

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

IPR2025-00432
Patent 11,575,148

PATENT OWNER'S RESPONSE

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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 Statistics for Judge Rodney Gilstrap (accessed May 5, 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.)

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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	Reserved
2014	Reserved
2015	Declaration of Dean R. Wheeler, Ph.D.
2016	<i>Curriculum Vitae</i> of Dean R. Wheeler, Ph.D.
2017	Reserved
2018	Reserved
2019	Reserved
2020	Reserved
2021	Reserved
2022	Reserved
2023	Reserved
2024	Reserved
2025	<i>2016 Batteries Conference GRC</i> , https://www.grc.org/batteries-conference/2016/ (accessed on May 12, 2025)
2026	<i>Hubs – Department of Energy</i> , https://www.energy.gov/hubs (accessed on May 12, 2025)
2027	<i>DOE Energy Innovation Hubs</i> , https://science.osti.gov/bes/Research/DOE-Energy-Innovation-Hubs (accessed on May 12, 2025)
2028	Salvatore Luiso & Peter Fedkiw, <i>Lithium-ion battery separators: Recent developments and state of art</i> , 20 <i>Current Opinion in Electrochemistry</i> 99–107 (2020).
2029	Sugino Machine Ltd., <i>StarBurst® P2218E 102501 AS</i> (Sugino Machine Ltd. 2025)
2030	<i>Declaration of Brady Cox in Support of Patent Owner’s Notice of Intent to Designate Provisionally Recognized PTAB Attorney Under 37 C.F.R. § 42.10(c)(2)</i>

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2031	Declaration of Samuel P. Gido, Ph.D., dated February 22, 2023, IPR2023-00587
2032	CosMX Proposed Construction of Claim Terms, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:24-cv-00728-JRG
2033	Deposition Transcript of Samuel P. Gido, Ph.D., dated November 13, 2025, IPR2025-00432
2034	Supplemental Declaration of Dean R. Wheeler, Ph.D.
2035	Valadoula Deimede and Costas Elmasides, <i>Separators for Lithium-Ion Batteries: A Review on the Production Processes and Recent Developments</i> , <i>Energy Technol.</i> 2015, 3, 453–468
2036	Hyun-Seok Jeong et al., <i>Effect of phase inversion on microporous structure development of Al₂O₃/poly(vinylidene fluoride-hexafluoropropylene)-based ceramic composite separators for lithium-ion batteries</i> , <i>Journal of Power Sources</i> 195 (2010) 6116–6121
2037	Muhammad Rehman Asghar et al., <i>A Review on Inorganic Nanoparticles Modified Composite Membranes for Lithium-Ion Batteries: Recent Progress and Prospects</i> , <i>Membranes</i> 2019 , 9, 78; doi:10.3390/membranes9070078
2038	Marie-Francine Lagadec et al., <i>Characterization and performance evaluation of lithium-ion battery separators</i> , <i>Nature Energy</i> , 4 (2019); https://doi.org/10.1038/s41560-018-0295-9
2039	Kwang Man Kim et al., <i>Characterization of poly(vinylidenefluoride-co-hexafluoropropylene)-based polymer electrolyte filled with TiO₂ nanoparticles</i> , <i>Polymer</i> 43 (2002) 3951–3957
2040	Wenjing Lu et al., <i>Porous membranes in secondary battery technologies</i> , <i>Chem. Soc. Rev.</i> , 2017, 46, 2199
2041	Shuhua Liu, et al., <i>Effect of grinding time on the particle characteristics of glass powder</i> , <i>Powder Technology</i> 295, 133-141 (2016)
2042	Laser diffraction for particle sizing – Anton Paar, available at: https://wiki.anton-paar.com/en/laser-diffraction-for-particle-sizing (last accessed on July 30, 2025)
2043	W. Pabst & E. Gregorova, <i>Characterization of particles and particle systems</i> , ICT Prague (2007).

Exhibit Number	Description
2044	<i>Various types of chambers for “STAR BURST”</i> , https://www.sugino.com/en/column/sbs-technical-chamber/ (accessed on November 25, 2025)
2045	Declaration of Quinn Horn, Ph.D., dated October 21, 2025, <i>Ningde Amperex Tech. Ltd. v. Zhuhai CosMX Battery Co.</i> , No. 2:24-cv-00728-JRG
2046	KISUMA™ 5 Product Sheet
2047	U.S. Pat. No. 10,774,229 B2 to Maeda (“Maeda”)
2048	U.S. Pat. No. 10,793,748 to Yamamoto et al. (“Yamamoto”)
2049	Russel Paterson et al., <i>IUPAC-NIST Solubility Data Series 70. Solubility of Gases in Glassy Polymers</i> , Journal of Physical and Chemical Reference Data 28, 1255 (1999); https://doi.org/10.1063/1.556050
2050	Alpha Aluminum Oxide Data Sheet
2051	<i>Pore Size Distribution</i> , https://micromeritics.com/pore-size-distribution/ (accessed on November 25, 2025)
2052	Kim Min et al., <i>Preparation of a Trilayer Separator and Its Application to Lithium-Ion Batteries</i> , J. Power Sources (2010) 8302-8305
2053	Ohji et al., <i>Advanced Processing and Manufacturing Technologies for Structural and Multifunctional Materials</i> , The American Ceramic Society (2008)
2054	Takemura et al., <i>A Powder Particle Size Effect on Ceramic Powder Based Separator for Lithium Rechargeable Battery</i> , J. Power Sources (2005) 779-783

I. INTRODUCTION

Ningde Ampere Technology Ltd. (“ATL” or “Patent Owner”) respectfully submits this Response (“POR”) to the Petition (“Petition”) filed by Zhuhai CosMX Battery Co., Ltd. (“Petitioner” or “CosMX”). Paper 2 (“Pet.”). The Petition seeks *inter partes* review (“IPR”) of claims 1-19 (the “Challenged Claims”) of U.S. Patent No. 11,575,148 (the “’148 Patent,” Ex. 1001). However, none of the cited art, alone or in combination, discloses or renders obvious a porous film having both the claimed pore structure requirements and claimed particle size requirements.

First, Murakami, Beard, and Akiike all fail to satisfy the claimed pore structure requirements. The pores in Murakami and Akiike are formed by gaps between inorganic particles and so are not “formed by the binder” (but instead by inorganic particles), and do not “at least comprise[] a part of the inorganic particles” (because the particles only define the boundaries of their pores). In contrast, Beard uses significantly more binder (and less filler) than either Murakami or Akiike, teaching a POSITA to use a structure where particles are fully encapsulated by binder (and thus do not extend into the pores). Beard therefore fails to satisfy or render obvious “pores at least comprises a part of the inorganic particles.”

Second, Murakami and Akiike fail to satisfy the claimed particle sizes. Murakami fails because it reports only initial D10, D50, and D90 values that are significantly altered by high-pressure dispersion, meaning that the initial “recipe”

values before manufacture are not the same sizes of the particles in Murakami's porous layer. Akiike fails because its measured D10, D50, and D90 values are representative of *all* particles used in Akiike's slurry—which includes particles *other than* the inorganic particles. Thus, Akiike's reported values do not disclose the D10, D50, and D90 values of just the inorganic particles, as required.

Third, a POSITA would not have been motivated to combine, or have a reasonable expectation of success in combining, Beard with Murakami or Akiike with Beard. A POSITA would have recognized that it would be impossible to substitute the small particles in Beard with Murakami's or Akiike's much larger particles and still retain Beard's pore structure because variables such as particle size and distribution, relative amount of binder, pore wall thickness, and pore size have unpredictable but significant effects on pore structure, and a change in one may result in undesirable changes to another variable or to the pore structure.

Finally, Petitioner's grounds for dependent claims 3, 4, 12, and 13 also fail. Petitioner's secondary references, Honda and Tanaka, introduce more pore structures and variables that undercut any combination. Petitioner's unsupported assumption that a POSITA could and would change just one variable in the porous layer, without changing anything else about the porous structure, runs counter to the evidence of record.

For at least these reasons, none of the challenged claims of the '148 Patent have been shown unpatentable.

II. BACKGROUND¹

A. Technology Overview

Designing a safe and effective separator is a complicated process involving diverse interdependent variables, and the optimal design depends on the intended application. Ex. 2033 at 92:14-22, 96:3-97:3, 204:3-205:9; Ex. 2034 ¶¶15-27, 38-39. In designing a porous film for a separator, both experts agree that a POSITA would consider variables such as porosity, binder type and amount, particle characteristics, and methods of solidification, among many others, that determine the film's pore structure and properties. Ex. 2033 at 96:3-97:3, 204:3-205:9, 211:10-213:15; Ex. 2034 ¶¶28-37; Ex. 2038, 3-5, 8. Both experts agree that these variables have a complex interrelationship and affect the pores' structure and separator's properties, with no predictable "1:1 relationship"—changes in one variable often affect others. Ex. 2033 at 204:3-205:9, 96:3-97:3; Ex. 2034 ¶27. As a result, extensive experimentation is required to achieve desired separator properties. Ex. 2033 at 205:10-206:15, 259:19-260:9; Ex. 2034 ¶¶27, 39.

¹ Patent Owner's expert provided a technology overview and a summary in Ex. 2015, § IV.A-B, ¶¶ 41-66 and in Ex. 2034, §IV, ¶¶14-40.

B. The '148 Patent

The inventors of the '148 Patent recognized that, for existing separators, a gap created between the electrode and separator during cycling would result “in a reduction of the cycle capacity of the lithium-ion battery and thereby hav[e] an influence on its service life.” Ex. 1001, 1:29-33. Their solution was a novel porous film with a specific pore structure and particle size requirements that led to “excellent adhesion” while still maintaining pore structure “after being immersed in the electrolyte, thereby reducing the probability of pore blockage of the porous film and enabling the porous film to have high ionic conductivity.” *Id.* at 2:47-56. “[T]he rate performance of the lithium-ion battery is greatly improved, and the provided lithium-ion battery has excellent rate performance and cycle performance.” *Id.*

III. LEVEL OF ORDINARY SKILL IN THE ART

For purposes of this POR, ATL adopts the definition proposed by Petitioner. Pet., 14; *see also* Ex. 2015 ¶¶67-69.

IV. CLAIM CONSTRUCTION

Petitioner contends “[n]o claim terms require express construction for purposes of granting the Petition.” Pet., 15. However, in a related district court litigation, Petitioner asserts that “pores at least comprises a part of the inorganic particles” is indefinite. Ex. 2032, 8. Petitioner has not (and cannot) explain why advancing these different positions is warranted. *Tesla, Inc. v. Intellectual Ventures*

II LLC, IPR No. 2025-00340, Paper 18 at 3-4 (PTAB Nov. 5, 2025). Petitioner has not made any showing that a POSITA would understand this term “notwithstanding” its own allegation of indefiniteness. *Id.* at 3-4. “Allowing a petitioner to advance a claim construction before the Board when that petitioner has made inconsistent indefiniteness arguments in district court fails to further, but instead detracts from, the Office’s goal of providing greater predictability and certainty in the patent system.” *Id.* at 4 (omitting internal citations). Thus, Petitioner’s unpatentability claims should be denied, or the institution decision should be reversed. *Id.*

If Petitioner is allowed to advance inconsistent positions, the Board should adopt the plain and ordinary meaning of all terms. Ex. 2034 ¶¶42-43. The parties dispute the plain meaning of (1) pores “formed by the binder,” (2) “pores at least comprises a part of the inorganic particles,” and (3) the Dv10, Dv50, and Dv90 requirements. *See, e.g.*, Paper 10 at 17, 19, 20. The Board must analyze and resolve the plain and ordinary meaning of each. *Homeland Housewares, LLC v. Whirlpool Corp.*, 865 F.3d 1372, 1375 (Fed. Cir. 2017).

1. Pores “formed by the binder”

Petitioner incorrectly assumes this limitation is met by *any* pores in a layer containing binder. Pet., 23; Ex. 1003 ¶90; Ex. 2033 at 37:8-15. This incorrect interpretation is unsupported by the claims and specification and would include pores created by space or voids between inorganic particles, not binder.

The key dispute is whether “formed by the binder” requires the pores to be formed by binder itself, or by other components like inorganic particles. The claims and specification make clear that only pores whose outer geometry is defined by binder meet this limitation.

The claims set forth three main components of the claimed porous film: (1) “a binder,” (2) “inorganic particles,” and (3) “pores.”² Importantly, the claims separately require pores that are “formed by the binder,” not just *any* pores in a binder-containing film. Ex. 2034 ¶¶44-50.

Petitioner’s interpretation renders this term meaningless. *Merck & Co. v. Teva Pharms. USA, Inc.*, 395 F.3d 1364, 1372 (Fed. Cir. 2005). Porous layers containing binder and inorganic particles exhibit many different pore types. Ex. 2034 ¶¶20-26, 49-50. Petitioner’s expert, Dr. Gido, provided at least two examples. He has opined that, for porous layers with “high particle loadings up to as much as 90% by weight, or more,” “the binder is there as a glue to hold the particles together, but the structure of the layer is dominated by the particles, and *the porosity is a result of the*

² The parties’ disagreement about whether “pores” includes the walls surrounding the pores is separate from the dispute over “formed by the binder” and is addressed below.

