

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner

v.

NINGDE AMPEREX TECHNOLOGY LTD.,
Patent Owner

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

PATENT OWNER'S RESPONSE

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Cases

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2001	Second Amended Complaint, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , Case No. 2:24-cv-00728-JRG, ECF No. 23 (E.D. Tex. Jan. 28, 2025)
2002	Scheduling Order, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , Case No. 2:24-cv-00728-JRG, ECF No. 27 (E.D. Tex. Feb. 6, 2025)
2003	CosMX Invalidity Contentions Cover Pleading, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , Case No. 2:24-cv-00728-JRG (E.D. Tex. Jan. 7, 2025)
2004	Summons to attend oral proceedings in German Case No. 3 Ni 12/23 (EP) (“Germany Order 1”)
2005	Summons to attend oral proceedings in German Case No. 3 Ni 12/24 (EP) (“Germany Order 2”)
2006	Docket Navigator Time-to-Trial Statistics for Judge Rodney Gilstrap (accessed July 2, 2025)
2007	Docket, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , Case No. 2:22-cv-00232 (E.D. Tex.)
2008	Joint Motion for Entry of Protective Order, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:24-cv-00728-JRG, ECF No. 30 (E.D. Tex. Feb. 11, 2025)
2009	Amended Final Judgment, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , Case No. 2:22-cv-00232, ECF No. 427 (E.D. Tex.)
2010	Article, <i>Lithium battery manufacturer ATL won injunction against its Chinese rival COSMX in German Court</i> , China IP Today (April 6, 2024)
2011	Reserved
2012	Reserved
2013	Darts IP Reports: CN109301326, CN104466097, CN206490141, CN108352492 (May 6, 2025)
2014	IDS Filings for U.S. Patent Application No. 17/119,194
2015	Declaration of Dean R. Wheeler, Ph.D.
2016	<i>Curriculum Vitae</i> of Dean R. Wheeler, Ph.D.

Exhibit Number	Description
2017	V. Srinivasan and J. Newman, <i>Design and Optimization of a Natural Graphite/Iron Phosphate Lithium-Ion Cell</i> , 151 J. Electrochem. Soc. A1530 (2004)
2018	<i>Laser diffraction for particle sizing – Anton Paar</i> , available at: https://wiki.anton-paar.com/en/laser-diffraction-for-particle-sizing (accessed on 30 July 2025)
2019	<i>Understanding the Mechanical and Electrochemical Impacts of Binder Systems on Silicon Anodes in Lithium-Ion Batteries – BYU Scholar Archives</i> , available at: https://scholarsarchive.byu.edu/etd/10449 (accessed on 30 July 2025)
2020	Westphal, Bockholt, Günther, Haselrieder, and Kwade, <i>Influence of Convective Drying Parameters on Electrode Performance and Physical Electrode Properties</i> , ECS Transactions, 64 (22) 57-68 (2015)
2021	Liu, Chen, Liu, Chu, and Tiu, <i>Improvement of Lithium-Ion Battery Performance by Two-Layered Slot–Die Coating Operation</i> , Energy Technology 2017, 5, 1235–1241
2022	Reserved
2023	Reserved
2024	Reserved
2025	<i>2016 Batteries Conference GRC</i> , available at: https://www.grc.org/batteries-conference/2016/ (accessed on 12 May 2025).
2026	<i>Hubs – Department of Energy</i> , available at: https://www.energy.gov/hubs (accessed on 12 May 2025)
2027	<i>DOE Energy Innovation Hubs</i> , available at: https://science.osti.gov/bes/Research/DOE-Energy-Innovation-Hubs (accessed on 12 May 2025)
2028	Amir-Sina Hamed, Fezzeh Pouraghajan, Fei Sun, Mojdeh Nikpour, & Dean R. Wheeler, <i>Interplay of Electrode Heterogeneity and Lithium Plating</i> , 169 J. Electrochem. Soc. 020551 (2022)
2029	Amir-Sina Hamed, Adrian Yao, Roxana Martin, Raymundo Roig, Michael Rivas Valadez, Donald Pile, Annadanesh Shellikeri, Baichuan Liu, and Dean R. Wheeler, <i>Multi-layer</i>

Exhibit Number	Description
	<i>anodes for high-current applications</i> , 439 <i>Electrochimica Acta</i> 141649 (2023)
2030	Fezzeh Pouraghajan, Andrea I. Thompson, Emilee E. Hunter, Brian Mazzeo, Jake Christensen, Ram Subbaraman, Michael Wray, & Dean Wheeler, <i>The Effects of Cycling on Ionic and Electronic Conductivities of Li-ion Battery Electrodes</i> , 492 <i>J. of Power Sources</i> 229636 (2021)
2031	Amir-Sina Hamed, Edmund M. Shumway, & Dean R. Wheeler, <i>Electrode-Level Modeling of Silicon Anodes for Improved Cell Design</i> , 171 <i>J. Electrochem. Soc.</i> 120539 (2024)
2032	Reserved
2033	Reserved
2034	<i>Lithium-ion Battery Design: Effects of Optimal Compaction Density</i> , https://www.neware.net/news/lithium-ion-battery-design-effects-of-optimal-compaction-density/230/83.html (last visited on May 23, 2025)
2035	Shu Lu, et al., <i>Binder-Free LiCoO₂/Carbon Nanotube Cathodes for High-Performance Lithium Ion Batteries</i> , 24 <i>Adv. Mater.</i> 2294(2012)
2036	Lei-Lei Lu, et al., <i>Wood-Inspired High-Performance Ultrathick Bulk Battery Electrodes</i> , <i>Adv. Mater.</i> 1706745 (2018)
2037	Yasuhiko Takahashi, et al., <i>Structure and electron density analysis of electrochemically and chemically delithiated LiCoO₂ single crystals</i> , 180 <i>J. Solid State Chem.</i> 313 (2007) , https://doi.org/10.1016/j.jssc.2006.10.018
2038	<i>Carbon Black</i> , https://pubchem.ncbi.nlm.nih.gov/compound/carbon%20black , (last visited on May 23, 2025)
2039	Sankar Mandal, et al., <i>The Role of Carbon Black in LiMn₂O₄-Based Composites as Cathodes for Rechargeable Lithium Batteries</i> . 148 <i>J. Electrochem. Soc.</i> A24 (2001)
2040	Chris Meyer, et al., <i>Characterization of the Calendering Process for Compaction of Electrodes for Lithium-Ion Batteries</i> , 249 <i>J. Materials Processing Tech.</i> 172 (2017), https://doi.org/10.1016/j.jmatprotec.2017.05.031 .
2041	CosMX Amended Exhibit 118-19, “Invalidity of U.S. Patent No. 12,015,118 over ATL 265066 Cell/Electrode in view of Japan Patent Application Publication No. JP 2013-21109,” <i>Ningde</i>

Exhibit Number	Description
	<i>Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co., Case No. 2:24-cv-00728-JRG, ECF No. 64-1 (E.D. Tex. July 31, 2025)</i>
2042	U.S. Patent Pub. No. 2021/0214234 (“Lee”)
2043	U.S. Patent Pub. No. 2022/0403062 (“Cha”)
2044	Declaration of Brady Cox
2045	Zhuhai CosMX Battery Co., Ltd.’s Responsive Claim Construction Brief, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co., Case No. 2:24-cv-00728-JRG, ECF No. 64-1 (E.D. Tex. December 16, 2025)</i>
2046	U.S. Patent Publication No. US 2021/0214234 A1 to Lee et al.
2047	U.S. Patent Publication No. 2022/0403062 A1 to Cha et al.
2048	Yang, S., et al. High Tap Density Spherical Li[Ni _{0.5} Mn _{0.3} Co _{0.2}]O ₂ Cathode Material Synthesized via Continuous Hydroxide Coprecipitation Method for Advanced Lithium-Ion Batteries. <i>Int. J. Electrochem.</i> , 9 (2012)
2049	Zhang J, Huang H, Sun J. <i>Investigation on mechanical and microstructural evolution of lithium-ion battery electrode during the calendering process</i> . Powder Technology, 2022, 409: 117828.
2050	Deposition Transcript of Samuel Gido, Ph.D., dated January 12, 2026
2051	Product data sheet for the Microtrac Particle Size Analyzer S3500
2052	U.S. Patent Publication No. US 2016/0326003 A1 to Ishizuka
2053	User’s Manual dated September 2019 for the Beckman Coulter LS 13 320 Laser Diffraction Particle Size Analyzer
2054	User’s Manual dated October 2011 for the Beckman Coulter LS 13 320 Laser Diffraction Particle Size Analyzer
2055	U.S. Patent Publication No. US 2024/0291110 A1 to Lee et al.
2056	M Nikpour, B Liu, P Minson, Z Hillman, BA Mazzeo, DR Wheeler, “Li-ion Electrode Microstructure Evolution during Drying and Calendering,” Batteries 8 (9), 107. https://www.mdpi.com/1807812
2057	H. Zheng, J. Li, X. Song, G. Liu, V. S. Battaglia, “A comprehensive understanding of electrode thickness effects on the electrochemical performances of Li-ion battery cathodes,”

Exhibit Number	Description
	Electrochimica Acta 71 (2012) 258– 265. http://dx.doi.org/10.1016/j.electacta.2012.03.161
2058	Supplemental Declaration of Dean R. Wheeler, Ph.D.

I. INTRODUCTION

Ningde Amperex Technology Ltd. (“ATL” or “Patent Owner”) respectfully submits this Patent Owner Response (“POR”). Zhuhai CosMX Battery Co., Ltd. (“CosMX” or “Petitioner”) filed the Petition (“Petition”) for, and the Board instituted (Paper 11, “Decision”), *inter partes* review (“IPR”) of claims 1-20 (“Challenged Claims”) of U.S. Patent No. 12,015,118 (the “’118 Patent,” Ex. 1001). The Board should find the Challenged Claims not unpatentable as Petitioner failed to meet its burden of proving “by a preponderance of evidence” that any of its four grounds render the Challenged Claims unpatentable. 35 U.S.C. § 316(e).

In Grounds 1 and 2, Petitioner relies on Ishigaki, but Ishigaki never discloses “a particle size of 90% accumulative volume of the first material is less than 40 μm .” Ishigaki discusses D90 values of cathode active materials but does *not* specifically discuss 90% cumulative volume diameter (“Dv90”) values. As the Director explained in his Order, the scope of Ishigaki’s D90 disclosure is subject to reasonable dispute and cannot be said to be necessarily equivalent to a Dv90 value. Paper 17, 3. At least because Ishigaki does not describe a Dv90 value, and Petitioner has not provided and cannot provide any additional evidence demonstrating that a POSITA would interpret Ishigaki’s D90 value as equivalent to a Dv90 value, the Petition is fatally flawed with respect to both Grounds 1 and 2.

Moreover, Ishigaki (Grounds 1 and 2) and Kim (Ground 2) do not disclose, teach, or suggest a two-layer electrode structure having a “total compaction density of the first layer and the second layer [that] is greater than 3.2 g/cc.” Ishigaki’s teachings for 2-layer cathode structures are incomplete and do not provide compaction density values. Even when Kim discusses single-layer cathode structures, Kim never provides a cathode compaction density. Instead, Kim’s density discussions focus on *press densities of active materials alone*. Even Petitioner’s expert deemed such press density values irrelevant to final electrode compaction densities. Ex. 2050, 128:2-9, 128:19-129:9, 131:4-21.

Grounds 3 and 4 also fail, at least because a POSITA would have no reason to look beyond Wang for “desired density” values for an electrode. A POSITA would recognize that Petitioner’s suggestion that a POSITA would have a “desired density in mind” when combining Wang with either Saka (Ground 3) or Li (Ground 4) is unsupported, given Wang’s porosity targets. Moreover, Saka (Ground 3) does not provide any disclosure leading towards the critical 3.2 g/cc compaction density of the claims. As the Board acknowledges, Saka’s disclosure suggests that performance *decreases as the density increases to 3.0 g/cc*.

