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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZHUHAI COSMX BATTERY CO., LTD.,
Petitioner

v.

NINGDE AMPEREX TECHNOLOGY LIMITED,
Patent Owner

Case IPR2023-00587
Patent No. 10,964,987

PETITION FOR *INTER PARTES* REVIEW

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LIST OF EXHIBITS

Exhibit	Description
Ex. 1001	U.S. Patent No. 10,964,987
Ex. 1002	Prosecution History of U.S. Patent No. 10,964,987
Ex. 1003	Declaration of Dr. Samuel Gido dated February 22, 2023
Ex. 1004	Curriculum Vitae of Dr. Samuel Gido
Ex. 1005	Nishikawa et al., U.S. Patent No. 7,976,987
Ex. 1006	Iwai et al., U.S. Patent App. Pub. No. 2014/0248525
Ex. 1007	Honda et al., U.S. Patent App. Pub. No. 2015/0263325
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Ex. 1015	Ueki et al., U.S. Patent No. 9,190,668
Ex. 1016	Akiike, U.S. Patent App. Pub. No. 2016/0013465
Ex. 1017	Patnaik, Handbook of Inorganic Chemicals (2003)

Ex. 1018	Ahmad et al., Synthesis of Polyvinylidene Fluoride (PVDF) Membranes for Protein Binding: Effect of Casting Thickness, Journal of Applied Polymer Science (2013)
Ex. 1019	Katayama et al., U.S. Patent App. Pub. No. 2010/0221965
Ex. 1020	ATL's Amended Complaint filed in Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co., Ltd., Civ. No. 2:22-cv-00232-JRG (E.D. Tex.)
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Ex. 1023	United States District Court Judicial Caseload Profile

I. INTRODUCTION

Petitioner Zhuhai CosMx Battery Co., Ltd., requests *inter partes* review of U.S. Patent No. 10,964,987 (Ex. 1001), assigned to Ningde Ampere Technology Limited, and cancellation of claims 1-17.

As the '987 patent admits, “lithium-ion batteries” including a “separator” were “widely used” by 2018. '987 patent, 1:20-31. Indeed, the examiner found during prosecution that the very “separator” claimed—a separator comprising a “porous substrate” and a “porous layer” of “inorganic particles and a binder”—was known. Ex. 1002, 248. The '987 patent claims were allowed only because claim 1, the sole independent claim, requires that “a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0.” *Id.*, 288.

But separators exhibiting this claimed ratio were also known by 2018. *Nishikawa* (Ex. 1005), for example, describes a separator having a “microporous membrane” and a “porous layer” of inorganic “filler” and “resin.” *See, e.g., Nishikawa*, 4:46-52. Two example separators described in *Nishikawa* exhibit a ratio of Dv90 of the inorganic filler to the thickness of the porous layer of 0.33 and 0.34, both of which fall within the claimed range from 0.3 to 3.0. *Id.* at Tables 1-2, 16:24-29. Likewise, *Iwai* (Ex. 1006) describes an example separator having a “porous substrate” and a “porous layer” of inorganic “filler” and a “resin” that acts as a “binder.” *See, e.g., Iwai*, [0021]-[0022]. *Iwai*'s example separator exhibits a

ratio of Dv90 of the inorganic filler to the thickness of the porous layer that has a value in a range from 0.72 to 1.27—a value which also falls within the claimed range from 0.3 to 3.0.

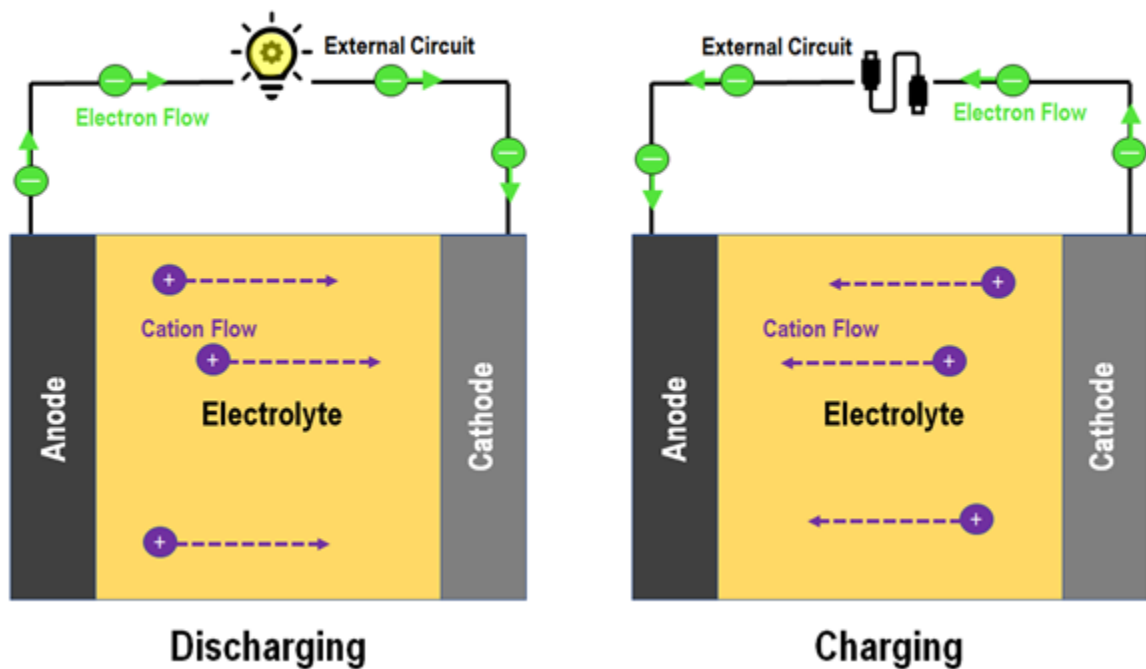
As explained below, *Nishikawa*, alone or in combination with *Honda*, and/or *Iwai* alone, anticipates and/or would have rendered obvious each of the challenged claims.

II. STATE OF THE ART

A. Lithium-Ion Battery Technology

The most basic structure of any battery is illustrated below. Ex. 1003
(Declaration of Dr. Samuel Guido) (“Guido”), ¶27.

General Battery Schematic



As illustrated, the battery includes a negative electrode, called an anode, and a positive electrode, called a cathode. Gido, ¶27. The anode and the cathode are separated from one another and immersed in a medium called an electrolyte through which ions—that is, atoms having either a positive or a negative electric charge—can be transported. Gido, ¶27.

When the battery is discharged, as illustrated on the left, positive ions called cations (atoms missing one or more electrons) diffuse from the anode, through the electrolyte, to the cathode. Gido, ¶27. To maintain electrical neutrality, electrons move separately through an external circuit from the anode to the cathode, where they are recombined with the cations to reform atoms. Gido, ¶27. As the electrons make this journey through the external circuit, they provide an electrical current, which can be used to, for example, light a lightbulb, as illustrated.

As illustrated on the right, charging the battery is the reverse process. Gido, ¶27. An external voltage is used to push electrons through the external circuit back to the anode, creating cations at the cathode that migrate through the electrolyte to meet the electrons and reform the atoms at the anode. Gido, ¶27. *See also* Gido, ¶¶28-29 (discussing batteries generally).

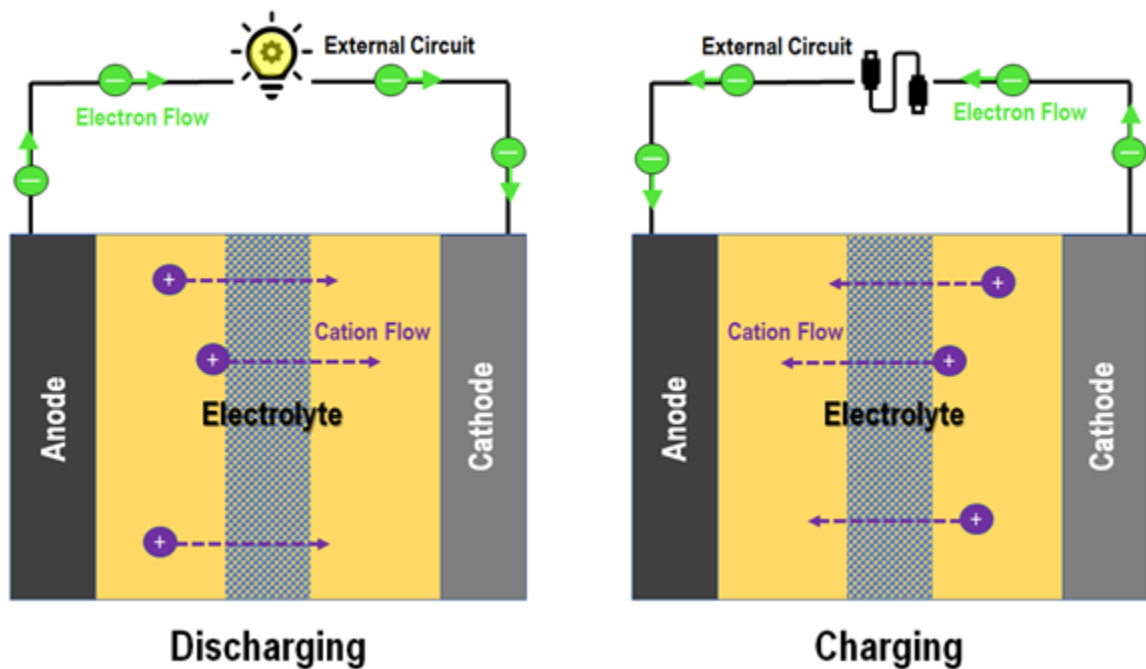
One type of battery is a lithium-ion battery. Gido, ¶30. First commercialized in 1991, lithium-ion batteries became ubiquitous by the 2000s. Gido, ¶¶30, 35, 37. But the prevalence of lithium-ion batteries posed a danger. Gido, ¶¶35, 37. In a

battery, the anode and the cathode must never touch. Gido, ¶31. If they do, an electrical short circuit will result, discharging the battery so quickly that the battery may catch fire or explode. Gido, ¶31. Early lithium-ion batteries were susceptible to such short-circuiting. Gido, ¶37. The battery industry responded by focusing on so-called separators. Gido, ¶¶32, 35, 38.

B. Separator Technology

A separator, as illustrated below, prevents short circuits between the anode and the cathode. Gido, ¶¶33, 36.

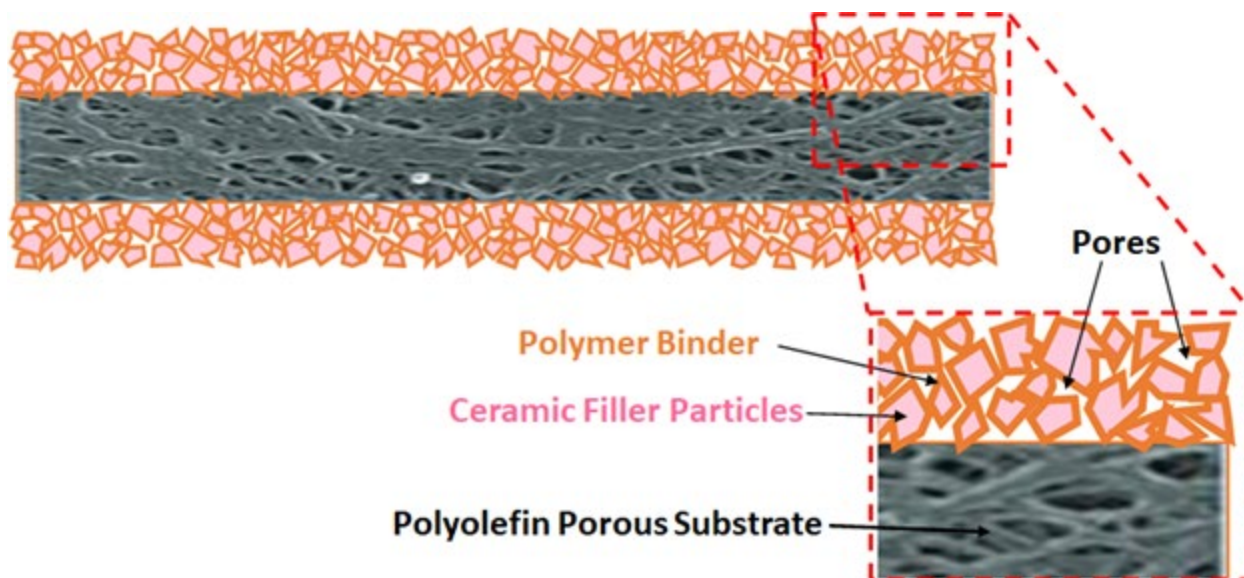
Li-Ion Battery with Separator



To this end, separators must be electrically insulating, preventing the flow of current carried by electrons between the anode and the cathode. Gido, ¶34. But separators must also permit the transport of cations through the electrolyte,

allowing discharging and charging to occur, as described above. Gido, ¶¶34. Thus, separators are typically both non-conducting, to prevent electron flow, and porous, to allow cation flow. Gido, ¶¶34, 36; Ex. 1008, 245.