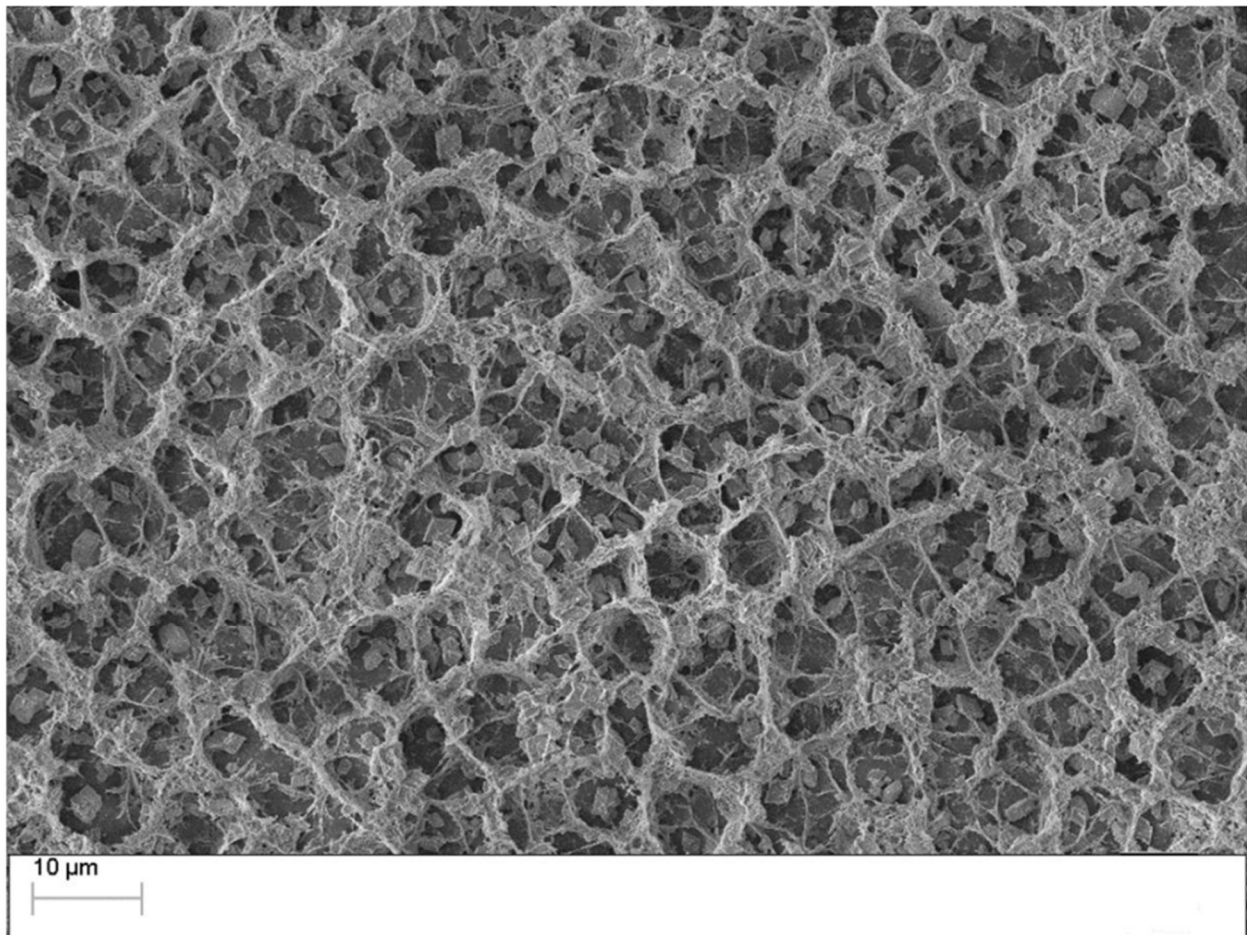
interstitial cavities between the relatively tightly packed particles.” Ex. 2031 ¶52.³

In contrast with these particle-dense porous layers, Dr. Guido explained that “[o]ther separators have been developed in which the amount of polymer binder in the ceramic particle containing layer is significantly greater, perhaps more than 50%,” and for *those* binder-heavy porous layers, “the particles are generally separated from one another and surrounded by binder” and “it is necessary to generate porosity *in the binder polymer* itself.” Ex. 2031 ¶52. Petitioner’s interpretation of this limitation would include both types of pores, even those formed by “interstitial cavities between the relatively tightly packed particles.” Dr. Guido believes that even the smallest amount of binder in the layer “forms” the pores, even if it is just acting as glue holding together inorganic particles that are “forming the wall of a pore.” Ex. 2033 at 106:8-14, 37:8-15. This incorrect interpretation makes the language “formed by the binder” superfluous in a layer that already requires pores, binder, and particles. *Merck & Co.*, 395 F.3d at 1372 (Fed. Cir. 2005).

The correct meaning is confirmed by the specification. *First*, both experts agree a POSITA would look to the specification’s SEM images to understand the claims. Ex. 2033 at 98:11-99:10, 100:12-101:9, 109:20-110:12 (Dr. Guido relying on

³ Emphasis is added unless otherwise noted.

these images to characterize pore structure); Ex. 2034 ¶51. A high-resolution version of Figure 1, copied from the prosecution history (Ex. 1002), is shown below.



“[T]he white material forming a matrix or network is the binder.” Ex. 2015 ¶81; Ex. 2034 ¶52. “[T]he binder itself defines the boundary of each pore in the same way that a circle’s perimeter defines the circle—thereby forming the pores.” *Id.*

Second, the specification explains that the patent’s porous layer is made by a process called “non-solvent phase separation” (“NIPS”). Ex.1001, 5:61-7:42; Ex. 2034 ¶¶30, 53, 103. A key step in NIPS is coagulating binder out of solution by

adding a non-solvent to a solution that contains binder. Ex. 2034 ¶103. The patent explains that, during that step, “**the binder** in the coating solution is coagulated and separated out, **thus forming** a porous film.” Ex. 1001, 6:26-32; *see also* Ex. 2015 ¶79; Ex. 2034 ¶53.

Third, the specification provides a high ratio of binder that a POSITA would associate with pores delineated by binder, as opposed to pores resulting from interstitial cavities between particles. In the “high particle loading” porous layers Dr. Gido described, there is a very low ratio of binder to inorganic particles—according to Dr. Gido, “**just enough** [binder] for ‘the filler [to be] bound by the binder resin.’” Ex. 1003 ¶101 (quoting Ex.1005, ¶[0070]); Ex. 2031 ¶52 (in such layers, “the structure of the layer is dominated by the particles, and the porosity is a result of the interstitial cavities between the relatively tightly packed particles”). Dr. Gido **contrasted** these with layers having pores formed by binder, “in which the amount of polymer **binder in the ceramic particle containing layer is significantly greater, perhaps more than 50%**” because for such layers, “the particles are generally separated from one another and surrounded by binder” and “it is necessary to generate porosity in the binder polymer itself.” Ex. 2031 ¶52; *see also* Ex. 2033 at 211:10-212:18 (distinguishing porous layers with “a significant amount of binder,” such as “30 percent binder or more” from porous layers with less binder). It is undisputed that the ratio of binder to inorganic particles affects whether the pores

are formed by interstitial spaces between inorganic particles, on one hand, or formed by binder, on the other. Ex. 2031 ¶52; Ex. 2033 at 101:3-9; Ex. 2034 ¶54.

The '148 Patent uses a relatively high ratio of binder relative to inorganic particles, disclosing “25 vol% to 83 vol% binder in the solid portion of the porous layer comprised of binder and inorganic particles.” Ex. 2015 ¶80 (citing Ex. 1001, 5:50-52). Thus, a POSITA would have understood that the patent describes the type of porous layer with significantly more binder, for which Dr. Guido explained pores must be generated “in the binder polymer itself.” Ex. 2031 ¶52. This confirms that pores “formed by a binder” means pores with their outer geometry defined by the binder.

Fourth, the plain meaning is supported by dependent claims 3 and 12, which additionally require that the “average wall thickness between the pores is in a range of 20 nm to 500 nm,” or 0.02 μm to 0.5 μm . Ex. 1001, 25:49-51, 26:33-36; Ex. 2034 ¶55. This thin pore wall thickness would not make sense for “high particle loading” porous layers, where the pores are formed by cavities between particles, because there is no binder wall in those layers—instead, the “walls” are the “edges of the particles.” Ex. 2033 at 123:4-8; Ex. 2034 ¶55. The claims separately require a different measurement for particle sizes, and they require at least some particles to be much larger than 0.02 μm to 0.5 μm (for example, between 1 μm and 10 μm). Ex. 2034 ¶55; Ex. 1001, 25:33-47. Thus, a POSITA would have understood that the

types of pores formed by cavities between inorganic particles do not make sense in the context of the claims, which contemplate that the pore walls are something *other (and much thinner) than* the inorganic particles. Ex. 2034 ¶55; Ex. 1001, 5:3-14.

Finally, nothing in the prosecution history negates the plain meaning. Ex. 2034 ¶56. The Federal Circuit does “not depart from the plain meaning of the claims” except for “lexicography or disavowal.” *Luminara Worldwide, LLC v. Liown Elecs.*, 814 F.3d 1343, 1353 (Fed. Cir. 2016). Patentee consistently argued that a reference with pores formed between inorganic particles *does not* satisfy this limitation. Ex. 1014, 42.

2. “Pores at least comprises a part of the inorganic particles”

Under Petitioner’s interpretation, any reference that discloses inorganic particles would satisfy this limitation, even if that filler is solely inside the binder wall and does not extend into the pore itself. Ex. 1003 ¶¶97, 175. However, the limitation’s plain meaning requires that at least a part of the inorganic particles extend into the pore defined by binder walls. Ex. 2034 ¶¶57-61. The claim’s minor subject-verb disagreement (“comprises” vs. “comprise”) is acknowledged by Dr. Gido and does not change his opinions. Ex. 2033 at 12:4-13:1; Ex. 2045 ¶¶52-60; Ex. 2034 ¶60.

A key dispute for this limitation is the meaning of “pores.” The plain and ordinary meaning of “pores” means voids or interstitial spaces—the pore does not

include the binder wall that must define the limits of the pore. Ex. 2034 ¶61. Petitioner disagrees, arguing that the “pore” is **both** the void and the physical walls of binder surrounding that void, and claiming this limitation is met when particles are only found in the binder walls, but not in the pores themselves. Pet., 52; Ex. 2033 at 51:6-13. This overbroad interpretation is incorrect.

First, Patent Owner’s interpretation of “pores” is supported by Dr. Guido’s own testimony. Ex. 2034 ¶¶62-64. In a prior IPR between the same parties involving a family member of the ’148 Patent, Dr. Guido used “pore” and “void” interchangeably, asserting that stretching a polyolefin “opens up **voids** or **pores** in the film.” Ex. 2031 ¶41. He also equated “pores” with “interstitial space” or “interstitial cavities” in multiple instances. *Id.* ¶¶48, 52. Thus, Dr. Guido clearly understands “pore” to be synonymous with “void” or “interstitial space” or “interstitial cavity.” Ex. 2034 ¶62.

Here, Dr. Guido repeatedly defines and illustrates “pores” as voids or interstitial spaces **between** (not including) binder walls:

