.4g/cc, and up to 3.6 g/cc. EX1004, ¶25; EX1010, ¶212. Ishigaki even teaches a POSA to pack the electrode active material “as densely as possible” in order to maximize the energy capacity of the battery. EX1004, ¶7. A POSA would therefore already be motivated to choose densities at the higher end of the range disclosed in Ishigaki. EX1010, ¶214. A POSA would look to the density values of Kim to ensure the battery’s capacity is sufficient. Kim explains that densities less than 3.31 g/cc may be too low to achieve sufficient energy capacity—a goal of Ishigaki. EX1010, ¶214. Therefore, a POSA would have an expectation of success of the combination.

B. 1.P-1.4.3

Ishigaki teaches limitations 1.P–1.4.3 as discussed in Ground 1. Section VIII.A.1-6; EX1010, ¶215. The combination of Ishigaki and Kim therefore teaches these limitations for the same reasons.

1. 1.5

a. Ishigaki

Ishigaki teaches this limitation as discussed in Ground 1. EX1010, ¶216. To the extent Ishigaki’s broader range and embodiments do not anticipate compaction densities greater than 3.2 g/cc, it at least renders such densities obvious. To the extent PO argues that Ishigaki does not explicitly teach the criticality of the total compaction density being at least 3.2 g/cc, Kim teaches this feature.

b. Kim

Kim teaches a cathode layer density of 3.31 g/cc or greater, and of 3.4 to 4.0 g/cc. EX1009, ¶36. Kim explains that compaction densities, which is the density of the electrode material layer after it has been subjected to the compression step of the electrode formation process, below 3.31 g/cc “may be too small to obtain a high electrical capacity.” EX1009, ¶36.

c. KSR

Kim’s ranges are compatible with Ishigaki, and encourage a POSA to pursue compaction densities towards the higher end of Ishigaki’s range. EX1004, ¶25; EX1010, ¶218. Furthermore, Ishigaki teaches increasing the battery capacity by

“packing [the] electrode active material ... as densely as possible,” preferably at least 2.5 g/cc and up to 3.6 g/cc. EX1004, ¶7. A POSA reading Ishigaki would therefore already be motivated to choose compaction densities as high as possible, and would be further motivated by Kim to choose a compaction density over 3.2 g/cc in order to avoid a compaction density that is too small to obtain the desired electrical capacity. EX1010, ¶219.

Accordingly, A POSA reading Ishigaki would be motivated to select a compaction density that packs the electrode material “as densely as possible,” which Ishigaki suggests is around 3.4 – 3.6 g/cc. EX1010, ¶220. A POSA would look to Kim for information regarding why one should choose certain densities over others within Ishigaki’s range. Kim’s express teaching that compaction densities lower than 3.31 g/cc may be too small to obtain high energy capacity would motivate a POSA to choose only densities of 3.31 g/cc or higher in practicing Ishigaki because achieving high energy capacity is a primary objective of Ishigaki. EX1010, ¶220. A POSA would expect compaction densities of 3.31 or higher to be successful in Ishigaki’s battery because Ishigaki expressly embraces densities of 3.4 g/cc, 3.5 g/cc and 3.6 g/cc. EX1010, ¶220.

2. Claims 2-4

Ishigaki teaches claims 2-4 as discussed in Ground 1. Sections VIII.A.8 - VIII.A.10; EX1010, ¶221-223.

3. Claim 5

a. Ishigaki

Ishigaki teaches claim 5 as discussed above in Ground 1. If PO disagrees, Ishigaki alone also renders the limitations of this claim obvious because Ishigaki teaches an overlapping range and a reason to choose densities at the higher end of this range (and therefore within the claimed range): to maximize energy density. To the extent PO argues a criticality of the compaction density being greater than 2.8 g/cc for the first layer and greater than 3.2 g/cc for the second layer, and argues that Ishigaki does not explicitly teach the criticality, Kim teaches this feature. EX1010, ¶224.

b. Kim

Kim teaches a cathode layer density of 3.31 g/cc or greater, and of 3.4 to 4.0 g/cc. EX1009, ¶36. Kim explains that compaction densities below 3.31 g/cc “may be too small to obtain a high electrical capacity.” EX1009, ¶36.

c. KSR

Kim’s ranges are compatible with Ishigaki, and encourage a POSA to pursue compaction densities towards higher values in the range taught by Ishigaki, which also has a stated goal of achieving high energy density. EX1004, ¶25; EX1010, ¶225.

A POSA using Kim’s teaching to inform the compaction densities of Ishigaki’s two-layer structure, where the first layer has a lower compaction density

than the second layer as taught in Ishikgaki, EX1004, ¶216, would be motivated to select a compaction density of 3.31 g/cc or greater for the first layer, and a compaction density of 3.4 to 4.0 g/cc for the second layer. EX1010, ¶226. This is consistent with the teachings of both Ishigaki and Kim, as discussed above, and is the natural result of their combination. *Id.*

Furthermore, it would be well known to a POSA that higher compaction densities were commonplace in the art and that common sense dictates choosing the highest workable compaction density for a given application. EX1010, ¶227; EX1004, ¶7. A POSA would have a greater expectation of success using the compaction densities in the higher end of the range taught by Ishigaki as compared to the lower end of that range. EX1003, ¶44. A POSA would be especially motivated to choose densities 3.31 g/cc or greater for both layers in view of Kim's teaching that densities less than 3.31 g/cc may be too small. EX1009, ¶36; EX1010, ¶227.

4. Claims 6-9

Ishigaki teaches claims 6-9 as discussed in Ground 1. Sections VIII.A.12 - VIII.A.15; EX1010, ¶¶228-231.

C. 10.P.-10.4.3

Ishigaki teaches limitations 10.P-10.4.3 as discussed in Ground 1. EX1010, ¶232. Additionally, the limitations of claim 10 (other than the preamble) duplicate

the limitations of claim 1, and Ishigaki at least renders these limitations obvious as discussed for claim 1 of Ground 2.

1. 10.5

Ishigaki teaches the compaction-density limitation of claim 10.5 for the same reason as claim 1.5. To the extent Ishigaki does not teach the criticality of the compaction density being at least 3.2 g/cc, Kim teaches this feature, as discussed for claim 1.5. EX1010, ¶¶233-234.

2. Claims 11-18

Claims 11-18 duplicate claims 2-9. Ishigaki alone or in combination with Kim therefore renders these claims obvious for the same reasons. Sections VIII.A.8 - VIII.A.15; EX1010, ¶¶235-245.

D. 19.P.-19.4.3

Ishigaki teaches limitations 19.P-19.4.3 as discussed in Ground 1. Section VIII.C; EX1010, ¶246. Additionally, the limitations of claim 19 (other than the preamble) duplicate the limitations of claim 1, and Ishigaki at least renders these limitations obvious as discussed for claim 1 of Ground 2.

1. 19.5

Ishigaki teaches the compaction-density limitation of claim 19.5 for the same reason as claim 1.5. Section VIII.A.7; EX1010, ¶¶247-248. To the extent Ishigaki does not teach the criticality of the compaction density being at least 3.2 g/cc, Kim teaches this feature, as discussed for claim 1.5. Section VIII.A.7.

2. Claim 20

Dependent claim 20 duplicates the limitations of claim 6. Ishigaki teaches the limitations of claim 20 as discussed in Ground 1, and the Ishigaki-Kim combination renders these claims obvious as discussed for claim 6. EX1010, ¶249.

XIII. GROUND 3: CLAIMS 1-20 ARE OBVIOUS IN VIEW OF WANG AND SAKA

A. Motivation to Combine

Wang discloses all limitations of claims 1-20 except compaction densities. For that, a POSA would look to Saka, which discloses the claimed compaction densities. EX1010, ¶250.

Specifically, Wang discloses a lithium-ion battery for an electronic device, the battery having an electrode with all of the '118 patent structural claim features. EX1010, ¶251. Saka also discloses a lithium-ion battery having a very similar structure to Wang and the '118 patent, including an electrode with the material features of the '118 patent claims. EX1010, ¶252.

Claimed ranges that “overlap or lie inside ranges disclosed by the prior art,” are obvious. *Wertheim*, 541 F.2d at 267; *Woodruff*, 919 F.2d at 1578. Similarly, a prima facie case of obviousness exists where the claimed ranges or amounts do not overlap with the prior art but are merely close. *Titanium Metals Corp. of Am. v. Banner*, 778 F.2d 775, 783 (Fed. Cir. 1985). Wang and Saka render the challenged claims obvious under both doctrines.