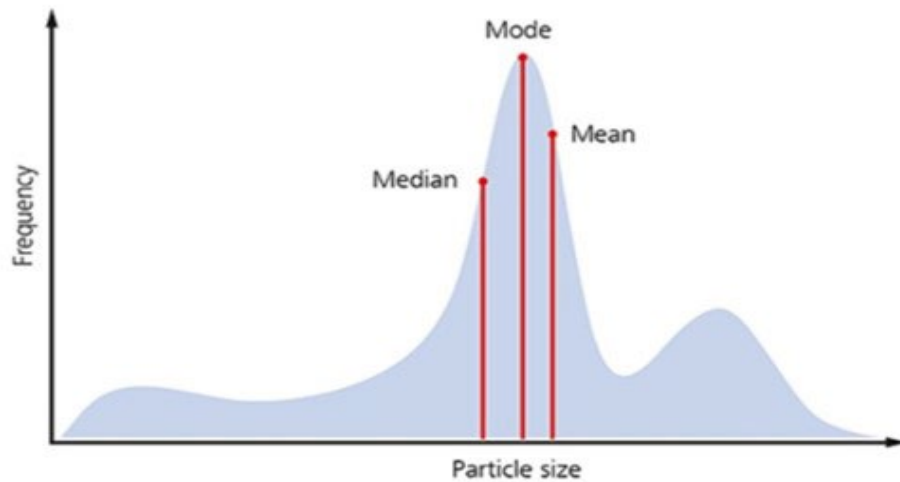
To this end, well before 2018, separators regularly included a porous substrate and a porous layer formed on one or both sides of the porous substrate. Gido, ¶53; *see, e.g., Nishikawa*, Abstract; *Iwai*, Abstract. It was likewise known to form the porous layer from a polymer binder and inorganic, such as ceramic, filler particles, such as particles of magnesia or alumina, as illustrated. Gido, ¶53; Ex. 1009, 6:17-22. As those in the art recognized, a polymer binder is non-conducting and can be formed to be porous, while the addition of inorganic particles improves both mechanical strength and high-temperature stability. Gido, ¶39, ¶53. *See also* Gido, ¶¶51, 52.



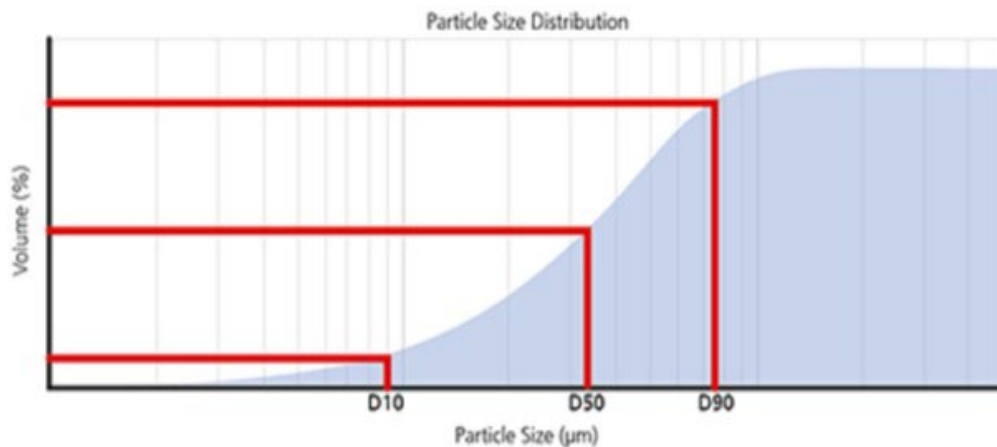
Over the last two decades, improving separators to promote battery safety has been a focus of extensive effort in the battery industry. Gido, ¶38. One approach has been to make separators more robust by adjusting parameters of the polymer binder and the inorganic particles to achieve desirable properties in the porous layer, including not only mechanical strength and high-temperature stability, but also adhesion, internal resistance, flame retardancy, energy density, and other properties. Gido, ¶¶38-50; *see, e.g.*, Ex. 1009, 11:30-37; Ex. 1012, [0010]-[0017]; Ex. 1014, [0050], [0061]; Ex. 1015, 3:35-47, 9:6-15; *Nishikawa*, 7:19-40.

One parameter those in the art knew to adjust was particle size of the inorganic particles. Gido, ¶62; *see also, e.g.*, Ex. 1014, [0038]. In particular, it was known in the art to adjust cumulative particle size values known as “D10,” “D50,” and “D90.” Gido, ¶62; *see also, e.g.*, Ex. 1012, [0053]; Ex. 1015, 3:19-47; *Nishikawa*, 7:8-40.

These cumulative particle size values are typically used because inorganic particles are prepared through processes like pulverizing, grinding, or milling that produce particles of varying sizes. Gido, ¶54. These varying particle sizes may be represented by, for example, a distribution in which a particle size (typically a diameter) is plotted against a frequency of particles having that particle size, as illustrated below. Gido, ¶54.



As illustrated, it is possible that the distribution of particle sizes is multimodal, meaning the distribution is not strictly bell-shaped but, rather, has more than one peak. Gido, ¶54. While certain values—mean, median, and mode—can be gleaned from the distribution, these values alone cannot convey much about the distribution as a whole. Gido, ¶¶55-57. Instead, those in the art frequently refer to cumulative particle size distributions, like that illustrated below, which provide additional information. Gido, ¶58.



In a cumulative particle size distribution, as illustrated, as particle size increases, a running total of the particle volume (as a percentage of the volume of all the particles in the distribution) of the particles up to that size is plotted. Gido, ¶58. Eventually, at a large particle size, the cumulative particle size distribution reaches a plateau because all the particles in the distribution are accounted for. Gido, ¶58.

The cumulative particle size distribution can be characterized by particle sizes at which the cumulative volume reaches different percentages of the total. Gido, ¶58. Shown in the figure, for example, are particle sizes designated D10, D50, and D90. Gido, ¶58. D10 is typically used to refer to the particle size at which 10% of the total volume is reached. Gido, ¶59. Likewise, D50 is typically used to refer to the particle size at which 50% of the total volume is reached, and D90 is used to refer to the particle size at which 90% of the total volume is reached. Gido, ¶59. *See also* Gido, ¶60. Another value, D90-D10 (or “span”) can also be provided to indicate a difference between the D90 and D10 values, which indicates a breadth of the distribution. Gido, ¶61.

Thus, it was known in the art to adjust particle size—including as indicated through cumulative particle size values D10, D50, and D90—of the inorganic particles to achieve desirable separator properties. Gido, ¶62. Another parameter those in the art knew to adjust was thickness of the porous layer. Gido, ¶62; *see*

also, e.g., Ex. 1009, 8:48-55; Ex. 1010, 7:55-67; Ex. 1012, [0053]; Ex. 1014, [0060]-[0061]; Ex. 1015, 9:6-15. Moreover, it was recognized by those in the art that particle size and porous layer thickness were related parameters that were to be adjusted together. Gido, ¶62. For instance, a patent application published in 2015 taught that “[t]he choice of the exact particle size” in a porous layer “depends on the thickness of” the porous layer. Ex. 1012, [0053]. Thus, this publication recommended a porous layer in which “the D90 value is no more than 50% of the thickness of the” porous layer. *Id.* Likewise, *Nishikawa* taught that, in a porous layer, “[a] value for d50 exceeding 1 μm is not preferred due to such factors that the heat resistant porous layer is difficult to be formed to have a suitable thickness.” *Nishikawa*, 7:33-35.

Finally, it was known in the art to adjust pore size and porosity of the porous layer. Gido, ¶62. Those in the art recognized, for example, that “pore size and the porosity are very important factors for the control of ion conductivity in a battery and thus, are directly related to the quality of the battery.” Ex. 1009, 4:34-37. *See also* Ex. 1010, 5:47-50 (“[T]he present inventors have recognized that controlling the porosity and pore size” of a porous layer “is one of the factors affecting the quality of a battery.”).

III. OVERVIEW OF PRIOR ART

A. Nishikawa

U.S. Patent No. 7,976,987 (Ex. 1005) (“*Nishikawa*”) issued July 12, 2011, and constitutes prior art under at least 35 U.S.C. §§ 102(a)(1) and (a)(2).

Nishikawa describes a separator for use in a lithium-ion battery. *Nishikawa*, 1:8-18. *Nishikawa*’s separator includes a “microporous membrane” that is “laminated with a heat resistant porous layer.” *Id.*, 2:47-52. *Nishikawa*’s porous layer includes both “inorganic filler” and a “resin.” *Id.*

As shown below in Table 2, *Nishikawa* describes separators in Example 4 and Example 5 in which the porous layer has a D90¹ of the inorganic particles that is 1.05µm and 1.07µm, respectively. In *Nishikawa*’s Example 4 and 5 separators, the porous layer has a thickness of 3.15µm. *Id.*, Table 1, 16:25-29, 16:37-38. Thus, in *Nishikawa*’s Example 4 and 5 separators, a ratio of the D90 of the inorganic filler to the thickness of the porous layer is 0.33 and 0.34, respectively—both of which are within the claimed range from 0.3 to 3.0.

¹ As explained below in Section VIII.A.1.e, a POSA would have understood

“D90,” as used by *Nishikawa* in Examples 4 and 5, to disclose the claimed “Dv90.”

TABLE 2

	d10	d50	d90	α	Sliding property	Coating property
Example 4	0.38	0.75	1.05	0.89	good	good
Example 5	0.50	1.02	1.07	0.56	good	good
Example 6	1.50	8.0	22.0	2.56	good	poor
Example 7	5.10	23.0	58.0	2.30	good	poor

B. Iwai

U.S. Patent App. Pub. No. 2014/0248525 (Ex. 1006) (“*Iwai*”) has a 35 U.S.C. § 371(c) date of April 17, 2014, and constitutes prior art under at least 35 U.S.C. §§ 102(a)(1) and (2).

Iwai describes a separator for use in a lithium-ion battery. *Iwai*, [0001]. *Iwai*’s separator includes a “porous substrate” and an “adhesive porous layer” that is “appl[ied] on one or both sides of the porous substrate.” *Iwai*, [0021]. *Iwai*’s adhesive porous layer includes both “inorganic particles” and a “polyvinylidene-fluoride resin.” *Id.*, [0022]. *Iwai*, like others in the art (*supra* Section II.B), recognized that desirable properties of a separator could be achieved by adjusting particle size—as indicated through cumulative particle size values D10, D50, and

D90²—of the inorganic particles. In particular, *Iwai* taught that desirable adhesion of the separator could be achieved by keeping a “ratio a/r between an average thickness ‘a’ (μm) of the adhesive porous layer on one of the sides of the porous substrate and a volume average particle diameter ‘r’ (μm) of the” inorganic particles within a prescribed range. *Id.*, [0043]. *Iwai* equates the “volume average particle diameter ‘r’ (μm)” with D50. *Id.*, [0160].

As shown in Table 1 below, *Iwai* describes an example separator, the Example 7 separator, in which the adhesive porous layer has a D50 of 1.2μm and a D90-D10 span of 1.6μm. *Iwai*, [0039].

TABLE 1

	Average		Filler				
	thickness a (μm) of adhesive porous layer	Resin type	Type	Volume average particle diameter r (μm)	D90 – D10 (μm)	Content (% by mass)	a/r
Example 1	2.1	Resin A	Organic filler A	1.8	1.3	5	1.2
Example 2	1.1	Resin A	Organic filler A	1.8	1.3	20	0.6
Example 3	1.5	Resin A	Organic filler A	1.8	1.3	25	0.8
Example 4	3.5	Resin A	Organic filler A	1.8	1.3	1	1.9
Example 5	4.7	Resin A	Organic filler A	1.8	1.3	0.3	2.6
Example 6	3.0	Resin A	Organic filler B	3.0	2.0	20	1.0
Example 7	2.2	Resin A	Inorganic fillers C, D	1.2	1.6	10	1.8
Example 8	2.1	Resins A, B	Organic filler A	1.8	1.3	30	1.2
Comparative Example 1	1.3	Resin A	—	—	—	0	—
Comparative Example 2	3.1	Resin A	Inorganic filler D	0.8	1.1	40	3.9
Comparative Example 3	5.5	Resin A	Organic filler A	1.8	1.3	20	3.1
Comparative Example 4	2.0	Resin A	Organic filler E	5.0	3.6	1	0.4
Comparative Example 5	0.7	Resin A	Organic filler A	1.8	1.3	5	0.4
Comparative Example 6	5.0	Resin A	Organic filler E	5.0	3.6	5	1.0
Comparative Example 7	2.1	Resin A	Organic filler F	4.0	2.5	30	0.5

Iwai, Table 1 (cropped and annotated)

² As explained below in Section VIII.D.1.e, a POSA would have understood “D90,” as used by *Iwai*, to disclose the claimed “Dv90.”