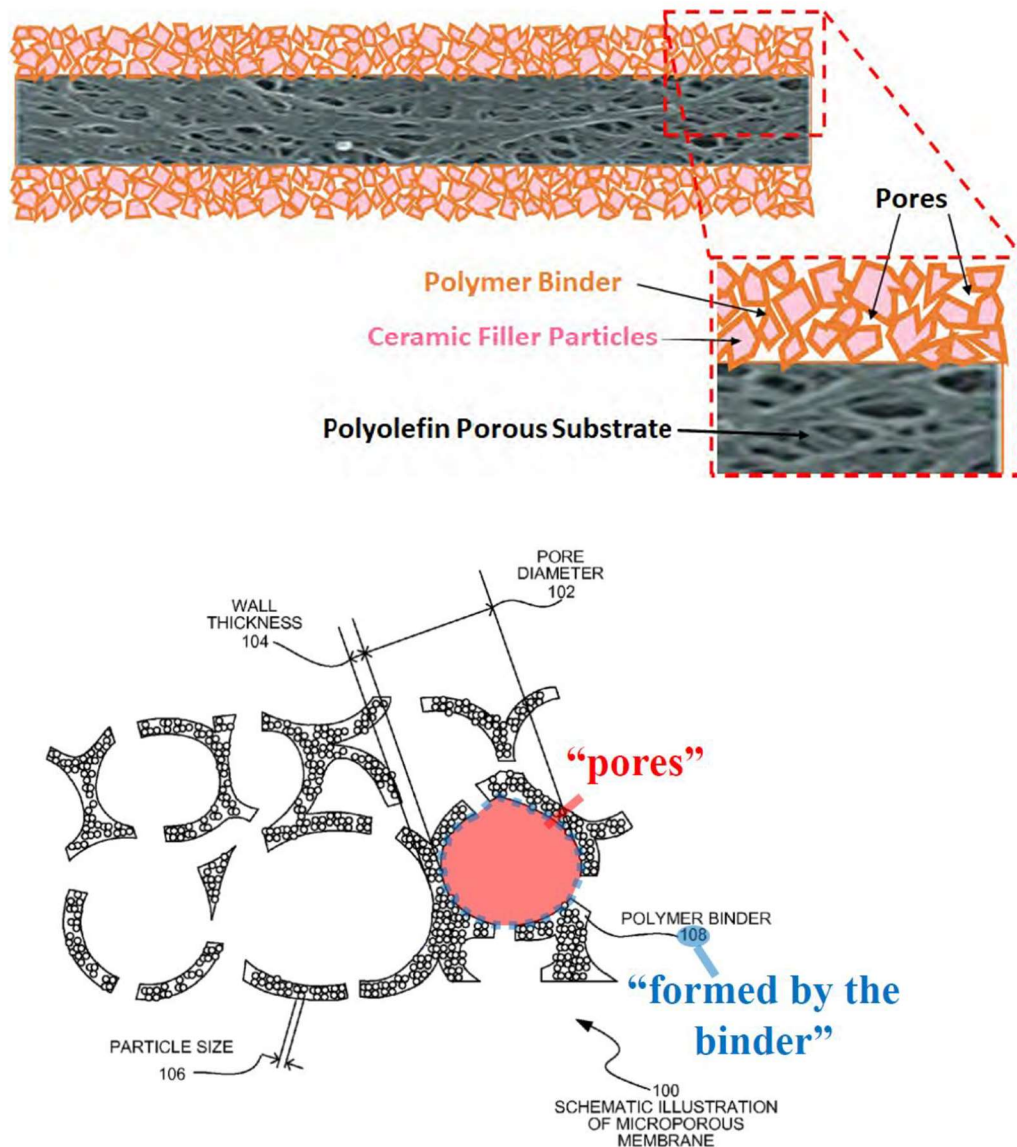


FIG. 1

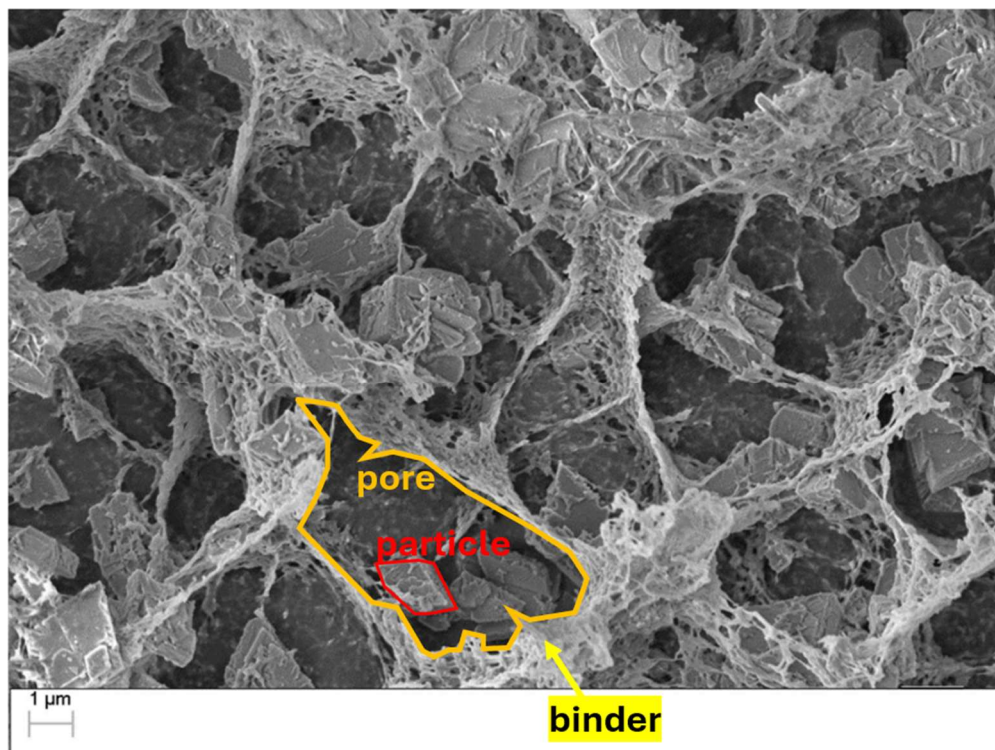
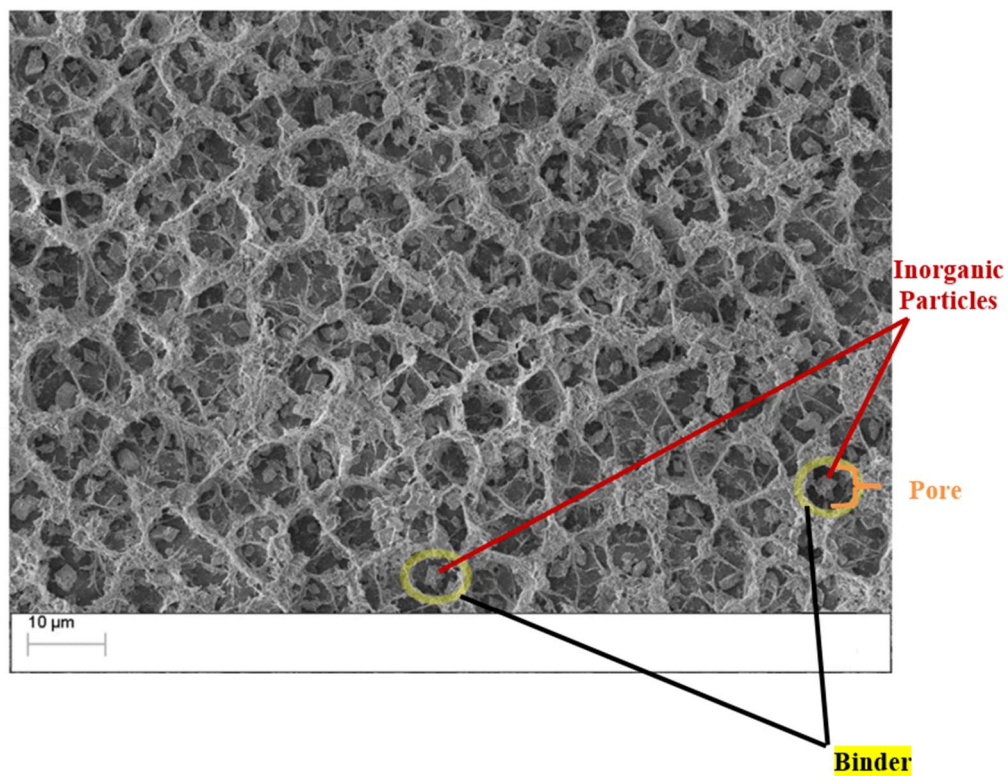
Ex. 1003 ¶¶33, 165; *see also*, e.g., Ex. 2003 at 241:14-242:2 (“So *the pores* are – yeah, *defined by the volume between these particles* and the walls of the pores are largely the walls or the sides of the particles.”).

Second, Petitioner’s interpretation is inconsistent with how a POSITA would understand “pore” in the context of “porosity.” Ex. 2034 ¶65. Porosity is a

measurement of the percentage of open space in a porous layer and is critical because it indicates how effectively ions are transferred through the layer. *Id.* Dr. Guido agrees that porosity is a “fraction with a numerator and a denominator” where “the **numerator** is the **volume of space that is the pores** and the denominator is the total volume.” Ex. 2033 at 44:13-21. When measuring “the volume of space that is the pores,” he agrees that a POSITA does not include the walls. *Id.* at 44:22-45:9.

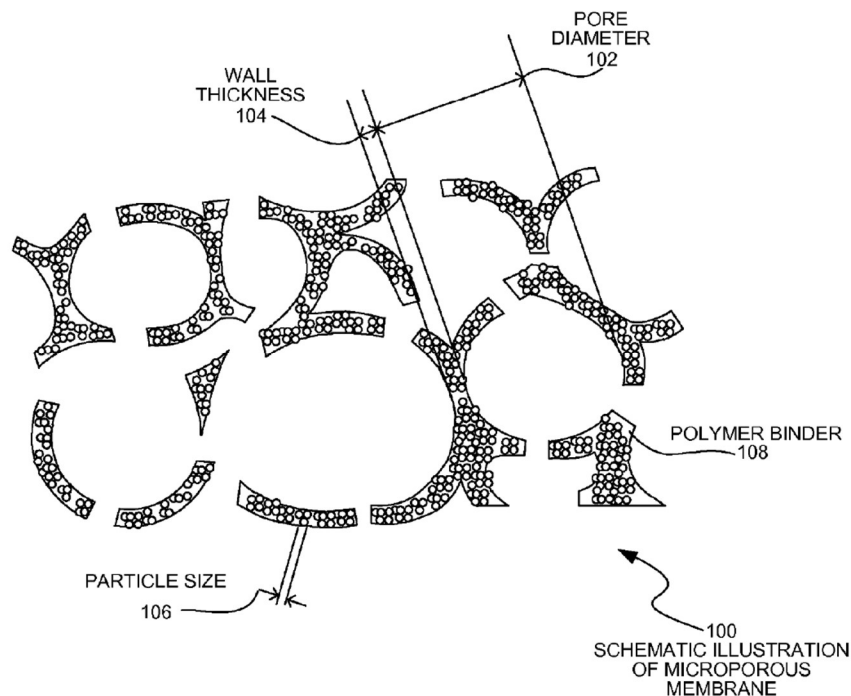
Third, the plain meaning is confirmed by the specification. Ex. 2034 ¶¶66-70. In describing the importance of thin walls, the patent states, “the average wall thickness **between** the adjacent pores in the porous film is low.” Ex. 1001, 3:30-32; *see also, e.g., id.* at 5:3-14, 6:8-13, 8:4-10, 8:52-58, 22:38-47, 23:50-25:5-11; 25:49-51, 26:34-36. The walls are thus not a part of the pores but rather are located “**between**” the pores. Ex. 2034 ¶¶66-67 (also citing Ex. 1001, 3:64-67). Moreover, the patent specifies an average wall thickness between 0.02 μm to 0.5 μm , whereas at least some of the particles in the ’148 Patent must be much larger, at least 1 μm to 10 μm based on the claims’ Dv10 value. *Id.* ¶67 (citing, e.g., Ex. 1001, 1:45-50, 4:61-64, 6:7-13, 25:33-51). This further confirms that inorganic particles must extend into the pores and cannot solely be a part of the walls between pores.

The patent’s SEM images confirm that the pores are the space defined by binder, and the inorganic particles extend at least partially into those pores. Ex. 2034 ¶¶68-70. This can be seen below (annotated):



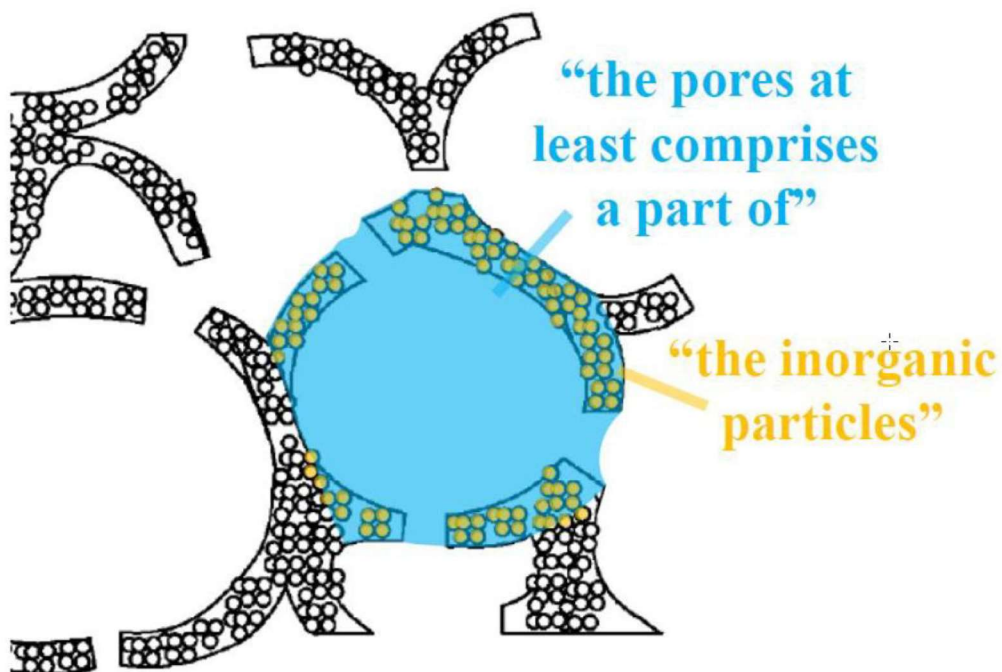
Fourth, Petitioner’s construction contradicts the prior art. Ex. 2034 ¶¶71-74.

Petitioner and Dr. Guido argue that Beard (Ex. 2010) discloses both pore structure limitations based on Figure 1 (below).



Beard Fig. 1 “*define[s]*” the “pore diameter 102” as extending from the *inside* of one wall to the *inside* of the wall on the other side. Ex. 1010 ¶[0017], Fig. 1; Ex. 2034 ¶71. The walls are defined as a separate component: “wall thickness 104.” To use an analogy from Dr. Wheeler, this is akin to how the measured dimensions of a room do not include the thickness of the walls that define the room’s boundaries. Ex. 2034 ¶71; *see also, e.g.*, Ex. 2051, 1 (“Pore size refers to the diameter of the void spaces within a material.”).

Petitioner and Dr. Guido change their interpretation of “pores” when applying Beard to different limitations. Ex. 2034 ¶¶72-73. In contrast to the red pore in Petitioner’s annotated illustration above, Petitioner inconsistently labels the same figure with a new interpretation of what constitutes the pore (in blue), to capture the inorganic particles:



Beard, FIG. 1*

Pet., 52; cf. Pet., 50; Ex. 1003 ¶165 (illustrating the pore, in red, as only the void). Petitioner cannot use two different interpretations. *See, e.g., Phil-Insul Corp. v. Airlite Plastics Co.*, 854 F.3d 1344, 1359 (Fed. Cir. 2017) (“It is well-established, however, that claim terms are to be construed consistently throughout a patent.”).

Finally, Petitioner's arguments related to the prosecution history do not demonstrate a clear and unmistakable disclaimer and do not negate the plain meaning for at least the same reasons explained above with respect to pores "formed by the binder." Ex. 2034 ¶74.

3. Dv10, Dv50, and Dv90

Petitioner suggests Dv10, Dv50, and Dv90 are satisfied if met by particles *at any point* during manufacture. *See, e.g.*, Ex. 1003 (Gido Decl.) ¶111; Pet., 31-32. But for the reasons explained below, the claims require these values for inorganic particles in the finished porous film.

First, the claims require a "porous layer" that comprises "inorganic particles." Those inorganic particles are the antecedent basis for the claims' later use of "*the* inorganic particles" that the pores at least comprise a part of and that the claim requires to have specific size requirements. The plain reading of this language requires that the inorganic particles *in the claimed porous layer* have the claimed Dv10, Dv50, and Dv90. Ex. 2034 ¶¶76, 78. Indeed, Drs. Gido and Wheeler agree that the claim language does not apply to pre-manufacturing measurements; the relevant sizes are those in the final porous layer. Ex. 2033 at 168:5-169:19; 170:21-171:18; Ex. 2034 ¶¶75-78.

Second, the place where the Dv10, Dv50, and Dv90 values are reported in the specification indicates that these values are the Dv10, Dv50, and Dv90 of the

inorganic particles as they exist in the porous layer. Ex. 2034 ¶79. Unlike the prior art (Murakami), the '148 Patent does not report particle sizes for its examples until the *end* of its “preparation of the separator” sections. *See, e.g.*, Ex. 1001, 12:33-35. If the patent meant for these sizes to be for the starting materials, a POSITA would have expected it to list those sizes at the beginning when first introducing the starting materials, like Murakami does. Ex. 2034 ¶ 79.

Third, even if the reported Dv10, Dv50, and Dv90 values were meant to indicate starting particle size distributions (they do not), a POSITA would have understood that—for the '148 Patent—the initial sizes would be effectively the same sizes as in the finished porous layer. Ex. 2034 ¶80. Nothing in the manufacturing process of the '148 Patent would significantly change the particle sizes. *Id.*; *see also* Ex. 2033 at 169:20-170:2 (Dr. Gido explaining “people are generally counting on” “methods of manufacture that do not significantly alter the size distribution of the particles”). As discussed below in Section V.A.3, this is *not* the case for references like Murakami, which significantly alters the particle sizes of its starting material. Ex. 2034 ¶80; Ex. 2033 at 173:11-18, 170:21-171:18.