Li (Ground 4) likewise does not provide teachings that would lead a POSITA to modify Wang to have a density of greater than 3.2 g/cc. Li’s disclosure focuses on a unique cathode geometry that uses a *uniform cathode composition throughout the*

entire cathode. Using Li's geometry with a gradient cathode as discussed in Wang would create a cathode with varying compositions along its length, which would lead to uneven discharge of the cathode. Worse still, Petitioner's singular focus on the density of an example in Li, to the exclusion of the remainder of Li's teachings, does not reflect how a POSITA would view Li's teachings in light of Wang.

Petitioner provides no other reasons why a POSITA would modify Wang's disclosure based on Saka or Li, both of which describe different cathode structures with different particle sizes and different intended uses. Indeed, a POSITA would not modify Wang with a "desired density" based on cathode structures described in other references.

Petitioner fails to prove the existence of all elements of the Challenged Claims in the cited references and fails to prove that a POSITA would have been motivated to make any of the purported combinations with any expectation of arriving at the claimed subject matter. Accordingly, Patent Owner requests the Board find the Challenged Claims not unpatentable.

II. BACKGROUND¹

A. The '118 Patent claims a two-layer electrode structure with improved safety, increased manufacturability, and higher energy density

The '118 Patent describes a two-layer electrode structure to improve safety when the cell is punctured. Ex. 1001, 2:58-64; Ex. 2015 ¶¶ 46-47; 2058 ¶ 23. The two-layer electrode structure, including a first layer comprising a first material and a second layer comprising a second material, improves safety by reducing the likelihood of the active material delaminating or otherwise separating from the current collector when the battery is punctured, and thereby maintains a barrier between the cathode current collector and the anode to prevent a short circuit. *Id.*, 4:3-12; Ex. 2015 ¶ 48.

III. LEVEL OF ORDINARY SKILL IN THE ART

For purposes of this POR, Patent Owner adopts the definition proposed by Petitioner. Pet, 9; Ex. 2015 ¶¶ 53-55; Ex. 2058 ¶¶ 24-26.

¹ Patent Owner's expert, Dr. Wheeler, provided a technology overview and a summary of the '118 Patent. Ex. 2015, § IV.A-C, ¶¶ 41-52. Dr. Wheeler meets the definition of a POSITA as proposed by Petitioner. Ex. 2058, ¶¶ 1-17, 24-26; Ex. 2015, ¶¶ 7-13.

IV. PETITIONER'S EXPERT IS NOT A POSITA

Petitioner's expert, Dr. Gido, does not meet the definition of a POSITA as presented by Petitioner, at least because Dr. Gido does not have "two years of experience in the field of battery materials and construction." Pet, 9; Ex. 2050, 29:16-30:3, 30:12-16, 31:4-17, 35:15-36:11. Dr. Gido's education did not include any study of batteries (Ex. 2050, 33:14-35:7) and so Dr. Gido's higher level of education is not an adequate substitute for work experience in the field of battery materials and construction. Dr. Gido's experience lies in designing and manufacturing polymers that may be used in batteries or other industries. Dr. Gido admitted that he has not designed or constructed a lithium ion battery at any point in his professional or academic career, has no experience in mixing electrode compositions or compacting electrodes for use in batteries, and has no education focusing on lithium ion battery design or construction. Ex. 2050, 29:16-30:3, 30:12-16, 31:4-17, 35:15-36:11. Because Dr. Gido has no professional experience in the field of battery construction, and his education does not provide an adequate substitute therefore, Dr. Gido is not qualified to provide expert testimony from the perspective of a skilled artisan. *Kyocera Senco Indus. Tools Inc. v. Int'l Trade Comm'n*, 22 F.4th 1369, 1377 (Fed. Cir. 2022).

V. CLAIM CONSTRUCTION

Petitioner does not propose any claim constructions in the Petition. Pet., 9. However, Petitioner's expert, Dr. Gido, presented an understanding of "compaction density" and "average particle size" in his declaration. Ex. 1010 ¶¶ 67-70; *see* Ex. 2058 ¶¶ 18-22. Dr. Gido's understanding of these claim terms distinguish the claims from the cited references. *See* Ex. 2058 ¶¶ 19-22.

For example, Dr. Gido explains that "compaction density" refers to "the density of the electrode active material layer (including all components of this layer: active material powder, binder polymer, and conductive additive)." Ex. 1010 ¶ 68; Ex. 2050, 12:18-13:3; *see* Ex. 2058 ¶ 19. By contrast, Kim focuses on a "press density" of the *active material alone*. Ex. 1009 ¶¶ [0035]-[0037]; *see* Ex. 2058 ¶ 19. The Board agreed with this general distinction—that compaction density refers to the density of an electrode (not only electrode active material) but found Kim's density values to remain instructive of an electrode compaction density. Paper 11, 52-53. Testimony from Dr. Gido undercuts the Board's findings.

During his deposition, Dr. Gido stated that press densities "certainly are not the same thing" as compaction densities, and compaction densities of cathode layers can be lower than Kim's description of active material press densities. Ex. 2050, 124:5-125:18, 128:2-9, 128:19-129:9, 131:4-21. For example, low-density additives (e.g., binders and conductors) in an electrode layer lower the compaction density for

cathodes that include the cathode active material, and compaction pressures for a cathode may differ from what Kim describes for the press density. *Id.* Kim’s discussion of cathode press density values cannot be used as target “compaction density” values for an electrode layer and its included components. Ex. 2058 ¶ 19.

Moreover, Dr. Gido’s explanation that “average particle size” is ambiguous undercuts later testimony regarding particle size distribution. Ex. 2058 ¶¶ 20-21. Dr. Gido states this ambiguity arises “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.” Ex. 1010 ¶ 69. Dr. Gido’s testimony emphasizes that there is a clear distinction between *measuring* a particle size (such as through laser diffraction) and *calculating* a particle size distribution, including an “average particle size.” That is, Dr. Gido is clear that knowing “average particle size” is not enough information to determine the type of particle size distribution used to describe a set of particles.

VI. ARGUMENT

A. Ground 1: Ishigaki does not anticipate claims 1-20

Petitioner fails to establish that Ishigaki discloses each limitation of the independent claims, arranged as is recited in the claims. Instead, Petitioner improperly combines teachings from different and unrelated embodiments from Ishigaki in support of the alleged anticipation rejection. Pet., 9-27; *see* Ex. 2015

¶¶ 59-89; Ex. 2058 ¶¶ 28-82; *see also Blue Calypso, LLC v. Groupon, Inc.*, 815 F.3d 1331, 1341 (Fed. Cir. 2016) (anticipation is not appropriate where a reference does not disclose the claim elements arranged in the same way as the claim). Even still, Petitioner has failed to show that this improper combination of embodiments supports an anticipation rejection, as detailed below.

1. Petitioner fails to show that Ishigaki discloses a particle size of 90% accumulative volume of the first material is less than 40 μm

Each of the independent claims of the '118 Patent, requires, *inter alia*, a first layer comprising a first material, wherein the first layer is arranged between the current collector and a second layer, and *a particle size of 90% accumulative volume of the first material is less than 40 μm* . Ex. 1001, Claims 1, 10, and 19; Ex. 2015 ¶¶ 57, 59; Ex. 2058 ¶ 30.

Petitioner alleges that secondary particles², not the primary particles, disclose “a particle size of 90% accumulative volume of the first material is less than 40 μm .”

² Ishigaki describes positive electrodes formed by depositing one or two electrode layers onto a positive electrode current collecting foil. Ex. 1004 ¶¶ [0345]-[0366]; Ex. 2015 ¶ 60. Ishigaki explains that the positive electrode active material comprises larger “secondary particles” of active material which are formed from aggregating smaller “primary particles.” *Id.* ¶ [0092] (“a slurry obtained by wet-pulverizing a

Pet., 14-15; *see also* Ex. 1010 ¶¶ 81-84; Ex. 2015 ¶ 61; Ex. 2058 ¶ 32. Specifically, Petitioner states that “Ishigaki’s first positive electrode material has particles with 90% *cumulative diameter* less than 10 µm,” and “[t]en microns is less than 40 µm, which meets this limitation.” *Id.* 14-15 (citing Ex. 1004 ¶¶ 38-39, Ex. 1010 ¶ 81); Ex. 2015 ¶ 61; Ex. 2058 ¶ 32. But there is no disclosure in Ishigaki of any particle of Ishigaki having a 90% *accumulative volume*, which is what the claim requires, and the assumption that Ishigaki’s “90% cumulative diameter (D90)” is equivalent to the claimed 90% accumulative volume is simply wrong. Ex. 2015 ¶ 62; Ex. 2058 ¶ 33.

a. Ishigaki does not disclose an accumulated volume distribution

Petitioner points to Ishigaki’s disclosure of “a particle diameter standard as a volume standard” and makes the conclusory statement that “[a] particle size of 90% accumulative volume is a standard metric in the art also known as D90 or Dv90. Ishigaki’s particle size is measured by volume, which corresponds to Dv90 (the volume standard).” Pet., 14; n.1 (internal citations omitted); Ex. 2015 ¶¶ 63-64; Ex. 2058 ¶ 34. But Petitioner misinterprets Ishigaki. Ex. 2015 ¶¶ 65-69; Ex. 2058 ¶ 34. The fact that a particle size is described as *measured* using a laser diffraction device

raw material compound and additive is spray-dried to obtain a powder in which primary particles are aggregated to form secondary particles.”); Ex. 2015 ¶ 60.

using “a particle diameter standard as a volume standard” does not dictate or disclose how a distribution of said particle sizes is defined. Ex. 2015 ¶¶ 69-70; Ex. 2058 ¶¶ 35-41. Indeed, during cross-examination, Dr. Guido admitted that particle size distribution measurements *are not the same* as particle measurements, yet Petitioner provides no evidence that Ishigaki’s laser diffraction measurements are used to calculate a *cumulative volume* particle distribution. *See* Ex. 2050, 17:4-15 (discussing numbers-based and volume-based distributions).

Ishigaki’s reference to “a particle diameter standard as a volume standard” makes clear to a POSITA that Ishigaki is referring to the *measurement* process for determining particle diameters, and *not* the mathematical summary for describing a *distribution* of particle diameters. Ex. 2058 ¶ 36. In Ishigaki’s description of what is meant by “Median Diameter and 90% Cumulative Diameter (D90),” Ishigaki states that its measurements are performed by laser diffraction:

Note that, in the present invention, the 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, with a set refractive index of 1.60a 0.10i, and a *particle diameter standard as a volume standard*. In the present invention, for the dispersion medium used during measurement, measurement was performed using a 0.1 wt% sodium hexametaphosphate aqueous solution.

Ex. 1004 ¶ [0039]; Ex. 2015 ¶ 65; Ex. 2058 ¶ 36. Petitioner asserts that the use of a laser diffraction instrument in Ishigaki *necessarily* stipulates the type of distribution Ishigaki had in mind. Pet., 14-15; Ex. 1010 ¶ 84 (“This type of device and this method of particle size measurement is specifically sensitive to particle volume and thus the median diameter or average diameter it measures is Dv50 and the 90% cumulative diameter it measures is Dv90.”). That is, the sole basis for Petitioner’s theory regarding Ishagaki’s particle distribution is its disclosure of laser diffraction. Yet, as the Director recognized, Petitioner has provided no supporting evidence discussing particle size distributions and conversions, and Petitioner cannot provide such evidence now. Paper 17, 3; *see also Ariosa Diagnostics v. Verinata Health, Inc.*, 805 F.3d 1359, 1368 (Fed. Cir. 2015) (citing 37 C.F.R. § 42.104(b)(5)).

The use of laser diffraction, which is a measurement technique that is used to estimate the size of a particle, is *not* indicative of a particular type of distribution. Ex. 2058 ¶¶ 34-36. Instead, laser diffraction indicates to a POSITA that the diameter of a particle is determined from the estimated volume of the particle. Ex. 2015 ¶ 65 (citing Ex. 1004 ¶ [0039]); Ex. 2058 ¶ 36. As Dr. Wheeler explains, laser diffraction measurements characterize how light is diffracted by a particle, and laser diffraction devices use one of multiple mathematical equations that make assumptions on particle volume to convert the light-characterization data into a particle diameter.