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Wang and Saka both disclose cathode structures with two positive electrode mixture layers for increasing the energy density of lithium-ion batteries. EX1010, ¶253. Wang generally discloses the same structures and materials recited in the '118 patent claims, including the same layer materials having the same particle sizes. While Wang teaches compression to increase the density of its layers, Wang does not provide values for the density that results from that compression. *See, e.g.,* EX1005, ¶¶58, 86. A POSA would understand, however, the battery manufactured by Wang's process is consistent with, and would accommodate, the compaction density of the electrode recited in the '118 patent claims. EX1010, ¶253. A POSA could confirm that understanding by looking to the electrode disclosed in Saka. *Id.*

Saka's battery includes a cathode with two active layers, made of the same materials as Wang. Saka provides extensive data from which a POSA could determine the values for the compaction density of the cathode layers. EX1010, ¶254. Accordingly, a POSA practicing the disclosure of Wang would look to Saka for that specific information, and incorporate Saka's compaction density into the layers of Wang. *Id.*

Wang repeatedly teaches a POSA to use compaction to achieve a "desired net density." EX1005, ¶¶67, 73, 89, 92, 106, 109. A POSA would know the reason for achieving any net density is to increase the energy capacity of the cathode and

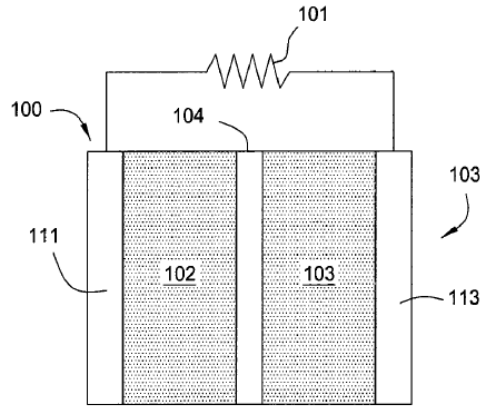
therefore the battery capacity.⁵ EX1010, ¶255. Since Wang does not teach or give examples of what a desired net density would be, a POSA would be motivated to look to another reference, such as Saka, for numerical values. EX1010, ¶255.

An express goal of Saka is to maintain enough mixture density to maintain a good battery capacity. EX1006, ¶7. Saka’s teaching of the connection between layer density and battery capacity would therefore motivate a POSA to apply Wang’s battery construction methods to achieve Saka’s disclosed densities to arrive at a battery with high energy capacity—a stated goal of Wang, Saka, and the ’118 patent. EX1010, ¶256. Therefore, a POSA would look to Saka for numerical values of Wang’s “desired net density” and find success in the combination.

B. 1.P

Wang’s cathode structure 103 is an electrode. *See* EX1005, ¶¶10, 11, 35. Wang teaches, “[t]he primary functional components of Li-ion battery 100 include an anode structure 102, **a cathode structure 103**, [and] a separator layer 104....” EX1005, ¶41.

⁵ “‘*Battery capacity*’ is a measure (typically in Amp-hr) of the charge stored by the battery, and is determined by the mass of active material contained in the battery. The battery capacity represents the maximum amount of energy that can be extracted from the battery....” EX1022, 0002.

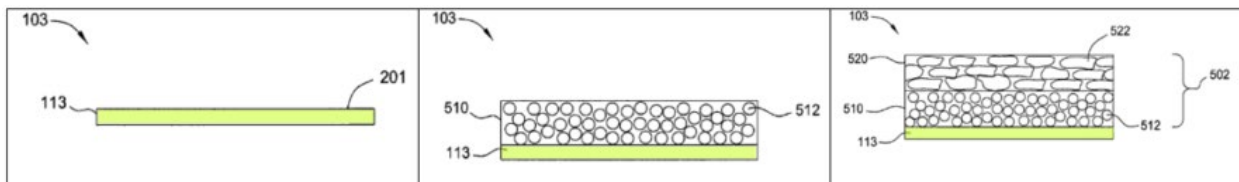


EX1005, FIG. 1A.

Wang therefore teaches this limitation. EX1010, ¶¶257-258.

1. 1.1

Wang’s current collector 113 is the claimed current collector. EX1010, ¶259; EX1005, ¶42; *see also* EX1005, ¶¶10, 11. Wang teaches that “FIGS. 5A-5C are schematic cross-sectional views of one embodiment of a graded cathode electrode structure 103 having a particle size gradient.” EX1005, ¶80.



EX1005, FIGs. 5A-5C (annotated).

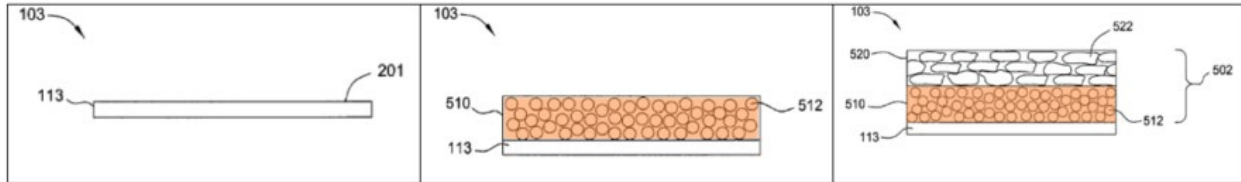
Wang therefore teaches this element. EX1010, ¶260.

2. 1.2

Wang’s electrode comprises a first layer, which comprises a first material. *See* EX1005, ¶¶10, 11. Wang’s first layer 510 is the claimed first layer. EX1010, ¶261. Wang’s first cathodically active particles 512 are the claimed first material.

Id. Wang teaches “a first layer 510 having first cathodically active particles 512 having a first diameter is formed over a surface 201 of the current collector 113.”

EX1005, ¶81; *see also* EX1005, FIGs. 5A-5C.

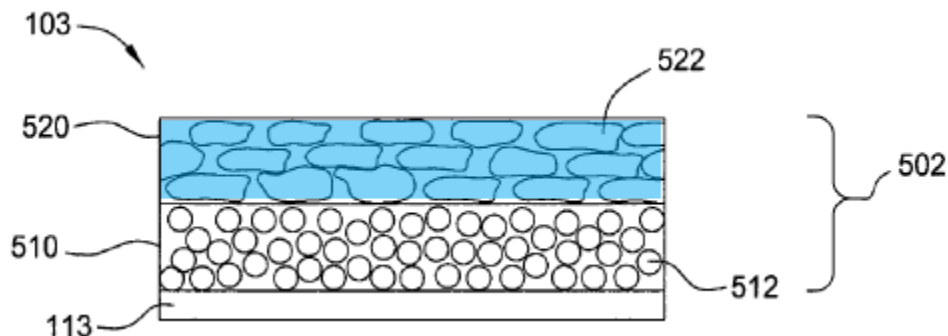


EX1005, FIGs. 5A-5C (annotated).

Wang therefore teaches this element. EX1010, ¶262.

3. 1.3

Wang teaches the electrode comprises a second layer, which comprises a second material. *See* EX1005, ¶¶10, 11. Wang’s second layer 520 is the claimed second layer. EX1010, ¶263. Wang’s second cathodically active particles 522 is the claimed second material. *Id.* Wang teaches “a second layer 520 having second cathodically active particles 522 having a second diameter is formed over the first layer 510.” EX1005, ¶83; *see also* EX1005, FIG. 5C.

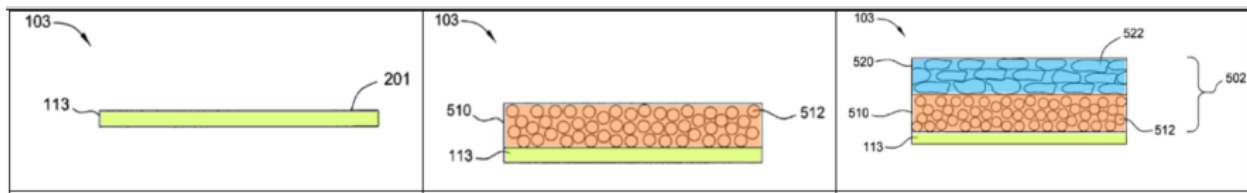


EX1005, FIG. 5C (annotated).

Wang therefore teaches this element. EX1010, ¶264.

4. 1.4.1

Wang's first layer is arranged between the current collector and the second layer. *See* EX1005, ¶¶10, 11, 38; EX1010, ¶265. Wang teaches "a first layer 510...is formed over a surface 201 of the current collector 113" and "a second layer 520...is formed over the first layer 510." EX1005, ¶¶81, 83; *see also* EX1005, FIGs. 5A-5C.

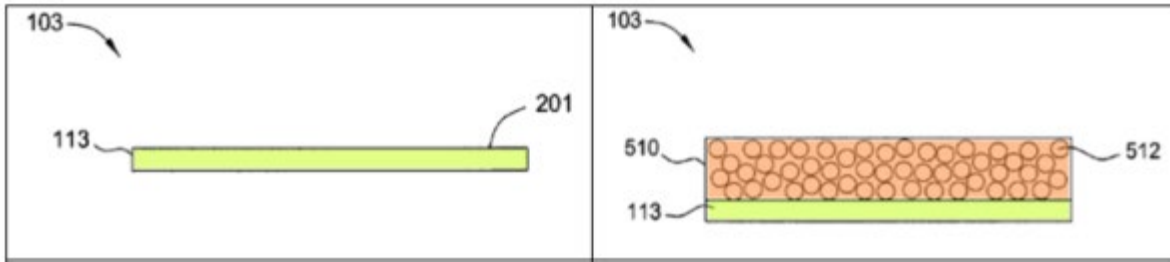


EX1005, FIGs. 5A-5C (annotated).