V. ARGUMENT

A. Ground 1: Murakami Does Not Render Obvious Claims 1, 2, 5-11, and 14-19

1. Murakami Does Not Disclose or Render Obvious Pores “Formed by the Binder”

Petitioner **first argues** Murakami satisfies this limitation because it has pores in a porous layer in which “filler is bound by the binder resin.” Pet. 23, Ex. 1003 ¶¶90 (quoting Ex. 1005 ¶[0070]); Ex. 2034 ¶¶81-85. While Murakami has *filler particles* bound by resin, it does not follow that Murakami’s *pores* are “formed by the binder.” Ex. 2034 ¶86. To the contrary, Murakami’s pores cannot satisfy this limitation because they are formed by gaps between filler particles, not by binder. *Id.*

Murakami does not disclose its pore structure. Ex. 2015 ¶¶83-85. Without SEM (or other) images, a POSITA cannot know whether Murakami’s pores are “formed by the binder.” *Id.* And, reviewing Murakami’s remaining disclosure, a POSITA would conclude they are not so formed.

First, Murakami states that its pores are formed, not by binder, but by inorganic particles. Ex. 2034 ¶¶87-89. Murakami explains that it includes “***gaps formed by contacts of particles of the filler.***” Ex. 1005 ¶[0069]. A POSITA would have understood these “gaps formed by contacts of particles” are Murakami’s pores. Ex. 2034 ¶¶88-89.

Second, it is undisputed that “[f]or high particle load layers where the percentage of particles is more than 90 percent, generally the pores are defined as the gaps between the edges of the particles.” Ex. 2033 at 123:4-8; *see also, e.g., id.* at 241:14-242:2 (“So the pores are – yeah, defined by the volume between these particles.”); Ex. 2031 ¶52; Ex. 2034 ¶¶90-94. It is also undisputed that Murakami teaches this type of “high particle load” layer. Ex. 1003 ¶101 (Dr. Guido opining that Murakami’s “composition consist[s] of nearly *all* filler.”) (emphasis in original); ¶99 (“Murakami states that the filler content makes up most of the filler-binder combination by weight, *preferably up to 99 wt%.*”); Ex. 2033 at 244:13-245:2; Ex. 2034 ¶¶90-94. According to Dr. Guido, a POSITA would have been motivated to use Murakami’s porous layers in Examples 1 and 2 (which are 97% by weight filler, 93% by volume) over Murakami’s other examples (such as Example 3, which uses no filler) because Examples 1 and 2 have “superior performance.” Ex. 1003 ¶¶80, 100. Thus, the pores in Murakami’s “high particle load” porous layer are “the gaps between the edges of the particles” and are not “formed by the binder.” Ex. 2033 at 123:4-8.

Third, Petitioner’s reliance on Paragraph 70 is misplaced. Paragraph 70 confirms Murakami’s pores are ***not*** formed by the binder:

The porous layer containing a filler and a binder resin is preferably a porous layer in which the filler is bound by the binder resin. That is, ***a***

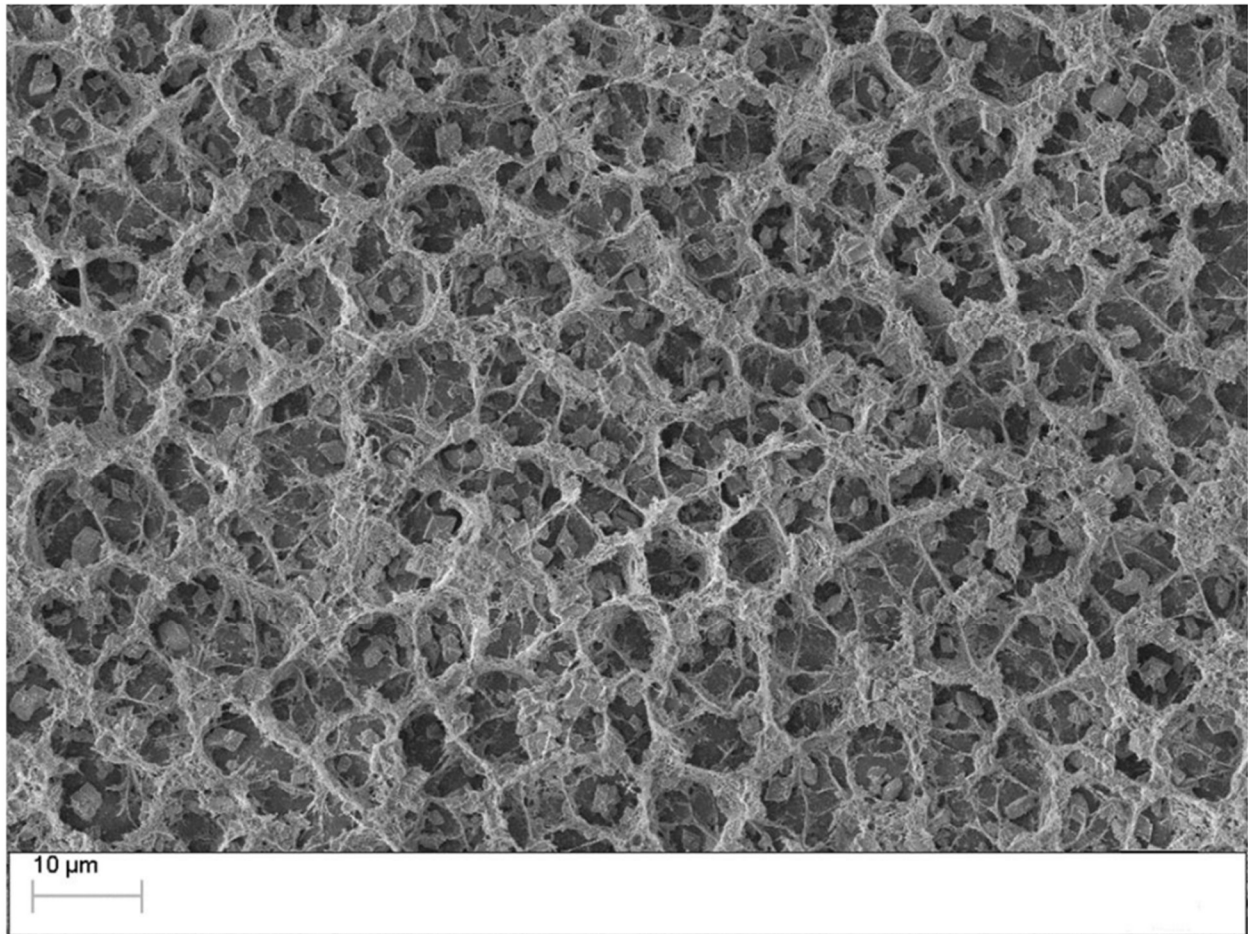
porous layer in which a filler is dispersed in a resin (binder resin) is not suitable as the porous layer containing a filler and a binder resin.

Ex. 1005 ¶¶95. This teaches a POSITA to ***avoid*** layers where particles are “dispersed” in binder, and instead use layers where “the binder is there as a glue to hold the particles together” but “the structure of the layer is dominated by the particles.” Ex. 2031 ¶52. This is also what Murakami teaches when stating it is most preferable to use only a minimal amount of binder in Murakami’s porous layer. Ex. 2034 ¶¶95-98. As Dr. Gido put it, “[t]here is simply ***not enough resin*** material [in Murakami] to completely subsume the much greater amount of filler—***just enough*** for ‘the filler [to be] bound by the binder resin.’” Ex. 1003 ¶101; *see also* Ex. 2015 ¶87; Ex. 2034 ¶¶95-96. Thus, Paragraph 70 ***confirms*** the rest of Murakami’s disclosure that Murakami is the type of high-particle loading layer where the binder acts only as glue and the pores are formed by inorganic particles—not by binder. Ex. 2034 ¶¶99-100.

Petitioner **next argues** this limitation is met because “Murakami forms those pores through a process like that described in the ’148 Patent.” Ex. 1003 ¶94; Pet., 23-25. This is incorrect. Ex. 2034 ¶¶102-113.

The ’148 Patent forms its porous layer using NIPS, wherein the key to pore formation is the coagulation step: “after the coating solution is coated on the substrate and then immersed in the coagulation solution, since the first solvent in the

coating solution is extracted into the third solvent (for example, deionized water) in the coagulation solution, *the binder in the coating solution is coagulated and separated out, thus forming a porous film.*” Ex. 1001, 6:26-32; Ex. 2034 ¶¶103-105. This coagulation process “pulls the binder out of solution into a solid phase, thus forming a porous web of binder with the inorganic particles dispersed throughout the web ‘in the vicinity’ of large pores.” *Id.* (quoting Ex. 1001, 3:64-67).



In contrast to the '148 Patent, nothing in Murakami suggests a POSITA should use a coagulation process—which Dr. Gido agrees is typically reserved for layers

having a significant amount of binder (Ex. 2033 at 112:7-15, 212:5-10)—for a high particle loading layer like those in Murakami’s Examples 1 and 2. Ex. 2034 ¶¶106-112. Rather, Murakami teaches it is preferable **not** to use this type of coagulation process with particle-dense porous layers.⁴ Ex. 2034 ¶106. As Dr. Gido admits, Murakami discloses two different processes for forming a porous layer. Ex. 2033 at 130:11-14; Ex. 2034 ¶107; Ex. 1005 ¶[0087]. The first is a simple drying process, whereas the second adds an “optional” solvent substitution step before using the simple drying process. Ex. 1005 ¶[0087]; Ex. 2033 at 130:11-14; Ex. 2034 ¶¶107-08. Murakami teaches its simple drying method (without any solvent substitution) is the preferred method for forming its porous layers. Ex. 1005 ¶[0088]; Ex. 2034 ¶109.

Unlike Example 3, for instance, Examples 1 and 2 do **not** use a solvent substitution process. Ex. 2034 ¶108. As Dr. Gido admits, Examples 1 and 2 use only the simple drying method on its own (without the “optional” solvent substitution step). Ex. 2033 at 130:11-131:8; Ex. 1005 ¶¶[0139]-[0143], [0160]-[0163]. In

⁴ Even if Murakami taught a POSITA to use a solvent substitution process (which it does not for the reasons explained herein), there are many more solvent substitution processes than just NIPS, and even within the NIPS subcategory, pore structure depends on various other factors (such as the types and amounts of solvents and other materials used). Ex. 2034 ¶¶111-12 (citing Ex. 2041, Fig. 3).

contrast, Example 3's porous layer is made only of polymer and is made using a solvent substitution process. Ex. 2033 at 131:9-11, 134:15-135:4, 36:8-9; Ex. 1005 ¶[0174]; Ex. 2034 ¶108. Thus, Murakami teaches a POSITA to use the '148 Patent's simple drying process *instead of* a coagulation process to achieve porous layers like Examples 1 and 2, and if anything, teaches away from using the coagulation process used in Example 3. *See, e.g., Chemours Co. FC, LLC v. Daikin Indus.*, 4 F.4th 1370, 1376-77 (Fed. Cir. 2021). A POSITA would not have applied the pore formation process of an underperforming example in Murakami (Example 3) to other examples that performed better (Examples 1 and 2) and which have a different composition (mostly inorganic particles with very little binder). Ex. 2034 ¶¶106, 108-110; Pet., 21 (arguing a POSITA would be motivated to follow the teachings of Examples 1 and 2 over all other examples because of their "superior performance").

2. Murakami Does Not Disclose or Render Obvious "Pores at Least Comprises a Part of the Inorganic Particles"

As set forth in Section IV.2, a "pore" and its "wall" are distinct elements. Ex. 2034 ¶116. The '148 Patent emphasizes pore walls and how important it is to have thin walls. *See, e.g.,* Ex. 1001, 5:3-14; Ex. 2034 ¶118. Murakami does not discuss "walls" at all, let alone report measurements for walls. Ex. 2034 ¶119. This is because Murakami's structure has pores formed by gaps between inorganic particles, and there are no walls of binder for the inorganic particles to extend into. Ex. 2034

¶117. Instead, the inorganic particles themselves represent the outer boundaries of the pores or voids, and thus are not “a part” of the pores or voids themselves. *Id.*; Ex. 2033 at 241:16-242:2 (“[T]his is the *same as Murakami*, the – *the particles connected together by the binder*, which in this case is a particulate polymer, *define the walls of the pores.*”); *id.* at 123:4-8; Ex. 2034 ¶¶114-19.

3. Murakami Does Not Disclose or Render Obvious the Claimed Particle Size Distributions of the Inorganic Particles In the Porous Layer

Both experts agree Murakami’s D10, D50, and D90 values are the particle size distribution of Murakami’s *starting material*. Ex. 2033 at 172:15-173:10; Ex. 2034 ¶¶122, 126, 133. The disagreement is whether those starting sizes accurately reflect the particle sizes in Murakami’s porous layer, or if they are significantly altered during Murakami’s manufacturing process. Ex. 2034 ¶¶120-47.

Murakami teaches using high-pressure dispersion, which would significantly alter the particle size distribution in Murakami’s porous layer at least because (1) the high pressure would alter individual particle sizes, and (2) the high pressure would break up agglomerated particles that would have been present in—and influenced the D10, D50, and D90 values of—Murakami’s starting material. Ex. 2034 ¶¶120-145; Ex. 2015 ¶¶104-109.

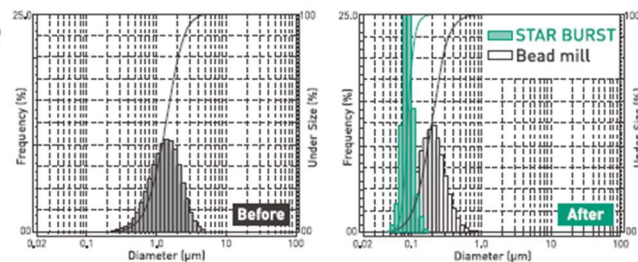
First, a POSITA would have recognized that Murakami’s high-pressure dispersion would have significantly altered the sizes of individual particles. Ex. 2034

¶¶123, 127-128, 133, 144. Murakami lists “[c]oncrete examples of the method for preparing the coating liquid,” and includes examples that a POSITA would understand affect particle size, such as “wet grinding device” (elsewhere described as a “ball mill” or “bead mill”) or “a high-pressure dispersion method.” *Id.* ¶¶[0073], [0064]; Ex. 2034 ¶127; Ex. 2033 at 170:3-20 (Dr. Gido agreeing a ball mill (i.e. wet grinding device) would significantly alter particle sizes). Examples 1 and 2 apply the “high-pressure dispersion method” to the coating liquid used to form these examples’ porous layers. Ex. 1005 ¶¶[0141], [0161]. Murakami explains that an “alumina dispersion was obtained” by mixing 3 parts binder with 100 parts by weight of α -alumina, and a solvent. *Id.* After obtaining that dispersion, Murakami discloses a second, “more intensive dispersion” in which “[t]he obtained dispersion was dispersed by high pressure with the use of a high-pressure dispersing device (manufactured by SUGINO MACHINE LIMITED; Star Burst).” Ex. 2033 at 166:2-18; Ex. 1005 ¶¶[0141], [0161]. Murakami discloses that this high-pressure dispersion involved three passes at 100 MPa (which is roughly ***1,000 times atmospheric pressure***). Ex. 1005 ¶¶[0141], [0161]; Ex. 2033 at 154:19-155:13. It was well-known that this intense level of pressure would have a significant impact on the particle size distribution of the inorganic particles. Ex. 2034 ¶128 (citing, e.g., Exs. 2047, 2048).