Ex. 2058 ¶ 36. However, the size of a particle is agnostic to the actual distribution—all distributions require particle size measurements.³ Ex. 2015 ¶ 66; Ex. 2058 ¶ 36.

Moreover, laser diffraction devices are well-known to provide users with options for selecting a statistical method for describing the distribution of measured particle sizes. *See e.g.*, Ex. 2046; Ex. 2047; Ex. 2052; Ex. 2053; Ex. 2054; Ex. 2055; Ex. 2058 ¶¶ 37-39. As Dr. Guido recognizes, certain Laser Diffraction devices can generate multiple different particle size distributions, including numbers-based distributions, area-based distributions, volume-based distributions, and others. Ex. 2050, 51:16-52:9. Ishigaki itself provides no indication about which particle distribution is used to describe its “D90” values, and therefore a POSITA would not

³ A POSITA would have understood that the particle distribution can be constructed or defined using multiple statistical approaches, including a volume-based or number-based approach. Ex. 2015 ¶ 67. The number-based distribution is constructed by counting the number of particles within each size range such that equal weight is given to all of the particles regardless of size, whereas the volume-based distribution is constructed by measuring the volume of particles within each size range such that larger particles contribute more to the distribution, given that their volume is greater. *Id.* Either method of defining a particle distribution requires *measuring* the particles, for example, using a laser diffraction instrument. *Id.*

have understood Ishigaki's disclosure as satisfying the claimed recitation of accumulated particle sizes being less than 40 μm . Ex. 2058 ¶¶40-41.

There is no dispute that knowing the type of distribution used is critical to understanding the particle sizes used in an electrode because a POSITA would have recognized that the same set of particles can have very different cumulative-volume, cumulative-number, and cumulative-area distributions. Ex. 2015 ¶ 68; Ex. 2058 ¶¶ 42. Dr. Wheeler describes an example in which a single set of particles can be described by widely varying numbers-based and volume-based distributions. *Id.* Petitioner's expert agreed, and testified that the D90 value of a cumulative number distribution differs substantially from a Dv90 value for the same particle set. Ex. 2015 ¶ 68 (citing Ex. 1010 ¶ 83 "Ishigaki's statement 'cumulative diameter (D90)' may be alleged to be, by itself, insufficient to establish that the parameter Ishigaki is teaching corresponds to Dv90" because "[t]here are multiple ways of 'accumulating' the particle size distribution" and "[t]hese different accumulation averages do not necessarily yield the same number values."); Ex. 2050, 51:16-52:9; Ex. 2058 ¶ 42.

Indeed, a POSITA would have understood that the measured Dv90 value will always be greater than the D90 value for any continuous non-uniform distribution (i.e. for any set of differently-sized particles). *Id.* ¶ 68; Ex. 2058 ¶ 42. Because Ishigaki does not explain what particle size distribution is used to describe its particle sizes, and because Petitioner has not provided any other evidence demonstrating the

type of distribution used by Ishigaki, Petitioner's Ground 1 is fatally flawed, and does not demonstrate that Ishigaki anticipates claim 1 of the '118 Patent. Ex. 2058 ¶ 41.

b. Ishigaki's D90 value corresponds to a number-based distribution

A POSITA would have understood that Ishigaki's D90 value corresponds to a numbers-based distribution, *not* a volume-based distribution. Ex. 2058 ¶¶ 43-50. Ishigaki provides a discussion of the importance of primary particle sizes *and* the importance of secondary particle sizes for achieving Ishigaki's goals. Ex. 1004 ¶ [0041] ("If the average primary particle diameter exceeds the upper limit, powder packing properties may be adversely affected and the specific surface area may be reduced, which may increase the possibility of a decrease in battery performance such as rate characteristics and output characteristics. If the lower limit is exceeded, crystals do not fully develop, which may result in issues such as poor reversibility of charging and discharging."); Ex. 2058 ¶ 44. However, laser diffraction is incapable of measuring primary particles that are agglomerated into secondary particles as described in Ishigaki. *See e.g.*, Ex. 2018 ("In order to get a clear diffraction, it is necessary to have a proper dispersion of the sample. This means that each particle should be visible as a single particle in front of the laser, moving through either liquid medium or air."); Ex. 2058 ¶ 45. Therefore, a POSITA would have understood that an alternative measurement technique, such as particle size

measurement and counting using Scanning Electron Microscope (“SEM”) images would have been used to assemble a primary particle size distribution. Ex. 2058 ¶¶ 45-46. Because SEM images are 2-dimensional images that are incapable of relaying volume information, the resulting primary particle size distributions would be numbers-based distributions based on manual counting of particles at each particle size. Ex. 2058 ¶ 46.

Because Ishigaki discusses the importance of primary particle sizes *and* secondary particle sizes, a POSITA would have understood that all of the particle size distributions would be reported using the same statistical approach, so that the particle sizes of primary particles and secondary particles can be easily compared, even if those particles are measured using different measurement tools. Ex. 2058 ¶¶ 47-48. Thus, because volume-based particle size distributions would have been impossible to assemble for the primary particles, a POSITA would have used a numbers-based distribution to characterize secondary particles for comparison with the primary particle distribution. Ex. 2058 ¶ 48. By extension, Ishigaki’s reported D90 value would correspond to a cumulative number (not volume) distribution. Ex. 2058 ¶¶ 49-50.

2. Petitioner fails to show that Ishigaki discloses a two-layer electrode structure with a compaction density of greater than 3.2 g/cc

Each of the Challenged Claims of the '118 Patent also requires, *inter alia*, a first layer and a second layer, wherein a total compaction density of the first layer and the second layer is greater than 3.2 g/cc. Ex. 1001, Claims 1, 10, and 19. Ishigaki does not teach the claimed compaction density. Ex. 2015 ¶ 78 Ex. 2058 ¶ 51. The only time Ishigaki discloses “mixture density” values for two-layer electrode structures, Ishigaki *only describes a density value of 2.4 g/cc*. Ex. 1004 ¶ [0366]; Ex. 2015 ¶ 86; Ex. 2058 ¶ 52. A density value of 2.4 g/cc is not a compaction density of greater than 3.2 g/cc.

a. Compaction densities of single-layer electrode structures do not disclose compaction densities of two-layer electrode structures

Ishigaki does not disclose a *two-layer electrode* structure that has a compaction density value of greater than 3.2 g/cc. Ex. 2058 ¶¶ 53-60. Thus, Ishigaki cannot anticipate claim 1 of the '119 Patent. Ex. 1001, 6:20-27 (“To ensure the energy density of a lithium-ion battery, it is required that the positive electrode has a higher compaction density, the compaction density of the first active material layer is greater than 2.8 g/cc, the compaction density of the second active material layer is greater than 3.3 g/cc and the compaction density of the all [*sic*] active material layers is greater than 3.2 g/cc.”).

To the extent it is argued that Ishigaki discusses a density range with an upper limit approaching the theoretical maximum density of an electrode active material (*see* Pet. 16), a POSITA would recognize that Ishigaki provides these density values for *single-layer* electrode structures, and does not provide any discussion of compaction density ranges for the disclosed two-layer electrode structure of Ishigaki or to two-layer electrode structures generally. Ex. 2058 ¶¶ 53-55. Even Dr. Gido admits that, at best, Ishigaki's density ranges *are only applicable to the first layer of a two-layer electrode structure*. Ex. 2050, 107:5-108:3.

Regarding “mixture density” values, Ishigaki states:

The **mixture density** of the electrode of the present invention is characterized as 2.0 g/cm³ or more, and from the viewpoint of increasing capacitance density, it is preferably 2.0 g/cm³ or more, and particularly preferably 2.5 g/cm³ or more. The upper limit is not particularly limited, but since 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.

The thickness of **the positive electrode active material layer** is usually about 10 to 200 μm.

Ex. 1004 ¶ [0025] (emphasis added).

Paragraph [0025] in Ishigaki provides a range of densities for “the positive electrode” in which “[t]he thickness of *the* positive electrode active material *layer* is

usually about 10 to 100 μm .” *Id.* (emphasis added). In other words, this disclosure *only* refers to a *single* “positive electrode active material *layer*.” *Id.* (emphasis added); Ex. 2015 ¶ 81; Ex. 2058 ¶¶ 54-55. This disclosure of Ishigaki does not indicate that the positive electrode includes multiple layers, nor does this disclosure provide a total density for a two-layer electrode structure. *Id.* That is, this disclosure of Ishigaki is careful to specify that the provided densities apply only to a *single layer structure* with a particular thickness. *Id.* A POSITA would therefore have understood that Ishigaki’s disclosed density range in paragraph [0025] applies only to a single-layer electrode structure. *Id.*

Further, regarding “electrode density” values, Ishigaki states:

The **electrode density** of the positive electrode after pressing has a lower limit of normally 2.0 g/cm³ or more, preferably 2.4 g/cm³ or more, and 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.

Note that **the positive electrode active material layer** obtained by coating and drying is preferably compressed by a roller press or the like in order to increase the packing density of the positive electrode active material.

Thus, the positive electrode for lithium rechargeable batteries of the present invention can be prepared.

Ex. 1004 ¶ [0151] (*emphasis added*).

Paragraph [0151] of Ishigaki provides a range of densities for “the positive electrode after pressing” in which “*the positive electrode active material layer* [is] obtained by coating and drying [and] is preferably compressed by a roller press.” *Id.* (emphasis added). In other words, this disclosure also *only* refers to a *single* “*positive electrode active material layer*.” *Id.* (emphasis added); Ex. 2058 ¶¶ 53-55. This disclosure of Ishigaki does not indicate that the positive electrode of Paragraph [0151] includes multiple electrode layers, nor does this disclosure provide a total density for multiple electrode layers. Ex. 2015 ¶ 81; Ex. 2058 ¶¶ 54-55. Indeed, this disclosure of Ishigaki is careful to specify that the provided densities apply only to a single layer electrode structure that is preferably compressed by a roll press. *Id.* A POSITA would therefore interpret this disclosure consistently with Ishigaki’s paragraph [0025]: describing a density range applicable to a single-layer electrode structure. *Id.*

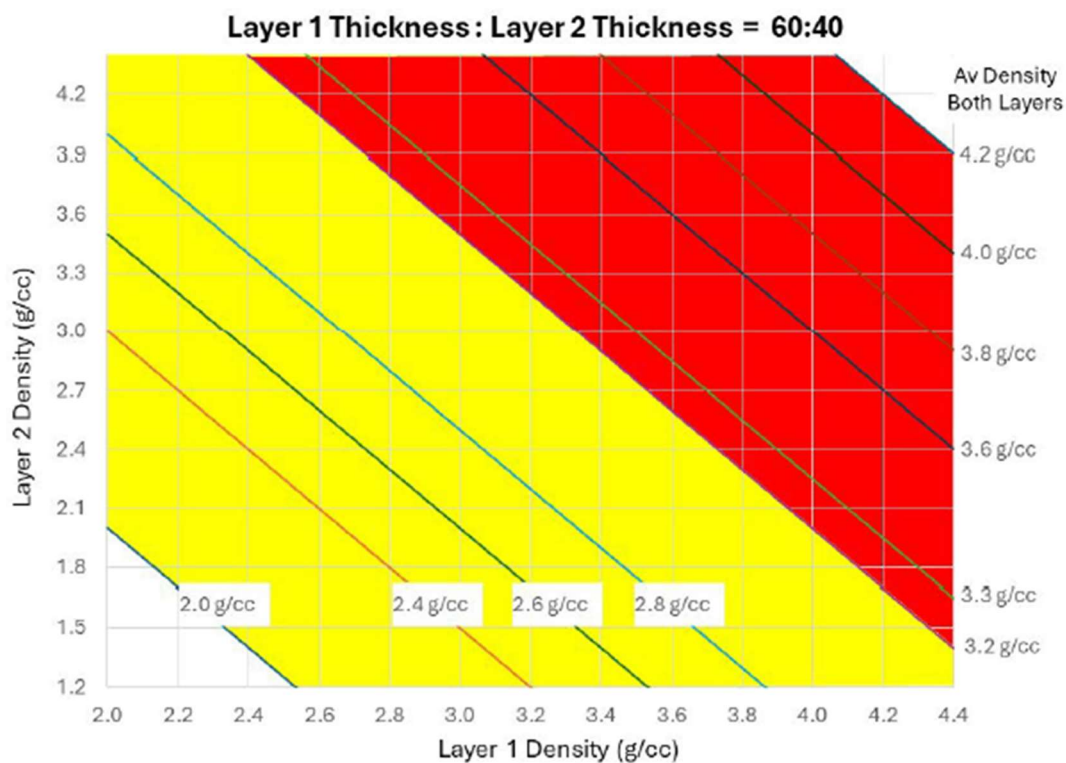
Dr. Guido confirms that Ishigaki’s discussion at paragraphs [0024]-[0025] and [0151] (reciting “mixture density” and “electrode density” values, respectively) are provided for a “single layer or [] the first layer of 2 layers.” Ex. 2050, 107:2-108:3. Ishigaki does not provide any separate discussion of compaction density values for a second layer, and so these single-layer density values cannot anticipate “a first layer and a second layer, wherein a total compaction density of the first layer and the second layer is greater than 3.2 g/cc.” Pet., 15-18; *see also e.g.*, Ex. 1010 ¶¶ 87-

88 (citing Paragraphs [0025] and [0151] of Ishigaki, which disclose densities of single-layer electrode structures).