From *Iwai*'s Table 1, a POSA would have recognized that D90 of the inorganic filler in *Iwai*'s Example 7 separator must necessarily be between 1.6 μ m and 2.8 μ m. Gido, ¶¶69, 70. In particular, a POSA would have recognized from the provided span, D90-D10, that D10 must be related to the D90 value as follows:

$$D90 - D10 = 1.6$$

$$D90 = 1.6 + D10$$

$$D90 - 1.6 = D10 \text{ (Equation 1)}$$

Gido, ¶¶71, 72. Further, a POSA would have recognized that D10 for *Iwai*'s Example 7 separator must necessarily be greater than 0 and less than D50, namely, 1.2 μ m:

$$0 < D10 < 1.2 \text{ (Equation 2)}$$

Gido, ¶72. Replacing D10 in Equation 2 per Equation 1, a POSA would have recognized:

$$0 < D90 - 1.6 < 1.2$$

$$1.6 < D90 < 2.8$$

Gido, ¶73. Thus, as a POSA would have recognized, D90 for *Iwai*'s Example 7 separator must be greater than 1.6 μ m and less than 2.8 μ m. Gido, ¶74.

In *Iwai*'s Example 7 separator, the adhesive porous layer has a thickness of 2.2 μ m. *Iwai*, Table 1. Thus, a POSA would have recognized that in *Iwai*'s Example 7 separator, a ratio of the D90 of the inorganic particles to the thickness

of the porous membrane must necessarily have a value in a range from 0.72 to 1.27, a value which falls within a range from 0.3 to 3.0. Gido, ¶75.

Also from *Iwai*'s Table 1, and employing similar calculations, a POSA would have recognized that D90 of the inorganic filler in *Iwai*'s Comparative Example 2 separator must be between 1.1µm and 1.9µm. Gido, ¶¶76-81.

In *Iwai*'s Comparative Example 2 separator, the adhesive porous layer has a thickness of 3.1µm. *Iwai*, Table 1. Thus, as a POSA would have understood, in *Iwai*'s Comparative Example 2 separator, a ratio of the D90 of the inorganic particles to the thickness of the porous membrane must have a value in a range from 0.35 to 0.61, a value which falls within a range from 0.3 to 3.0. Gido, ¶82.

C. Honda

U.S. Patent App. Pub. No. 2015/0263325 (Ex. 1007) ("*Honda*") has a 35 U.S.C. § 371(c) date of May 6, 2015, and constitutes prior art under at least 35 U.S.C. §§ 102(a)(1) and (2).

Honda describes a separator that includes a "porous substrate" and a "porous layer that is provided on one side or both sides of the porous substrate." *Honda*, [0021]-[0023]. *Honda*'s porous layer, like *Nishikawa*'s and *Iwai*'s, includes a resin and inorganic filler. *Honda*, [0023], [0033]; *see also id.*, [0229]. *Honda* teaches an embodiment of the porous layer in which "a resin has a fibril shape to form a three-dimensional network structure, by which a filler is trapped." *Honda*, [0164] *see*

also id., [0228]. *Honda* states such a structure is “preferable.” *Honda*, [0164]; *see also id.*, [0228].

Nishikawa, *Iwai*, and *Honda* are all analogous art to the ’987 patent. Each “is from the same field of endeavor,” separators for lithium-ion batteries. *Unwired Planet, LLC v. Google Inc.*, 841 F.3d 995, 1000–01 (Fed. Cir. 2016) (citation omitted); ’987 patent, 1:14-34; *Nishikawa*, Abstract; *Iwai*, [0001]-[0002]; *Honda*, [0001]-[0002]. Moreover, each is reasonably pertinent to “one of the particular problems dealt with by the inventor,” such as improving adhesion, heat resistance, and cycle performance of a battery. ’987 patent, Abstract, 4:57-62; *Nishikawa*, 2:35-41; *Iwai*, [0017]-[0018]; *Honda*, [0016]. *Gido*, ¶85.

IV. THE ’987 PATENT

Like *Nishikawa*, *Iwai*, and *Honda*, the ’987 patent describes a “separator” for use in an “energy storage device,” such as a lithium-ion battery. ’987 patent, 1:14-24. Like the separators in *Nishikawa*, *Iwai*, and *Honda*, the claimed separator includes a porous substrate and a porous layer arranged on a surface of the porous substrate. *Id.*, 1:48-50. And like the porous layers in *Nishikawa*, *Iwai*, and *Honda*, the claimed porous layer includes both inorganic particles and a binder. *Id.*, 1:50-51.

The ’987 patent requires that a ratio of Dv90 of the inorganic particles to the thickness of the porous layer be in a range from 0.3 to 3.0. *Id.*, 1:51-53. “[B]y

controlling the ratio of Dv90 of the inorganic particles to the thickness of the porous layer,” the ’987 patent states, “pores having a larger average pore size can be obtained.” *Id.*, 5:13-16. When the ratio is in this range, the patent states, “the mechanical strength of the porous layer is increased, and the porous layer is prevented from undergoing pore blockage due to compression in the preparation or cycle process of the energy storage device.” *Id.*, 5:28-35.

Claim 1, the sole independent claim, recites:

A **separator**, comprising:

a **porous substrate**; and

a **porous layer** arranged on a surface of the **porous substrate**,

wherein the **porous layer** comprises **inorganic particles** and a **binder**,

and

a ratio of Dv90 of the **inorganic particles** to the thickness of the

porous layer is in a range from 0.3 to 3.0.

As explained below, both *Nishikawa* and *Iwai* describe example separators for which a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in the range required by the ’987 patent.

V. LEVEL OF ORDINARY SKILL IN THE ART

The level of ordinary skill in the art may be reflected by the prior art of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). A person

of ordinary skill in the art (“POSA”) at the time of the alleged invention in 2018 would have had at least a bachelor’s degree or equivalent degree from an accredited institution in chemistry, chemical engineering, materials science, or a similar discipline covering relevant principles of organic and inorganic chemistry, polymer processing, ceramic materials, and ceramic processing, as well as three or more years of experience in electrochemical energy storage devices, lithium-ion battery technology, separators, characterizations and analyses of particle size, film thickness, and/or materials compositions, battery performance characterization, or other applications of polymer chemistry, ceramic chemistry, and ceramic processing. Gido, ¶14. More education could substitute for less experience, and vice versa. *Id.*

VI. CLAIM CONSTRUCTION

The Board construes claims in accordance with 37 C.F.R. § 42.200(b) and *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). Claims need only be construed to the extent necessary to resolve a controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). No terms need construction at this time because the claims encompass the prior-art mappings below under any construction consistent with *Phillips*.

VII. STATEMENT OF PRECISE RELIEF REQUESTED FOR EACH CLAIM CHALLENGED

CosMx requests review of claims 1-17 under the following grounds:

Ground	References	Basis	Claims
1	<i>Nishikawa</i>	§ 102	1-2, 4-9
2	<i>Nishikawa</i>	§ 103	10-16
3	<i>Nishikawa</i> and <i>Honda</i>	§ 103	17
4	<i>Iwai</i>	§ 102	1-2, 4-9
5	<i>Iwai</i>	§ 103	3

VIII. THE CHALLENGED CLAIMS ARE UNPATENTABLE

As described below, each of the challenged claims is anticipated by or would have been rendered obvious by either *Nishikawa*, alone or in combination with *Honda*, and/or *Iwai* alone.

A. Ground 1: *Nishikawa* Anticipates Claims 1-2, and 4-9

1. Claim 1

Nishikawa anticipates claim 1.

a. 1[p] A **separator**, comprising:

To the extent this preamble is limiting, *Nishikawa* describes “[a] **separator**.” Gido, ¶92. *Nishikawa* describes a “**separator** for a nonaqueous secondary battery” and two example **separators** in Examples 4 and 5. *Nishikawa*, 2:47-52, 15:51-16:44, 22:10-52.

b. 1[a] a porous substrate; and

Nishikawa discloses “a porous substrate.” *Gido*, ¶93. In *Nishikawa*, the separator includes a “microporous membrane.” *Nishikawa*, 2:47-52; *see also id.*, 8:57-67, 15:51-16:6³. A POSA would have understood *Nishikawa*’s microporous membrane to be a “porous substrate” at least because: (i) *Nishikawa* describes the microporous membrane as having “pores inside”; (ii) like embodiments of the porous substrate in the ’987 patent, *Nishikawa*’s microporous membrane is formed of polyethylene and/or polypropylene, *compare Nishikawa*, 8:62-67 with ’987 patent, 2:9-52; and (iii) just as the ’987 patent describes a porous layer being “coat[ed] ... onto a surface of [the] porous substrate,” ’987 patent, 2:25-26,

³ *Nishikawa*’s Example 4 separator is “produced in the same manner as in Example 1, except that” the coating slurry is modified. *Nishikawa*, 22:37-40. *Nishikawa*’s Example 5 separator is “produced in the same manner as in Example 4 except that the inorganic filler was changed” from H-43M to H-42M, where H-42M and H-43M are both commercially available aluminum hydroxide organic fillers having different particle size distribution as shown in Table 2. *Nishikawa*, 22:26-33, 22:46-51. Accordingly, throughout Section VIII.A, VIII.B, and VIII.C, citations to discussions of Example 1 are provided where they apply equally to Example 4 and Example 5.

Nishikawa describes a **heat resistant porous layer** being “coat[ed] ... on both the surfaces of the **microporous membrane**,” *Nishikawa*, 16:24-29. Gido, ¶93.

Nishikawa’s Example 4 and Example 5 **separators** each include a polyethylene **microporous membrane** onto which a **heat resistant porous layer** is coated.

Nishikawa, 15:51-16:14, 22:37-38.

c. 1[b] a **porous layer arranged on a surface of the **porous substrate**,**

Nishikawa discloses “a **porous layer** arranged on a surface of the **porous substrate**.” Gido, ¶94. In *Nishikawa*, the **separator** includes a “**heat resistant porous layer**” that is “laminated” onto both sides of the **microporous membrane**.

Nishikawa, 2:47-52. *Nishikawa*’s Example 4 and Example 5 **separators** each include a **heat resistant porous layer** that is “coat[ed] ... on both the surfaces of the polyethylene **microporous membrane**.” *Id.*, 16:24-35.

d. 1[c] wherein the **porous layer comprises **inorganic particles** and a **binder**,**

Nishikawa discloses “wherein the **porous layer** comprises **inorganic particles** and a **binder**.” Gido, ¶¶95-97.

Regarding the **inorganic particles**, in *Nishikawa*, the **heat resistant porous layer** includes “**inorganic filler**.” *Nishikawa*, 2:47-52. In the **heat resistant porous layer** in each of *Nishikawa*’s Example 4 and Example 5 **separators**, the **inorganic filler** is aluminum hydroxide, like embodiments of the claimed “**inorganic**

particles” described in the ’987 patent. *Compare Nishikawa*, 22:26-33, 22:46-51 with ’987 patent, 2:1-6.

Regarding a **binder**, in *Nishikawa*, the **heat resistant porous layer** includes a “**heat resistant resin**.” *Nishikawa*, 2:47-52. A POSA would have understood *Nishikawa*’s **heat resistant resin** to be a “**binder**” at least because (i) just as the ’987 patent describes “pores formed by the **binder**” through which “diffusion” takes place, *Nishikawa*’s **heat resistant resin** has “pores inside ... through which a gas or a liquid can pass,” *compare* ’987 patent, 3:59-61, 4:10-14 with *Nishikawa*, 7:41-45; and (ii) like embodiments of the **binder** in the ’987 patent, *Nishikawa*’s **heat resistant resin** is formed of polyamide, *compare Nishikawa*, 3:5-9 with ’987 patent, 2:7-52. *Gido*, ¶97. *Compare also Nishikawa*, 7:49-57 (listing materials for *Nishikawa*’s **heat resistant resin**, including polyamide and carboxymethylcellulose (a form of cellulose)) with ’987 patent claim 7 (listing materials for claimed “**binder**,” including polyamide and cellulose). *Nishikawa*’s Example 4 and Example 5 **separators** each include polyamide **heat resistant resin**. *Nishikawa*, 22:26-35.

- e. **1[d] a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0.**

Nishikawa discloses that “a ratio of Dv90 of the **inorganic particles** to the thickness of the **porous layer** is in a range from 0.3 to 3.0” because in each of

Nishikawa's Example 4 and Example 5 **separators**, a ratio of the D90 of the **inorganic filler** to the thickness of the **heat resistant porous layer** is within the claimed range. *Gido*, ¶¶98-102.