The Sugino brochure (Ex. 2029) confirms this well-known proposition by including examples of particle size distributions after being exposed to high-pressure dispersion. Ex. 2034 ¶¶129-30. For example, the brochure shows that “homogenized particle size,” or a narrower size distribution, is a key goal of using high-pressure dispersion.

Homogenized Particle Size

Uniform particle with narrow particle size distribution can be achieved by controlling the injection speed of raw material.



Ex. 2029, 3. Murakami teaches a POSITA to narrow particle size distribution to decrease variability in voidage, and in particular to aim for as narrow a distribution as possible, most preferably a difference between Dv90 and Dv10 that is less than 1 micron. Ex. 2034 ¶130 (citing Ex. 1005 ¶[0066]); *see also, e.g.*, Ex. 2033 at 179:16-180:6 (Dr. Gido admitting Murakami teaches the distribution “should be narrower than 1 micron” and “it doesn’t say anything about a lower limit”). Thus, a POSITA would have understood Murakami used high-pressure dispersion not just to mix the binder, particles, and solvent (which were already mixed in a previous step to obtain the initial dispersion), but also to further narrow the particle size distribution in the finished porous layer, thereby decreasing variability in voidage. Ex. 2034 ¶¶129-30. A POSITA would have also viewed the Sugino brochure as validating that three

passes using the Sugino Star Burst at 100 MPa would significantly reduce particle size (in addition to narrowing particle size distribution). Ex. 2034 ¶¶134-40.⁵

Dr. Gido admits that if particles are “smashing into each other” or “run into each other,” then that “certainly would smash them up and that – and that’s what those dispersion modes are.” Ex. 2033 at 156:13-20; Ex. 2034 ¶127. While Dr. Gido argued Murakami would have used Sugino’s single nozzle chamber⁶ and that this

⁵ A POSITA would have used the Sugino examples as confirmation that high-pressure dispersion would reduce particle size because (1) Murakami explicitly says it used the Sugino Star Burst instrument, and (2) at least one of the examples uses the same type of particle (alumina) and similarly high pressure (98 MPa) as Murakami. Ex. 2034 ¶¶134-138. A POSITA would not use the brochure to quantitatively determine particle size after high-pressure dispersion and thus would not require the examples to perfectly match Murakami’s specifications to be instructive regarding general concepts. Ex. 2034 ¶¶139-40.

⁶ Dr. Gido’s incorrectly assumes that Murakami used the single nozzle chamber. Ex. 2034 ¶¶141-142. If anything, a POSITA would have understood that Murakami would *not* have used the single nozzle chamber but instead would have used the oblique collision type chamber, which is the chamber designed specifically

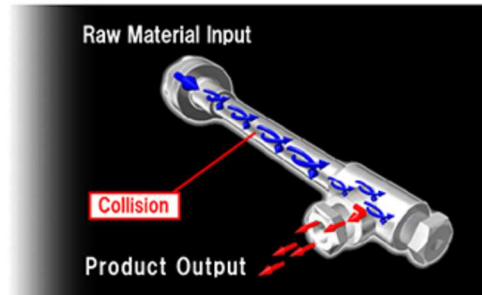
chamber would not pulverize the particles, he later admitted he has “no idea” what effect 100 MPa of pressure would have on particle sizes (even in the context of the single nozzle chamber). *Id.*; *see also id.* at 155:14-21 (“Q: And it’s your belief that applying 1,000 times atmospheric pressure to a set of particles or a slurry of particles will not cause them to run into each other, shrink or change their size distribution in any way? A: Well, first of all, ***I don’t know that.***”); 156:18-20 (“***I really have no idea what that high pressure does*** just shooting a single nozzle out into space.”); 156:7-8 (“***I really don’t know what that’s going to do to a particle.***”). Dr. Gido suggested going to the Sugino website for more information regarding the single nozzle chamber. Ex. 2033 at 166:19-167:13. But the Sugino website contradicts Dr. Gido’s testimony—it states that the Star Burst’s single nozzle chamber ***does*** pulverize materials. Ex. 2044, 2; Ex. 2034 ¶143.

for particles like alumina, is the “standard-type” chamber, and minimizes contamination. *Id.* (citing Ex. 2029, 4); Ex. 2044, 1.

Single nozzle chamber

Raw materials are pulverized and dispersed with a cavitation effect generated by the injection of pressurized raw material slurry. Layered clay minerals, such as mica or bentonite, can be effectively cleaved.

Applications: Dispersing, Cleaving, and Surface reforming



Second, even setting aside what almost 1,000 atmospheres of pressure would do to an *individual* particle, there is no dispute that high-pressure dispersion would break up the *agglomerated* particles. A POSITA would have understood that particle size distributions reported for an alumina starting material include the sizes of larger agglomerated particles, or “clumps” of individual particles, and both experts agree the initial dispersion step in Murakami would not “break them up into their individual particles.” Ex. 2033 at 166:2-18; Ex. 2034 ¶128. Instead, both experts agree high-pressure dispersion in Murakami is necessary to “break [larger agglomerated particles] up into their individual particles”—even if that step is performed only using the dispersion setting with the single nozzle chamber. Ex. 2033 at 166:10-167:8; Ex. 2034 ¶144. This alone would cause a significant shift in the D10, D50, and D90 values of the particles in Murakami’s finished porous layer. Ex. 2034 ¶144.

A POSITA would have understood that it is not a coincidence that the two examples that use high-pressure dispersion in Murakami (Examples 1 and 2) are the examples that have “superior performance.” Ex. 2034 ¶¶129-30; Pet., 21. This “superior performance” can be attributed, at least in part, to the facts that Examples 1 and 2 have a narrower size distribution (just like Sugino says they would) and that this led to decreased variability in voidage (just like Murakami says it would). Ex. 2034 ¶¶129-30.

Finally, the Institution Decision suggested that arguments about high-pressure dispersion in Murakami altering particle size “are difficult to reconcile with the express disclosure of Murakami,” namely that Murakami devoted significant space to specifying certain D10, D50, and D90 values and explaining the importance of those values. Paper 10, 22. But the fact that high-pressure dispersion would have altered Murakami’s initial D10, D50, and D90 values does not contradict Murakami’s focus on providing those values in the first place. Ex. 2034 ¶¶131-32. **First**, it is entirely possible Murakami understood that the distribution values in the finished porous layer would not reflect the initial starting values⁷ and still chose to

⁷ See, e.g., Ex. 1011 ¶[0048] (“In general, the D10, D50, and D90 of the non-conductive particles before the porous membrane slurry is prepared are different

report the starting values, anyway. It is not uncommon for an author to provide the particle size distribution of the starting material because, as Dr. Guido testified, (1) starting sizes are easier to know, and (2) POSITAs typically use commercial particles that come labeled with those distributions. Ex. 2033 at 168:20-169:19, 172:19-173:10, 175:21-176:16; Ex. 2034 ¶131. A POSITA would have understood it was simpler for Murakami to report starting sizes and give a specific procedure (type of dispersion, name of instrument, pressure settings for instrument, and number of passes), than it was for Murakami to report particle sizes after applying high-pressure dispersion. Ex. 2034 ¶131. To use Dr. Wheeler’s analogy, the author of a smoothie recipe might instruct the user to safely cut a frozen banana into 2-inch pieces before adding it to the blender, but that does not mean the smoothie will have 2-inch pieces of banana in it if the recipe also instructs the user to hit “blend” at high power for 2 minutes. Ex. 2034 ¶132. Nor would the user assume it was the author’s intention to make a chunky smoothie with 2-inch pieces of banana. *Id.*

Second, even if Murakami’s inventors did not know that high-pressure dispersion altered the particle sizes, Murakami still teaches a POSITA to use that

from those of the non-conductive particles contained in the porous membrane slurry.”).

process.⁸ Regardless of whether the authors recognized the effects of using high-pressure dispersion does not negate that (1) they disclosed using it and (2) it would have affected particle size. *See, e.g., Amgen Inc. v. Hoechst Marion Roussel*, 314 F.3d 1313, 1357 (Fed. Cir. 2003) (“Under § 103, however, a reference need not be enabled; it qualifies as a prior art, regardless, *for whatever is disclosed therein.*”); Ex. 2034 ¶144.

B. Ground 2: Murakami and Honda Do Not Render Obvious Claims 3 and 12

Petitioner asserts Murakami and Honda render obvious Claims 3 and 12. Pet., 41-42. These claims depend from Claims 1 and 10, respectively, and additionally require that “the average wall thickness between the pores is in a range of 20 nm to

⁸ That other examples do not use high pressure dispersion, and that there is a broad range of sizes disclosed in the general description of Murakami, do not alter this conclusion. Petitioner argues that Examples 1 and 2 have “superior performance” and that a POSITA would emulate these examples instead of all other examples in Murakami. Pet., 21. A POSITA would understand that Murakami teaches applying high-pressure dispersion to the starting material, even if that starting material falls within Murakami’s general range (and does not exactly match the starting material in Examples 1 and 2).

500 nm.” These claims are not obvious for at least the same reasons noted above with respect to Independent Claims 1 and 10, and for the additional reasons set forth below. Ex. 2034 ¶¶148-150.

No motivation to combine. Murakami and Honda disclose incompatible pore structures and variables, including different pore types and surfactant use.⁹ Ex. 2034 ¶¶151-58.

First, as explained above in Sections V.A.1 and 2, Murakami’s particle-dense porous layer has pores formed by gaps between particles, and no binder walls. In contrast, Honda’s resin-based porous layer has a honeycomb structure made of polyvinylidene fluoride resin (binder), as shown in Honda’s Figure 1. Ex. 2034 ¶¶151-53; Ex. 2033 at 253:13-17, 256:3-19. Honda’s binder wall thickness cannot be applied to Murakami’s “porous particles” structure (as Petitioner suggests) because Murakami does not have binder walls whose thickness can be adjusted to match Honda. Ex. 2034 ¶153.

⁹ Other variables in Murakami and Honda also conflict, including their particle sizes and distributions, pore sizes, amount of filler, and goals. Ex. 2034 ¶¶159-163. Each conflicting variable and goal further demonstrates why a POSITA would not apply Honda’s wall thickness to Murakami’s pore structure. *Id.*

To match Honda's wall thickness (0.1-2 μm), a POSITA would need to reduce Murakami's particle sizes and distribution below the claimed ranges (D10: 0.015 to 3 μm , D50: 0.2 to 5 μm , D90: 1 to 10 μm). *Id.* To fit the wall thicknesses of Claims 3 and 12, a POSITA would have to further reduce those particle sizes to an average thickness of 20 nm to 500 nm (0.02 μm to 0.5 μm). It is impossible for the inorganic particles to fall within this 0.1 μm to 0.5 μm range (the lowest thickness in Honda to the maximum thickness in the claims) and still satisfy the Dv10, Dv50, and Dv90 values required by the claims. *Id.*

Second, Honda relies on a surfactant to achieve its porous structure, including its wall thicknesses. Ex. 1007 ¶[0064]; Ex. 2033 at 258:2-259:5; Ex. 2034 ¶¶ 154-157. A surfactant is a chemical designed to “modify the surface interaction” between two phases. Ex. 2034 ¶155; Ex. 2033 at 257:1-258:1. Whether to use surfactant (let alone what kind and how much) is a substantive change that affects pore structure. Ex. 2034 ¶¶155-157. While surfactants have advantages for some applications, they also have disadvantages, such as destroying a desired pore structure or being left behind in the electrode following evaporation of the solvent. *Id.*

Murakami does not use a surfactant in Examples 1 and 2, and a POSITA would have had to conduct undue experimentation to validate whether adding Honda's surfactant would be helpful with the specific formulations of Examples 1 and 2. Ex. 2034 ¶158. Dr. Guido admits, “a POSITA would need to, you know, do

some tests, make some sample materials, and investigate them to see how that works out.” Ex. 2033 at 260:3-9. “You don’t necessarily know how much to add, there is different kinds of surfactants, you don’t know which one to use and so forth.” *Id.* A POSITA would not have been motivated to jeopardize the carefully crafted porous structure and performance characteristics achieved in Murakami by adding a surfactant like in Honda. Ex. 2034 ¶158.

No reasonable expectation of success. Even if a POSITA were motivated to combine Honda and Murakami, a POSITA would not have a reasonable expectation of success. Ex. 2034 ¶¶164-166. As explained above with respect to motivation to combine, applying Honda’s wall thickness to Murakami’s existing structure would require significant alterations to particle size and distribution, such that the resulting sizes would fall outside the claimed ranges. Ex. 2034 ¶164. Or, if a POSITA were to try Honda’s porous structure and wall thickness but with Murakami’s inorganic particle sizes, they would be unsuccessful because Honda’s structure relies on different inorganic particle sizes than those required by Murakami, and Murakami’s large particle sizes could not be effectively held in place by the thin pore walls required by Honda and the claims. Ex. 2034 ¶165. In addition, a POSITA would have known that it would be impossible to achieve Honda’s perfect honeycomb structure without the use of a surfactant. *Id.* Neither Dr. Guido nor Petitioner suggest using the surfactant of Honda in their proposed combination, and a POSITA would

have understood that applying a surfactant to Murakami would significantly alter Murakami's desired pore structure.

Therefore, Honda and Murakami do not render claims 3 and 12 obvious.

C. Ground 3: Murakami and Tanaka Do Not Render Obvious Claims 4 and 13

Petitioner asserts Murakami and Tanaka render obvious Claims 4 and 13, which further require a pore size distribution coefficient of 1 to 5. Pet., 43-48. These claims are not obvious for at least the same reasons noted above with respect to Independent Claims 1 and 10, and for the additional reasons explained below. Ex. 2034 ¶¶167-69.