Wang therefore teaches this element. EX1010, ¶266.

5. 1.4.2

Wang's first layer is formed on a surface of the current collector. *See* EX1005, ¶¶10, 11; EX1010, ¶267. Wang teaches "a first layer 510...is formed over a surface 201 of the current collector 113." EX1005, ¶81; *see also* EX1005, FIGs. 5A, 5B.



EX1005, FIGs. 5A, 5B (annotated).

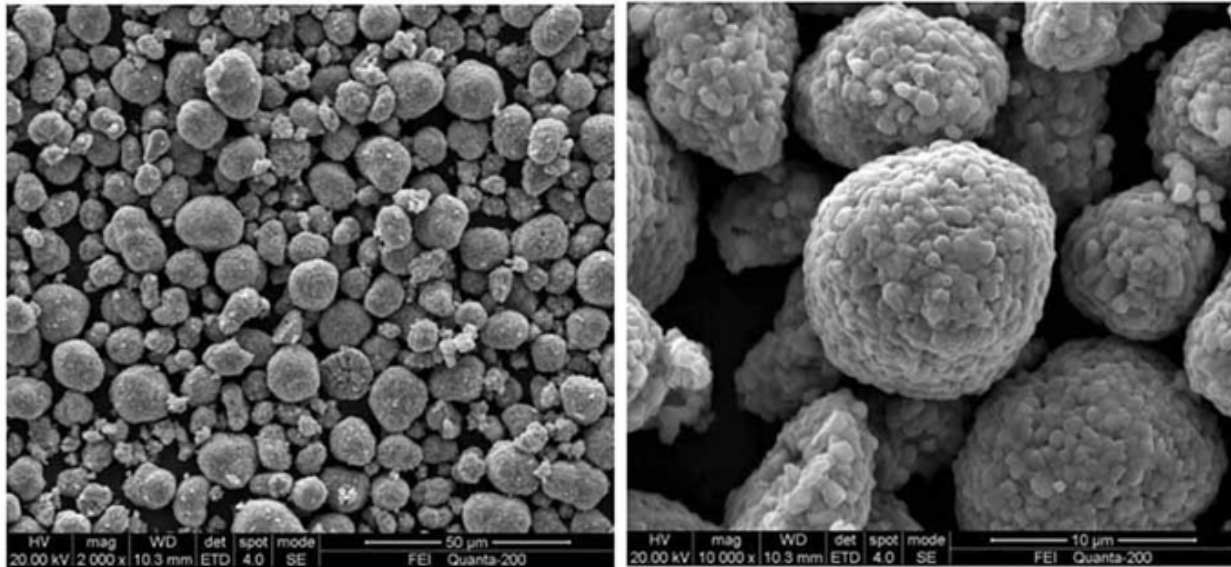
Wang therefore teaches this element. EX1010, ¶268.

6. 1.4.3

Wang teaches that a particle size of 90% accumulative volume of the first material is less than 40 μm . EX1005, ¶81. In one embodiment, the first cathodically active particles 512 “are nano-scale particles.” EX1005, ¶81 (“In one embodiment, the nano-scale particles have a diameter between about 1 nm and about 100 nm.”). A diameter range of 1 nm to 100 nm is the same as 0.001 μm to 0.1 μm . EX1010, ¶269. The plain language of this statement is not referring to a range of possible average sizes of particles across all different possible embodiments. Rather, it is referring to “one embodiment” in which the full distribution of all the individual sizes of first cathodically active particles 512 fall in the range between 0.001 μm and 0.1 μm . The Dv90 of this particle size distribution must necessarily be less than the upper end of this range, 0.1 μm , which is less than 40 μm . EX1010, ¶269.

Wang references two particle sizes, nano-scale and micro-scale, because the types of active materials described in Wang form both primary and secondary

particles. EX1010, ¶¶270-271. Scanning electron microscope (SEM) images of lithium nickel manganese cobalt oxide powder of the type used by both Wang, EX1005, ¶51, and the '118 patent illustrate what this means:



EX1013 (showing micro-scale particles at 2000x magnification (left) and revealing at 10,000x that these micro-scale particles are aggregates of smaller nano-scale particles (right)).

It would be abundantly clear to a POSA the nano-scale particles taught by Wang, EX1005, ¶81, ranging in size from 1 nm (0.001 μm) to 100 nm (0.1 μm), meet the claim limitation that a particle size of 90% accumulative volume of the first material is less than 40 μm . EX1010, ¶271.

Wang also teaches another embodiment of the first cathodically active particles 512 are “micro-scale particles.” EX1005, ¶81 (“In one embodiment, the micro-scale particles have a diameter between about 2 μm and about 15 μm .”).

Once again, the plain language of this statement refers to “one embodiment” in which the full distribution of first cathodically active particles 512 fall between 2 μm and 15 μm . The Dv90 of this particle-size distribution must necessarily be less than the upper end of this range, 15 μm , which is less than 40 μm . EX1010, ¶272. Thus, Wang teaches that a particle size of 90% accumulative volume of the first active material is less than 40 μm .

7. 1.5

Wang in view of Saka teaches that a total compaction density of the first layer and the second layer is greater than 3.2 g/cc. EX1010, ¶273.

a. Wang

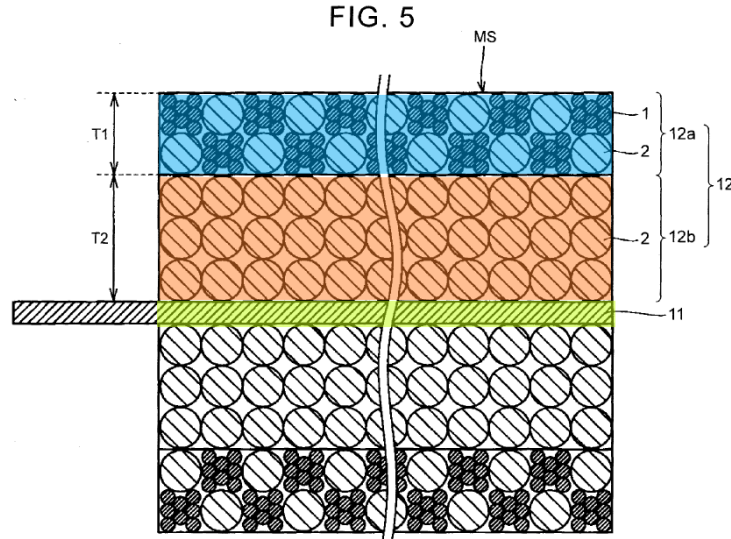
Wang teaches that, following the deposition of “cathodically active particles over the vertically oriented flexible conductive substrate,” the cathode is further compacted using a “compression process” to compress the layers “to a desired net-density.” EX1005, ¶¶15, 58; EX1010, ¶274. Wang further describes there can be one or two compression steps. EX1005, ¶92. Wang thus teaches the processes required for achieving the desired compaction density of the layers, in order to achieve a high packing density of active material in the cathode layers and thus a high energy density for the battery. EX1010, ¶275.

The only aspect of limitation 1.5 Wang may not explicitly teach is the numeric value for the desired compaction density. EX1010, ¶276. Wang assumes

the reader already has a desired density in mind, and teaches the method one would use to achieve any such density. A POSA would look to a reference such as Saka to determine what net density to pursue. EX1010, ¶276. Saka discusses the reasons for achieving particular densities. While Wang may not expressly teach that a total compaction density of the first layer and the second layer is greater than 3.2 g/cc, the density recited in limitation 1.5 is explicitly taught in Saka.

b. Saka

Saka teaches an electrode having a positive electrode mixture 12 on a current collector 11, where positive electrode mixture 12 includes a first layer 12a and a second layer 12b. *See* EX1006, FIG. 5. Saka teaches that “the dried positive electrode mixture layer 12 may be pressed using a rolling mill or the like to adjust the thickness and the mixture density thereof.” EX1006, ¶51. After being pressed, the density of mixture layer 12 is a compaction density. EX1010, ¶277. Saka further teaches that “[t]he mixture density of the positive electrode mixture layer 12 is, for example, 2.5 g/cm³ to 3.5 g/cm³.” EX1006, ¶51. Therefore, Saka teaches the compaction density of the positive electrode mixture layer 12 (including both first and second layers 12a and 12b) can be greater than 3.2 g/cc. EX1010, ¶277.