As shown below in Table 2, in *Nishikawa*'s Example 4 and Example 5 **separators**, the **heat resistant porous layer** has a D90 of the **inorganic filler** that is 1.05µm and 1.07µm, respectively. A POSA would have understood "D90," as used by *Nishikawa* in Examples 4 and 5, to disclose the claimed "Dv90." *Gido*, ¶99. While the '987 patent uses a cumulative volume distribution (hence the "v" in "Dv90") and *Nishikawa* defines its D90 with reference to a cumulative weight distribution, *see Nishikawa*, 3:52-55, a POSA would have recognized that where, as in *Nishikawa*'s Examples 4 and 5, the **inorganic filler** is of a single material (aluminum hydroxide, *see Nishikawa*, 22:26-35, 22:46-51), a cumulative volume distribution and a cumulative weight distribution will have the same D90 value because volume is directly proportional to weight. *Gido*, ¶97. *Compare also Nishikawa*, 3:52-55 (defining "D90" as "an average **particle** diameter (µm) of weight accumulation of 90% by weight calculated from a smaller particle side in a particle size distribution") *with* '987 patent, 1:53-56 (defining "Dv90" as "a **particle** size which reaches 90% [of] the cumulative volume from the side of small particle size in the granularity distribution on a volume basis.").

TABLE 2

	d10	d50	d90	α	Sliding property	Coating property
Example 4	0.38	0.75	1.05	0.89	good	good
Example 5	0.50	1.02	1.07	0.56	good	good
Example 6	1.50	8.0	22.0	2.56	good	poor
Example 7	5.10	23.0	58.0	2.30	good	poor

In each of *Nishikawa*'s Example 4 and Example 5 **separators**, the **heat resistant porous layer** has a thickness of 3.15 μ m on each side of the **microporous membrane** (both sides totaling 6.3 μ m). *Nishikawa*, Table 1, 16:24-44; Gido, ¶100. Thus, as summarized in *Nishikawa*'s Ratios Table below, in each of *Nishikawa*'s Example 4 and Example 5 **separators**, a ratio of the D90 of the **inorganic filler** to the thickness of the **heat resistant porous layer** is 0.33 and 0.34, respectively.

<i>Nishikawa</i> 's Example	D90 (μ m)	Thickness (μ m)	Ratio ($\frac{D90}{Thickness}$)
4	1.05	3.15	0.33
5	1.07	3.15	0.34

Nishikawa's Ratios Table

Thus, *Nishikawa* discloses two example **separators** in which a ratio of D90 of the **inorganic filler** to the thickness of the **heat resistant porous layer** "is in a

range from 0.3 to 3.0.”⁴ Gido, ¶102. Each of *Nishikawa*’s example **separators** thus anticipates the claimed range because a claimed range is anticipated “if one of [the values in the range] is in the prior art.” *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 782 (Fed. Cir. 1985).

2. Claim 2: The **separator according to claim 1, wherein the **porous layer** has a thickness of 0.2 μm to 10 μm.**

Nishikawa discloses “wherein the **porous layer** has a thickness of 0.2 μm to 10 μm.” Gido, ¶103. In each of *Nishikawa*’s Example 4 and Example 5 **separators**, the **heat resistant porous layer** has a thickness of 3.15μm on each side of the **microporous membrane**. *Nishikawa*, Table 1, 16:24-44; Gido, ¶103. Each of *Nishikawa*’s Example 4 and Example 5 **separators** anticipates the claimed range of thicknesses because a claimed range is anticipated “if one of [the values in the range] is in the prior art.” *Titanium*, 778 F.2d at 782.

⁴ Because the IPR procedure does not permit challenges under 35 U.S.C. § 112, Petitioner has not included any indefiniteness arguments herein, but may present such arguments in other proceedings.

3. **Claim 4: The separator according to claim 1, wherein a volume ratio of the inorganic particles to the binder is in a range from 0.2 to 3.0.**

Nishikawa discloses “wherein a volume ratio of the inorganic particles to the binder is in a range from 0.2 to 3.0,” because a POSA would have understood from *Nishikawa* that each of the Example 4 and Example 5 separators has a volume ratio of 1.71, as explained below. *Gido*, ¶¶104-116.

Nishikawa provides a mass ratio of the inorganic filler to the resin for the Example 4 and Example 5 separators, stating the poly-m-phenylene isophthalamide resin and the inorganic filler containing aluminum hydroxide “were mixed at a weight ratio of 25/75.” *Nishikawa*, 22:26-29. From this, a POSA would have recognized the mass ratio of the inorganic filler to the resin is as follows:

$$\frac{M_{\text{resin}}}{M_{\text{filler}}} = \frac{25}{75}$$

Gido, ¶105. Or, equivalently:

$$\frac{M_{\text{filler}}}{M_{\text{resin}}} = \frac{75}{25}$$

$$\frac{M_{\text{filler}}}{M_{\text{resin}}} = 3 \text{ (Equation 3)}$$

Gido, ¶106. While Equation 3 provides a mass ratio, a POSA would have known how to determine a volume ratio from a mass ratio. *Gido*, ¶107. In particular, a POSA would have known that a mass ratio is convertible to a volume

ratio by multiplying the masses by a reciprocal of the densities, ρ , of the materials.

Gido, ¶107. This is shown in Equation 4, where “ ρ_{filler} ” refers to a density of the **inorganic filler** and “ ρ_{resin} ” refers to a density of the **resin**, and “ V_{filler} ” refers to a volume of the **inorganic filler** and “ V_{resin} ” refers to a volume of the **resin**:

$$\frac{V_{\text{filler}}}{V_{\text{resin}}} = \frac{M_{\text{filler}}}{M_{\text{resin}}} \times \frac{\rho_{\text{resin}}}{\rho_{\text{filler}}} \text{ (Equation 4)}$$

Gido, ¶107. Replacing $\frac{M_{\text{filler}}}{M_{\text{resin}}}$ in Equation 4 with Equation 3 provides

Equation 5 below:

$$\frac{V_{\text{filler}}}{V_{\text{resin}}} = 3 \times \frac{\rho_{\text{resin}}}{\rho_{\text{filler}}} \text{ (Equation 5)}$$

Gido, ¶108. In the **separator** of Example 4 in *Nishikawa*, the **inorganic filler** is aluminum hydroxide, which has a density ρ_{filler} of 2.42 g/cm³. Gido, ¶109; Ex. 1011, 5. The **separator** of Example 4 in *Nishikawa* uses a poly-m-phenylene isothalamide **resin** that has a density ρ_{resin} of 1.38 g/cm³. Gido, ¶¶110-112; Ex. 1013, 4. Finally, plugging these values of ρ_{filler} and ρ_{resin} into Equation 5, a POSA would have arrived at a volume ratio for *Nishikawa*’s Example 4 **separator** of:

$$\frac{V_{\text{filler}}}{V_{\text{resin}}} = 3 \times \frac{\rho_{\text{resin}}}{\rho_{\text{filler}}} \text{ (Equation 5)}$$

$$\frac{V_{\text{filler}}}{V_{\text{resin}}} = 3 \times \frac{1.38}{2.42}$$

$$\frac{V_{\text{filler}}}{V_{\text{resin}}} = 1.71$$

Gido, ¶113. Thus, *Nishikawa*'s Example 4 separator has a volume ratio of 1.71. *Nishikawa*'s Example 5 separator has the same volume ratio. *Nishikawa*, 22:46-51 (Example 5, same as Example 4 in relevant aspects); Gido, ¶115. Thus, a POSA would have understood *Nishikawa* to disclose that, in each of the separators of Examples 4 and 5, a volume ratio of the inorganic particles to the binder is 1.71, a value that is "in a range from 0.2 to 3.0." Gido, ¶¶114-116. This disclosed volume ratio of 1.71 discloses the claimed range of volume ratios because a claimed range is taught "if one of [the values in the range] is in the prior art." *Titanium*, 778 F.2d at 782.

4. Claim 5: The separator according to claim 1, wherein the porous layer has a porosity of 20% to 90%.

Nishikawa discloses "wherein the porous layer has a porosity of 20% to 90%." Gido, ¶117. *Nishikawa* states "[t]he heat resistant porous layer preferably has a porosity of 60 to 90%." *Nishikawa*, 8:49-50. Indeed, in each of the Examples 1-3 and 8-10 for which *Nishikawa* provides a porosity, the porosity is between 65% and 79%. *Id.*, Tables 1, 3. Because a porosity having any value in *Nishikawa*'s preferred range falls within the claimed range of "20% to 90%," *Nishikawa* discloses the claimed range. *Titanium*, 778 F.2d at 782 (a claimed range is taught "if one of [the values in the range] is in the prior art.").

5. **Claim 6: The separator according to claim 1, wherein the inorganic particles are one or more selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, zirconia, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate.**

Nishikawa discloses “wherein the inorganic particles are one or more selected from the group consisting of ... aluminum hydroxide [and] magnesium hydroxide.” *Gido*, ¶118. In the heat resistant porous layer in each of *Nishikawa*’s Example 4 and Example 5 separators, the inorganic filler is aluminum hydroxide. *Nishikawa*, 22:26-35, 22:46-52. *Nishikawa* additionally envisions that the inorganic filler may be magnesium hydroxide. *Id.*, 5:48-50.

6. **Claim 7: The separator according to claim 1, wherein the binder is one or more selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylates, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.**

Nishikawa discloses “wherein the binder is one or more selected from the group consisting of ... polyamide.” *Gido*, ¶119. The heat resistant porous layer in each of *Nishikawa*’s Example 4 and Example 5 separators includes a resin of poly-m-phenylene isophthalamide, which a POSA would have understood to be polyamide, at least because (i) the chemical structure of this polymer shows it is

linked together by amide linkages in its backbone and (ii) this is indicated by its chemical name (poly-m-phenylene isophthal~~amide~~). *Nishikawa*, 22:10-35, 22:46-51; Gido, ¶119. *See also Nishikawa*, 7:49-57 (recommending a resin of polyamide).

7. Claim 8: An energy storage device, comprising the separator according to claim 1.

Nishikawa discloses “[a]n energy storage device, comprising the separator according to claim 1.” Gido, ¶120. Each of *Nishikawa*’s Example 4 and Example 5 separators discloses “the separator according to claim 1,” *supra* Section VIII.A.1. And *Nishikawa* discloses using its example separators “for a nonaqueous secondary battery,” which is one “energy storage device” described in the ’987 patent. *Nishikawa*, 22:37-40, 22:46-51; ’987 patent, 1:20-21 (describing “[n]on-aqueous secondary batteries”).

8. Claim 9: The energy storage device according to claim 8, wherein the energy storage device is a lithium-ion battery.

Nishikawa discloses “wherein the energy storage device is a lithium-ion battery.” Gido, ¶121. *Nishikawa*’s Example 4 and Example 5 separators are “for a nonaqueous secondary battery,” *supra* Section VIII.A.7, which *Nishikawa* states “is represented by a lithium ion secondary battery.” *Nishikawa*, 1:14-18.

B. Ground 2: *Nishikawa* Would Have Rendered Obvious Claims 10-16

1. Claim 10

Nishikawa would have rendered obvious claim 10.

a. 10[p] A method for preparing the separator of claim 1, wherein the method comprises steps of:

Each of *Nishikawa*'s Example 4 and Example 5 separators discloses "the separator of claim 1." *Supra* Section VIII.A.1. *Nishikawa* further discloses "[a] method for preparing" each of *Nishikawa*'s Example 4 and Example 5 separators. Gido, ¶123; *Nishikawa*, 15:51-16:44 (Example 1), 22:10-42 (Example 4, same as Example 1 in some aspects), 22:46-52 (Example 5, same as Examples 1 and 4 in some aspects).

b. 10[a] mixing inorganic particles with a binder to generate a mixture; and 10[b] adding a first solvent into the mixture;

Nishikawa teaches "mixing inorganic particles with a binder to generate a mixture" and "adding a first solvent into the mixture." Gido, ¶¶124-25. *Nishikawa* teaches that, to prepare each of the Example 4 and Example 5 separators, a poly-m-phenylene isophthalamide resin and an inorganic filler containing aluminum hydroxide "were mixed at a weight ratio of 25/75." *Nishikawa*, 22:26-29. *Nishikawa* further teaches that the resin and inorganic filler, once mixed together, were "mixed [at a particular concentration] with a mixed solvent containing

dimethylacetamide (DMAc) and tripropylene glycol (TPG) [in a particular weight ratio], thereby providing a coating slurry.” *Nishikawa*, 22:26-33 (Example 4), 22:46-51 (Example 5, same as Example 4 in relevant aspects). The solvent *Nishikawa* describes, dimethylacetamide, is one embodiment of the claimed “first solvent” described in the ’987 patent. *Compare Nishikawa*, 22:26-33 with ’987 patent, 2:35-38.

c. 10[c] stirring the mixture with the first solvent to obtain a uniform coating solution;

Nishikawa would have rendered obvious “stirring the mixture with the first solvent to obtain a uniform coating solution.” *Gido*, ¶¶126-28. *Nishikawa* teaches that the resin and inorganic filler, once mixed together, were “mixed [at a particular concentration] with a mixed solvent containing dimethylacetamide (DMAc) and tripropylene glycol (TPG) [in a particular weight ratio], thereby providing a coating slurry.” *Nishikawa*, 22:26-33 (Example 4), 22:46-51 (Example 5, same as Example 4 in relevant aspects). A POSA would have understood *Nishikawa*’s “mix[ing]” to be synonymous with—or at least to have rendered obvious—the claimed “stirring.” *Gido*, ¶126. This is so at least because stirring was a typical and widespread technique known to a POSA for mixing dry ingredients, like the resin and inorganic filler, into a solvent like the first solvent. *Gido*, ¶126. For this reason, mixing by stirring would have been nothing more than

the use of a known technique and would have yielded nothing more than predictable results. Gido, ¶126.