First, Tanaka is non-analogous art, and a POSITA would not rely on it for improving battery performance. *See, e.g., In re Clay*, 966 F.2d 656, 660 (Fed. Cir. 1992). Tanaka is not from the same field of art, and a POSITA would not have reasonably expected to solve the problem of the '148 Patent (a gap between separator and electrode) by following Tanaka's teachings. *Id.*; Ex. 2034 ¶170. Tanaka is geared toward improving water absorption performance through a porous sintered compact for use in non-battery applications (Ex. 1009, Abstract), such as "filters or maybe separators for biomedical kind of applications that may involve you know putting an aqueous solution through them and separate out a protein or something like that." Ex. 2033 at 265:14-22. Even Dr. Guido admits Tanaka is fundamentally

different than a reference like Honda, for example, which “actually constructs batteries and you know tests them.” Ex. 2033 at 268:17-269:4. In contrast to Murakami, “Tanaka is mainly focused on more of these sort of filtration type applications.” *Id.* A POSITA would not rely on a pore size distribution coefficient in Tanaka, which is non-analogous art and never tested as a battery separator, over relying on Murakami, which constructs and tests battery separators. Ex. 2034 ¶¶170-171. Moreover, nothing in Tanaka suggests it would reasonably “solve the problem” solved by the ’148 Patent, which as explained above was to eliminate or reduce the gap formed between the separator and electrode. *Id.*; *In re Clay*, 966 F.2d at 660.

Second, a POSITA would not have been motivated to combine Tanaka and Murakami. The two have fundamentally different pore structures. Ex. 2034 ¶171. Tanaka’s filter is made of polymer with no inorganic particles, and its pore sizes necessarily depend on that polymer and the process of formation. *Id.*; Ex. 2033 at 266:3-9. Murakami is a high particle porous layer whose pore structure and size depends on Murakami’s inorganic particles. Ex. 2034 ¶171; Ex. 2033 at 204:3-11. Thus, a POSITA would not have expected to achieve Tanaka’s pore sizes or pore size coefficient while maintaining Murakami’s particle sizes and distribution, and they would not be motivated to do so because of the great risk of harming Murakami’s tested pore structure and features. Ex. 2034 ¶171.

Moreover, Tanaka's sintering method is different from (and incompatible with) Murakami's manufacturing process. Ex. 2034 ¶172. "[S]intering is taking little particles of something like little grains of something and – bonding them together." Ex. 2033 at 265:5-13. As Dr. Guido admits, sintering in Tanaka is applied to a polyolefin without any inorganic particles. Ex. 2033 at 266:3-9, 267:8-16. This is different from Murakami, which Dr. Guido characterizes as a "porous layer [that] consists of nearly *all* filler material and relatively little resin by weight." Ex. 1003 ¶[0103] (emphasis in original). Given these crucial differences, a POSITA would not expect the sintering process of Tanaka's polyolefin to work with Murakami's high particle porous layer; nor would it have been necessary, as Murakami uses binder to hold together its inorganic particles. Ex. 2034 ¶172.

Finally, a POSITA would not have a reasonable expectation of success. Ex. 2034 ¶¶173-74. First, Tanaka's pore size distribution coefficients are for a polyolefin porous ***substrate***, but the claims require the claimed pore size distribution coefficient to be in a porous ***film*** (i.e. the layer that generally coats the substrate). *Id.* A POSITA would not expect to achieve the pore sizes and pore size distribution coefficient of Tanaka's polyolefin porous substrate in Murakami's mostly inorganic particle porous film. *Id.* Second, a POSITA would not expect to accomplish Tanaka's pore sizes and pore size distribution coefficient while retaining Murakami's particle sizes and distribution. *Id.* Dr. Guido admitted in his deposition that particle sizes and

particle size distribution influence “pore geometry,” “pore size,” and “porosity.” Ex. 2033 at 204:3-205:9. Tanaka’s pore size distribution coefficient depends on the relative pore sizes in Tanaka. Ex. 2034 ¶173. A POSITA could not successfully achieve Tanaka’s pore sizes and distribution coefficient without altering Murakami’s particle sizes and particle size distribution because Murakami’s articles are what define its pores. *Id.*

D. Ground 4: Murakami and Beard Do Not Render Obvious Claims 1, 2, 5-11, and 14-19

Petitioner asserts Murakami and Beard render obvious Claims 1, 2, 5-11, and 14-19. Pet., 48-56. This ground fails at least because, as described in Section V.A.3, Murakami does not disclose or render obvious the Dv10, Dv50, and Dv90 limitations (and Petitioner does not rely on Beard to satisfy those limitations), in addition to the reasons provided below. Ex. 2034 ¶¶175-78.

1. Neither Beard Nor Murakami Disclose or Render Obvious “Pores at least Comprises a Part of the Inorganic Particles”

Beard’s pore structure does not solve Murakami’s failure to disclose or render obvious “pores at least comprise[] a part of the inorganic particles.” *See discussion supra* at Section V.A.2; Ex. 2034 ¶¶179-94. In Beard, inorganic particles are packed tightly inside the binder pore walls, such that the inorganic particles are fully encapsulated by binder and thus are only part of the pore walls—the particles do not contact or extend into the pores themselves. Ex. 2034 ¶¶184-85. This is shown in

Petitioner's annotated version of Beard Figure 2 (below), which shows the “pore” (in red) as *excluding* the inorganic particles that are in the pore walls.

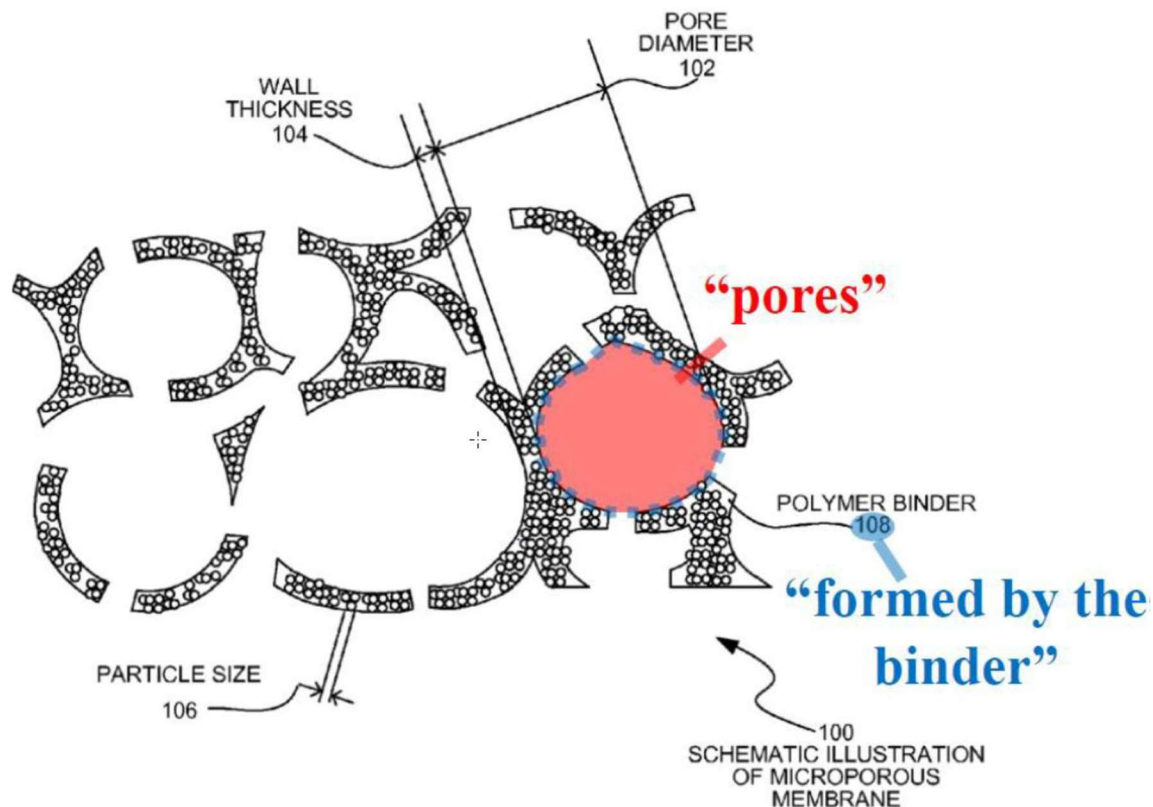


FIG. 1

Pet., 50.

However, the Institution Decision suggested that “Beard accounts for this limitation in its disclosure in Figure 1 of particles that extend into the pores.” Paper 10, 32. This is incorrect.

First, Beard’s pore structure is designed to limit the inorganic particles’ “interference in pore creation.” Ex. 1010 ¶[0086] (teaching against allowing filler “to block the pore pathways” or to directly or indirectly “interfer[e] in pore

creation”). In explaining Figure 1, Beard states: “[t]he particles in the example of embodiment 100 may be *captured inside the polymer binder 108, as opposed to having the particles loosely positioned within the pores.*” *Id.* ¶[0026]. Beard further explains that its inorganic particles are “[w]ithin the pore walls” and “may be less than 0.02 microns in width,” and “a densely packed filler material may have an average diameter of less than 0.005 microns.” *Id.* at Abstract. Beard also states: “TiO₂ particles are on the order of or smaller than the cell wall thickness **208.**” *Id.* ¶[0037]. Beard explains: “[g]ood results may be achieved when the solid particles are contained exclusively or largely within the pore walls.” *Id.* ¶[0086]. These disclosures all confirm the general idea conveyed by Beard’s Figure 1—the best porous layer is one in which the pore walls are made of binder and are packed tightly with inorganic “within” those walls. Ex. 2034 ¶¶187-88.

While the Institution Decision discounted the above disclosures because of language like “may,” permissive language does not negate the facts that: (1) Beard teaches that even particles that seemingly “peek out” of the binder walls (like the red arrows in Petitioner’s annotated version in Fig. 1, below) are, in fact, *fully encapsulated* by a thin layer of binder such that they do not extend into the pores; and (2) even if Beard suggests that inorganic particles extending into the pores is theoretically *possible*, it teaches a POSITA not to allow that to achieve the best results.

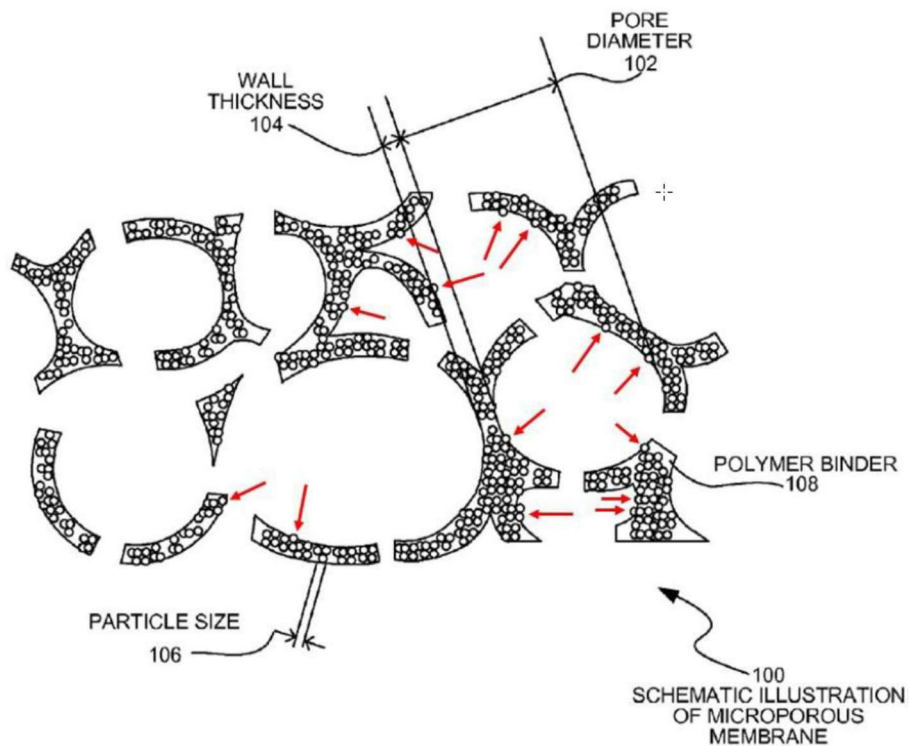


FIG. 1

As to (1), a POSITA would have understood that the inorganic particles in Beard are fully encapsulated (i.e. “coated” or “wet”) by the binder. Ex. 2034 ¶¶190-191. The large relative amount of binder in Beard (between 33 and 67% binder by volume) makes Beard’s porous layer one in which Dr. Guido says, “the particles are generally separated from one another and *surrounded by binder*” and “it is necessary to generate porosity in the binder polymer itself.” Ex. 2031 ¶52; Ex. 2034 ¶191. The much higher percentage of binder in Beard means that, unlike Murakami, there is enough binder to fully encapsulate all the inorganic particles. *Id.* In addition, Beard teaches its “most optimized” pore structures result in a “filled polymer” where the polymer coats (or wets) all the inorganic particles. Ex. 1010 ¶[0085]; Ex. 2034 ¶191;

Ex. 2033 at 221:6-222:8. Indeed, an example of this type of “filled polymer” is shown in Figure 3, an SEM showing filler material that is “***fully encapsulated*** by the polymer” (i.e. “[t]he ***polymer has fully wet the TiO₂ filler***”). Ex. 1010 ¶[0050], Fig. 3. As Dr. Guido explains, the interaction between Beard’s polymer and filler creates “a thermodynamic driving force to coat or spread on the surface” that causes binder to extend/creep over the face of (or “wet”) the particle. Ex. 2033 at 221:6-222:8.

As to (2), Beard teaches a POSITA to use a porous layer in which “the filler material [is] ***fully encapsulated*** by the polymer” (i.e. does not and cannot extend into the pores delineated by binder), and ***not to use*** a structure where particles extend into the pores. Ex. 1010 ¶[0050]; Ex. 2034 ¶¶192-94. Beard teaches its “most optimized” pore structure is achieved when “the filler and polymer under favorable thermodynamics coat/wet/bond and hence create the strongest possible filled polymer system.” Ex. 1010 ¶[0085]. Thus, a POSITA would have been motivated to fully encapsulate the inorganic particles by the binder. Ex. 2034 ¶¶192-93. This type of system is shown in Figure 3 of Beard, where “the filler material [is] ***fully encapsulated*** by the polymer,” and “[t]he polymer has fully wet the TiO₂ filler, yet the microporous structure remains.” Ex. 1010 at [0050]. Moreover, Beard teaches, “[w]hen filler additives are allowed to block the pore pathways or when the total porosity and pore structures are negatively impacted either by the direct filler

addition or by indirect interference in pore creation, an inferior membrane may result.” *Id.* ¶[0086]. A POSITA would have understood that allowing inorganic particles to extend into the pores would interfere with pore creation or otherwise limit porosity and block the pores. Ex. 2034 ¶¶192-93. Thus, a POSITA would have been motivated by Beard to use a pore structure in which the inorganic particles are kept fully encapsulated by binder and thus do not extend into the pores. Ex. 2034 ¶194.