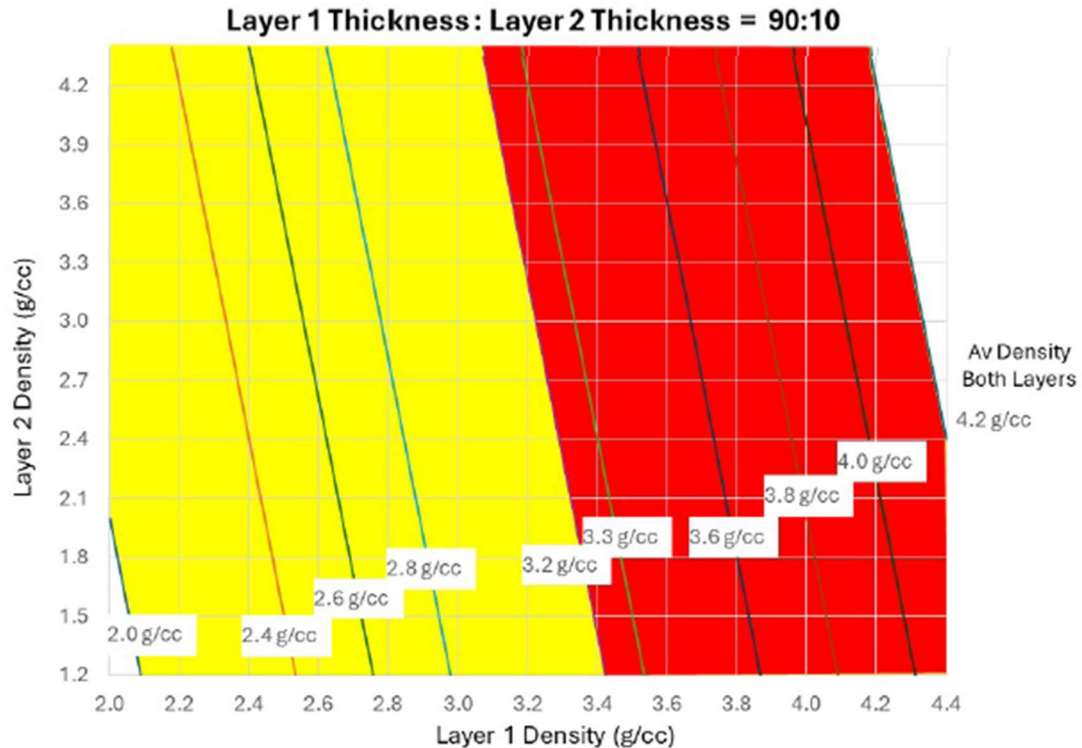
As such, nothing in Ishigaki would lead a POSITA to consider the range of densities described in paragraphs [0025] and [0151] (described for single-layer electrode embodiments) as being applicable to a two-layer electrode structure, and neither Petitioner nor Dr. Gido provide any arguments to explain why a POSITA would apply single-layer electrode embodiments to a two-layer electrode structure. Ex. 2015 ¶¶ 81-84; Ex. 1004 ¶¶ [0025], [0151]; Ex. 2058 ¶¶ 56-60.

b. Dr. Gido's Demonstratives are not supported by Ishigaki

Dr. Gido provides Demonstratives (shown below) that suggest that Ishigaki's two-layer electrode structures can include individual layers that *exceed the 4.2 g/cc* maximum disclosed in Ishigaki. The Demonstratives are contrary to Ishigaki's disclosure. Ex. 2058 ¶¶ 61-65.



Gido Demonstrative 7.



Worse, Dr. Gido admitted during his deposition that his Demonstratives include embodiments that are not disclosed by Ishigaki, *and* include certain embodiments that may not be physically possible. Ex. 2050, 112:22-114:4, 115:12-118:3; Ex. 2058 ¶ 75. Dr. Gido was unable to distinguish between physically possible and physically impossible data points on these Demonstratives, thereby rendering these illustrations of no value in visualizing Ishigaki's teachings. *Id.*

Moreover, while these demonstratives suggest that Ishigaki discloses density ranges to two-layer electrode structures, Ishigaki makes no such disclosure. Indeed, a POSITA would not have understood that Ishigaki's single-layer electrode densities would have been applicable to a two-layer electrode structure. Ex. 2015 ¶ 82; Ex.

2058 ¶¶ 57, 66-67. For example, a POSITA would have understood that when Ishigaki's second, wet electrode layer is applied to Ishigaki's first, pre-dried layer, the solvent of the second layer re-wets the first layer, causing the two layers to partially mix and to change the compaction of the first layer. *Id.* (citing Ex. 1004 ¶ [0366]); *see also* Ex. 2019, 51; Ex. 2058 ¶ 57. Dr. Gido did not recognize this physical phenomenon occurs when forming multi-layer electrodes. Instead, Dr. Gido provided an inaccurate analogy, suggesting that cathode materials are akin multiple layers of "paint" wherein a first layer would generate a permanent "skin" that would remain after the second layer is coated thereon. Ex. 2050, 23:3-16, 79:9-80:19; Ex. 208 ¶ 57-58. Dr. Gido's failure to recognize the physical characteristics of cathode materials can be explained by the fact that he has never manufactured a lithium ion electrode, and so his testimony should be ignored. Ex. 2050, 29:16-30:3, 30:12-16, 31:4-17, 35:15-36:11.

Ishigaki's examples only discuss one two-layer electrode structure, which has a density of 2.4 g/cc, which is below 3.2 g/cc or higher regions in Dr. Gido's Demonstratives. Ex. 1004 ¶ [0366]; Ex. 1010 ¶¶ 90-92, as well as Demonstratives 7 and 8; Ex. 2058 ¶¶ 71, 74. Ishigaki's examples make clear that the density of the two-layer electrode structure *is less* than the densities of the single-layer electrode structures, which are *well below* the claimed 3.2 g/cc compaction density. *Id.* ¶¶ 85-87 (citing Ex. 1004 ¶¶ [0348]-[0349], [0356]-[0357], [0361]-[0363], [0366]); Ex.

2058 ¶¶ 71, 74. A POSITA would have recognized that Ishigaki intentionally uses a lower compaction density value for the two-layer electrode structure, which ensures that each layer has a different structure. Ex. 2058 ¶¶ 66-70.

Thus, contrary to Petitioner’s assertion that “Ishigaki instructs a POSA to choose the highest density possible in order to maximize energy capacity,” (Pet., 17) Ishigaki never states that two-layer electrode structures would have density values above 3.2 g/cc. Ex. 2015 ¶¶ 85-87; Ex. 2058 ¶ 71. Ishigaki’s only mention of a total density for a two-layer electrode structure suggests working in the *lower* density ranges provided in Ishigaki; specifically below 2.6 g/cc. *Id.* ¶ 88; Ex. 2058 ¶ 72. Neither Petitioner nor its expert addresses Ishigaki’s examples or provides any explanation as to why the only two-layer electrode structure example in Ishigaki is (1) at the lower limit of Ishigaki’s disclosed range, (2) lower than all other disclosed examples, and (3) well below the claimed 3.2 g/cc compaction density. *Id.*; Ex. 2058 ¶ 72.

Even if Petitioner’s assertion were true—that Ishigaki instructs a POSITA to choose “the highest density possible,” a POSITA would have recognized that the highest density *possible* is limited by factors beyond the theoretical density of the active material, particularly for a two-layer electrode structure. Ex. 2058 ¶ 73. One such factor is highly porous secondary particles. Ex. 1004, Claim 5, ¶¶ 26, 29, 30, 80, 81, 86, 87, 94, 103, 109; Ex. 2058 ¶¶ 68-70. The pores within those secondary

particles effectively lower the maximum possible density achieved in a compacted electrode below the maximum theoretical density of the electrode active material.

Ex. 2058 ¶¶ 68-69. Dr. Gido's demonstratives ignore these limiting factors.

Two-layer electrode structures add other complexities, as two-layer electrode structures may incorporate *different structures* in each layer. Ex. 2058 ¶ 70; *see also* Ex. 2029. Different structures, such as different active materials, different porosities, and/or different mixtures of additives would all result in different densities among the first and second layers—again, limiting the maximum *possible* density to a value well-below the maximum theoretical density values recited in Ishigaki's ranges. *Id.* Dr. Gido's demonstratives (including Demonstratives 7 and 8 on page 42 of his declaration) ignore this distinction, and misleadingly suggest (a) that it is possible to achieve a density of 4.4 g/cc based on Ishigaki's disclosure (despite Ishigaki never disclosing a density above 4.2 g/cc), (b) that it is possible to achieve identical densities in both layers of a two-layer electrode structure, despite Ishigaki's teaching that each layer should have a different structure, and (c) that it is possible to achieve a combined average density of greater than 3.2 g/cc, even though Ishigaki's only disclosure of a two-layer electrode structure has a density of 2.4 g/cc. Ex. 2058 ¶¶ 61-76. Ishigaki's teaching to achieve a maximum *possible* compaction density cannot be viewed in a vacuum, and must be considered in the context of the other structural consideration of the intended electrode structure. Ex. 2058 ¶ 70. Without

context of the exact electrode structure to be achieved, a POSITA would interpret such a teaching to achieve high densities only through single-layer electrode structures, and not through two-layer electrode structures as recited in the claims of the '118 Patent. *Id.*

c. Ishigaki's compaction density ranges maintain space to hold electrolyte in a single-layer electrode structure

Petitioner also asserts that “Ishigaki further explains why the preferred boundaries [of the provided density ranges] are what they are,” because Ishigaki states that “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.” Pet., 17 (citing Ex. 1004 ¶ [0025]). But this assertion is a red herring. Ex. 2015 ¶¶ 83-84; Ex. 2058 ¶¶ 77-78.

A POSITA would have understood that Ishigaki's discussion of leaving space to “hold the electrolyte” is not informative of the density of a two-layer cathode structure. Ex. 2058 ¶ 77. The compaction density values provided in Ishigaki would have left adequate space “to hold the electrolyte” *in a single layer* based on the particle size distribution, active material densities, and additive concentration. Ex. 2015 ¶ 84 (citing Ex. 1004 ¶ [0025]); Ex. 2058 ¶ 77. However, this reasoning does *not* suggest that two-layer electrodes necessarily have the same density values. Indeed, two-layer electrode structures may vary the space for holding the electrolyte

in each layer to provide different ion movement characteristics therein. Ex. 2058 ¶ 77. This is an added variable of two-layer electrode construction, and Petitioner does not explain or provide evidence as to why Ishigaki's disclosed compaction density values for single-layer electrode structures would have been suitable for providing space within each layer of a two-layer electrode structure. Ex. 2015 ¶¶ 83-84; Ex. 2058 ¶ 77.