EX1006, FIG. 5 (annotated).

c. KSR

The combination teaches this element. EX1010, ¶278. It would have been obvious to a POSA to combine Wang and Saka. EX1010, ¶279. To start, Wang and Saka are analogous to each other and to the problem in the '118 patent. Both are directed towards battery electrodes, particularly cathodes, having a current collector and a bilayer structure of active materials. EX1010, ¶279. Wang describes a first layer 510 on a current collector 113 and a second layer 520 on the first layer 510, with the first and second layers 510 and 520 having particles of different sizes. EX1005, FIG. 5C. Saka describes a second layer 12b on a current collector 11 and a first layer 12a on the second layer 12b, with the first and second layers 12a and 12b having different compositions. EX1006, FIG. 5.

Both Wang and Saka teach compression treatments to the active materials to consolidate the bilayer structure and increase its density. EX1006, ¶7. Although Wang may not explicitly provide values for the compaction density, a POSA reading Wang would reasonably understand the purpose and the outcome of the compression treatment, and would reasonably be motivated to review additional teachings about quantitative values or ranges of the compaction density, of which Saka teaches. EX1010, ¶¶280-281.

Having reviewed Saka, a POSA would have been motivated to supplement Wang's teaching by combining Saka's range of the compaction density with the properties of the active material in Wang's cathode structure. EX1010, ¶282. The resulting combination would have provided more detailed characteristics of Wang's structure of the electrode, and a POSA would have had a reasonable expectation of success that the active material taught by Wang could reach the quantitative range of Saka's compaction density, and thus battery energy densities, after the compression treatment. *Id.*

8. Claim 2

Wang discloses the thickness of the first layer is not less than the Dv90 of the first material. EX1010, ¶283; EX1005, ¶81. Specifically, Wang discloses the first layer 510 has a thickness between about 10 μm to about 150 μm , or between about 50 μm to about 100 μm . EX1005, ¶81. Wang teaches particle sizes that are

smaller than this layer thickness. EX1005, ¶81 (“In one embodiment, the nano-scale particles have a diameter between about 1 nm and about 100 nm.”). A diameter range of 1 nm to 100 nm is the same as 0.001 μm to 0.1 μm . EX1010, ¶284. The statement refers to “one embodiment” in which the full distribution of all the individual sizes of first cathodically active particles 512 fall in the range between 0.001 μm and 0.1 μm . EX1010, ¶284. Dv90 of this particle-size distribution must necessarily be less than the upper end of this range, 0.1 μm , which is less than any possible layer thicknesses in Wang. *Id.*

Wang also teaches another embodiment where the first cathodically active particles 512 are “micro-scale particles.” EX1005, ¶81 (“diameter between about 2 μm and about 15 μm .”). The full distribution of all the individual sizes of first cathodically active particles 512 fall in the range between 2 μm and 15 μm . *Id.* The Dv90 of this particle size distribution must necessarily be less than the upper end of this range, 15 μm , which is less than most of the first layer thicknesses in Wang’s broadest disclosed range of 10 to 150 μm , and is demonstrably less than the minimum thickness, 50 μm , of Wang’s other quoted layer thickness range of 50 to 100 μm . EX1010, ¶285. Thus, Wang teaches that a thickness of the first layer is not less than the particle size of 90% accumulative volume of the first material in the first layer. EX1010, ¶286.

9. Claim 3

Wang discloses the claimed ratio between the particle sizes of the layers. EX1005, ¶83; EX1010, ¶287. Specifically, Wang discloses a second layer 520 having second cathodically active particles 522 having a second diameter formed over the first layer 510. EX1005, ¶83. In one embodiment, “the second cathodically active particles 522 have a second diameter greater than five times the particle size of the particles of the first layer.” EX1005, ¶83. In other words, the ratio of the average particle size of the second material to the first material is at least 5:1. This is within the claimed numeric range of 1:1 to 40:1. EX1010, ¶287; *see also* EX1005, ¶84. Wang therefore discloses the claimed ratio of particle sizes between layers. EX1010, ¶288.

10. Claim 4

Wang discloses a first material with an average particle size within this range. EX1005, ¶81; EX1010, ¶289. Wang teaches an embodiment of the first cathodically active particles 512 are “micro-scale particles.” EX1005, ¶81 (“In one embodiment, the micro-scale particles have a diameter between about 2 μm and about 15 μm .”). The full distribution of all the individual sizes of first cathodically active particles 512 fall in the range between 2 μm and 15 μm , and therefore their average falls in this range. In this embodiment, “average particle size” of Wang’s

first cathodically active layer, which the '118 patent uses to denote Dv50, falls within this claimed size range between 2 and 15 μm . EX1010, ¶¶289-290.

11. Claim 5

The combination of Wang and Saka teaches a battery in which the compaction density of the first layer is greater than 2.8 g/cc and a compaction density of the second layer is greater than 3.3 g/cc. EX1010, ¶291.

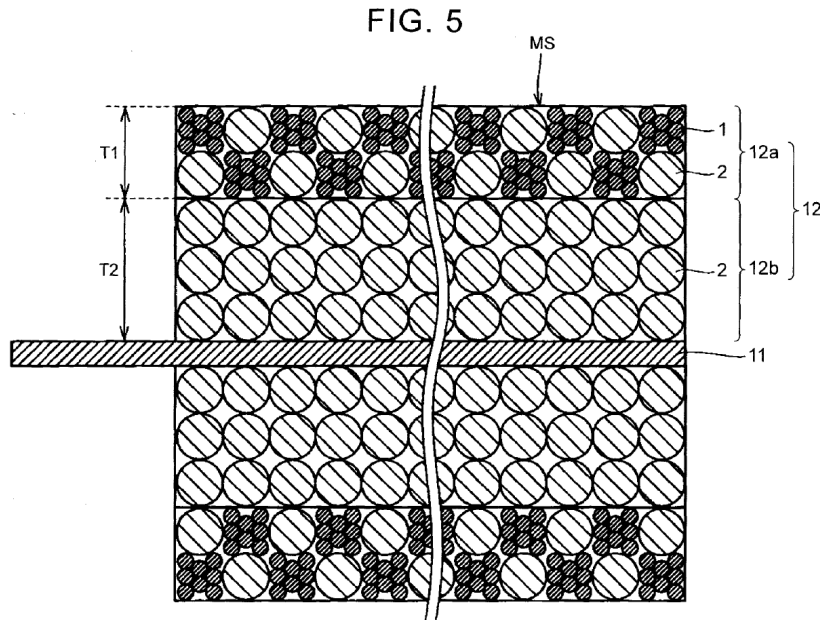
a. Wang

As discussed for limitation 1.5, Wang describes one or both layers can be exposed to a compression process to compact the packing density of the particles and achieve a desired net density. EX1005, ¶¶15, 58; EX1010, ¶292. Wang specifically describes embodiments where the two layers have different densities. EX1005, FIG. 3, ¶¶73, 92; EX1010, ¶293. Wang may not explicitly teach the numeric values of the compaction densities for the two layers. Saka does. A POSA would be motivated to combine Wang with Saka for the purpose of learning specific compaction densities for the layers. EX1010, ¶¶292-293.

b. Saka

As discussed above, Saka teaches that “[t]he mixture density of the positive electrode mixture layer 12 is, for example, 2.5 g/cm³ to 3.5 g/cm³.” EX1006, ¶51. Accordingly, Saka teaches densities as high as 3.5 g/cc, which is greater than 2.8 g/cc and greater than 3.3 g/cc. EX1010, ¶291.

Saka teaches a layering process with compression steps, comparable to the process in Wang. EX1010, ¶294. The structure of Saka's cathodes is illustrated below.



EX1006, FIG. 5.

Saka's layers are labeled opposite to the convention used in the '118 patent and Wang, namely the "first" layer is the outer (top) layer of the structure. Wang and the '118 patent refer to that layer as the second layer. Likewise, Saka's "second" layer is the inner (bottom) layer, or the layer sitting directly on the current collector. EX1010, ¶297. A POSA would readily appreciate that the enumeration of layers in the '118 patent, Wang, and Saka is arbitrary. A POSA would easily be able to associate which layer has which properties and why when combining Wang and Saka's teachings. EX1010, ¶297.

Saka goes on to disclose the numeric values of several properties of the layers across numerous embodiments. While Saka may not directly provide the compaction densities for the individual layers, Saka discloses ample information from which a POSA could easily calculate those compaction densities using standard formulas and simple algebra. EX1010, ¶294.

Specifically, Saka discloses the relative amounts (ratios) by weight (mass) of the various components of the layers (particles, additive, and binder) and the relative volumes of the layers. From this information, a POSITA can calculate the separate layer densities. To the extent porosity also affects the density, Saka provides that information too. The compaction densities for Saka's examples, and the corresponding calculations, are shown in Exhibit 1007. EX1010, ¶295. The examples of Saka for which the compaction densities of the first layers render obvious claim 5 are as follows. *See* EX1007.