Finally, Petitioner briefly cites a “second optional embodiment” in Beard that uses “larger fibrous particles, greater than 1 micron” that “may extend through, across or between the pores creating a porous fibrous network independent of the fillers deployed within the polymer membrane walls that surround the larger fibrous particles.” Pet., 54; Ex. 1010 ¶[0025]. But this embodiment is *not* depicted in Fig. 1, which is the embodiment Petitioner relies on for arguing that Beard meets the claimed pore structure. Ex. 2034 ¶255. A POSITA would not have been motivated to use the large particle size in this “second optional embodiment” because doing so would lead to pores formed by gaps between the large inorganic particles (as discussed with Murakami above and Akiike below), and thus would not meet the claimed pore structure requirements or achieve Beard’s “most optimized” structure. *Id.*; *see also* Ex. 2015 ¶¶131-34.

2. A POSITA Would Not Have Been Motivated to Combine Murakami and Beard with a Reasonable Expectation of Success

No motivation to combine. *First*, Murakami and Beard have fundamentally incompatible pore structures, at least because of vastly different binder ratios, particle sizes/distribution, and formation processes. Ex. 2034 ¶ 198. As explained above, Murakami uses a particle-dense porous layer formed by gaps between inorganic particles. *See* discussion *supra* at Section V.A.1. Beard is the type of porous layer Dr. Gido characterizes as having a “significantly greater” percentage of binder, with a different type of pore structure—one in which its pores are delineated by binder and the inorganic particles are fully encapsulated by that binder. Ex. 2031 ¶52. Adjusting Murakami’s pore structure to match Beard would require significant (or impossible) changes to at least three variables, which is neither addressed by Petitioner nor feasible without undermining Murakami’s desired properties and structure—even a single changed variable would significantly affect pore structure and would require undue experimentation. Ex. 2034 ¶ 197; Ex. 2033 at 205:10-207:1 (“[Y]ou can move this parameter space all over the place and get different pore sizes and different porosities for all kinds of different reasons.”).

Beard’s and Murakami’s particle sizes and distributions are incompatible. As for particle size, Beard teaches using “extremely small” inorganic particles. *E.g.*, Ex. 1010 ¶[0064]; Abstract; ¶[0037]; Ex. 2034 ¶199. Even Dr. Gido

concedes that the “maximum” particle size taught by Beard is 0.2 μm (only in some embodiments, whereas it is 0.1 μm in others). Ex. 2033 at 72:1-15. A POSITA would have understood that Beard’s “[g]ood results” are because “the solid particles are contained exclusively or largely within the pore walls” and thus “an open, continuous pore structure is provided throughout the film.” Ex. 1010 ¶[0086]; Ex. 2034 ¶199. Using “extremely small” particle sizes is necessary to achieve Beard’s pore structure; otherwise, the particles could not be “contained exclusively or largely within the pore walls” and instead would be “allowed to block the pore pathways” or otherwise “interfer[e] in pore creation,” which Beard teaches results in an “inferior membrane.” Ex. 1010 ¶[0086]; Ex. 2034 ¶¶199, 202.

Beard also discloses that particle size should not exceed wall thickness, which in Beard is a “maximum” thickness of 0.1 μm . Ex. 1010 ¶[0021]; Ex. 2034 ¶200. While Beard discloses a particle size up to 0.2 μm in some embodiments, it separately teaches ratios of wall thicknesses to particle size that are *at least* 1:1 and can even be 20:1 or greater, and every claim in Beard requires a “pore wall thickness *greater than* said maximum filler size.” Ex. 1010 ¶[0022], Claims 1-20. A POSITA would have understood that particle sizes should be no larger than 0.1 μm to achieve the best results of Beard, and even under Dr. Gido’s interpretation, should not exceed 0.2 μm lest the particles be “allowed to block the pore pathways” or otherwise “interfere[e] in pore creation.” Ex. 2034 ¶¶200-02; Ex. 1010 ¶[0086].

Murakami's broadest particle size range spans from 0.005 to 0.4 μm on the low end to 0.5 to 5.0 μm on the high end, thus requiring at least some particles to be between 0.5 μm and 5.0 μm .¹⁰ Ex. 2034 ¶203 (citing Ex. 1005 ¶[0018]). Example 1 discloses D10:0.22 μm , D50: 0.44 μm , and D90: 1.03 μm . Ex. 1005 ¶[0140]. Example 2 uses D10:0.26 μm , D50:0.66 μm , and D90:1.53 μm . *Id.* ¶[0160]. Thus, even Murakami's smallest particle sizes in the preferred examples are bigger than the largest particle sizes in Beard. A POSITA would have understood that they could not substitute Beard's very small particles with Murakami's larger particles and retain Beard's pore structure or desirable features. Ex. 2034 ¶¶203-06. A POSITA would not be motivated to try because they would recognize that bigger particles would be more likely to "block the pore pathways" and otherwise "interfere[e] in pore creation," two results that Beard teaches a POSITA to avoid. Ex. 2034 ¶¶205-06. Even if a POSITA did try, the resulting pore structure would not be like Beard's (pores delineated by walls made of binder, tightly packed with inorganic particles),

¹⁰ As explained above in Section V.A.3, the particle sizes of Murakami would much smaller than this after the high-pressure dispersion step in Murakami. However, given that Petitioner relies on these larger particle sizes in Murakami for this ground (Pet., 48, 31-32), this section uses the starting sizes reported in Murakami for the purpose of the motivation to combine analysis.

but would be like that of Murakami (pores formed by gaps between inorganic particles). *Id.* ¶205. Indeed, Beard confirms that this would result because that is what happens in the alternative embodiment in Beard (an embodiment a POSITA would not have been motivated to use and a different embodiment than the Fig. 1 embodiment Petitioner relies on) where the particle sizes are “greater than 1 micron”; those larger particles extend through the pore walls (are no longer encompassed by binder like in Beard’s preferred embodiment) and create their own porous network (i.e. pores formed by gaps between particles). *Id.* (citing Ex. 1010 ¶[0086]). In that case, like in Murakami, neither of the pore structure limitations would be satisfied. *Id.*

A POSITA also would not have been motivated to adjust Beard’s pore wall thicknesses to accommodate Murakami’s larger particles because Beard teaches against pore walls that are greater than 0.1 μm . Ex. 2034 ¶206. A POSITA would have understood that trying to change pore wall thickness would negatively affect Beard’s other variables, such as pore size and porosity. *Id.*

As for particle size ***distribution***, Dr. Guido agrees that Beard’s average particle size (D50) must at least fall in the range reported in Paragraph 22 of Beard. Ex. 2033 at 180:15-181:8. Although Beard does not explicitly list a D10 or D90 value, a POSITA would have understood that Beard requires its particles to be smaller than its pore wall thickness. Ex. 2034 ¶¶200-01. Thus, Beard’s maximum particle size

would not exceed Beard's maximum pore wall thickness, 0.1 μm . *Id.*; *see, e.g.*, Claim 1 (requiring "pore wall thickness greater than said **maximum** filler size). This method of reporting an average particle size (D50) with a maximum cutoff (the size of the pore wall thickness) is simply another way to report size distribution. Ex. 2034 ¶¶247-48; *see also, e.g.*, Ex. 1007 ¶ [0058].

A POSITA would have understood that Murakami's reported particle size distribution (D10: 0.005 to 0.4 μm , D50: 0.01 to 1.0 μm , and D90: 0.5 to 5.0 μm) is much broader than the narrow size distribution in Beard (D50 between 0.005 to 0.1 μm and maximum particle size less than pore wall thickness, 0.1 μm). Ex. 2034 ¶203. Like with particle size, using Murakami's broader size distribution means the particles would be too big to accommodate Beard's pore structure and would instead make a different type of pore structure that does not satisfy the claims. Ex. 2034 ¶205. Conversely, if a POSITA were to use the size distribution reported in Beard (D50: 0.005 to 0.1 μm and maximum particle size less than pore wall thickness, 0.1 μm), the resulting combination would not satisfy the claimed size distribution (Dv10: 0.015 to 3 μm , Dv50: 0.2 to 5 μm , and Dv90: 1 to 10 μm). Ex. 2034 ¶204. In that combination, no particles would be bigger than 0.1 μm (or 0.2 μm in Dr. Gido's view) and therefore would at least fall short of Dv90 between 1 to 10 μm . Ex. 2034 ¶205.

Murakami's very small amount of binder is incompatible with the large amount of binder required by Beard. Achieving Beard's pore structure requires a relatively high amount of binder (at least 33% binder/67% filler and up to 67% binder/33% filler by volume). Ex. 2034 ¶207 (citing Ex. 1010 ¶[0029]). This higher amount of binder is what allows Beard to create binder pore walls and fully encapsulate (or coat) its small inorganic particles. Ex. 2034 ¶¶209-10; Ex. 2033 at 212:5-10.

This is not the case in Murakami, which teaches that the less binder used relative to inorganic particles, the better. Ex. 2034 ¶¶207-08; Ex. 1005 ¶[0070]. It is not possible to achieve the pore walls of Beard by using the small amount of binder Murakami requires. Ex. 2034 ¶210. This is especially true considering the larger particle sizes and broader size distribution of Murakami, which would necessarily require even more binder to fully encompass the inorganic particles and create packed binder walls. *Id.*

Murakami's teaching against using solvent substitution is incompatible with achieving Beard's porous structure. As explained above in Section V.A.1, Murakami teaches that a POSITA should *not* use solvent substitution with its preferred examples, but instead should use the simple drying method only. In contrast, Dr. Gido has explained that the pore structure in high-binder references like Beard *requires* the very solvent substitution or phase separation process that

Murakami's Examples 1 and 2 teach a POSITA not to use. Ex. 2032 ¶52; Ex. 2033 at 112:7-15, 120:7-14. A POSITA would not have been motivated to use a solvent substitution process to achieve Beard's structure over Murakami's teaching that doing so is ill-advised for Murakami's particle sizes and distribution in Examples 1 and 2. Ex. 2034 ¶211.

Second, Murakami and Beard have different goals. Murakami's goal is to decrease variability in voidage to improve capacity retention. Ex. 2034 ¶212 (citing Ex. 1005 ¶[0088]). This means avoiding significant irregularities. *Id.* Yet Beard shows an SEM image (in Figure 2) of a highly irregular pore structure. *Id.*; *see also* Ex. 2015 ¶147. That irregularity would mean **increased** variability in voidage in Beard, a result that a POSITA applying Murakami would avoid.¹¹

Moreover, if Dr. Guido is correct that Beard's structure includes inorganic particles that extend into the pores (which it does not for the reasons explained

¹¹ The Board appears to view Fig. 2 as a separate embodiment not relied on by Petitioner. Paper 10, 33. But although Petitioner did not cite Figure 2, this figure still illustrates to a POSITA reading Beard the type of real-world pore structure disclosed in Beard. Moreover, Dr. Guido repeatedly relied on Figure 2 during his deposition to make arguments about Beard. *See, e.g.*, Ex. 2033 at 54:11-55:21, 66:6-18, 67:13-68:19.

above), this would be another reason not to adopt Beard's pore structure. Ex. 2034 ¶213. A POSITA would recognize that inorganic particles extending partially or wholly into pores would *increase* variability in voidage in the porous layer. *Id.* This would directly contradict the main goal of Murakami, which is to *minimize* variability. *Id.* Thus, a POSITA would not be motivated to use a structure where inorganic particles extend into the pores. *Id.*

Finally, a POSITA would not have a reasonable expectation of success. Beard's pore structure relies on many variables, including a particular average particle size (small) and a specific ratio of binder to inorganic particles (large). Ex. 2034 ¶¶214-17. As explained above, changing either or both variables (which one would have to do achieve Beard's structure) means that an entirely different pore structure would result. *Id.* ¶215. Moreover, to the extent Petitioner argues it relies on Beard's teaching of packing inorganic particles tightly into pore walls, while still maintaining the rest of Murakami's teachings, such a combination is impossible. Ex. 2034 ¶216. A POSITA would have understood there is no binder wall in Murakami. *Id.* To follow Beard's packing teaching, a POSITA would have to change Murakami's pore structure to first form binder walls to pack the inorganic particles into. *Id.* Making these changes would require at least changing the inorganic particle sizes to fit into the pore walls of Beard, which are *at most* 0.1 µm. *Id.*; Ex. 1010 ¶[0021]; Ex. 2033 at 71:15-22, 190:4-5. As explained above, this would mean the

combination no longer meets the required particle size distribution requirements (including Dv50: 0.2 to 5 μm and Dv90: 1 to 10 μm). Ex. 2034 ¶216. Also as explained above, there is no reasonable expectation of success in using thicker walls than the maximum disclosed in Beard. *Id.* A POSITA would have recognized that thicker walls would not only require much more binder than Murakami's preferred examples, but also would be more likely to swell in electrolyte and close the pores. *Id.* A POSITA likewise would not have had a reasonable expectation of success in using Beard's thin pore walls (at most 0.1 μm) to hold much larger particle sizes of Murakami (up to at least 5 μm in the general disclosure, 1.03 μm in Example 1, and 1.53 μm in Example 2) because this creates the exact situation Beard warns against: "filler additives [being] allowed to block the pore pathways" or otherwise "interfere[e] with pore creation." *Id.* (quoting Ex. 1010 ¶[0086]). Not to mention that very thin walls of binder would be less effective at holding together such large particles, meaning the particles would be more likely to fall off—an outcome Dr. Gido admits a POSITA would want to avoid. *Id.*; Ex. 2033 at 93:1-94:6. Thus, effectively combining Beard and Murakami to arrive at the claimed invention is not feasible. Ex. 2034 ¶217.

E. Ground 5: Murakami, Beard, and Honda Do Not Render Obvious Claims 3 and 12

Petitioner asserts Murakami, Beard, and Honda render obvious Claims 3 and 12. Pet., 48-56. These claims are not obvious for at least the same reasons noted above with respect to Independent Claims 1 and 10, and with respect to Ground 2. Ex. 2034 ¶¶218-19.