Thus, Petitioner has failed to show that Ishigaki discloses a compaction density value greater than 3.2 g/cc for all electrode layers in the two-layer electrode structure. *Id.* ¶ 89; Ex. 2058 ¶ 78.

3. Claims 2-9, 11-18, and 20 are not unpatentable

Claims 2-9, 11-18, and 20 are not unpatentable for at least the same reasons as discussed above with respect to independent claims 1, 10, and 19.

a. Claims 5 and 14

Moreover, Ishigaki does not disclose claims 5 and 14. As pointed out in reference to the independent claims, Ishigaki does not disclose a range of density values for a two-layer electrode structure. Ex. 2058 ¶ 80. Dr. Gido agreed that the density ranges in Ishigaki are disclosed for a single-layer electrode structure or the first layer of a two-layer electrode structure. Ex. 2050, 107:2-4 (when asked if paragraph [0025] of Ishigaki discusses multiple layers, Dr. Gido stated, "It is talking about a layer."); Ex. 2050, 107:5-108:3 (when asked if paragraph 151 of Ishigaki

discusses a single layer, Dr. Gido stated “Yes. And well in reading this, when I read it and also a POSA when they would read it, would understand that this is either a single layer or it is the first layer of 2 layers, because further on down they put the second layer on, so either.”). Ishigaki only discloses one compaction density value for a two-layer electrode structure: Ishigaki’s Example 2 has a combined density of 2.4 g/cc. Ex. 1004 ¶ [0366]. Thus, contrary to Petitioner’s assertions, Ishigaki does not “lead[] to a range of combinations for the individual densities of layers 1 and 2,” (Ex. 1010 ¶ 121) and by extension, cannot anticipate “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.” as recited in claims 5 and 14. Ex. 2058 ¶ 80.

b. Claims 6, 15, and 20

With respect to claims 6, 15, and 20, which recite “wherein the first layer has a lower compaction density than the second layer,” Petitioner points to Ishigaki’s discussion of bulk densities of Ishigaki’s active materials that can be mixed into electrode layers. Pet., 23. However, the bulk density of an active material is merely a manner of comparing characteristics of different electrode active material powders – but it does not inform how much a complete electrode is ultimately compacted. Ex. 2058 ¶ 81.

Petitioner also relies on additional Demonstratives (Demonstratives 11 and 12, at Pet., 24) created by Dr. Gido to suggest that Ishigaki’s disclosed compaction

density ranges would anticipate these dependent claims. Ex. 2058 ¶ 82. However, like Dr. Gido's prior Demonstratives, these show compaction densities *not disclosed by Ishigaki* (e.g., compaction densities above 4.2 g/cc). *Id.* And more generally, Dr. Gido's mathematical calculations do not demonstrate that Ishigaki discloses an embodiment in which the Layer 1 electrode density is lower than the Layer 2 electrode density, nor does Dr. Gido explain whether such a combination would be physically possible based on Ishigaki's disclosure. *Id.* Accordingly, Petitioner has not demonstrated that claims 6, 15, and 20 are anticipated by Ishigaki.

B. Ground 2: Ishigaki and Kim do not render obvious claims 1-20

Petitioner relies on the disclosure of Ishigaki for all elements of independent claims 1, 10, and 19, except for elements [1.5], [10.5], and [19.5], which recite, wherein a total compaction density of the first layer and the second layer is greater than 3.2 g/cc, for which Petitioner allegedly relies on the disclosure of Kim. Pet., 27-31; *see also* Ex. 1010 ¶¶ 216-220; Ex. 2058 ¶¶ 83-86. However, Kim fails to make up for the shortcomings of Ishigaki outlined above. In addition, Ishigaki and Kim fail for at least the following reasons.

1. Kim does not disclose or teach multi-layer electrodes

Kim describes a “composite cathode active material” consisting of a mixture of large diameter and small diameter active materials. Ex. 1009 ¶ [0024]. Such a mixture “in a specific particle diameter ratio and in a specific weight ratio may

improve volume density, and thus leading to further increased electrical capacity of a lithium battery.” *Id.* ¶ [0035]. Kim never mentions multi-layer electrode structures and therefore necessarily fails to disclose a two-layer electrode structure (including choosing material for each layer and compaction densities for each layer). Ex. 2058 ¶¶ 87-88. Dr. Guido acknowledges this, explaining that Kim is directed to a composite cathode active material for use in “a single active material layer.” Ex. 1010 ¶ 65; *see also* Ex. 1009, Abstract. As such, the teachings of Kim fail to address the shortcomings of Ishigaki identified above.

2. Kim does not teach the density of an electrode layer

Petitioner argues that “Kim teaches a cathode layer density of 3.31 g/cc or greater, and of 3.4 to 4.0 g/cc.” Pet., 28. Not true. Ex. 2058 ¶¶ 89-98.

Kim discloses a “press density” of a composite cathode *active material*. Kim defines “press density” as “an apparent press density when the composite cathode active material powder is pressed at a pressure of 2.5 ton/cm².” Ex. 1009 ¶ [0037]. As the Board recognized, press density is *not* a compaction density of a complete electrode layer. Paper 11, 52-53; *see also* Ex. 2058 ¶¶ 89-92. Even though Kim separately describes that a process of manufacturing a cathode includes mixing the composite cathode active material with additives and pressing into sheet form, Kim does *not* specify a compaction density (or even a compaction pressure):

The slurry was coated on an aluminum (Al) current collector using a doctor blade, to a thickness of about 200 μm. The coated slurry was

dried at room temperature, and then dried again under a vacuum at about 110° C., thereby preparing a cathode plate. *The cathode plate was pressed into a sheet form using a roll press.*

Ex. 1009 ¶ 80; Ex. 2015 ¶¶ 96, 100-106; Ex. 2058 ¶ 90.

Kim never describes a compaction density value of a complete electrode. Even Kim's discussion of *disassembled complete batteries* only discloses measuring the press density after "the *cathode active material* was extracted therefrom." Ex. 1009 ¶ [0094] ("after disassembling each of the charged coin cells, the *cathode active material* was extracted therefrom, and then analyzed using a differential scanning calorimeter (DSC). The analysis results are shown in Table 1 and FIG. 1."). Table 1 includes press density values. See Ex. 1009 ¶¶ [0036] (Kim describing that "a press density of *the composite cathode active material* may be about 3.31 g/cm³ or greater"); [0040] (Kim describing that "*the composite cathode active material*, a conducting agent, a binder, and a solvent are mixed to prepare *the cathode active material composition*."); Ex. 2015 ¶¶ 101-106. Petitioner's own expert, Dr. Gido, undercuts the reliance on "press density" as he explains that "compaction density" should be interpreted to refer to the total compaction density of an electrode, including all components thereof. Ex. 1010 ¶ 68 (compaction density refers "to the density of the electrode active material layer (including all components of this layer: active material powder, binder polymer and conductive additive)."); see also Ex. 2050, 122:1-5, 124:5-125:18, 128:2-9, 128:19-129:9, 131:4-21; Ex. 2058 ¶ 19. Dr.

Gido confirms that these materials can structurally change during compaction, including “deformation of the binder material, rearrangement and change to the packing of particles, and reduction in void volume, i.e., porosity, of the material.”

Id.

Press density values (alternatively referred to in Kim as “volume density of the composite cathode active material”) of the *active material alone* are not indicative of a compaction density of entire electrode composition, which may include additives such as binders and conductors. Ex. 1009 ¶ [0036]; Ex. 2050, 128:2-9, 128:19-129:9, 131:4-21; Ex. 2058 ¶ 19. These binders and conductors have much lower densities—1.8g/cc—and so mixing these additives with an active material will cause the resulting mixture to have a density that is *much lower* than the active material alone, even after compression. Ex. 2050, 128:2-9, 128:19-129:9, 131:4-21; Ex. 1010 ¶ 85. As such, the press density of the active material alone would be much different than the compaction density of entire electrode composition. Ex. 2058 ¶ 89.

A POSITA would have understood that creating a complete electrode (e.g., cathode) would have required *mixing binder and conductor material with the active material before compaction*, such that Kim’s press densities are not informative of electrode compaction densities. *Id.* Moreover, a POSITA would have recognized that Kim’s 2.5 ton/cm² pressure used to test press density would have created a low-

porosity material unsuitable for use in a complete cathode. *Id.* ¶¶ 90-91. Without explicit guidance in Kim, a POSITA would have sought to test various levels of porosity (and by consequence, various lower density values) in the complete electrode based on desired discharge performance. *Id.* ¶¶ 93-97. Kim never explains what electrode compaction density was used in a complete electrode, nor provides any suggestion about compaction densities usable for complete electrodes. The Petition incorrectly assumes that Kim teaches an overall compaction density of an electrode, and does not explain how Kim's disclosure would teach a POSITA to provide an electrode including binder and conductor, that has a density greater than 3.2 g/cc. *Id.*

3. Petitioner does not show that a POSITA would have been motivated to combine Ishigaki and Kim

Petitioner's proposed motivation to combine Ishigaki and Kim stands on unstable foundation. Petitioner asserts that "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." Pet., 29; Ex. 2015 ¶¶ 95-96. Contrary to Petitioner's assertions, Kim discusses neither two-layer electrode structures nor compaction densities of electrodes *at all*. Ex. 2058 ¶¶ 99-101. Accordingly, Ground 2 of the Petition must fail.

As discussed with respect to Ground 1, Ishigaki teaches that two-layer electrode structures are provided with *lower* densities as compared with single-layer

electrode structures for the electrodes discussed therein (*below* 3.2 g/cc). Section VI.A.2, *supra*; *see also* Ex. 2015 ¶¶ 87-88, 95, 97-98; Ex. 2058 ¶ 100. Indeed, and fatal to Petitioner's case, Ishigaki's *only* disclosure of compaction density values for two-layer electrode structures has a density of 2.4 g/cc (below the density values provided for single-layer electrode structures). Ex. 1004 ¶¶ [0348]-[0349], [0356]-[0357], [0361]-[0363], [0366]; Ex. 2058 ¶ 100.

What's more, Ishigaki teaches that densities *well below* 3.2 g/cc are sufficient to meet Ishigaki's objectives. Ex. 2015 ¶ 97 (citing Ex. 1004 ¶¶ [0382]-[0383]); Ex. 2058 ¶¶ 102-104; *see also R.J. Reynolds Vapor Co. v. Fontem Holdings I B.V.*, IPR2016-01692, Paper 45 (P.T.A.B. Mar. 2, 2018) (finding no motivation to combine where the prior art already disclosed a reliable solution); *BMW of North America, LLC v. Carrum Techs., LLC*, IPR2019-00902, Paper 10 (P.T.A.B. Oct. 18, 2019).

Given that Kim does not discuss two-layer electrode structures, or electrode compaction density values *at all*, Kim does not provide any insight into what compaction density values would, or even could, have been usable with Ishigaki's two-layer electrode structure. Ex. 2058 ¶ 204. As such, Petitioner has no basis to combine these two references.

Therefore, a POSITA would have understood that the density values discussed in Kim are only relevant to the composite cathode active material discussed in Kim,

which encompasses multiple active materials having different particle size distributions in a single-layer. Ex. 2015 ¶ 109; Ex. 2058 ¶ 105.⁴ The total compaction density of a complete electrode (such as a mixture of active materials as is the case in Kim) will be different from the total compaction density of multiple layers within a two-layer electrode structure (as is the case in Ishigaki). *Id.* (citing Ex. 1009 ¶¶ [0006], [0035]); *see also* Ex. 1010 ¶ 65, *see also* Ex. 2040; *see also* Ex. 2058 ¶ 105. As such, Kim's densities would not have been applicable to Ishigaki's two-layer electrode structure. *Id.* ¶¶ 109-112.