A POSA would also have been motivated and found it obvious to make the “coating slurry” taught by *Nishikawa* “uniform.” Gido, ¶¶127-28. As *Nishikawa* explains, it is “favorable” for the heat resistant porous layer formed from the coating slurry to “hav[e] uniform minute pores,” and a POSA would have recognized that uniformity in the coating slurry would lead to *Nishikawa*’s desired uniformity in the heat resistant porous layer formed from the coating slurry. Gido, ¶127. Moreover, such uniformity was known to be desirable in the art and, indeed, a POSA would have recognized that a uniform coating slurry is fundamental to a successful coating process. Gido, ¶¶127-28 (citing *Honda*, [0127] (recommending “enhancing the dispersibilities of the resin particles and inorganic filler” in a coating liquid, which a POSA would have recognized leads to greater uniformity); Ex. 1010, 10:50-53 (recommending a solvent that “facilitates uniform mixing”); Ex. 1019, [0011-0013] (discussing problems with non-uniformity)). Moreover, a POSA would have known how to achieve such uniformity. Gido, ¶127 (citing Ex. 1019, [0113] (discussing how to achieve desired uniformity in a separator)). A POSA would have known, for example, that dispersion is achievable through commercially available dispersing devices in which desirable dispersion is

achieved by controlling dispersion conditions such as a number of rotations, dispersion energy, and dispersion time. Gido, ¶127.

d. 10[d] coating the uniform coating solution onto a surface of a porous substrate to form a wet film;

Nishikawa teaches “coating the uniform coating solution onto a surface of a porous substrate to form a wet film.” Gido, ¶129. In *Nishikawa*, the coating slurry is “coat[ed] ... on both the surfaces of the polyethylene microporous membrane.” *Nishikawa*, 16:25-29 (Example 1); 22:37-40 (Example 4, same as Example 1 in relevant aspects), 22:46-51 (Example 5, same as Example 4 in relevant aspects). A POSA would have understood the coating slurry thus coated in *Nishikawa* to be “a wet film” at least because the term “slurry” used by *Nishikawa*, like the term “solution” used in the ‘987 patent, always refers to a wet fluid. Gido, ¶129. And any coating process using a wet fluid (slurry or solution) necessarily produces a wet coating or wet film, at least before it is dried. Gido, ¶129. (*Nishikawa* does disclose a drying step, but this is later in the process. *Nishikawa*, 16:31-32.) Gido, ¶129. Finally, *Nishikawa* describes its own process as a “wet coating method,” *Nishikawa*, 7:58-63.

- e. 10[e] [wherein the solid content in] the **coating solution** is in a range from 7% to 25%⁵;

Nishikawa teaches “[wherein the solid content in] the **coating solution** is in a range from 7% to 25%” because a POSA would have recognized that each of *Nishikawa*’s Example 4 and Example 5 **separators** is prepared with a solid content in the **coating slurry** that “is in a range from 7% to 25%.” *Gido*, ¶¶130-133.

For Example 4, *Nishikawa* states that, in the **coating slurry**, the poly-m-phenylene isophthalamide **resin** has a concentration “of 5.5% by weight.”

Nishikawa, 22:26-35. *Nishikawa* also states that the poly-m-phenylene isophthalamide **resin** and the **inorganic filler** containing aluminum hydroxide “were mixed at a weight ratio of 25/75,” meaning there is three times as much (by weight) **inorganic filler** as **resin** in the **coating slurry**. *Id.*; *Gido*, ¶133. From this, a POSA would have recognized that, in the **coating slurry**, the **inorganic filler** has a concentration of 16.5% by weight, as this is three times the 5.5% concentration by

⁵ For purposes of this IPR, Petitioner reads “the **coating solution** is in a range from 7% to 25%” as “wherein the solid content in the **coating solution** is in a range from 7% to 25%.” *See, e.g.*, 2:30-31, 6:14-15, claim 11. A POSA would have understood the “solid content” to refer to a mass concentration of solids. *Gido*, ¶¶131-32.

weight of the **resin**. *Gido*, ¶133. The “solid content” of the **coating slurry**, a POSA would have known, is simply the sum of the concentrations by weight of any solid content in the **coating slurry**—here, the **resin** and the **inorganic filler**. *Gido*, ¶133. Accordingly, a POSA would have understood that the “solid content” of the **coating slurry** in Example 4 is the sum of the 5.5% concentration by weight of the **resin** and the 16.5% concentration by weight of the **inorganic filler**, namely, 22%. *Gido*, ¶133. *Nishikawa*’s Example 5 has the same solid content, as it is the same as Example 4 in the relevant aspects. *Nishikawa*, 22:46-51; *Gido*, ¶133. Each of *Nishikawa*’s Example 4 and Example 5 **separators** thus teaches the claimed range because a claimed range is anticipated “if one of [the values in the range] is in the prior art.” *Titanium*, 778 F.2d at 782.

- f. **10[f] wherein a ratio of Dv90 of the **inorganic particles** to the thickness of the **porous layer** is in a range from 0.3 to 3.0.**

Nishikawa discloses “wherein a ratio of Dv90 of the **inorganic particles** to the thickness of the **porous layer** is in a range from 0.3 to 3.0.” *Supra* Section VIII.A.1.e.

- 2. **Claim 11: The method according to claim 10, wherein the solid content in the **coating solution** is in a range from 7% to 25%.**

Nishikawa teaches “wherein the solid content in the **coating solution** is in a range from 7% to 25%.” *Supra* Section VIII.B.1.e.

3. **Claim 12:** The method according to claim 10, wherein the **coagulating solution** comprises a **second solvent** and a **third solvent**, and the **second solvent** has a mass percentage of 20% to 60%.

Nishikawa teaches “wherein the **coagulating solution** comprises a **second solvent** and a **third solvent**, and the **second solvent** has a mass percentage of 20% to 60%.” *Gido*, ¶¶136-139.

Nishikawa describes a “**coagulation bath**,” used in both Examples 4 and 5, in which the **microporous membrane**, coated with the **coating slurry**, is “immersed.”

Nishikawa, 16:29-31, 22:37-40 (Example 4, same as Example 1 in relevant aspects), 22:46-51 (Example 5, same as Example 4 in relevant aspects).

Nishikawa’s **coagulation bath**, a POSA would have recognized, teaches the claimed “**coagulating solution**,” in which the ’987 patent likewise states the **porous substrate**, coated with the **coating solution**, is “immers[ed].” *Gido*, ¶137; ’987 patent, 2:22-29.

Nishikawa’s **coagulation bath** includes **dimethylacetamide**, which is one of the embodiments of the “**second solvent**” in the ’987 patent. *Compare Nishikawa*, 16:29-31 with ’987 patent, 6:40-43. *Nishikawa*’s **coagulation bath** also includes **water**, which is one of the embodiments of the “**third solvent**” in the ’987 patent. *Compare Nishikawa*, 16:29-31 with ’987 patent, 6:40-46.

Nishikawa also teaches that the dimethylacetamide “has a mass percentage of 20% to 60%.” Gido, ¶139. *Nishikawa*’s coagulation bath is described as having “a weight ratio of water / DMAc [dimethylacetamide] / TPG [tripropylene glycol] of 50/25/25,” from which a POSA would understand the dimethylacetamide has a mass percentage of 25%. Gido, ¶139. Each of *Nishikawa*’s Example 4 and Example 5 separators thus teaches the claimed range because a claimed range is anticipated “if one of [the values in the range] is in the prior art.” *Titanium*, 778 F.2d at 782.

4. **Claim 13: The method according to claim 10, wherein the first solvent is one or more independently selected from the group consisting of N-methylpyrrolidone, dimethylacetamide and dimethylformamide.**

Nishikawa teaches “wherein the first solvent is one or more independently selected from the group consisting of ... dimethylacetamide.” Gido, ¶140. In preparing each of the Example 4 and Example 5 separators, *Nishikawa* uses a solvent containing dimethylacetamide. *Nishikawa*, 22:26-33 (Example 4), 22:46-51 (Example 5, same as Example 4 in relevant aspects).

5. **Claim 14:** The method according to claim 10, wherein the **porous substrate** comprises a polymer film, a multilayer polymer film, or a non-woven fabric formed by any one or more of the following polymers: polyethylene, polypropylene, polyethylene terephthalate, polyphthaloyl diamine, polybutylene terephthalate, polyester, polyacetal, polyamide, polyimide, polyetheretherketone, polyaryletherketone, polyetherimide, polyamide imide, polybenzimidazole, polyethersulfone, polyphenylene oxide, cycloolefin copolymer, polyphenylene sulfide, and polyethylene naphthalene.

Nishikawa teaches “wherein the **porous substrate** comprises a polymer film ... formed by ... polyethylene.” *Gido*, ¶141. In each of *Nishikawa*’s Example 4 and Example 5 **separators**, the **microporous membrane** is a “polyethylene **microporous membrane**,” formed of polyethylene. *Nishikawa*, 15:51-16:14 (Example 1), 22:36-37 (Example 4 uses “polyethylene **microporous membrane** of Example 1), 22:46-51 (Example 5, same as Example 4 in relevant aspects). A POSA would have understood a “polyethylene **microporous membrane**” to be an example of a polymer film. *Gido*, ¶141.

6. **Claim 15:** The method according to claim 14, wherein the polyethylene is at least one selected from the group consisting of high density polyethylene, low density polyethylene, and ultrahigh molecular weight polyethylene.

Nishikawa teaches “wherein the polyethylene is at least one selected from the group consisting of high density polyethylene, ... and ultrahigh molecular weight polyethylene.” *Gido*, ¶142. *Nishikawa* states that “preferred examples of

polyethylene” for the microporous membrane “include high density polyethylene and a mixture of high density polyethylene and ultrahigh molecular weight polyethylene.” *Nishikawa*, 8:63-67.

7. **Claim 16:** The method according to claim 12, wherein the second solvent is one or more independently selected from the group consisting of N-methylpyrrolidone, dimethylacetamide and dimethylformamide, and the third solvent is one or more selected from the group consisting of deionized water, ethanol, propanol, acetone, dimethyl carbonate and diethyl carbonate.

Nishikawa teaches that “the second solvent is ... dimethylacetamide” and “the third solvent is ... deionized water.” *Gido*, ¶143. In preparing each of the Example 4 and Example 5 separators, *Nishikawa*’s coagulation bath includes dimethylacetamide and water. *Nishikawa*, 16:29-31. A POSA would have understood *Nishikawa*’s use of water to teach “deionized water” at least because a POSA would have known it would be desirable to use pure water in *Nishikawa*, to avoid any complications from impurities, and deionized water would have been the most likely source of pure water for a POSA. *Gido*, ¶143.

C. Ground 3: *Nishikawa* and *Honda* Would Have Rendered Obvious Claim 17

1. **Claim 17:** The separator according to claim 1, wherein the porous layer has pores formed by the binder, at least a part of the inorganic particles are embedded in the pores.

Nishikawa and *Honda* would have rendered obvious “wherein the porous layer has pores formed by the binder, at least a part of the inorganic particles are

embedded in the pores.” Gido, ¶¶144-48.