Example	Compaction Density (g/cc) First Layer	Compaction Density (g/cc) Second Layer
A1	2.88	3.04
A2	2.88	3.04
B7	2.89	3.04
B8	2.93	3.07
A3	2.93	3.07
A4	2.93	3.07
A5	2.93	3.07
B9	2.93	3.07
A6	2.97	3.10
A7	2.97	3.10
B10	2.97	3.11

Example	Compaction Density (g/cc) First Layer	Compaction Density (g/cc) Second Layer
A8	2.97	3.11
A9	2.97	3.11
B11	2.87	3.01
B12	2.98	3.12
B13	2.98	3.12
B14	2.99	3.13
A15	2.93	3.07

c. KSR

The layer densities of Saka's examples render obvious the compaction densities recited in claim 5. EX1010, ¶313. The inner layer densities (the claimed first material) are greater than 2.8 g/cc (because 2.88, 2.89, 2.93, 2.97, 2.98, and 2.99 > 2.8). The outer layer (the claimed second layer) in these examples are very close to 3.3 g/cc (because, for instance, 3.04, 3.07, 3.10, 3.11, 3.12, and 3.13 are very close to 3.3). A POSA would find it obvious that the outer layer could instead be greater than 3.3 g/cc, because Saka expressly teaches the compaction density can be as high as 3.5 g/cc, EX1006, ¶51, and Wang teaches a compression method that can achieve any desired density. EX1010, ¶315.

A POSA would have a reasonable expectation of success in using Wang's method to make a battery with a compaction density greater than 2.8 g/cc in the inner layer and greater than 3.3 g/cc in the outer layer based on Saka's various battery examples, Saka's teaching of a density of 3.5 g/cc, and the porosities of Saka's layers. EX1006, ¶51. That is because Wang teaches that its compression

method decreases porosity. A POSA would be motivated to use Wang's compression method to achieve an outer layer density of 3.5 g/cc in view of the knowledge in the art that higher densities are more desirable and that densities below 3.1 may be too low for adequate energy capacity. *See, e.g.*, EX1009, ¶36.

The porosity of Saka's layers is determined by comparing the volumes of the layers to the occupied volumes of the material components making up the layers. The difference between the layer volume and the occupied volume, is empty space, i.e. the porosity. Porosity as a percentage of the layer volume was also calculated for the various Saka examples. EX1007; EX1010, ¶313. For Saka's battery example A1, the porosity of layer 1 is 19% and the porosity of layer 2 is 30%. These porosity values reinforce the comparison between the density values of Saka and the compaction density values of claim 5. EX1010, ¶¶313-315.

The combination of Wang and Saka therefore teaches an electrode wherein a compaction density of the first layer is greater than 2.8 g/cc, and a compaction density of the second layer is greater than 3.3 g/cc. EX1010, ¶¶315-316. They would have been obvious to combine, and once combined, there would be an expectation of success of their combination. *Id.*

12. Claim 6

a. Wang

Wang teaches that “it is desirable to perform a calendaring process after deposition of the second porous layer in order to increase the packing density of the particles of the second layer relative to the particles of the first layer.” EX1005, ¶92. This indicates the particles of the first layer have a lower compaction density than the second layer. EX1010, ¶317.

b. Saka

To the extent Wang’s teaching of this limitation is not explicit enough, Saka also teaches the first layer has a lower compaction density than the second layer, as all examples discussed above for claim 5 list a compaction density for the first layer that is less than for the second layer. *See* EX1007.

c. KSR

A POSA would be motivated to combine Wang and Saka’s teachings for the reasons stated with respect to claim 1, and for the additional reason that the teachings of the two references are consistent and reinforce one another in the context of the first layer having a lower compaction density than the second layer. EX1010, ¶318.

13. Claim 7

a. Wang

Wang teaches the first “cathodically active material 212 is selected from the group comprising: lithium cobalt dioxide (LiCoO_2), lithium manganese dioxide (LiMnO_2), titanium disulfide (TiS_2), $\text{LiNi}_x\text{Co}_{1-2x}\text{MnO}_2$, LiMn_2O_4 , LiFePO_4 , $\text{LiFe}_{1-x}\text{MgPO}_4$, LiMoPO_4 , LiCoPO_4 , $\text{Li}_3\text{V}_2(\text{PO}_4)_3$, LiVOPO_4 , LiMP_2O_7 , $\text{LiFe}_{1.5}\text{P}_2\text{O}_7$, LiVPO_4F , LiAlPO_4F , $\text{Li}_5\text{V}(\text{PO}_4)_2\text{F}_2$, $\text{Li}_5\text{Cr}(\text{PO}_4)_2\text{F}_2$, $\text{Li}_2\text{CoPO}_4\text{F}$, $\text{Li}_2\text{NiPO}_4\text{F}$, $\text{Na}_5\text{V}_2(\text{PO}_4)_2\text{F}_3$, $\text{Li}_2\text{FeSiO}_4$, $\text{Li}_2\text{MnSiO}_4$, $\text{Li}_2\text{VOSiO}_4$, LiNiO_2 , and combinations thereof.”⁶ EX1005, ¶51. Wang therefore teaches most items in the Markush group of claim 7. EX1010, ¶¶319-320. The only items in the Markush group of claim 7 that are not in Wang’s paragraph 51 are lithium nickel cobalt aluminate and lithium titanate. EX1010, ¶321.

⁶ Lithium cobalt dioxide (LiCoO_2) is lithium cobaltate, $\text{LiNi}_x\text{Co}_{1-2x}\text{MnO}_2$ is lithium nickel cobalt manganese oxide, LiMn_2O_4 is lithium manganate, LiFePO_4 is lithium iron phosphate, $\text{LiFe}_{1-x}\text{MgPO}_4$ is lithium iron manganese phosphate, $\text{Li}_3\text{V}_2(\text{PO}_4)_3$ is lithium vanadium phosphate, LiVOPO_4 is lithium vanadyl phosphate, and LiNiO_2 is lithium nickelate. EX1010, ¶321.

b. Saka

Saka teaches the particles of its first (inner) layer are lithium nickel cobalt manganese oxide ($\text{LiNi}_x\text{Co}_{1-2x}\text{MnO}_2$). EX1006, ¶10. Saka therefore also teaches an item within the Markush group that is common to Wang. EX1010, ¶322.

c. KSR

Accordingly, a POSA combining Wang's teachings with Saka's particle densities would know that Saka's lithium-nickel-cobalt-manganese-oxide particles are compatible with Wang's device and the compaction density for Saka's particles can be readily incorporated into Wang's device. EX1010, ¶323. The combination therefore teaches claim 7. EX1010, ¶324.

14. Claim 8

a. Wang

Wang teaches the second "cathodically active material 222 is selected from the group comprising: lithium cobalt dioxide (LiCoO_2), lithium manganese dioxide (LiMnO_2), titanium disulfide (TiS_2), $\text{LiNi}_x\text{Co}_{1-2x}\text{MnO}_2$, LiMn_2O_4 , LiFePO_4 , $\text{LiFe}_{1-x}\text{MgPO}_4$, LiMoPO_4 , LiCoPO_4 , $\text{Li}_3\text{V}_2(\text{PO}_4)_3$, LiVOPO_4 , LiMP_2O_4 , $\text{LiFe}_{1.5}\text{P}_2\text{O}_7$, LiVPO_4F , LiAlPO_4F , $\text{Li}_5\text{V}(\text{PO}_4)_2\text{F}_2$, $\text{Li}_5\text{Cr}(\text{PO}_4)_2\text{F}_2$, $\text{Li}_2\text{CoPO}_4\text{F}$, $\text{Li}_2\text{NiPO}_4\text{F}$, $\text{Na}_5\text{V}_2(\text{PO}_4)_2\text{F}_3$, $\text{Li}_2\text{FeSiO}_4$, $\text{Li}_2\text{MnSiO}_4$, $\text{Li}_2\text{VOSiO}_4$, LiNiO_2 , and combinations thereof." EX1005, ¶55. Wang therefore teaches all items in the Markush group of claim 8 except lithium nickel cobalt aluminium oxide. EX1010, ¶¶325-326.

b. Saka

Saka teaches the second material is lithium iron phosphate (LFP) and lithium nickel cobalt manganese oxide (NCM). EX1006, ¶10. Saka therefore teaches two items within the Markush group of claim 8 that are also common to Wang. EX1010, ¶327.

c. KSR

A POSA combining Wang's teachings with Saka's cathode-layer densities would know that both Saka's LFP and NCM particles are compatible with Wang's method and the compaction density for Saka's layers can be readily incorporated into Wang's method. The combination therefore teaches claim 8. EX1010, ¶328.