Lastly, Kim and Ishigaki are directed to different problems. Ishigaki focuses on including recesses in a cathode to prevent short circuits. While Ishigaki explains that this geometry is usable with two-layer electrode structures, Ishigaki does not

⁴ A POSITA would have understood that electrode composition and active material particle size impact the density of an electrode layer. Ex. 2015 ¶¶ 112, 119-121. That is, the active material composition limits the theoretical maximum compaction density, and the active material particle size limits the porosity (e.g., smaller particles can fit in the gaps or interstitial spaces between the larger particles, thus decreasing the porosity and increasing possible compaction density). Ex. 2015 ¶ 112.

explain what compaction density values are usable with two-layer electrode structures. That is not the focus of Ishigaki.

In contrast, Kim aims to maximize energy density by mixing two different active materials into an otherwise homogenous positive electrode used in a single layer. Ex. 2015 ¶ 127 (citing Ex. 1009 ¶ [0006]); Ex. 2058 ¶ 104. Kim does not address whether different compaction densities of an electrode composition would yield different performance. Worse, Kim does not disclose electrode composition compaction density values at all.

Therefore, neither Ishigaki nor Kim was concerned with the specific performance of two-layer electrode structures, and so neither reference includes adequate information that would have led a POSITA to create a two-layer electrode structure, let alone a two-layer electrode structure having a compaction density greater than 3.2 g/cc. Therefore, Petitioner has failed to show that the combination discloses a two-layer electrode structure having a compaction density greater than 3.2 g/cc or would have motivated a POSITA to pursue compaction densities above 3.2 g/cc. Ex. 2015 ¶ 124; Ex. 2058 ¶ 106.

4. The '118 Patent's claimed density ranges are critical

The '118 Patent describes a two-layer electrode structure that can improve safety by avoiding internal short circuits of the lithium-ion battery caused by external forces puncturing the battery. Ex. 1001, 1:45-49; Ex. 2058 ¶ 108. The '118 Patent

also explains that its specific electrode compaction densities, including a total compaction density of the first layer and the second layer is greater than 3.2 g/cc, ensures, and is required to achieve, the desired energy density of a lithium-ion battery. *Id.* 6:4-27; Ex. 2058 ¶ 108.

Specifically, the '118 Patent states:

Since the positive electrode active material of the first active material layer has a small particle size, the compaction density thereof will be relatively low. Therefore, in order to achieve a high energy density of the lithium-ion battery, the thickness of the second active material layer needs to be increased, and the thickness of the second active material layer is increased, e.g., to 30 µm or more. The thicker the second active material layer, the higher the energy density of the lithium-ion battery.

...

To ensure the energy density of a lithium-ion battery, it is required that the positive electrode has a higher compaction density, the compaction density of the first active material layer is greater than 2.8 g/cc, the compaction density of the second active material layer is greater than 3.3 g/cc and ***the compaction density of the all [sic] active material layers is greater than 3.2 g/cc.***

Id.; see also Ex. 2015 ¶¶ 122, 130-131.

With respect to the combination of Ishigaki and Kim (and similarly the combinations of Wang and Saka and Wang and Li), neither Petitioner nor its expert explains that a POSITA would have known of the unexpected benefits discovered by the inventors of the '118 Patent to seek out a two-layer electrode structure having

a density greater than 3.2 g/cc based on the disclosures of Ishigaki, Kim, or otherwise. Ex. 2015 ¶¶ 123, 132; Ex. 2058 ¶ 107-114. Indeed, Ishigaki never mentions a compaction density value greater than 3.2 g/cc for a two-layer electrode structure. *Id.* ¶¶ 132-133. As discussed above, Kim focuses on comparing density characteristics of composite active materials and does not discuss two-layer electrode structures or electrode compaction densities.

Thus, Ishigaki and Kim fails to render obvious the claimed density ranges, and because Ishigaki's disclosure is directed to a completely different problem (too many recesses), Ishigaki's disclosure would not lead a POSITA to the '118 Patent's critical range of density values for a two-layer electrode structure, and instead teaches away from using values higher than 2.6 g/cc. *Id.* ¶ 139; Ex. 2058 ¶ 110-111.

5. Claims 2-9, 11-18, and 20 are not unpatentable

Claims 2-9, 11-18, and 20 are not unpatentable for at least the same reasons as discussed above with respect to independent claims 1, 10, and 19. Ex. 2058 ¶ 115.

a. Claims 5 and 14

As discussed above, Kim does not discuss a two-layer electrode structure, nor does Kim discuss electrode compaction densities at all. Ex. 2058 ¶¶ 115-116. As discussed above, a POSITA would not interpret Kim's electrode active material press densities as being compaction densities. Accordingly, a POSITA reviewing Kim and Ishigaki would not have determined that Kim suggests "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.” as recited in claims 5 and 14.

Moreover, as discussed above, the claimed density values are critical, including the overall “compaction density of the all [*sic*] active material layers is greater than 3.2 g/cc” *and* the recited “compaction density of the first active material layer is greater than 2.8 g/cc, [and] the compaction density of the second active material layer is greater than 3.3 g/cc.” Ex. 1001, 6:20-27; Ex. 2058 ¶ 117. These values “ensure the energy density of a lithium-ion battery” remains high, while satisfying the ’118 Patent’s discussion that the described two-layer electrode structure improves safety by avoiding internal short circuits caused by external forces puncturing the battery. *Id.* 3:21-30, 6:20-27. These density values are critical to ensuring appropriate energy density, since “the positive electrode active material of the first active material layer has a small particle size, the compaction density thereof will be relatively low.” *Id.*, 6:4-27. Neither Petitioner nor Dr. Guido explains that a POSITA would have known of the unexpected benefits discussed in the ’118 Patent for a two-layer electrode structure satisfying claims 5 and 14 based on Ishigaki or Kim. Therefore, these references fail to render obvious the claimed ranges in dependent claims 5 and 14.

b. Claims 6, 15, and 20

Petitioner relies entirely on the disclosure of Ishigaki as allegedly teaching these the limitations of these claims. For at least those reasons discussed in reference to Ground 1, Ishigaki and Kim, do not suggest “wherein the first layer has a lower compaction density than the second layer.” *See* Ex. 2058 ¶¶ 115, 118.

C. Ground 3: Wang and Saka do not render obvious claims 1-20

Petitioner fails to establish that Wang in view of Saka teaches each limitation of the independent claims, or that a POSITA would be motivated to combine those references. Ex. 2015 ¶ 141; Ex. 2058 ¶¶ 119-120.

1. Petitioner fails to show why a POSITA would have had a “desired density in mind” greater than 3.2 g/cc when combining Wang and Saka

Petitioner relies on the disclosure of Wang for all elements of independent claims 1, 10, and 19, except for elements [1.5], [10.5], and [19.5], which recite, “wherein a total compaction density of the first layer and the second layer is greater than 3.2 g/cc,” for which Petitioner relies on the disclosure of Saka. Pet., 43-46. Absent actual disclosure, Petitioner leans heavily on silence—the fact that Wang “does not provide values for the density that results from that compression” (Pet., 36) and argues that “Wang assumes the reader already has *a desired density in mind*.” Pet., 43-44 (citing Ex. 1010 ¶ 276) (emphasis added). However, a POSITA would have recognized that Wang’s disclosure is comprehensive and Wang’s porosity targets are informative of electrode densities, such that a POSITA need not have a

density “in mind” to understand Wang’s disclosure. Ex. 2058 ¶ 121. Wang reaches these porosity targets by calendering “at least one of the first porous layer 210 and the second porous layer 220 ... to *increase the density of and decrease the porosity of* the first porous layer 210 and/or the second porous layer 220.” Ex. 1005 ¶ [0058]; Ex. 2015 ¶ 143. In other words, Wang discusses density and “compression steps” as a way of describing how to achieve an electrode structure satisfying the target porosity values. Ex. 2015 ¶ 143 (citing Ex. 1005 ¶¶ [0058], [0067], [0073], [0092]); Ex. 2058 ¶¶ 121-122. Wang’s discussion of “compression steps” does not suggest that higher density/lower porosity would be desirable, and so nothing in Wang would have led a POSITA to seek out a “desired density” that is greater than 3.2 g/cc. *Id.*

Petitioner’s assertion that the lack of numerical density values in Wang would motivate a POSITA “to look to another reference, such as Saka, for numerical values,” is misguided. Pet., 37; Ex. 2015 ¶ 145. A POSITA would not need a density “in mind” to implement Wang’s disclosed porosity target, and a POSITA would have recognized that Wang’s disclosure suggests that higher porosity/lower density values are desirable for increased rate performance. Ex. 2058 ¶¶ 121-123, 134

Even if a POSITA reviewing Wang had a “desired density in mind,” that density is defined by Wang’s porosity values, active material selection, particle size selection, binder selection, conductor selection, and other characteristics of the specific electrode materials described in Wang—not based on disclosure in a

separate reference. Ex. 2015 ¶¶ 148-151; Ex. 2058 ¶ 121. Wang acknowledges this by stating “the cathode electrodes have graded properties, such as, porosity, conductivity, particle size, and combinations thereof that vary throughout the cathode electrode structure,” and “it is desirable to modify the properties of the cathode electrode through the inclusion of additives such as conductive additives and/or binding agents ... the graded properties of the cathode electrode may be further modified during the manufacturing process through the use of such techniques as calendaring, annealing, and various drying processes.” Ex. 1005 ¶ [0035]; *see also e.g.*, Ex. 1005 ¶¶ [0051] (Wang describing that particle size impacts density), [0058] (Wang describing that porosity impacts density), [0086] (Wang describing that particle shape impacts density); *see also* Ex. 2058 ¶ 121.

a. A POSITA would not look beyond Wang for a “desired density”

As discussed above, a POSITA would not need to have a “desired density in mind” when reviewing Wang’s discussion of porosity targets. That is, a POSITA would not have “look[ed] to another reference, *such as Saka*, for numerical values of a desired cathode density.” Ex. 2058 ¶¶ 124-130. A POSITA would have recognized that implementing high density values disclosed in other references would teach away from Wang’s disclosure of increasing porosity in a graded electrode. Ex. 2015 ¶¶ 152-155.

Wang discloses a list of available active materials and additives that can be used in an electrode structure constructed according to Wang's disclosure (Ex. 1005 ¶¶ [0043], [0051]-[0053]), but Petitioner does not discuss how these active materials and additives would impact the maximum density values that a POSITA could "have in mind" for Wang, nor whether a density of greater than 3.2 g/cc would be achievable in light of Wang's disclosed porosity values. Ex. 2015 ¶¶ 152-153; Ex. 2058 ¶¶ 124-126.

Moreover, Wang suggests *higher porosity*, which translates to *lower density* values, relative to solid films formed of the same material. Ex. 1005 ¶ [0056] ("In one embodiment, the first porosity is between about 40% and about 70% as compared to a solid film formed from the same material and the second porosity is between about 20% and about 40% as compared to a solid film formed from the same material."); Ex. 2015 ¶¶ 154-155; Ex. 208 ¶¶ 127-130. Yet Petitioner does not discuss Wang's porosity requirements and how those porosity values impact the maximum density values that a POSITA could "have in mind" while achieving Wang's targeted porosity. Therefore, Petitioner's analysis falls short. Ex. 2015 ¶¶ 154-156.

b. Compaction densities of greater than 3.2 g/cc as claimed are critical

Where a prior art reference discloses an overlapping range, "evidence of teaching away, unexpected results or criticality, or other pertinent objective indicia"

overcomes an obviousness challenge based on the overlapping range. *Belcher Pharm., LLC v. Hospira, Inc.*, 11 F.4th 1345, 1353 (Fed. Cir. 2021) (quoting *E.I. DuPont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1008 (Fed. Cir. 2018 (internal quotes omitted))). Here, as explained above in Section VI.B.4, the '118 Patent explains that the claimed compaction density is critical: a compaction density value greater than 3.2 g/cc for the first layer and the second layer, ensures, and is required to achieve, the desired energy density of a lithium-ion battery. Ex. 2058 ¶ 133.