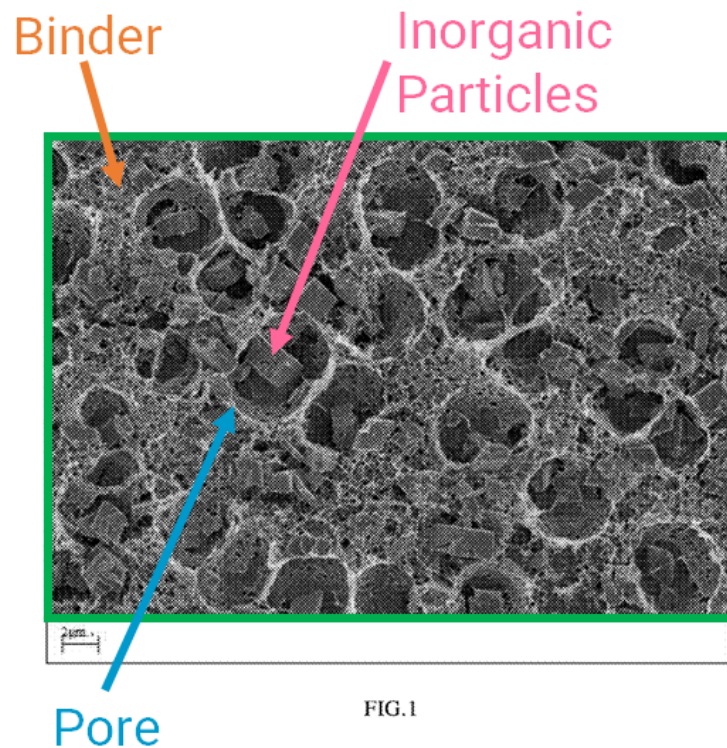
Nishikawa describes “pores in the heat resistant porous layer.” *Nishikawa*, 7:26-30. As *Nishikawa* explains, “[t]he heat resistant porous layer of the invention contains the heat resistant resin, has numerous minute pores inside, and has such a structure that the minute pores are connected to each other, thereby providing a porous layer, through which a gas or a liquid can pass from one surface to the other surface.” *Id.*, 7:41-45. *Nishikawa* also explains that the “inorganic filler contribut[es] to the formation of pores” in the heat resistant porous layer, but does not explain how. *Nishikawa* does not further describe the structure of those pores.

Honda explains how inorganic filler can contribute to the formation of pores. In particular, *Honda* recommends a porous layer in which “a resin has a fibril shape to form a three-dimensional network structure, by which a filler is trapped.” *Honda*, [0164] *see also id.*, [0228]. A POSA would have recognized from *Honda* that such “a three-dimensional network structure” of the resin would include “pores formed by the” resin. Gido, ¶146. In particular, the pores are formed in the voids of the “three-dimensional network structure” *Honda* describes. Gido, ¶146.

Thus, from *Honda*, a POSA would have recognized that one way for the “inorganic filler [to] contribut[e] to the formation of pores” in the resin of heat resistant porous layer—as *Nishikawa* envisions—is for the inorganic filler to be

“trapped by” the pores in the resin, as *Honda* describes. *Gido*, ¶147. Accordingly, from *Nishikawa* and *Honda*, a POSA would have been motivated and found it obvious for the inorganic filler to be “trapped by” the pores in the resin. *Gido*, ¶147.

Thus, from *Nishikawa* and *Honda*, a POSA would have been motivated and found it obvious to implement *Nishikawa*’s heat resistant porous layer to have pores formed by the resin, with at least a part of the inorganic filler trapped in the pores, as *Honda* describes. *Gido*, ¶148. A POSA would have understood such inorganic filler trapped in the pores to be “embedded in” the pores, at least because the ’987 patent shows such “embedded” inorganic particles are trapped in the pores, as annotated Figure 1 of the ’987 patent, below, shows. *Gido*, ¶148.



D. Ground 4: *Iwai* Anticipates Claims 1-2 and 4-9

1. Claim 1

Iwai anticipates claim 1.

a. 1[p] A **separator, comprising:**

To the extent this preamble is limiting, *Iwai* describes “[a] **separator**.” Gido, ¶150. *Iwai* describes a “**separator** for a non-aqueous secondary battery” and example **separators** in Example 7 and Comparative Example 2. *Iwai*, [0001], [0206]-[0208], [0215]-[0217].

b. 1[a] a porous substrate; and

Iwai discloses “a porous substrate.” *Gido*, ¶151. In *Iwai*, the separator includes a “porous substrate.” *Iwai*, [0020]; *see also id.*, [0046]-[0047]. Each of *Iwai*’s Example 7 and Comparative Example 2 separators includes a porous substrate. *Id.*, [0157] (Example 1 includes a “porous substrate”); [0206]-[0208] (Example 7, same as Example 1); [0215]-[0217] (Comparative Example 2, same as Example 1)⁶.

⁶ *Iwai*’s Example 7 is “obtained in the same manner as in Example 1, except that” the “organic filler A” used in Example 1 is replaced with a mixture of “inorganic filler C,” which is “a magnesium hydroxide filler having a volume average particle diameter of 1.6 μm,” and “inorganic filler D” which is “a magnesium hydroxide filler having a volume average particle diameter of 0.8 μm,” and “the average thickness a of the adhesive porous layer” was changed as shown in Table 1. *Iwai*, [0206]. *Iwai*’s Comparative Example 2 is “obtained in the same manner as in Example 1, except that the inorganic filler D was used instead of the organic filler A and that the average thickness of the adhesive porous layer” was changed as shown in Table 1. *Id.*, [0215]. Accordingly, throughout Sections VIII.D and VIII.E, citations to discussions of Example 1 are provided where they equally to Example 7 and Comparative Example 2.

c. 1[b] a porous layer arranged on a surface of the porous substrate,

Iwai discloses “a porous layer arranged on a surface of the porous substrate.”
Gido, ¶152. In *Iwai*, the separator includes an “adhesive porous layer” that is
“provided on one or both sides of the porous substrate.” *Iwai*, [0021]; *see also id.*,
[0063]. Each of *Iwai*’s Example 7 Comparative Example 2 separators includes an
adhesive porous layer that is “applied ... to both sides of” the porous substrate.
Gido, ¶152; *Iwai*, [0189].

d. 1[c] wherein the porous layer comprises inorganic particles and a binder,

Iwai discloses “wherein the porous layer comprises inorganic particles and a
binder.” Gido, ¶¶153-55.

Regarding inorganic particles, in *Iwai*, the adhesive porous layer includes
“filler” such as “inorganic filler.” *Iwai*, [0087]-[0088]. In the adhesive porous layer
in each of *Iwai*’s Example 7 and Comparative Example 2 separators, the inorganic
filler is magnesium hydroxide, which is one embodiment of the claimed “inorganic
particles” described in the ’987 patent. *Id.*, [0206] (Example 7), [0215]
(Comparative Example 2), Table 1; ’987 patent, 2:1-6. *Compare also Iwai*, [0092]
(listing materials for *Iwai*’s inorganic filler) with ’987 patent claim 6 (listing
materials for claimed “inorganic particles”).

Regarding a **binder**, in *Iwai*, the **adhesive porous layer** includes a “**resin**” of “**polyvinylidene-fluoride**,” which is one embodiment of the claimed “**binder**” described in the ’987 patent. *Iwai*, [0022]; ’987 patent, 2:7-13 The **adhesive porous layer** in each of *Iwai*’s Example 7 and Comparative Example 2 **separators** includes the **polyvinylidene-fluoride resin**. *Id.*, [0187], Table 1. Compare also *Iwai*, [0074]-[0075] (listing materials for *Iwai*’s **polyvinylidene-fluoride resin**) with ’987 patent claim 7 (listing materials for claimed “**binder**”).

- e. **1[d] a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0.**

Iwai discloses that “a ratio of Dv90 of the **inorganic particles** to the thickness of the **porous layer** is in a range from 0.3 to 3.0” because a POSA would have recognized that, in each of *Iwai*’s Example 7 and Comparative Example 2 **separators**, a ratio of the D90 of the **inorganic filler** to the thickness of the **porous membrane** must have a value that falls within the claimed range. *Gido*, ¶¶156-175.

Table 1, below, shows *Iwai*’s Example 7 **separator** includes **inorganic filler** having a volume average particle diameter of 1.2µm. Table 1 also shows that D90-D10 span for the **inorganic filler**—that is, a difference between the D90 of the **inorganic filler** and the D10 of the **inorganic filler**—in *Iwai*’s Example 7 **separator** is 1.6µm.

TABLE 1

	Average		Filler				
	thickness a (μm) of adhesive porous layer	Resin type	Type	Volume average particle diameter r (μm)	D90 – D10 (μm)	Content (% by mass)	a/r
Example 1	2.1	Resin A	Organic filler A	1.8	1.3	5	1.2
Example 2	1.1	Resin A	Organic filler A	1.8	1.3	20	0.6
Example 3	1.5	Resin A	Organic filler A	1.8	1.3	25	0.8
Example 4	3.5	Resin A	Organic filler A	1.8	1.3	1	1.9
Example 5	4.7	Resin A	Organic filler A	1.8	1.3	0.3	2.6
Example 6	3.0	Resin A	Organic filler B	3.0	2.0	20	1.0
Example 7	2.2	Resin A	Inorganic fillers C, D	1.2	1.6	10	1.8
Example 8	2.1	Resins A, B	Organic filler A	1.8	1.3	30	1.2
Comparative Example 1	1.3	Resin A	—	—	—	0	—
Comparative Example 2	3.1	Resin A	Inorganic filler D	0.8	1.1	40	3.9
Comparative Example 3	5.5	Resin A	Organic filler A	1.8	1.3	20	3.1
Comparative Example 4	2.0	Resin A	Organic filler E	5.0	3.6	1	0.4
Comparative Example 5	0.7	Resin A	Organic filler A	1.8	1.3	5	0.4
Comparative Example 6	5.0	Resin A	Organic filler E	5.0	3.6	5	1.0
Comparative Example 7	2.1	Resin A	Organic filler F	4.0	2.5	30	0.5

***Iwai*, Table 1 (cropped and annotated)**

From *Iwai*'s Table 1, a POSA would have recognized from *Iwai* that D90 of the **inorganic filler** in *Iwai*'s Example 7 **separator** must necessarily be between 1.6μm and 2.8μm, as explained below. Gido, ¶158.

Volume average particle diameter. *Iwai* defines “volume average particle diameter” as “a particle diameter at 50% cumulative volume calculated from a smaller side in a volume particle size distribution.” *Iwai*, [0038]. For *Iwai*'s Example 7 **separator**, the volume average particle diameter of the **inorganic filler** is 1.2μm.

D10. *Iwai* defines D10 as “a particle diameter at which a cumulative volume of particles reaches 10% from a smaller side in a volume particle size distribution.” *Iwai*, [0039]. A POSA would have recognized from *Iwai* that D10 for *Iwai*'s Example 7 **separator** must necessarily be greater than 0, because it would not be

possible for particles at 10% of the **inorganic filler** volume to have a particle diameter of 0. Gido, ¶160. Further, a POSA would have recognized that D10 for *Iwai*'s Example 7 **separator** must necessarily be less than the volume average particle diameter of the **inorganic filler** for *Iwai*'s Example 7 **separator**, because it would not be possible for the particle diameter at 10% cumulative volume to be more than the particle diameter at 50% cumulative volume. Gido, ¶160. Thus, a POSA would have recognized that D10 for *Iwai*'s Example 7 **separator** must necessarily be less than 1.2µm. Gido, ¶160.

D90. *Iwai*'s Table 1 shows D90-D10 for *Iwai*'s Example 7 **separator** as 1.6µm, as shown above. Thus, a POSA would have recognized:

$$D90 - D10 = 1.6$$

$$D90 = 1.6 + D10$$

$$D90 - 1.6 = D10 \text{ (Equation 1)}$$

Gido, ¶161. Further, as explained above, a POSA would have recognized that D10 for *Iwai*'s Example 7 **separator** must necessarily be greater than 0 and less than 1.2µm:

$$0 < D10 < 1.2 \text{ (Equation 2)}$$

Gido, ¶162. Replacing D10 in Equation 2 per Equation 1, a POSA would have recognized:

$$0 < D90 - 1.6 < 1.2$$

$$1.6 < D90 < 2.8$$

Gido, ¶163. Thus, a POSA would have recognized, D90 for *Iwai*'s Example 7 **separator** must necessarily be greater than 1.6µm and less than 2.8µm. Gido, ¶164. A POSA would have recognized that “D90,” as used by *Iwai*, is synonymous with “Dv90,” as used in the '987 patent, at least because *Iwai* and the '987 patent define them synonymously. Gido, ¶164; *compare Iwai*, [0040] (defining “D90” as “particle diameter at which a cumulative volume of particles reaches 90% from a smaller side in a volume particle size distribution”) *with* '987 patent, 1:53-56 (defining “Dv90” as “a particle size which reaches 90% [of] the cumulative volume from the side of small particle size in the granularity distribution on a volume basis.”).

Thus, a POSA would have understood that, in *Iwai*'s Example 7 **separator**, a D90 of the **inorganic particles** must necessarily be greater than 1.6µm and less than 2.8µm. Gido, ¶165. Further, Table 1 shows that a thickness of the **adhesive porous layer** in *Iwai*'s Example 7 **separator** is 2.2µm. Thus, as summarized in *Iwai*'s Ratios Table below, in *Iwai*'s Example 7 **separator** a ratio of the D90 of the **inorganic particles** to the thickness of the **porous membrane** must necessarily be greater than 0.72 and less than 1.27. Gido, ¶165.