15. Claim 9

a. Wang

Wang teaches the first material can be graphite, soft carbon, hard carbon, silicon, silicon carbide, and lithium titanate. EX1005, ¶52. Wang therefore teaches several items in the Markush group of claim 9. EX1010, ¶329. "Soft carbon" and "hard carbon" are different grades of a common commodity in this industry called carbon black. *See, e.g.*, EX1023; EX1024. Wang teaches the use of "carbon black," EX1005, ¶52, and thus teaches a form of soft carbon and hard carbon. EX1010, ¶329.

b. Saka

Saka teaches there can be a conductive material in the first (inner) layer, which is compatible with Wang's listing of materials. EX1006, ¶22; EX1010, ¶330. Saka also mentions acetylene black (a form of hard carbon black) as a material for the first (inner) layer, and uses this form of hard carbon in its examples. EX1006, ¶75; EX1020 (characterizing acetylene black as a form of hard carbon black).

c. KSR

A POSA would understand the various forms of carbon and silicon listed in this Markush group are obvious in view of the combined teachings of Wang and Saka, including the compaction densities disclosed in Saka. EX1010, ¶331.

C. 10.P-10.5

Wang teaches a battery, which is an electrochemical device. *See* EX1005, ¶¶10, 11, 35. Wang's battery includes Wang's cathode structure 103, which is an electrode. EX1010, ¶332; EX1005, ¶41, FIG. 1A.

Claim elements 10.1-10.5 duplicate the limitations of claim 1, and are therefore obvious in view of Wang and Saka for the same reasons. Sections XIII.B.1-7; EX1010, ¶¶334-355.

1. Claims 11-18

Claims 11-18 duplicate claims 2-9. Wang and Saka therefore render these claims obvious for the same reasons. Sections XIII.B.8-15; EX1010, ¶¶356-376.

D. 19.P

Wang teaches a battery (an electrochemical device) that is appropriate for use in electronic devices. EX1005, ¶¶10, 11, 35; EX1010, ¶377. Wang teaches, “[t]he primary functional components of Li-ion battery 100 include an anode structure 102, a cathode structure 103, a separator layer 104....” EX1005, ¶41, FIG. 1A; EX1010, ¶378.

Claim elements 19.1-19.5 duplicate the limitations of claim 1 and are therefore obvious in view of Wang and Saka for the same reasons. Sections XIII.B.1-7; EX1010, ¶¶379-400.

1. Claim 20

Dependent claim 20 duplicates the limitations of claim 6. It is therefore obvious over Wang and Saka for the same reasons. Section XIII.B.12; EX1010, ¶401.

XIV. GROUND 4: CLAIMS 1-20 ARE OBVIOUS IN VIEW OF WANG AND LI

A. Motivation to Combine

As discussed for Ground 3, Wang discloses all limitations of claims 1-20 with the exception of the numeric values for the compaction densities of the layers. For that, a POSA would look to Li, which discloses a battery that can be manufactured by Wang’s method, with compaction densities within the ranges recited in the ’118 patent claims. EX1010, ¶402.

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Specifically, Wang discloses a lithium-ion battery for an electronic device having an electrode with virtually all of the structural and material features claimed. EX1010, ¶403. Li also discloses a lithium-ion battery having a similar structure and features as Wang and the '118 patent. EX1010, ¶404. Wang and Li both disclose cathode structures with two positive electrode mixture layers for increasing the energy density of lithium-ion batteries. EX1010, ¶405.

While Wang teaches compression steps to increase the compaction density of its layers, Wang does not provide numeric values for the density that results. *See, e.g.*, EX1005, ¶¶58, 86. A POSA would understand, however, Wang is consistent with and would accommodate the compaction density recited in the '118 patent claims. A POSA could confirm that understanding and would be motivated to choose the claimed compaction densities by looking to the electrode disclosed in Li. EX1010, ¶405.

Li's battery has a similar layer structure, including a cathode with two active layers, made of the same materials as Wang, and provides detailed information for the compaction density of the cathode active material layers. EX1010, ¶406. Accordingly, a POSA practicing the disclosure of Wang, would look to Li for the compaction density appropriate for his application, and incorporate Li's compaction density into the layers of Wang. *Id.*

Wang repeatedly teaches a POSA to use compaction to achieve a “desired net density.” EX1005, ¶¶67, 73, 89, 92, 106, 109. The reason for doing so is to increase the energy density of the cathode and therefore to increase the energy density, and the capacity, of the battery. EX1010, ¶407. Since Wang does not teach what the desired net density actually is, a POSA would be motivated to look to another reference, such as Li, for numerical values.

Li discloses numerical values for the compaction densities that work in a battery like Wang’s or like the ’118 patent. EX1003, ¶44. Li therefore teaches the numerical values of “desired net density” needed to practice Wang’s invention. EX1005, ¶¶67, 73, 89, 92, 106, 109. A POSA would have an expectation of success by using Li’s compaction densities in practicing Wang’s battery-construction method because Wang specifically discloses that its method can be used to achieve any desired density, and Li teaches a density that works in a battery made by a process similar to Wang’s method. EX1010, ¶408.

B. 1.P- 1.4.3

Wang teaches limitations 1.P.-1.4.3 as discussed in Ground 3. EX1010, ¶¶409-424.

1. 1.5

Wang in view of Li teaches that a total compaction density of the first layer and the second layer is greater than 3.2 g/cc. EX1010, ¶425.

a. Wang

Wang teaches that following the deposition of cathodically active particles, the cathode is further processed “to compress the deposited particles to a desired net-density.” EX1005, ¶¶15, 58; EX1010, ¶426. Wang further describes there can be one or two compression steps, depending on the desired compaction density of the layers. EX1005, ¶92. Wang thus teaches the processes required for achieving a high packing density of active material in the cathode layers and thus a high energy density for the battery. EX1010, ¶427.

The only aspect of limitation 1.5 Wang may not explicitly teach is the numeric value for the desired compaction density. EX1010, ¶428. Wang assumes the reader already has a desired density in mind, and teaches the method one would use to achieve any such density. *Id.* A POSA would therefore be motivated to look to a reference such as Li, which provides the specific numeric densities that result from the compaction steps of a process like Wang’s.

b. Li

Li discloses a lithium-ion battery for similar applications as Wang, and the ’118 patent. EX1003, ¶¶1-2, 27; EX1010, ¶429. The structure of Li’s cathode includes a current collector onto which is deposited two active material layers including the same materials disclosed in Wang and the ’118 patent. EX1003, ¶¶8, 26. Li specifically discloses a compaction density of 3.8 g/cm³ for the first layer,

and an average compaction density of 4.1 g/cm³ across the two-layer structure following the second compaction where Li's compaction density is the density of the electrode material layer after it has been subjected to the compression step of the electrode formation process. EX1010, ¶429; EX1003, ¶44.

Accordingly, the total compaction density of the first layer and the second layer is greater than 3.2 g/cc, because 4.1 g/cc > 3.2 g/cc. EX1010, ¶430. Li therefore teaches element 1.5, and the Wang-Li combination teaches all limitations of claim 1. *Id.*

c. KSR

It would have been obvious to a POSA to combine Wang and Li which are analogous to each other and to the problem in the '118 patent. EX1010, ¶431. Both are directed towards battery electrodes, particularly cathodes, having a current collector and a bilayer structure of active materials. Wang describes first layer 510 on a current collector 113 and a second layer 520 on first layer 510, with the first and second layers 510 and 520 having particles of different sizes. EX1005, FIG. 5C. Li describes the same overall structure, and provides the compaction densities that are missing from Wang.

Both Wang and Li teach compression treatments to the bilayer structure of active materials to consolidate the bilayer structure of active materials and increase its density. EX1005, ¶11; EX1003, ¶44. Although Wang does not explicitly

provide values for the compaction density, a POSA reading Wang would understand the purpose and the outcome of the compression treatment to the bilayer structure of active material, and would be motivated to review additional teachings about quantitative values of the compaction density, which Li teaches. EX1010, ¶432.

Li explains there are no special requirements for the active material in the layers, but suggests lithium-transition metal composite oxide, lithium-transition metal phosphate, or lithium-transition metal silicate as examples. EX1003, ¶26. This teaching is compatible with Wang. EX1010, ¶433. Various examples of Li disclose lithium cobalt oxide as a cathode active material and acetylene black as a cathode layer conductive additive. *See, e.g.*, EX1003, ¶¶38, 44. This teaching is also compatible with Wang. EX1010, ¶433.

Li's examples 2-13 specifically disclose a method of "coating twice and compaction twice" with a resulting first compaction density of 3.8 g/cm³ for the first layer, and then an average compaction density of 4.1 g/cm³ across the two-layer structure following the second compaction. EX1003, ¶44. This method is similar to Wang's method. EX1010, ¶434. While Wang states that its method can be used to achieve any desired net density, Li expressly teaches particular densities that work in the battery that results from this process.