By contrast, Saka teaches that superior battery performance was achieved with a density of 2.8 g/cc. and Saka demonstrates that its measured battery performance ***decreased*** when density values reached 3.0 g/cc. Ex. 1006 ¶ [0179]; Ex. 2015 ¶ 162, Paper 11, 73; Ex. 2058 ¶ 131-133, 135-138. Saka attributes this decrease in performance of high-density batteries (having density values of 3.0 g/cc) to the collapse of pores during pressing, which resulted in “the pore size of the positive electrode mixture layer [being] small.” *Id.*; Ex. 2058 ¶ 138 Therefore, Saka teaches using a density no greater than 2.8 g/cc when implementing an electrode with a desired pore size, and a POSITA reading Saka would have expected worse performance due to pore collapse with density values higher than 3.0 g/cc. *Id.* This further demonstrates a fatal conclusion in Petitioner’s arguments: the Petition provides no justification for why a POSITA would believe that higher electrode

density is always desirable above all other characteristics, and Saka confirms that batteries with higher densities can have *worse* performance than batteries with lower densities. Ex. 2058 ¶ 138-139.

2. Petitioner fails to show that a POSITA would have combined Wang with Saka

Neither Petitioner nor its expert have explained why Saka’s density range would be relevant to Wang’s disclosed porosity values. Ex. 2015 ¶ 157; Ex. 2058 ¶ 140. Contrary to Petitioner’s assertion, “common sense” alone would not have been sufficient to lead a POSITA to pursue compaction density values above 3.2 g/cc for a two-layer electrode based on the disclosure of Wang and Saka.

a. Wang and Saka focus on different cathode compositions

Because Wang’s disclosure provides a discussion of electrode active materials and additive materials, a range of particle sizes for the electrode active material, and a range of porosity values for electrode structures, a POSITA need not look beyond Wang for information about electrode layers. Ex. 2015 ¶ 158 (citing Ex. 1005 ¶¶ [0051], [0056]-[0057], [0081]-[0083]); Ex. 2058 ¶ 141-142. A POSITA would have understood that density values are not interchangeable among references teaching different electrode compositions and structures. Ex. 2015 ¶¶ 45, 95, 163-164; Ex. 2058 ¶ 142. Even Dr. Gido agreed that density values are case specific—a POSITA cannot know usable compaction densities for a particular electrode mixture

without specific knowledge of at least the active material type, active material particle distribution, additive concentration, and intended use of the electrode. Ex. 2050, 134:17-135:8, 136:7-137:10. Given the highly case-specific nature of electrode compositions, a POSITA cannot supplant the teachings of desired density and porosity values for one reference with that of another, absent some highly specific teaching supporting the substitution. Such a substitution is not warranted here. Ex. 2058 ¶ 142.

Whereas Wang discusses optimal porosity values for gradient cathodes that provide benefits such as facilitating ion transport through the electrode structure, Saka focuses on improving packing of cathodes a “mixture layer” that includes a composite of “LPF 1 and NMC 2.” Ex. 1006 ¶ [0056]; *see also* Pet. 44 (citing Ex. 1006 ¶ [0051]). Thus, Saka’s density values are relevant only to the disclosed compositions of cathodes discussed therein and a POSITA would have recognized that these density values are not relevant to Wang’s disclosure. Ex. 2058 ¶ 142. As discussed *supra* in Section VI.B.1 with respect to Kim, because composition and particle size directly impact density, the compaction of an electrode layer formed from a mixture of two different active materials will be different from the compaction of a single active material. Ex. 1005 ¶ [0053]; Ex. 2015 ¶ 160. Neither Petitioner nor its expert provides any analysis or evidence that demonstrates that the density values provided in Saka for composite electrode mixture 12 would have been

compatible with Wang's porosity values. Ex. 2015 ¶ 160. Simply assuming that a POSITA would cherry-pick density values from Saka to use with Wang is contrary to the actual understanding of a POSITA.

Saka does not discuss gradient electrode structures, nor does Saka mention porosity at all. Thus, a POSITA would not have known whether Saka's density values—specifically those compaction density values above 3.2 g/cc—would be consistent with Wang's porosity targets. Ex. 2015 ¶ 157; Ex. 2058 ¶ 142. Therefore, Petitioner does not and cannot provide support for its conclusion that a POSITA “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.” Pet., 46 (citing Ex. 1010 ¶ 282).

In sum, a POSITA would not have looked beyond Wang for an optimal density value, and would have understood that density values discussed in Saka, which focuses on improving the packing of specific cathode compositions, would not have been relevant to Wang's disclosure. Ex. 2058 ¶ 142. Wang's porosity value ranges restrict the possible density values that provide Wang's beneficial ion transportation characteristics, and Petitioner has not explained that Saka's density values would be achievable using Wang's electrode manufacturing method. *Id.* ¶¶ 152, 158-159; *see also* Pet., 37.

b. Common sense alone would not lead a POSITA to higher compaction densities based on Wang and Saka

Wang and Saka do not teach a two-layer electrode structure with a compaction density of greater than 3.2 g/cc. Thus, Dr. Gido (and Petitioner) argues that “*common sense* dictates choosing the highest compaction density that is workable for a given application.” Ex. 1010 ¶ 281; Ex. 2015 ¶ 161. However, common sense alone cannot provide a reason to provide a missing limitation. *Arendi S.A.R.L. v. Apple Inc.*, 832 F.3d 1355, 1362 (Fed. Cir. 2016) (“[R]eferences to ‘common sense’—whether to supply a motivation to combine or a missing limitation—cannot be used as a wholesale substitute for reasoned analysis and evidentiary support, especially when dealing with a limitation missing from the prior art references specified.”).

Moreover, common sense does not cut in Petitioner’s favor. As mentioned above in Section VI.B.4., because the claimed compaction density of greater than 3.2 g/cc is critical and because neither Wang nor Saka provides any reason to implement compaction density values greater than 3.2 g/cc, a POSITA reviewing these references would not seek to select any density values greater than 3.0 g/cc – the highest density value of Saka’s examples (even if Saka’s density values were achievable with Wang’s porosity targets). Ex. 2058 ¶¶ 143-144.

Dr. Gido recognizes that the “highest compaction density” is still limited by what “is workable for a given application.” Ex. 1010 ¶ 399. Here, Saka indicates that performance degrades above 3.0 g/cc, and neither Wang nor Saka provide any

suggestion that higher densities would be “workable” by combining these references. Saka points out that lower compaction densities (inherently having higher porosities) are “workable,” given Wang’s discussion of increased porosity values. *Id.*; Ex. 2058 ¶¶ 144-147.

Dr. Gido’s reliance on Kim’s indication that “densities less than 3.31 g/cc ‘may be too small to obtain a high electrical capacity’” does nothing to clarify the understanding of a POSITA. Ex. 1010 ¶ 281 (citing Ex. 1009 ¶ [0036]); Ex. 2015 ¶ 161. Kim’s statement is irrelevant, at least because it does not discuss the compaction density of electrode layers) *and* because *all* of Saka’s disclosed examples have density values of 3.0 g/cc *or less*. Ex. 2015 ¶ 161 (citing Ex. 1006, FIGS. 7, 8, 10, 11); Ex. 2058 ¶ 143.

A POSITA would have understood that compaction densities (and/or porosities) of electrode materials are impacted by density *and* other characteristics of the mixture, such as interactions between the various materials in an electrode (e.g., between the multiple active materials discussed in Saka), how the various particles “fit” into the interstices of one another (i.e., how a smaller particle fills the space between adjacent larger particles) and whether the resulting mixture leaves sufficient space for lithium ion movement. Ex. 2015 ¶ 164; Ex. 2058 ¶ 144. More generally, a POSITA would have understood that electrode density values are chosen based on the desired application of the resulting electrode. Dr. Gido agreed. Ex.

2050, 15:8-20, 134:17-135:8, 136:7-137:10; Ex. 2058 ¶ 145. Thus, workable density values are specific to the materials used in a particular electrode, and a POSITA would not have been motivated to look at density values that are described for use with other electrode structures having different material compositions. Ex. 2015 ¶ 165; Ex. 2058 ¶¶ 145-147.

Thus, Petitioner fails to show that a POSITA would have combined Wang with Saka. Ex. 2015 ¶ 165.

3. Claims 2-9, 11-18, and 20 are not unpatentable

Claims 2-9, 11-18, and 20 are not unpatentable for at least the same reasons as discussed above with respect to independent claims 1, 10, and 19. Ex. 2058 ¶ 148.

a. Claims 5 and 14

Petitioner admits that “Wang may not explicitly teach the numeric values of the compaction densities for the two layers,” and so Petitioner relies on Saka for claims 5 and 14. Pet., 49. However, Petitioner only relies on Saka’s examples as allegedly teaching a first layer compaction density greater than 2.8 g/cc. Pet., 51-52. Not only do these examples disclose total compaction densities of 3.0 g/cc *or less*, but as discussed herein, the density of any single layer in the examples is irrelevant to a two-layer electrode having a total compaction density of greater than 3.2 g/cc. Ex. 2058 ¶ 149. Nothing in Saka suggests that those examples would be modified to increase the overall density of the combined layers to provide a density of the first

layer and the second layer is at least 3.2 g/cc. *Id.* Petitioner's reference to the density values of a single layer in these examples is insufficient to support an obviousness rejection of these claims.

As discussed in reference to Ground 2, the density values recited in dependent claims 5 and 14 are critical and provide unexpected benefits for the performance of a two-layer electrode. *See supra*, at VI.B.5.a; Ex. 2058 ¶ 150. Accordingly, these references fail to render obvious the claimed ranges in dependent claims 5 and 14.

D. Ground 4: Wang and Li do not render obvious claims 1-20

Petitioner fails to establish that Wang in view of Li teaches each limitation of the independent claims for at least the reasons discussed below. Ex. 2058 ¶¶ 151-153.

1. Petitioner fails to show why a POSITA would have had a “desired density in mind” greater than 3.2 g/cc when combining Wang and Li

Like Ground 3, Petitioner relies on the disclosure of Wang for all elements of independent claims 1, 10, and 19, except for elements reciting a total compaction density of the first layer and the second layer is greater than 3.2 g/cc, for which Petitioner relies on the disclosure of Li. Pet., 61-65. Specifically, Petitioner states that “Wang assumes the reader already has a desired density in mind,” therefore, a POSITA would 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." Pet., 62 (citing Ex. 1010 ¶ 428). But Wang is silent as to any density value and a POSITA would not have had a desired density "in mind" to achieve the discussed porosity targets. Ex. 2058 ¶¶ 154-161. As such, Petitioner's ground fails.

For the same reasons as discussed in reference to Ground 3, Petitioner's argument that a POSITA would have relied on silence, because the POSITA would have had a "desired density in mind" (Ex. 1010 ¶ 428) that is greater than 3.2 g/cc when implementing Wang, is unsupported by the disclosure of Wang or the knowledge of a POSITA. Ex. 2015 ¶¶ 166-167. Given Wang's focus on achieving porosity targets in respective layers of a two-layer electrode structure, a POSITA would not look outside of Wang for a "desired density" to achieve with Wang's structure and Wang's discussion of "compression steps" to adjust the density from one layer to the next, such that the resulting electrode structure satisfies the target porosity values for each electrode layer. Ex. 2015 ¶¶ 169 (citing Ex. 1005 ¶¶ [0058], [0067], [0073], [0092]); Ex. 2058 ¶¶ 155-159. Since density is related to porosity, the fact that Wang does not explicitly discuss density is of no moment.