Similar calculations show that, in *Iwai*'s Comparative Example 2 **separator**, a ratio of the D90 of the **inorganic filler** to the thickness of the **porous membrane** must also have a value that falls within the claimed range. *Gido*, ¶166.

Table 1, above, shows *Iwai*'s Comparative Example 2 **separator** includes **inorganic filler** having a volume average particle diameter of 0.8µm. Table 1 also shows that D90-D10 for the **inorganic filler**—that is, a difference between the D90 of the **inorganic filler** and the D10 of the **inorganic filler**—in *Iwai*'s Comparative Example 2 **separator** is 1.1µm.

From *Iwai*'s Table 1, a POSA would have recognized that D90 of the **inorganic filler** in *Iwai*'s Comparative Example 2 **separator** must necessarily be between 1.6µm and 2.8µm, as explained below. *Gido*, ¶168.

Volume average particle diameter. For *Iwai*'s Comparative Example 2 **separator**, the volume average particle diameter of the **inorganic filler** is 0.8µm.

D10. A POSA would have recognized that D10 for *Iwai*'s Comparative Example 2 **separator** must necessarily be greater than 0, because it would not be possible for particles at 10% of the **inorganic filler** volume to have a particle diameter of 0. *Gido*, ¶170. Further, a POSA would have recognized that D10 for *Iwai*'s Comparative Example 2 **separator** must necessarily be less than the volume average particle diameter of the **inorganic filler** for *Iwai*'s Comparative Example 2 **separator**, because it would not be possible for the particle diameter at 10%

cumulative volume to be more than the particle diameter at 50% cumulative volume. Gido, ¶170. Thus, a POSA would have recognized, D10 for *Iwai*'s Comparative Example 2 separator must necessarily be less than 0.8µm. Gido, ¶170.

D90. *Iwai*'s Table 1 shows D90-D10 for *Iwai*'s Comparative Example 2 separator as 1.1µm, as shown above. Thus, a POSA would have recognized:

$$D90 - D10 = 1.1$$

$$D90 = 1.1 + D10$$

$$D90 - 1.1 = D10 \text{ (Equation 6)}$$

Gido, ¶171. Further, as explained, a POSA would have recognized that D10 for *Iwai*'s Comparative Example 2 separator must necessarily be greater than 0 and less than 0.8µm:

$$0 < D10 < 0.8 \text{ (Equation 7)}$$

Gido, ¶172. Replacing D10 in Equation 7 per Equation 6, a POSA would have recognized:

$$0 < D90 - 1.1 < 0.8$$

$$1.1 < D90 < 1.9$$

Gido, ¶173. Thus, a POSA would have understood that, in *Iwai*'s Comparative Example 2 separator, a D90 of the inorganic particles must necessarily be greater than 1.1µm and less than 1.9µm. Gido, ¶174. Further,

Table 1 shows that a thickness of the **adhesive porous layer** in *Iwai*'s Comparative Example 2 **separator** is 3.1 μ m. Thus, as summarized in the *Iwai*'s Ratios Table below, in *Iwai*'s Comparative Example 2 **separator** a ratio of the D90 of the **inorganic particles** to the thickness of the **porous membrane** must necessarily be greater than 0.35 and less than 0.61. *Gido*, ¶174.

<i>Iwai</i> 's Example	D90 (μ m)	Thickness (μ m)	Ratio ($\frac{D90}{Thickness}$)
Example 7	1.6 < D90 < 2.8	2.2	0.72 < Ratio < 1.27
Comparative Example 2	1.1 < D90 < 1.9	3.1	0.35 < Ratio < 0.61

***Iwai*'s Ratios Table**

Thus, *Iwai* discloses an example **separator** (Example 7) in which a ratio of D90 of the **inorganic particles** to the thickness of the **porous membrane** must have a value that falls between 0.72 and 1.27, and *Iwai* discloses an example **separator** (Comparative Example 2) in which a ratio of D90 of the **inorganic particles** to the thickness of the **porous membrane** must have a value that falls between 0.35 and 0.61. *Gido*, ¶175. Put differently, inherent in *Iwai* is that each of *Iwai*'s Example 7 and Comparative Example 2 **separators** has a ratio of D90 of the **inorganic particles** to the thickness of the **porous membrane** having a value “in a range from 0.3 to

3.0.”⁷ A POSA would have understood each of *Iwai*’s Example 7 and Comparative Example 2 **separators** to thus disclose, as claim 1 requires, a **separator** in which “a ratio of Dv90 of the **inorganic particles** to the thickness of the **porous layer** is in a range from 0.3 to 3.0.” *Gido*, ¶175; *Brassica Prot. Prods. LLC v. Sunrise Farms*, 301 F.3d 1343, 1349 (Fed. Cir. 2022) (“It is well settled that a prior art reference may anticipate when the claim limitations not expressly found in that reference are nonetheless inherent in it.”). The D90 value for each of *Iwai*’s Example 7 and Comparative Example 2 **separators** thus anticipates the claimed range because a claimed range is anticipated “if one of [the values in the range] is in the prior art.” *Titanium*, 778 F.2d at 782. *See also ClearValue, Inc. v. Pearl River Polymers, Inc.*, 668 F.3d 1340, 1344 n.1 (Fed. Cir. 2012) (affirming a jury finding that a claimed range of “approximately 1,000,000 to approximately 3,000,000” was anticipated by a disclosed example with a range of “1-2 million”).

⁷ Because the IPR procedure does not permit challenges under 35 U.S.C. § 112, Petitioner has not included any indefiniteness arguments herein, but may present such arguments in other proceedings.

2. Claim 2: The separator according to claim 1, wherein the porous layer has a thickness of 0.2 μm to 10 μm .

Iwai discloses “wherein the porous layer has a thickness of 0.2 μm to 10 μm .” *Gido*, ¶176. As Table 1 shows, in *Iwai*’s Example 7 separator, the adhesive porous layer has a thickness of 2.2 μm , and in *Iwai*’s Comparative Example 2 separator, the adhesive porous layer has a thickness of 3.1 μm . *Iwai*, Table 1. Each of *Iwai*’s Example 7 and Comparative Example 2 separators anticipates the claimed range of thicknesses because a claimed range is anticipated “if one of [the values in the range] is in the prior art.” *Titanium*, 778 F.2d at 782. *See also Iwai*, [0065] (“an average thickness of the adhesive porous layer on one side of the porous substrate is preferably from 0.5 μm to 5 μm , and more preferably from 1 μm to 5 μm .”).

3. Claim 4: The separator according to claim 1, wherein a volume ratio of the inorganic particles to the binder is in a range from 0.2 to 3.0.

Iwai discloses “wherein a volume ratio of the inorganic particles to the binder is in a range from 0.2 to 3.0,” because a POSA would have understood from *Iwai* that the separator of Comparative Example 2 has a volume ratio of 0.51, as explained below. *Gido*, ¶¶177-186.

As Table 1 shows, the separator of Comparative Example 2 has “Content (% by mass)” of 40%. *Iwai*, Table 1. As *Iwai* explains, this “Content (% by mass)”

refers to “[a] content of the **filler** in the coating liquid ... with respect to a total mass of the **polyvinylidene-fluoride resin** and the **filler**.” *Iwai*, [0188]; Gido, ¶178.

Thus, a POSA would have understood from *Iwai* that, in the **separator** of Comparative Example 2, the **inorganic filler** accounts for 40% of the total mass of the **polyvinylidene-fluoride resin** and the **inorganic filler**. Gido, ¶178. This is reflected in Equation 8 below, where “ M_{filler} ” refers to a mass of the **inorganic filler** and “ M_{resin} ” refers to a mass of the **polyvinylidene-fluoride resin**:

$$\frac{M_{\text{filler}}}{M_{\text{filler}} + M_{\text{resin}}} = 0.4 \text{ (Equation 8)}$$

Gido, ¶178. Taking the reciprocal of Equation 8 provides Equation 9:

$$\frac{M_{\text{filler}} + M_{\text{resin}}}{M_{\text{filler}}} = 2.5$$

$$M_{\text{filler}} + M_{\text{resin}} = 2.5M_{\text{filler}}$$

$$M_{\text{resin}} = 1.5M_{\text{filler}}$$

$$\frac{M_{\text{resin}}}{M_{\text{filler}}} = 1.5 \text{ (Equation 9)}$$

Gido, ¶179. And taking the reciprocal of Equation 9 provides Equation 10:

$$\frac{M_{\text{filler}}}{M_{\text{resin}}} = 0.67 \text{ (Equation 10)}$$

Gido, ¶180. While Equation 10 provides a mass ratio, a POSA would have known how to determine a volume ratio from a mass ratio. Gido, ¶181. In particular, a POSA would have known that a mass ratio is convertible to a volume

ratio by multiplying the masses by a reciprocal of the densities, ρ , of the materials. Gido, ¶181. This is shown in Equation 11, where “ ρ_{filler} ” refers to a density of the inorganic filler and “ ρ_{resin} ” refers to a density of the polyvinylidene-fluoride resin, and “ V_{filler} ” refers to a volume of the inorganic filler and “ V_{resin} ” refers to a volume of the polyvinylidene-fluoride resin:

$$\frac{V_{\text{filler}}}{V_{\text{resin}}} = \frac{M_{\text{filler}}}{M_{\text{resin}}} \times \frac{\rho_{\text{resin}}}{\rho_{\text{filler}}} \text{ (Equation 11)}$$

Gido, ¶181. Replacing $\frac{M_{\text{filler}}}{M_{\text{resin}}}$ in Equation 11 per Equation 10 provides

Equation 12 below:

$$\frac{V_{\text{filler}}}{V_{\text{resin}}} = 0.67 \times \frac{\rho_{\text{resin}}}{\rho_{\text{filler}}} \text{ (Equation 12)}$$

Gido, ¶182. In the separator of Comparative Example 2 in *Iwai*, the inorganic filler is magnesium hydroxide, which has a density ρ_{filler} of 2.36 g/cm³. Gido, ¶183; Ex. 1017, 525. The separator of Comparative Example 2 in *Iwai* uses a polyvinylidene-fluoride resin that is a vinylidene fluoride / hexafluoropropylene copolymer in which the vinylidene fluoride and hexafluoropropylene monomers are provided in a ratio of 98.9 to 1.1. *Iwai*, [0187] (Example 1), [0215] (Comparative Example 2, same as Example 1); Gido, ¶182. From this, a POSA would have been able to identify a density ρ_{resin} of the resin to be 1.8 g/cm³. Gido, ¶¶182-83; Ex. 1018, 3440. Finally, plugging the values of ρ_{filler} and ρ_{resin} into

Equation 13, a POSA would have arrived at a volume ratio for *Iwai*'s Comparative Example 2 separator of:

$$\frac{V_{\text{filler}}}{V_{\text{resin}}} = 0.67 \times \frac{\rho_{\text{resin}}}{\rho_{\text{filler}}} \text{ (Equation 12)}$$

$$\frac{V_{\text{filler}}}{V_{\text{resin}}} = 0.67 \times \frac{1.78}{2.36}$$

$$\frac{V_{\text{filler}}}{V_{\text{resin}}} = 0.51$$

Gido, ¶185. Thus, a POSA would have understood *Iwai* to disclose that, in the separator of Comparative Example 2, a volume ratio of the inorganic particles to the binder is 0.51, a value that is “in a range from 0.2 to 3.0.” Gido, ¶186. This disclosed volume ratio of 0.51 discloses the claimed range of volume ratios because a claimed range is taught “if one of [the values in the range] is in the prior art.” *Titanium*, 778 F.2d at 782.

4. Claim 5: The separator according to claim 1, wherein the porous layer has a porosity of 20% to 90%.

Iwai discloses “wherein the porous layer has a porosity of 20% to 90%.” Gido, ¶187. *Iwai* discloses that “it is preferable that the adhesive porous layer has a porosity of from 30% to 60%.” *Iwai*, [0066]. As *Iwai* explains, “in a case in which the porosity is 30% or more, good ion permeability can be obtained.” *Id.* See also Ex. 1008, 246 (“High porosity is desirable for unhindered ionic current flow.”). *Iwai*'s disclosed porosity range, which falls entirely within the claimed range,

anticipates the claimed range because a claimed range is anticipated “if one of [the values in the range] is in the prior art.” *Titanium*, 778 F.2d at 782. *See also ClearValue*, 668 F.3d at 1344 n.1.