Having reviewed Li, a POSA would have been motivated to supplement Wang's teaching by combining Li's range of the compaction density with the properties of the active material in Wang's cathode. EX1010, ¶435. The resulting combination would have provided more detailed characteristics of Wang's electrode, and a POSA would have had a reasonable expectation of success that the active material as taught by Wang could reach the quantitative range of the compaction density, and thus battery energy densities, as taught by Li after the compression treatments. *Id.*

2. Claim 2

Wang teaches claim 2 as discussed in Ground 3. EX1010, ¶¶436-439.

3. Claim 3

Wang teaches claim 3 as discussed in Ground 3. EX1010, ¶¶440-441.

4. Claim 4

Wang teaches claim 4 as discussed in Ground 3. EX1010, ¶¶442-443.

5. Claim 5

Wang in view of Li teaches that a compaction density of the first layer is greater than 2.8 g/cc and the second layer is greater than 3.2 g/cc. Li specifically discloses a compaction density of 3.8 g/cm³ for the first layer, and an average compaction density of 4.1 g/cm³ across the two-layer structure following the second compaction. EX1003, ¶44. Accordingly, Li teaches a density for the first layer that is greater than 2.8 g/cc. EX1010, ¶444. It is possible the second

compaction process will compact the first layer even further, and possible that it will not. Either way, the compaction density of the first layer will be at least 3.8 g/cc, which satisfies the first-layer density element of claim 5. *Id.*

While Li's teaching does not provide a numeric value for the density of the second layer, a POSA would immediately recognize that if the density of the first is 3.8 g/cm³ and the average density across the two layers is 4.1 g/cm³, then the density of the second layer is *necessarily* greater than 3.8 g/cm³, and most likely greater than 4.1 g/cm³. EX1010, ¶445. Either way, the compaction density of the second layer is necessarily greater than 3.3 g/cc. As such, Li discloses the second-layer density limitation.

A POSA would be motivated to combine Li with Wang for the compaction densities as discussed above. EX1010, ¶446. For instance, as discussed for limitation 1.5, Wang describes that one or both layers can be exposed to a compression process to increase the packing density of the particles and achieve a desired net density. EX1005, ¶¶15, 58. Wang specifically describes layers having different densities, and subjecting both layers to separate compression processes. EX1010, ¶447; EX1005, FIG. 3, ¶¶73, 92 (“[I]t is desirable to perform a calendaring process after deposition of the second porous layer in order to increase the net density of the second porous layer relative to the first porous layer.”).

Wang may not teach the numeric values of the compaction densities for the two layers. Li does. Li teaches a layering process with compression steps, comparable to Wang. EX1010, ¶448. Li goes on to disclose the numeric compaction densities of the layers being 3.8 g/cm³ and ~ 4.1 g/cm³. The combination of Wang and Li therefore teaches a compaction density of the first layer greater than 2.8 g/cc, and a compaction density of the second layer is greater than 3.3 g/cc. These references would have been obvious to combine, and once combined, there would be an expectation of success of their combination. EX1010, ¶448.

6. Claim 6

Wang teaches that “it is desirable to perform a calendaring process after deposition of the second porous layer in order to increase the packing density of the particles of the second layer relative to the particles of the first layer.” EX1005, ¶92. This implies the particles of the first layer have a lower compaction density than the second layer. EX1010, ¶449. Li also teaches the first layer has a lower compaction density than the second layer. Li specifically discloses a compaction density of 3.8 g/cm³ for the first layer, and an average compaction density of 4.1 g/cm³ across the two-layer structure. EX1003, ¶44. The compaction density of the second layer is necessarily greater than the compaction density of the first layer,

because the average density across the two layers is greater than the density of the first layer alone. EX1010, ¶450.

One of skill in the art would be motivated to combine Wang and Li's teachings in this regard for the reasons stated above with respect to claim 1, and for the additional reason the teachings of the two references are consistent and reinforce one another in the context of the first layer having a lower compaction density than the second layer. EX1010, ¶451.

7. Claim 7

Wang teaches the additional limitations of claim 7 as discussed in Ground 3. EX1010, ¶¶452-455. Additionally, Li teaches the positive electrode slurry comprises at least one of lithium cobalt oxide, lithium manganese oxide, nickel-cobalt-manganese, or lithium iron phosphate. EX1012, ¶17. Li therefore teaches items in the Markush group that are common with Wang.

8. Claim 8

Wang teaches the additional limitations of claim 8 as discussed in Ground 3. EX1010, ¶¶456-457. Additionally, Li teaches the positive electrode slurry comprises at least one of lithium cobalt oxide, lithium manganese oxide, nickel-cobalt-manganese, or lithium iron phosphate. EX1012, ¶17. Li therefore teaches items in the Markush group that are common with Wang.

9. Claim 9

Wang teaches the additional limitations of claim 9 as discussed in Ground 3. EX1010, ¶458. To the extent a POSA looks to Li for compatibility, examples of Li disclose acetylene black as a cathode layer conductive additive. *See, e.g.*, EX1003, ¶38, ¶44. Li also teaches electrode material comprising natural graphite, artificial graphite, carbon-silicon material, soft carbon, or hard carbon. EX1012, ¶20. Li therefore teaches items in the Markush group that are common with Wang.

B. 10.P.-10.4.3

Wang teaches all limitations of claim 10.P–10.4.3 as discussed in Ground 3. Additionally, the limitations of claim 10 (other than the preamble) duplicate the limitations of claim 1, and Wang teaches these limitations as discussed for claim 1 of Ground 4. EX1010, ¶¶459-472.

1. 10.5

The combination of Wang and Li teaches that a total compaction density of the first layer and the second layer is greater than 3.2 g/cc, as discussed for claim 1.5. EX1010, ¶¶473-483.

2. Claim 11

Claims 11-18 duplicate claims 2-9. Wang and Li therefore render these claims obvious for the same reasons. Sections XIV.B.8-15; EX1010, ¶¶484-500.

C. 19.P.–19.4.3

Wang teaches all of the limitations of 19.P–19.4.3 as discussed in Ground 3 above. Additionally, limitations 19.1-19.4.3 duplicate the limitations of claim 1, therefore Wang teaches these limitations as discussed for claim 1. Sections XIII.B.1-6; EX1010, ¶¶501-514.

1. 19.5

The combination of Wang and Li teaches that a total compaction density of the first layer and the second layer is greater than 3.2 g/cc as discussed for claim 1.5. EX1010, ¶¶515-525.

2. Claim 20

The additional limitations of claim 20 duplicate the limitations of claim 6. The combination of Wang and Li render this claim obvious for the same reasons. EX1010, ¶¶526-528.

X. THERE ARE NO FACTORS UNDER SECTIONS 325(D) OR 314(A) THAT WEIGH AGAINST INSTITUTING TRIAL

Petitioner presents substantially different prior art and arguments than those previously considered by the Office, and identifies an error made in prosecution. 35 U.S.C. § 325(d); *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 7-10 (PTAB Feb. 13, 2020) (precedential). Specifically, none of Petition’s cited prior-art references were previously considered by the Office during original prosecution, and the examiner

Petition for Inter Partes Review of U.S. Patent No. 12,015,118

misapprehended the claimed features relative to the examiner-cited prior art.

EX1010, ¶¶49-50.

PO asserts the '118 patent against Petitioner in related litigation filed November 22, 2024. *See Ningde Amperex Technology Limited v. Zhuhai CosMX Battery Co., Ltd.*, Case No. 2:24-cv-00728 (E.D. Tex.). IPR should be instituted under *Fintiv* regardless. *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (PTAB Mar. 20, 2020) (precedential). Petitioner files this IPR Petition just after the exclusionary PGR period. Regardless, the parties have invested little resources and timing remains uncertain, so this proceeding will help resolve the parties' dispute. The Petition sets forth compelling patentability challenges, overriding any *Fintiv* concerns. If IPR is instituted, Petitioner stipulates not to pursue in the related litigation the Grounds in this Petition or any other ground Petitioner reasonably could have raised in this Petition. *Id.* at 3; *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020) (precedential as to § II.A)..

XI. CERTIFICATION THAT THE PATENT MAY BE CONTESTED VIA *INTER PARTES* REVIEW BY PETITIONER AND STANDING (37 C.F.R. § 42.104(A))

Petitioner certifies the '118 patent is available for IPR and Petitioner is not barred or estopped from requesting IPR of any '118 patent claim.

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

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

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

The '118 patent is currently at issue in the litigation *Zhuhai CosMX Battery Co., Ltd., v. Ningde Amperex Technology Limited*, Case No. 2:24-cv-00728 (E.D. Tex.), filed September 6, 2024.

Petitioner has filed the following additional petitions for *inter partes* review of patents also at issue in the above-listed litigation:

Proceeding No.	U.S. Patent No.
IPR2025-00432	11,575,148
IPR2025-00405	11,769,910
IPR2025-00389	11,923,498
IPR2025-00385	10,964,927
IPR2025-00431	11,799,131
IPR2025-00722	11,799,131

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

Lead Counsel for Petitioner is:

Jason D. Eisenberg (Reg. No. 43,447)
STERNE, KESSLER, GOLDSTEIN & FOX PLLC
1101 K Street, NW, 10th Floor
Washington, DC 20005
202-772-8645 (telephone)
202-371-2540 (facsimile)
jason-PTAB@sternekeessler.com.