These claims are not obvious for the additional reason that a POSITA would not have been motivated to combine Murakami, Beard, and Honda with a reasonable expectation of success. Beard and Honda disclose incompatible wall thicknesses. Ex. 2034 ¶220; *compare* Ex. 1010 ¶[0022] (“The wall thickness 104 may vary from 0.01 to 0.05 microns, but may vary from 0.001 to 0.1 micron in some areas, depending on the pore size.”) *with* Ex. 1007 ¶[0045] (disclosing thicker pore walls: 0.1 to 2 μm). Neither Petitioner nor Dr. Guido explain which wall thickness a POSITA would use and why. Ex. 2034 ¶220. Nor do they address whether the use of Honda’s thicker walls would mean the particles are even more likely to be fully encapsulated by the binder and not stick out into the pores themselves. *Id.*

F. Ground 6: Murakami, Beard, and Tanaka Do Not Render Obvious Claims 4 and 13

Petitioner asserts Murakami, Beard, and Tanaka render obvious Claims 4 and 13. Pet., 48-56. These claims are not obvious for the same reasons noted above with

respect to Independent Claims 1 and 10, and for all the same reasons presented above with respect to Ground 3. Ex. 2034 ¶¶221-22.

G. Ground 7: Beard and Akiike Do Not Render Obvious Claims 1-3, 5-12, and 14-19

Petitioner asserts Beard and Akiike render obvious Claims 1-3, 5-12, and 14-19. This is not so. Ex. 2034 ¶¶223-24.

In addition to the reasons listed below, this ground fails at least because Petitioner relies solely on Beard to disclose “pores at least comprises a part of the inorganic particles” and does not argue it is satisfied by Akiike. Pet., 60. But, as explained in Section V.D, Beard does not teach this limitation. Ex. 2034 ¶225.

1. Akiike Does Not Disclose or Render Obvious the Claimed Dv10, Dv50, or Dv90 Values

Petitioner relies on Akiike’s examples and non-comparative examples as well as the ranges reported in Paragraphs 31-33 for the claimed Dv10, Dv50, and Dv90 of inorganic particles in the porous layer. Pet., 60-62. But Akiike does not disclose or render obvious these limitations because (1) Akiike’s D10, D50, and D90 are based on particle distributions measured in a slurry encompassing *all* particles, and (2) Akiike’s disclosed D10, D50, and D90 ranges are applicable to organic *and* inorganic non-conductive particles. Ex. 2034 ¶¶226-27.

As to (1), Akiike uses laser diffraction to measure the sizes of particles contained in the slurry. Ex. 2034 ¶¶228-229. In every example and non-comparative

example in Akiike, the slurry used to make Akiike's porous layer is a dispersion of not only non-conductive particles, but also other particles, including the (organic) particulate polymer particles used in Akiike. *Id.* (citing e.g., Ex. 1011 ¶¶[0235], [0238], [0238], and [0241]; *see also id.* ¶[0067], [0241]). *Id.* A POSITA would have understood that laser diffraction methods *cannot differentiate* between particles made of different materials. *Id.* ¶¶230-31. Thus, a POSITA would have understood that the D10, D50, and D90 values constructed from the laser diffraction measurement process in Akiike reflect the size of *all* particles in Akiike's measured slurry, including particulate polymer and any non-conductive particles. *Id.*

Akiike discloses that the particulate polymer in its slurry is 6% by weight the total particles in the slurry (nearly one fifth *by volume* in Example 1, for instance). *Id.* ¶¶ 232-241 (citing, e.g. Ex. 1011 Table 1, [0009], [0235]-[0236]). Thus, a POSITA would have understood that the presence of particulate polymer particles significantly impacts Akiike's reported D10, D50, and D90 values in slurry. *Id.* While Akiike explains the starting size of its particulate polymer is a volume average particle diameter of 50nm to 500nm (0.05 μm to 0.5 μm) (*id.* ¶[0095])—lower than the 0.87 μm D50 value Akiike attributes to the non-conductive particles in Example 1, for example—Akiike does not disclose a D90 value for the particulate polymer alone. *Id.* Thus, a POSITA would have insufficient information to estimate whether the non-conductive particles alone would have a higher or lower particle distribution

that the total particles in the slurry. *Id.* In other words, a POSITA would have understood that Akiike's reported D10, D50, and D90 values reflect the particle sizes of ***all*** particles in Akiike's slurry (not just non-conductive particles) and would have been unable to calculate based on the information in Akiike what the D10, D50, and D90 values are for the non-conductive particles ***alone***.

As to (2), even assuming, *arguendo*, that a POSITA could attribute Akiike's D10, D50, and D90 ranges to the non-conductive particles alone, these ranges still are not size distributions of ***just*** the inorganic particles. Ex. 2034 ¶¶ 242-43. Akiike describes both inorganic particles and organic particles as "non-conductive particles in the porous membrane slurry," and the described particle distributions apply to all non-conductive particles. *Id.* As stated by Dr. Gido, "Akiike teaches the use of 'non-conductive particles' and that '[a]s such non-conductive particles, any of inorganic particles and organic particles may be used.'" Ex. 1003 ¶193 (citing EX1011, ¶[0038]). Akiike therefore teaches that "the inorganic particles and the organic particles may be used [alone or] in combination as non-conductive particles." Ex. 1011 ¶[0042]. When discussing D10, D50, and D90 values for "non-conductive particles in the porous membrane slurry," Akiike does not describe the distribution for inorganic particles alone, so the described values apply to any "non-conductive particles in the porous membrane slurry." Ex. 2034 ¶¶242-43 (citing Ex. 1011 ¶[0031]-[0033]). Thus, a POSITA would have understood Akiike's particle size

distribution ranges in Paragraphs 31-33 encompass not only porous membrane slurries including only inorganic particles, but also slurries including organic particles and slurries including a combination of organic and inorganic particles (in addition to the fact that all slurries also contain particulate polymer, as explained above). *Id.*

2. A POSITA Would Not Have Been Motivated to Combine Beard and Akiike with a Reasonable Expectation of Success

First, a POSITA would not have been motivated to use Akiike's particle size distributions because Beard already teaches a different, narrower distribution. Ex. 2034 ¶¶247-49. As Dr. Gido admits, there are many ways to report particle size distributions. Ex. 2033 at 227:5-230:2. As explained in Section V.D, Beard discloses its particle size distribution by providing an average particle size (D50) and a maximum particle size (pore wall thickness). *Id.* Given that Beard reports a size distribution, a POSITA would have had no reason to look for another reference with a different size distribution. *Id.*

Second, even if a POSITA were to look for a new distribution, a POSITA would not choose Akiike's particle sizes and distribution because they are incompatible with Beard's pore structure and goals. Ex. 2034 ¶¶250-56. Beard teaches its "most optimized" cases are ones with "high levels of porosity" and create "the strongest possible filled polymer system." Ex. 2034 ¶252 (quoting Ex. 1010

¶[0085]). In contrast, Akiike's goal is to improve the "high temperature cycle property" of its porous layer. *Id.* ¶253. A POSITA would have understood that these are different, competing goals. *Id.* ¶¶251-54. For example, Akiike's high temperature cycle property requires maximizing the amount of inorganic particles in the porous layer (because that is the component raising temperature stability), whereas Beard teaches that its "high level of porosity" and "strongest possible filled polymer system" requires significantly increasing the relative amount of binder in the system, which **decreases** the amount of inorganic particles and also the physical strength of the separator. *Id.* ¶¶253-54.

Moreover, a POSITA would have understood that it is impossible to densely pack Akiike's larger, broader range of particles into Beard's thin binder walls, or "polymer system." Ex. 2034 ¶¶250, 252, 254. A POSITA would have known that using Akiike's much larger inorganic particles and broader range would mean that the particles block the pores or otherwise interfere with pore creation, therefore decreasing porosity and doing exactly what Beard teaches against. *Id.*; Ex. 1010 ¶[0086]. Thus, a POSITA looking for a distribution with D10, D50, and D90 would have looked for a **different** reference—one in which D10, D50, and D90 fall within Beard's preferred size requirements (Dv50 between 0.001 μm and 0.1 μm and a maximum size of 0.1 μm). *Id.* ¶254.

The Institution Decision suggests that Beard's "extremely small" particle sizes are not key to achieving Beard's pore structure because "[t]he examples cited by Patent Owner either use the word 'may' or deal with a particular embodiment of Beard." Paper 10, 43. Respectfully, this conclusion overlooks the context of Beard's disclosures and a POSITA's knowledge, which are supported by Dr. Guido's testimony. Ex. 2034 ¶256. As Dr. Guido admits, a POSITA would have understood that Beard reports a *maximum* wall thickness of 0.1 µm and a *maximum* inorganic particle size of (at the very most, in some embodiments) 0.2 µm. Ex. 2033 at 190:4-5, 70:7-71:4. Beard teaches that particle sizes should not exceed maximum wall thickness. Ex. 1010 ¶[0028], Claims 1-20. This is furthered by Beard's teaching that "good results" stem from inorganic particles not being allowed to block the pores or otherwise interfere with pore creation. Ex. 2034 ¶256; Ex. 1010 ¶¶[0064], [0086]. Thus, even if the permissive language in Beard implies that a particle "may" exceed Beard's small sizes, a POSITA would have understood that they *should not* do so. Ex. 2034 ¶256; *InTouch Techs., Inc. v. VGo Communs., Inc.*, 751 F.3d 1327, 1352 (Fed. Cir. 2014) (finding hindsight bias where it focused on the argument "that one of ordinary skill in the art *could* combine these references, not that they *would* have been motivated to do so") (emphasis in original).

Third, a POSITA would not have been motivated to combine Akiike and Beard because they have fundamentally incompatible pore structures. Ex. 2034

¶¶257-63. Dr. Gido agrees Akiike's pore structure is essentially the same as Murakami's because it is just another example of a high particle loading porous layer. Ex. 2033 at 230:7-22. Thus, in Akiike, the pores are formed by gaps between inorganic particles. Ex. 2034 ¶¶260-261; Ex. 1011 ¶¶[0094], [0150]. As explained above, this structure is incompatible with Beard's pore structure, in which the pores are delineated by walls of binder packed with inorganic particles. *See* discussion *supra* at Section V.D; Ex. 2034 ¶¶257-63. Achieving Beard's structure by simply substituting in Akiike's particle sizes and distribution would not be possible for the same reasons described above with respect to Murakami.

Further, Akiike teaches using a "particulate polymer" or a polymer "formed in a particulate shape," such that "the particulate polymer can be bound to the non-conductive particles not through a face contact but through a point contact." Ex. 1011 ¶¶[0094]. This binder in Akiike acts as "little dots of glue" or "sticky jellybeans" that hold the inorganic particles together only at specific contact areas between particles, without coating the surfaces of the particles (as Beard teaches a POSITA to do). Ex. 2033 at 242:22-244:12. Akiike teaches that this structure is better because "pores are formed in the space between the non-conductive particles" and "[t]hus the porous membrane has a porous structure." Ex. 1011 ¶¶[0150]. Akiike explains that this resulting "porous structure" means a membrane that "has excellent mechanical strength," "is able to resist the shrinkage stress," and "usually exhibits

excellent heat resistance.” *Id.* ¶¶[0151]-[0152]. Thus, a POSITA would have been motivated to use Akiike’s high-particle structure over Beard’s structure. Ex. 2034 ¶¶264, 253; Ex. 2031 ¶53 (Dr. Guido explaining “the addition of inorganic particles improves both mechanical strength and high temperature stability”).

Finally, a POSITA would not have a reasonable expectation of success. Ex. 2034 ¶¶265-70. It is impossible to retain Beard’s pore structure while using Akiike’s much larger particles and broader distribution. Ex. 2034 ¶¶266-67. Assuming Petitioner’s view of Akiike’s inorganic particle sizes is correct (which it is not for the reasons discussed in Section V.G.1), Akiike teaches D10: 0.2 to 0.4 μm , D50: 0.5 to 0.9 μm , and D90: 1.0 to 3.0 μm . *See, e.g.*, Ex. 1011 ¶¶[0031]-[0033]. This means ***all*** the particle sizes in Akiike are ***significantly*** larger than the maximum particle size contemplated by Beard (0.1 μm for its preferred embodiments, or at most 0.2 μm). Ex. 2034 ¶267. A POSITA would not have been able to pack these much larger particles into the pore walls of Beard without at least increasing the thickness of the walls to encompass the bigger particles in Akiike (up to 3 μm). *Id.* This is an astronomical increase in Beard’s maximum wall thickness (0.1 μm). *Id.* Moreover, increasing wall thickness by that much would decrease porosity and would require much more binder than is taught by Akiike. *Id.* And, even ***if*** a POSITA did increase Beard’s wall thickness to accommodate the much larger particle sizes of Akiike, the resulting walls would far exceed the claimed wall thickness of ’148

Patent and would run counter to the '148 Patent's teaching that it is important to have thin pore walls. Ex. 2034 ¶268 (citing Ex. 1001 at Claim 3, 5:3-9, and 24:4-8).

Conversely, if a POSITA used Akiike's larger particle sizes and distribution without adjusting the Beard's wall thickness, the resulting pore structure would be Akiike's (not Beard's). Ex. 2034 ¶269. The pores would be formed by gaps between inorganic particles and would not meet the claimed pore structure. *Id.* In addition, a POSITA would not have been motivated to attempt this because they would have understood that trying to hold 3 µm wide inorganic particles, for example, with a 0.1 µm wide binder wall would mean that many more particles are likely to fall out of the binder. Ex. 2034 ¶¶269, 216. It would also lead to inorganic particles blocking the pore pathways, which Beard teaches not to do. *Id.*

H. Ground 8: Beard, Akiike, and Tanaka Do Not Render Obvious Claims 4 and 13

Petitioner asserts Beard, Akiike, and Tanaka render obvious Claims 4 and 13. Pet., 73-75. These claims are not obvious for at least the same reasons noted above with respect to Independent Claims 1 and 10, and for all the same reasons discussed above with respect to Ground 3. Because Murakami and Akiike have similar high particle load structures, Ground 3's reasons apply equally as to why a POSITA would not have been motivated to combine Tanaka with Beard and Akiike. *See* discussion *supra* at Section V.C; Ex. 2034 ¶¶271-76; Ex. 2033 at 230:7-22.

VI. CONCLUSION

Patent Owner respectfully submits that the Board should find all Challenged Claims to be patentable.

Dated: November 25, 2025

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 response complies with the type-volume limits of 37 C.F.R. §42.24(b)(1) because it contains 13,983 words, according to the word-processing system used to prepare this response, excluding the parts of this response that are exempted by 37 C.F.R. §42.24(b) (including a 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: November 25, 2025

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 2031-2054** were served in their entirety on November 25, 2025 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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