5. **Claim 6: The separator according to claim 1, wherein the inorganic particles are one or more selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, zirconia, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate.**

Iwai discloses “wherein the inorganic particles are one or more selected from the group consisting of alumina, ... titanium oxide, hafnium dioxide, tin oxide, zirconia, ... aluminum hydroxide, magnesium hydroxide, ... and barium sulfate.” *Gido*, ¶188. In the adhesive porous layer in each of *Iwai*’s Example 7 and Comparative Example 2 separators, the inorganic filler is magnesium hydroxide. *Iwai*, [0206], [0215]. *Iwai* additionally envisions that the inorganic filler may be alumina, zirconia, and other metal oxides; aluminum hydroxide and other metal hydroxides; and barium sulfate. *Iwai*, [0092].

6. **Claim 7: The separator according to claim 1, wherein the binder is one or more selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylates, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.**

Iwai discloses “wherein the binder is one or more selected from the group consisting of polyvinylidene fluoride [and] vinylidene fluoride-hexafluoropropylene copolymer.” *Gido*, ¶189. The porous membrane in each of *Iwai*’s Example 7 and Comparative Example 2 separators includes as the polyvinylidene-fluoride resin a vinylidene fluoride-hexafluoropropylene copolymer. *Iwai*, [0187] (Example 1), [0206] (same as Example 1), [0215] (same as Example 1). *Iwai* additionally envisions that the polyvinylidene-fluoride resin may be polyvinylidene fluoride. *Iwai*, [0074].

7. **Claim 8: An energy storage device, comprising the separator according to claim 1.**

Iwai discloses “[a]n energy storage device, comprising the separator according to claim 1.” *Gido*, ¶190. Each of *Iwai*’s Example 7 and Comparative Example 2 separators discloses “the separator according to claim 1,” *supra* Section VIII.A.1, and *Iwai* discloses using each of the Example 7 and Comparative Example 2 separators in a “lithium ion secondary battery,” which is one “energy

storage device” described in the ’987 patent. *Iwai*, [0002]-[0003] (describing “a separator for non-aqueous secondary batter[ies] ... which are represented by lithium-ion secondary batteries”), [0187]-[0199] (describing production of “test battery” in Example 1), [0207] (same for Example 7), [0216] (same for Comparative Example 2); ’987 patent, 1:20-21 (describing “[n]on-aqueous secondary batteries, particularly lithium-ion batteries”), 2:17-18 (“the energy storage device is a lithium-ion battery”).

8. Claim 9: The energy storage device according to claim 8, wherein the energy storage device is a lithium-ion battery.

Iwai discloses “wherein the energy storage device is a lithium-ion battery.” Gido, ¶191. *Iwai* discloses using each of the Example 7 and Comparative Example 2 separators in a “lithium ion secondary battery.” *Supra* Section VIII.D.7.

E. Ground 5: *Iwai* Would Have Rendered Obvious Claim 3

1. Claim 3: The separator according to claim 1, wherein the pores have an average pore size of 0.3 μm to 20 μm.

Iwai would have rendered obvious “wherein the pores have an average pore size of 0.3 μm to 20 μm,” Gido, ¶¶192-94. *Iwai* teaches that “the adhesive porous layer is a layer having a structure in which a large number of micropores are present inside thereof and the micropores connect to one another, which allows gas or liquid to pass therethrough from one side to the other side.” *Iwai*, [0062]. From *Iwai*, a POSA would have been motivated and found it obvious to implement

Iwai's **separator** to have “an average pore size” within the claimed range for at least two reasons. Gido, ¶192.

First, *Iwai* recognizes, like the '987 patent, that pore size must be adjusted to accommodate two competing concerns: the pores must be large enough to suppress “the blockage of pores” but small enough to promote uniformity of ion flow and to prevent “non-uniformity of the pores at the surface,” which can undermine adhesion. *Iwai*, [0067]; *compare with* '987 patent, 5:28-35 (“pore blockage”), 5:43-49 (“non-uniform surface of the porous layer”). From these competing concerns described in *Iwai*, a POSA would have been motivated and found it obvious to implement each of *Iwai*'s Example 7 and Comparative Example 2 **separators** to address these concerns. Gido, ¶193. And a POSA would have understood how to adjust pore size, as it was understood by 2018 that “pore size and the porosity are very important factors for the control of ion conductivity in a battery and thus, are directly related to the quality of the battery.” Ex. 1009, 4:34-37. *See also* Ex. 1010, 5:47-50 (“[T]he present inventors have recognized that controlling the porosity and pore size” of a porous layer “is one of the factors affecting the quality of a battery.”); Gido, ¶193. Thus, because *Iwai* teaches that pore size is a parameter to be adjusted to address these competing concerns, and adjustment of pore size would have been within a POSA's skill, a pore size within the claimed range would have been obvious to a POSA. Gido, ¶193. *ModernaTx*,

Inc. v. Arbutus Biopharma Corp., 18 F.4th 1364, 1375 (Fed. Cir. 2021) (“It has long been established law that ‘where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.’”) (quoting *In re Aller*, 220 F.2d 454, 456 (CCPA 1955)).

Second, while *Iwai* recommends a specific range of pore diameters—“from 20 nm to 100 nm,” that is, from .02 μ m to .1 μ m—a POSA would still have found it obvious to adjust *Iwai*’s pore size outside this range, as pore size adjustment was widely understood, *supra*, and a POSA would have not have found *Iwai*’s recommended range to be limiting. Gido, ¶194. Rather, a POSA would have recognized that “micropore,” as used by *Iwai* to describe the pores of its porous layer, was a term used in the art to refer to a broader range of pores, namely, those having any size less than approximately 1 μ m. Gido, ¶194. *See, e.g.*, Ex. 1008, 247 (“One distinguishes between microporous and microporous separators, the latter having to show pore diameters below 1 micron (μ m), i.e., below one-thousandth of a millimeter.”). Accordingly, a POSA would have found it obvious to adjust pore size for each of *Iwai*’s Example 7 and Comparative Example 2 **separators** within a broader range, provided *Iwai*’s identified competing concerns of pore blockage and non-uniformity were addressed. Gido, ¶194. As noted above, because *Iwai* teaches that pore size is a parameter to be adjusted to address these competing concerns,

and adjustment of pore size would have been within a POSA's skill, adjusting *Iwai*'s pore size would have been obvious to a POSA. *Gido*, ¶194.

IX. MANDATORY NOTICES

A. Real Party-in-Interest

The real party-in-interest is Zhuhai CosMx Battery Co., Ltd.

B. Related Matters

To the best of Petitioner's knowledge, the '987 Patent is, or has been, involved in the following district court litigations.

Name	Number	Court	Filed
<i>Ningde Amperex Technology Limited v. Zhuhai CosMx Battery Co.</i>	2:22-cv-00232	EDTX	June 24, 2022
<i>Zhuhai CosMx Battery Co. v. Ningde Amperex Technology Limited</i>	5:22-cv-04510	NDCA	August 4, 2022

In addition, U.S. Patent App. Serial No. 17/178,843 filed February 18, 2021, which claims priority to the application that issued as the '987 patent, is pending before the U.S. Patent and Trademark Office. Petitioner is also aware of related Chinese Patent Application Serial No. 202211401984.5, which is pending before the Chinese National Intellectual Property Administration. Petitioner is not aware of any other related matters.

C. Lead and Back-Up Counsel, and Service Information

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Please address all correspondence to lead counsel and back-up counsel at the addresses shown above. Petitioner also consents to electronic service by email.

X. DISCRETIONARY DENIAL IS NOT WARRANTED

A. The Board Should Not Deny Institution Under § 314(a)

The Board should not exercise its discretion to deny institution under § 314(a). This Petition has been filed well before the one-year bar date imposed by 35 U.S.C. § 315(b) in view of Patent Owner's assertion of the '987 patent against Petitioner in *Ningde Ampere Tech. Ltd. v. Zhuhai CosMx Battery Co., Ltd.*, Civ. No. 2:22-cv-00232-JRG (E.D. Tex.). Moreover, *Fintiv* and the Office's interim

guidelines dated June 21, 2022 (“Interim Procedures”) require institution.

IPR2020-00019, Paper 11 (Mar. 20, 2020) (precedential). As detailed below, Factor 6 requires institution; Factors 3 and 4 favor institution; and Factors 1, 2, and 5 are, at worst, neutral.

Factor 6 requires institution because Petitioner presents a compelling unpatentability challenge. “[W]here the PTAB determines that the information presented at the institution stage presents a compelling unpatentability challenge, that determination alone demonstrates that the PTAB should not discretionarily deny institution under *Fintiv*.” Interim Procedures, 4-5 (emphasis added). The Interim Procedures define a compelling challenge as one in which “the evidence, if unrebutted in trial, would plainly lead to a conclusion that one or more claims are unpatentable by a preponderance of the evidence.” Interim Procedures, 4. As explained in this Petition, the evidence plainly demonstrates that each of the challenged claims is anticipated by or would have been rendered obvious by either *Nishikawa*, alone or in combination with *Honda*, and/or *Iwai* alone.

Factor 3 further favors institution because almost no parallel investment has occurred. See *Nearmap US, Inc. v. Eagle View Techs., Inc.*, IPR2022-01009, Paper 7 at 9 (“The litigation also is in a relatively early stage because the parties appear to have recently completed exchanging infringement and invalidity contentions and no claim construction hearing has occurred.”). The parties only finished

exchanging infringement and invalidity contentions last month, and the claim construction hearing is not scheduled until August 2023. Ex. 1022, 4-5. *Id.*

Factor 4 favors institution because this petition challenges claims 3, 4, 5, and 10-17, which are not involved in the litigation. Petitioner also reserves the right to submit a stipulation to address Factor 4 based upon developments here and/or in the related litigation.

Regarding Factors 1, 2, and 5, Patent Owner filed its Amended Complaint (asserting the presently challenged '987 patent for the first time) against Petitioner on August 2, 2022. Ex. 1020. No stay has been requested, trial is currently scheduled for February 5, 2024, and the median time-to-trial in the Eastern District of Texas is 24.2 months, so trial is projected to occur, at the earliest, in June or July 2024. Ex. 1022, 1; Ex. 1023, 35; Ex. 1021, 12. A FWD is anticipated in August or September 2024, about six months after trial if the current schedule is maintained or about one month after trial if the median time-to-trial holds true. In these circumstances, Factors 1, 2, and 5 are at worst neutral. *Protect Animals with Satellites v. OnPoint Sys.*, IPR2021-01483, Paper 11 at 12-13, 17 (Mar. 4, 2022). Indeed, the Board has instituted with similar time between trial and FWD. *See NetNut v. Bright Data*, IPR2021-01492, Paper 12 at 9-16 (Mar. 21, 2022) (instituting IPR without stipulation and co-pending trial date six months before FWD); *Protect Animals*, IPR2021-01483, Paper 11 at 18 (instituting IPR without

stipulation and co-pending trial date one month before FWD); Interim Procedures,
8.

Denial of institution is accordingly not warranted under *Fintiv*.

B. The Board Should Not Deny Institution Under § 325(d)

The Board should not exercise its discretion to deny institution under § 325(d). The relevant considerations are: (1) whether the same or substantially the same art previously was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office; and (2) if either condition of the first part of the framework is satisfied, whether the petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 (P.T.A.B. Feb. 13, 2020).

Here, neither factor supports denial of institution. During prosecution, the Examiner did not consider any of *Nishikawa*, *Honda*, or *Iwai*, nor did the Examiner consider any reference that was cumulative of *Nishikawa*, *Honda*, or *Iwai*. The Office has previously granted institution where Petitioners challenge all claims based on uncited art. *See, e.g., Oticon Medical AB v. Cochlear Limited*, IPR2019-00975, Paper 15 at 20 (PTAB Oct. 16, 2019) (precedential) (declining to deny

institution where “new, noncumulative prior art [is] asserted in the Petition”). The Board should do so again here.

XI. GROUNDS FOR STANDING

Petitioner certifies that the '987 patent is available for IPR and that Petitioner is not barred or estopped from requesting IPR challenging the patent claims on the grounds identified herein.

XII. CONCLUSION

The Board should institute IPR and cancel the claims. The Office may charge any required fees to Deposit Account No. 06-0916.

Dated: February 24, 2023

Respectfully submitted,

/Michele C. Bosch/

Michele C. Bosch

Reg. No. 40,524

CERTIFICATION OF COMPLIANCE

The undersigned hereby certifies that the foregoing Petition contains 12,758 words, excluding those portions identified in 37 C.F.R. § 42.24(a), as measured by the word-processing system used to prepare this paper.

By: /Michele C. Bosch/
Michele C. Bosch (Reg. No. 40,524)

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e) and 42.105(a), the undersigned certifies that on February 24, 2023, a copy of the foregoing **Petition for *Inter Partes* Review**, the associated **Power of Attorney**, and **Exhibits 1001 through 1023** are being served by FedEx Priority Overnight® at the correspondence address of record indicated in the Patent Office's Patent Center system for U.S. Patent No. 10,964,987:

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