Petition for Inter Partes Review of U.S. Patent No. 12,015,118

Back-up Counsel for Petitioner is:

Jason A. Fitzsimmons (Reg. No. 65,367)
STERNE, KESSLER, GOLDSTEIN & FOX PLLC
1101 K Street, NW, 10th Floor
Washington, DC 20005
202-371-8701 (telephone)
202-371-2540 (facsimile)
jfitzsimmons-PTAB@sternekessler.com;

Kristina Caggiano Kelly (Reg. No. 58,164)
STERNE, KESSLER, GOLDSTEIN & FOX PLLC
1101 K Street, NW, 10th Floor
Washington, DC 20005
202-371-8524 (telephone)
202-371-2540 (facsimile)
kkelly-PTAB@sternekessler.com;

Pengke Li (Reg. No. 80,713)
Sterne, Kessler, Goldstein & Fox PLLC
1101 K Street, NW, 10th Floor
Washington, DC 20005
202-371-8602 (telephone)
202-371-2540 (facsimile)
pli-PTAB@sternekessler.com; and

James D. Stein (Reg. No. 63,782)
LEE & HAYES, P.C.
75 14th Street NE, Suite 2500
Atlanta, Georgia 30309
404-736-1918
509-323-8979 (fax)
james.stein@leehayes.com.

Petition for Inter Partes Review of U.S. Patent No. 12,015,118

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

XIII. PROCEDURAL STATEMENTS

This Petition is filed in accordance with 37 C.F.R. § 42.106(a). Concurrently filed herewith are a Power of Attorney and Exhibit List under 37 C.F.R. §§ 42.10(b) and 42.63(e), respectively. The required fee is paid through Deposit Acct. No. 19-0036 (Customer ID No. 45324). The Office is authorized to charge any fee deficiency, or credit any overpayment, to Deposit Acct. No. 19-0036 (Customer ID No. 45324).

XIV. CONCLUSION

The challenged claims are unpatentable as anticipated and/or obvious and IPR is warranted.

Petition for Inter Partes Review of U.S. Patent No. 12,015,118

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX PLLC

/Jason D. Eisenberg/

Jason D. Eisenberg (Reg. No. 43,447)

Jason Fitzsimmons (Reg. No. 65,367)

Kristina Caggiano Kelly (Reg. No. 58,164)

Pengke Li (Reg. No. 80,713)

James D. Stein (Reg. No. 63,782)

Counsel for Petitioner

Date: April 2, 2025

1101 K Street, NW, 10th Floor
Washington, DC 20005
(202) 371-2600

CLAIMS APPENDIX

Claim 1.P: An electrode, comprising
1.1: a current collector;
1.2: a first layer comprising a first material; and
1.3: a second layer comprising a second material;
1.4.1: wherein the first layer is arranged between the current collector and the second layer;
1.4.2: the first layer is formed on a surface of the current collector;
1.4.3: and a particle size of 90% accumulative volume of the first material is less than 40 μm ; and
1.5: wherein a total compaction density of the first layer and the second layer is greater than 3.2 g/cc.
Claim 2: The electrode according to claim 1, wherein a thickness of the first layer is not less than the particle size of 90% accumulative volume of the first material in the first layer.
Claim 3: The electrode according to claim 1, wherein a ratio of the average particle size of the second material to the average particle size of the first material is from 1:1 to 40:1.
Claim 4: The electrode according to claim 1, wherein the first material has an average particle size in a range of 0.2 μm to 15 μm .
Claim 5: The electrode according to claim 1, wherein a compaction density of the first layer is greater than 2.8 g/cc, and a compaction density of the second layer is greater than 3.3 g/cc.
Claim 6: The electrode according to claim 1, wherein the first layer has a lower compaction density than the second layer.
Claim 7: The electrode according to claim 1, wherein the first material comprises one selected from the group consisting of lithium cobaltate, lithium manganate, lithium nickelate, <i>lithium nickel cobalt manganese oxide</i> , lithium iron phosphate, lithium iron manganese phosphate, lithium vanadium phosphate, lithium vanadyl phosphate, lithium-rich manganese-based materials, lithium nickel cobalt aluminate and lithium titanate, and combinations thereof.

Claim 8: The electrode according to claim 1, wherein the second material comprises one selected from the group consisting of lithium cobaltate, lithium nickel cobalt manganese oxide, lithium nickel cobalt aluminum oxide, lithium-rich manganese-based material, lithium iron phosphate, and combinations thereof.
Claim 9: The electrode according to claim 1, wherein the first material comprises one selected from the group consisting of artificial graphite, natural graphite, mesocarbon microbeads, soft carbon, hard carbon, silicon, silicon carbide, lithium titanate, and combinations thereof.
Claim 10.P: An electrochemical device, comprising an electrode, wherein the electrode comprises:
10.1: a current collector;
10.2: a first layer comprising a first material; and
10.3: a second layer comprising a second material;
10.4.1: wherein the first layer is arranged between the current collector and the second layer,
10.4.2: the first layer is formed on a surface of the current collector,
10.4.3: and a particle size of 90% accumulative volume of the first material is less than 40 μm ;
10.5: wherein a total compaction density of the first layer and the second layer is greater than 3.2 g/cc.
Claim 11: The electrochemical device according to claim 10, wherein a thickness of the first layer is not less than the particle size of 90% accumulative volume of the first material in the first layer.
Claim 12: The electrochemical device according to claim 10, wherein a ratio of the average particle size of the second material to the average particle size of the first material is from 1:1 to 40:1.
Claim 13: The electrochemical device according to claim 10, wherein the first material has an average particle size in a range of 0.2 μm to 15 μm .
Claim 14: The electrochemical device according to claim 10, wherein a compaction density of the first layer is greater than 2.8 g/cc, and a compaction density of the second layer is greater than 3.3 g/cc.

Claim 15: The electrochemical device according to claim 10, wherein the first layer has a lower compaction density than the second layer.
Claim 16: The electrochemical device according to claim 10, wherein the first material comprises one selected from the group consisting of lithium cobaltate, lithium manganate, lithium nickelate, lithium nickel cobalt manganese oxide, lithium iron phosphate, lithium iron manganese phosphate, lithium vanadium phosphate, lithium vanadyl phosphate, lithium-rich manganese-based materials, lithium nickel cobalt aluminate and lithium titanate, and combinations thereof.
Claim 17: The electrochemical device according to claim 10, wherein the second material comprises one selected from the group consisting of lithium cobaltate, lithium nickel cobalt manganese oxide, lithium nickel cobalt aluminum oxide, lithium-rich manganese-based material, lithium iron phosphate, and combinations thereof.
Claim 18: The electrochemical device according to claim 10, wherein the first material comprises one selected from the group consisting of artificial graphite, natural graphite, mesocarbon microbeads, soft carbon, hard carbon, silicon, silicon carbide, lithium titanate, and combinations thereof.
Claim 19.P. An electronic device, comprising an electrochemical device, the electrochemical device comprising an electrode, wherein the electrode comprises:
19.1: a current collector;
19.2: a first layer comprising a first material; and
19.3: a second layer comprising a second material;
19.4.1: wherein the first layer is arranged between the current collector and the second layer,
19.4.2: the first layer is formed on a surface of the current collector,
19.4.3: and a particle size of 90% accumulative volume of the first material is less than 40 μm ;
19.5: wherein a total compaction density of the first layer and the second layer is greater than 3.2 g/cc.
Claim 20: The electronic device according to claim 19, wherein the first layer has a lower compaction density than the second layer.

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

1. This Petition for *Inter Partes* Review complies with the type-volume limitation of 14,000 words, comprising 13,671 words, excluding the parts exempted by 37 C.F.R. § 42.24(a)(1).

2. 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 2016 in 14-point Times New Roman font.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX PLLC

/Jason D. Eisenberg/

Jason D. Eisenberg
Registration No. 43,447
Counsel for Petitioner

Date: April 2, 2025

1101 K Street, NW, 10th Floor
Washington, DC 20005
(202) 371-2600

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. 12,015,118 and associated Exhibits 1001-
1013, 1015-1018, and 1020-1028 were served in their entireties upon the Patent
Owner on April 2, 2025, via FedEx® Express at the following address:

MAIER & MAIER, PLLC
345 South Patrick Street
Alexandria, VA 22314
Patent Owner's Correspondence Address of Record for U.S. Patent No.
12,015,118

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX PLLC

/Jason D. Eisenberg/

Jason D. Eisenberg
Registration No. 43,447
Counsel for Petitioner

Date: April 2, 2025

1101 K Street, NW, 10th Floor
Washington, DC 20005
(202) 371-2600