Even Wang itself acknowledges this by stating "the cathode electrodes have graded properties, such as, porosity, conductivity, particle size, and combinations thereof that vary throughout the cathode electrode structure," and "it is desirable to modify the properties of the cathode electrode through the inclusion of additives such as conductive additives and/or binding agents ... the graded properties of the

cathode electrode may be further modified during the manufacturing process through the use of such techniques as calendaring, annealing, and various drying processes.” Ex. 1005 ¶ [0035]; *see also e.g.*, Ex. 1005 ¶¶ [0051] (Wang describing that particle size impacts density), [0058] (Wang describing that porosity impacts density), [0086] (Wang describing that particle shape impacts density); Ex. 2015 ¶ 173. A POSITA therefore would not have been motivated to select a density for Wang’s electrode using Petitioner’s inaccurate suggestion that a POSITA “would be motivated to look to another reference, *such as Li*, for numerical values of a desired cathode density.” Ex. 2015 ¶ 174.

The density values resulting from Wang’s porosity values are specific to the active material and additives used in the electrode constructed according to Wang’s disclosure. Ex. 1005 ¶¶ [0043], [0051]-[0053]; Ex. 2058 ¶¶ 160-161. Yet neither Petitioner nor its expert discusses, let alone supports with evidence, whether a density of greater than 3.2 g/cc would be attempted, let alone be achievable, in an electrode including Wang’s active materials and additives while achieving Wang’s disclosed porosity values. Ex. 1005 ¶ [0056]; Ex. 2015 ¶¶ 178-179. Petitioner has not explained why a POSITA would seek out lower porosity values contrary to Wang’s disclosure, even considering other references, such as Li. Therefore, Dr. Gido’s analysis falls short of explaining how a POSITA would have achieved a density value greater than 3.2 g/cc based on Wang’s disclosure. Ex. 2015 ¶ 177.

2. Petitioner fails to show that a POSITA would have combined Wang and Li

Petitioner has failed to demonstrate that a POSITA would have sought to compact Wang's electrode structure to a compaction density greater than 3.2 g/cc based on Li's disclosure. Ex. 2015 ¶¶ 172, 175; Ex. 2058 ¶ 162.

Li focuses on changing geometry of an electrode using "gap coating" methods to provide thick regions and thin regions in the electrode. Ex. 1003, *Abstract*; Ex. 2058 ¶ 163. However, Li discloses that, regardless of thickness of the electrode region, the composition of the electrode remains the same. *See id.*, ¶¶ [0038], [0044] (describing that *the same cathode slurry* was coated in each layer); Ex. 2058 ¶ 164. Moreover, Li does not distinguish between the densities of the first layer and second layer (nor does Li explain that the different coatings result in separate layers at all). Li explains that the first application is coated and compacted to a density of 3.8 g/cc and then the second application of electrode material is "gap coated" onto the first coating and compacted such that the overall density is 4.1 g/cc. Ex. 2058 ¶ 164. Petitioner admits that it is unknown whether Li's first coating is compacted further or not (Pet., 65-66), but given that the first coating remains exposed in the "gaps" of the second coating, a POSITA would have understood that a second compaction step would apply a further compaction pressure to the first coating, causing the first coating to be compacted to a density similar to the density of the second coating (and potentially creating a homogenous, single-layer structure) to achieve Li's average

compaction density of 4.1 g/cc. Ex. 2058 ¶ 164. Petitioner's admission regarding the unknowns of Li's first coating density further shows that Li seeks a substantially uniform cathode construction in both applied coatings (in terms of both composition and compaction).

This makes sense, if the electrode coatings were of different composition, the resulting electrode would have different discharge characteristics at different points along its length. Ex. 2058 ¶ 165. Indeed, as Dr. Wheeler explains, battery manufacturers would not seek to create a gap-coated electrode with two different electrode compositions in each layer because such a structure would introduce significant uncertainty as to the safety and performance of the resulting battery. Ex. 2058 ¶ 165; Ex. 2057. Thus, a POSITA reviewing Li in light of Wang would have determined that Li's gap coating method would not be applicable to Wang, which discloses electrodes having an electrode gradient between the separator and current collector. Ex. 2058 ¶¶ 166-167.

a. Wang and Li describe electrodes with incompatible structures

Petitioner's unsupported reasons for combining Wang and Li overlooks the structural differences disclosed in these references. Specifically, Petitioner is incorrect in stating "Li describes the same overall structure, and provides the compaction densities that are missing from Wang." Pet., 63; Ex. 2058 ¶ 168. As

mentioned, Li discloses that both coatings are *identical* in composition, whereas Wang explicitly teaches that the electrode layers have *different* compositions.

A POSITA reviewing Wang and Li would have determined that Wang discloses a combination of characteristics for the electrode layer (e.g., a list of electrode active materials and additive materials, a range of particle sizes for the electrode active material, and a range of porosity values for electrode structures) that would be sufficient for a POSITA to construct the electrode layer for a lithium ion battery. Ex. 2015 ¶ 178 (citing Ex. 1005 ¶¶ [0051], [0056]-[0057], [0081]-[0083]); Ex. 2058 ¶ 168. Those characteristics are described as providing a gradient electrode structure across two layers. A POSITA would not be motivated to look to another reference, such as Li, that discusses electrode geometries that integrate identical electrode compositions in each of multiple applications of electrode material for numerical density values. Ex. 2058 ¶ 169.

Neither Petitioner nor its expert explain what density values are possible for Wang's disclosure or why Li's gap coated electrode with uniform electrode compositions would have been relevant for Wang's gradient electrode structure. *Id.*

Li's focus is on something entirely unrelated to compaction density—or the composition of an electrode at all. Ex. 2058 ¶ 163. Li's examples only provide sufficient detail for a POSITA to replicate the described geometry of an electrode using identical electrode compositions in each coating, a POSITA could not

determine whether Li's example density values are usable with Wang's disclosure, as suggested by Petitioner. *Id.* The use of an *identical* electrode composition in each of Li's coatings makes sense for Li's "gap-coating" process. *See* Ex. 2050, 162:19-164:8 (Dr. Gido confirming that the same electrode composition is used in each of Li's coatings); Ex. 2058 ¶ 163. Li's gap-coating method would create thick and thin areas of the electrode (some or all of those regions being a single layer). Ex. 2058 ¶ 163. A POSITA reviewing Li would have determined that Li's teachings are incompatible with Wang's gradient electrode structure in which each layer has a different set of characteristics. Combining the teachings of Wang and Li would result in an electrode having some regions with Wang's gradient structure, and other regions that do *not* have this gradient structure. Ex. 2058 ¶¶ 166-167. A POSITA would recognize that this inconsistent structure would have unpredictable safety and discharge characteristics, and accordingly a POSITA would not seek to combine these teachings at all. Ex. 2058 ¶¶ 165-167.

b. Petitioner fails to show that Li's compaction density values are compatible with Wang

Moreover, a POSITA would have understood that Li's high-density examples (e.g., higher than 3.8 g/cc) would only be possible with certain specific electrode materials, additives, particle size distributions, and porosity values. Ex. 2015 ¶¶ 181-182; Ex. 2058 ¶ 168. Consequently, a POSITA would have also understood that Li's compaction density is not combinable with Wang's gradient electrode structure. *Id.*

When selecting an appropriate compaction density for an electrode, a POSITA would consider several other electrode characteristics including target porosity values, particle size distributions, electrode thicknesses, and other characteristics of an electrode. Li does not discuss these characteristics, except to the extent necessary to describe Li's gap coating geometry with thicker and thinner regions. *Id.* ¶ 180 (citing Ex. 1003 ¶ [0038]); Ex. 2058 ¶ 168. Li explains that the *same composition* is used in both coatings and does not indicate that each coating has a different compaction density. Li does not even explain that the resulting structure is multiple layers. Li's examples do not provide enough detail to reproduce the described batteries, including expected compaction density values for each coating. *Id.* For example, Li does not explain what electrode particle distribution is used, or how the energy density or discharge performance differs from prior electrode designs. *Id.* Li focuses only on the "gap coated" *geometry* of an electrode, and does not disclose the *composition* of its electrodes such that a POSITA would be able to determine that Li's composition is the "same" or "compatible" with Wang. *Id.* ¶ 177; Ex. 2058 ¶ 169. Therefore, given the silence in Li regarding electrode characteristics, Petitioner has not shown that Li's teachings would, in fact, "work in a battery like Wang's." Pet., 61; Ex. 2015 ¶ 177-178.

Dr. Guido fares no better as he confirmed that he did not perform calculations to confirm whether Li's density values would be compatible with Wang's disclosure.

Ex. 2050, 165:20-166:16 (“Q: Do you know if Li’s density values could be achieved while maintaining Wang’s targeted porosity values? A: I haven’t done that calculation so I don’t know”). Dr. Gido’s response of “I don’t know” is fatal to the combination.

Moreover, nothing in Li indicates that the compaction density used in the examples are desirable or even possible with Wang’s teachings. *Id.* ¶ 179; Ex. 2058 ¶¶ 170-172. A POSITA would have understood that compaction densities (and/or porosities) of electrode materials are not based solely on the densities of the contained active materials and additives. Other characteristics of the mixture, such as interactions between the various materials in an electrode (e.g., between the multiple active materials discussed in Li), how the various particles “fit” into the interstices of one another, whether the resulting mixture leaves sufficient space for lithium ion movement, and the desired application of the electrode, need to be considered. Ex. 2015 ¶ 182; Ex. 2058 ¶ 168. Thus, workable density values are specific to the materials used in a particular electrode, and a POSITA would not have been motivated to look at density values that are described for use with other electrode structures having different material compositions. *Id.*; Ex. 2058 ¶ 172.

Thus, at least because neither Petitioner nor its expert discusses how or why a POSITA would have looked at the density values of Li to modify Wang, Petitioner

fails to show that a POSITA would have combined Wang with Li. *Id.*; Ex. 2058 ¶ 173.

c. Compaction densities of greater than 3.2 g/cc as claimed are critical

As discussed above in Section VI.B.4., the claimed density of greater than 3.2 g/cc is critical.

As discussed above, Wang does not discuss that higher density/lower porosity values would be desirable, and nothing in Wang would have led a POSITA to compaction density values above 3.2 g/cc. Ex. 2058 ¶¶ 174-177. Li does not focus on compaction density at all, and provides no discussion of benefits of high density values. Li focuses on electrode *geometry* (not composition). Ex. 2058 ¶¶ 176-177. Li's limited disclosure of example compositions would not have led a POSITA to recognize any benefits associated with the disclosed density values. *Id.*

Accordingly, because the claimed compaction density values are critical, as discussed in Sections VI.B.4 and VI.C.1.c above, Applicant respectfully submits that the cited references of Ground 4 do not provide adequate teachings to support an obviousness rejection of the challenged independent claims.

3. Claims 2-9, 11-18, and 20 are not unpatentable

Claims 2-9, 11-18, and 20 are not unpatentable for at least the same reasons as discussed above with respect to independent claims 1, 10, and 19. Ex. 2058 ¶ 178.

VII. CONCLUSION

Patent Owner respectfully submits that the claims are not unpatentable under any of the presented grounds. Ex. 2058 ¶ 179.

Dated: January 27, 2026

Respectfully submitted,

By: / Christopher TL Douglas /
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CERTIFICATION UNDER 37 C.F.R. §42.24

Pursuant to 37 C.F.R. §42.24(d), I certify that this reply complies with the type-volume limits of 37 C.F.R. §42.24(c)(1) because it contains 13,739 words, according to the word-processing system used to prepare this reply, excluding the parts of this reply that are exempted by 37 C.F.R. §42.24(c) (including the table of contents, a table of authorities, a listing of facts which are admitted, a certificate of service or this certificate word count, and appendix of exhibits).

Dated: January 27, 2026

By: / Christopher TL Douglas /
Christopher TL Douglas

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §42.6(e), the undersigned hereby certifies that true and correct copies of the foregoing **PATENT OWNER'S RESPONSE and NINGDE AMPEREX TECH. EXHIBITS 2044-2058** were served their its entirety on January 27, 2026 by filing this document through the PTAB's P-TACTS Filing System as well as delivering true and correct copies by electronic mail on Petitioner's lead and backup counsel at the following email addresses (as agreed by counsel for Petitioner):

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